JECAMI

Joint Ecological Continuum Analysis and Mapping Initiative

A booklet on what Jecami is and how to use it

Table of contents

Chapter A. Introduction

A.1. Purpose of Jecami

Ecological connectivity is hard to understand and explain. The main goal of Jecami is to overcome this problem and to help analyzing connectivity and barriers of the landscape. How can that be done? By providing data for the Alps and analysis tools that will calculate specific indicators used to measure the ecological connectivity potential.

Jecami developed as part of the Econnect Project, whose main objective is the protection of diversity in the Alps by promoting the ecological continuum. There are two underlying concepts when referring to ecological continuum: **structural connectivity** and **functional connectivity**. The influencing factors for each type of connectivity are used as indicators for Jecami analysis tools. Each indicator has a specific value that indicates if it has a positive or a negative role in ecological connectivity.

Structural connectivity

also called the landscape connectivity, it refers to the physical conditions (shape, size, location) of the landscape (Brooks, 2003).

Factors that influence structural connectivity and have been used by Jecami:

Population | Infrastructure | Land Use | Altitude Topography | Patch Cohesion | Edge Density | Environmental Protection | Fragmentation

Functional connectivity

uses a „species approach" and it refers to the response of individual species to landscape conditions (Haddad 1999).

Factors that influence functional connectivity:

Habitat needs | Behaviour of each individual

A.2. Available Spatial Information

The data used for Jecami is divided into detailed, high-resolution data used in the 7 pilot regions (Fig. 1 with blue) and less detailed in lower resolution data for the whole alpine region (Fig. 1 with red).

The 7 pilot regions were defined by the project partners of the Continuum Project. The alpine region perimeter was defined within the Alpine Convention, an international treaty between the Alpine countries.

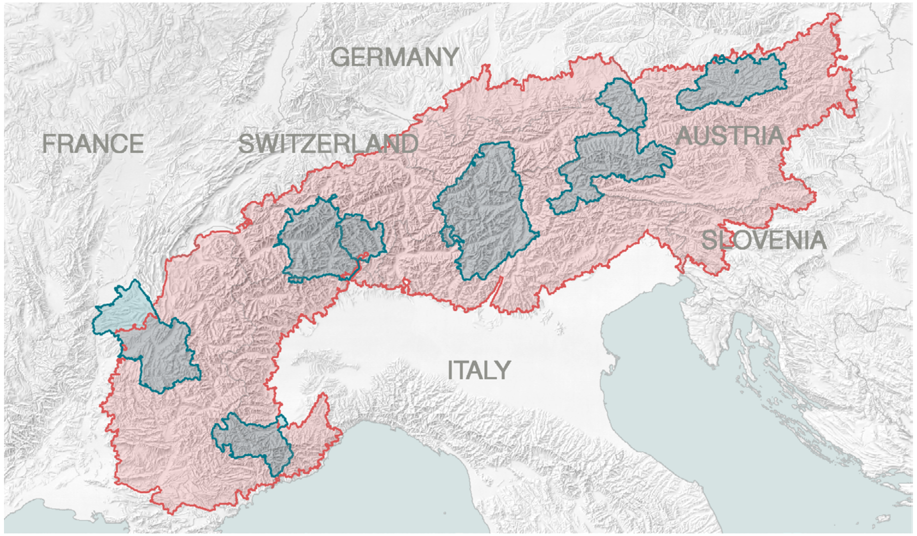


Fig. 1 - Map of the pilot regions (blue) and of the alpine region (red)

Ecological connectivity factors include : protected areas, population, land use, infrastructure, altitude, fragmentation, patch cohesion, environmental protection and ecological measures.

Habitat needs and behaviour of individuals were used to calculate **habitat models** for species like brown bear, black grouse, lynx, wolf or red deer.

Other data included in Jecami are **forest areas** in the alpine regions, **Natura 2000 sites**, data from the **National Ecological Network** project for Switzerland and data on connectivity in **riverine landscapes**.

To explore the included data the best is to use the online version of Jecami and turn on and off the different data layers (Fig. 2).

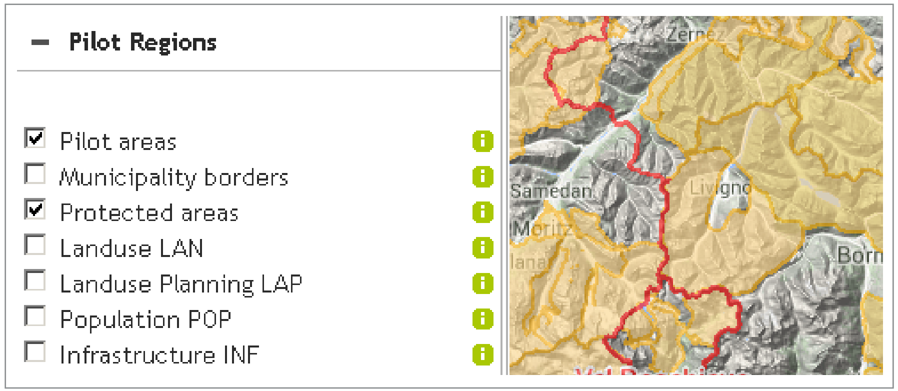


Fig. 2 - Example of data visualization in the online version of Jecami

A.3. Continuum Suitability Index

What is it?

Continuum Suitability Index (CSI) was created to show the ecological connectivity potential by using the indicators identified for structural connectivity. It is important to notice that although this index shows a value as an aggregation of all the other indicators, analyzing the values of each indicator is much more valuable than the actual CS Index.

How does it work?

This index is an unweighted average of the 10 identified indicators on a specified region. For each of the 10 indicators values between 0 and 100 were given in order to set up a common value scale. Then a raster surface was created and each pixel was given the value of the indicator. In this way, the region is represented as a matrix of values for each indicator (Fig. 3).

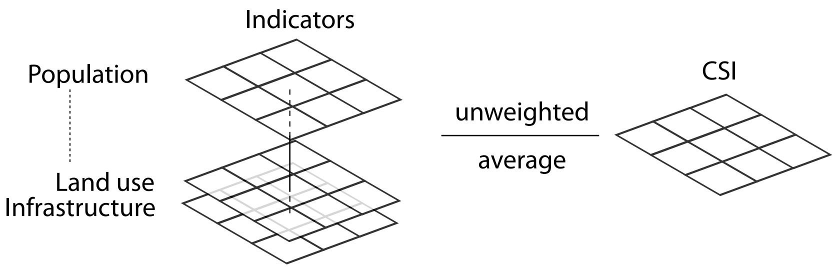


Fig. 3 - Calculation of the CSI index

What are the indicators?

1. Population (POP) - represents the impact of human pressure on nature both exerted by permanent inhabitants of settlements and tourists who stay overnight. The indicator refers to the density of inhabitants and tourist overnight stays. A high indicator value describes a low density of human impact and expresses positive connectivity conditions.

2. Land use (LAN) - can have a big impact on connectivity and depending on this impact, different values were defined by a group of experts. These values range from 1 - bad influence to 100 - good influence on the connectivity.

3. Patch Cohesion (COH) - describes the linkage between areas of one land use type. The more connected the areas (with few interruptions or barriers), the higher the index. The only aspect that is considered is the size and shape of the area.

4. Edge Density (ED) - is the length of edges between different land use types within an area, calculated in meters. The impact of a high edge density on connectivity depends on each species.

5. Fragmentation (FRA) - of the landscape describes the degree of fragmentation by roads, dams, railroads etc. The degree of fragmentation is expressed by the size of the area between the barriers. If this area is large, then it is not so fragmented and it is easier for animals to cross it. Therefore, a big fragmentation index means the area is not so fragmented and that indicates good conditions for connectivity.

