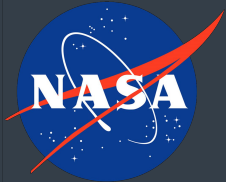


CoLa - Connecting landscape

App demo

Founded by



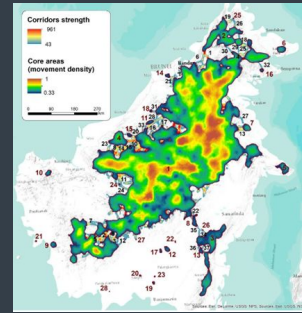
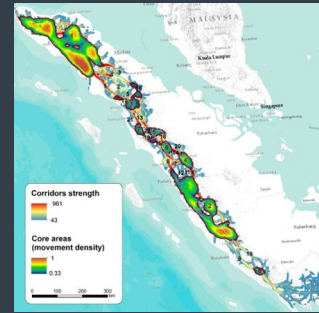
Developed by



Tutorial

18.190.126.82:3838/connecting-landscapes/

Intro

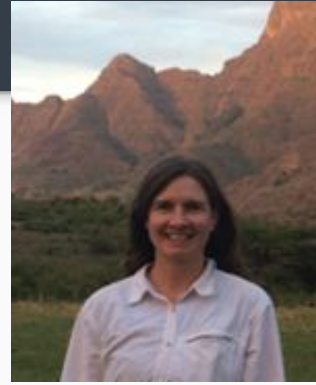


Increasing loss and fragmentation of habitats has resulted in an urgent need to identify areas for conservation that also maintain and enhance ecological connectivity of protected areas. End-users lack easy to use tools to objectively identify connectivity priorities.

Outcome: User friendly software to automatically generate and visualize wildlife connectivity priorities and scenarios using habitat suitability layers derived from NASA Earth observations.

Value: end-users can generate actionable connectivity priorities, enhancing interagency planning, improving protected area technical cooperation programs, improving sustainable forest management, and informing conservation crime assessments related to poaching and illegal land use.

