

CoLa - Connecting Landscapes Decision Support System

Vientiane, Laos
November 20th, 2024

Funded by:

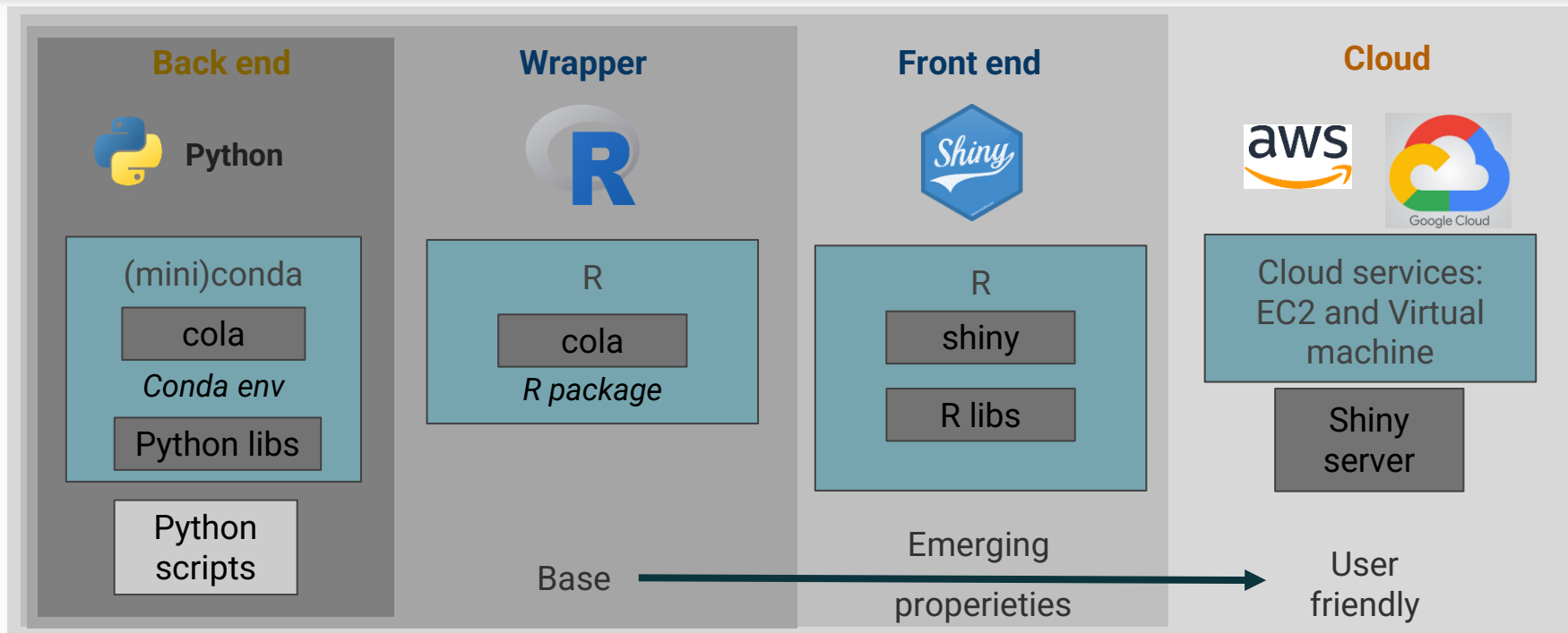


Developed by:





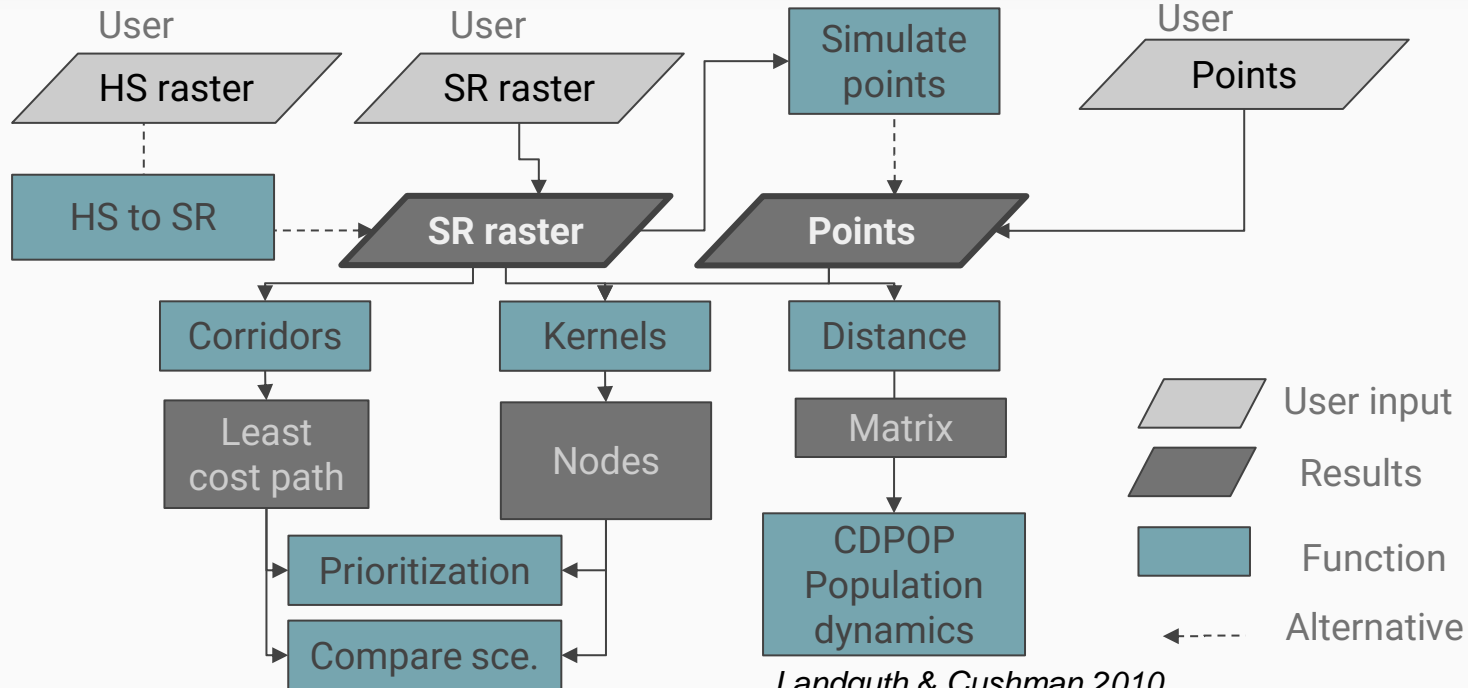
4. DSS Overview



Complete workflow

HS: Habitat suitability

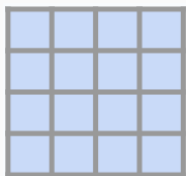
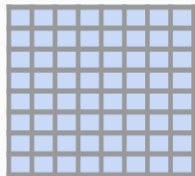
SR: Surface resistance



