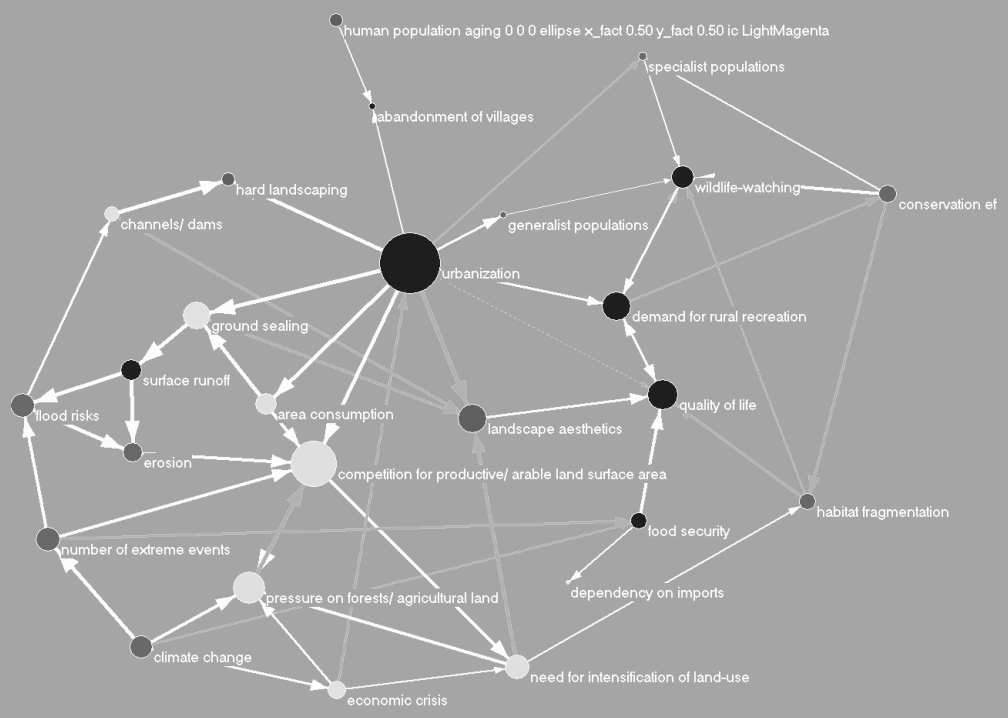
Peyresq 2009

Fuzzy Cognitive Mapping

"What factors will lead to a change in the natural environment and how will that effect human well-being"

Martin Wildenberg



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Introduction:

In this document the results of a Fuzzy cognitive mapping exercise conducted at the 2009 ALTER-Net Summer School in Peyresq are presented. 29 maps were produced by the participants trying to answer the "easy" question:

"What factors will lead to a change in the natural environment and how will that effect human well-being".

The attempts of the participants (and tutors) to find a response to this question can be found on these pages. The document has three main parts, the first giving an overview over all maps, the second introducing the aggregated map and some results of the dynamical analysis (simulation) of this map and finally the third part contains all individual maps & their indices.

This document mainly lists the results of the mapping and does not discuss them in depth. Feel free to take your own conclusions out of your maps! Additional material like the net-files & the adjacency matrixes will also be made available on www.FCMappers.net .

Fuzzy Cognitive Mapping

In the following a short overview over the FCM indices is given:

Indices:

Density (D) shows how highly connected the factors are to each other within the network. It is calculated by dividing the number of counted connections (C) by the number of possible connections between N factors (Hage & Harary 1983).

Equation 1: If no self-feedback is allowed (main diagonal consist solely of zero) max. number of connections is N (N-1) if factors are allowed to influence themselves than there are N^2 possible connections within a network.

$$D = \frac{C}{N(N-1)} \qquad\qquad D = \frac{C}{N^2}$$

More connections per concept will result in a higher density (D). A system with higher density is seen as containing more available options to manipulate the system (Özesmi & Özesmi 2004).

To define the type and the role of each factor within the network Indegree, Outdegree and Centrality are calculated.