The (great!) team





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Agenda

0 - 10 min: Welcome

10 - 20: The tool. Main directions

20 - 30: Suitability to resistance

30 - 40: Edit scenarios

40 - 50: Simulate/load points

50 - 60: Corridors

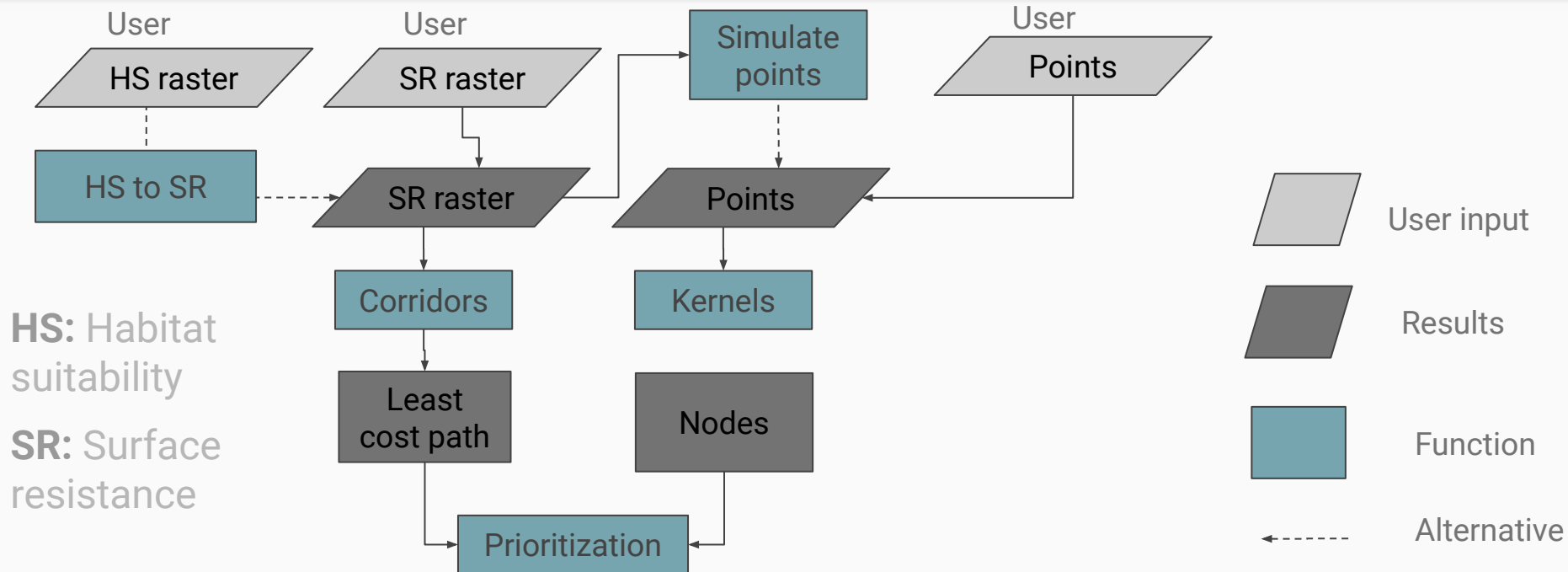
60 - 70: Kernels

70 - 80: Prioritize

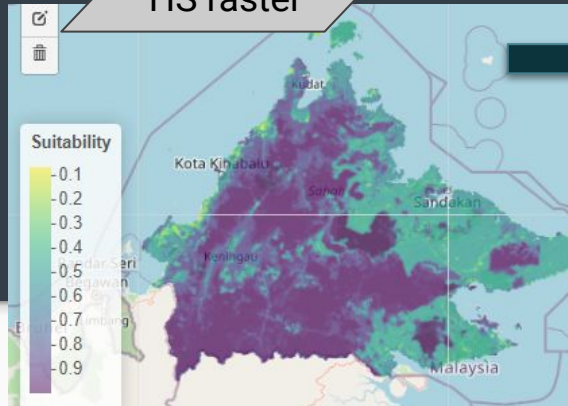
80 - 100: Debug + known issues

100 - 120m: Concluding remarks

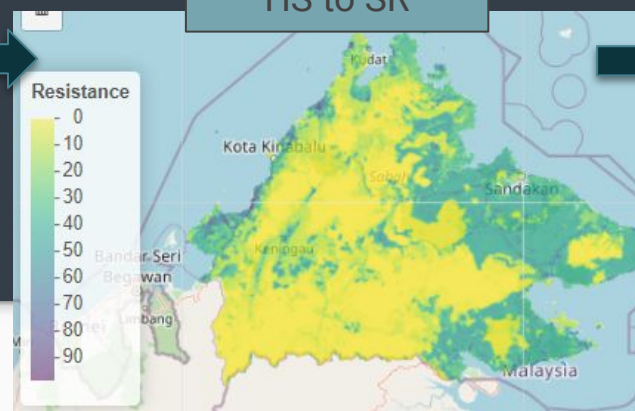
Complete workflow



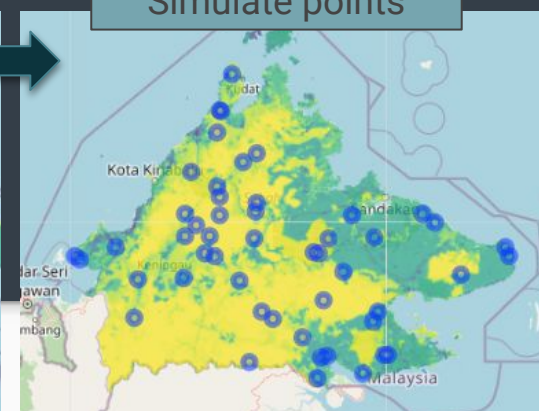
HS raster



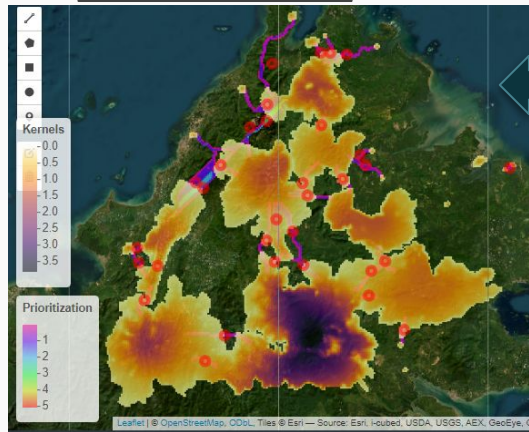
HS to SR



