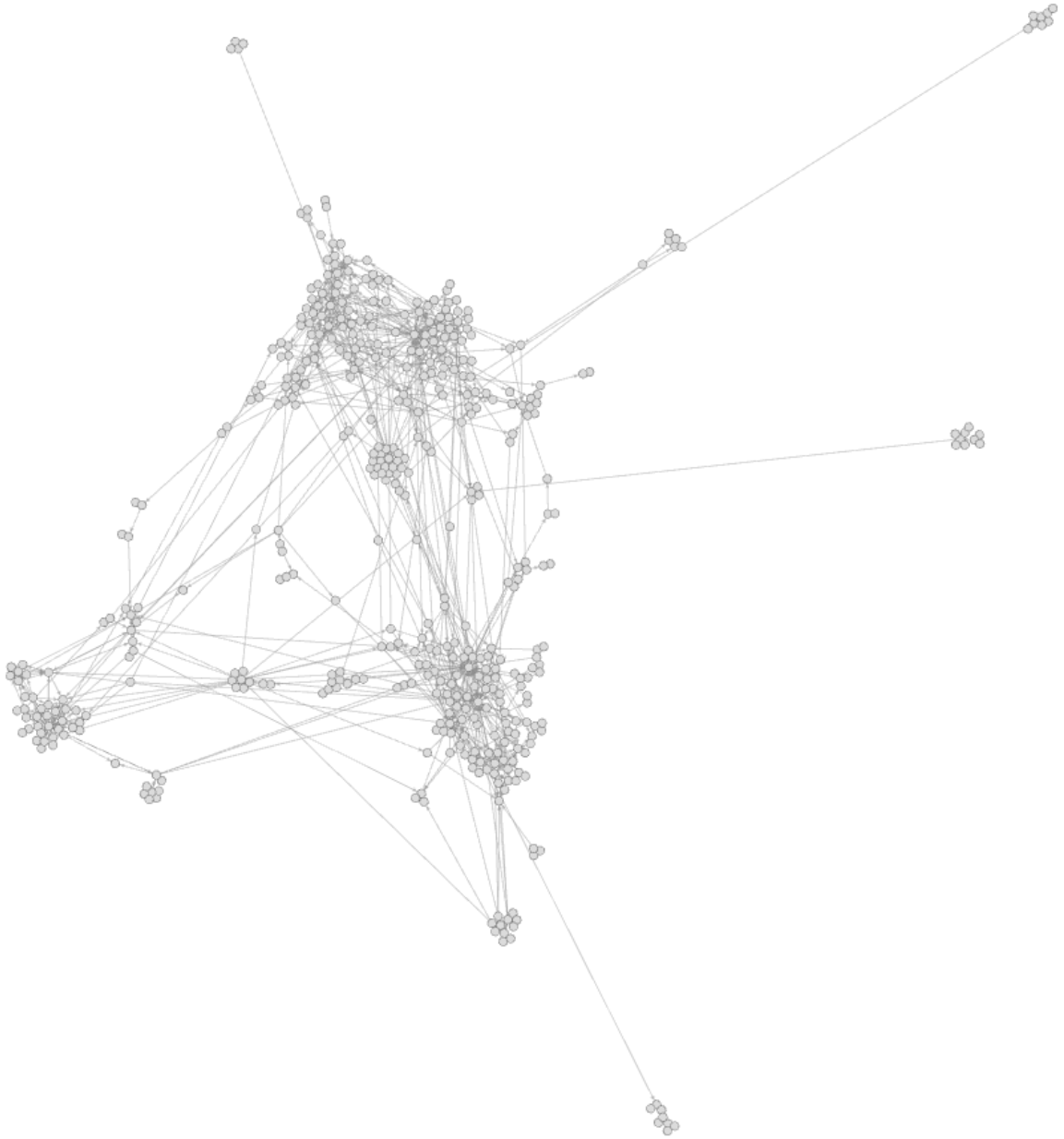
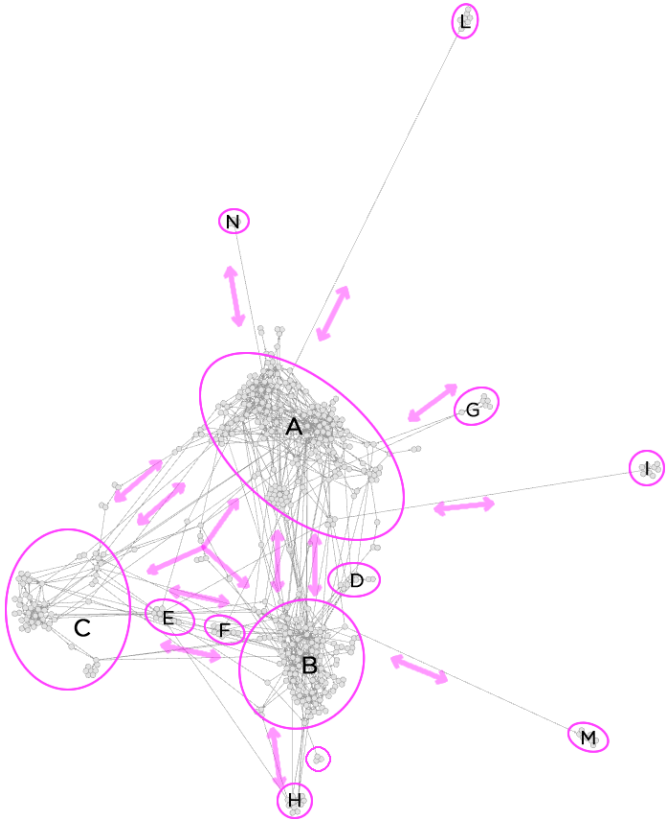
An Example of Visual Network Analysis

