MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Environmental modeling

GIScience for Dynamic Environmental Sensors

Silvana Amaral

Bilateral Research Workshop
National Institute for Space Research (INPE) and the Institute for Geoinformatics (ifgi), University of Münster

March 12, 2009

Environmental modeling

- “Environmental”
- Modeling
- Questions

amazônia

Projeto GEOMA

Rede Temática de Pesquisa em Modelagem Ambiental da Amazônia

- GEOMA Network

("Rede Cooperativa de Modelagem Ambiental")

  - Cooperative Network for Environmental Modeling
  - Ministry of Science and Technology
  - INPE/OBT, INPE/CPTEC, LNCC, INPA, IMPA, MPEG

- Long-term objectives - Phase I

  - Develop computational - mathematical models to predict the spatial dynamics of ecological and socio-economic systems at different geographic scales, within the framework of sustainability
  - Support policy decision making at local, regional and national levels, by providing decision makers with qualified analytical tools.
  - LUCC, Data Base, Human Dimension, Wetlands, Climate, Physical processes, Biodiversity.

geoma · Museu Paraense Emílio Goeldi · Laboratório Nacional de Computação Científica · INPE · INPA Instituto Nacional de Pesquisas da Amazônia · impa · CBPF · FINEP · Ministério da Ciência e Tecnologia · Brasil Um País de Todos Governo Federal

GEOMA Biodiversity

- Biodiversity & Conservation planning
  - Systematic Planning for Conservation
  - Species Distribution Models
  - Economic interest species Population Dynamic

ATUALIZAÇÃO DAS ÁREAS PRIORITÁRIAS PARA CONSERVAÇÃO, UTILIZAÇÃO SUSTENTÁVEL E REPARTIÇÃO DE BENEFÍCIOS DA BIODIVERSIDADE NO BIOMA AMAZÔNIA

ARPA

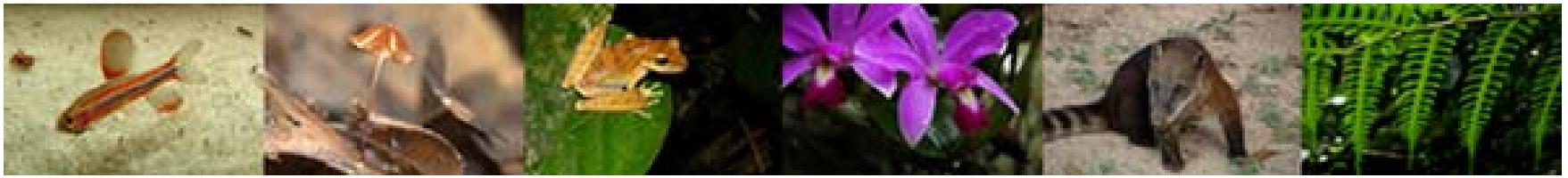
Biodiversity

Biological diversity or Biodiversity

Totality of genes, species, and ecosystems of a region Or Variation of life at all levels of biological organization

- Variability of Genetic Resources
- Economic interest
- Human demands and presence
- Climatic changes

- How to measure ?
- Strategies for conservation?

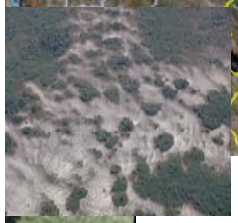


AMAZONIA

5 million km^2

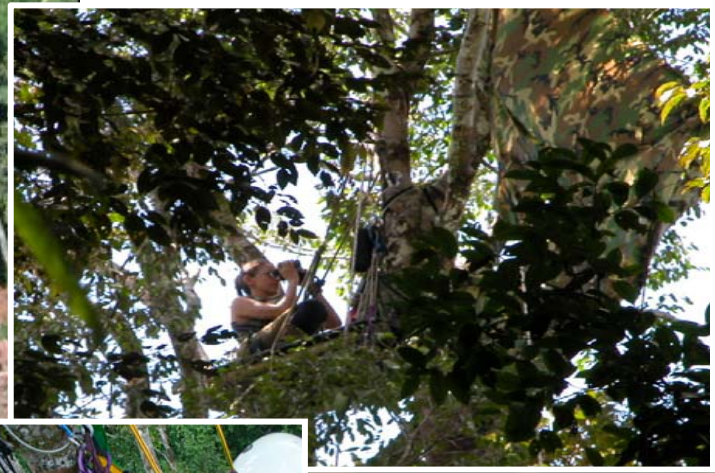
AMAZONIA

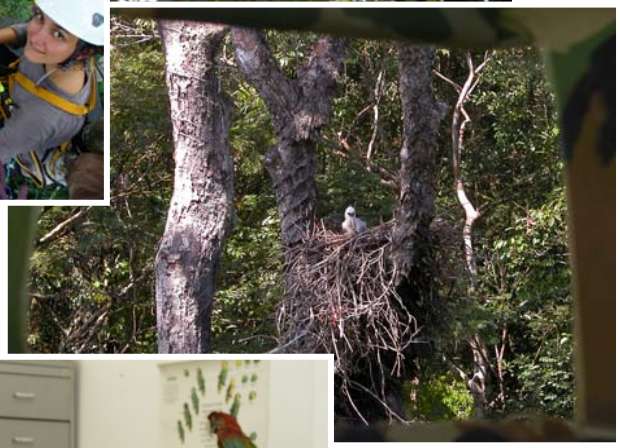
4 million km^2 of forest



Photos by Cohn-Haft, 2006

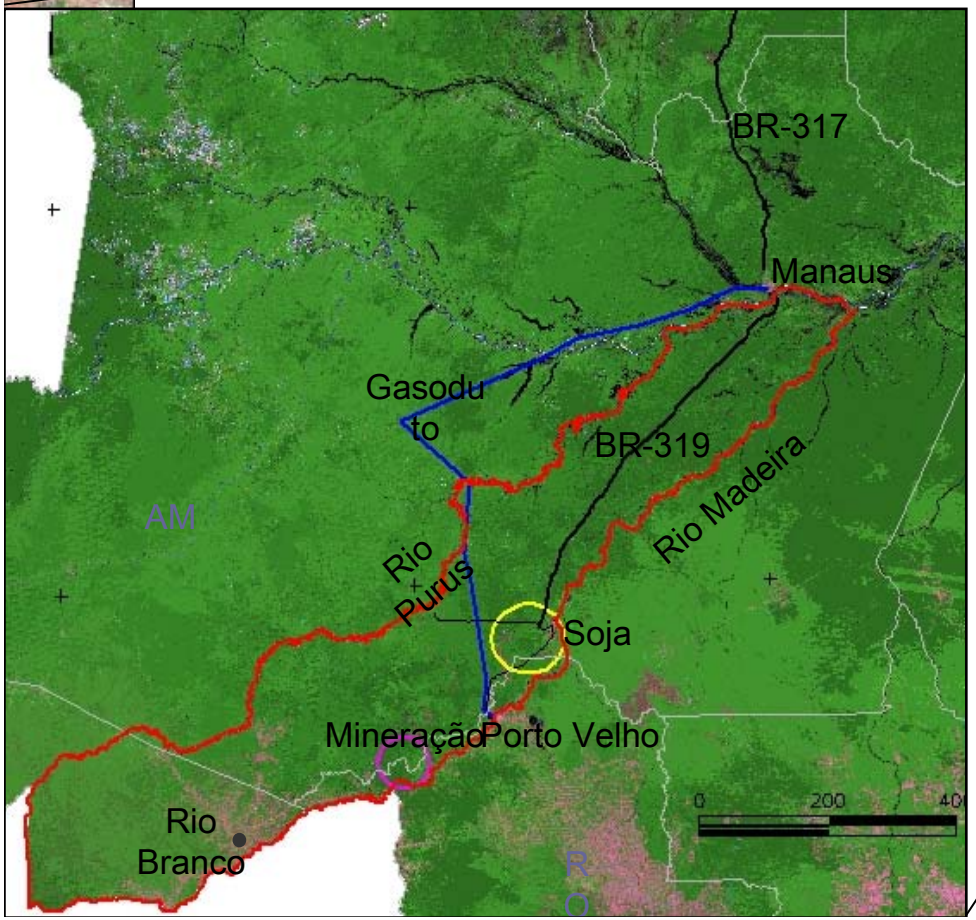
Field Work

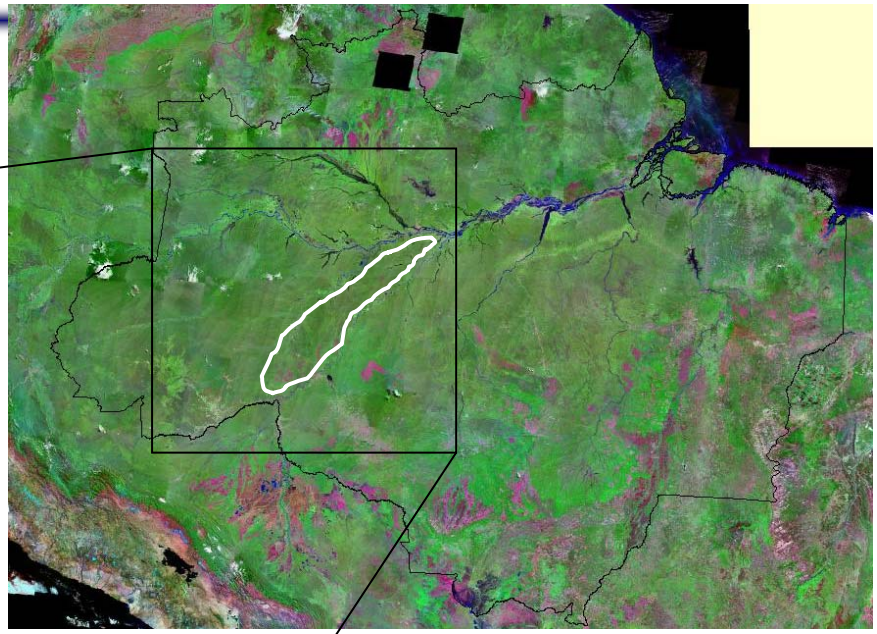




GEOMA Biodiversity – Field Data

- Field Work
  - Madeira - Purus rivers
  - BR-319 road
  - Human pressure

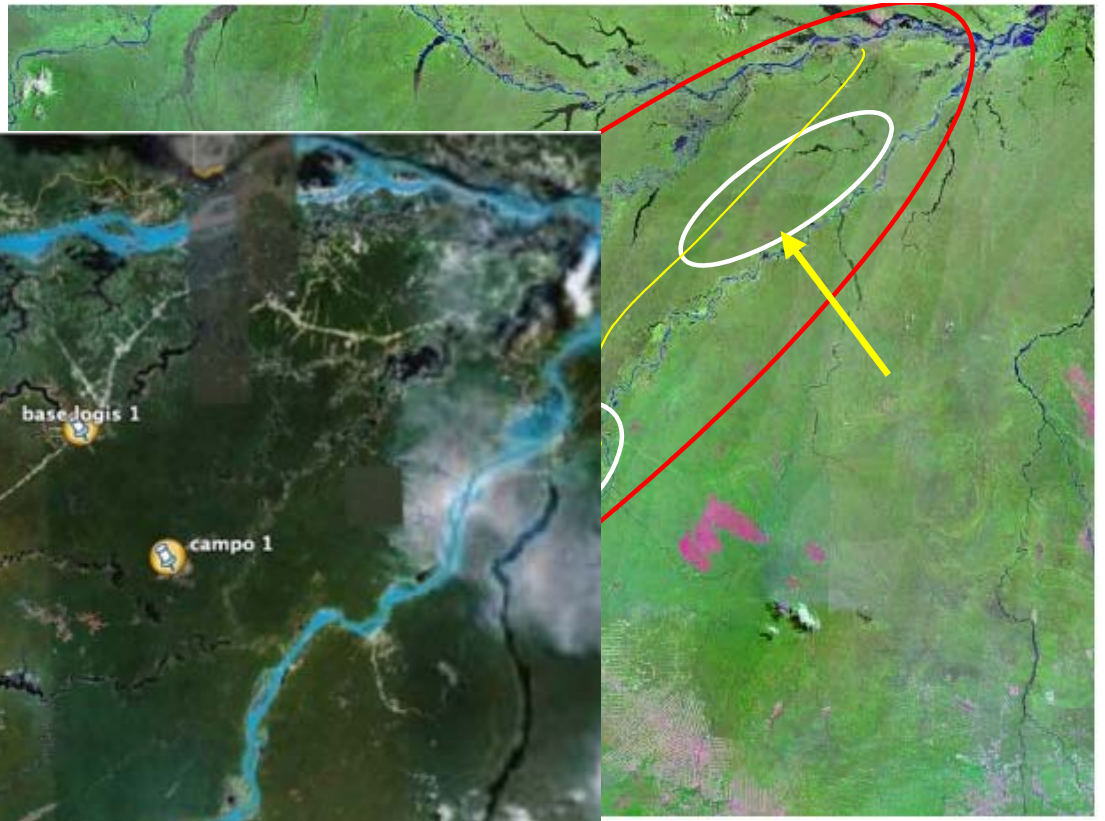




Photos by Cohn-Haft, 2006

GEOMA Biodiversity – Field Data

- Field Work:(23 researchers) birds, fishes, insects (bee,butterfly), arthropods (spiders), mammals, lizards, vegetation (palm trees), landscape.