Indegree [id(vi)] is calculated by summing up the absolute values of all ingoing arrows (the sum over the column of a factor in the matrix). **Outdegree** [od(vi)] is calculated by summing up the absolute

values of all out going arrows (the sum over the row of a factor in the matrix). Absolute values give positive and negative values equal importance (Yaman & Polat 2009).

$$\mathrm{id}(v_i) = \sum_{k=1}^{N} \bar{a}_{ki} \qquad \mathrm{od}(v_i) = \sum_{k=1}^{N} \bar{a}_{ik}$$

The **centrality** or total degree (Harary et al., 1965) of a factor is the sum of the in- and outdegrees. In FCMs, unlike cognitive maps or some SNA approaches, the value of centrality of a factor can be higher although it has fewer connections than others, as the weight of the connections enters the calculation of centrality (Kosko 1986). Centrality is a measure for the importance of a node. Concepts with high centrality-values should therefore get special attention (Yaman & Polat 2009).

Three different types of factors can be found in a FCM: transmitter, receiver and ordinary. Transmitters have positive outdegree but no indegree. They impact the system but the system does not directly affect them they act as drivers or forcing functions. Receivers have a positive indegree but zero outdegree, and are also called end. Ordinary factors have both positive in- and outdegrees (Harary et al 1965).

Complexity is the ratio of the number of transmitters to the number of receivers. It shows if the system is rather externally or endogenously driven (Eden et al. 1992). If the quotient of receivers / transmitters is high, complexity is high. If this quotient is low, it shows that the system is perceived as rather out-side driven with little bottom-up control (Simon 1996, p 185).

Social Map:

A social map is a map produced through augmenting several FCMs through matrix addition. In contrast to an “Cognitive Interpretation Diagram” the concepts of a social map are only augmented if they express the same meaning. For example “Farming” and “Agriculture” can be fused into one concept while “Biodiversity” and “Species Diversity” will not – as these concepts have similar but different meaning. The aim of a social map is to conserve the richness of the individual maps. The resulting map usually contains too many nodes to be visually interpreted in a meaningful. It is the basis of the dynamic analyses (Özesmi & Özesmi 2004).

Dynamic Analysis:

With the dynamic analysis the steady state of the system can be determined and scenarios can be calculated. As described in Özesmi & Özesmi (2004) we use the auto-associative neural network method (Reimann 1998). A vector of initial states of variables is multiplied with the adjacency matrix of the social map. Through the connections input is transmitted from one node to the next connected node(s) according the strength attributed to this connection. The output is scaled in the interval of 0-1 by using a logistic function. The multiplication is iterated until the network converges to a fixed point. This results in the steady state of the network.

When running scenarios some factors (concepts) are set to high respectively low values. The results of a Scenario run is then compared to the steady state results to see if the value of the concept has increased or decreased i.e. if the factor shows a positive or a negative trend compared to the reference scenario.

Software

For calculating the indices, running the scenarios and transforming the adjacency matrix into a net-file format "FCMapper" was used. To produce the network images and to extract sub-networks the social-network software "Pajek" and "Visone" were used. The material needed to repeat all the calculations presented here will be made available on www.FCMappers.net. Here you can also find the links to the social network software and a short tutorial on how to use Pajek to open your net-files.