Landguth & Cushman 2010

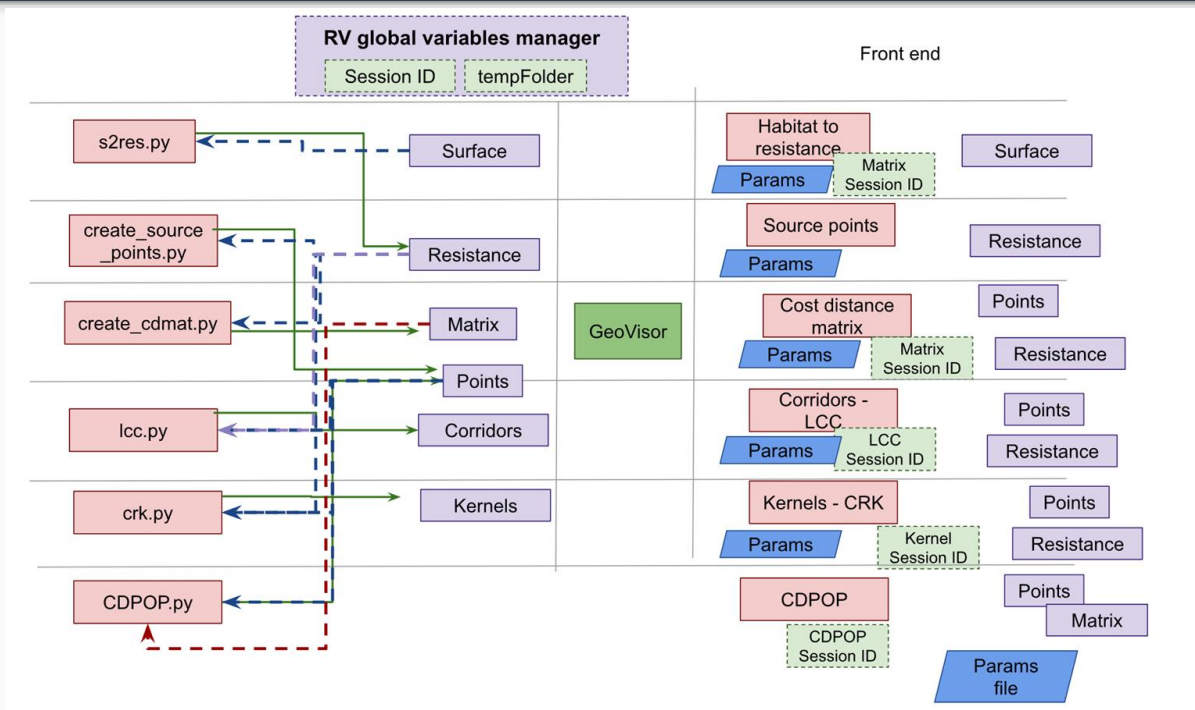
**Original
(system):**

**Web
visor:**





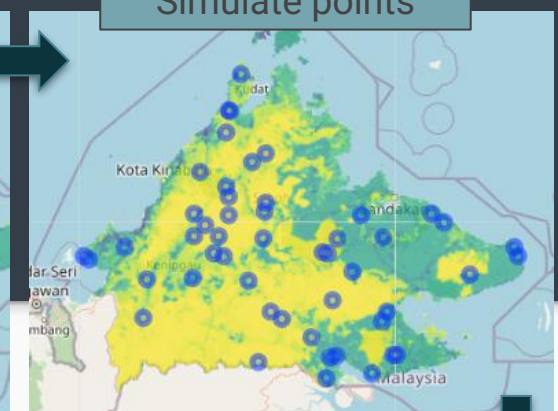
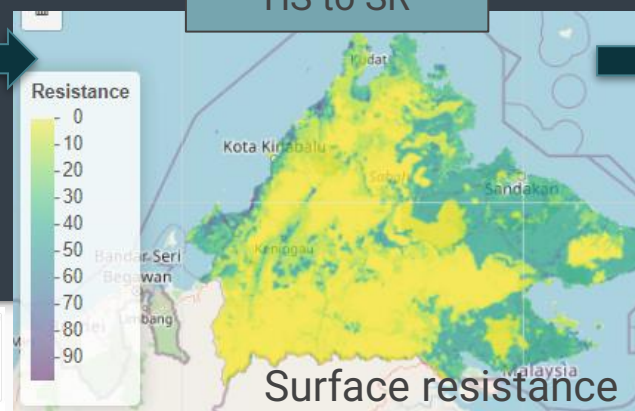
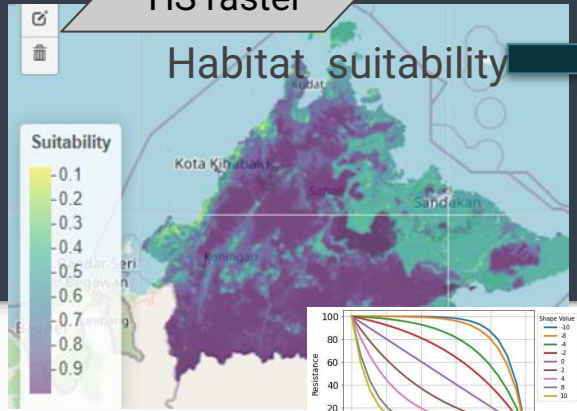
DSS Overview



HS raster

HS to SR

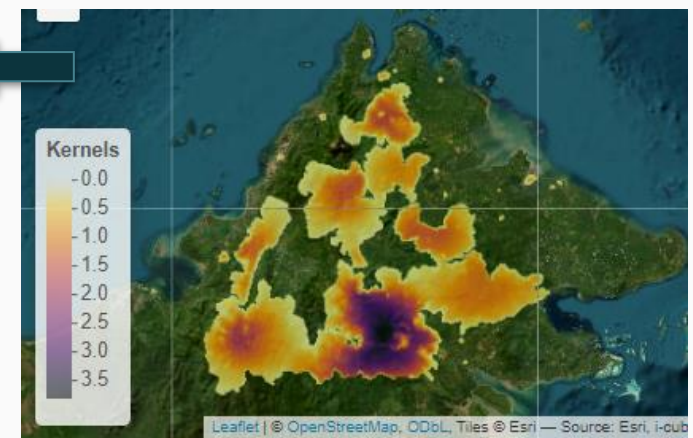
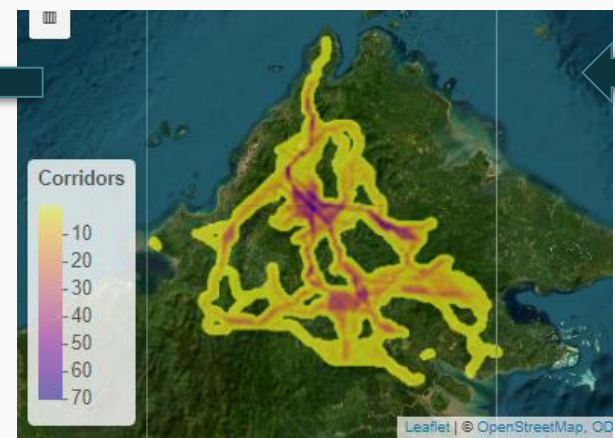
Simulate points



