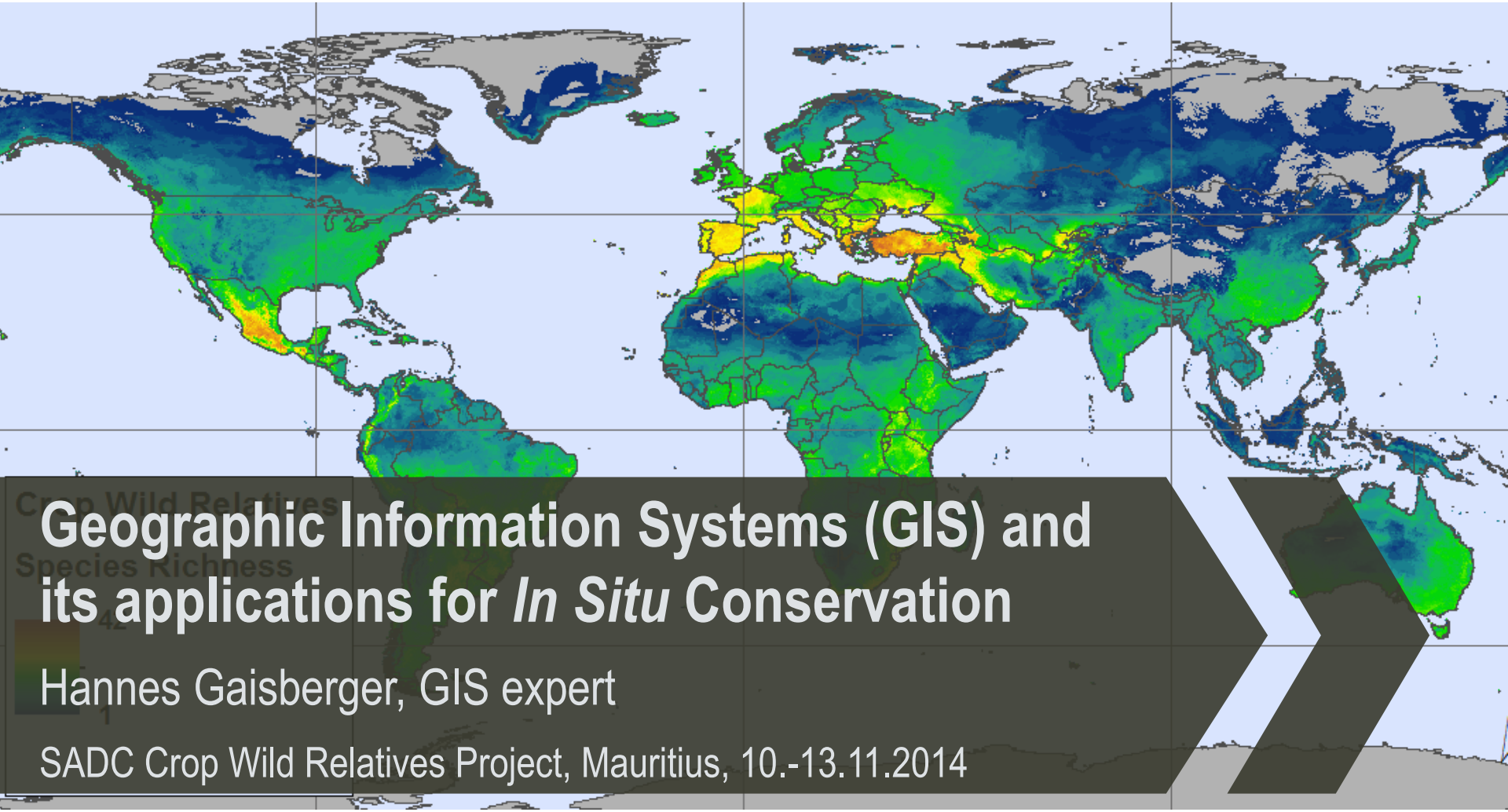


Geographic Information Systems (GIS) and its applications for *In Situ* Conservation

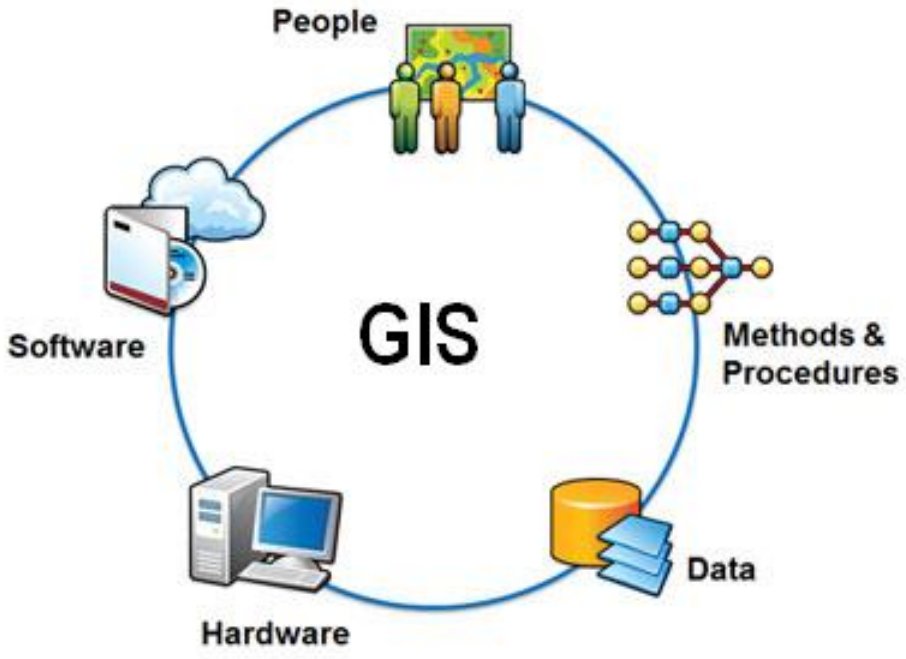
Hannes Gaisberger, GIS expert

SADC Crop Wild Relatives Project, Mauritius, 10.-13.11.2014

GIS concepts

Geographic Information System (GIS)

Computer based system that allows to capture, store, manipulate, analyze, manage, and visualize all types of spatial information and associated attributes



Geographic Information System (GIS)

GIS applications (such as DIVA-GIS) allow users to create combined queries (user-created searches), analyze spatial information, edit data in maps, and present the results in tables or maps.

GIS can relate unrelated information deriving from "real" physical locations by using location as the key index variable.

This key characteristic of GIS enables scientific inquiry and has many applications (Biology, ecology, environmental sciences, forest science, geology, engineering, transportation/logisitics, archeology, geography, agriculture, urban planning, atmospheric sciences,…....)

GIS is much more than a tool to make nice maps for reports, it is a tool for spatial analysis!

Geographic Information System (GIS)

Development in recent years:

- Generalized access to GPS -> more georeferenced data
- Faster processors -> more complex analyses
- Growing amount of data and hard disk capacity -> use of more detailed maps and data (e.g. climate)
- General access to internet -> exchange of data and maps

GIS and Genetic Resources:

Answers to important questions can be obtained with the use of GIS:

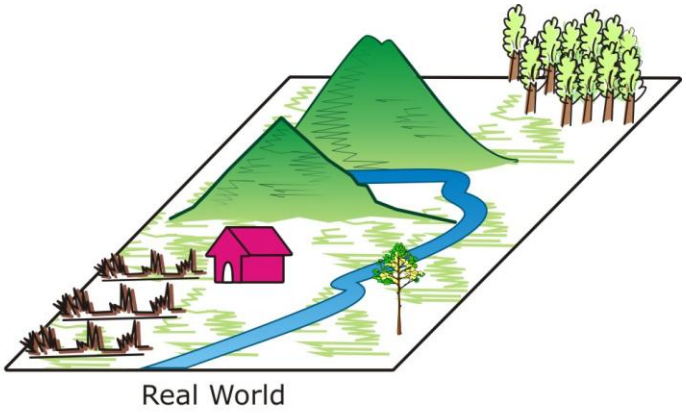
- What is the conservation status of priority species?
- Where are the areas with highest diversity?
- How to formulate optimal in situ conservation strategies?
- Which accessions perform best where?
- Are there any significant gaps in current collections?
- How can diversity be used in climate change adaptation strategies?
- ...