6. Altitude and Topography (TOP) - consists of 2 elements:

- altitude above sea level in m. The assumption is that with increasing height, the conditions get worse as for example temperature and vegetation decrease. This regards only natural aspects and not human impacts and pressure. Therefore, the indicator values get smaller with increasing height.
- the altitude relative to the surrounding neighbours. The relative altitude indicates if the area is a valley, a flat surface, a mid slope or a hilltop. The landforms are mostly rated with high values of 100.

7. Infrastructure (INF) - is somehow similar to fragmentation, but it refers to ski lifts, ski slopes, cable cars etc. A high indicator value means a low degree of fragmentation and is thus positive.

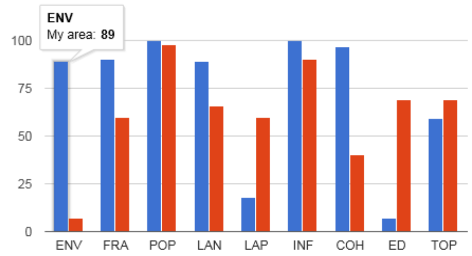
8. Environmental Protection (ENV) - refers to the number of protected areas in the region and to their level of protection. A high degree of protection correlates to a high indicator value.

9. Ecological Measures (ECO)* - quantifies the small-scale existing environmental protection measures as for example, the construction of wildlife overpasses. Again, a high degree of protection means a high indicator value.

10. Land Use Planning (LAP)* - evaluates different measures which are planned to be realized in the future. Good measures (for example designation of a new protected area) get a high index value and bad measures (building up a new road) get a small index value.

What are the results?

Jecami calculates the values of these different indicators for a given area and returns them as graphics and tables (Fig. 4). The user compares these values with optimum values for different species and investigates what should be done in order to improve the connectivity.



Index	Mean	Geometric Quality	Thematic Quality	Completeness Quality	Actuality Quality
ENV	89	87	67	100	100
FRA	90	52	50	100	92
POP	100	52	20	100	76
LAN	89	98	29	100	92
LAP	18	89	7	100	100
INF	100	52	60	100	76
COH	97	95	21	100	92
ED	7	95	21	100	92
TOP	59	47	50	100	100
ECO	No data	No data	No data	No data	No data

Fig. 4 - Results of CSI Analysis tool on the online version

* these two indicators are available only for the 7 pilot regions

A.4. Species Mapping Application

What is it?

The Species Mapping Application (SMA) is a tool that helps detecting barriers or corridors for specific animal species, based on habitat and connectivity maps. Using a cost path function the tool returns modeled virtual tracks of species between two given points.

How does it work?

The SMA uses species habitat models as cost rasters. These models were developed by the Austrian Federal Environment Office (Johannes Signer) and have a spatial resolution of 1500m.

On the basis of these models a cost path function calculates the most barrier-free path for a key species from one point to another in the Alps (Fig. 5).

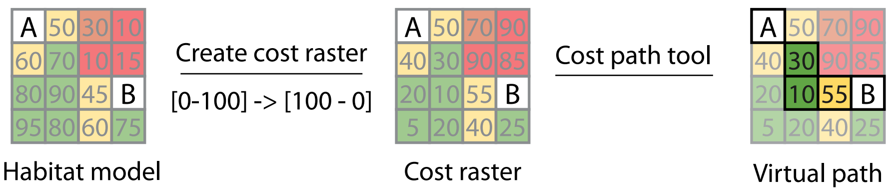


Fig. 5 - Least cost path tool to model animal paths between A and B

What are the results?

The tool returns the path as polygon features. Each polygon has as attribute the cost value (between 0 and 100). Values are coded in colors on the online application from green - low values to red - high values and barriers (Fig. 6).

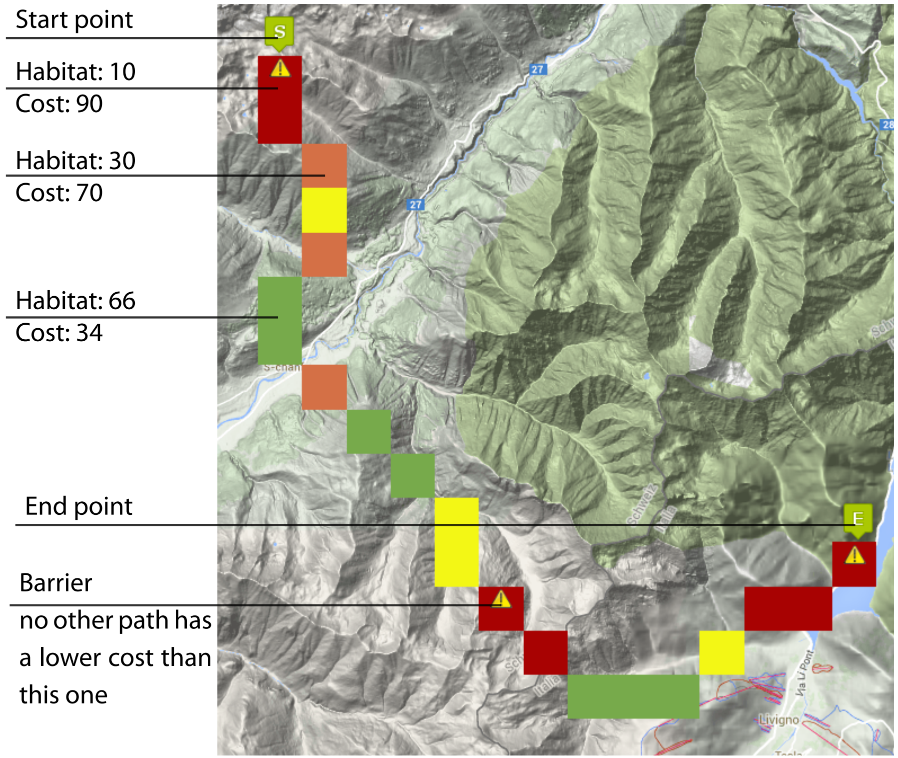


Fig. 6 - Results of SMA

Chapter B. Jecami online

Structure

The online version of Jecami has a top main menu with access to the layers and to the tools. The schema below (Fig. 7) explains how to interact with each of the menu elements and what each tool does.