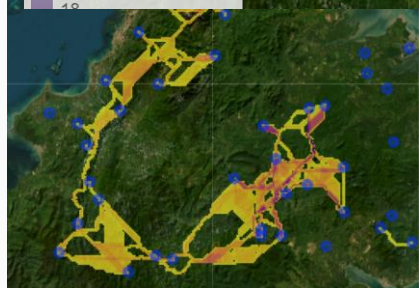
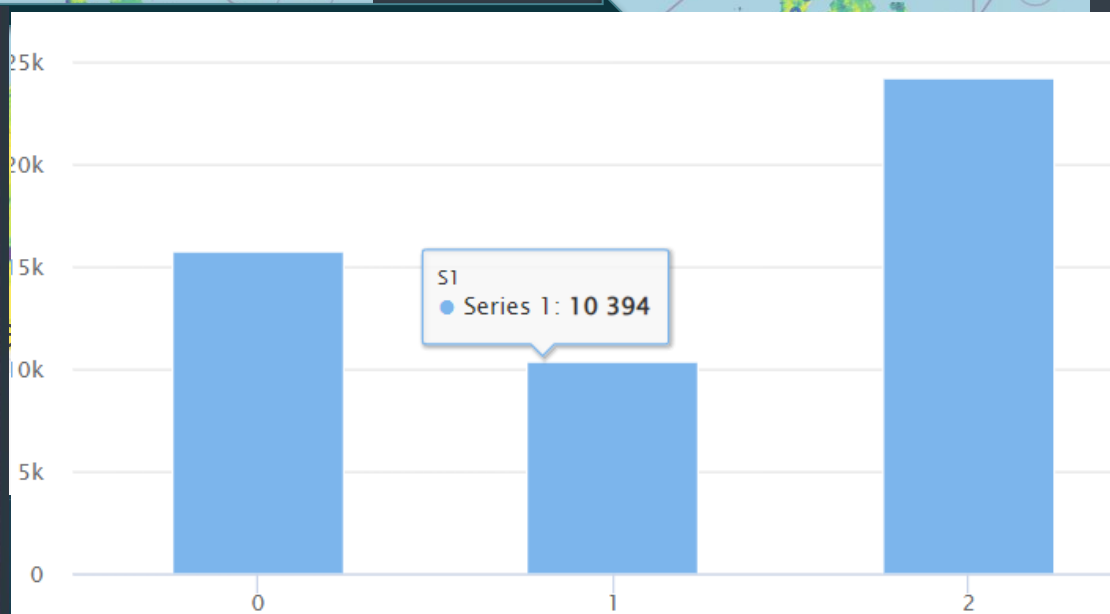
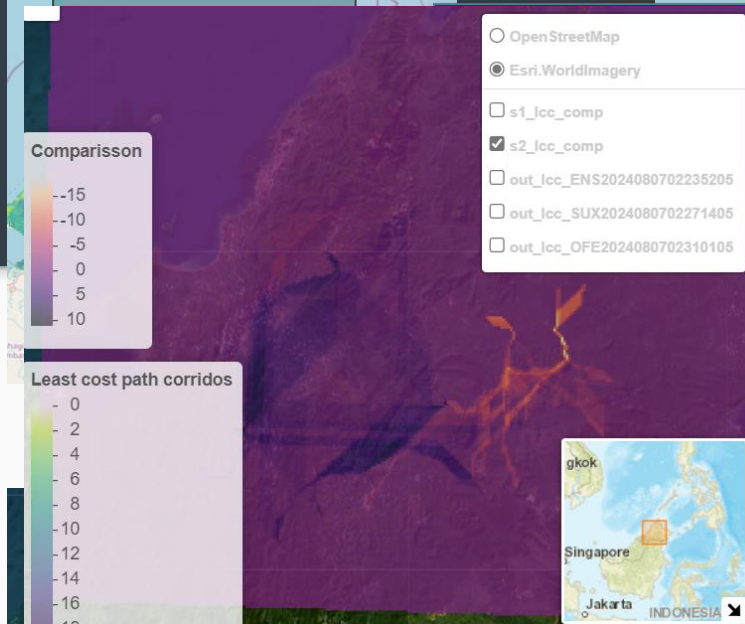
Prioritization