Simulate points



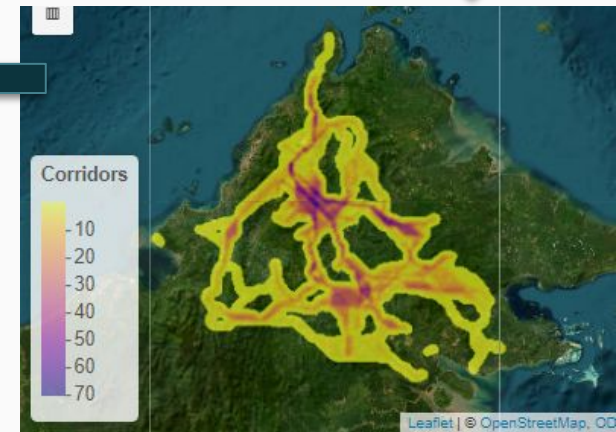
Prioritization



Kernels



Corridors



Overview

ConnectingLandscapes ☰

🏠 Home

↔ Habitat suitability <>
resistance surface

🔧 Customize resistance surface

📍 Create source points

📊 Cost distance matrix

🐾 CDPOP

🌐 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, Ž., 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, Ž., 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, Ž., Cushman, S.A., Htun, S., Naing, H., Burnham, 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. CDPOP: 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:

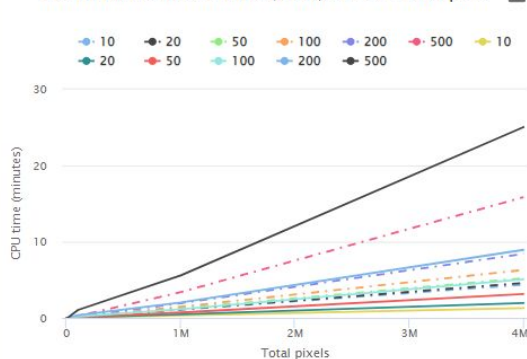
Least cost path

☐ Factor X-axis

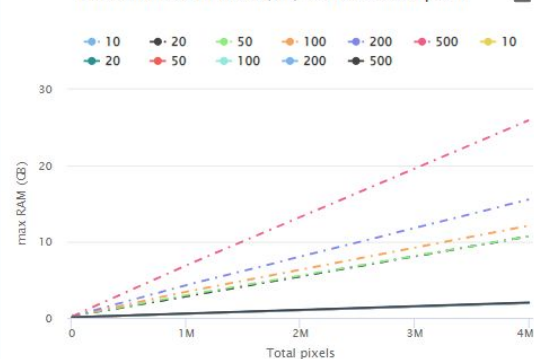
☐ Log X-axis

☐ 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

Run /
download

The screenshot shows the ConnectingLandscape web application interface. On the left is a sidebar menu with the following items: Home, Habitat suitability <> resistance surface, Load Suitability (with a search bar and 'No file' button), Customize resistance surface, Create source points, Cost distance matrix, CDPOP, Connectivity - corridors, Connectivity dispersal kernels, Connectivity - prioritization, Assign coords, PDF, and Run locally. The main content area is titled 'Create surface resistance'. It features a 'Log box' containing 'Your session ID: 5M2024030520101205file402de34298a' and 'Waiting for inputs...'. Below this is a 'Parameters' section with input fields for 'min-grid' (0), 'max-grid' (100), 'max-resistance' (100), 'slope' (1), and 'No Data' (-999). To the right of the parameters is a 'Run / download' section with buttons for 'Sample Hab. Sui.', 'Get resistance surface', and 'Download'. The main area is a 'Geovisor' map with 'Draw tools' on the left and a 'Basemap + measure' control on the right. The map shows a world map with a grid overlay.

Functions

Parameters

Draw tools

Geovisor

Basemap
+ measure

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 gess forum your raster as a prior. Modify as you consider
3. Click on “**Get resistance surface**”
4. Download the resulting raster in TIFF format

ConnectingLandscapes

Home

Habitat suitability <> resistance surface

Load Suitability

Search No file

Customize resistance surface

Create source points

Cost distance matrix

CDPOP

Connectivity - corridors

Connectivity dispersal kernels

Connectivity - prioritization

Assign coords

PDF

Run locally

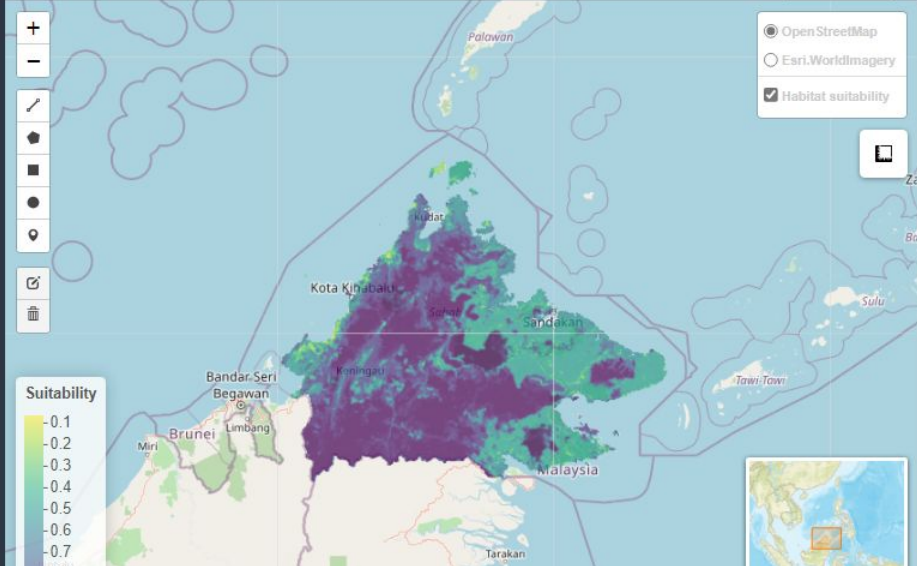
Create surface resistance

Your session ID: SW2024030520101205file402de34298a
Waiting for inputs ...

| Min-grid: | Max-grid: | Max-resistance: | Shape: | No Data: | |
|-------------|-------------|-----------------|--------|----------|---|
| 0.067884348 | 0.998932540 | 100 | 1 | -9999 | Sample Hab.Sui. Get resistance surface Download |

Suitability

-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7



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”. Multiple geometry types allowed
3. Provide a “value to add”. Number positive or negative
4. Click on “**Add values to raster**”
5. Download the resulting raster in TIFF format

The screenshot shows the 'ConnectingLandscapes' web application interface. The main title is 'Customize surface resistance'. Below the title, it displays a session ID: 'ZE2024030620051305file56ac86fd6525c' and status messages: 'Waiting for inputs ...' and 'Creating resistance surface ... DONE'.