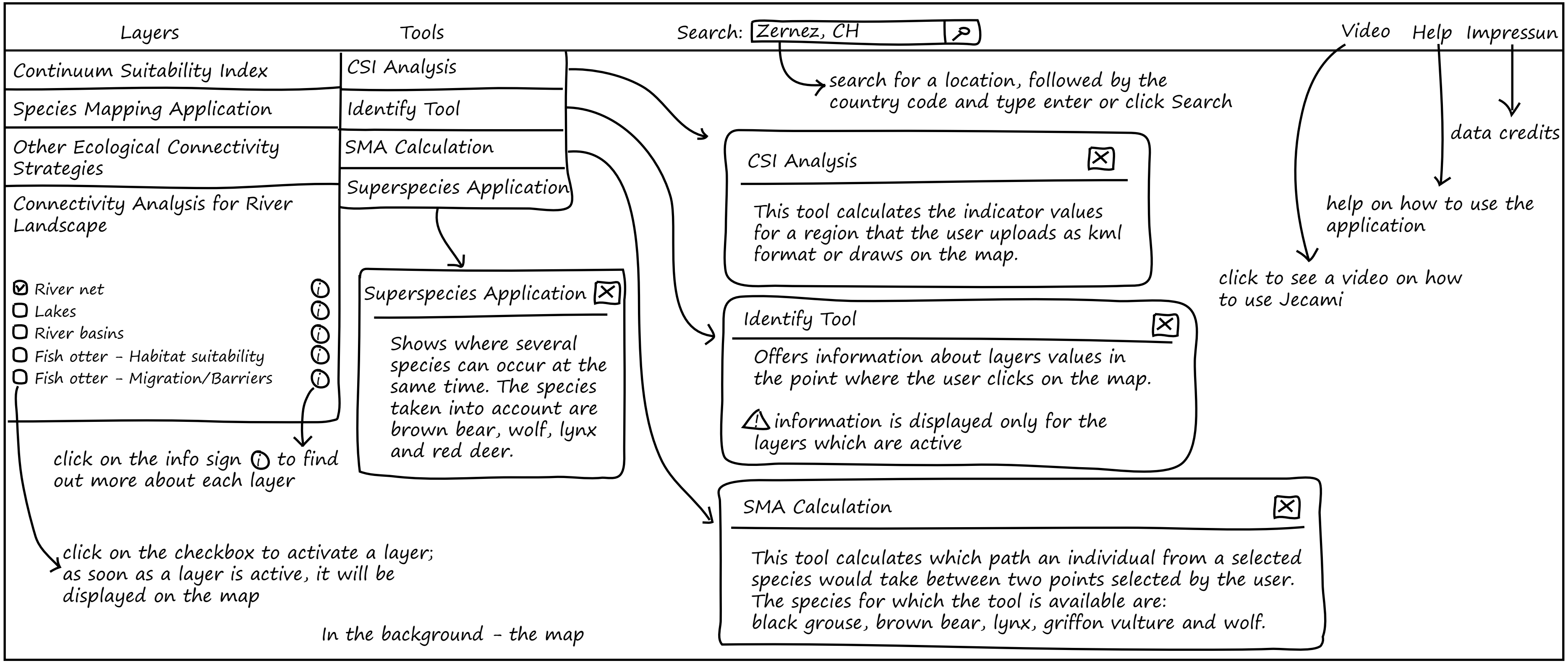


Fig. 7 - Schema of the online application Jecami

The tools

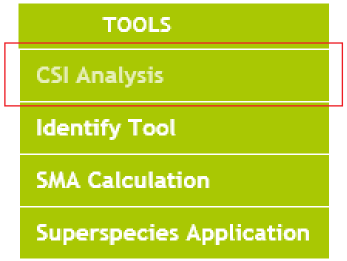
There are 4 tools that are currently working: CSI Analysis, Identify Tool, SMA Calculation and Superspecies Application.

Next, an example on how each of the tools work will be given.

B.1. CSI Analysis

This tools calculates the indicators of the connectivity potential.

1. Click on the CSI Analysis button on Tools submenu.



2. The CSI Analysis Window opens up. There are 3 steps to follow (Fig. 8):

Step 1 requires to add the data for which the indicators should be calculated.

Step 2 allows to choose if the data is from the whole alpine region or from one of the pilot areas.

In **Step 3** the tool can be run.

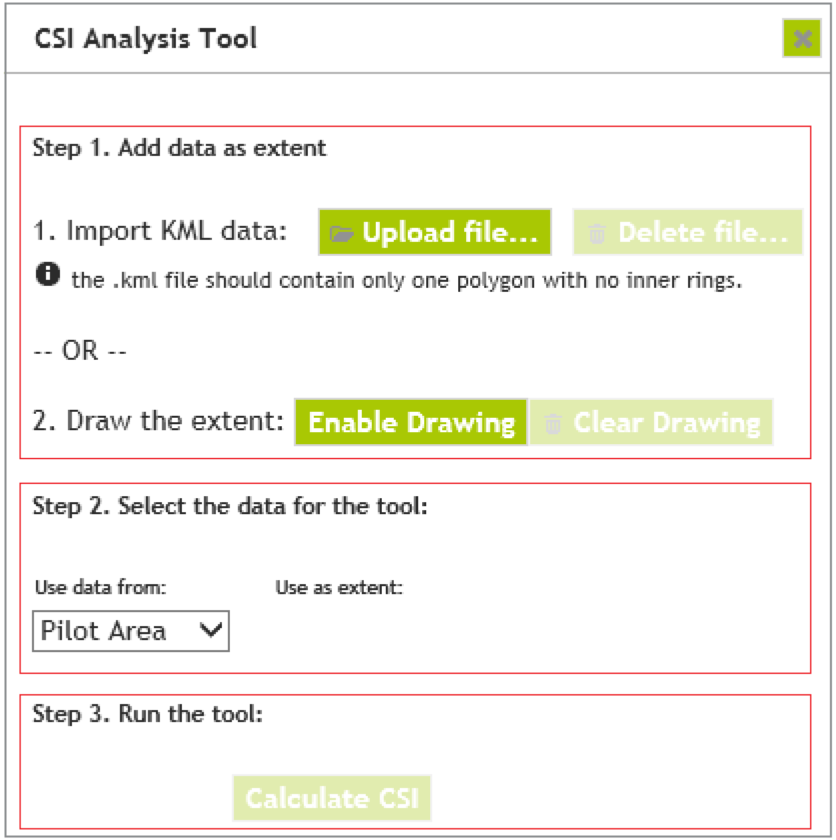


Fig. 8 - The 3 steps required for running the CSI Analysis Tool

3. Add the data for which the indicators should be calculated.

There are 2 possibilities to do this: one is to add a kml file and the other one is to draw the polygon directly using the drawing tool in jecami.

Option A. Add a kml file (Fig. 9).

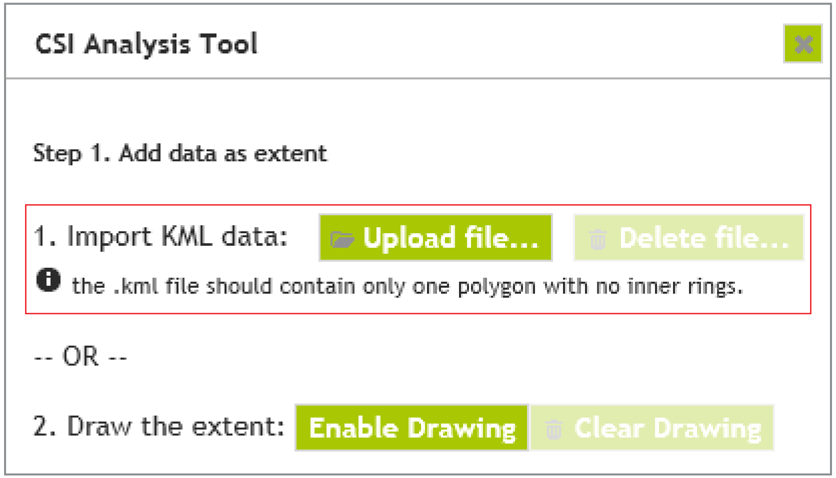
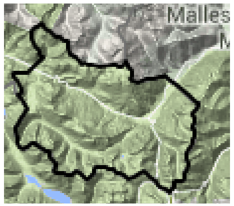


Fig. 9 - Adding data as kml

This assumes that your kml contains only one polygon with no inner rings. This is because the tool only works for one polygon at a time. See Appendix A. on how to check if the kml has more than 1 polygon. Click on the Upload file... button and select the .kml file you want to upload. A polygon with the region of Val Müstair has been uploaded and this is the result:



Option B. Draw a polygon on the map (Fig.10).