Corridors

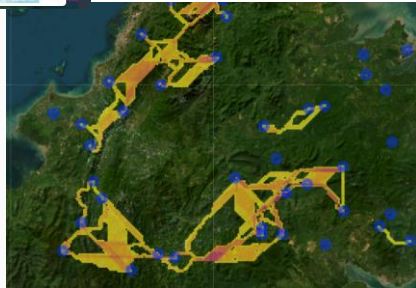
Kernels



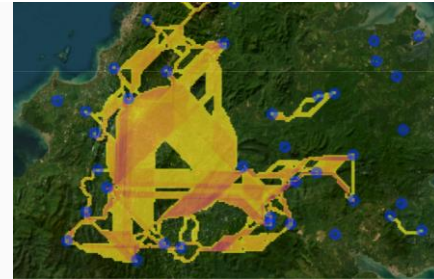
SR +PTS



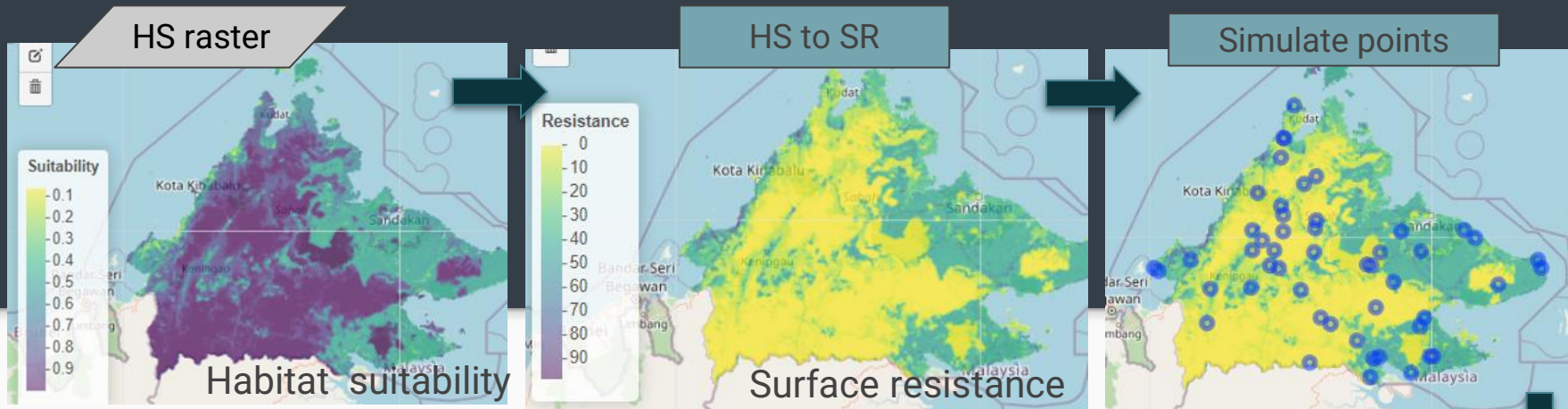
Corridors



Corridors



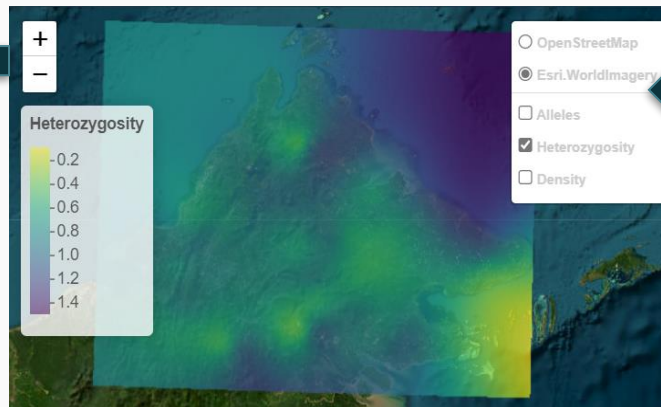
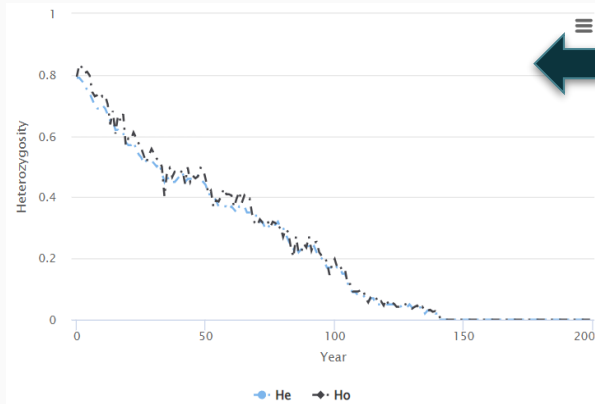
Corridors



Heterozygosity

Heterozygosity

Cost distance matrix



	1,2	1,3	4,n
2,1		2,3	2,n
3,1	3,2		3,n
n,1	n,2	n,3	

Decision support system (DSS)

Funders



Developers





Project

Run each of the previous steps using the sample data (or yours) and provide a screenshot and brief explanation of your results.

Include:

- a) Surface resistance
- b) Points
- c) Resistant kernels
- d) Corridors


Make a Word or PDF document and upload it [here](#)


[Fill this form](#) (5mins)


Overview

ConnectingLandscapes

 Home


 Habitat suitability <>
resistance surface


 Customize resistance surface


 Create source points


 Cost distance matrix

 CDPPOP


 Connectivity - corridors

 Connectivity
dispersal kernels

 Connectivity - prioritization

 Assign coords

 PDF

 Run locally

Home

How it works

Performance

Showcase

ShowcasePriv

Toolkit Overview

Increasing loss and fragmentation of habitats has resulted in an urgent need to identify areas for conservation that also maintain and enhance ecological connectivity of protected areas. The Connecting Landscapes (**CoLa**) toolkit integrates and enhances numerous landscape genetics and habitat connectivity tools (Landguth and Cushman 2010, Landguth et al. 2012) to aid in identifying connectivity conservation priorities and areas of potential human wildlife conflict.

The toolkit is supported by NASA Biological Diversity & Ecological Conservation program Grant No. 80NSSC21K1942 - Strengthening Natural Resource Management with New Protected Area Connectivity Tools, and was co-developed with the Wildlife Conservation Research Unit (WildCRU) of University of Oxford and the United States Forest Service (USFS) Rocky Mountain Research Station, USFS International Programs.

Primary inputs to the tools include habitat suitability layers or spatially explicit estimates of animal movement potential across different land use types (resistance layers), and population source points. When properly parameterized, the toolkit can generate estimates of population genetic structure, population density, core movement areas, and long-distance dispersal corridors.

For recent examples of how the individual tools have been used for wildlife research and conservation assessments see *Kaszta et al. (2020a)*, *Kaszta et al. (2020b)*, *Zeller et al. (2021)*, *Ash et al. (2023)*, *Makwana et al. (2023)*.

>> References

Ash, E., Cushman, S., Kaszta, Z., Landguth, E., Redford, T. and Macdonald, D.W., 2023. Female-biased introductions produce higher predicted population size and genetic diversity in simulations of a small, isolated tiger (*Panthera tigris*) population. *Scientific Reports*, 13(1), p.11199.

Kaszta, Z., Cushman, S.A. and Macdonald, D.W., 2020a. Prioritizing habitat core areas and corridors for a large carnivore across its range. *Animal Conservation*, 23(5), pp.607-616.

Kaszta, Z., Cushman, S.A., Htun, S., Naing, H., Bumham, D. and Macdonald, D.W., 2020b. Simulating the impact of Belt and Road initiative and other major developments in Myanmar on an ambassador felid, the clouded leopard, *Neofelis nebulosa*. *Landscape Ecology*, 35, pp.727-746.

Landguth, E.L. and Cushman, S., 2010. CDPPOP: a spatially explicit cost distance population genetics program. *Molecular ecology resources*, 10(1), pp.156-161.

Landguth, E.L., Hand, B.K., Glassy, J., Cushman, S.A. and Sawaya, M.A., 2012. UNICOR: a species connectivity and corridor network simulator. *Ecography*, 35(1), pp.9-14.

Makwana, M., Vasudeva, V., Cushman, S.A. and Krishnamurthy, R., 2023. Modelling landscape permeability for dispersal and colonization of tigers (*Panthera tigris*) in the Greater Panna Landscape, Central India. *Landscape Ecology*, 38(3), pp.797-819.

Zeller, K.A., Schroeder, C.A., Wan, H.Y., Collins, G., Denryter, K., Jakes, A.F. and Cushman, S.A., 2021. Forecasting habitat and connectivity for pronghorn across the Great Basin ecoregion. *Diversity and Distributions*, 27(12), pp.2315-2329.

>> Contact

Write Patrick.Jantz@nau.edu or Ig299@nau.edu (Ivan Gonzalez) for questions and suggestions

Overview

[Home](#)[How it works](#)[Performance](#)[Showcase](#)[ShowcasePriv](#)

User guide

Depending on the function you want to run you will need different set of inputs.

