

Forest Similarity Index (FSI)

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The problem

Most of the time, remote sensing is used for land cover classification, being necessary to define whether or not a specific object belongs to a class or another. When dealing with areas under restoration process, it is expected to have a gradual change in the area through the time. Thus, would be more interesting to infer its evolution in an index manner than to classify the land cover (for instance identifying its membership to the forest class) in different moments.

About analysis proposal

To overcome this challenge, a Forest Similarity Index (FSI) is proposed. The idea behind of the Forest Similarity Index is to make use of vegetation index to monitor the restoration process through the time.

How to do it

There are several ways we could propose this analysis. Due to this different approach, and inputs, would be interesting to identify its pros and cons. First point is to identify the best vegetation index to be used as a proxy of forest evolution. Then, would be necessary to define the best approach: a) mean vegetation index; b) mean vegetation index similarity (i.e: the evolution compared to forest -reference- area); c) Response ratio of vegetation index (i.e: the response ratio evolution in relation to forest -reference- area);

Dataset used

To do so, six scenes of Landsat 5 TM of different years were selected. The assured consistency was selected imagery between May and August.

Number	year	date
1	1985	11/08
2	1991	31/05
3	1995	16/07
4	2000	25/05
5	2005	28/08
6	2010	09/07

From the raw satellite imagery an atmospheric correction was processed using the “Dark Object Subtraction - DOS 1” as well as the transformation of the pixel value from Digital Number to Reflectance was done.

Band Number	spectral	reference
1	0,45 a 0,52 μm	azul
2	0,52 a 0,60 μm	verde

Band Number	spectral	reference
3	0,63 a 0,69 μm	vermelho
4	0,76 a 0,90 μm	infravermelho próximo
5	1,55 a 1,75 μm	infravermelho médio
6	10,4 a 12,5 μm	infravermelho termal
7	2,08 a 2,35 μm	infravermelho distante

From the landsat bands, we generated some indexes: NVI, EVI and SAVI.

Band Number	spectral	reference
8	$\frac{B_{NIR}-B_{Red}}{B_{NIR}+B_{Red}}$	Índice Normalizado de Vegetação (NDVI)
9	$\frac{B_{NIR}-B_{Red}}{B_{NIR}+6*B_{Red}-7.5*B_{Blue}+1}$	Índice de Vegetação Realçado (EVI)
10	$\frac{B_{NIR}-B_{Red}}{B_{NIR}+B_{Red}+0.5}$	Índice de Vegetação Ajustado ao Solo (SAVI)

About vegetation Indexes

- **Normalized Vegetation Index:** Is widely used and known for sazonal and temporal vegetation status. It ranges from -1 to 1, indicating areas with low/high photosynthesis activities. This index is highly influenced by shadows, thus the expected relation between NDVI and biomass can not be true. In some cases it is possible to identify the opposite relation (high values of NDVI in secondary forest and lower in old growth), due shadow occurrences.
- **Soil Adjusted Vegetation Index:** Soil characters influences the radiation from sparse vegetation, hence in the vegetation index. Thus SAVI, imply a constant L in the index calculation to minimize the soil effects. In this case, we used $L=0.5$ which is defined for mean density. The L must be defined for each biome or ecosystem.
- **Enhanced Vegetation Index:** Presents optimization for both soil and atmospheric influence on vegetation index, is mostly used in forest with high biomass densities.