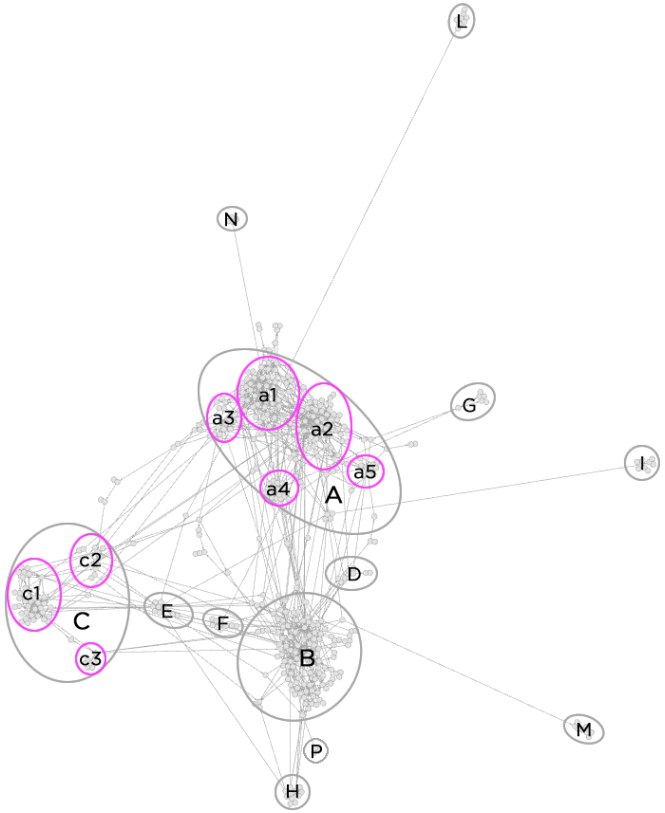
Synoptic table of visual network analysis

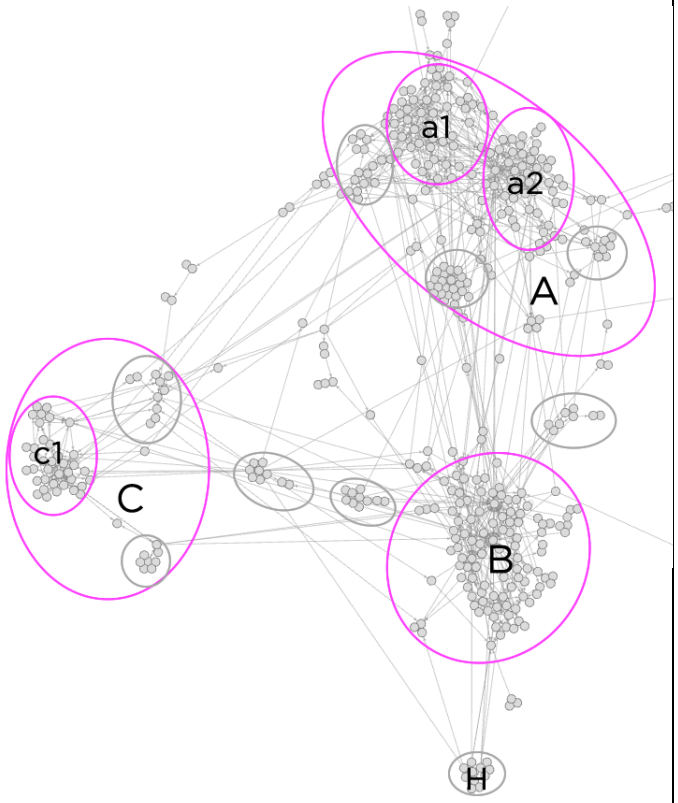
			Global (network)	**Local (clusters)**	**Individual (nodes)**
Layout (position)	Density	Is the density of nodes and links uniform?	Which are the emptier zones of the graph? Structural holes Which are the denser ones? Clusters	Which are the emptier zones of each cluster? Which are the denser ones? Sub-clusters	
		How dense are different zones?	Which are the larger clusters? Which the denser ones?	Which are the larger sub-clusters? Which the denser ones?	
	Relative Position	What elements are central?		Which clusters are central in the graph?	Which nodes are central in each cluster?
		What elements bridge different zones?		Which clusters are between other clusters? Bridge	Which nodes are between clusters? Bridge
Ranking (size)	Connectivity	What elements have higher (In-)degree?			Nodes with more in-links in the graph? Global authorities In a cluster? Local authorities
		What elements have the higher Out-degree?			Nodes with more out-links in the graph? Global hubs In a cluster? Local hubs
Partitions (color)	Distribution	How nodes distribute in partitions?	Which partitions contain more nodes of the graph?		
	Consistency	Are partitions consistent with topology ?		Do partitions coincide with clusters?	Which nodes are 'out of place'