Each tab have the following goal:

Home:

- Project description
- Performance
- Examples and showcase

Habitat suitability (HS) to surface resistance (SR): Converts HS into SR using user parameters Inputs:

- HS georeferenced raster
- User parameters

Outputs: SR raster (TIF)

Create source points: Inputs:

- SR georeferenced raster
- User parameters

Outputs: Points (SHP)

Cost distance matrix: Inputs:

- SR georeferenced raster
- Coordinates or spatial points
- User parameters

Outputs: Matrix (CSV)

CDPOP: Inputs: SR raster Coordinates or spatial points Distance matrix User parameters

Outputs: Population data (xy)

Landscape genetics: Inputs: Outputs: SR raster (TIF)

Corridors: Inputs:

- SR georeferenced raster
- Coordinates or spatial points
- User parameters

Outputs: Corridors (TIF)

Performance

[Home](#)[How it works](#)[Performance](#)[Showcase](#)[ShowcasePriv](#)[Graphs](#)[Scenarios table](#)[Results table](#)

These results are the comparison of the developed functions with existing software. You can see the results for several scenarios (# of pixels, # of points), in terms of RAM (GB) and time (minutes) spent for both softwares

X-axis

Total pixels

Software:

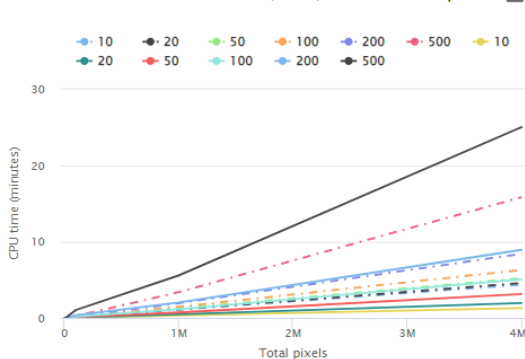
Least cost path

☐ Factor X-axis

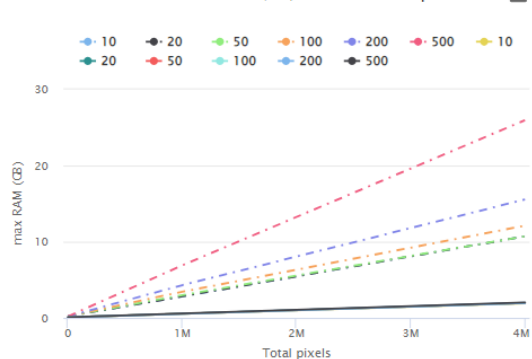
☐ Log X-axis

☐ Log Y-axis

Performance in CPU time (mins) of Least cost path



Performance in RAM (GB) of Least cost path



The visuals

Log box +
session ID

Ready / Not
ready label

Run /
download

The screenshot shows the ConnectingLandscapes web application interface. The main title is "ConnectingLandscapes". The interface is divided into several sections:

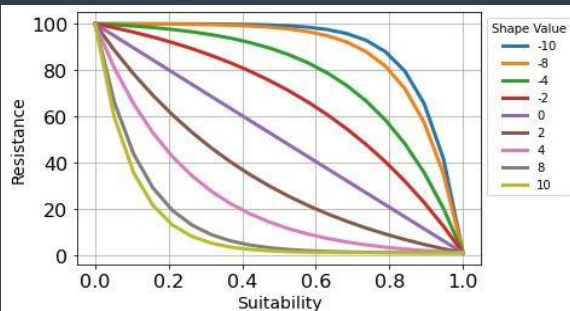
- Left Sidebar (Functions):** Contains a list of functions: Home, Habitat suitability <-> resistance surface, Load Suitability, Customize resistance surface, Create source points, Cost distance matrix, CDPOP, Connectivity - kernels, Connectivity - corridors, Connectivity - prioritization, Compare results, Assign coords, PDF, and Run locally.
- Top Center (Create surface resistance):** A form with input fields for Min. val: (0), Max. val: (100), Shape: (12), and New layer name: (NameOfNewLayerToCreate). A log box above the form displays "Your session ID: colaIPW2024110721123605" and "Waiting for inputs ...".
- Top Right (Ready / Not ready label):** A label indicating the status of the process, currently showing "Not ready".
- Top Right (Run / download):** Buttons for "Load sample data", "Get Res Surf", and "Download".
- Center (Geovisor):** A world map with a "Parameters" label and "Draw tools" (a vertical toolbar with icons for zooming, panning, and drawing).
- Bottom Right (Basemap + measure):** A small inset map showing a zoomed-in view of a region.

Save your
session ID
for
questions
or bugs

1. Suitability to resistance

For running:

1. Load a valid TIF raster with continuous values
2. Define the parameters. They are calculated from your raster by default. Modify as needed.
3. Look for the green **Ready** labels
4. Click on “**Get resistance surface**”
5. **Download** the resulting raster in TIFF format



ConnectingLandscapes

Home

Habitat suitability ↔ resistance surface

Habitat suitability name:

Load Suitability

Search No file

Customize resistance surface

Create source points

Cost distance matrix

CDPOP

Connectivity - kernels

Connectivity - corridors

Connectivity - prioritization

Compare results

Assign coords

PDF

Run locally

Create surface resistance

Your session ID: colaHBM2024110717095805
Waiting for inputs ...

Min. val: 0.06788434833

Max-resistance: 5

No Data: -9999

Source layer:

Max. val: 0.99893254041

Shape: 12

New layer name: NameOfNewLayerToCreate

Input: Habitat suitability **Ready**

Load sample data

Get Res Surface

Download

Open StreetMap

Esri.WorldImagery

Habitat suitability

Suitability

0.0

0.2

No data? Load the **sample dataset**

2. Customize resistance surface

For running:

1. Load a valid TIF raster with continuous values if skipping last step. No extra SR required
2. Draw figures you want to “burn” in. Multiple geometry types allowed
3. Provide a “value to add”. Number positive or negative
4. Look for the green **Ready** labels
5. Click on “**Add values to raster**”
6. Download the resulting raster in TIFF format

The screenshot shows the 'ConnectingLandscapes' web application interface. The main title is 'Customize surface resistance'. The interface is divided into several sections:

- Top Bar:** Includes a 'Home' link, a session ID 'colahBM2024110717095805', and status messages 'Waiting for inputs ...' and 'Creating resistance surface ... DONE'.
- Left Sidebar:** Contains navigation links: 'Habitat suitability <> resistance surface' (highlighted with a red box), 'Customize resistance surface', 'Load Resistance', 'Load polygon', 'Create source points', 'Cost distance matrix', 'CDPOP', 'Connectivity - kernels', 'Connectivity - corridors', 'Connectivity - prioritization', 'Compare results', 'Assign coords', 'PDF', and 'Run locally'.
- Main Content Area:**
 - Customize resistance surface:** Includes a text input for 'Surface resistance name:', a 'Value:' input set to '0' (highlighted with a red box), and a 'Pixel width:' input set to '1'.
 - Buttons:** 'Add vals' (highlighted with a green box), 'Replace vals', 'Download' (highlighted with a red box), and 'Add values to raster' (highlighted with a green box).
 - Map:** A map of Borneo showing a resistance surface. A legend on the left indicates resistance values from -1.0 (yellow) to -5.0 (purple). A toolbar on the left of the map includes icons for adding, subtracting, and drawing polygons.
 - Map Controls:** On the right, there are map style options: 'Open StreetMap', 'Esri.WorldImagery', 'Surface resistance' (checked), and 'Habitat suitability'. A 'Download' button is also present.