Forest Similarity Index

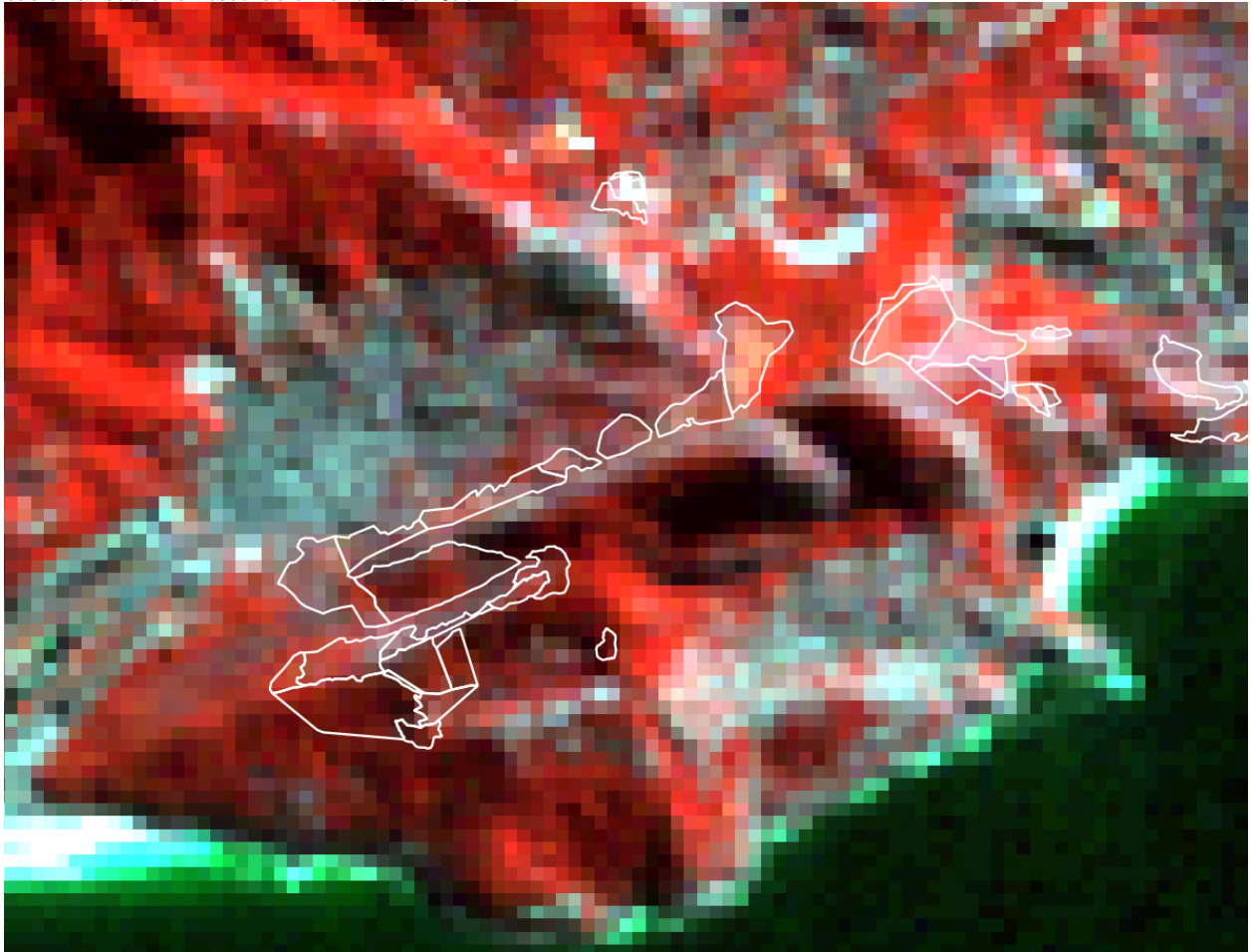
The proposal can be based in tow approaches:

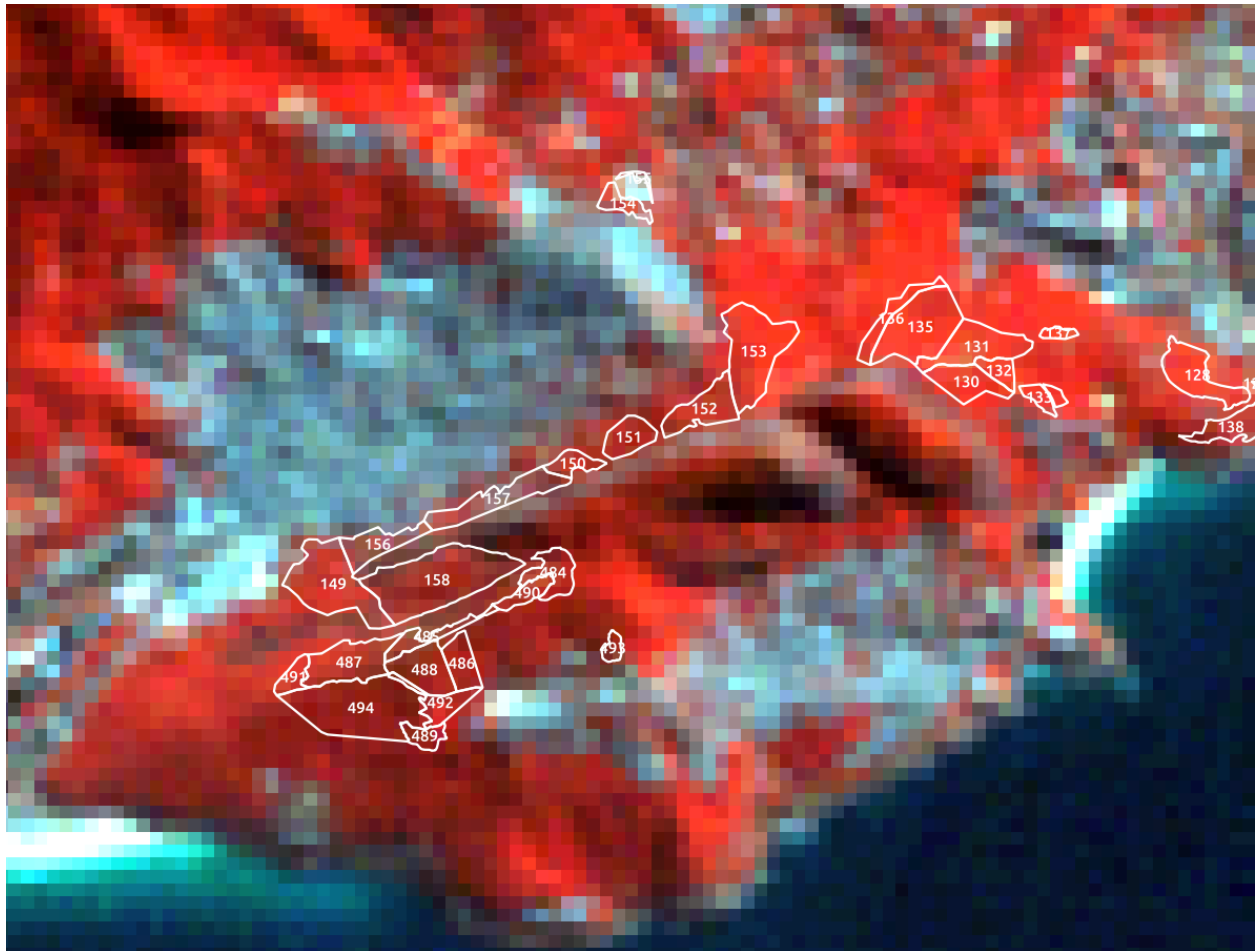
- Temporal change (‘evolution’) of mean vegetation index (e.g: Normalized Difference Vegetation Index) the restoration polygon;
 - NDVI
 - EVI
 - SAVI

Once produced the unsupervised classification, the statistical results (not spatially explicit) can be used to identify a statistical distance from one area (the area under monitoring) to its reference (in this case, forest area). It is expected that, bare soil areas have a bigger distance from the forest areas than a degraded forest.