FCMapper: http://www.fcmappers.net/joomla/

Pajek: http://pajek.imfm.si/doku.php?id=download

Visone: http://visone.info/index

Results

Overview

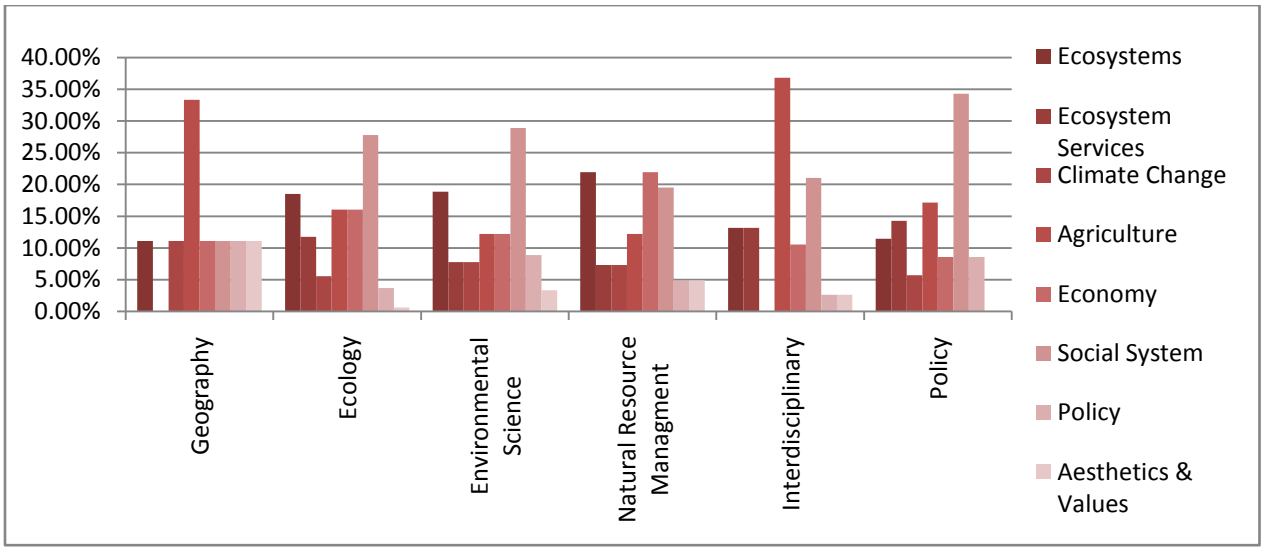


Figure 1: Distribution of concepts (grouped into 8 thematic groups) over the 6 disciplines.

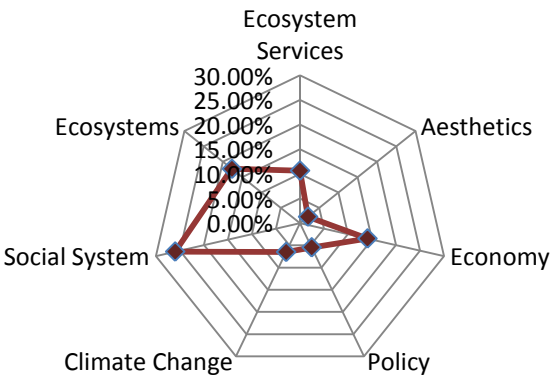


Figure 2: Fraction of concepts in the eight different thematic groups. Most concepts (26%) can be related to the social system.

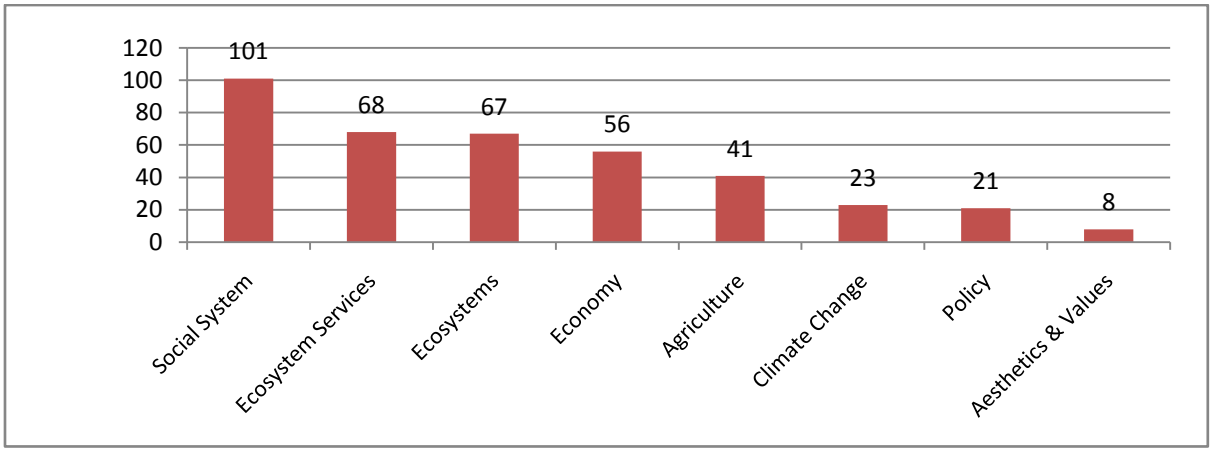


Figure 3: Total number of concepts in the eight different thematic groups.