Layout (position of the nodes)

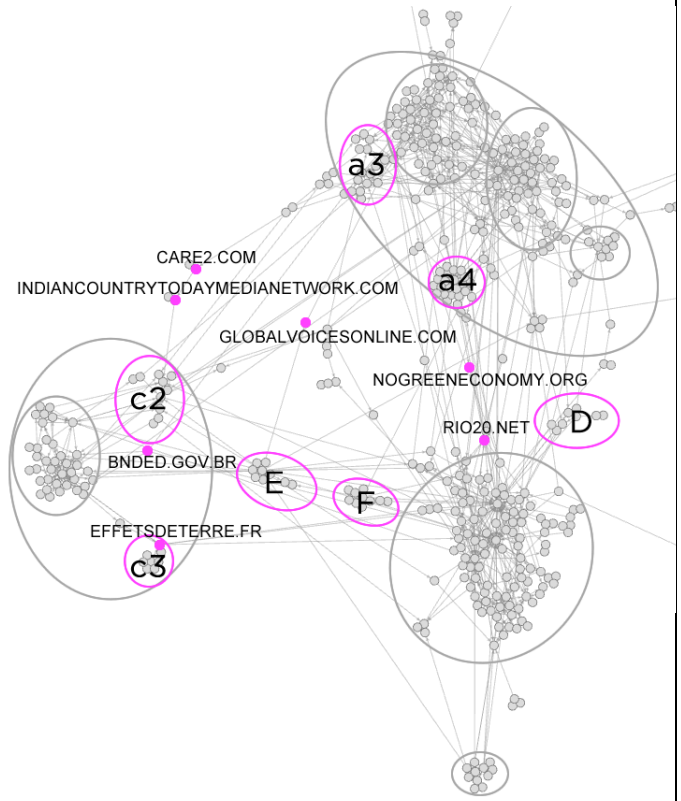


Density: Is the density of the nodes and edges uniform?		
Structural holes and clusters: Which are emptier zones of the graph and the denser?	The spatialization of the network with a force-vector algorithm (in Gephi, using ForceAtlas2, LinLog mode, scaling 0.35, gravity 0.2, prevent overlap) makes it evident that this network is highly clusterized. The nodes and the edges fill the space of the network in a very uneven way. It is therefore relatively easy to identify the structural holes of the network. The core of the graph (containing most of the network nodes and edges) is clearly separated from the outer ring of nodes. A separation between the top and the bottom of the graph is also evident, as well as an equally sharp separation between the bottom-left and the bottom right. This double separation entails that the center of the graph is relatively empty. Turning our attention from the emptier zones to the denser ones, the network is organized around three main clusters (A, B, C). Three smaller clusters are also present in the core of the network (D, E, F). The other nodes form an outer ring of satellite clusters (G, H, I, L, M, N).	