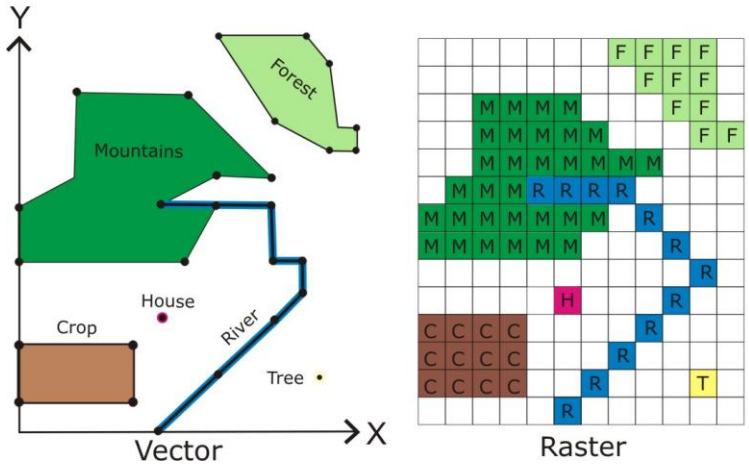
GIS file formats

GIS file formats

A GIS file format is a standard of encoding geographical information into a file

- **Vector format**
- **Raster format**





GIS file formats

Vector: Different geographical features are expressed by different types of geometry

- **Points**

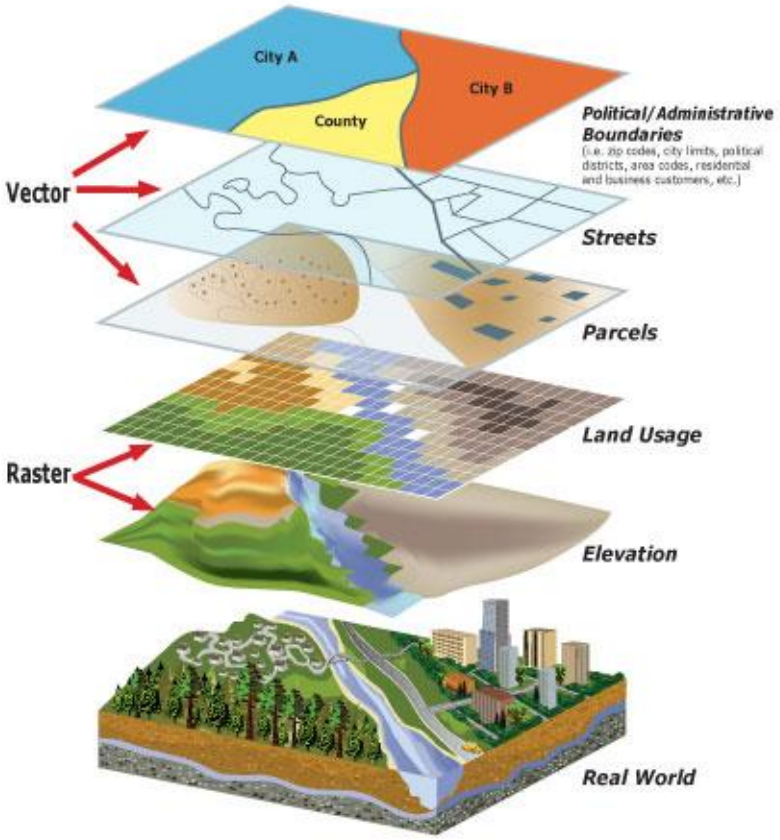
Zero-dimensional points used for geographical features that can best be expressed by a single location (e.g. samples)

- **Lines**

One-dimensional lines or polylines used for linear features such as rivers, roads, railroads, trails, and topographic lines.

- **Polygons**

Two-dimensional polygons used for geographical features that cover a particular area, such as lakes, admin boundaries, ecological zones, protected areas etc.

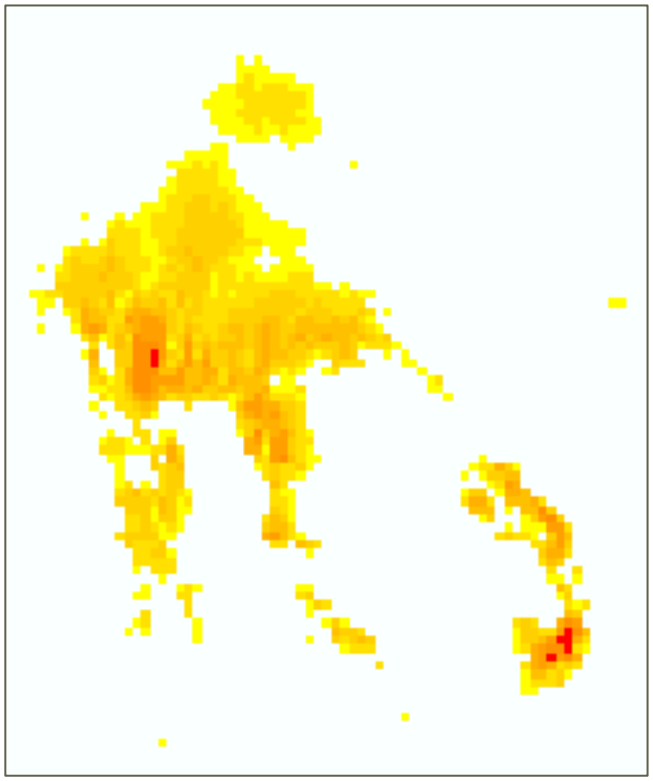


GIS file formats

Raster: Consists of a matrix of cells (or pixels) organized in a grid where each cell contains a single value representing information. Raster files usually derive from digital aerial photographs, satellites images or scanned maps.

Extent: size of area
Resolution: size of one cell

Approximate size of Geographic Units (close to the equator)	
Degrees	**Size**
30 seconds	1 km
2.5 minutes	5 km
5 minutes	9 km
10 minutes	18 km
1 degree	111 km

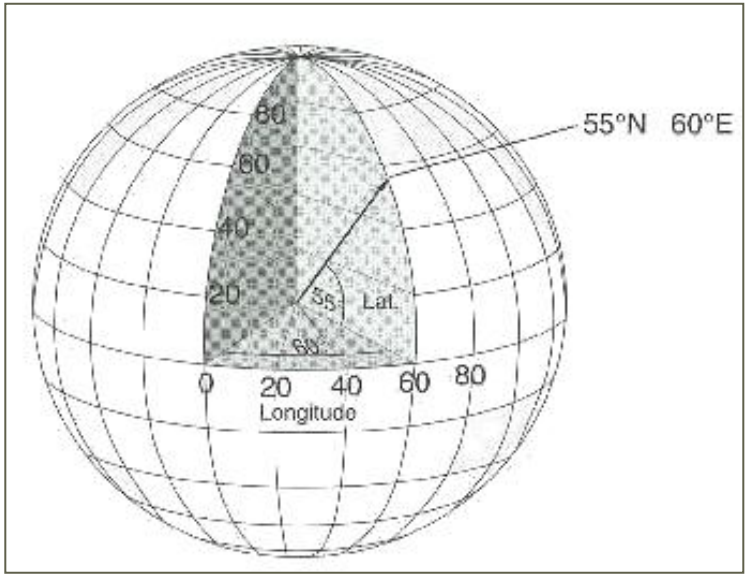


Georeferenced data

Geographic coordinates

Latitude and Longitude:

- Meridians (latitude) and parallels (longitude)
- Prime Meridian (Greenwich) and equator
- 180/360 degrees, 60 minutes, 60 seconds



Formats:

- degrees, minutes and seconds + hemisphere: DDºMM'SS" : 12º20'15" S
- decimal minutes: DDºMM.MMMM': -12º20.25'
- **decimal degrees: DD.DDDD: -12.3375**

Decimal degrees = [(Degrees (º) + Minutes (') / 60 + Seconds (") / 3600)] * H
H = 1 when the coordinate is in the Eastern (E) or Northern (N) Hemisphere
H = -1 when the coordinate is in the Western (W) or Southern (S) Hemisphere

Don't Mix!

12º20'15" S ≠ -12.2015 (= 12º12'05" S)
-12.2015 ≠ 12.2015

Watch out for lists of coordinates with decimals always < .59

UTM Coordinates

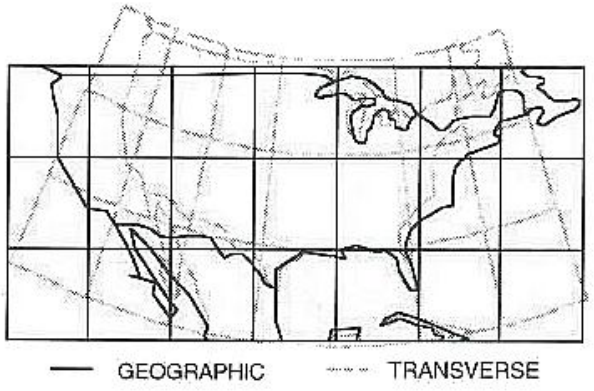
UTM: Universal Transverse Mercator

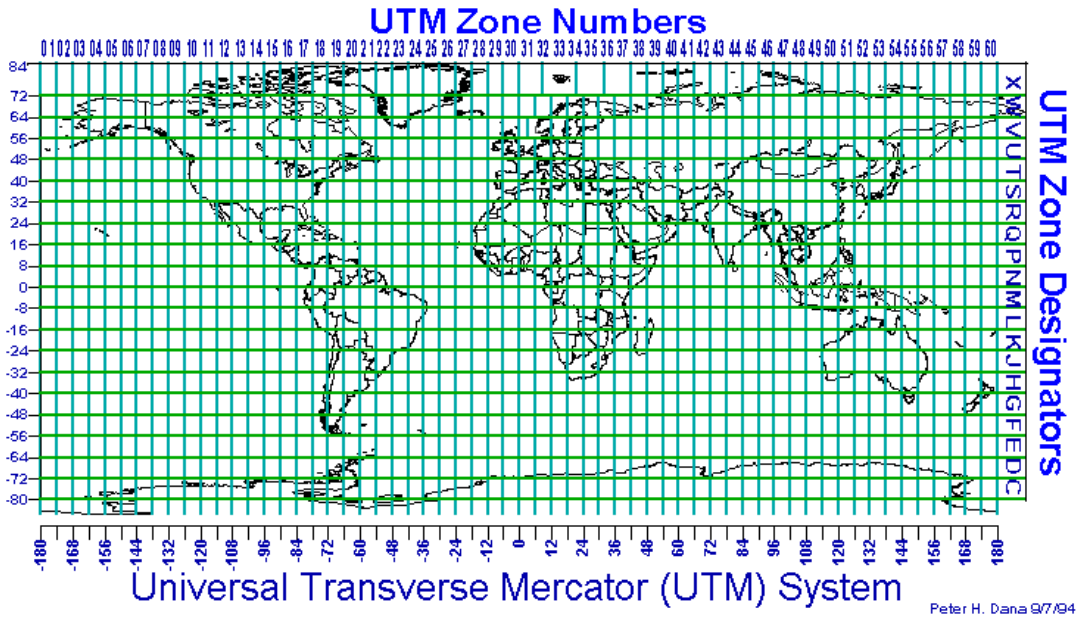
- metric-based Cartesian grid
- 60 zones/projections (180 x 800 km)