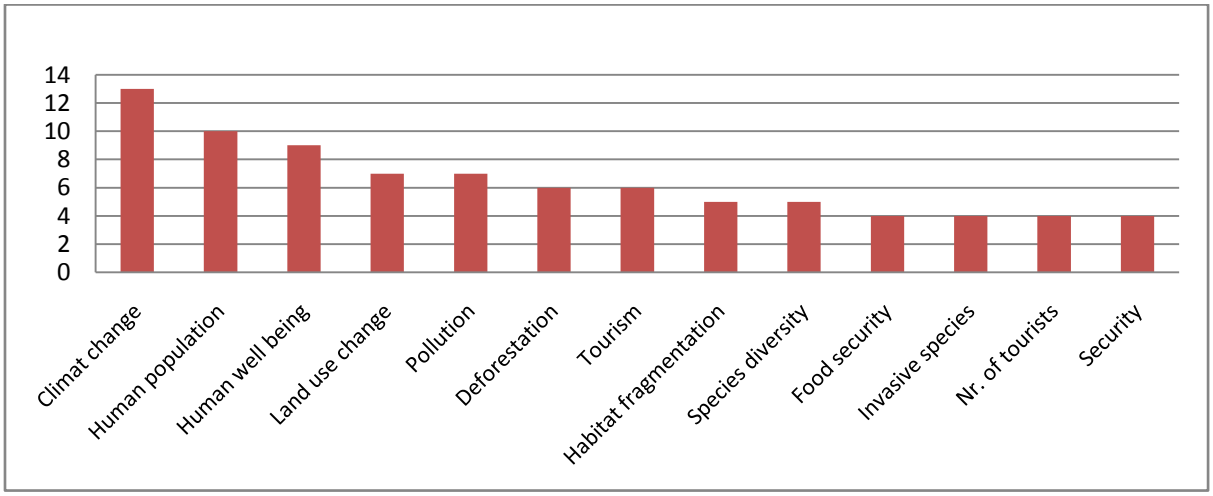


Figure 4: The most mentioned concepts in the 29 maps. Concepts mentioned at least four times were included into the graphic.