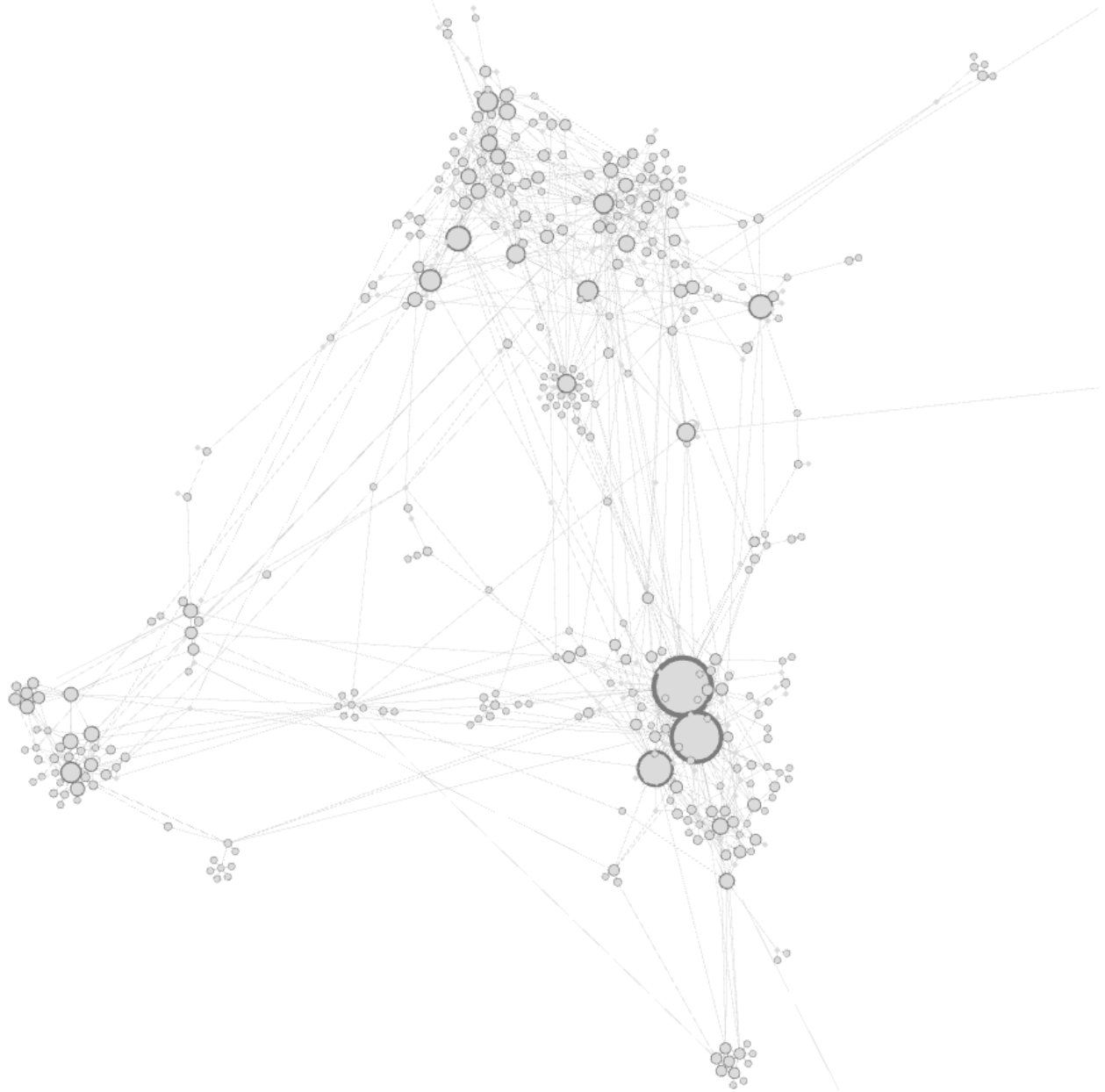
Sub-clusters: Which are denser zones of each cluster?	A close inspection of the three main clusters reveals several sub-clusters. These groups of nodes are not separated by major structural holes and yet they are clearly distinguishable. In particular, the nodes of the cluster A are distributed in five different sub-cluster (a1, a2, a3, a4, a5) and the nodes of the cluster C in three (c1, c2, c3). The case of the sub-cluster a1 and a2 is particularly interesting as these two sub-clusters are so close one another than there is almost no empty space between them. Only a difference in the density between the centers and the borders of these two sub-clusters allows telling them apart. Cluster B, on the contrary, is so dense that no sub-clusters can be distinguished.	

Density: How dense are different zones?		
Remarkable clusters: Which are larger clusters of the graph and the denser?	As we said the three main clusters of the graphs are A (by far the largest), B and C. The cluster B is particularly interesting the remarkable concentration of its nodes. As for the clusters in the outer ring, H stands out for its size and its density (and for its proximity to the core of the graph).	
Remarkable clusters: Which are larger sub-clusters of the graph and the denser?	As for the sub-clusters, a1, a2 and c1 are larger and denser than all other sub-clusters and clusters (with the exception of B)	

Relative position: What elements are central?		
Remarkable clusters: Which clusters are central in the graph?	As we said before, the center of the graph is relative empty: it contains a few nodes but no discernible clusters. In fact, the only central node is nature.com, which is the only node in the graph to be connected to the three clusters (and only indirectly to cluster B).	
Remarkable nodes: Which nodes are central in each cluster?	Among the three main clusters, only cluster B has a central node (un.org) whereas cluster A and C has no identifiable center. Several other clusters and sub-clusters, however has a distinct central nodes: - E: iucnworldconservationcongress.org - F: demilitarize.org - a4: cupoladospovos.org.br - c1: realclimate.org NB. Since this document is focused on the *visual* analysis of network, centrality has been determined just by looking at the image and identifying which nodes appeared in the middle of each cluster. However, it has to be mentioned that there exists several mathematical measures for the computation of the centrality of nodes (e.g. pagerank, closeness centrality, eigenvector centrality…).	