Advantage: low distortion: easy to calculate distances

Disadvantage: small scale

17N 630084 4833438



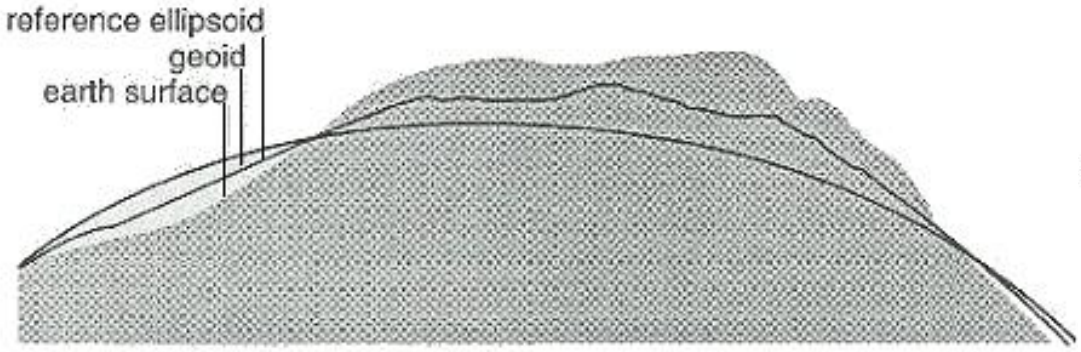


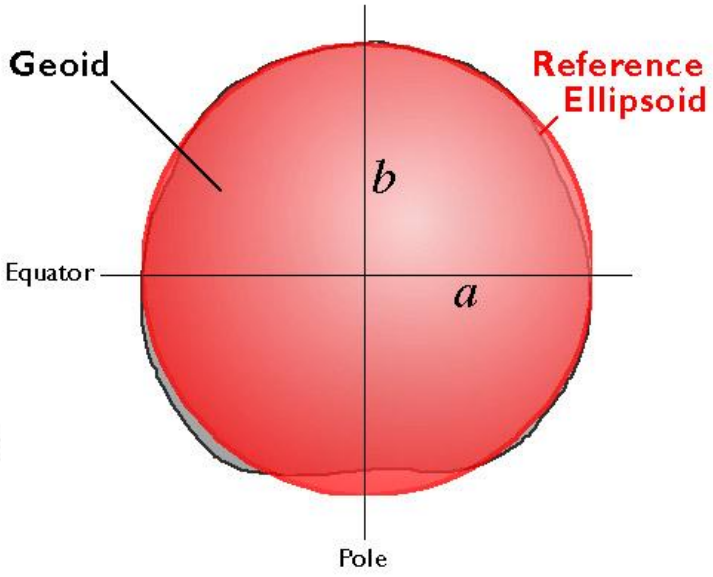
Datum

How to represent earth as simple geometric volume (ellipsoid)

Datum: Definition of used ellipsoid (reference ellipsoid)

Check! Standard: WGS 84 (World Geodetic System)!





Projections

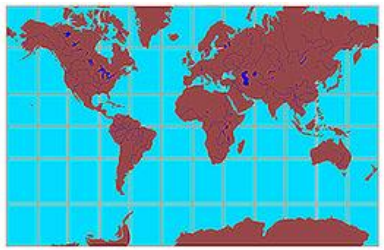
How to represent 3D as 2D

Map/projection properties:

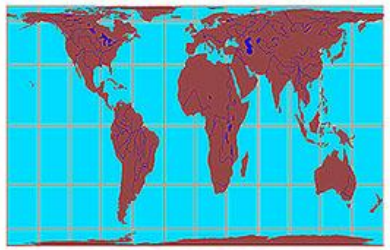
- Area
- Shape
- Direction
- Distance

Distortions

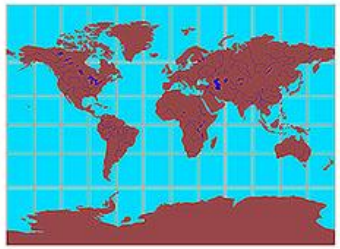
Don’t worry!



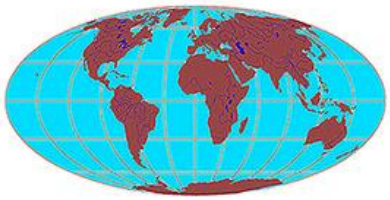
Mercator Projection



Gall-Peters Projection

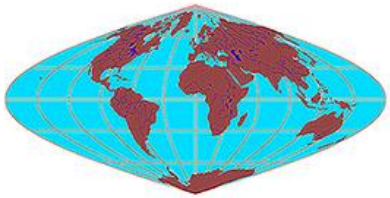


Miller Cylindrical Projection

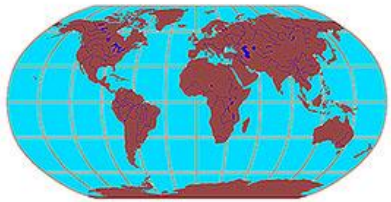


Mollweide Projection

Goode's Homolosine Equal-area Projection



Sinusoidal Equal-Area Projection



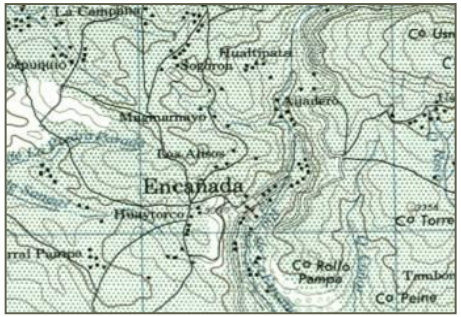
Robinson Projection

Georeferencing points

Data collection

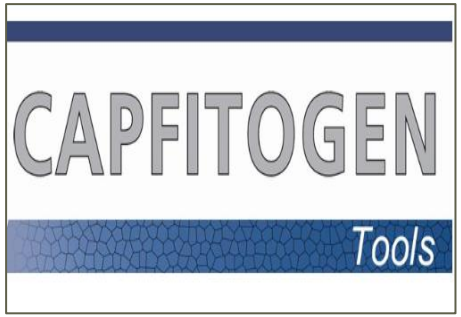
Possible data sources:

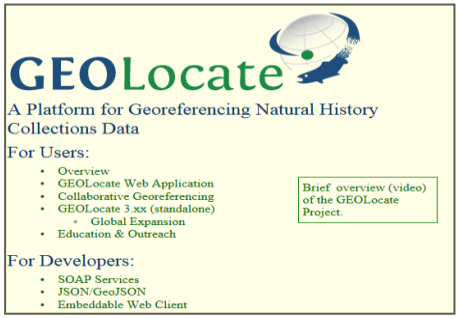
Maps



GPS

Gazetteers





Bioversity International

Georeferenced points + attributes

Passport data

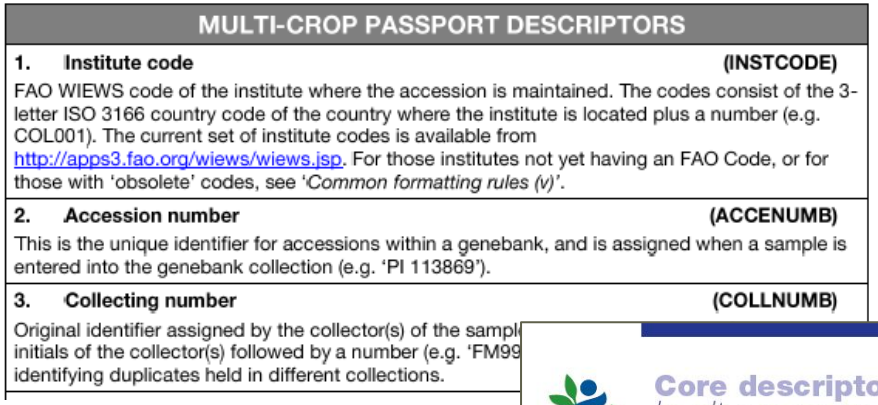
- Administrative data
- Detailed site description
- Coordinates!
- Status of sample
- Taxonomy etc.