Case Study

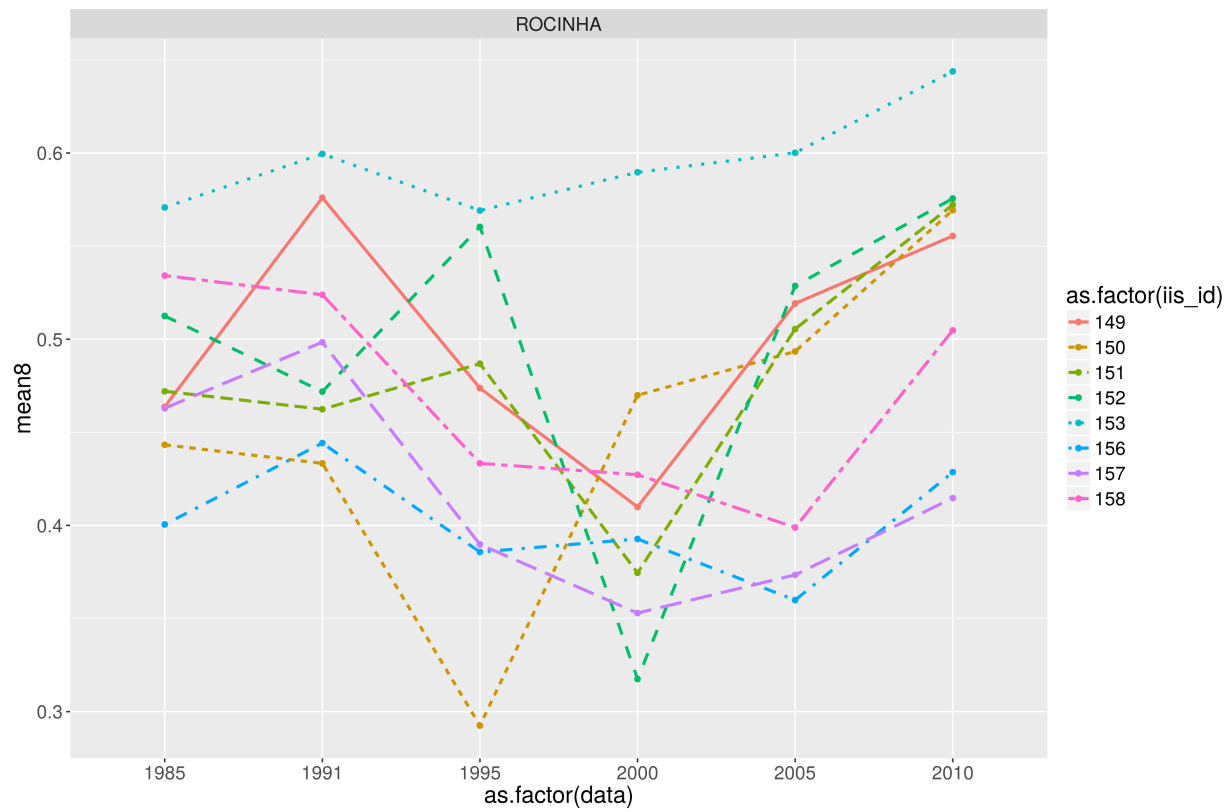
We analysed the restoration areas at Rocinha.





Mean Vegetation Index

Mean Normalized Vegetation Index (NDVI) evolution



Pros:

Cons:

Why to use this one? why not?