Relative position: What elements bridge different zone?		
Remarkable clusters: Which clusters are between other clusters?	While no cluster stands out for its centrality, many are remarkable for the betweens and in particular: - D bridges the structural hole between A and B - E and F (together) and bridge the hole between B and C - a3 and a4 (within A) and c2 (within C) bridge A and C It is interesting to remark the distinction among the D, E and F which work as 'external bridges' (being located outside the clusters that they bridge) and a3, a4 and c2 that work as 'internal bridges'.	
Remarkable nodes: Which nodes are between clusters?	There are several bridging node in the network, namely: - nogreeneconomy.org and rio20.net bridges A and B - care2.com and indiancountrytodaymedianetwork.com (together) and globalvoicesonline.com bridge A and C - effetsdeterre.fr (within C3) bridges B and C - bnded.gov.br bridges C (and c1 in particular) and E. NB. Since this document is focused on the *visual* analysis of network, bridging has been determined just by looking at the image and identifying which nodes appeared in-between different clusters. However, it has to be mentioned that bridging is often measured through the computation of a mathematical indicator called "betweenness".	

Ranking (size of the nodes)

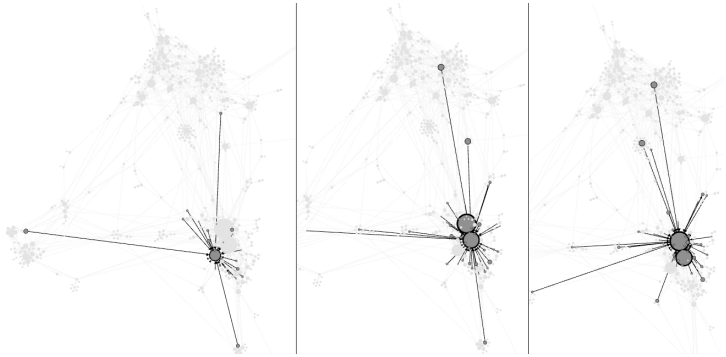


Connectivity: What elements have the higher degree or in-degree?

Remarkable nodes: Which nodes have the higher degree or in-degree?

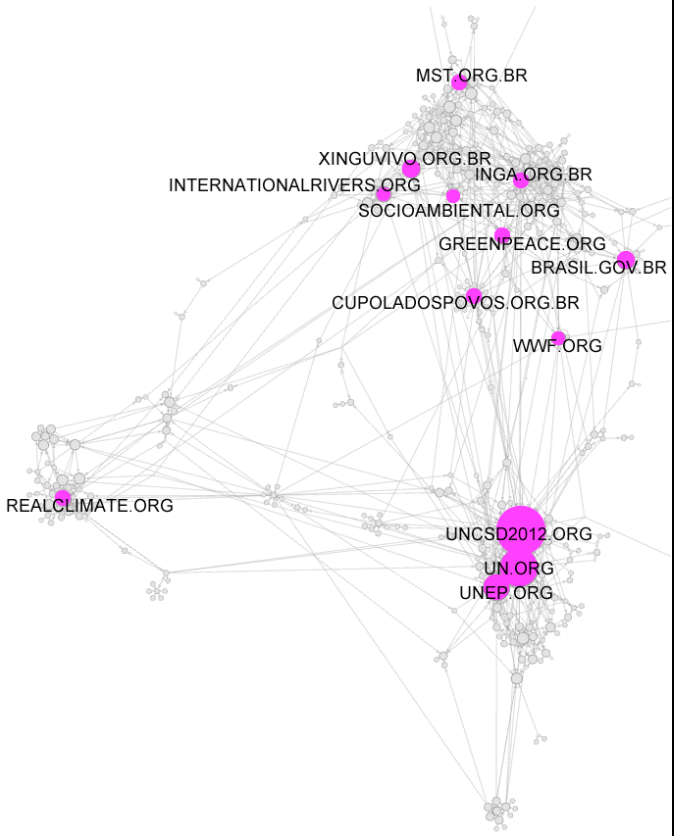
By changing the size of the nodes proportionally to the number of their incoming hyperlinks (in Gephi, in-degree ranking, scale 7-70), we can easily see which websites receive more attention within the network.