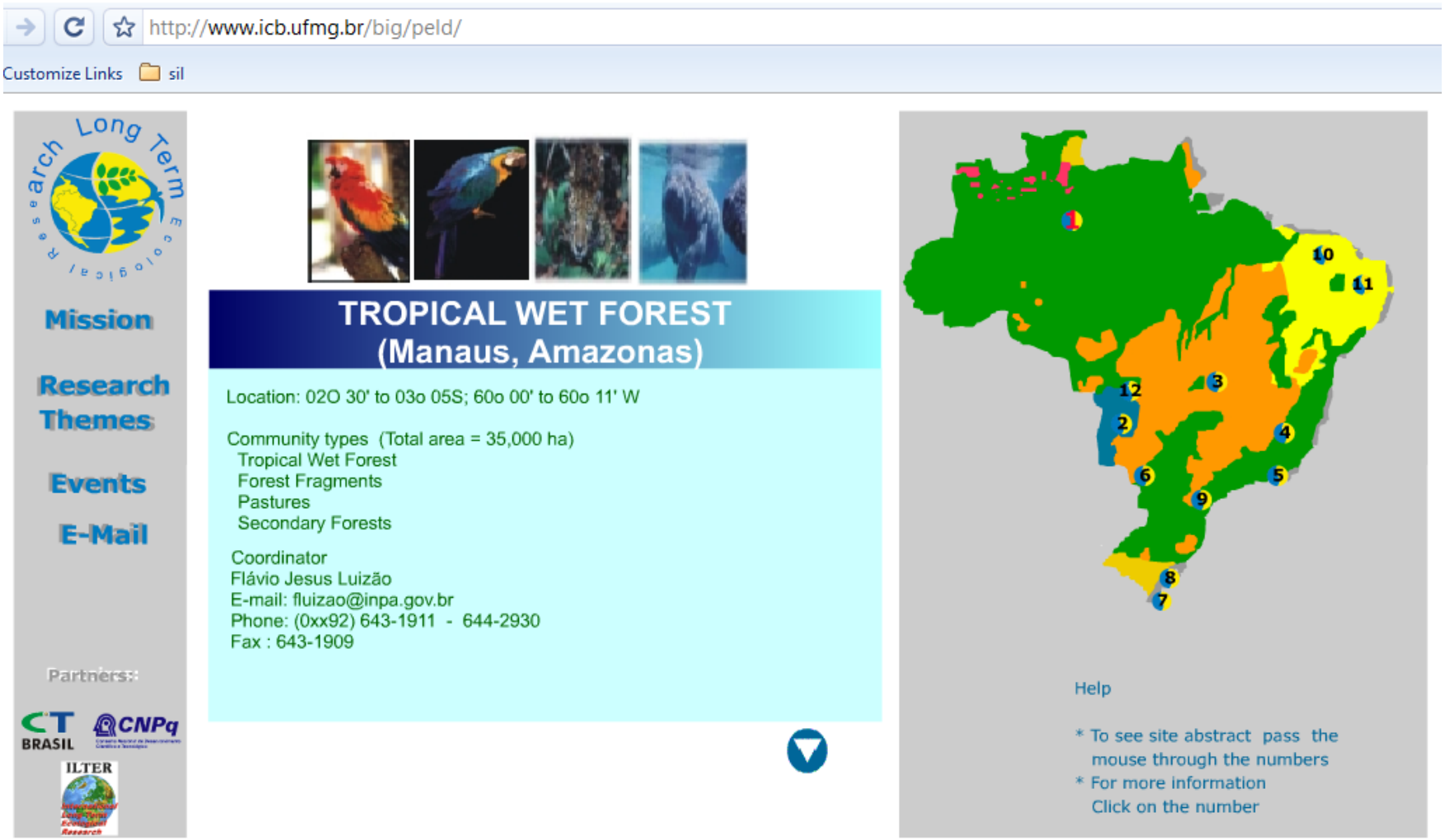


GEOMA Biodiversity – Field Data

- Field Work:(23 researchers) birds, fishes, insects (bee,butterfly), arthropods (spiders), mammals, lizards, vegetation (palm trees), landscape.

  - Several students, thesis and papers
  - Almost all $$ for the component
  - 3 points sampled – Modeling??
  - How to “extrapolate” point data (plots) for some region?
  - Environmental variables could be collected at regular temporal and/or spatial base sensors (light, moisture, canopy cover, etc.) ?

Field Work - Existed data - Plots (permanents)



PPBio

Research Program in Biodiversity

ngua/language | ppbio english | inventories | collections | t. projects

você está aqui: página inicial » metadata and data

navegação

- Página Inicial
- About the Program
- Biological Collections
- Biological Inventories
- Thematc Projects
- International PPBio
- Regional Hubs
- Research Sites
- Identification Guides
- Metadata and Data
- Publications
- Get in Touch

acessar

Usuário

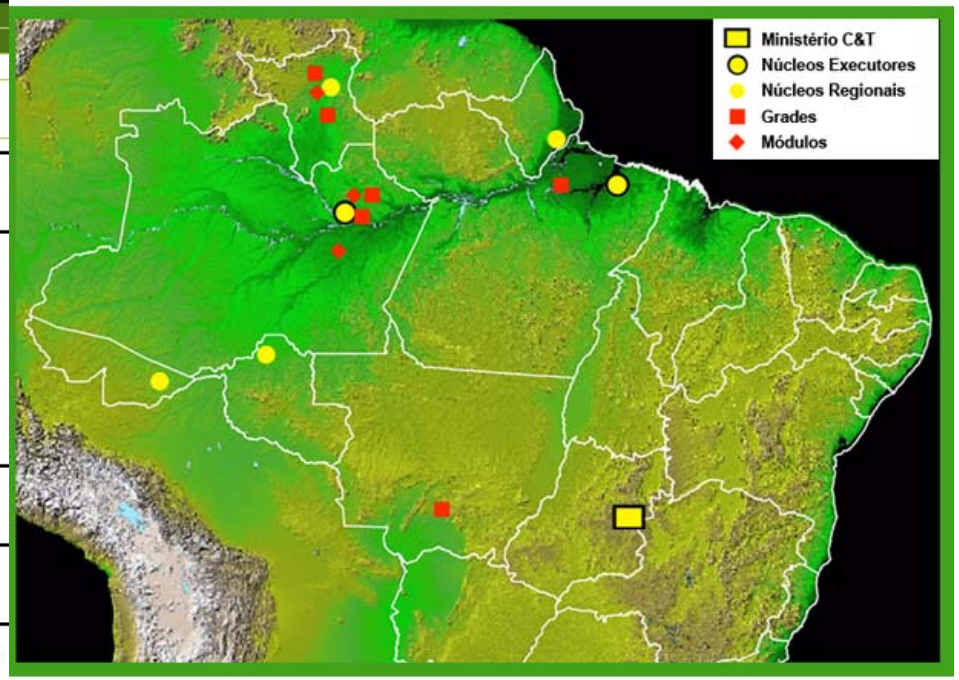
Senha

acessar

Esqueceu sua senha?

Information - Metadata and Data

Hubs	Research Sites
Amazonas	Modules BR-319 BDFFP Reserve Uatumã Biological Reserve Reserve Ducke
Australasia	Brisbane
North Pantanal	Pirizal
South Pantanal	Fazenda Experimental Nhumirim
Pará	Caxiuanã National Forest
Roraima	Água Boa - EMBRAPA RR Cauamé - UFRR Maracá Ecological Station Viruá National Park



MCT -- NEX - Manaus (INPA) -- NEX - Belém (MPEG) -- NR - Acre -- NR - Amapá -- NR - Rondônia -- NR - Roraima -- Água Boa-UFRR -- BR-319 -- Cauamé-EMBRAPA -- ESEC Maracá -- FLONA Caxiuanã -- Pantanal Norte -- Pantanal Sul -- PARNA Viruá -- PDBFF -- REBIO Uatumã -- Reserva Ducke

rainfor

Amazon Forest Inventory Network

| Project | Partners | Field Sites | Training | Publications | Manuals | Contact | Links |

RAINFOR News

March 2009
Science paper "Drought Sensitivity of the Amazon Rainforest"
Press release

November 2008
Oeco "Amazônia invade a academia britânica"

September 2008
NERC Features & special reports "Amazonia: pathways to policy-makers"

August 2008
Los Amigos forest ecology training workshop

Welcome to the RAINFOR Website

The Amazon Forest Inventory Network is an international network that has been established to understand the biomass and dynamics of Amazonian forests. Since 2000 we have established a systematic framework for long-term monitoring of this region, which holds more biodiversity, water, and vegetation carbon, than any other region of the planet. RAINFOR has worked step-by-step, including partners across the nations of Amazon, taking account of the potentially strong modulating role of environmental variables like soil nutrition, and the need to help develop a new generation of Amazon ecologists. RAINFOR is curently supported by the Andes and Amazon Initiative of the *Gordon and Betty Moore Foundation*.

English | Español | Português

Biovidersity data – Collections

Tropicos

Home Names Specimens References Images More▼ MOBOT Sign In | Login

TROPICOS was originally created for internal research but has since been made available to the world's scientific community. All of the nomenclatural, bibliographic, and specimen data accumulated in MBG's electronic databases during the past 25 years are publicly available here. This system has over one million scientific names, 3.4 million specimen records, 111,000 bibliographic citations, and more than 70,000 images of living plants and specimens.

Please continue to use the feedback link (Send feedback) at the bottom of the pages to submit suggestions, bug reports, and feature requests. We are not able to personally respond to all of the messages, but we do e can.

Search Search Exact

Caption: Flowers
Name: Passiflora nitida Kunth
Specimen: Solomon, James Clinton - 3434

Links:
arch
nicus digital library
logical Research
as

en. 01 Oct 2008 <http://www.tropicos.org>.

evard - Saint Louis, Missouri 63110

ssic Tropicos

THE NEW YORK BOTANICAL GARDEN

International Plant Science Center

The C. V. Starr Virtual Herbarium

Science Home ... Virtual Herbarium ... Virtual Herbarium

The C. V. Starr Virtual Herbarium, is the electronic gateway to the collections of the William and Lynda Steere Herbarium. The goals of the Virtual Herbarium are to make specimen data available electronically for use in biodiversity research projects; to reduce shipping of actual specimens for projects where digital representations will suffice for study; and to reunite data elements (e.g., photographs and drawings, manuscripts, published works, microscopic preparations, gene sequences) derived from a specimen with the catalog record for that specimen.

The digital collections of the Virtual Herbarium, comprising approximately 1,300,000 herbarium specimens and 225,000 high-resolution specimen images, are updated daily as the Garden pursues the goal of digitizing all of its 7,300,000 plant and fungi specimens.

A C. V. Starr Virtual Herbarium Sampler

History of the Virtual Herbarium

A Summary of Databasing Projects

Collectors Represented in the Herbarium

A Guide for Use of The C. V. Starr Virtual Herbarium

Treatment of Endangered and Threatened Plant Species

Specimen Showcases

New Projects

Catalog of Vascular Plant Species of Central and Northeastern Brazil
The Flora Borinqueña Digital Herbarium and Library

Electronic Floras and Monographs

The Lecythidaceae Pages
Plants and Lichens of Saba
Flowering Plants of the Osa Peninsula, Costa Rica
French Guianan e-Flora Project

Online Specimen Catalogs

Comprehensive Catalogs

Search All Catalogs

Additional Information

We are interested in comments from users and suggestions for additional features and functions.

For more information, please contact:

Barbara Thiers
Herbarium Director
bthiers@nybg.org
About Barbara Thiers

The New York Botanical Garden's new Digital Imaging Center

Policy regarding the Use of The C. V. Starr Virtual Herbarium Plant Images

Digital Plant Research Center

Biovidersity data

Species distribution data

- Herbarium

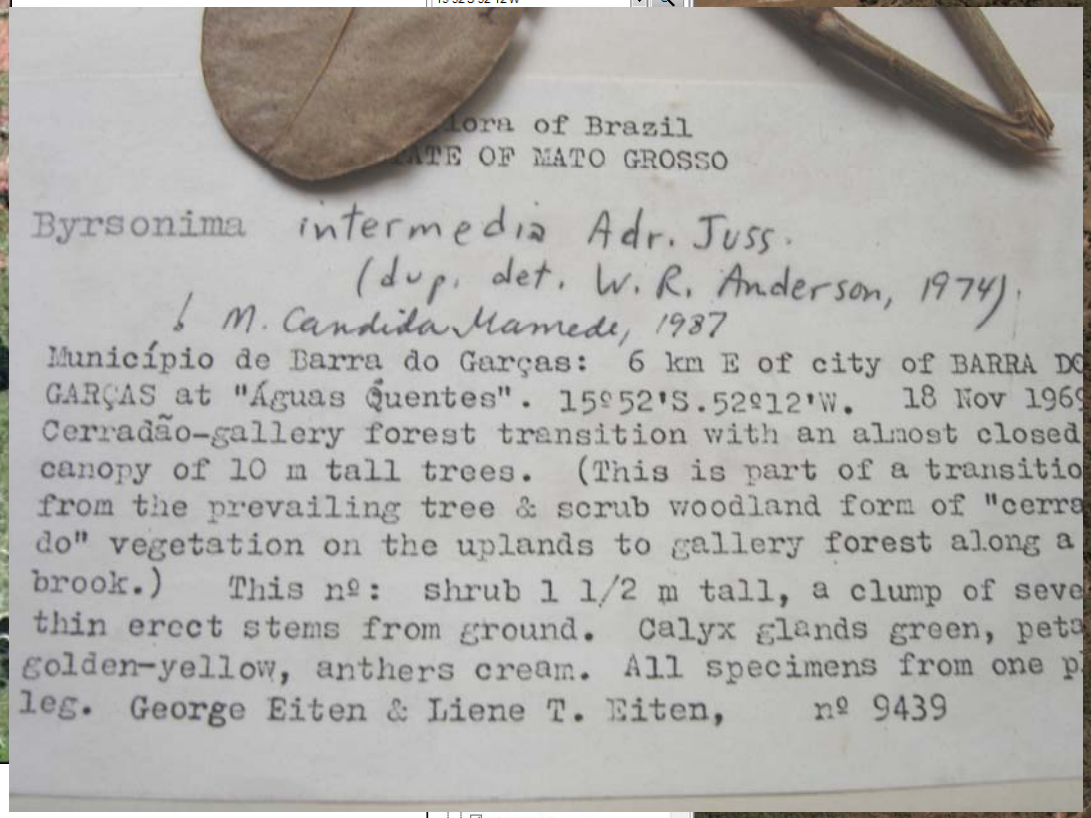
- Classification system
- Family, gender, specie
- Lockers

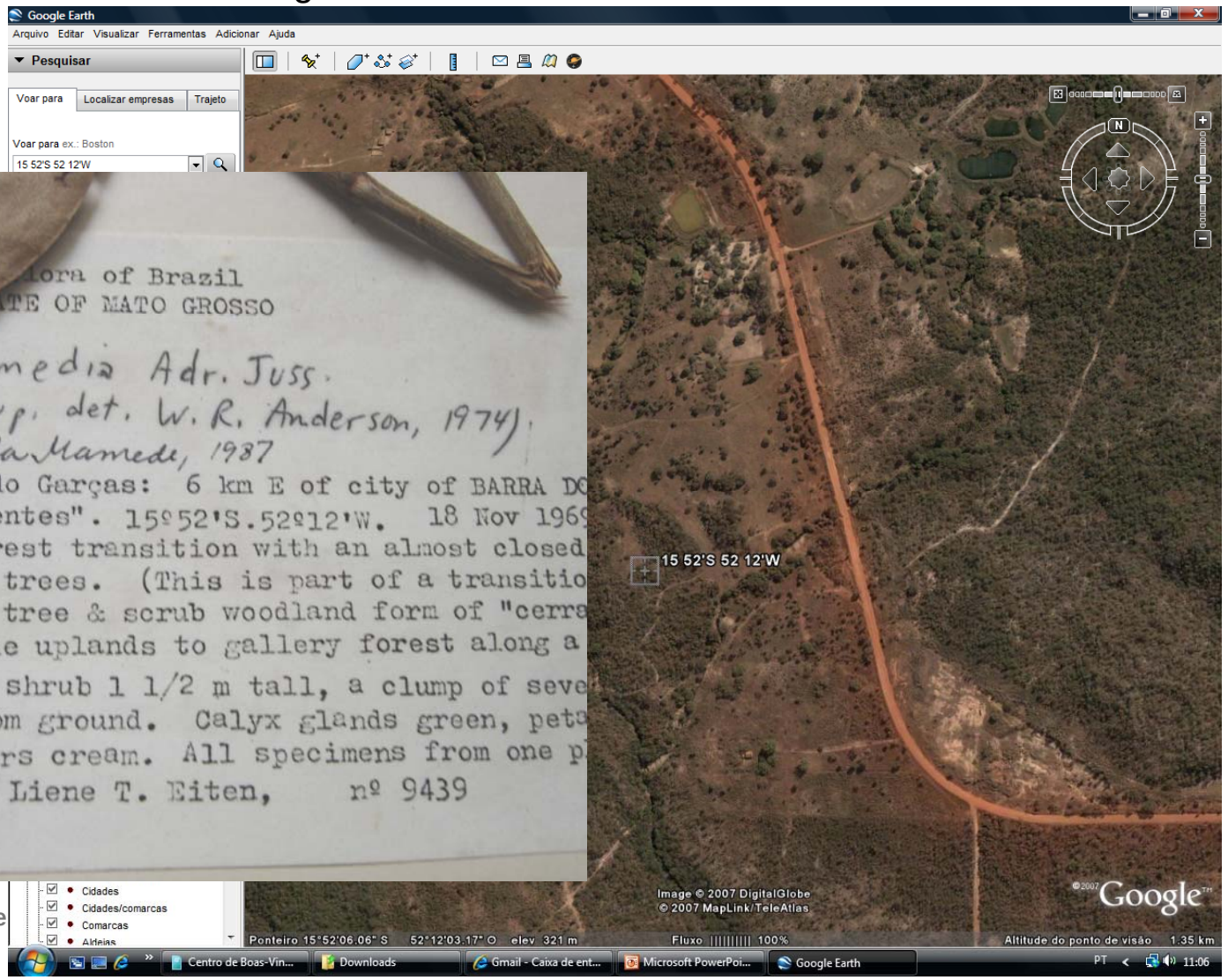
Excicata

- Herborization
- Species distribution – time and space
- Flora from preserved and alterated are
- Taxonomy and phylogeny studies
- Precise identification
- Associated Colections