3. Create source points

For running:

1. Load a valid TIF raster with continuous values if skipping previous steps. Can use HS or SR
2. Select the min-max range on the raster to simulate the points, and the total number of points
3. Look for the green **Ready** labels
4. Select which (available) layer to base the analysis on.
5. Click on **“Create points”**
6. Download the resulting raster in TIFF format

The screenshot displays the ConnectingLandscapes web application interface. The main title is "ConnectingLandscapes". The left sidebar contains a menu with options: Home, Habitat suitability <> resistance surface, Customize resistance surface, Create source points (highlighted with a red box), Surface resistance name: (with a search bar and "No file" button), Suitability TIF: (with a search bar and "No file" button), Resistance TIF: (with a search bar and "No file" button), Cost distance matrix, CDPOP, Connectivity - kernels, Connectivity - corridors, Connectivity - prioritization, Compare results, and Assign coords.

The main content area is titled "Create points". It features a session ID: colahRM2024110717095805, and status messages: "Waiting for inputs ..." and "Creating resistance surface ... DONE". Below this, there are input fields for "Source layer:" (set to "SurfaceResistance") and "New layer name:" (set to "Name new layer"). The "Input:" field is set to "Raster" and is labeled "Ready" in green. A green "Create points" button and a red "Download" button are visible.

Below the input fields, there is a table with three columns: "Min-grid:", "Max-grid:", and "# of points:". The values are 1, 5, and 50 respectively. The table is highlighted with a red box.

The main map area shows a map of Borneo with a resistance raster overlay. A legend titled "Resistance" shows a color scale from -1.0 (yellow) to -5.0 (purple). The map includes labels for various locations: Palawan, Kota Kinabalu, Sandakan, Brunei, Limbang, Bandar Seri Begawan, Miri, Bintulu, Sarawak, Kalimantan Utara, Tarakan, Malaysia, Zamboang City, Basilan, Sulu, and Tawi-Tawi. A small inset map shows the location of Borneo within Southeast Asia.

4. Kernels

For running:

1. Load a valid TIF raster with continuous values if skipping previous steps. No required to upload SR again. TIF before points.
2. Load a valid point shapefile if skipped previous steps
3. Look for the green **Ready** labels
4. Select parameters
5. Click on **“Get kernels”**
6. Download the resulting raster in TIFF format

ConnectingLandscapes

Home

Habitat suitability <> resistance surface

Customize resistance surface

Create source points

Cost distance matrix

CDPOP

Connectivity - kernels

Surface resistance name:

Load Resistance

Search TIF: No file

Points name:

Load points files (all)

Search: INC SHP, DBF, S

Connectivity - corridors

Connectivity - prioritization

Compare results

Assign coords

PDF

Create kernels

Input: Points **Ready**

Input: Surface resistance **Ready**

Max. dispersal distance (cost units): 20000

Kernel shape: linear

Kernel volume: 1

Source layer:

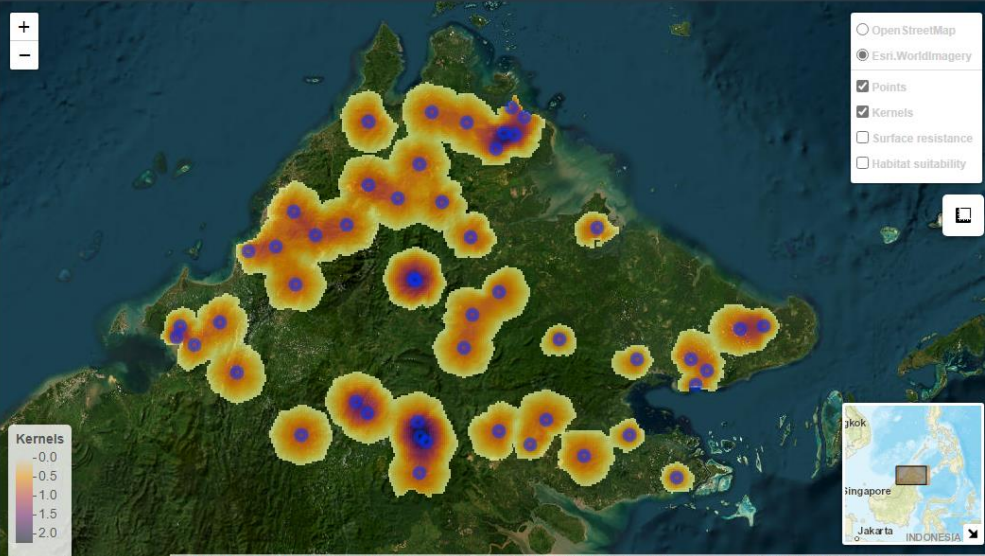
New layer name: Name new layer

Transform?: no

Your session ID: colaQUQ2024110720023605
Waiting for inputs ...
Creating resistance surface ... DONE

Get kernels

Download



The map displays the Indonesian archipelago with numerous yellow and orange circular kernels overlaid, indicating areas of high resistance or cost. A legend in the bottom left corner shows a color scale for 'Kernels' ranging from -0.0 (yellow) to -2.0 (dark purple). The map interface includes a zoom control on the left and a map type selector on the right (Open StreetMap, Esri, World Imagery). A small inset map in the bottom right corner shows the location of the study area within Southeast Asia, with labels for 'Jok', 'Singapore', 'Jakarta', and 'INDONESIA'.

5. Corridors

For running:

1. Load a valid TIF raster with continuous values if skipping previous steps. No required to upload SR again
2. Load a valid point shapefile if skipped previous steps
3. Look for the green **Ready** labels
4. Select parameters
5. Click on **"Get corridors"** or **"heavy"** for big rasters.
6. Download the resulting raster in TIFF format

ConnectingLandscapes

Home

Habitat suitability <> resistance surface

Customize resistance surface

Create source points

Cost distance matrix

CDPOP

Connectivity - kernels

Connectivity - corridors

Surface resistance name:

Load Resistance

Search TIF No file

Points name:

Load points files (all)

Search INC SHP, DBF, S

Connectivity - prioritization

Compare results

Assign coords

PDF

Run locally

Create corridors

Your session ID: colaHBM2024110717095805
Waiting for inputs ...
Creating resistance surface ... DONE

Input: Points **Ready**

Input: Surface resistance **Ready**

Max. dispersal distance (cost units): 8000

Corridor smoothing factor: 0

Corridor tolerance (meters): 5

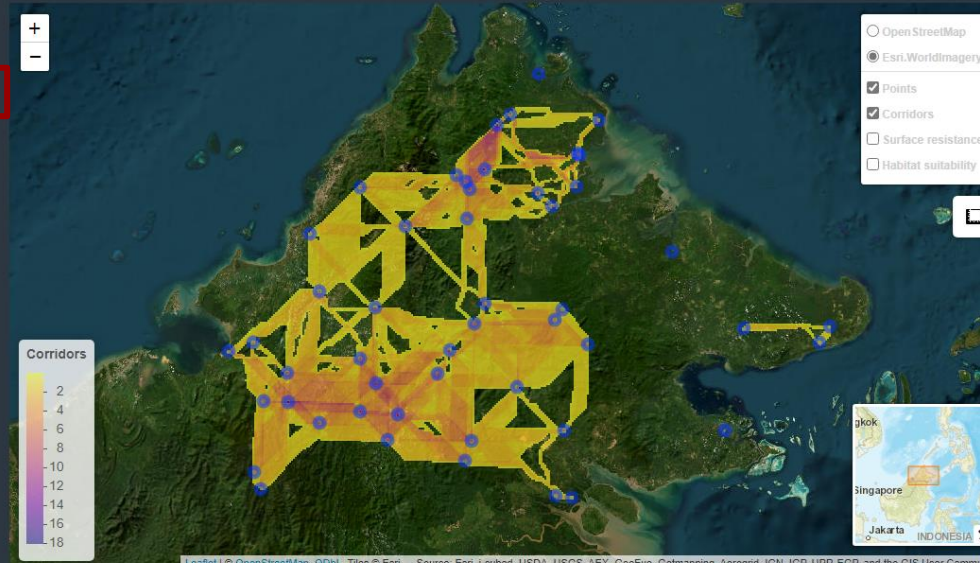
Source layer:

New layer name: Name new layer

Get corridors

Get corridors (heavy)

Download



Corridors

Legend: 2, 4, 6, 8, 10, 12, 14, 16, 18

OpenStreetMap, Esri, Worldimagery

Points

Corridors

Surface resistance

Habitat suitability

Leaflet | © OpenStreetMap, ODbL, Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community

6. Prioritization

For running:

1. Must have corridors and kernels developed on the app
2. Select parameters
3. Look for the green **Ready** labels
4. Click on **"Prioritize"**
5. Download the resulting raster in TIFF format

ConnectingLandscapes

Home

Habitat suitability <> resistance surface

Customize resistance surface

Create source points

Cost distance matrix

CDPOP

Connectivity - kernels

Connectivity - corridors

Connectivity - prioritization

Compare results

Assign coords

PDF

Run locally

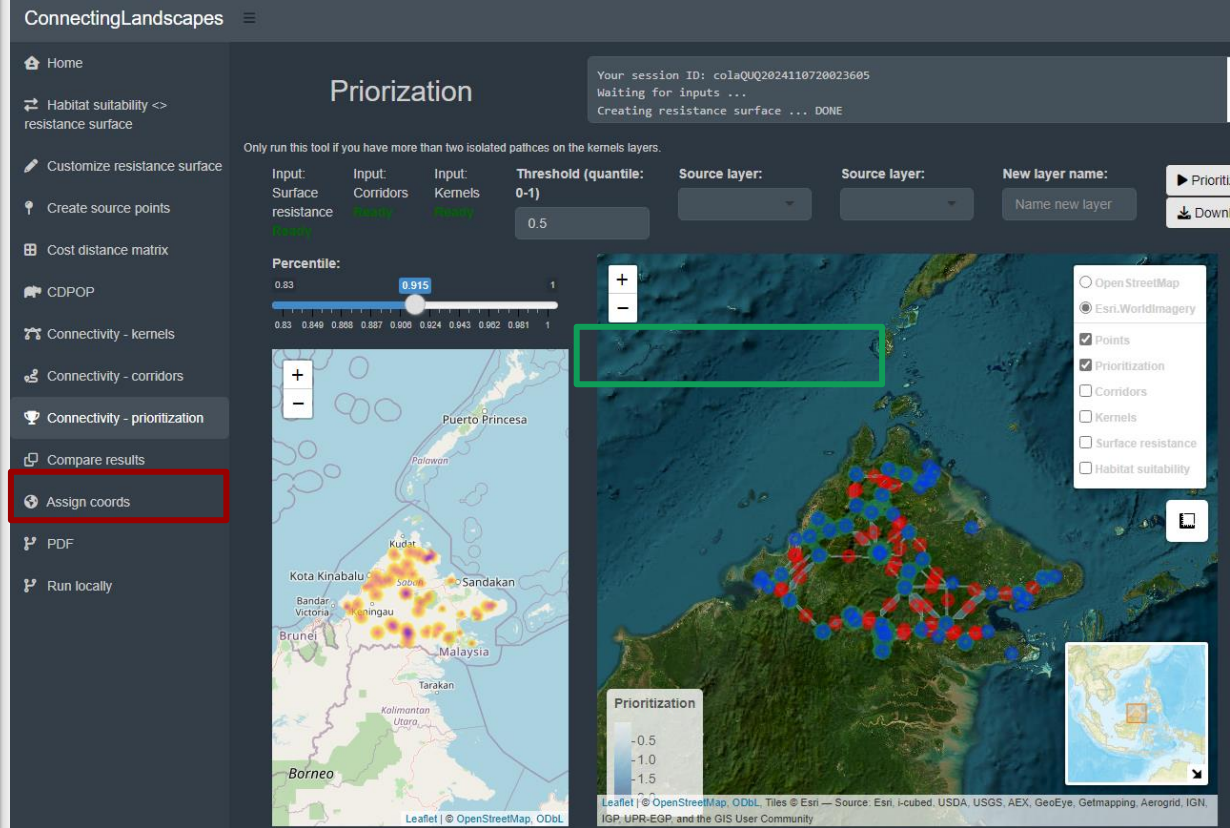
Priorization

Your session ID: colaQUQ2024110720023605
Waiting for inputs ...
Creating resistance surface ... DONE

Only run this tool if you have more than two isolated pathches on the kernels layers.

Input: Surface resistance **Ready** Input: Corridors **Ready** Input: Kernels **Ready** Threshold (quantile: 0-1) 0.5 Source layer: Source layer: New layer name: Name new layer ▶ Prioritization Download