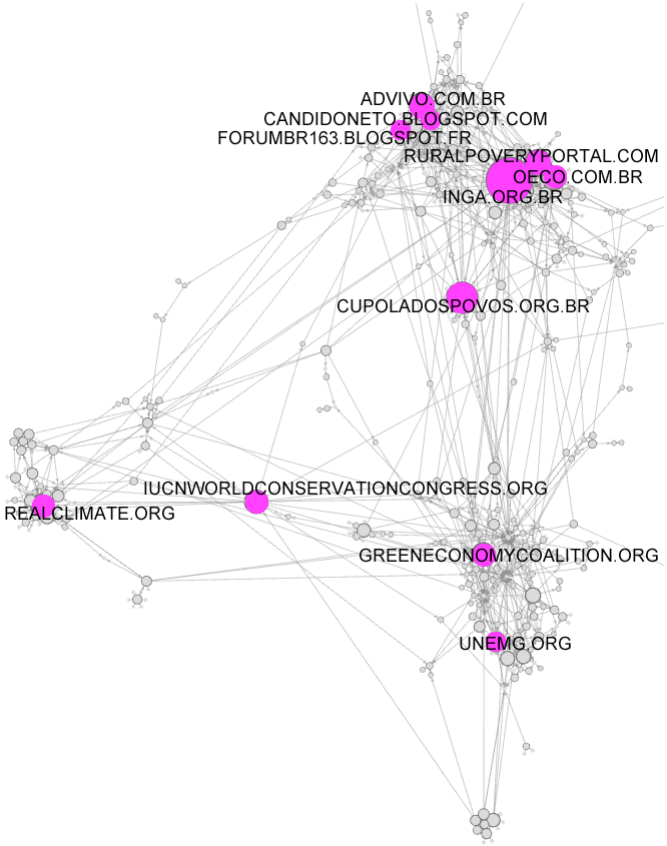
It is interesting to remarks the three bigger authorities of the graph (uncsd2012.org, un.org, unep.org) are located in cluster B. The high density of this cluster and the lack of sub-clustering are largely due to the centripetal force of these three websites. These three websites, however remain local authorities: even if they receive links from other clusters, the largest part of their neighbors remain within cluster B.



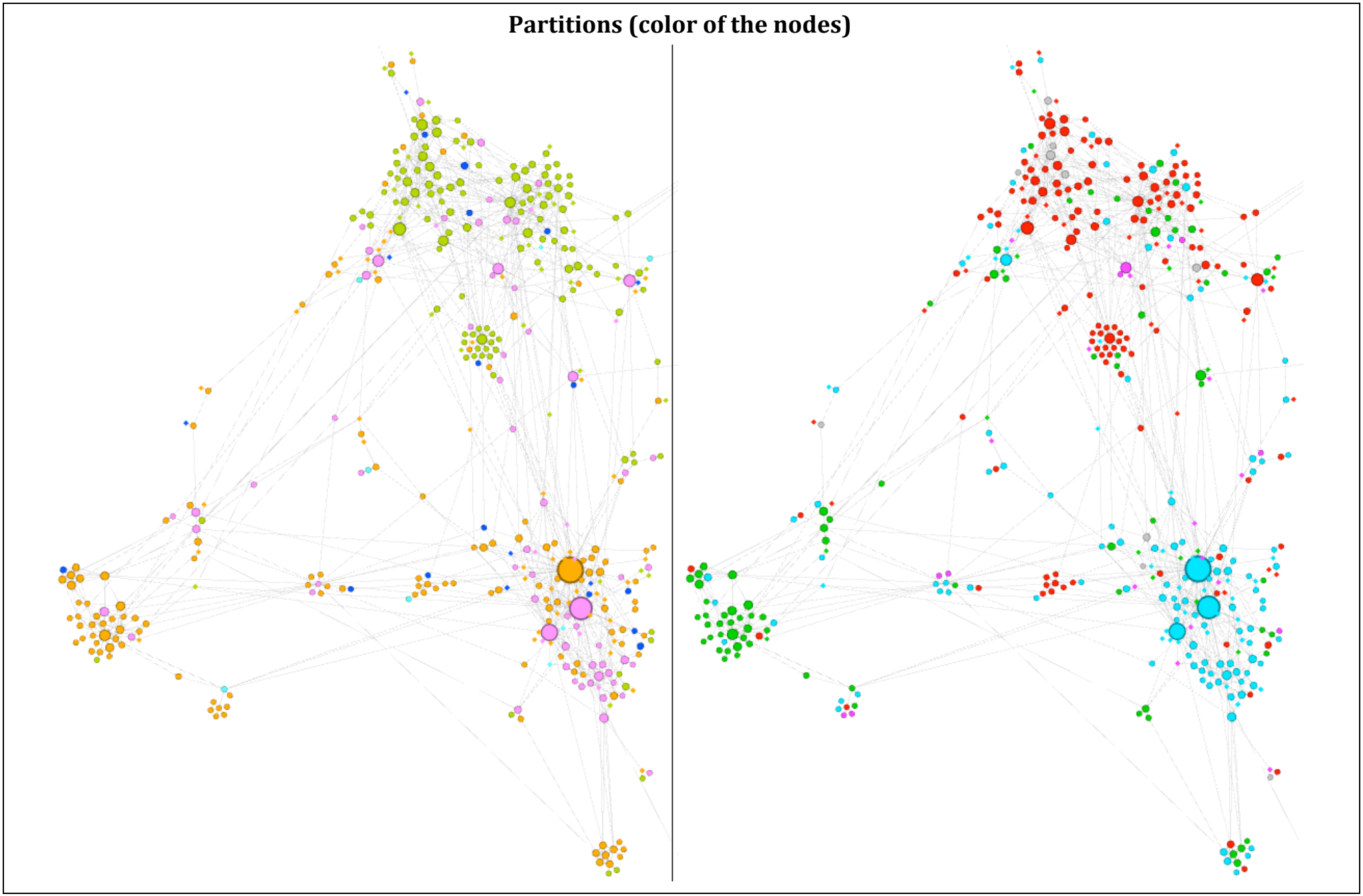
Cluster A contains the larger number of (local) authorities (even all of them are smaller than cluster B's authorities).