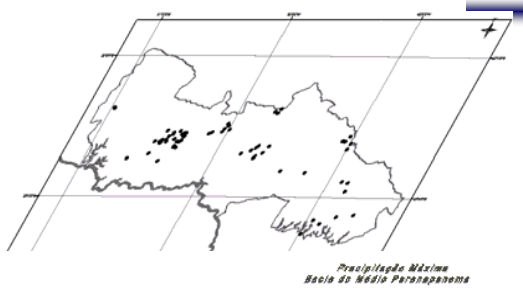
Species distribution data

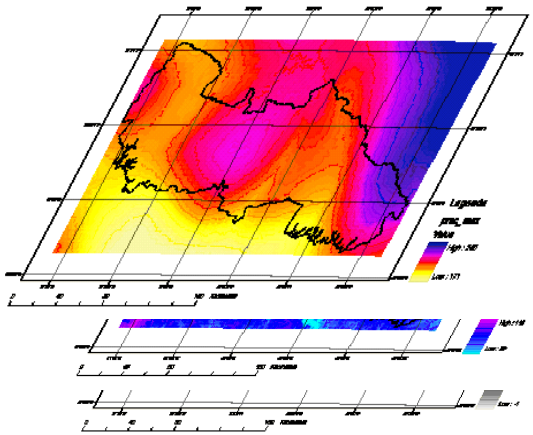
- Lables – information – geo-referenced
- Type

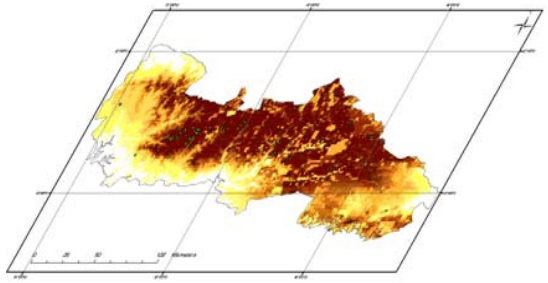




The Ecological Niche modeling process







Algorithm

specimen collection data

locality data

environmental variables

temperature

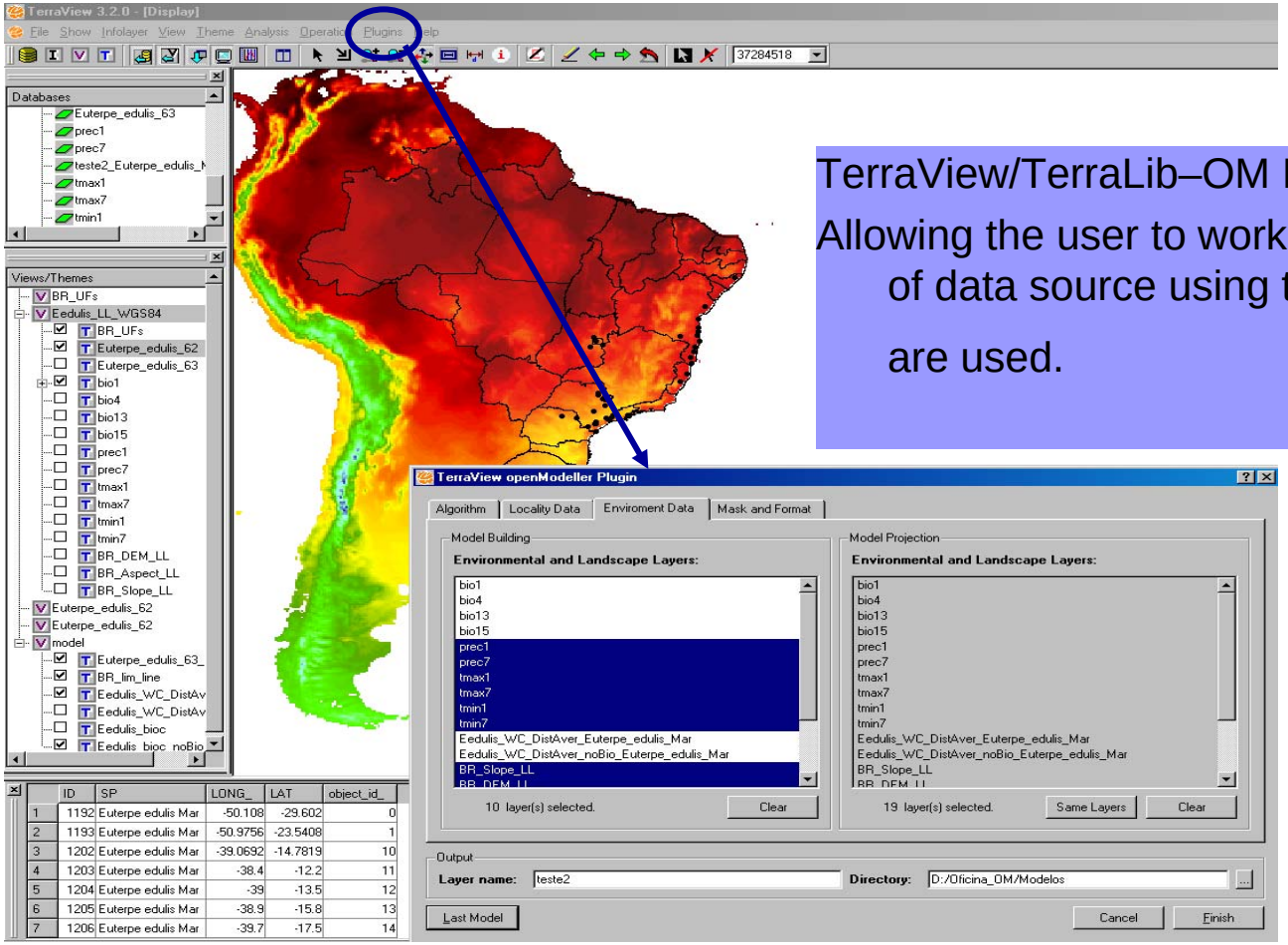
precipitation

topography

species distribution model

Distributional Prediction

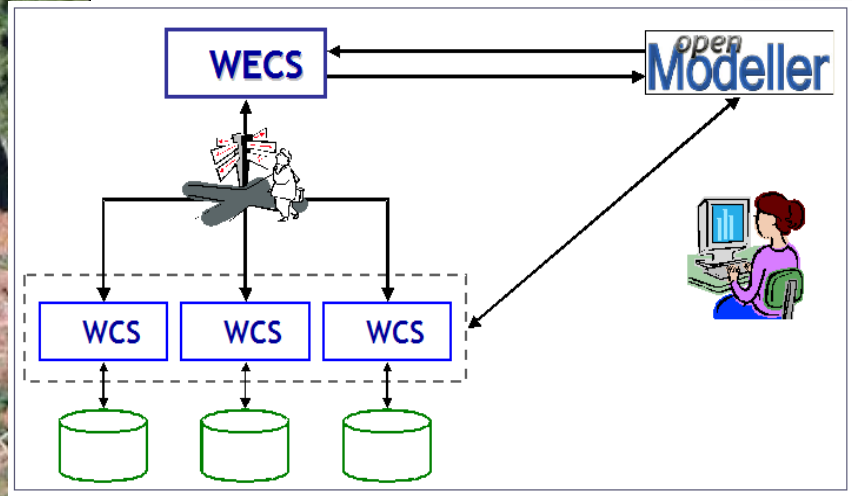
GIS integration – loose coupling

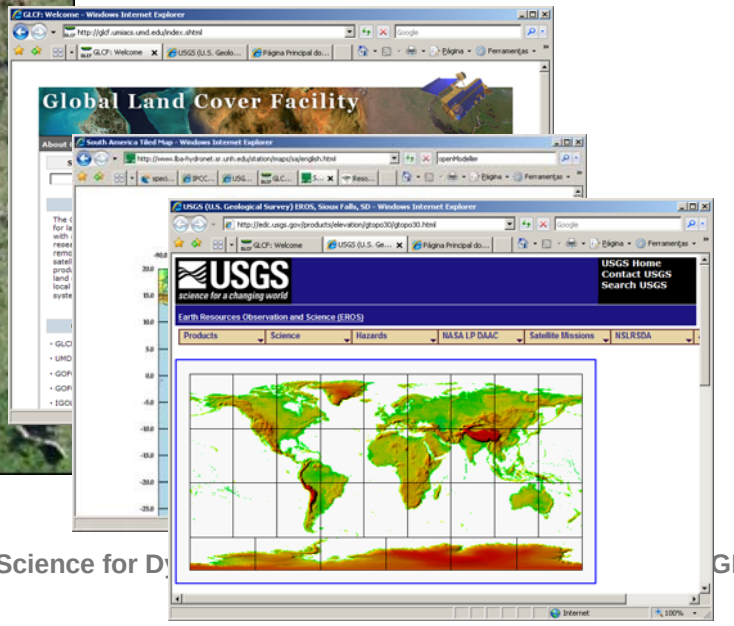


TerraView/TerraLib–OM Plugin:

Allowing the user to work with the concept of data source using the tools that they are used.

Environmental Data





Alexandre Jardim is a Master student, working on creating a *Web Environmental Catalogue Service*:

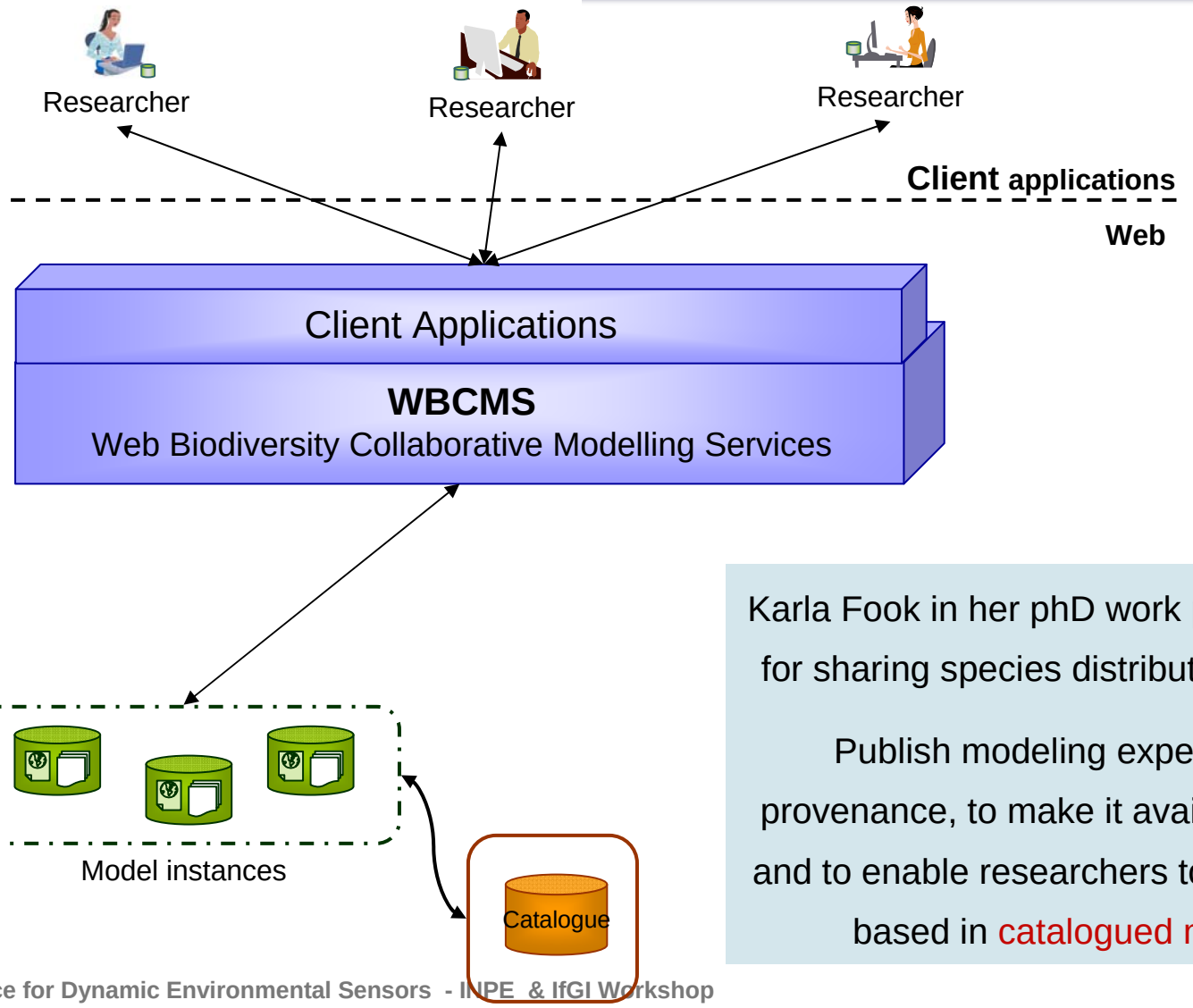
- an ontology for environmental data for the domain of SDM

- a WS that identifies data sources exporting data as WCS; makes a mapping between its metadata and the SDM ontology