Mean Enhanced Vegetation Index (EVI)

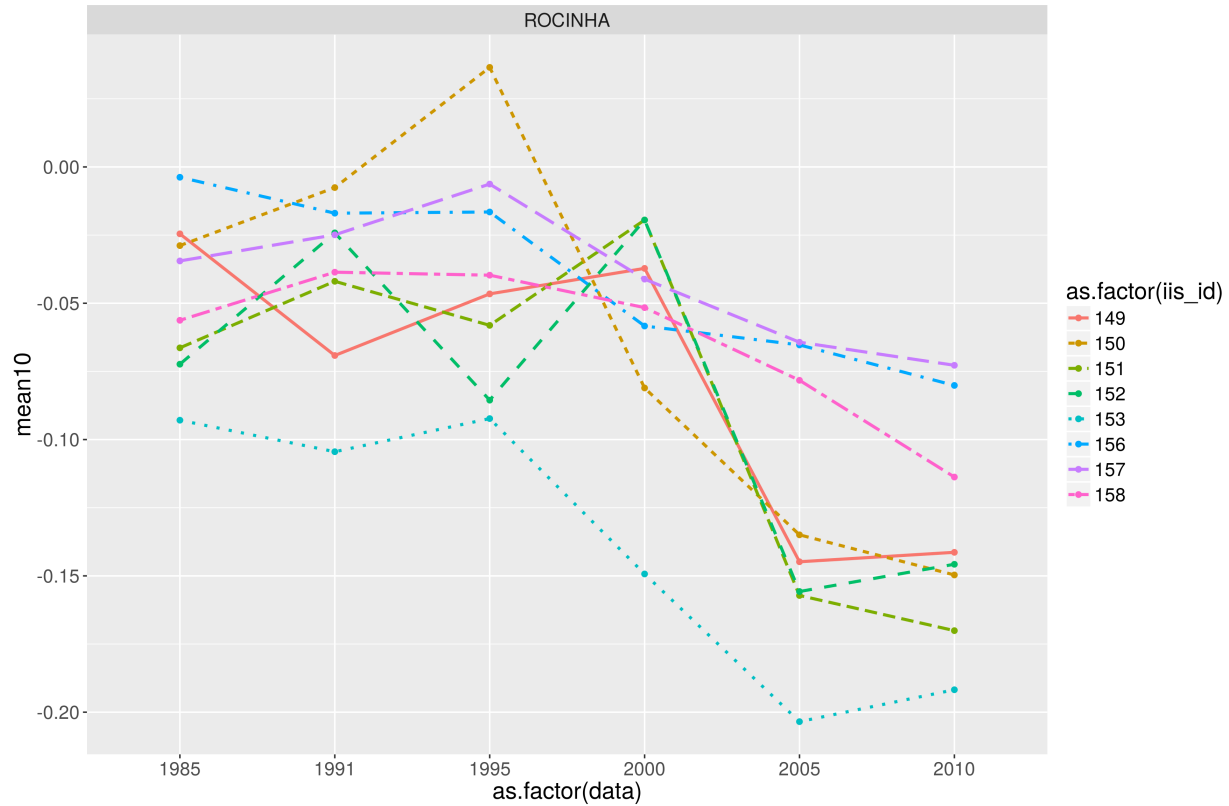


Pros:

Cons:

Why to use this one? why not?

Mean Soil Adjusted Vegetation Index (SAVI)