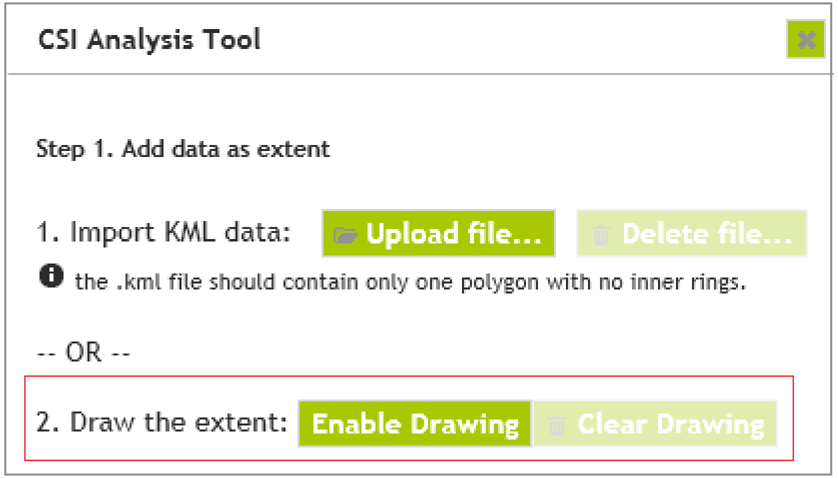
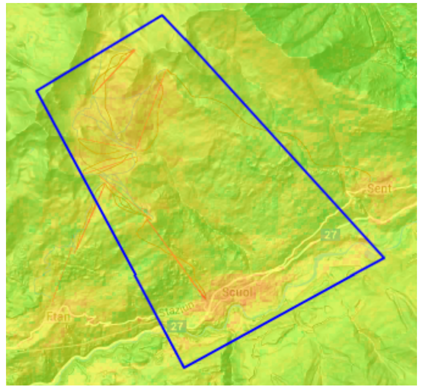


Fig. 10 - Adding data by drawing on the map

Click on Enable Drawing and start drawing on the map by adding single points. At the end click again on the first vertex to finish the polygon. If you made a mistake click on clear drawing and start again. On the image on the right, a polygon that covers the region of Scuol has been drawn. Further on, this polygon will be used.



4. Select the data for the tool.

The first option allows you to select if your area is in of the Pilot Areas or in the Alpine Area (see Fig. 11).

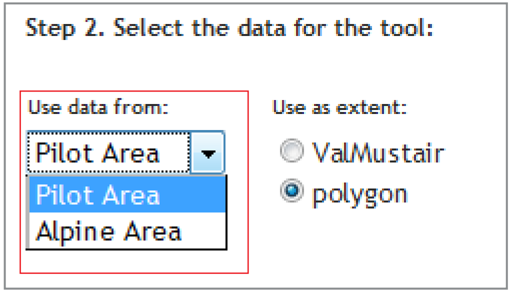


Fig. 11 - Select whether to use data from Pilot Areas or from the Alpine Area

In case you drew a polygon and uploaded a kml too, a second option (Fig. 12) allows to select if the drawn polygon or the uploaded kml should be used for the CSI calculation.

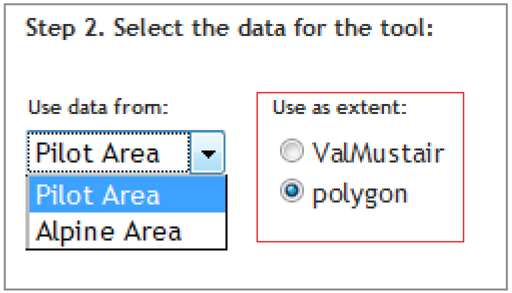


Fig. 12 - Select whether to use the polygon or the kml

5. Run the tool.

After uploading the data the Calculate CSI button becomes active. Click on it and the application will send the data to the server to calculate the indicators. Depending on the surface you uploaded this process may take up to 1 minute.

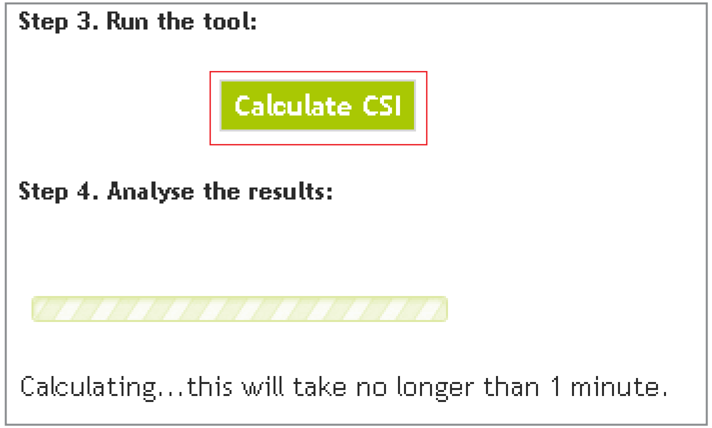


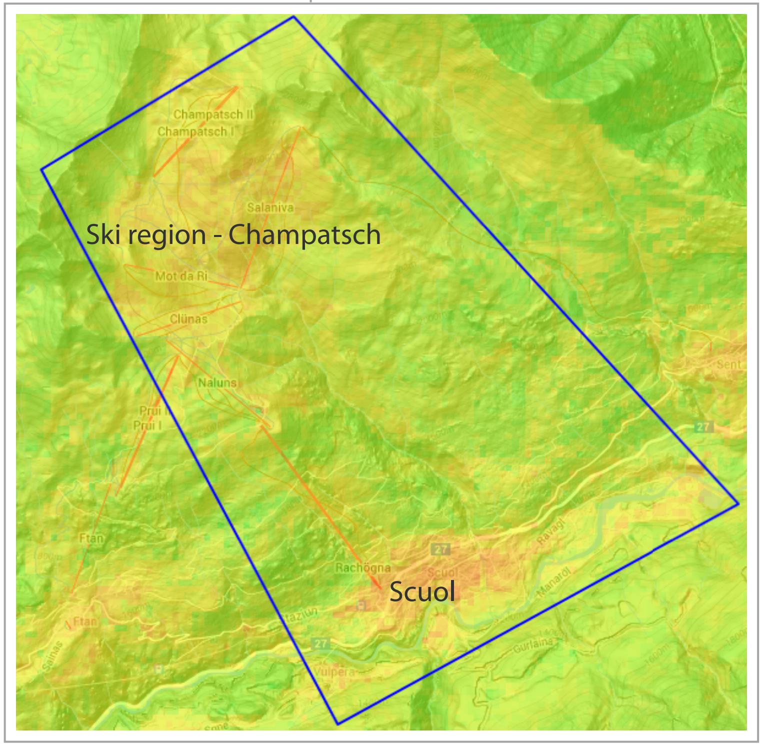
Fig. 13 - Running the CSI Analysis Tool

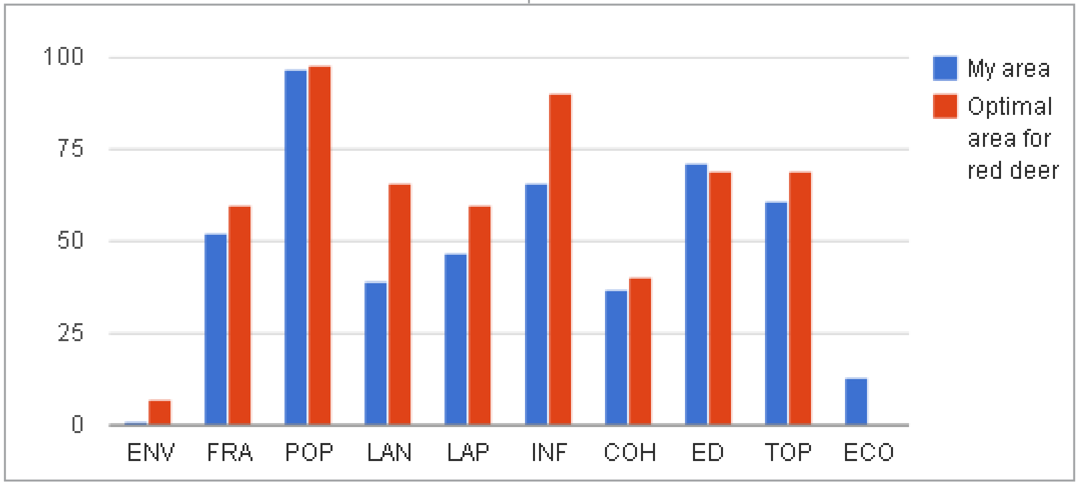
6. Analyse the results.