On the left sidebar, under 'Load Resistance', there is a 'Search TIF' input field and a 'No file' button. Below this, there are several icons for different tools: 'Create source points', 'Cost distance matrix', 'CDPOP', 'Connectivity - corridors', 'Connectivity dispersal kernels', 'Connectivity - prioritization', 'Assign coords', 'PDF', and 'Run locally'. The 'Customize resistance surface' option is highlighted with a red box.

In the main area, there is a 'Value to add:' input field with the value '0' (highlighted with a red box). To its right is a green button labeled 'Add values to raster' (highlighted with a green box). Further right is a 'Download' button with a download icon (highlighted with a red box).

Below the input fields, there is a map of a region in Southeast Asia, showing Brunei, Malaysia, and parts of Indonesia. The map displays a resistance surface with a color scale from 0 (yellow) to 90 (purple). A legend on the left of the map shows the resistance values. The map also includes a 'Resistance' legend with values from 0 to 90. The map is overlaid with a grid and various geometric shapes (polygons, lines, points) drawn on it. A red box highlights the drawing tools on the left side of the map.

On the right side of the map, there is a legend for map layers: 'OpenStreetMap' (selected), 'Esri.WorldImagery', 'Surface resistance' (checked), and 'Habitat suitability' (unchecked). There is also a 'Zamboanga City' label and a 'Raslan' label. A small inset map in the bottom right corner shows the location of the main map area within the context of the entire region.

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. Select which (available) layer to base the analysis on.
4. Click on **“Create points”**
5. Download the resulting raster in TIFF format

The screenshot displays the 'ConnectingLandscapes' web application interface. The left sidebar contains a navigation menu with options: Home, Habitat suitability < resistance surface, Customize resistance surface, **Create source points** (highlighted with a red box), Load Suitability, Load Resistance, Cost distance matrix, CDPOP, Connectivity - corridors, Connectivity dispersal kernels, Connectivity - prioritization, Assign coords, PDF, and Run locally. The main panel is titled 'Create points' and shows session information: 'Your session ID: ZE2024030620051305file56ac86fd6525c', 'Waiting for inputs ...', and 'Creating resistance surface ... DONE'. Below this, there are four input fields: 'Min-grid:' (0), 'Max-grid:' (98), '# of points:' (50, highlighted with a red box), and 'Source layer:' (SurfaceResistance, highlighted with a red box). To the right of these fields are two buttons: 'Create points' (highlighted with a green box) and 'Download' (highlighted with a red box). The bottom half of the interface features a map of Southeast Asia, specifically showing Brunei, Malaysia, and parts of Indonesia. A 'Resistance' legend on the left of the map shows a color scale from 0 (yellow) to 90 (dark purple). The map includes various geographical labels like Kota Kinabalu, Sandakan, and Zamboanga City. On the right side of the map, there are map controls including a legend for 'OpenStreetMap', 'Eari.WorldImagery', 'Surface resistance' (checked), and 'Habitat suitability' (unchecked). An inset map in the bottom right corner shows the location of the main map area within the broader context of Southeast Asia.

4. 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. Select parameters
4. Click on **"Get corridors"** or **"heavy"** for big rasters.
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 - corridors

Load Resistance

Search TIF No file

Load points files (all)

Search INC SHP, DBF, S

Connectivity dispersal kernels

Connectivity - prioritization

Assign coords

PDF

Run locally

Create corridors

Your session ID: ZE2024030620051305file56ac86fd6525c
Waiting for inputs ...
Creating resistance surface ... DONE
Creating resistance surface ... DONE
Creating points --- DONE
Generating corridors --- DONE: 8.52 secs