Characterization data

- Morphologic properties (GxE)
- Molecular marker data
- Standards/comparability!
- Crop specific

Evaluation data

- Performance data
- GxE



MULTI-CROP PASSPORT DESCRIPTORS

1. **Institute code** (INSTCODE)

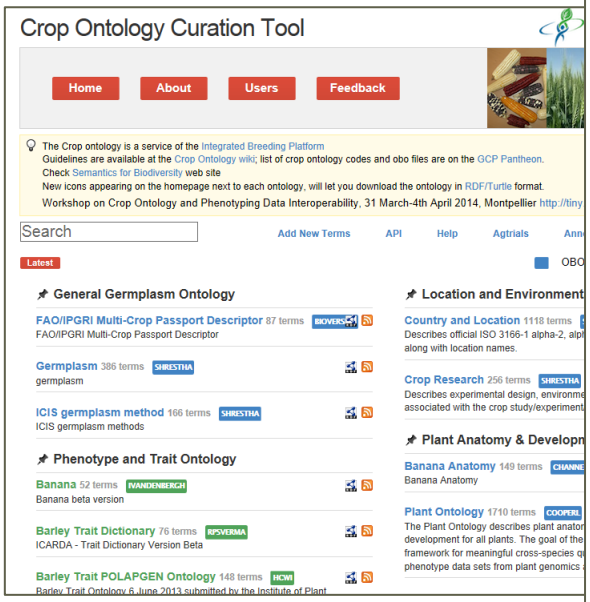
FAO WIEWS code of the institute where the accession is maintained. The codes consist of the 3-letter ISO 3166 country code of the country where the institute is located plus a number (e.g. COL001). The current set of institute codes is available from http://apps3.fao.org/wiews/wiews.jsp. For those institutes not yet having an FAO Code, or for those with 'obsolete' codes, see '*Common formatting rules (v)*'.

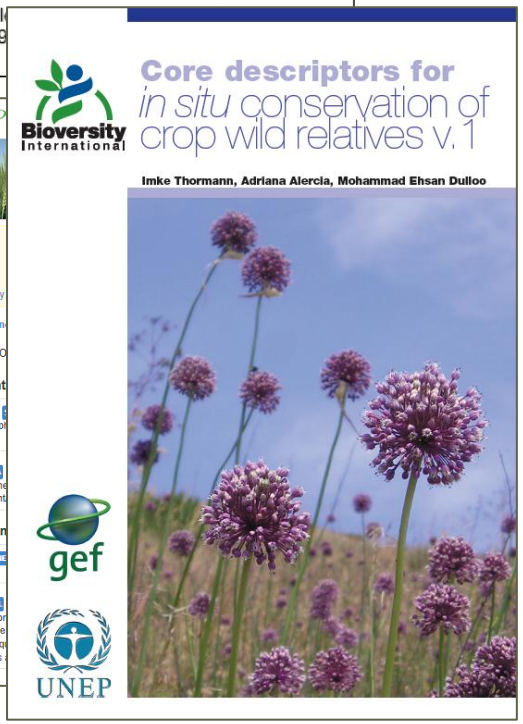
2. **Accession number** (ACCENUMB)

This is the unique identifier for accessions within a genebank, and is assigned when a sample is entered into the genebank collection (e.g. 'PI 113869').

3. **Collecting number** (COLLNUMB)

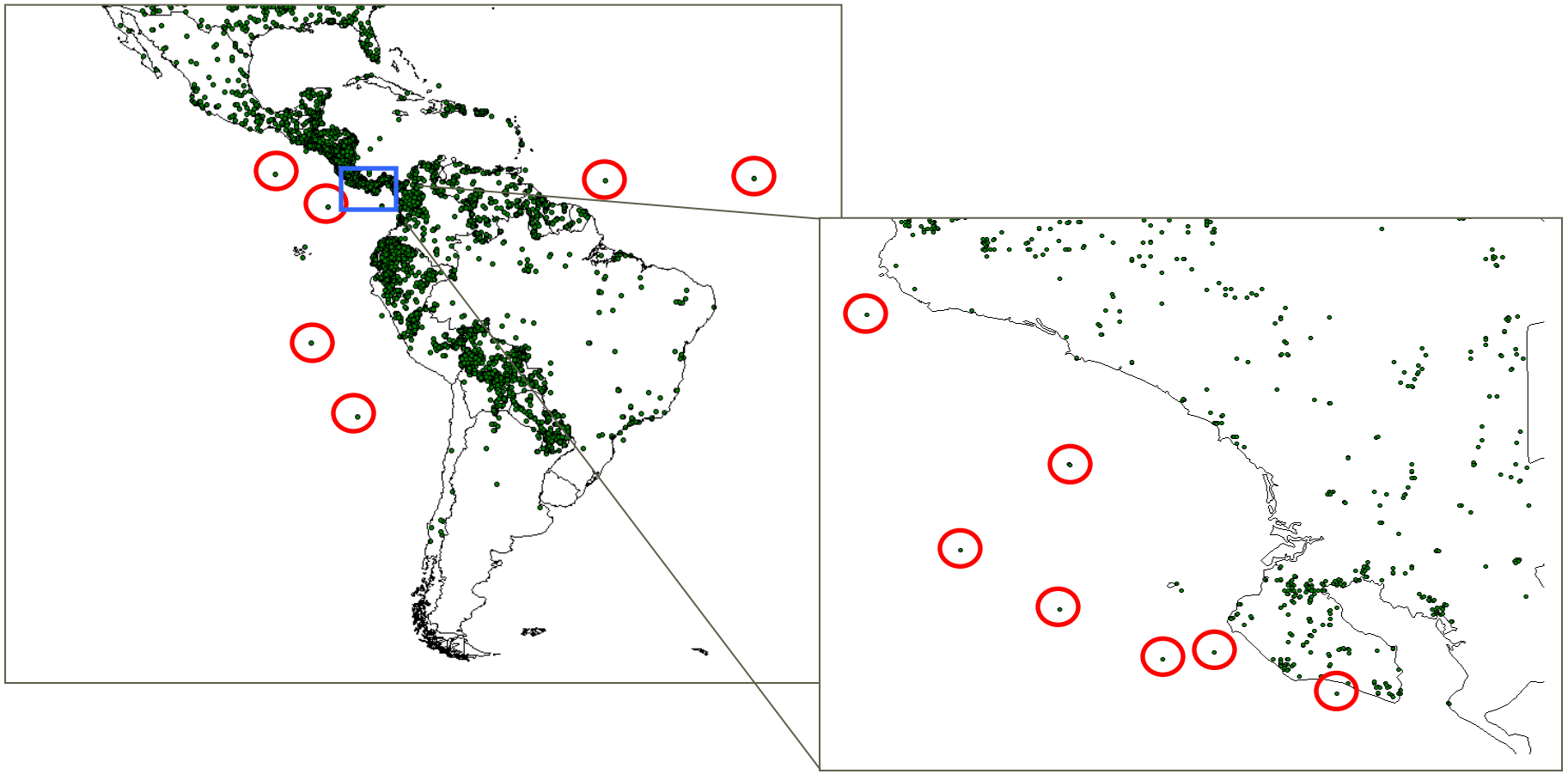
Original identifier assigned by the collector(s) of the sampl
initials of the collector(s) followed by a number (e.g. 'FM99
identifying duplicates held in different collections.