A further step, „Analyse the results" becomes visible. Here is where the indicators for the selected region are shown. An example of result interpretation is given on page 10 for the region of Scuol.

The map displays the CSI Layer in the region of Scuol (green color - high connectivity potential and red color - low connectivity potential).

The results of the Scuol region are represented with blue. These results can be compared with optimal results for a red deer (in red). As most indicators show, the area is almost optimal for a red deer. However, the indicators that have suboptimal values are Land Use and Infrastructure. This is due to the populated regions and to the numerous skiing infrastructure.





The results of the selected region can be compared with optimal values of different species.

B.2. SMA Calculation

This tool calculates the path a species could take between 2 given points.

1. Click on SMA Calculation in the Tools menu:

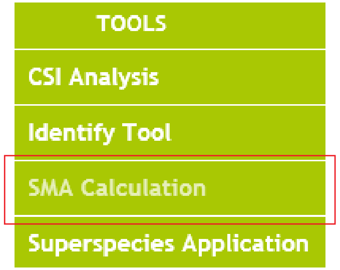


Fig. 14 - Access SMA Calculation Tool

2. The first step is to select the species for which you want to calculate the path. By default, the black grouse button is activated (Fig. 15). As an example, lynx will be selected.

Fig. 15 - Select the species for SMA Tool

In Layers, in Species Mapping Application menu the black grouse model layer is activated (Fig. 16). As soon as another species will be activated in the SMA Calculation tool, the associated layer will also be activated.

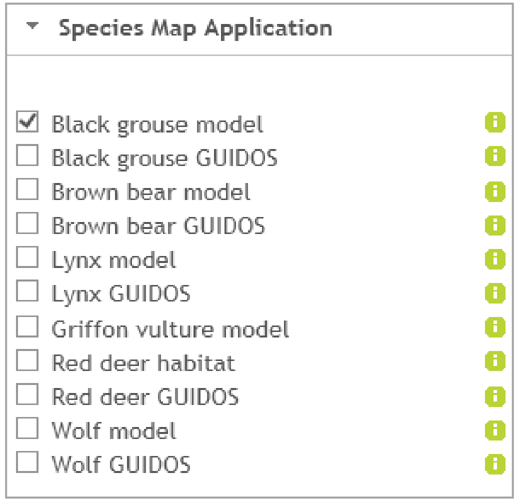


Fig. 16 - The habitat model of the selected species is automatically activated

3. Select the start point and the end point. Click on the start point icon and then on the map to set the start point. Then click on the end point icon and then again on the map to set the end point. You can move the points at any time on the map to change the position.

For the lynx example the start point will be set in Zernez and end point in

Trento (Fig. 17). The goal is to see what path would the lynx choose from Zernez to Trento.

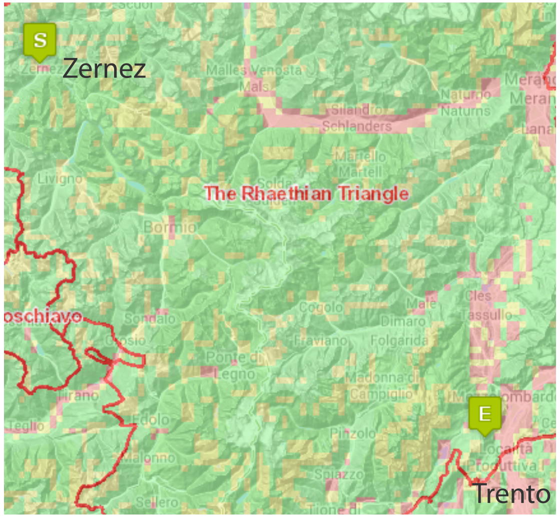


Fig. 17 - Setting start point and end point

4. There is an optional step of adding GPS data (in case you have such data) with the track of an individual of that species (Fig. 18). A GPS track of a lynx will be uploaded, but this will be done at the end, after the virtual path is computed, in order to compare it.

Fig. 18 - Upload GPS data to compare the end result

5. Click on Calculate Path. The path will be displayed on the map with colors ranging from green (suitable for crossing) to red (barrier - crossing is limited). After the path is displayed you can control its visibility using the visibility slider:

The barriers can also be made visible or invisible:

6. Analyze the results.

The path is mostly green and there are no barriers on the way to Trento. The only barrier is in Zernez because the start point is right in the village. To validate the points the GPS data was uploaded too (the yellow/black points) and one can see that the path is quite similar except the portion that starts in Bormio (Fig. 19).

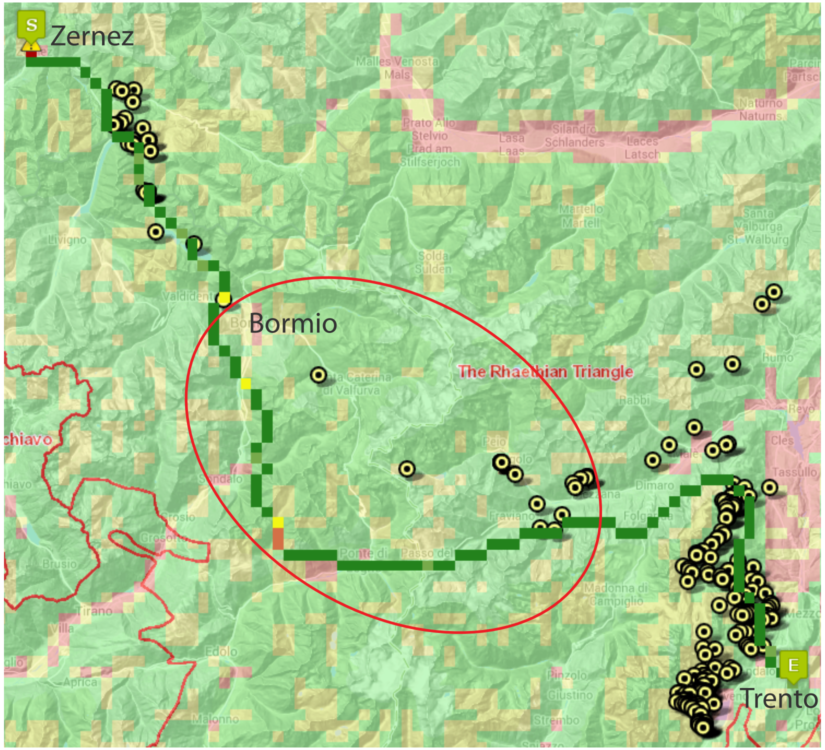


Fig. 19 - Real path (GPS points) and modeled path

If the tool is run starting a bit right from Bormio, one can see that the path changes and follows more or less the real GPS points (Fig. 20).