Distance threshold (meters): 500000

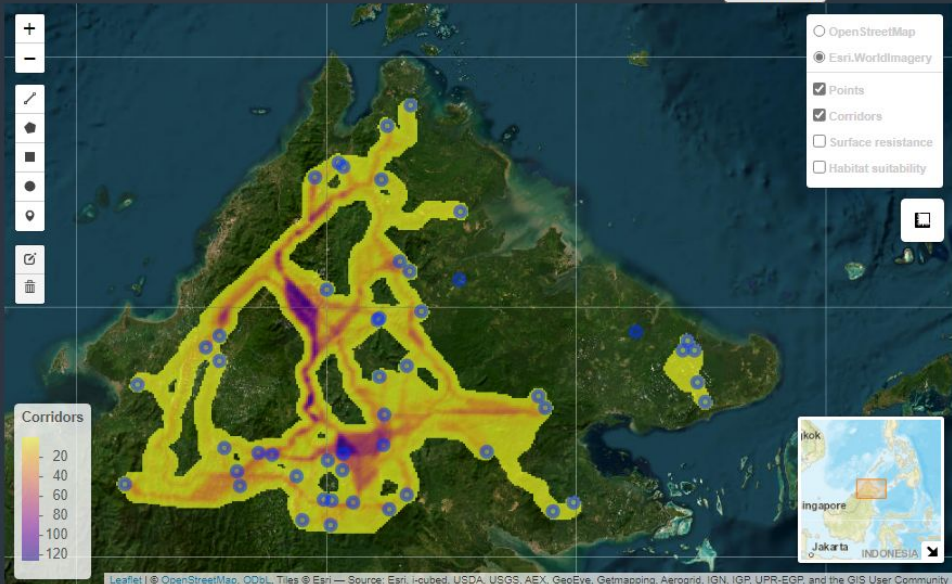
Corridor smoothing factor: 5

Corridor tolerance (meters x cost): 5

Get corridors

Get corridors (heavy)

Download



The map displays a network of corridors across Europe, with a color scale legend on the left indicating values from 20 (yellow) to 120 (purple). The map includes a sidebar with map controls and a legend on the right. The legend shows that 'Points' and 'Corridors' are selected, while 'Surface resistance' and 'Habitat suitability' are not. An inset map in the bottom right corner shows the location of the study area within Southeast Asia, with labels for 'Ikok', 'Singapore', 'Jakarta', and 'INDONESIA'.

Corridors

20
40
60
80
100
120

OpenStreetMap
Eri.WorldImagery
Points
Corridors
Surface resistance
Habitat suitability

Ikok
Singapore
Jakarta
INDONESIA

Leaflet | © OpenStreetMap, CC-BY, Imagery © Esri — Source: Esri, DeLorme, USGS, AEX, GeoEye, Getmapping, AeroGrid, IGN, IGP, UPR-EGP, and the GIS User Community

5. Kernels

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. Select parameters
4. Click on “**Get kernels**”
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 - corridors

Connectivity dispersal kernels

Load Resistance

Search TIF No file

Load points files (all)

Search INC SHP, DBF, S

Connectivity - prioritization

Assign coords

PDF

Run locally

Create kernels

Your session ID: EY2024030620282205file564d94f2f178c

Waiting for inputs ...