Finally, cluster C contains only one (local) authority: the website realclimate.org.



Connectivity: What elements have the higher out-degree?		
Remarkable nodes: Which nodes have the higher out-degree?	Moving from the in-coming link to the out-going links (in Gephi, in-degree ranking, scale 7-70), it is possible to highlight the most important hubs in the network. As it can be easily seen the distributions of hubs is more balanced than those of authorities, though we can still observe a clear prevalence of cluster A.	

Partitions (color of the nodes)



Distribution: How nodes distribute in partitions?

Partition projection: Which partitions contain more nodes of the graph?

The nodes of the network have been tagged according to two different classifications: the language of the websites and their nature. As for the latter, the websites have been categorized according to their political orientation, into four different classes:

- Social ecology.
- Green economy.
- Deep ecology.
- New ecologism.

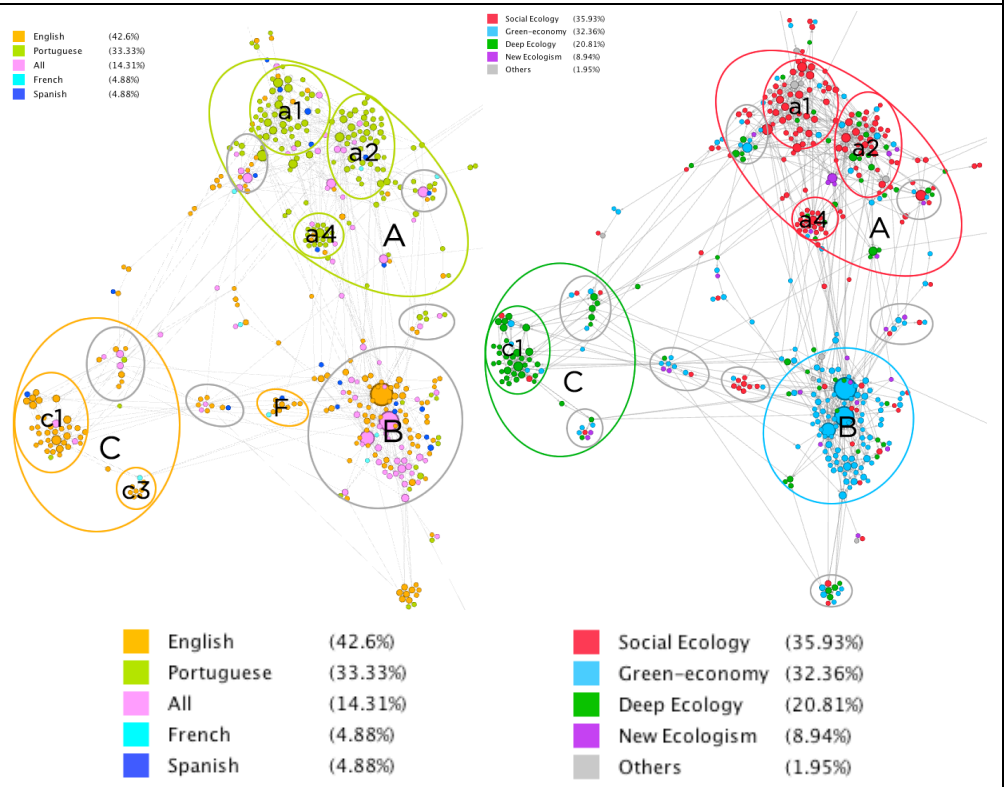
Distribution: Are partitions consistent with topology?