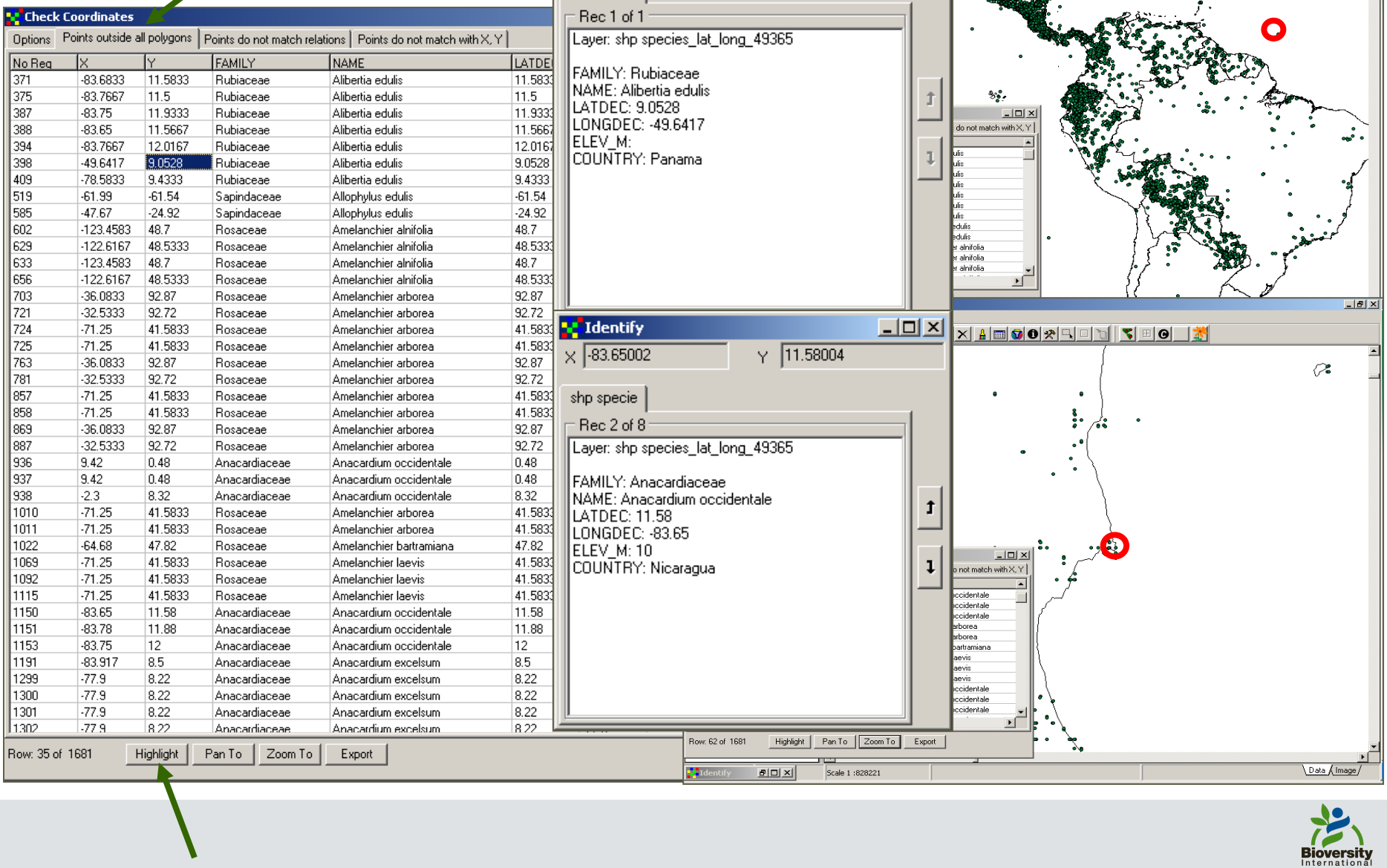


Errors

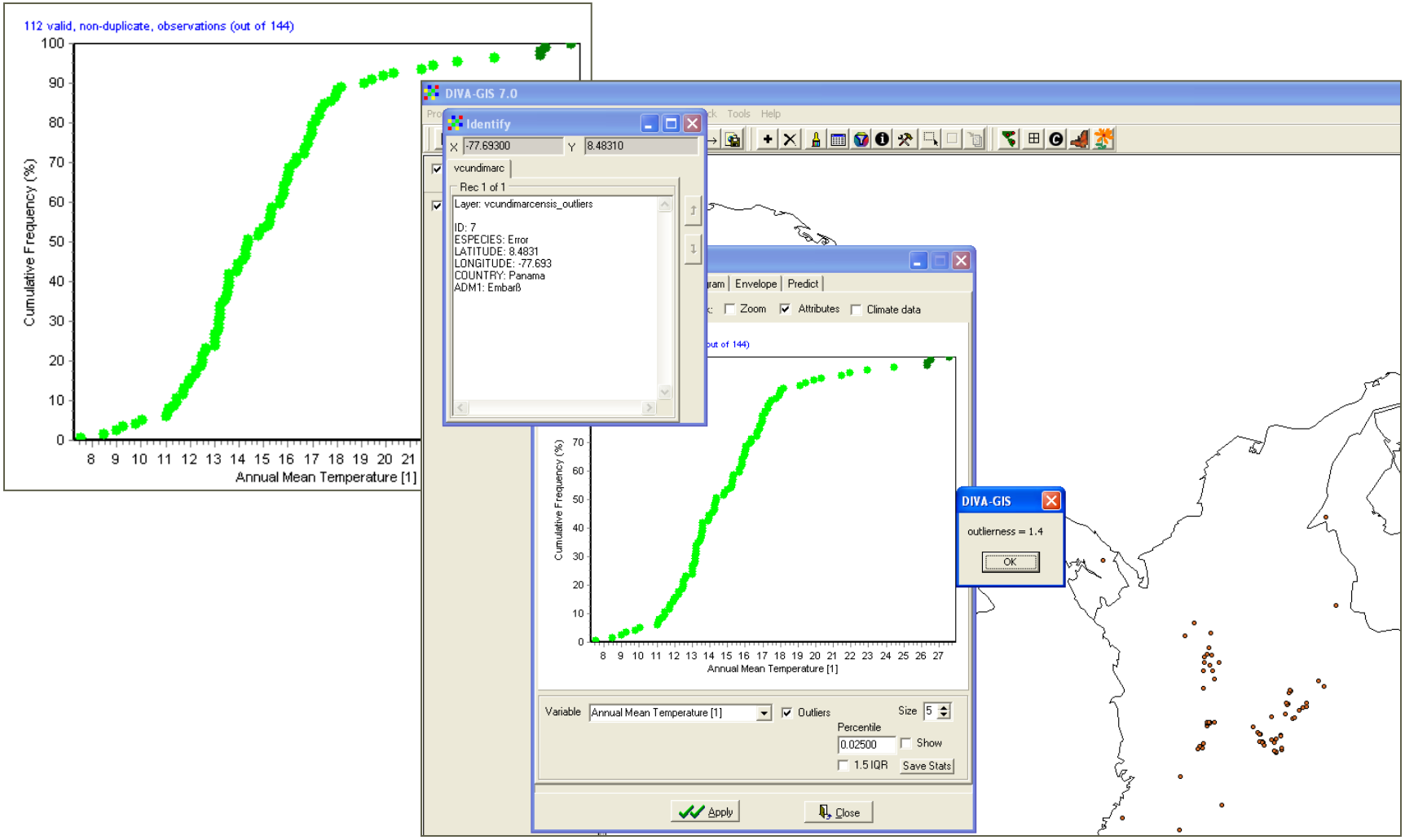
Errors are unavoidable, how to deal with them ?



Errors


Check Coordinates
Options
Points outside all polygons
Points do not match relations
Points do not match with X, Y
No Reg | X | Y | FAMILY | NAME | LATDE
371 | -83.6833 | 11.5833 | Rubiaceae | Alibertia edulis | 11.583
375 | -83.7667 | 11.5 | Rubiaceae | Alibertia edulis | 11.5
387 | -83.75 | 11.9333 | Rubiaceae | Alibertia edulis | 11.933
388 | -83.65 | 11.5667 | Rubiaceae | Alibertia edulis | 11.566
394 | -83.7667 | 12.0167 | Rubiaceae | Alibertia edulis | 12.016
398 | -49.6417 | 9.0528 | Rubiaceae | Alibertia edulis | 9.0528
409 | -78.5833 | 9.4333 | Rubiaceae | Alibertia edulis | 9.4333
519 | -61.99 | -61.54 | Sapindaceae | Allophylus edulis | -61.54
585 | -47.67 | -24.92 | Sapindaceae | Allophylus edulis | -24.92
602 | -123.4583 | 48.7 | Rosaceae | Amelanchier alnifolia | 48.7
629 | -122.6167 | 48.5333 | Rosaceae | Amelanchier alnifolia | 48.533
633 | -123.4583 | 48.7 | Rosaceae | Amelanchier alnifolia | 48.7
656 | -122.6167 | 48.5333 | Rosaceae | Amelanchier alnifolia | 48.533
703 | -36.0833 | 92.87 | Rosaceae | Amelanchier arborea | 92.87
721 | -32.5333 | 92.72 | Rosaceae | Amelanchier arborea | 92.72
724 | -71.25 | 41.5833 | Rosaceae | Amelanchier arborea | 41.583
725 | -71.25 | 41.5833 | Rosaceae | Amelanchier arborea | 41.583
763 | -36.0833 | 92.87 | Rosaceae | Amelanchier arborea | 92.87
781 | -32.5333 | 92.72 | Rosaceae | Amelanchier arborea | 92.72
857 | -71.25 | 41.5833 | Rosaceae | Amelanchier arborea | 41.583
858 | -71.25 | 41.5833 | Rosaceae | Amelanchier arborea | 41.583
869 | -36.0833 | 92.87 | Rosaceae | Amelanchier arborea | 92.87
887 | -32.5333 | 92.72 | Rosaceae | Amelanchier arborea | 92.72
936 | 9.42 | 0.48 | Anacardiaceae | Anacardium occidentale | 0.48
937 | 9.42 | 0.48 | Anacardiaceae | Anacardium occidentale | 0.48
938 | -2.3 | 8.32 | Anacardiaceae | Anacardium occidentale | 8.32
1010 | -71.25 | 41.5833 | Rosaceae | Amelanchier arborea | 41.583
1011 | -71.25 | 41.5833 | Rosaceae | Amelanchier arborea | 41.583
1022 | -64.68 | 47.82 | Rosaceae | Amelanchier bartramiana | 47.82
1069 | -71.25 | 41.5833 | Rosaceae | Amelanchier laevis | 41.583
1092 | -71.25 | 41.5833 | Rosaceae | Amelanchier laevis | 41.583
1115 | -71.25 | 41.5833 | Rosaceae | Amelanchier laevis | 41.583
1150 | -83.65 | 11.58 | Anacardiaceae | Anacardium occidentale | 11.58
1151 | -83.78 | 11.88 | Anacardiaceae | Anacardium occidentale | 11.88
1153 | -83.75 | 12 | Anacardiaceae | Anacardium occidentale | 12
1191 | -83.917 | 8.5 | Anacardiaceae | Anacardium excelsum | 8.5
1299 | -77.9 | 8.22 | Anacardiaceae | Anacardium excelsum | 8.22
1300 | -77.9 | 8.22 | Anacardiaceae | Anacardium excelsum | 8.22
1301 | -77.9 | 8.22 | Anacardiaceae | Anacardium excelsum | 8.22
1302 | -77.9 | 8.22 | Anacardiaceae | Anacardium excelsum | 8.22
Row: 35 of 1681
Highlight
Pan To
Zoom To
Export
Identify
X -49.57034
Y 8.97935
shp specie
Rec 1 of 1
Layer: shp species_lat_long_49365
FAMILY: Rubiaceae
NAME: Alibertia edulis
LATDEC: 9.0528
LONGDEC: -49.6417
ELEV_M:
COUNTRY: Panama
Identify
X -83.65002
Y 11.58004
shp specie
Rec 2 of 8
Layer: shp species_lat_long_49365
FAMILY: Anacardiaceae
NAME: Anacardium occidentale
LATDEC: 11.58
LONGDEC: -83.65
ELEV_M: 10
COUNTRY: Nicaragua
DIVA-GIS 5.0 - preparation maps
Project Data Layer Map Analysis Climate Grid Stack Tools Help
Row: 62 of 1681
Highlight
Pan To
Zoom To
Export
Scale 1 :828221
Data
Image