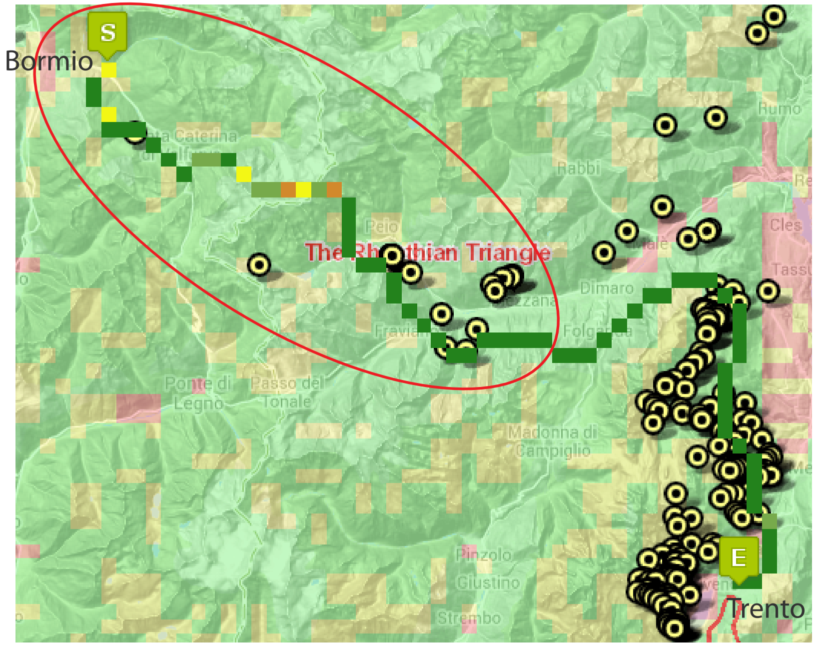


Fig. 20 - Bormio is a point where multiple solutions are possible and only a few pixels difference can change the modeled trajectory.

B.3. Identify Tool

The identify tool shows the values of the active layers at the point where the user clicks.

1. Click on the identify tool in the Tools menu:

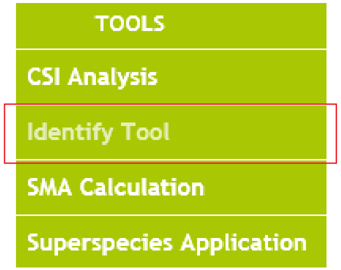
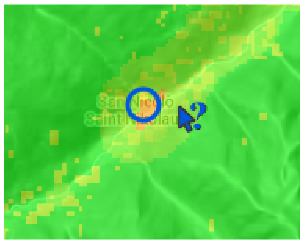


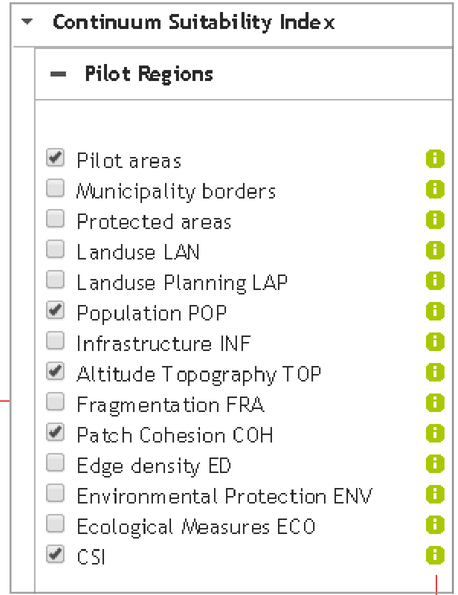
Fig. 21- Access Identify Tool

The mouse will turn into an arrow with a question mark when over the map. The Identify Tool window will also open.

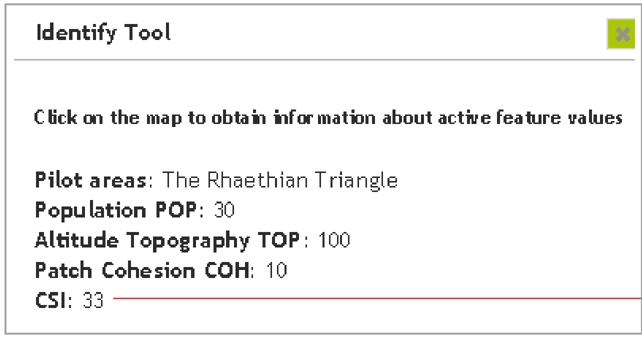
2. Click on the map to get information about the active layers.



3. Interpret the results.



only the active layers will be shown in the Identify Tool window.



to investigate what each value means, check the information about the layer

4. To turn off the Identify Tool just close the Identify Tool window.

B.4. Superspecies Application

This tool shows how many occurences of species in an area are possible. The model has been calculated for a maximum of 4 species. The species taken into consideration are: brown bear, wold, lynx and red deer.

1. Click on the Superspecies Application button in the Tools menu:

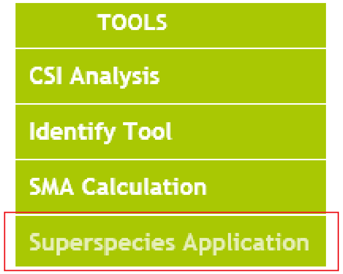
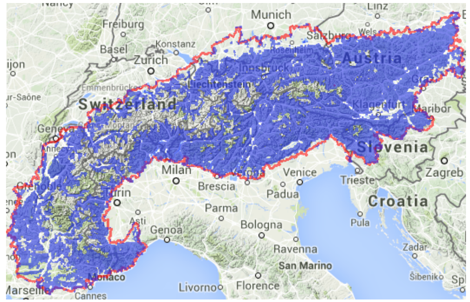


Fig. 21- Access Identify Tool

2. The Superspecies Application window opens and the default model shows on the map the area where one of the 4 species can simultaneously occur.

3. The user can change the number of occurrences using the slider (Fig. 22).

1 out of 4 species can be found in the blue areas in the alpine region.



2 out of 4 species can be simultaneously found in the blue areas in the alpine region.

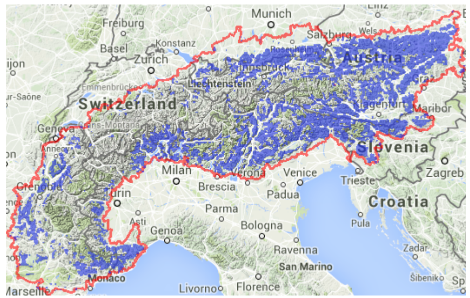


Fig. 22- Changing the number of species co-occurrences

Chapter C. Jecami for desktop

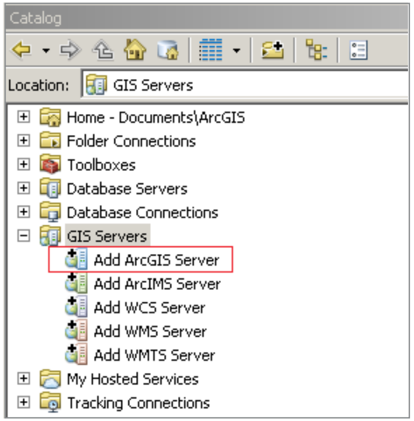
In this tutorial ArcGIS for Desktop is used. In case you don't have this software, then you can use the free viewer ArcGIS Explorer Desktop. You can download it here.

CSI Analysis in desktop

Embedding the data

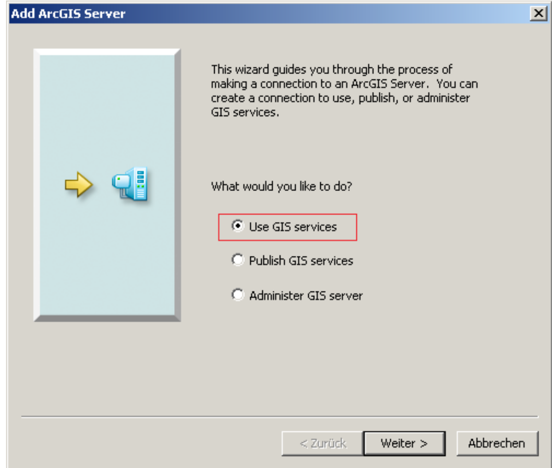
1. Open ArcMap and go to the ArcCatalog window.