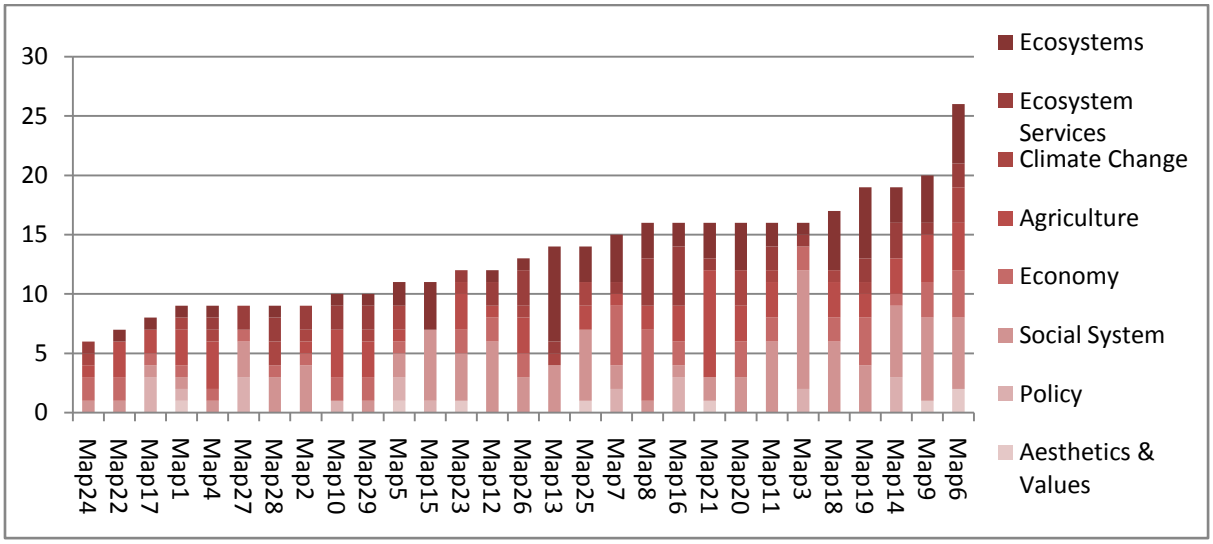


Figure 5: Maps with the number of concepts per map and their distribution into the eight thematic groups.

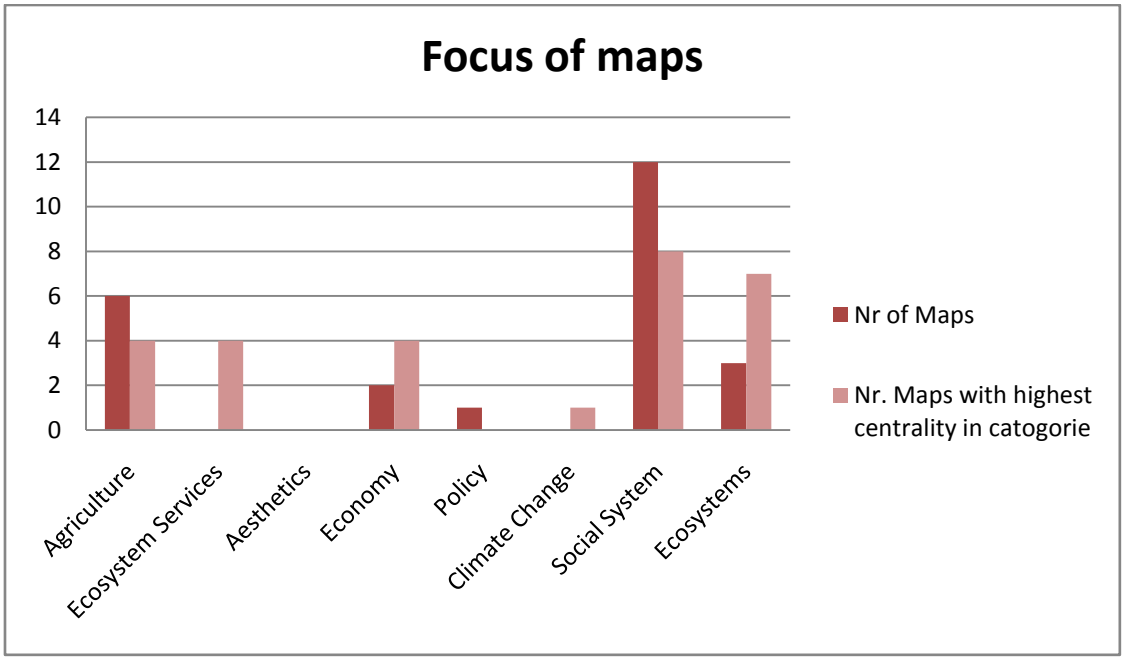


Figure 6: The dark red bar shows the number of maps in which concepts belonging to the thematic category dominate. The light red bars show the number of maps in which a concept belonging to a certain thematic category is the most central concept.