- a client interface to the WECS and openModeller

- evaluate the WCS specification for the SDM domain

Sharing modeling experience

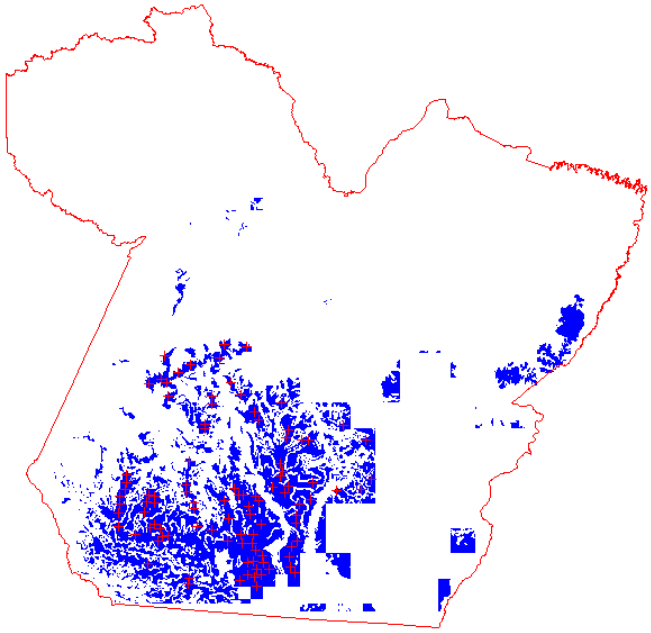


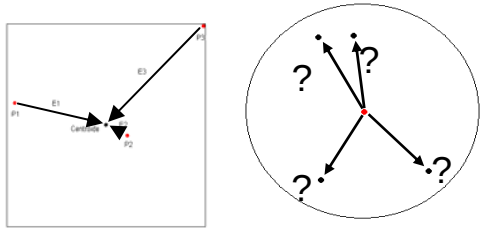
Karla Fook in her phD work proposes an approach for sharing species distribution modeling on Web

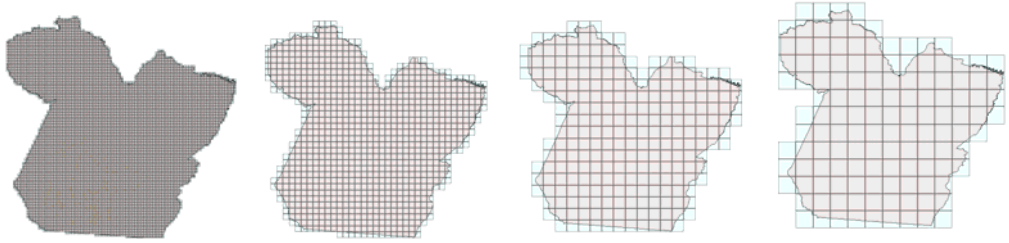
Publish modeling experiments and their provenance, to make it available into catalogues, and to enable researchers to perform new models based in catalogued model instances

Model Sensibility to input data positioning errors

- Fundamental Niche simulation: Non-restrict distribution, continuous, and typical from Amazon
  - 100 “GPS” points
- Positioning error simulation
  - Cell centroid
  - Polar coordinates
  - Errors up to 10 km; 0,25º; 0,5º; 1º

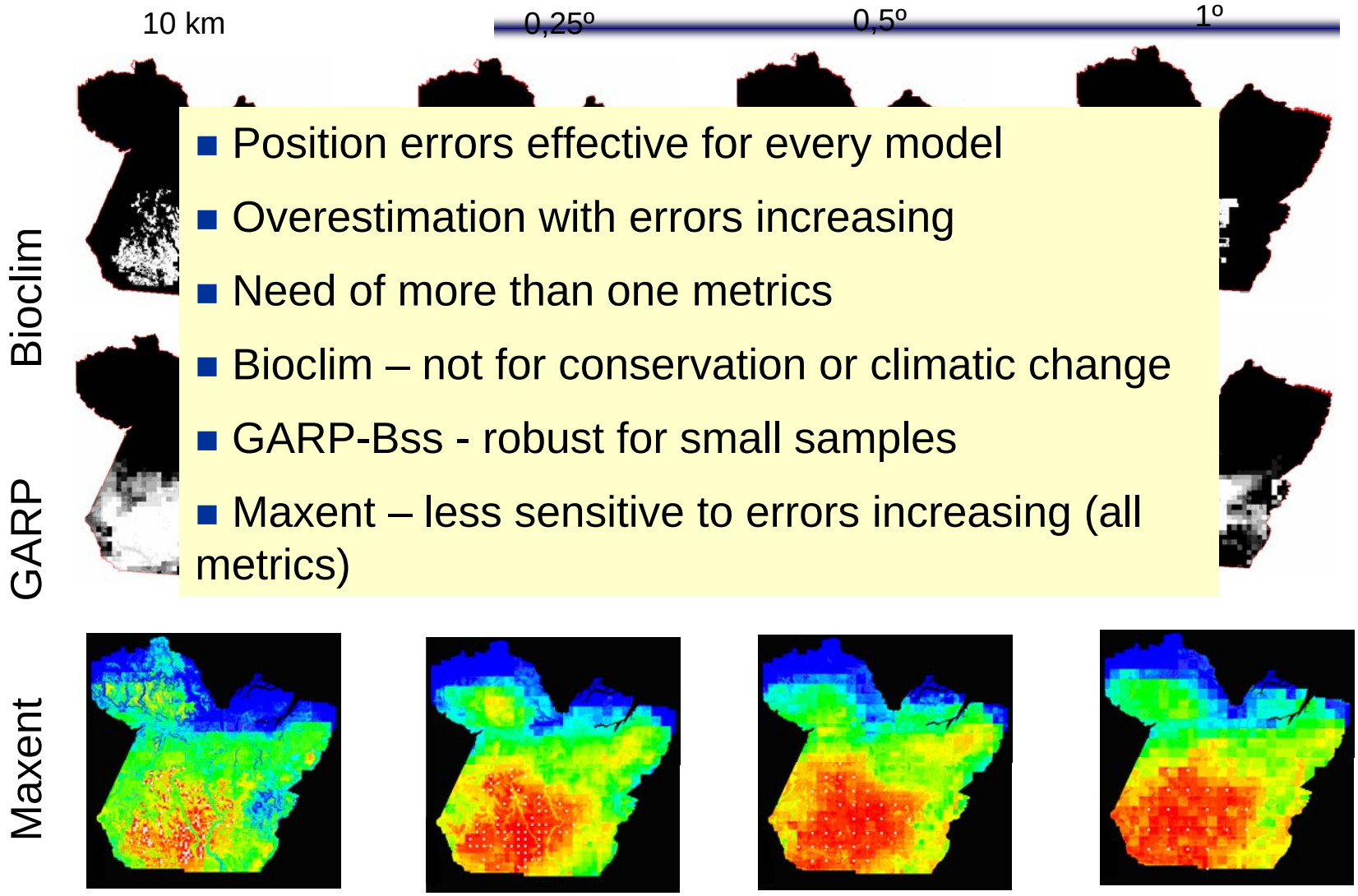






Fábio Iwashita – MsC

Model Sensibility to input data positioning errors

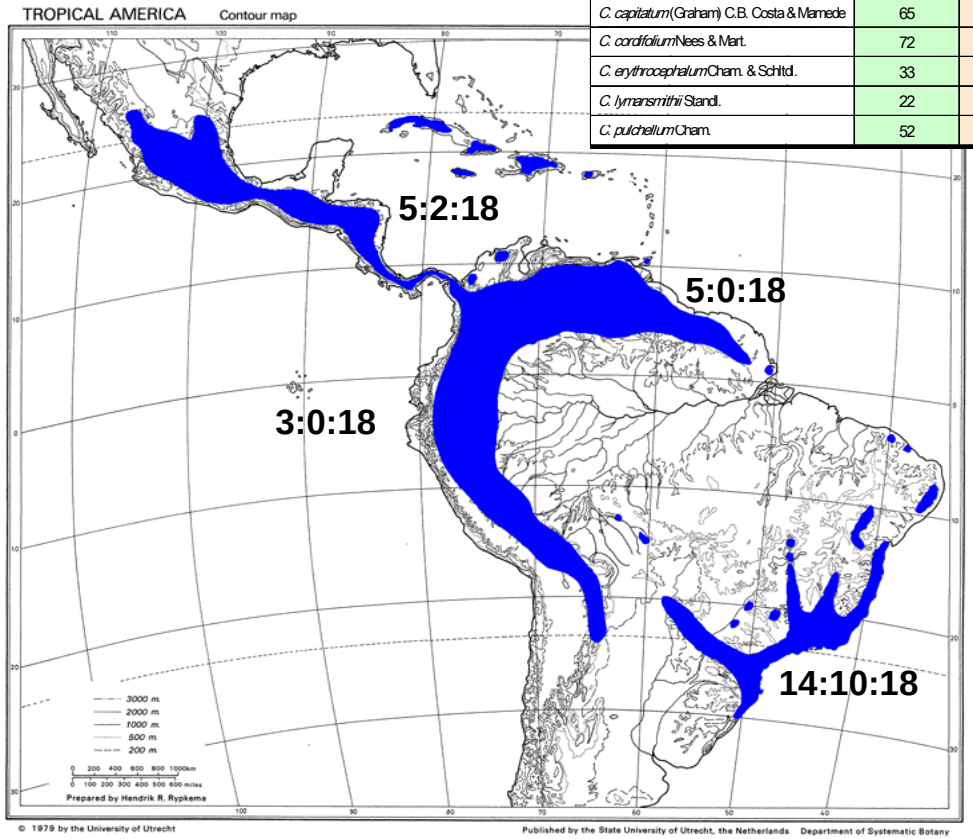


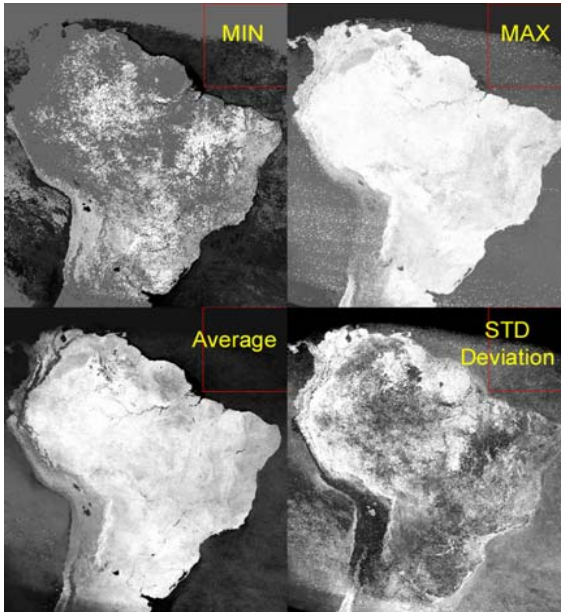
- Position errors effective for every model
- Overestimation with errors increasing
- Need of more than one metrics
- Bioclim – not for conservation or climatic change
- GARP-Bss - robust for small samples
- Maxent – less sensitive to errors increasing (all metrics)

RS and Species Distribution Modeling

Studied species	Training points	Evaluation points	
	Presence	Presence	Absence
C. capitatum (Graham) C.B. Costa & Mamede	65	15	15
C. cordifolium Nees & Mart.	72	16	16
C. erythrocephalum Cham. & Schltdl.	33	8	8
C. lymansmithii Standl.	22	5	5
C. pulchellum Cham.	52	12	12

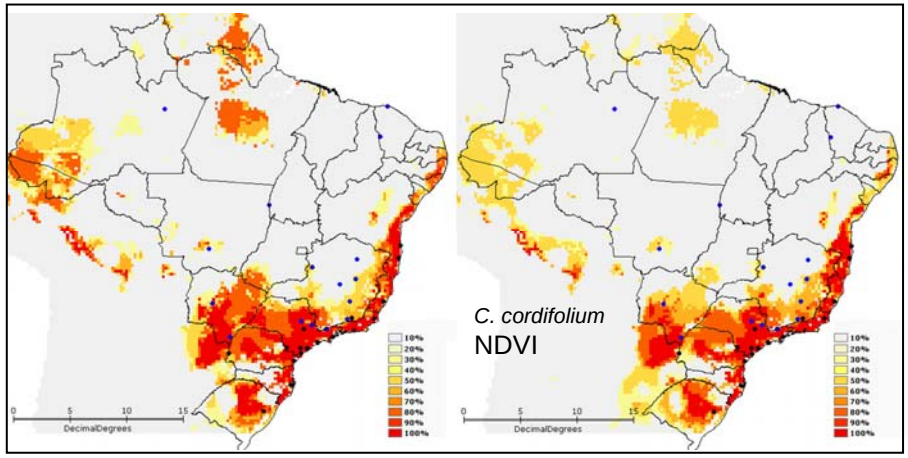
Nature	Variables	Resolution (Degree)	Source	Date
Clima	Maximum temperature Minimum temperature Average temperature Precipitation Bioclimatic variables	0.25	Weather stations WordClim Project	Average monthly climate data from 1950-2000 series
Relieve	Elevation Slope Aspect	0.0089	SRTM NASA	2000 imagery
Vegetation RS	Maximum NDVI Minimum NDVI Average NDVI Standard deviation NDVI	1.0	AVHRR-17 NASA/CPTEC	Fortnightly mosaic 2005