2. Click on Add ArcGIS Server to add ArcGIS Server Connection in ArcCatalog.



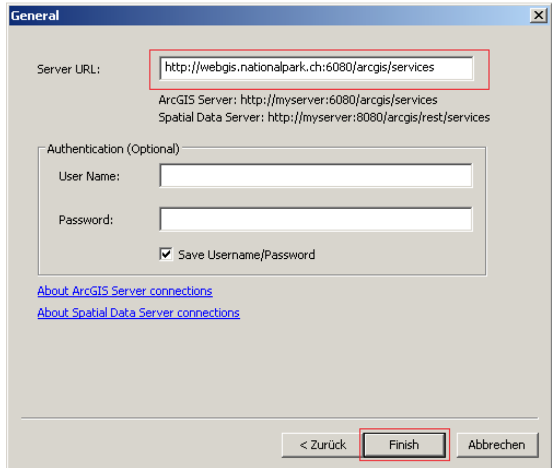
3. Follow the Add ArcGIS Server Wizard:

-> choose Use GIS services



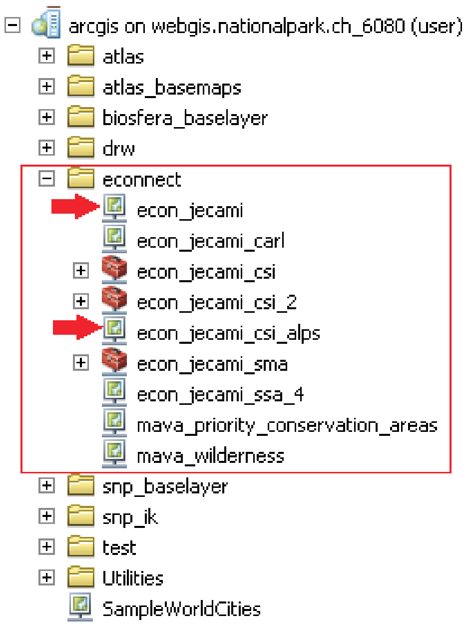
-> Server URL: http://webgis.nationalpark.ch:6080/arcgis/services

-> Finish

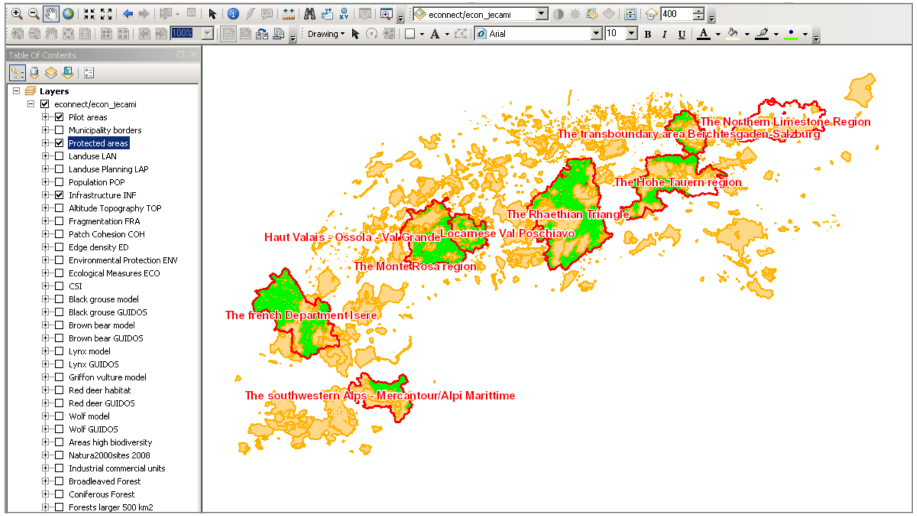


4. The connection to the data is now available in ArcCatalog. Click on the plus icon to see all the data available.

5. The jecami data and tools are found in the *econnect* folder. The CSI data of the pilot regions are in the ArcGIS server File *econ_jecami*. The CSI data for alpine space is in the file *econ_jecami_csi_alps*. Open these two files in an ArcMap window, via drag and drop.



6. The data is now available in the Table of Contents and ready to be explored.

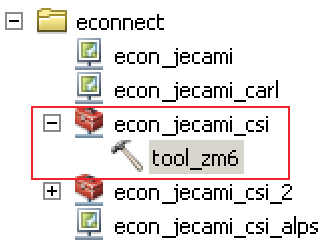


Working with the CSI Tool

To analyse the CSI result for a specific area, there is an ArcGIS-tool which calculates the mean values of all indicators.

1. Go to the ArcGIS Server Connection in the ArcCatalog window.

2. To calculate the CSI Analysis within a pilot region, double click the tool called *tool_zm6* in the *econ_jecami_csi* toolbox.



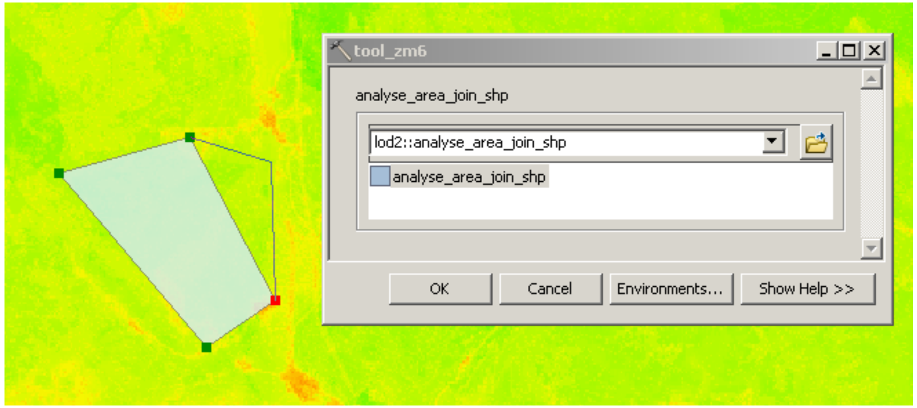
3. The tool window opens. There are 2 possibilities to obtain results from a desired area:

a. Draw manually a polygon

b. Include a polygon from a shape file/feature class

a. Draw manually a polygon

When the tool window is activated (opened), you can draw a polygon directly with the mouse on the map. Double click on the last vertex of the polygon to finish drawing. Your polygon is now included in the shapefile *analyse_area_sjoin_shp*.



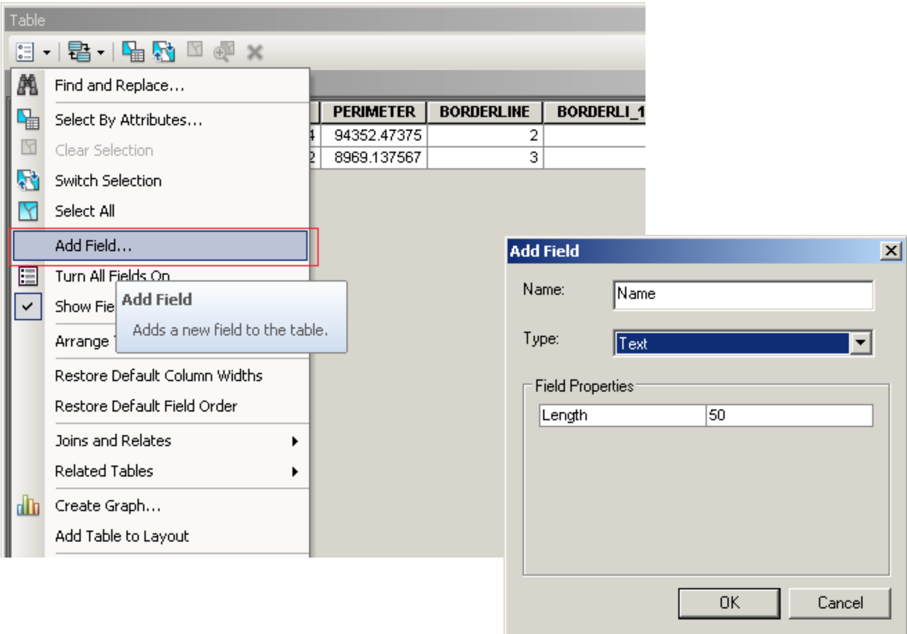
a.Include a polygon from a shape file/ feature class.