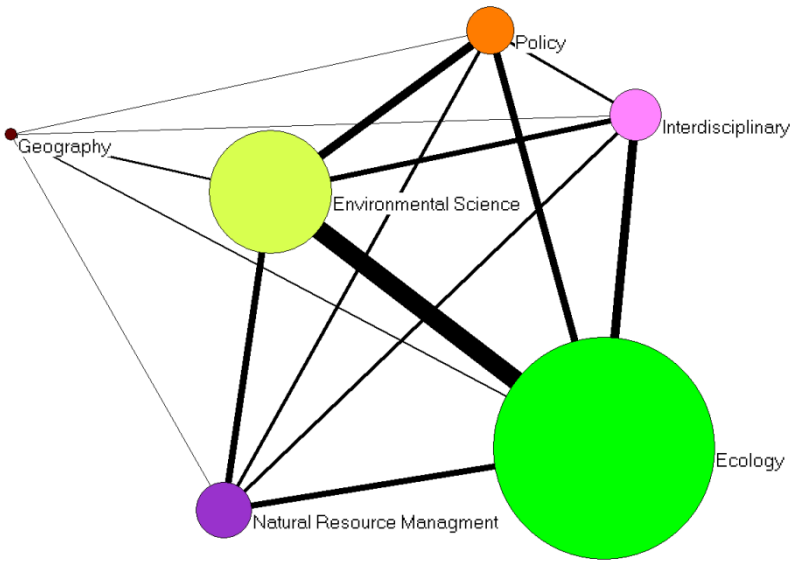


Figure 7: Graphic representation of overlap between maps grouped into the disciplinary background of the creator. The size of the circles represents the number of concepts counted in the maps of the respective discipline; the width of the line represents the number of similar concepts between the disciplines.

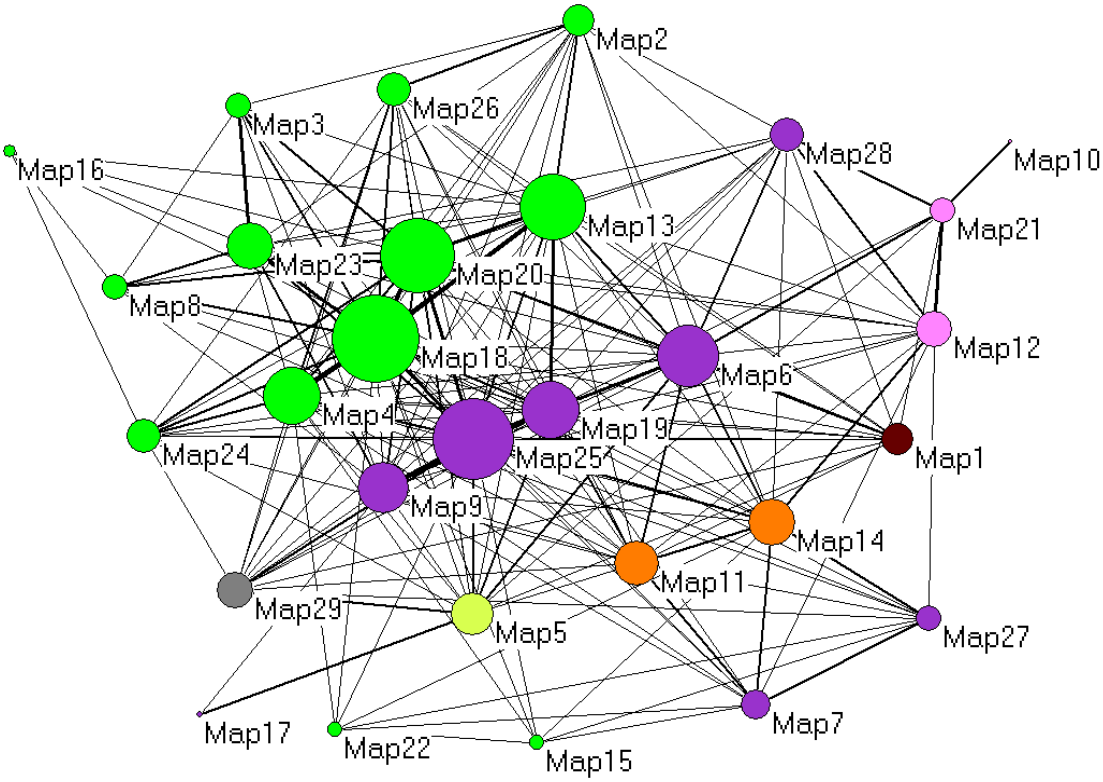


Figure 8. Overlap between the single maps. The colors of the circles represent the disciplines they belong to (see figure 7 for color code – gray = discipline not known). The size of the map represents the amount of shared concepts.