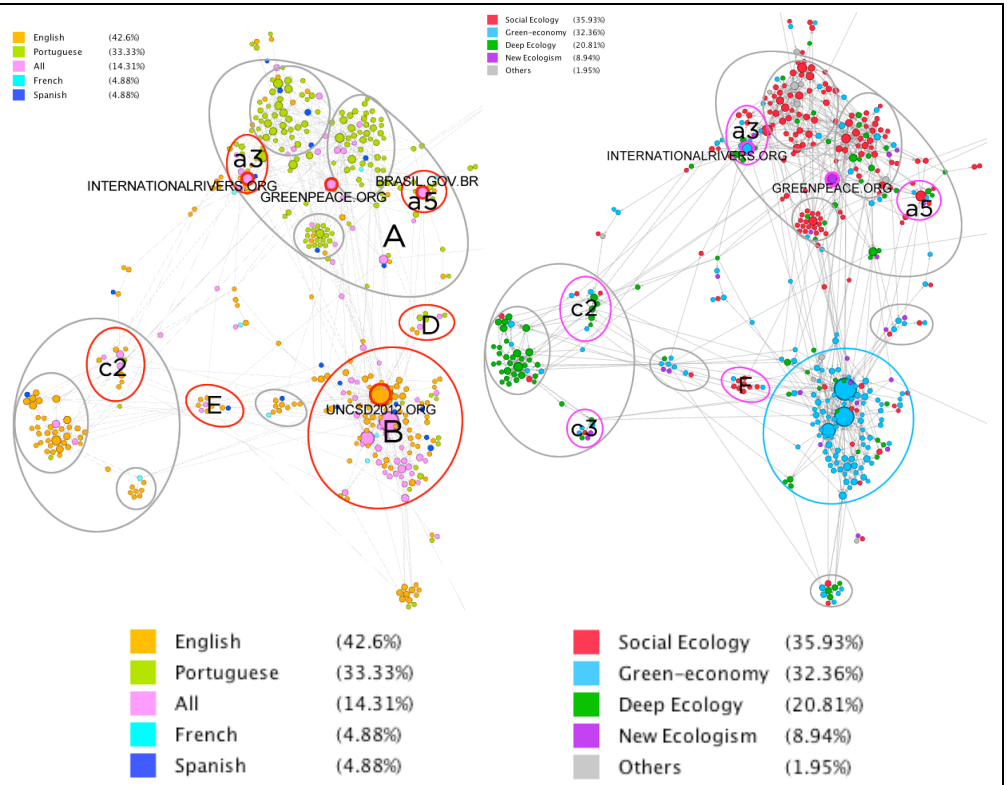
Partition projection: Do partitions coincide with clusters?

As often happens in web networks, linguistic frontiers are well visible in the clustering of the graph. English sites tend to be concentrated in cluster C (though several English sites are also present in cluster B), while Portuguese sites are prevalently located in cluster A. In addition, most sub-clusters within these two major clusters respect the same linguistic separation.

As for the nature of the websites, the coherence between categorization and topology is also remarkable. The three main classes correspond amazingly well to the three major clusters of the network (and their main sub-clusters) – an indication of the validity of such classification.

The fact that both language and nature are consistent with topology indicates an interesting correlation between the two. In particular social ecology seems to be a predominantly Brazilian approach, while deep ecology seems to be more popular in English speaking websites. As for green ecology its appears to be the dominant approach for the cluster B that gathers mostly international websites (see below).



Remarkable nodes: Which nodes are out of place?	The general consistency between partitioning and clustering does not rules out the existence of interesting exceptions. The most remarkable one is constituted by mixture of multi-lingual and English websites in cluster B. Particularly interesting is the fact that the two main authorities of the cluster (uncsd.org and un.org) are categorized differently. The fact the both are websites of international organizations suggests that the cluster is mainly composed of international websites (and therefore multi-lingual or using English a *lingua franca*). Other interesting exception are the nodes of the sub-clusters a3, a5 and c2, many of which (in particular internationalrivers.org greenpeace.org) fall in a different class than the majority of their cluster under both of the categorization.	

English (42.6%)
Portuguese (33.33%)
All (14.31%)
French (4.88%)
Spanish (4.88%)
Social Ecology (35.93%)
Green-economy (32.36%)
Deep Ecology (20.81%)
New Ecologism (8.94%)
Others (1.95%)