Creating resistance surface ... DONE

Creating points --- DONE

Generating kernels --- DONE: 8.1 secs

Generating corridors --- DONE: 8.66 secs

Generating kernels --- DONE: 8.2 secs

Distance threshold (meters x cost): 55000

Kernel shape: linear

Kernel volume (meters x cost): 1

Get kernels

Download

Kernels

-0.0

-0.5

-1.0

-1.5

-2.0

-2.5

-3.0

-3.5

-4.0

OpenStreetMap

Esri.WorldImagery

Points

Kernels

Corridors

Surface resistance

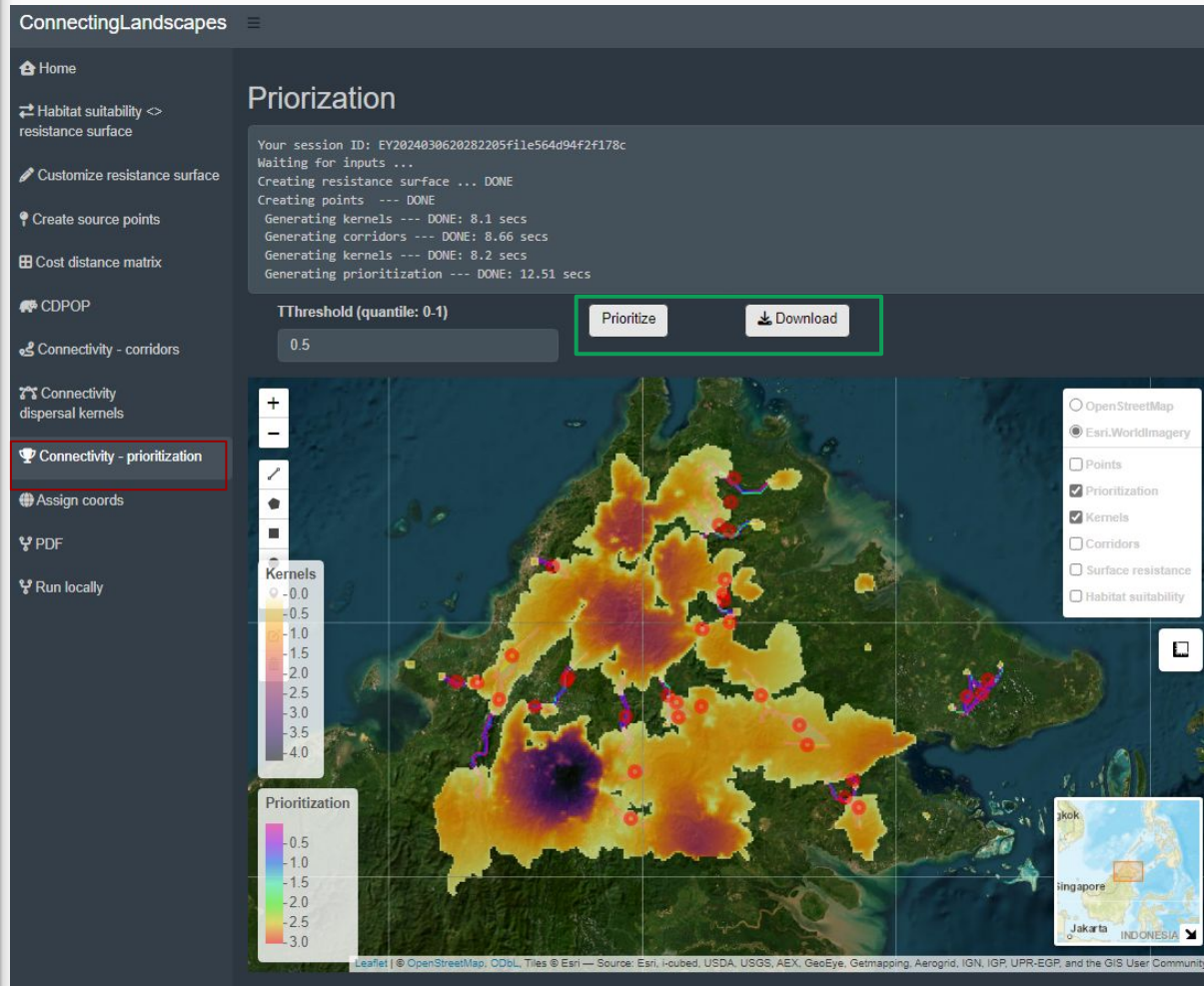
Habitat suitability

Leaflet | © OpenStreetMap, © OpenStreetMap, © OpenStreetMap, © Esri — Source: Esri, Imagery, 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. Click on “**Prioritize**”
4. Download the resulting raster in TIFF format





Known issues

It 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. Assign a coordinate reference system
3. Your TIFs are big

Thanks!

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github.com/forestrev/