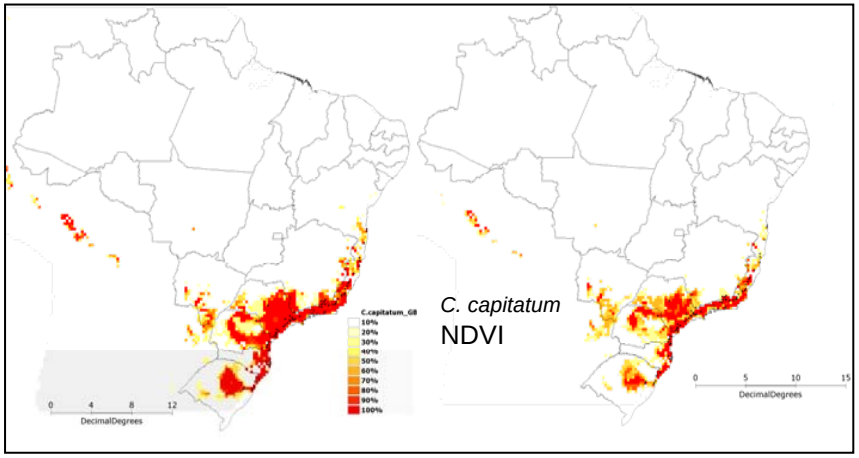


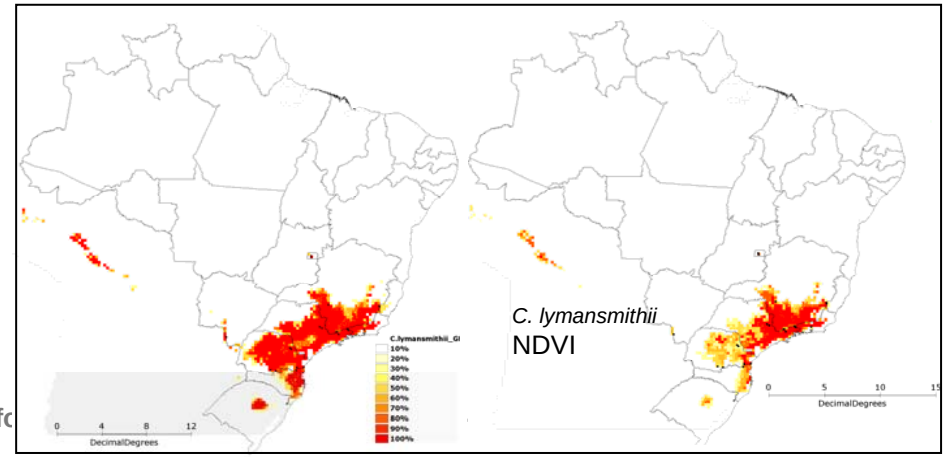


Amaral, Costa e Renó, 2007

RS and Species Distribution Modeling



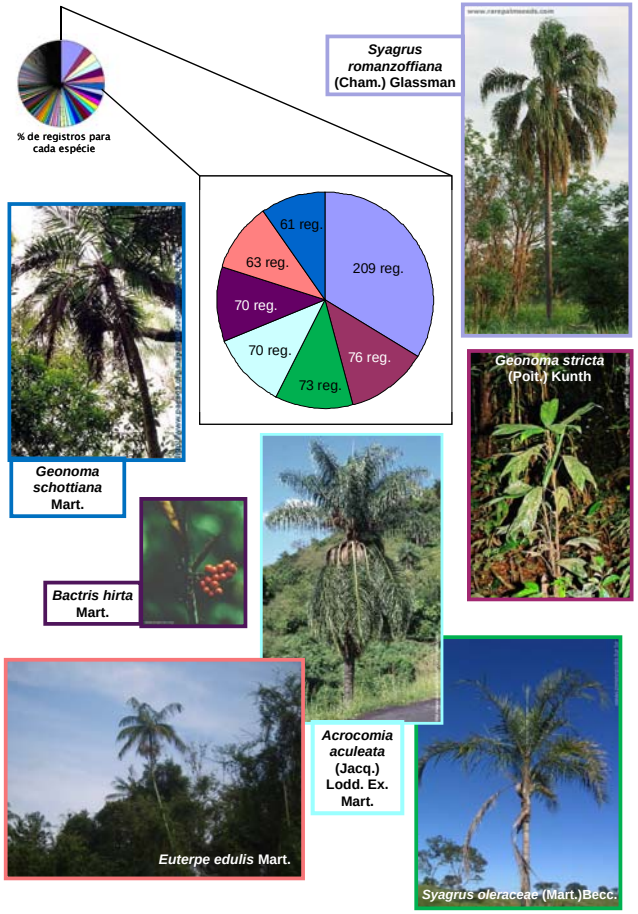


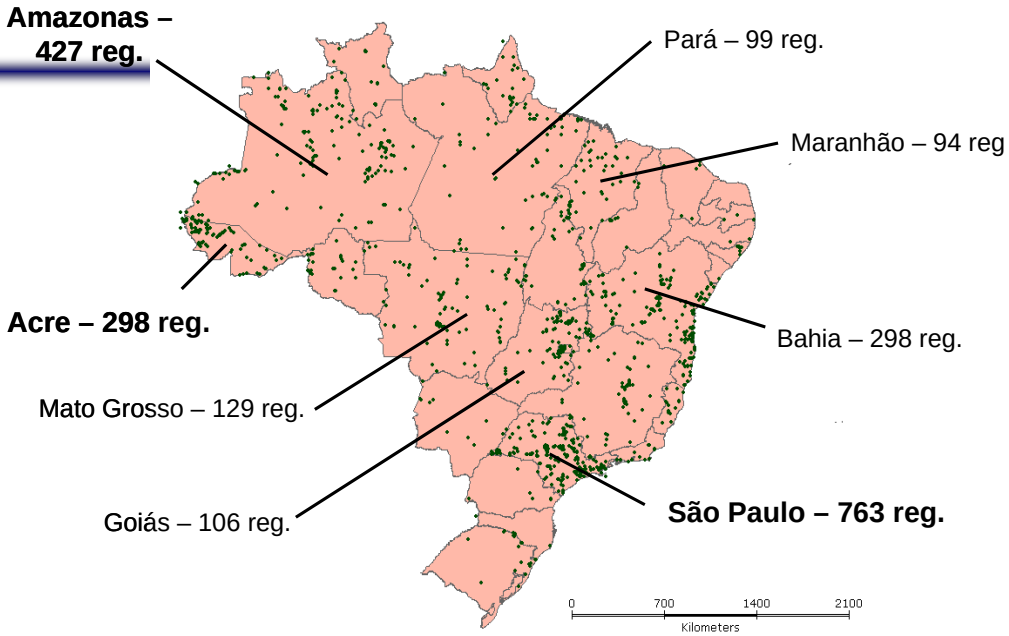


Specie	Kappa		Mann-Whitney (U Statistic)			
	no NDVI	NDVI	no NDVI	NDVI	Critical value (α =5%)	N
C. lymansmithii	0.8	0.8	7.5	7.5	2	5
C. erythrocephalum	0.5	0.5	21.5	22.5	12	8
C. pulchellum	0.83	0.83	**16***	**15***	37	12
C. capitatum	0.6	0.53	**55***	**48.5***	64	15
C. cordifolium	0.75	0.56	**46.5***	**36***	75	16

Species Distribution Modeling

- Data Base – Arecaceae
- RS data





✓ 9524 records, with 3360 records with geographical coordinates;

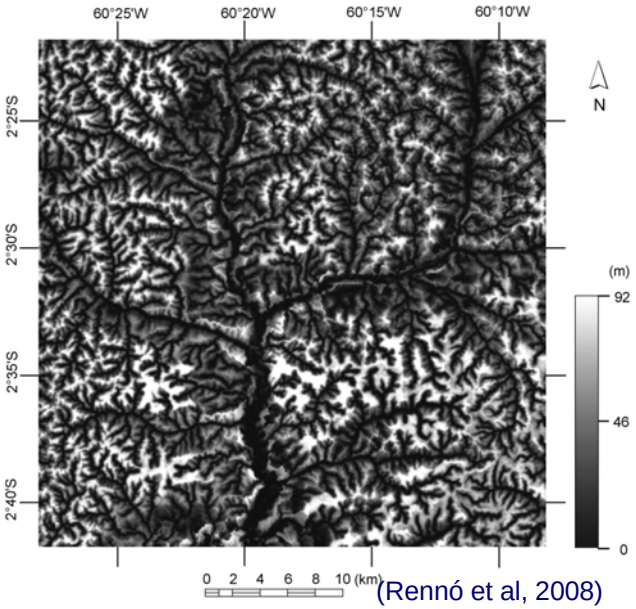
✓ 2637 records after corrections (errors: sea coordinates, duplications, and taxonomy);

✓Richer genders: Bactris (38spp.), Geonoma (37), Syagrus(25), Attalea (22) e Astrocaryum (13).

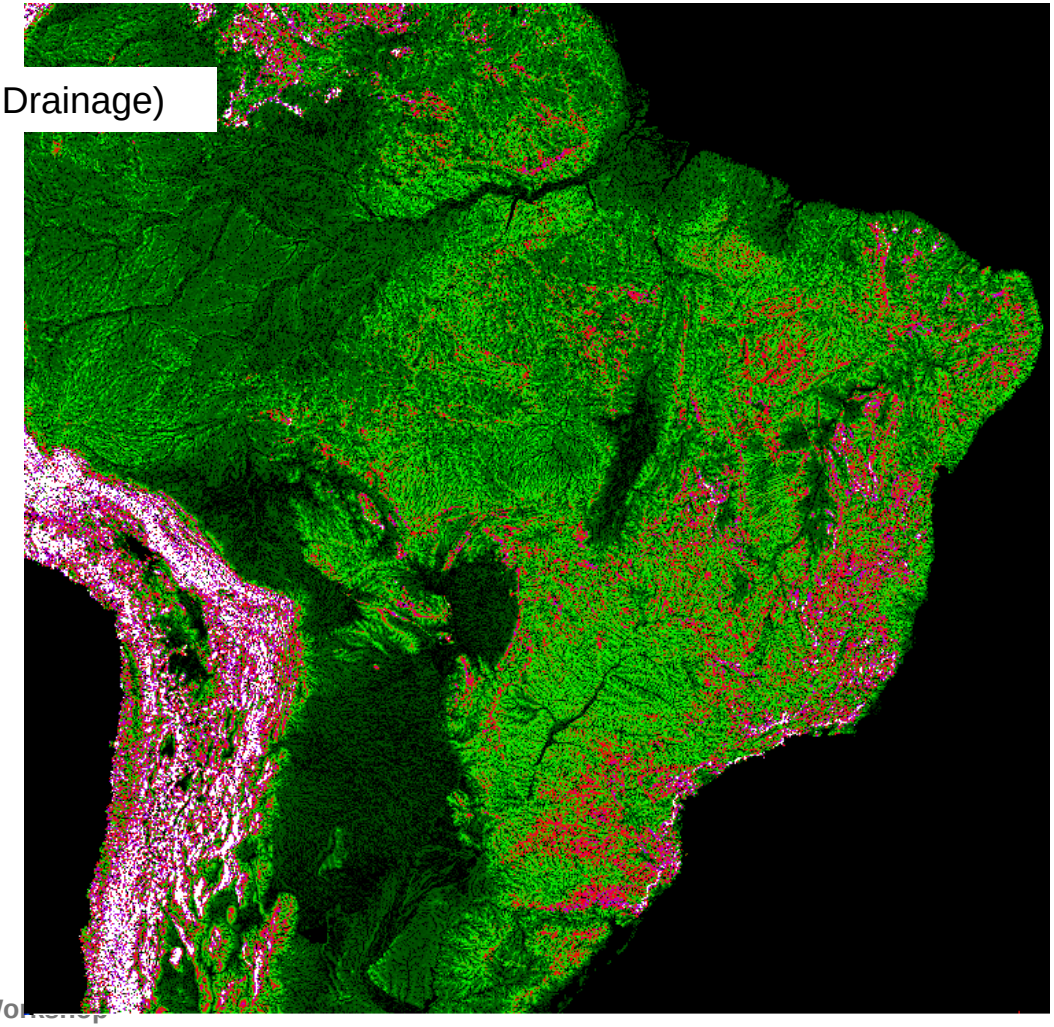
(Arasato, 2009)

RS and Species Distribution Modeling

HAND (Height Above the Nearest Drainage)

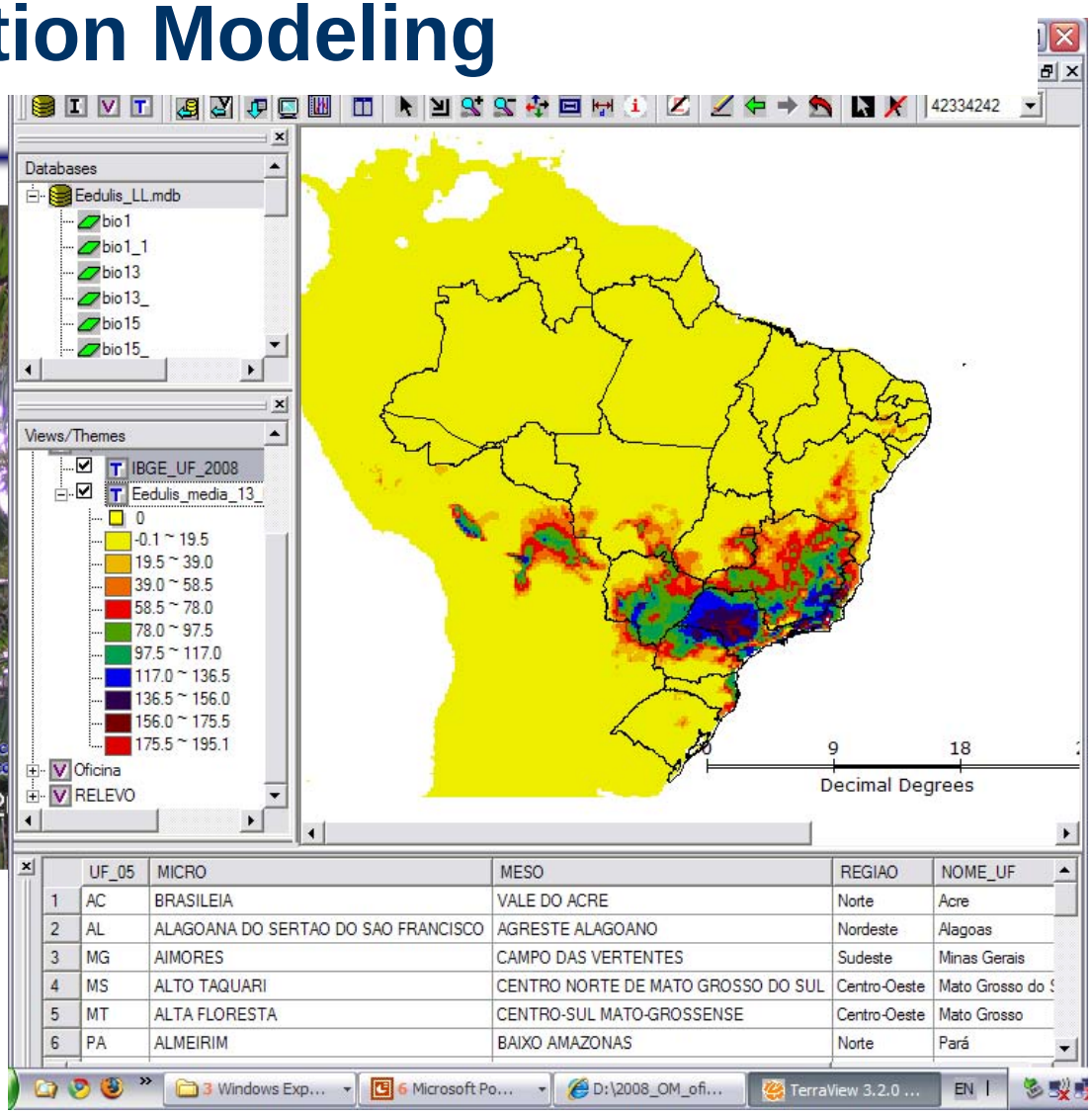


(Rennó et al, 2008)



Species Distribution Modeling

Euterpe edulis



Arasato (2009)

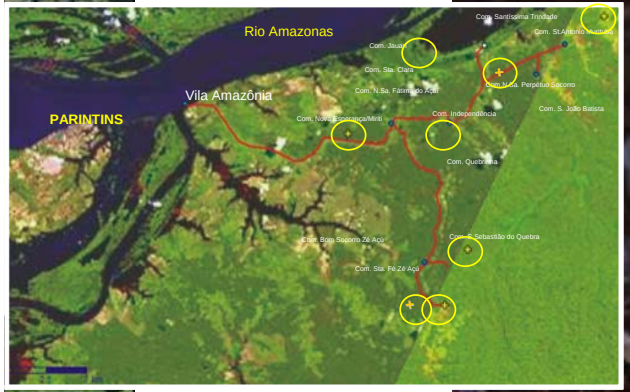
Restrict Distribution

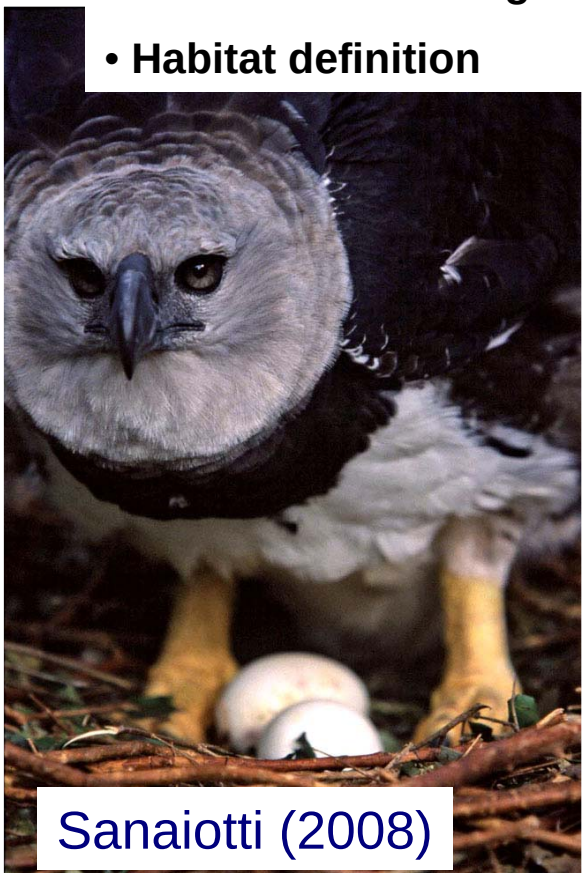
Ortophytum sp

Louzada (2008)