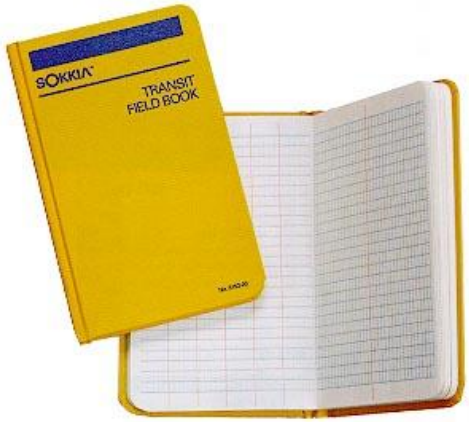
Identification of atypical points



Errors

Errors are unavoidable, how to deal with them ?

- Source data (field book)
- Information by collectors



Importance of proper documentation

Decision:
Eliminate or correct ?

Collecting Missions Files Repository

GPG2 Global Public Goods Project

SGRP

Collecting Missions Documents

Results of the query [permalink]

Click on the items of the results list to view the metadata and download the PDF file.

Go back to the search mask

Title	Modified
Collecting Mission to Mauritius and Rodriguez *(CN317Report.pdf)*	Jan 31, 2012
Collecting Mission to Mauritius and Rodriguez *(CN317AccessionVouchers.pdf)*	Jan 31, 2012
Collecting Mission to Mauritius and Rodriguez *(CN317SummaryForms.pdf)*	Jan 31, 2012

Bioversity International

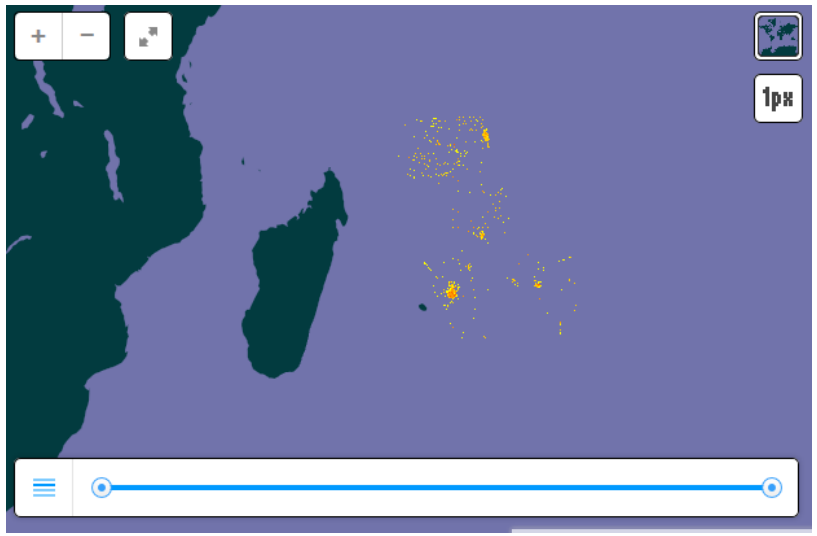
Additional data sources

GBIF

GBIF.ORG
Free and Open Access to Biodiversity Data

http://www.gbif.org/

International data providers' networks (established in 2001) that shares biodiversity data without any cost
Plantae, Animalia, Fungi, Bacteria, Viruses (516,757,748 records)
with coordinates: 448,781,964



Example:
Plant records in Mauritius
6,276 records
4,835 georeferenced sites
(quality control!!!)

Bioversity International

GENESYS

Genesys
Gateway to Genetic Resources

https://www.genesys-pgr.org/welcome

CGIAR initiative to group all the information from crop genebanks
Mainly crops (important)
Accession level information (including characterization data)
2,802,770 accessions

Example:
Plant records in Mauritius
315 records
7 georeferenced sites
(quality control!!)

Bioversity International

Bioversity Collecting Mission Database

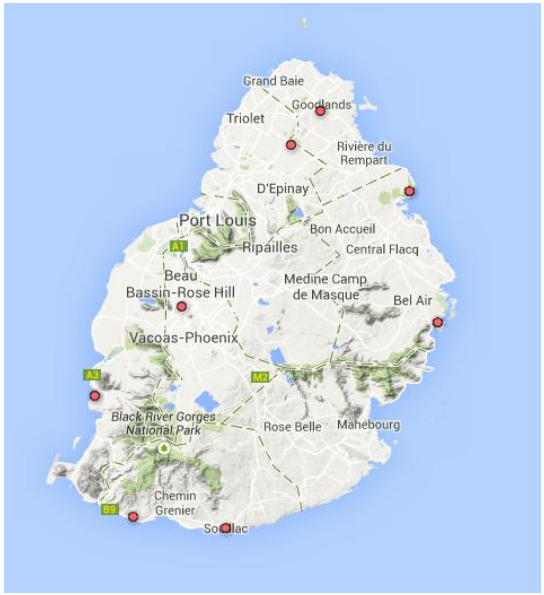
Collecting Missions

http://bioversity.github.io/geosite/

Access to original passport data of germplasm samples collected around the world during Bioversity International supported missions

Plant records (220,000 records)
with coordinates: 150,000

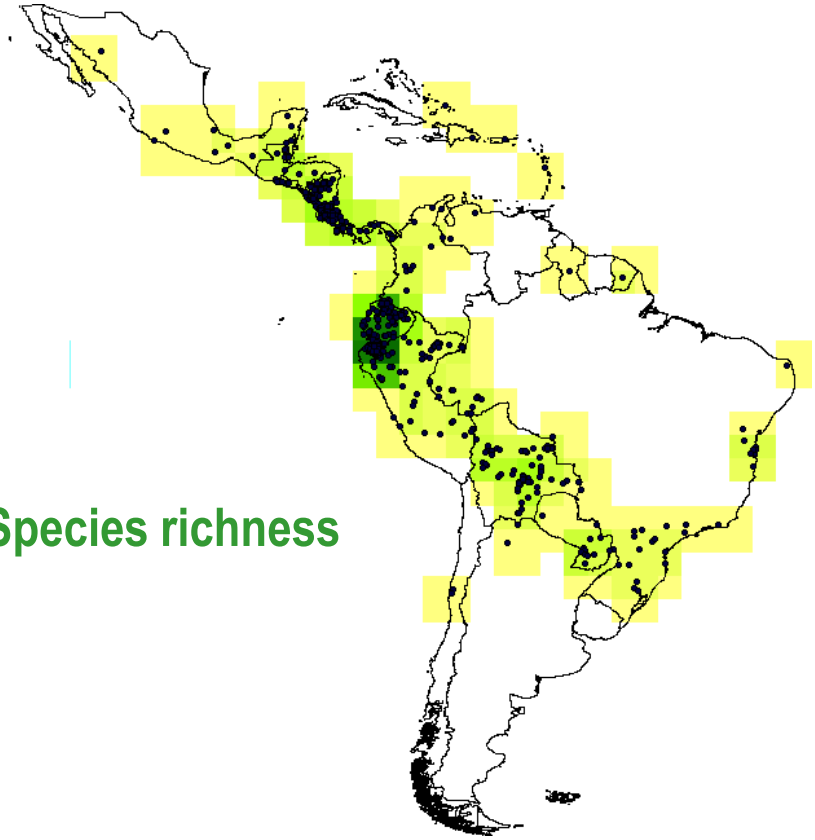
Example:
Plant records in Mauritius
47 records
47 georeferenced sites
(quality control!)