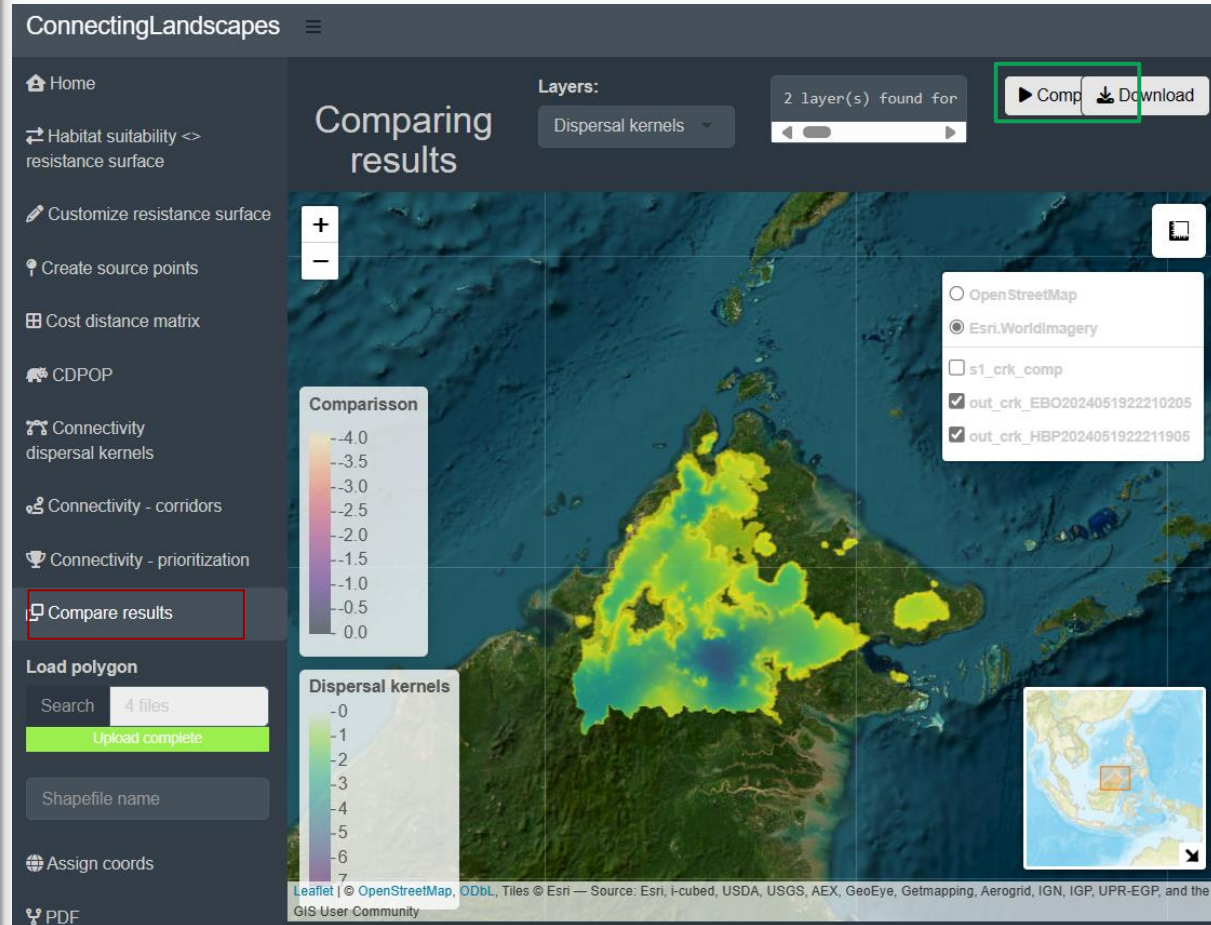
Percentile: 0.83 0.849 0.868 0.887 0.900 0.924 0.943 0.962 0.981 1 0.915



7. Compare

For running:

1. Must have at least two (2) corridors or kernels developed on the app
2. Choose layer to compare
3. Click on “Compare”
4. Download the resulting files on a compressed file



8. Distance matrix

For running:

1. Load a valid TIF raster with continuous values if skipping previous steps. No required to upload SR again
2. Load a valid point shapefile if skipped previous steps
3. Look for the green **Ready** labels
4. Select parameters
5. Click on **"Get matrix"**.
6. Download the resulting matrix in CSV format

ConnectingLandscapes

Home

Habitat suitability <> resistance surface

Customize resistance surface

Create source points

Cost distance matrix

Surface resistance name:

Load Resistance

Search TIF No file

Points name:

Load points files

Search INC SHP, DBF, S

CDPOP

Connectivity - kernels

Connectivity - corridors

Connectivity - prioritization

Create Distance Matrix

Your session ID: colaIMV2024110721123605
Waiting for inputs ...
Creating resistance surface ... DONE

Input: Surface resistance **Ready**

Input: Points **Ready**

Distance threshold (cost units): 200000

New CSV name: Name new CSV

Get matrix

Output: Distance matrix **Ready**

Download

Surface resistance: 1

Resistance

-1.0
-1.5
-2.0
-2.5
-3.0
-3.5

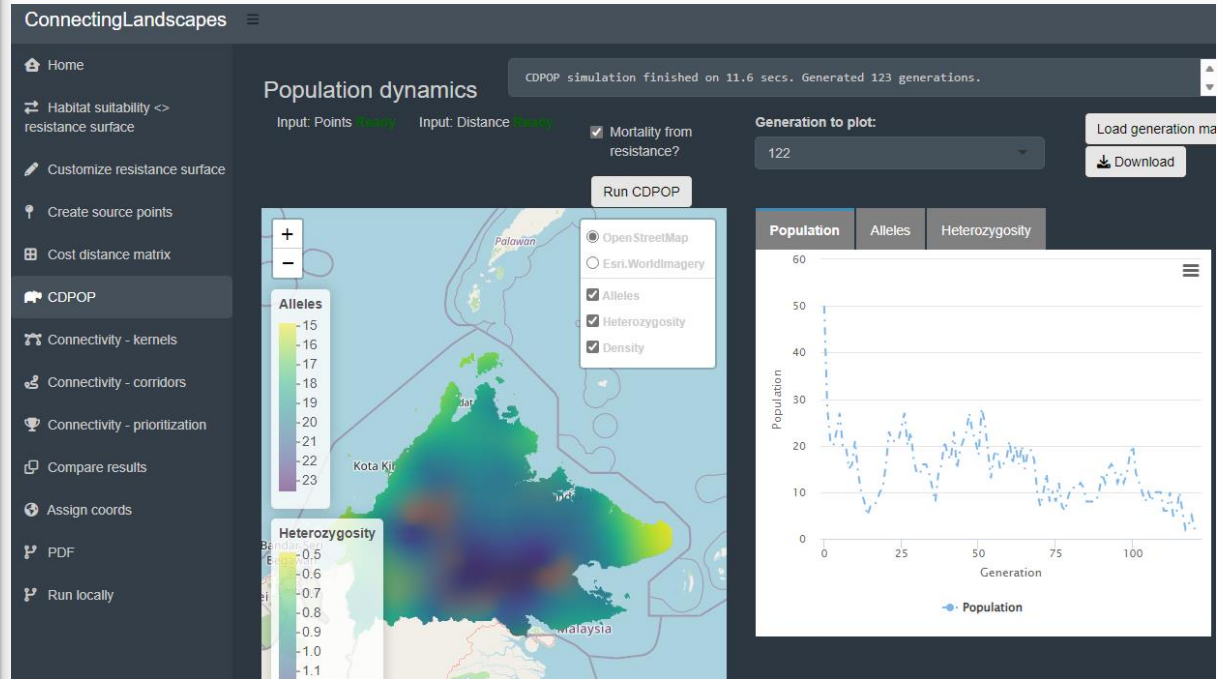
Kudat
Kota Kinabalu
Sandakan
Bandar Victoria
Bandar Seri Begawan
Limbang
Temburong
Bahagian Limbang
Singapore

OpenStreetMap
Esri.WorldImagery
Points
Surface resistance
Habitat suitability

9. CDPOP

For running:

1. Must have a distance matrix generated on the app.
2. load a valid point shapefile if skipped previous steps
3. Look for the green **Ready** labels
4. Select if the mortality should be 0 for all points or extracted from the surface resistance layer.
5. Click on **“Run CDPOP”**.
6. Download the resulting files in ZIP format





Known issues

They will not stop the algorithm but is good to keep this in mind:

1. Use a valid NODATA value in your raster, and be aware of which it is
2. Use PROJECTED rasters
3. Assign a coordinate reference system
4. Your TIFs are big