Sensitive species

- **Satellite monitoring**
- **Habitat definition**

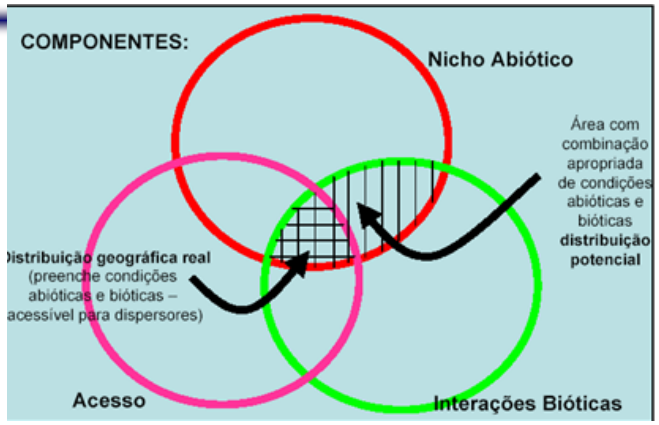




Harpia harpyja

Sanaiotti (2008)

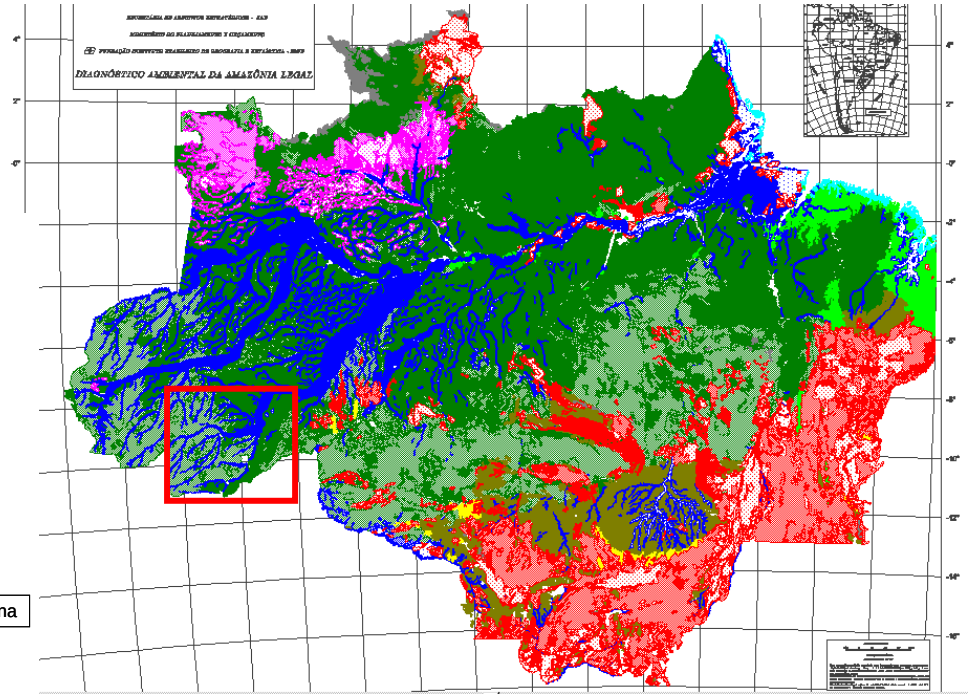
Species Distribution Modeling



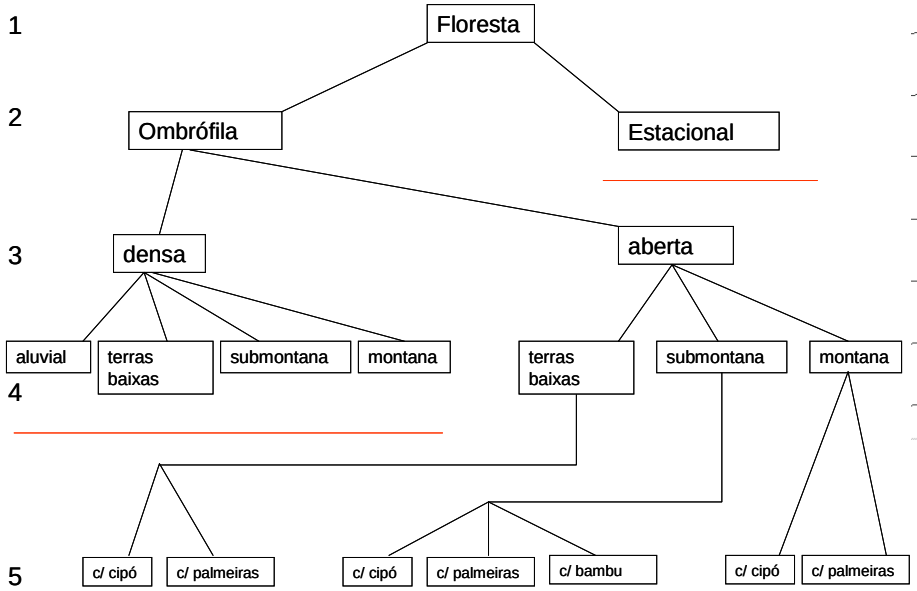
- Just geographical expression of part of "fundamental niche"
- Historical factors, genetic, biological interactions – not considered
- Biodiversity ? Based on Species (all of them?) How to integrate in space? In time?
- Community modeling ?

Biodiversity Inferences

- Alternative data to understand biodiversity
  - Phyto-fisionogmy (vegetation types) as proxy
  - Ecorregions
  - Remote Sensing

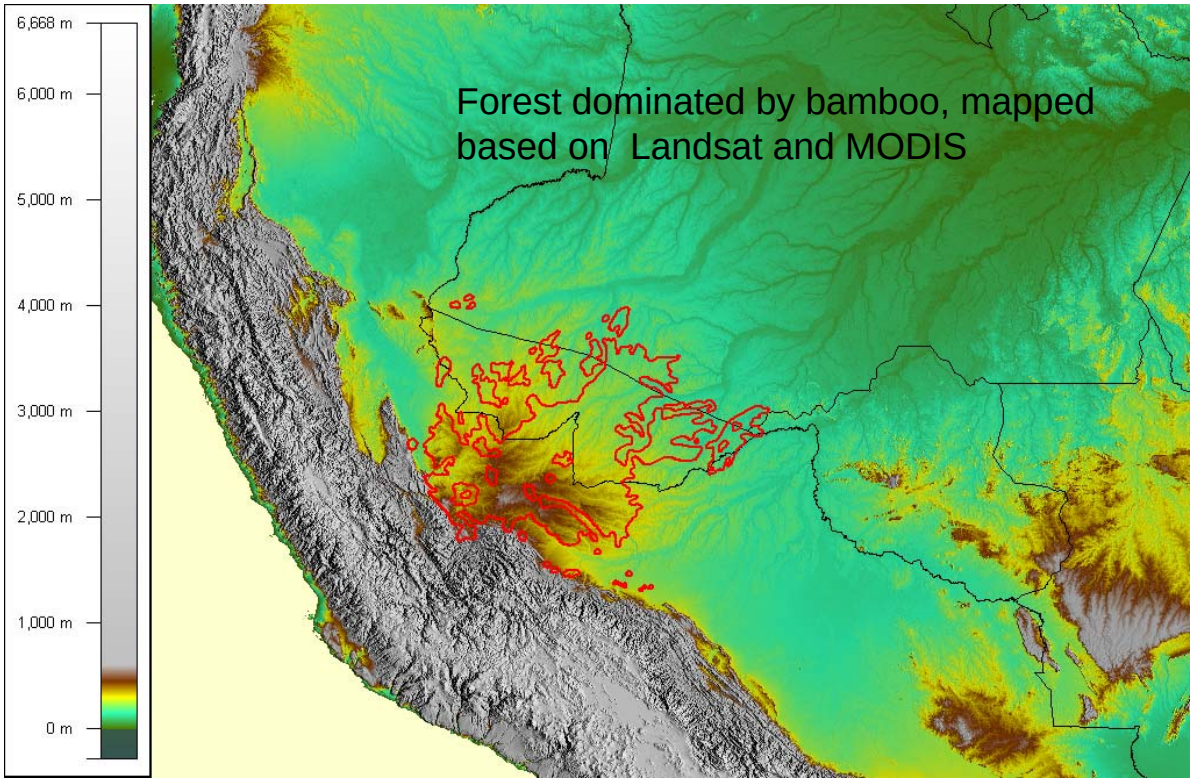


Natureza hierárquica do sistema do Veloso (1991)

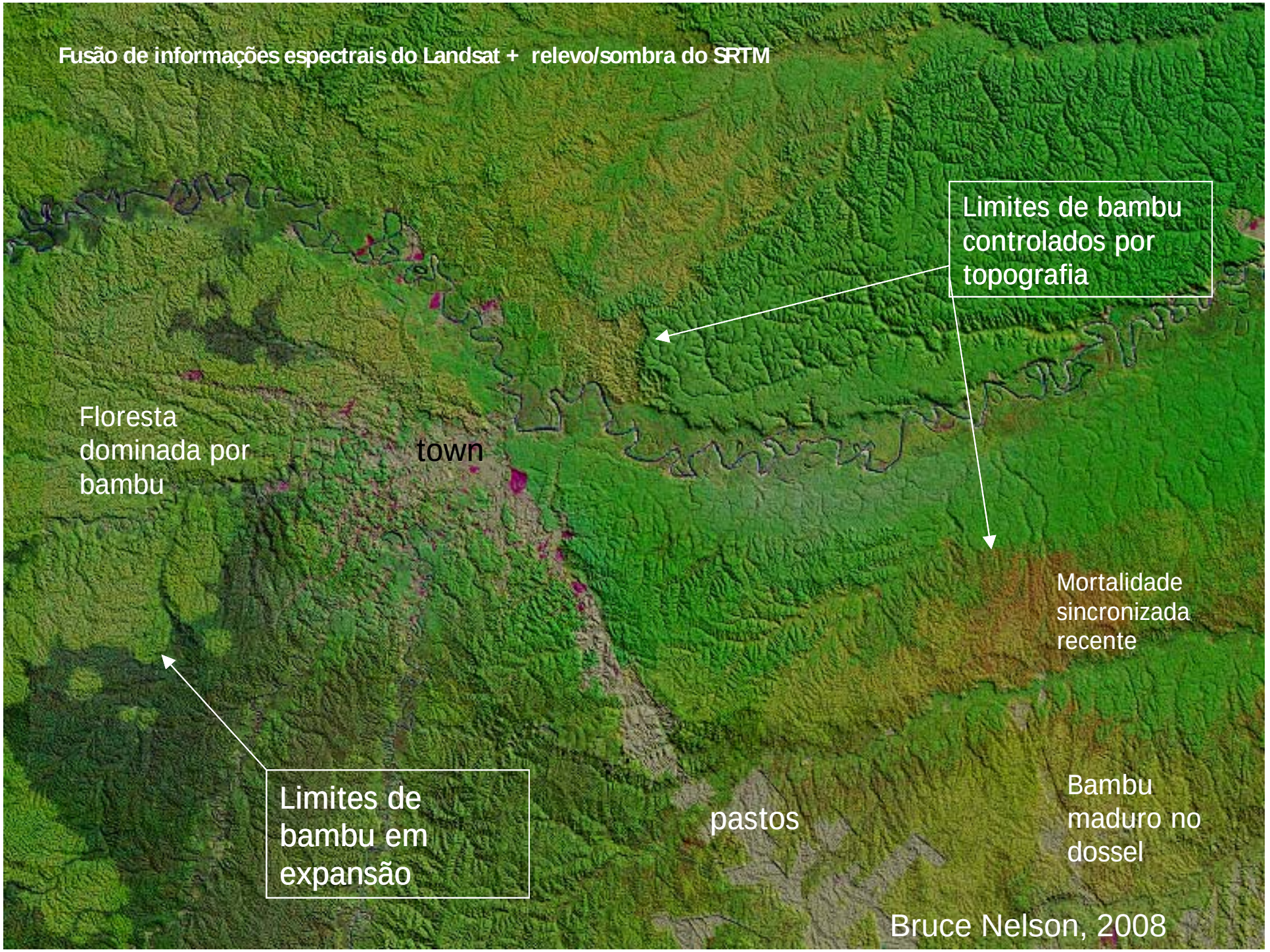


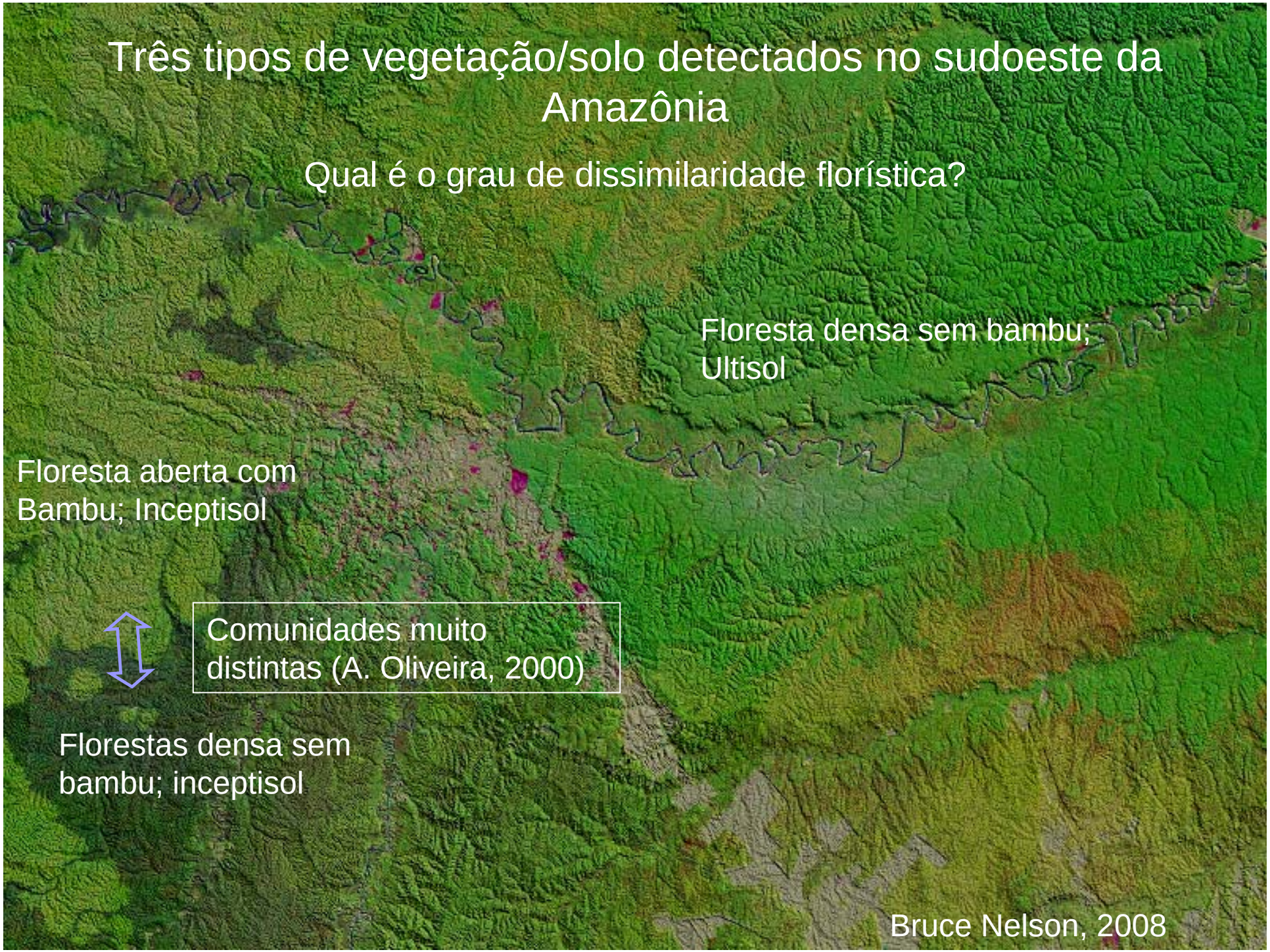
Biodiversity Inferences

- Alternative data to estimate biodiversity
  - Phyto-fisionogmy (vegetation types) as proxy