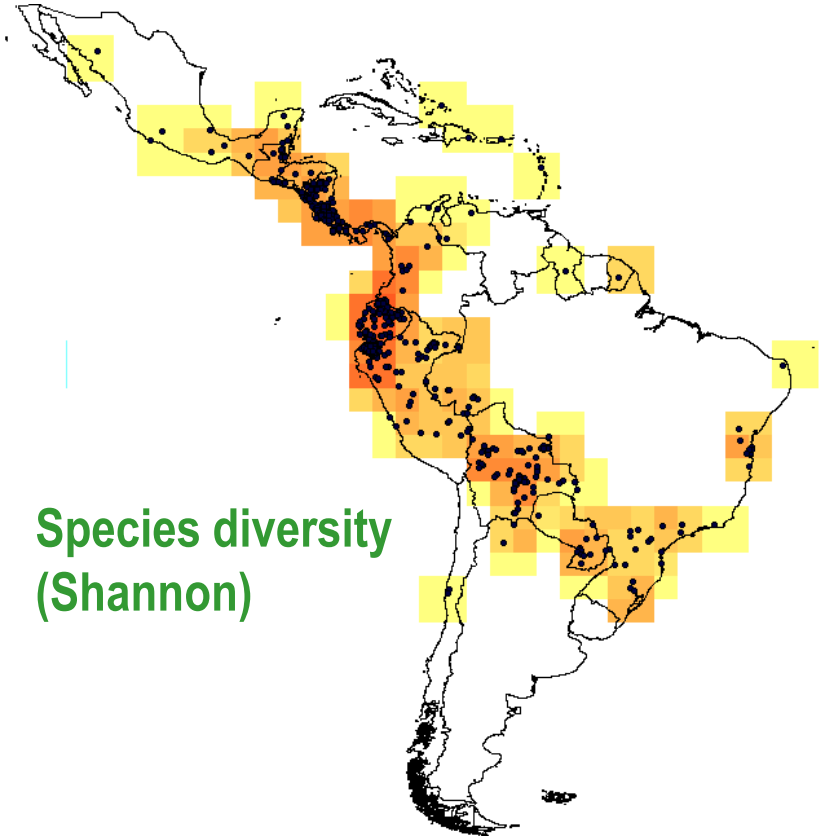
Case studies

Distribution and richness/diversity

Highland Papayas (*Vasconcellea spp.*)



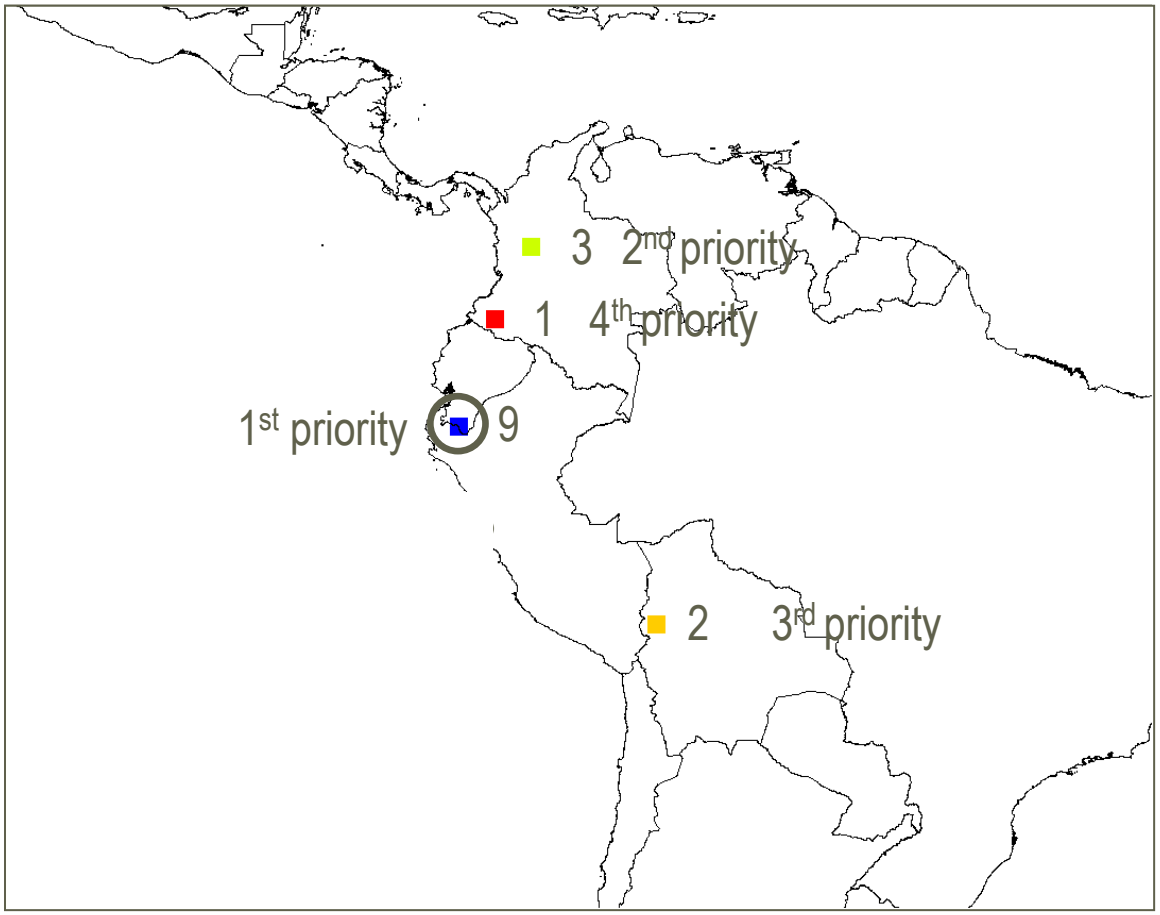
Species richness



Species diversity (Shannon)

Priority areas for in situ conservation

Highland Papayas (*Vasconcellea spp.*)

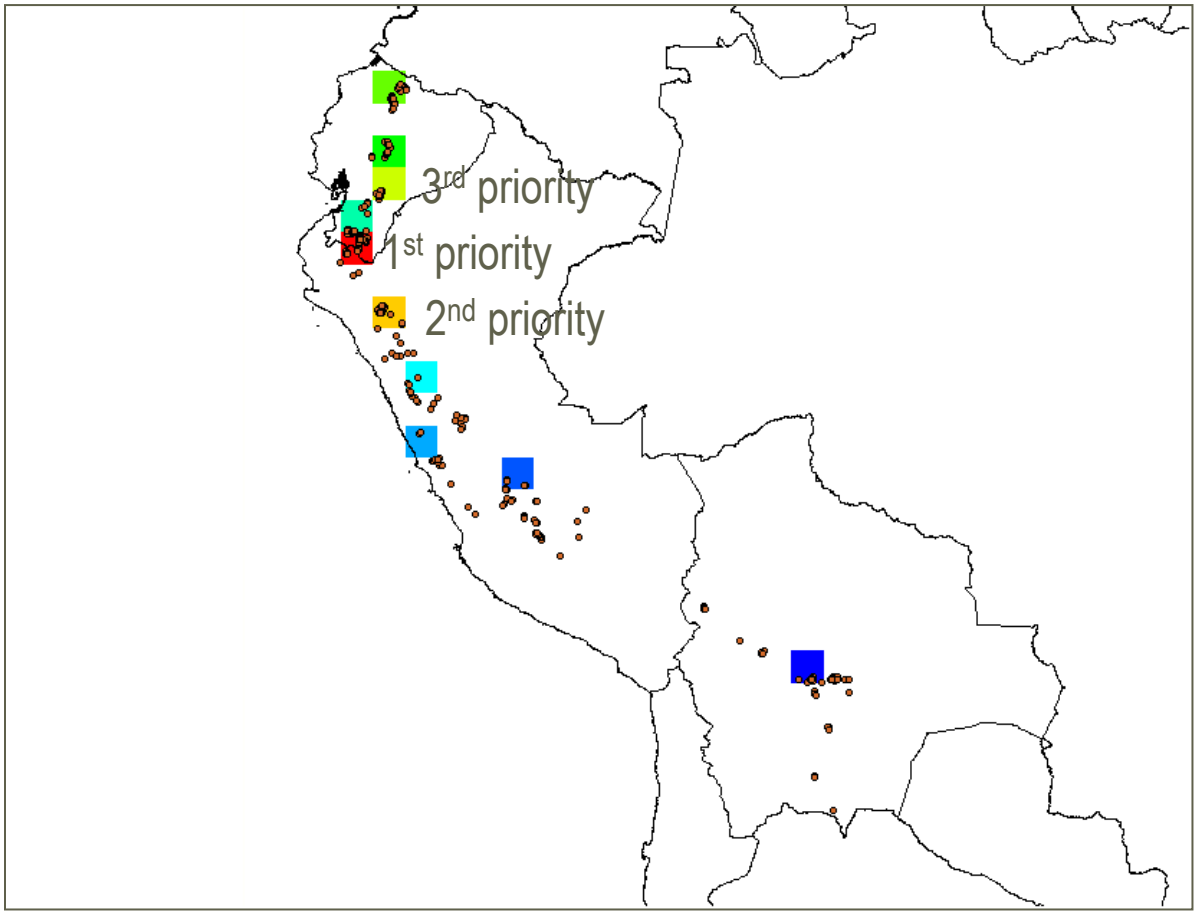


Species diversity

Additional species

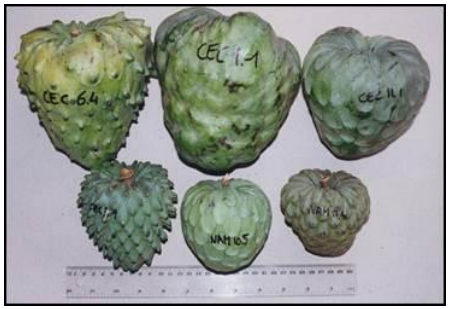
Priority areas for in situ conservation

Cherimoya (*Annona cherimola*)



Allelic diversity

Additional alleles



Collection gap analysis

Highland Papayas (Vasconcellea spp.)