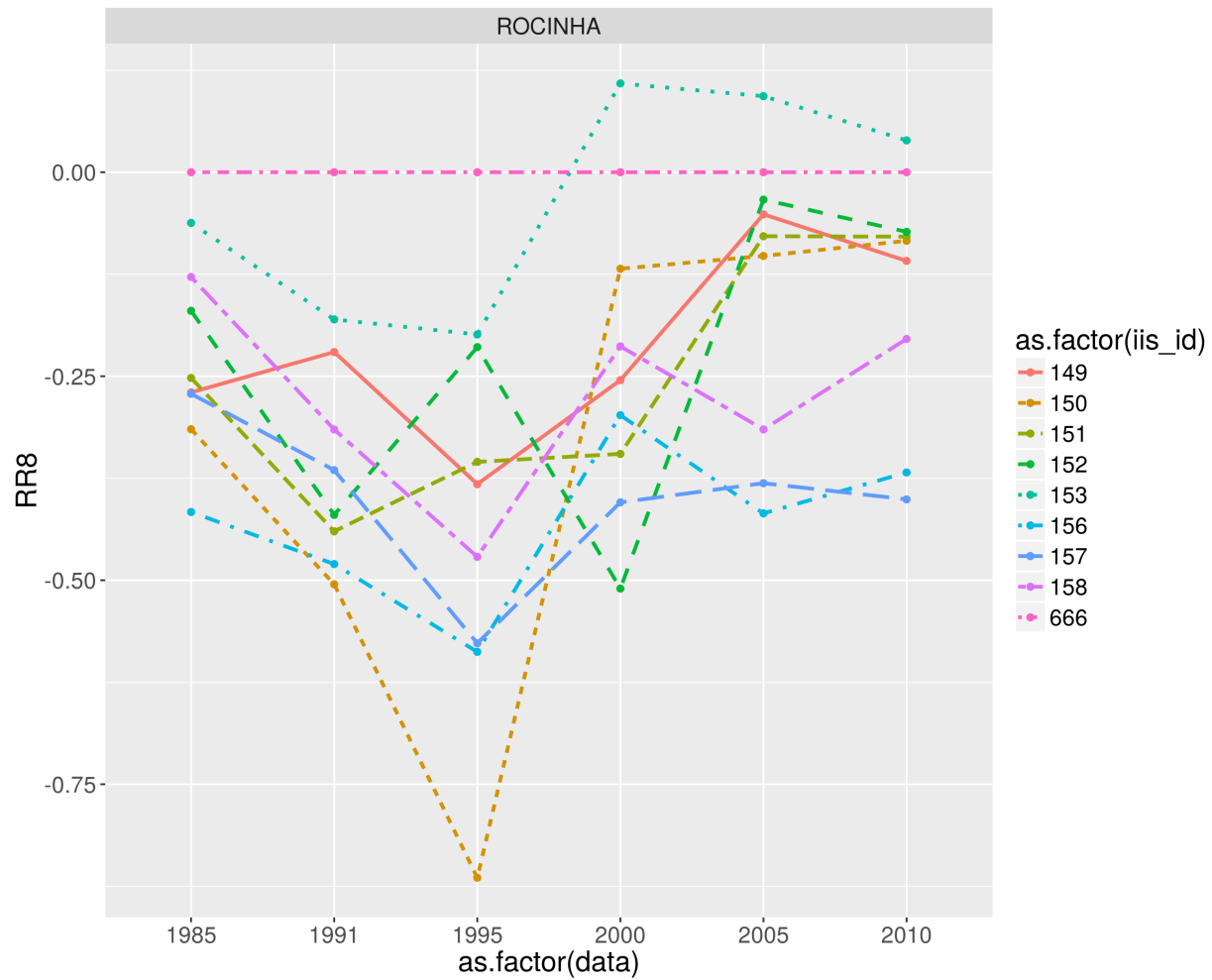
Pros:

Cons:

Why to use this one? why not?

Response ratio

Response Ratio ($\log \frac{Param_a}{Param_b}$) can be used for any of the vegetation index, and must have one reference area. In this example, we are using NDVI.



Pros:

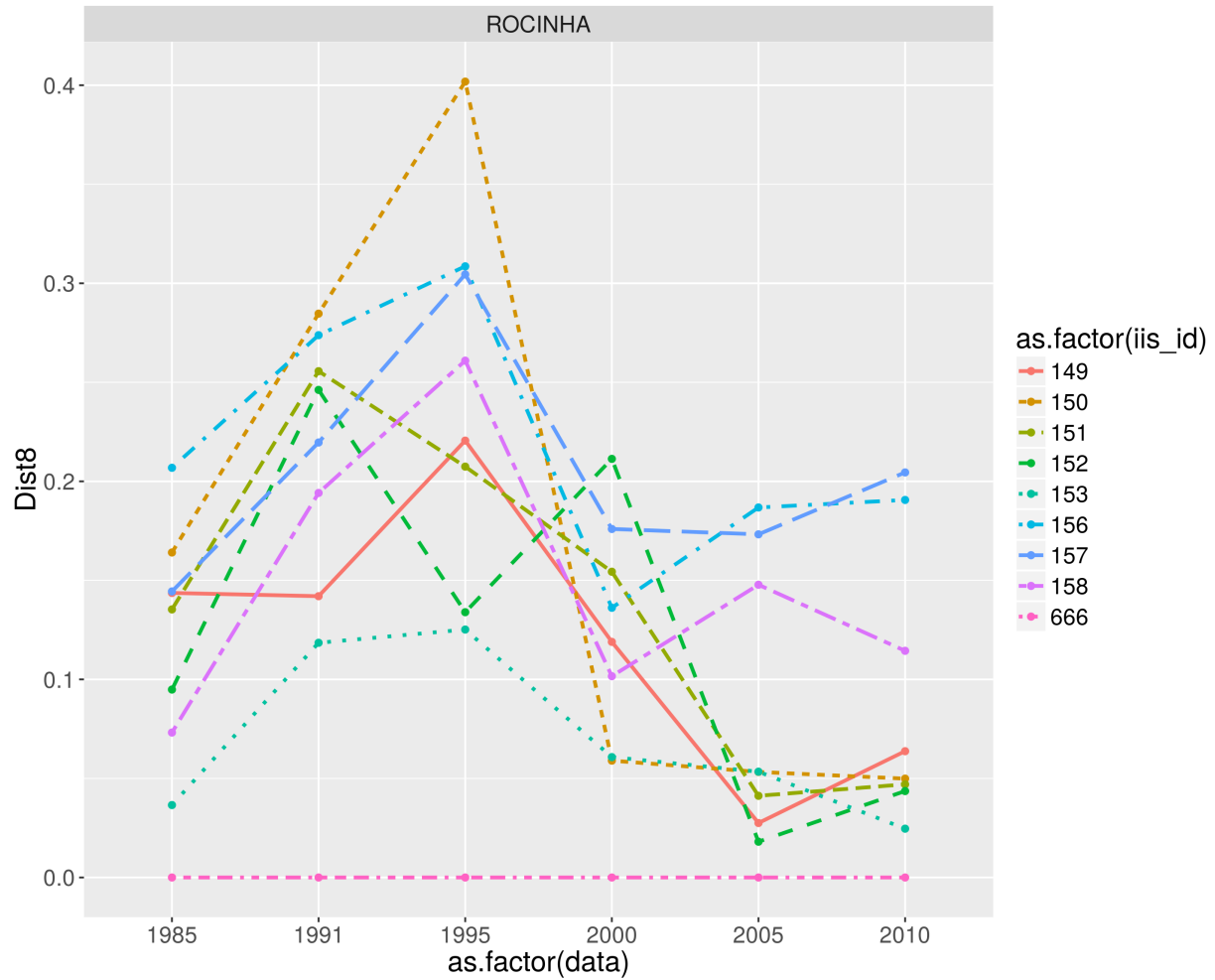
Cons: A reference area must be difficult to define, as its location (slope, orientation) might influence in the vegetation index.

Why to use this one? why not?

Acredito que os valores precisam ser corrigidos, uma vez que estou considerando os valores médios de DNVI (que por sua vez variam de 1 a -1).

Distance

Euclidean distance from mean reference forest vegetation Index to mean vegetation index of reclamation areas. In this example, we are using NDVI.



Pros:

Cons: A reference area must be difficult to define, as its location (slope, orientation) might influence in the vegetation index.

Why to use this one? why not?

Others concerns

1. some areas might be too small to be analysed with Landsat imagery (which has 30m spatial resolution)
 - 1.1 But we can define a minimum area to be analysed (like having more than 4 pixels)
2. Measuring mean values is dangerous?