Bruce Nelson, 2008


Fusão de informações espectrais do Landsat + relevo/sombra do SRTM
Limites de bambu controlados por topografia
Floresta dominada por bambu
town
Mortalidade sincronizada recente
Limites de bambu em expansão
pastos
Bambu maduro no dossel
Bruce Nelson, 2008

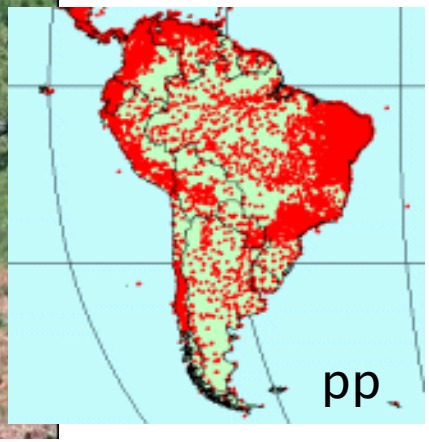

Três tipos de vegetação/solo detectados no sudoeste da Amazônia
Qual é o grau de dissimilaridade florística?
Floresta densa sem bambu; Ultisol
Floresta aberta com Bambu; Inceptisol
Comunidades muito distintas (A. Oliveira, 2000)
Florestas densa sem bambu; inceptisol
Bruce Nelson, 2008

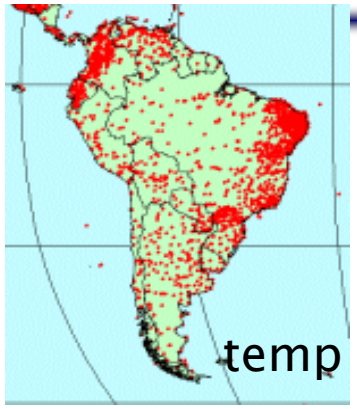
Biodiversity Inferences

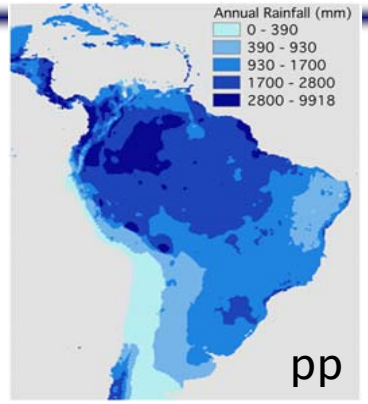
- Alternative data to estimate biodiversity
  - Ecoregions

Environmental Data Generation and Pré-processing

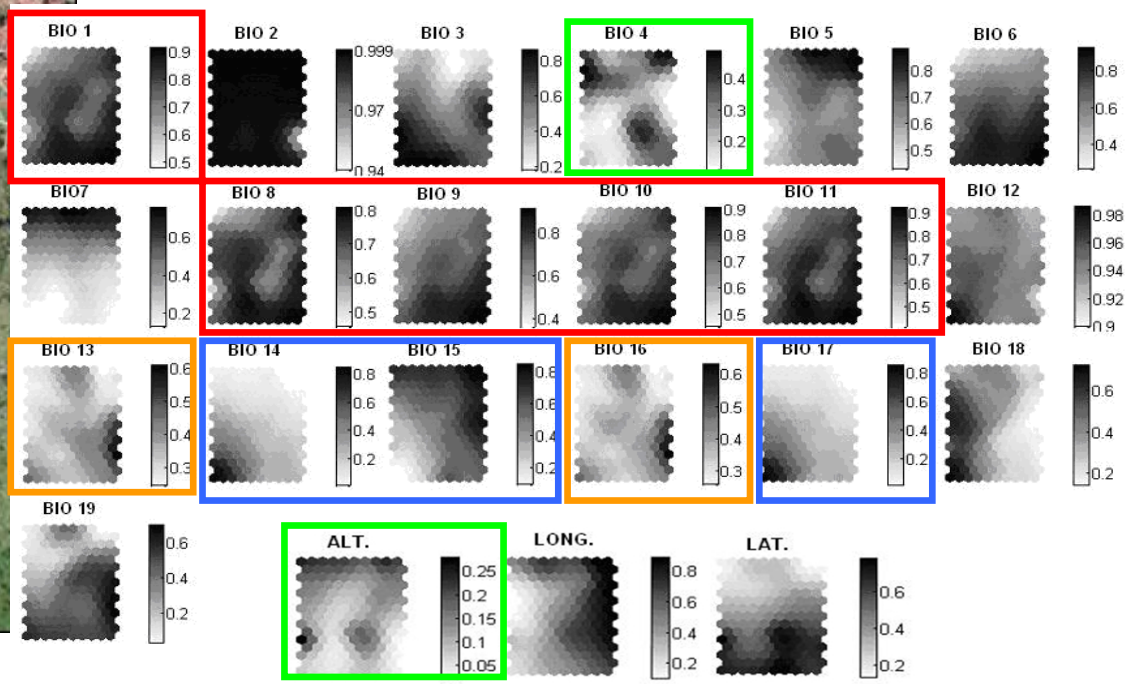
variables dependence

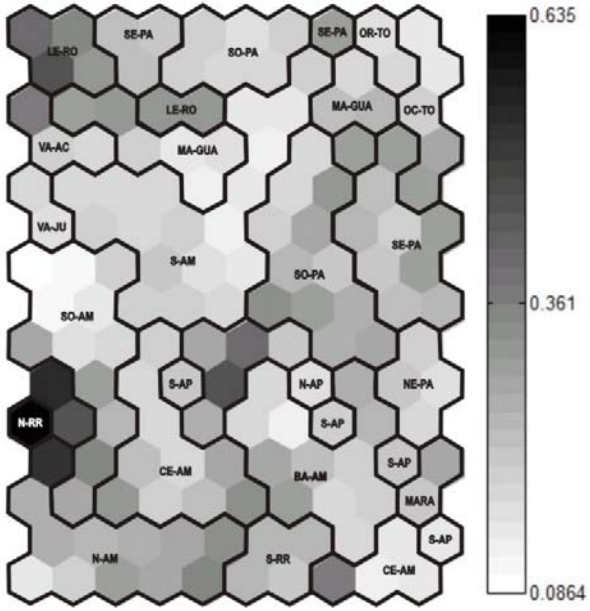






Dataset – HAND, Rivers Density, Radar image, clima, etc.





Self Organizing Mapping -

Ximenes (2008) March 2009

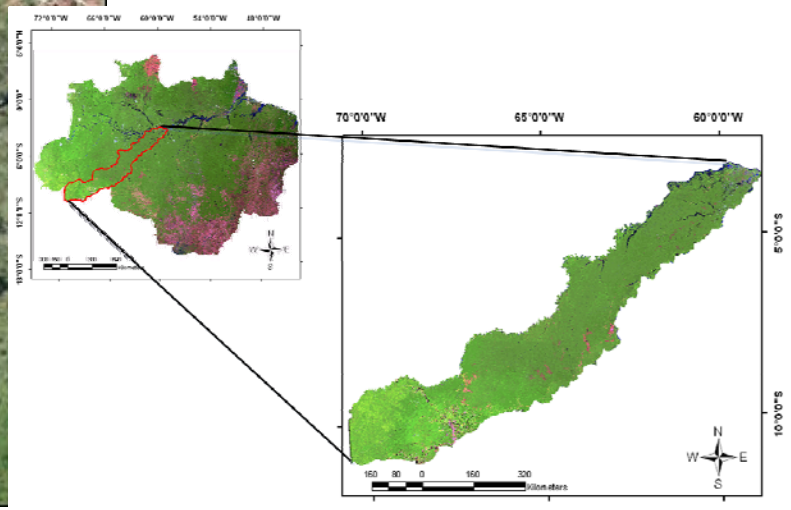
Environmental data for Biodiversity Modeling

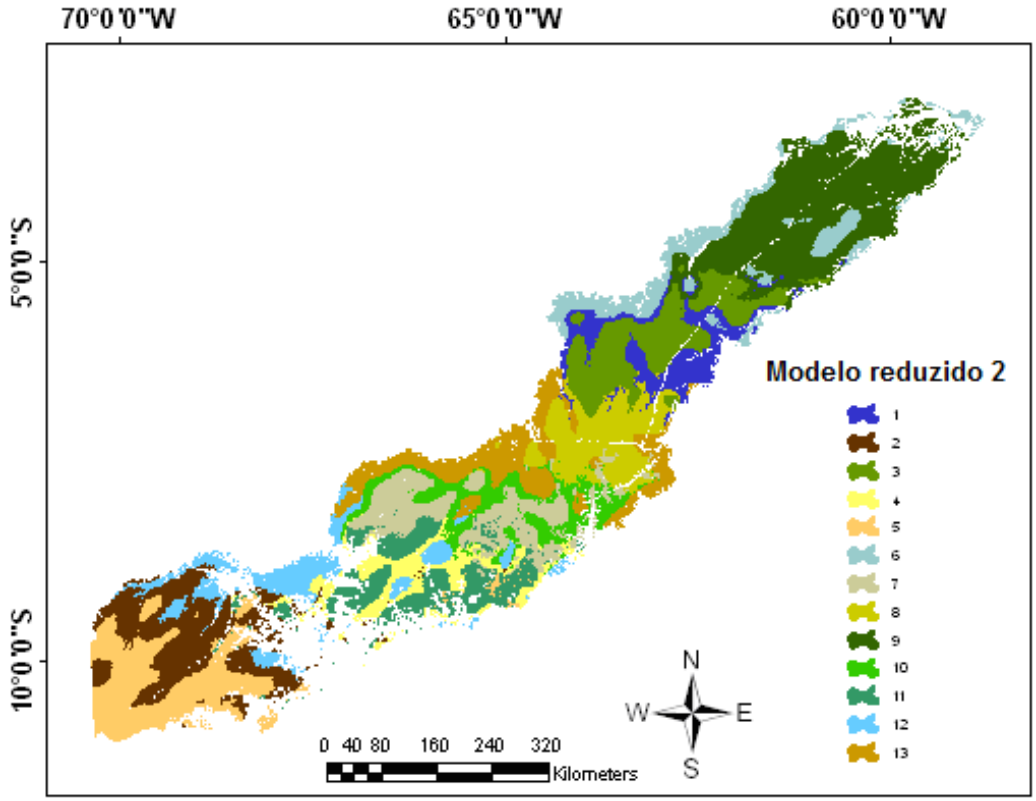
Ecoregions – Madeira-Purus, BR-319

Self Organizing Mapping

Regional Scale
Self Organizing Mapping

21 Environmental variables
Clima, vegetation, soil, altitude, geographical distance, drainage density, slope and NDVI





Self Organizing Mapping

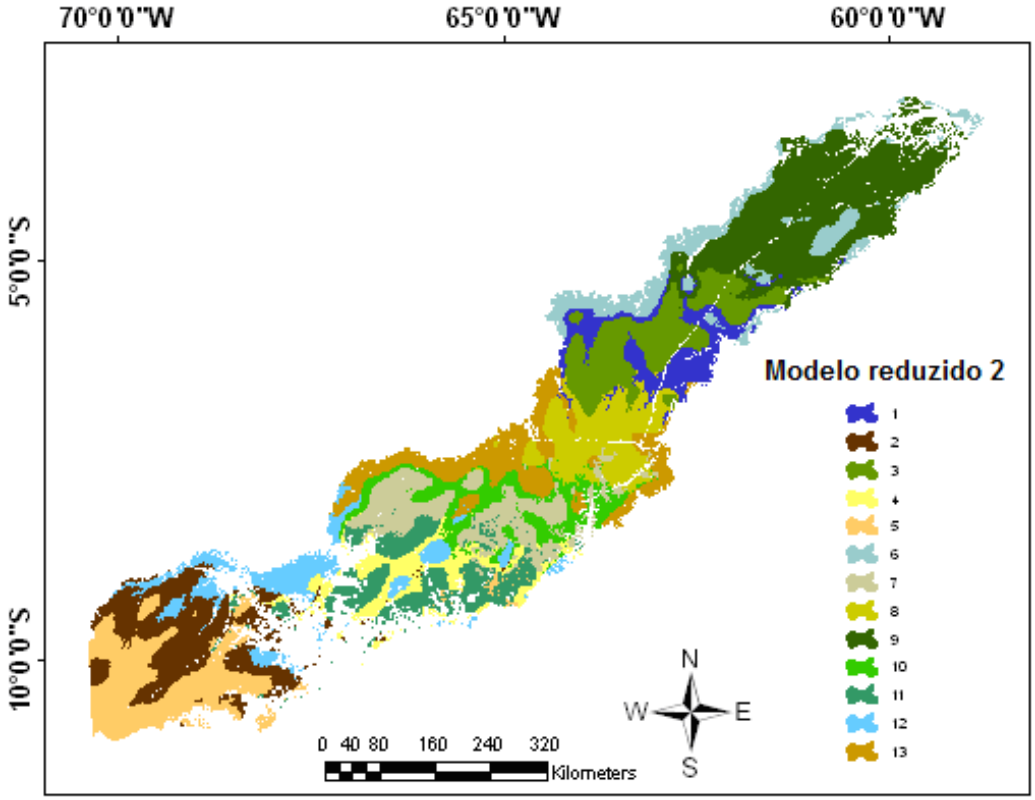
(Ximenes, 2008)