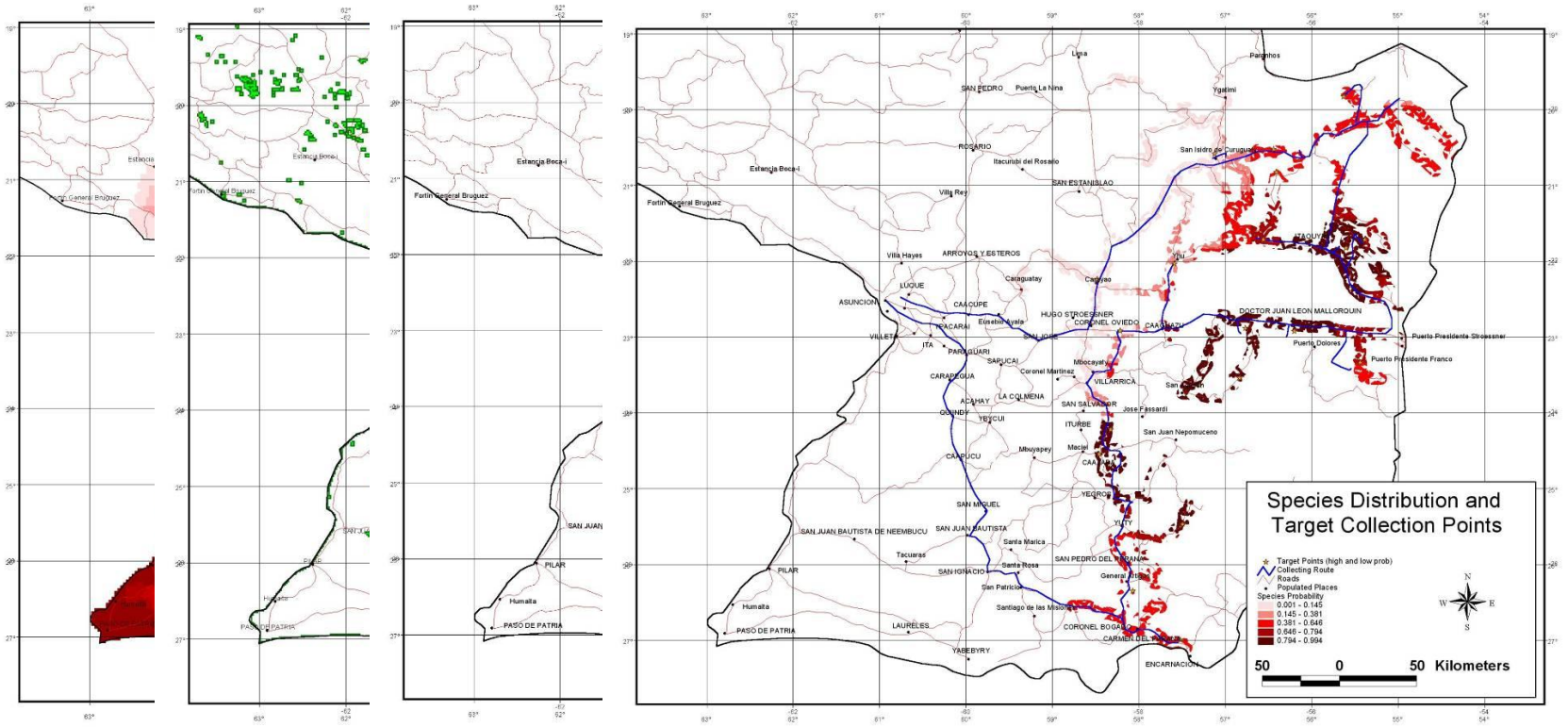
Observed species richness

Modeled species richness

Potential collection gap

Targeted germplasm collection

Wild and rare chilli species (*Capsicum flexuosum*)



Preser Forest m Access t Priority collection areas

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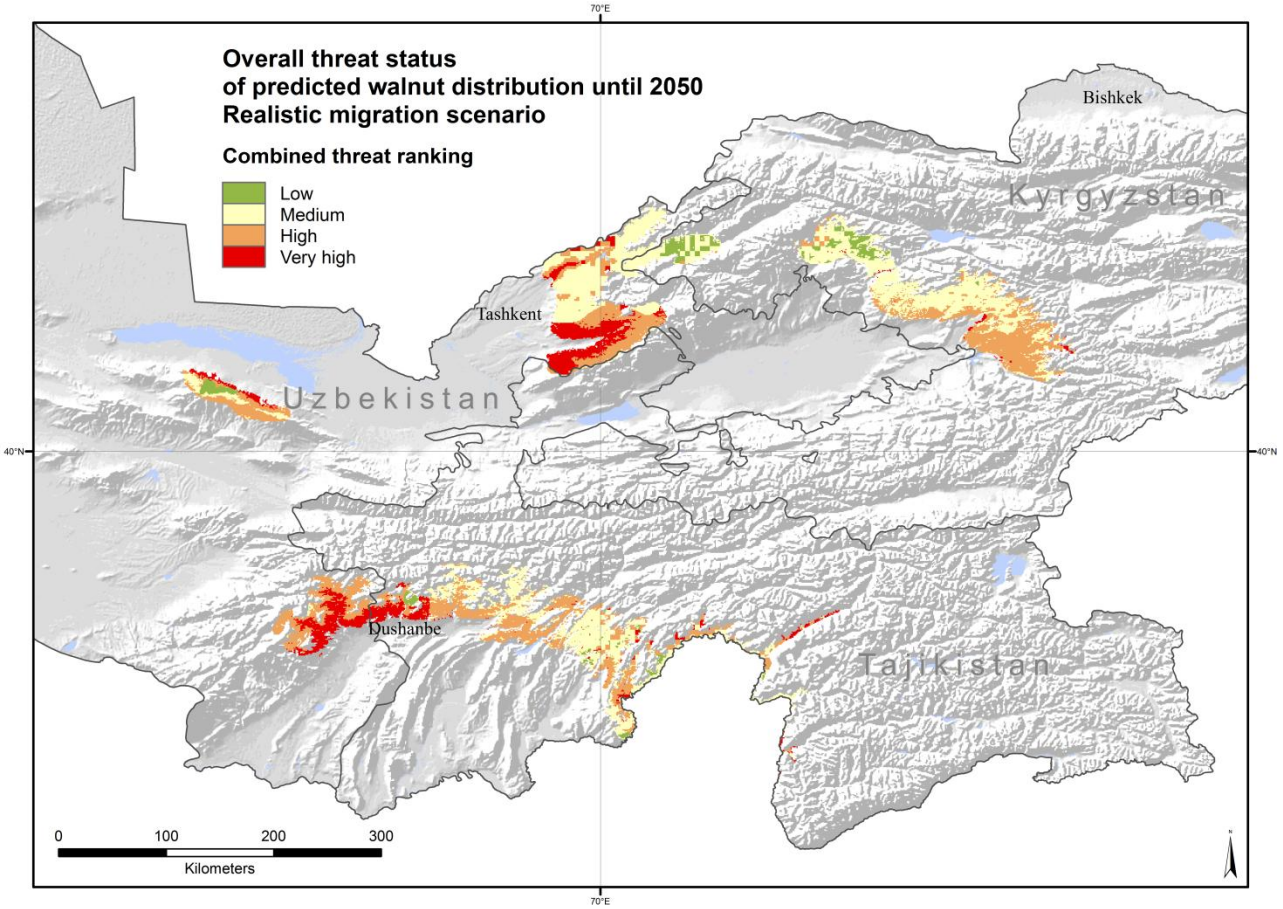
Threat analysis

Wild walnut (*Juglans regia*)



Livestock grazing

Landslides

Climate change

Human accessibility

Combined threat

Conclusions

- Georeferenced data contain much unknown or hidden information
- Importance to georeference (and carry out quality control)
- The quality of the analysis depends much on the amount (and quality) of the data: importance to integrate data (at regional / global levels)
- GIS: be careful in the interpretation of results (there are always results!)
- How can we better integrate intraspecific diversity data into spatial analysis?

DIVA-GIS

Bioversity International

DIVA-GIS

GIS software developed by CIP, Bioversity, and Berkeley University with support from FAO, USDA, SINGER, BMZ, and SENASA.

Emphasis in mapping and spatial analysis of diversity

Tools to check/correct data

Works with vector (shp) and raster (grd) data

Includes climate data and runs the BIOCLIM and DOMAIN niche models

Includes a tutorial handbook with exercises to learn how to use it

All without costs !!

http://www.diva-gis.org

Thank you ☺

www.bioversityinternational.org

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