Click on the Open File icon in the tool or select the file from the drop-down list if the file is already loaded in ArcGIS.

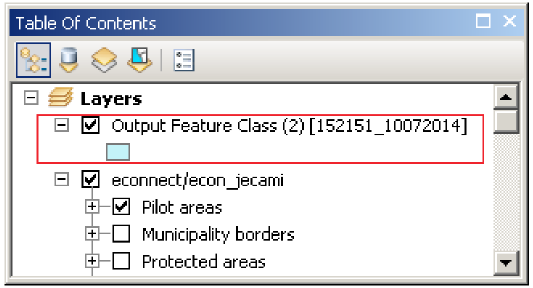
! the feature should be in the geographic coordinate system WGS84. If not, reproject it via the tool *Project* (Data Management toolbox, Projections and Transformations Toolset / Feature).

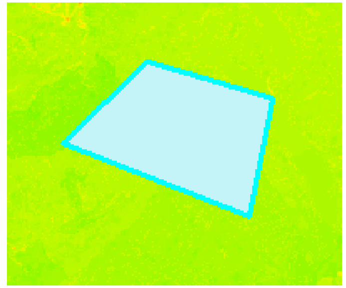
❗ if the feature class/shapfile contains more than one polygon, the one that is used for calculation should be selected. This is because the tool can calculate only one polygon at a time. Otherwise, the tool will calculate the indicators only for the first polygon.

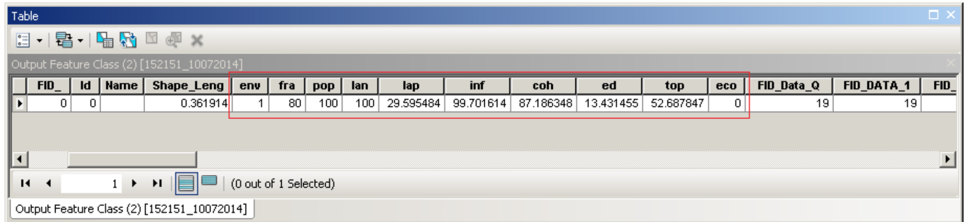
❗ the feature should contain the attribute Name (type text). If it doesn't, add a field in the attribute table.



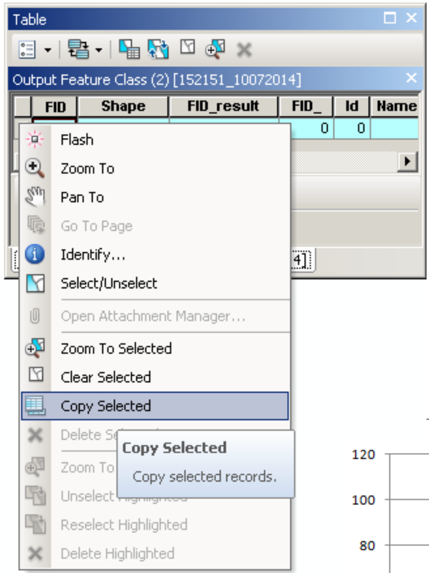
4. After selecting/loading the data, click on OK to start the tool. When the tool finishes calculating, a temporary Geodatabase with an output feature class is available in the Table of Contents. The results of the mean CSI Values are stored as attributes in the attribute table.

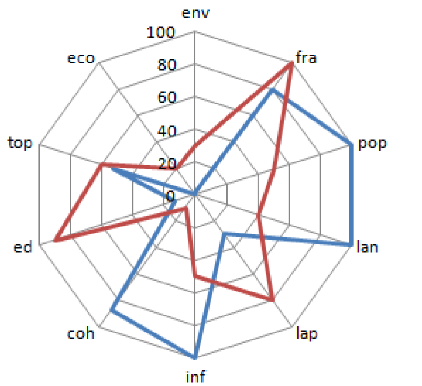


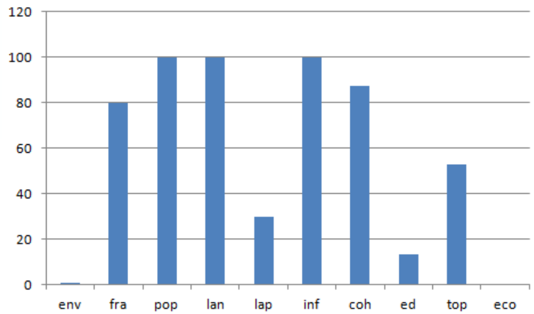




5. The results can then be copied in Excel and evaluated within graphs. Indices for several areas can be computed and then in Excel compared.

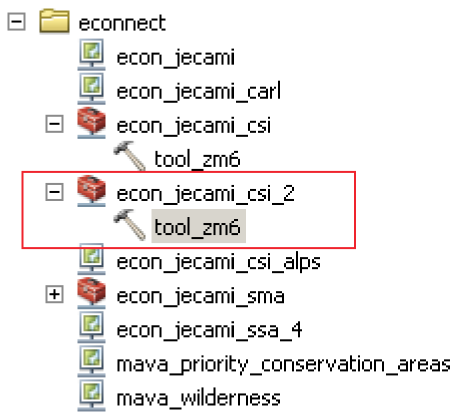






H	I	J	K	L	M	N	O
env	fra	pop	lan	lap	inf	coh	ed
1	80	100	100	29.59548	99.70161	87.18635	13.43146
30	100	50	40	80	50	10	90

! if your area is not within any of the pilot areas, then use the *tool_zm6* in the *econ_jecami_csi_2* toolbox. This tool uses the data for the whole alpine region.



Appendix

To check if your kml contains only one polygon, open the kml in Notepad or another text editor (right click -> Open with -> Notepad). In your file there should be just one polygon tag, like in the screenshot below.
The screenshot on the right is an example of a kml that contains 2 polygons. In this case the tool will only use Polygon1. If your file happens to have 2 polygons, then just delete the other polygons and then save the file.

```
<Folder>
    <name>Good Example</name>
    <open>1</open>
    <Placemark>
        <name>Polygon1</name>
        <styleUrl>#m_ylw-pushpin</styleUrl>
        <Polygon>
            <tessellate>1</tessellate>
            <outerBoundaryIs>
                <LinearRing>
                    <coordinates>
                        8.51795456577031,46.46690194059126,0
                    </coordinates>
                </LinearRing>
            </outerBoundaryIs>
        </Polygon>
    </Placemark>
</Folder>
```

```
<Folder>
    <name>BadExample</name>
    <open>1</open>
    <Placemark>
        <name>Polygon1</name>
        <styleUrl>#m_ylw-pushpin</styleUrl>
        <Polygon>
            <tessellate>1</tessellate>
            <outerBoundaryIs>
                <LinearRing>
                    <coordinates>
                        8.51795456577031,46.46690194059126,0
                    </coordinates>
                </LinearRing>
            </outerBoundaryIs>
        </Polygon>
    </Placemark>
    <Placemark>
        <name>Polygon2</name>
        <styleUrl>#m_ylw-pushpin</styleUrl>
        <Polygon>
            <tessellate>1</tessellate>
            <outerBoundaryIs>
                <LinearRing>
                    <coordinates>
                        8.54547546097133 9,46.49021907846861,0
                    </coordinates>
                </LinearRing>
            </outerBoundaryIs>
        </Polygon>
    </Placemark>
</Folder>
```

Bibliography

Brooks, C. P. (2003): A Scalar Analysis of Landscape Connectivity. Oikos 102, No 2: 433-439

Haddad, N. N. (1999): Corridor and distance effects on interpatch movements: a landscape experiment with butterflies. Ecol Appl, No 9: 612–622

Affolter, D. (2010): The Continuum Suitability Index - Technical Report.