Environmental data for Biodiversity Modeling

Ecorregions – Madeira-Purus, BR-319

Self Organizing Mapping

- Data Validation
- Natural Barriers
- Aquatic environment
- Historical factor



Self Organizing Mapping

(Ximenes, 2008)

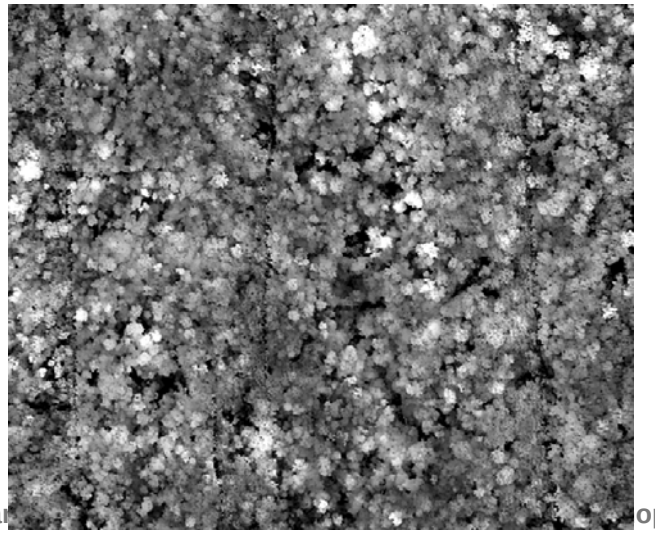
Biodiversity Inferences

- Alternative data to estimate biodiversity
  - Remote Sensing

High resolution data

Dossel structure, ground coverage, LAI

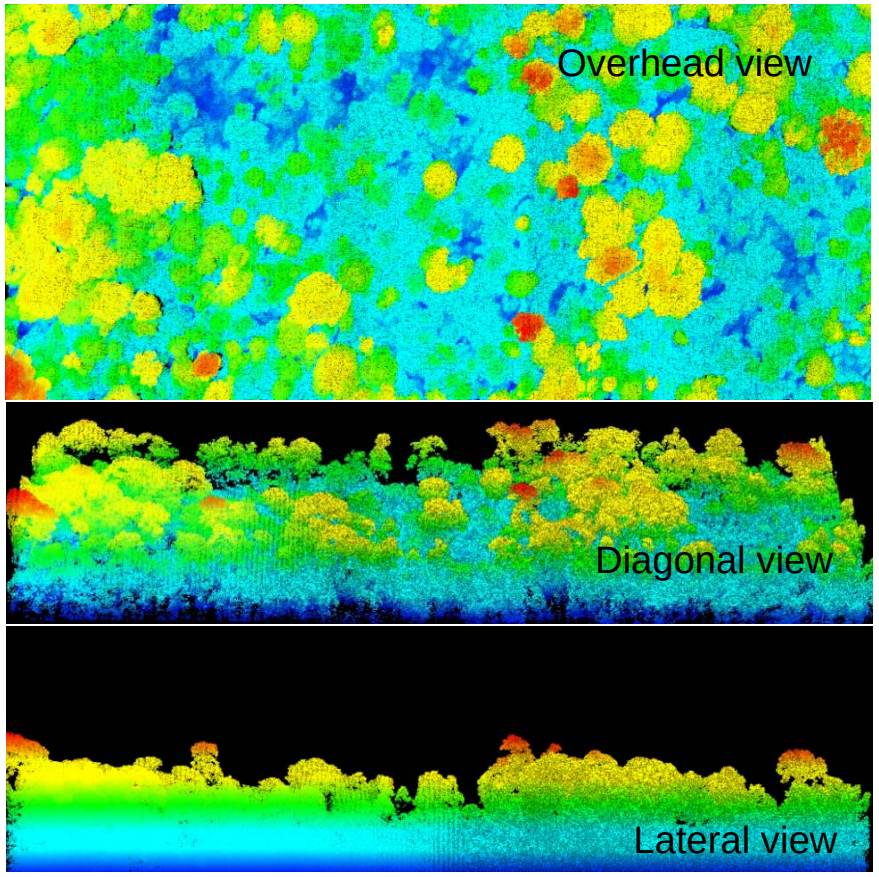
Understory vegetation
Composition



Remote Sensing Data

- Radar Data – clouds and above dossel information
  - Phenological aspects
  - LIDAR – forest structure
  - Carbon stocks – wood density

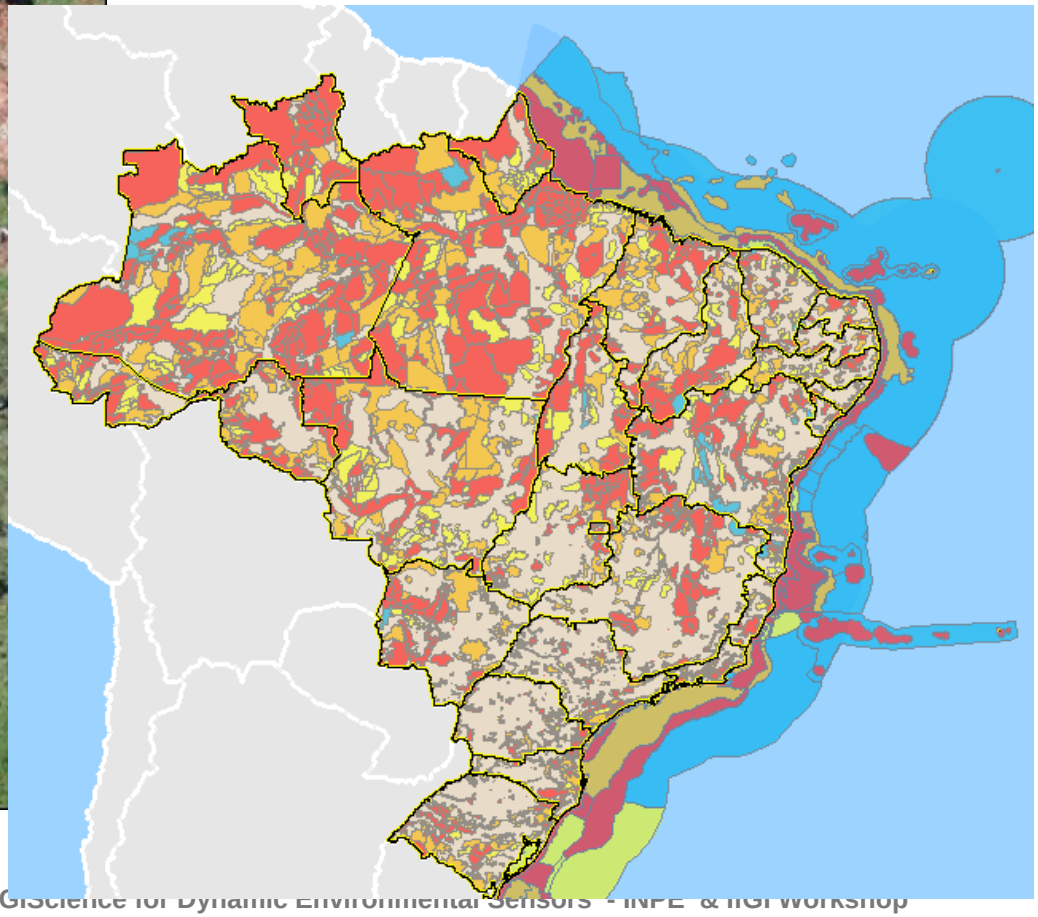
3-D information from the canopy



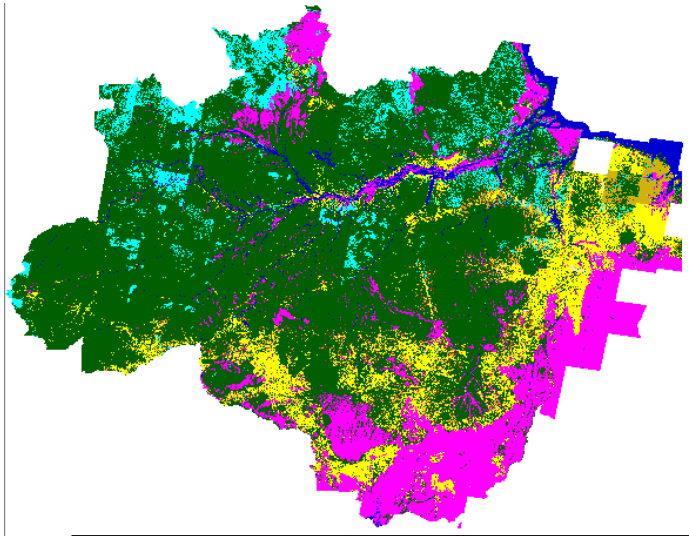
RS - Useful for inference and spatial generalization

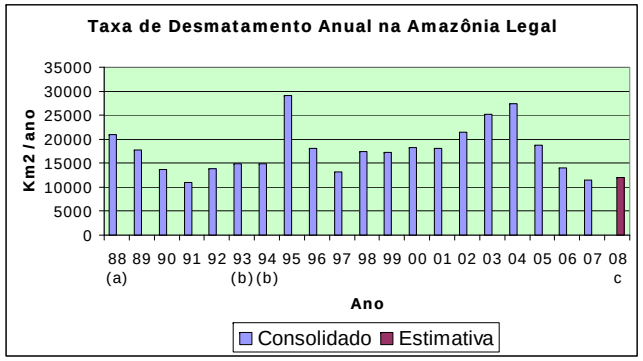
Biodiversity Modeling
Habitat loss, changes & threats

- Prioritary areas for biodiversity conservation



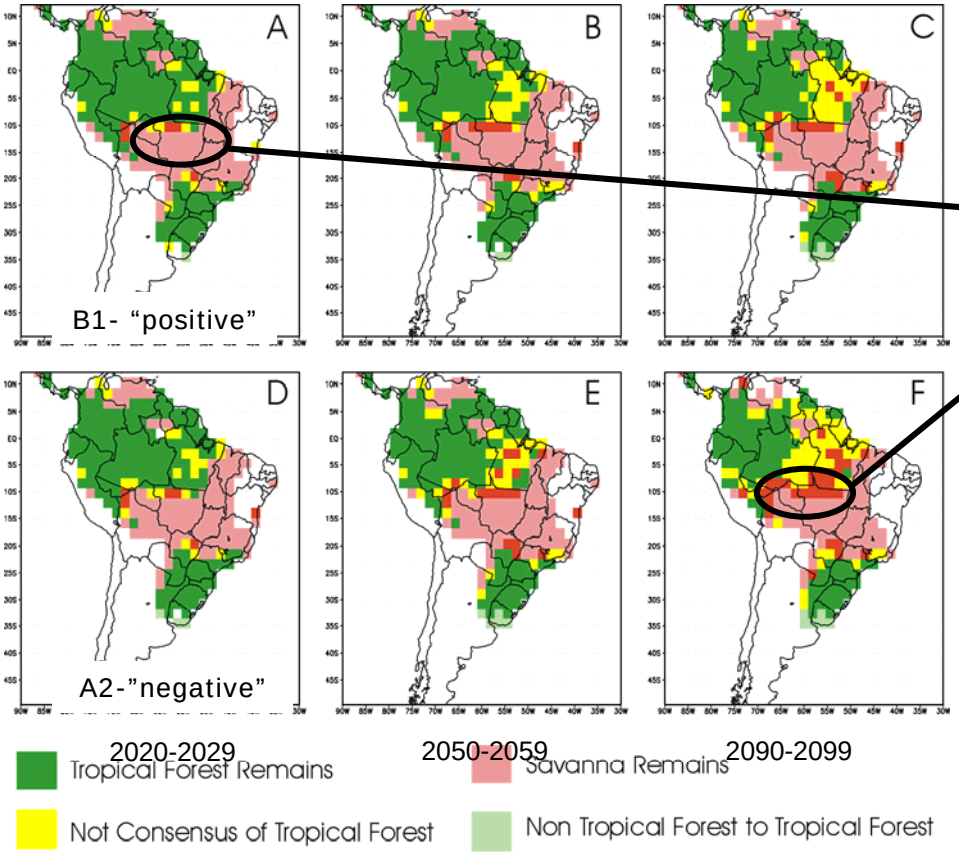
- Deforestation process





Global Climate Change Modelling

- Modeling Biodiversity based on Life Form
  - "Savanization" process



BIOMA approach

??? Given the climate warming and based on the plant form spectra, is there a tendency of "savannization" of Amazonian forest ?

(Salazar et al., 2007)

Jardim (2008)

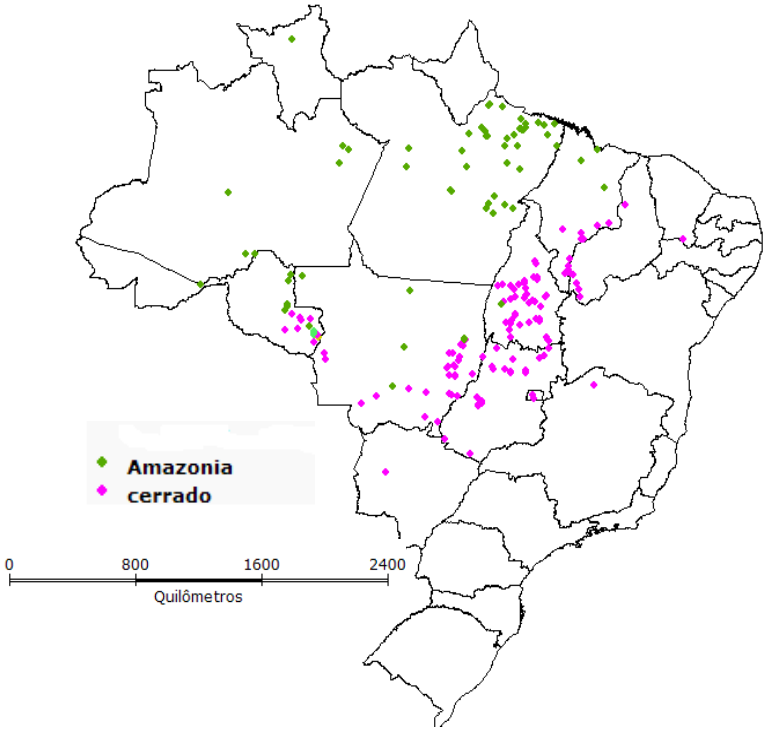
Modeling Biodiversity based on Life Form

- Potential life forms combination over cerrado and Amazon forest frontier considering cenarious of clima change
- Modeling based on bio-climatic envelops and life forms

Height

Specific Leaf Area (AFE)

Species classified base on the Function instead of taxonomy – Functional GROUPS



Species grouped by their form of life and survival strategy & E.Box Model

Final Comments

- Biodiversity modeling
  - Important Issue in times of Global Change
  - More questions/problems than solutions/answers
  - Complementary Approaches – every contribution is more than welcome !!
  - Understanding temporal (“slow”?) and spatial (“too diverse”?) Biodiversity dynamic
  - Modeling – despite the restrictions, one can learn from modeling exercises.

Thank you !
silvana@dpi.inpe.br