The Aggregated map and the dynamic analysis

All complete maps (n = 25) were aggregated into one big social map using the aggregation tool of FCMapper. Concept-names were only aligned if synonyms or different spelling was used. The aggregation resulted in a map containing 226 concepts. This map will be our basis to run dynamic analysis & scenarios.

Table 1: Basic figures of the aggregated map

Density	Total No. Factors	Total No. Connections	No. Transmitter	No. Receiver	No. Ordinary	Complexity
0.012	226	579	32	25	169	1.28

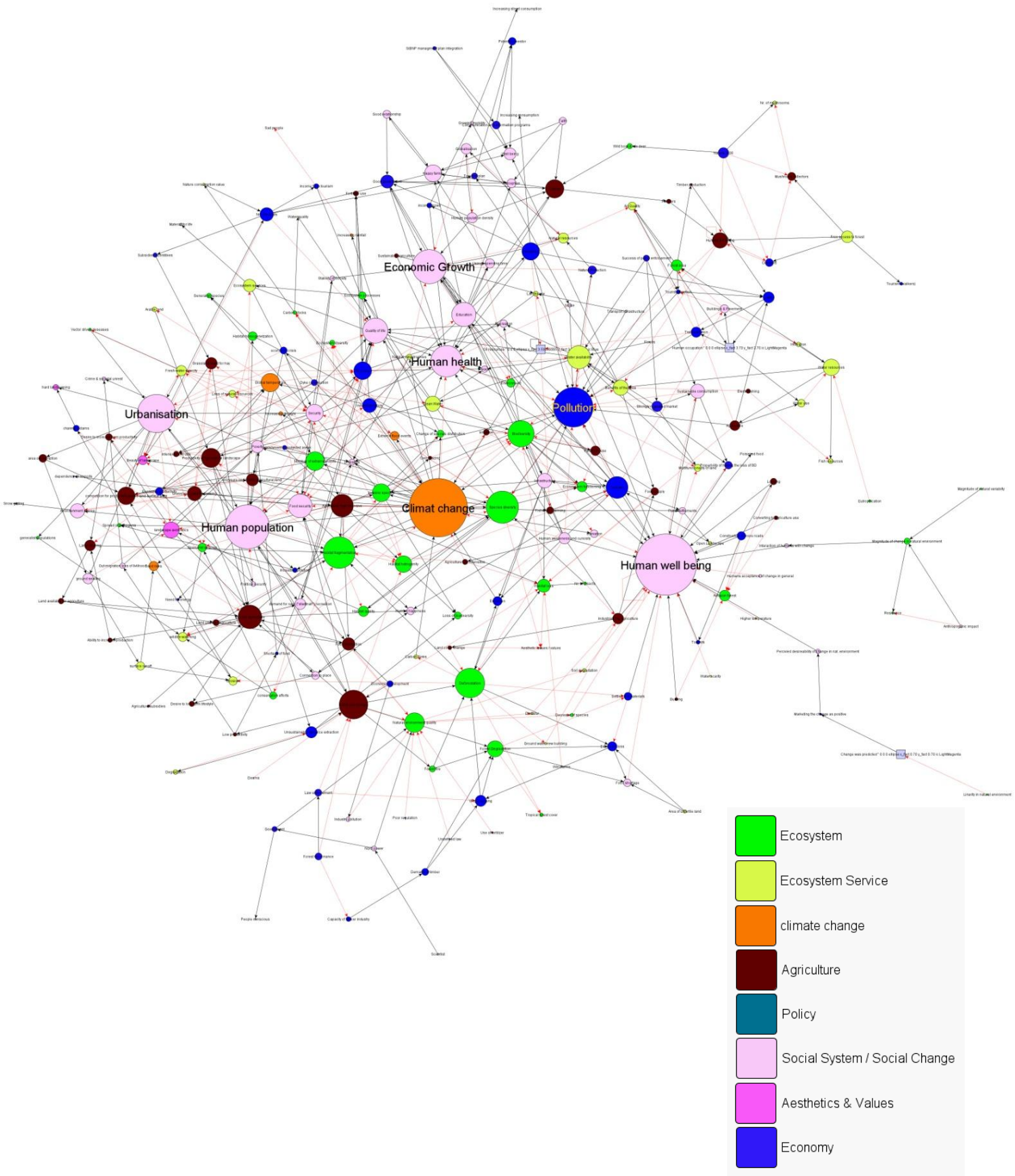


Figure 9: The aggregated social map with its 226 concepts. The same color code is also used in all following maps.

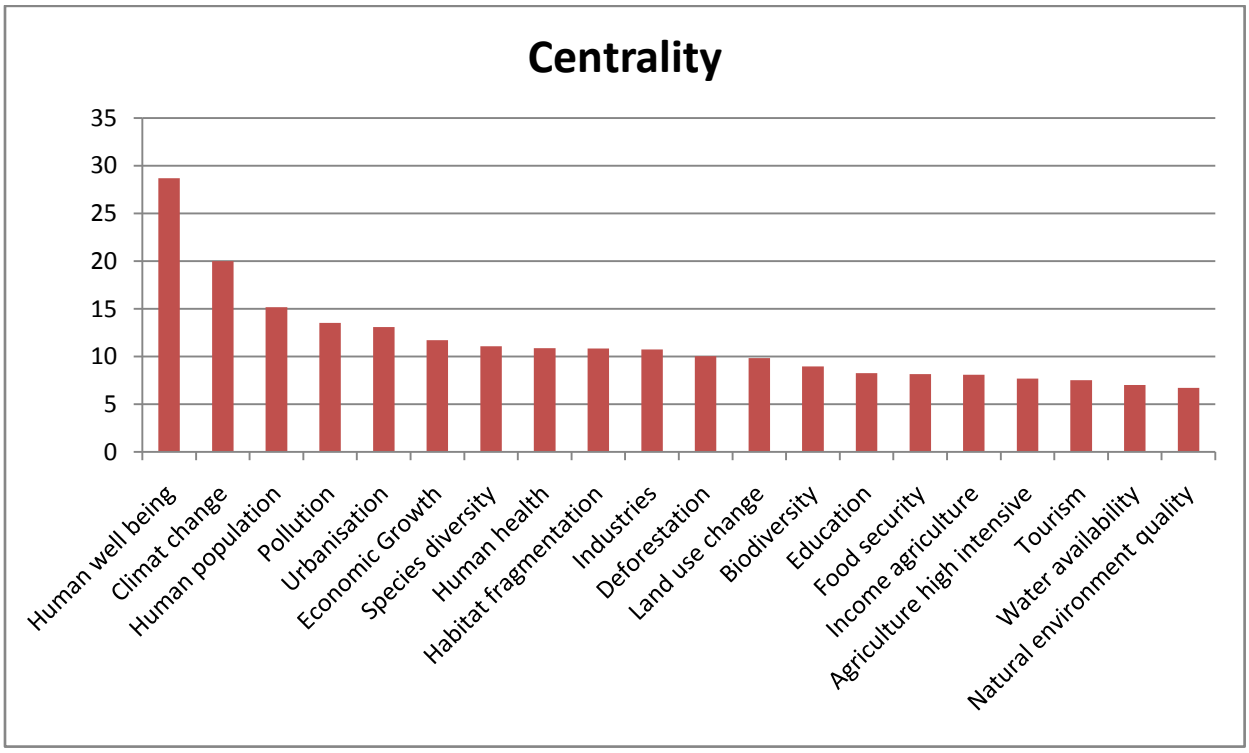


Figure 10: Concept with highest centrality in the aggregated map

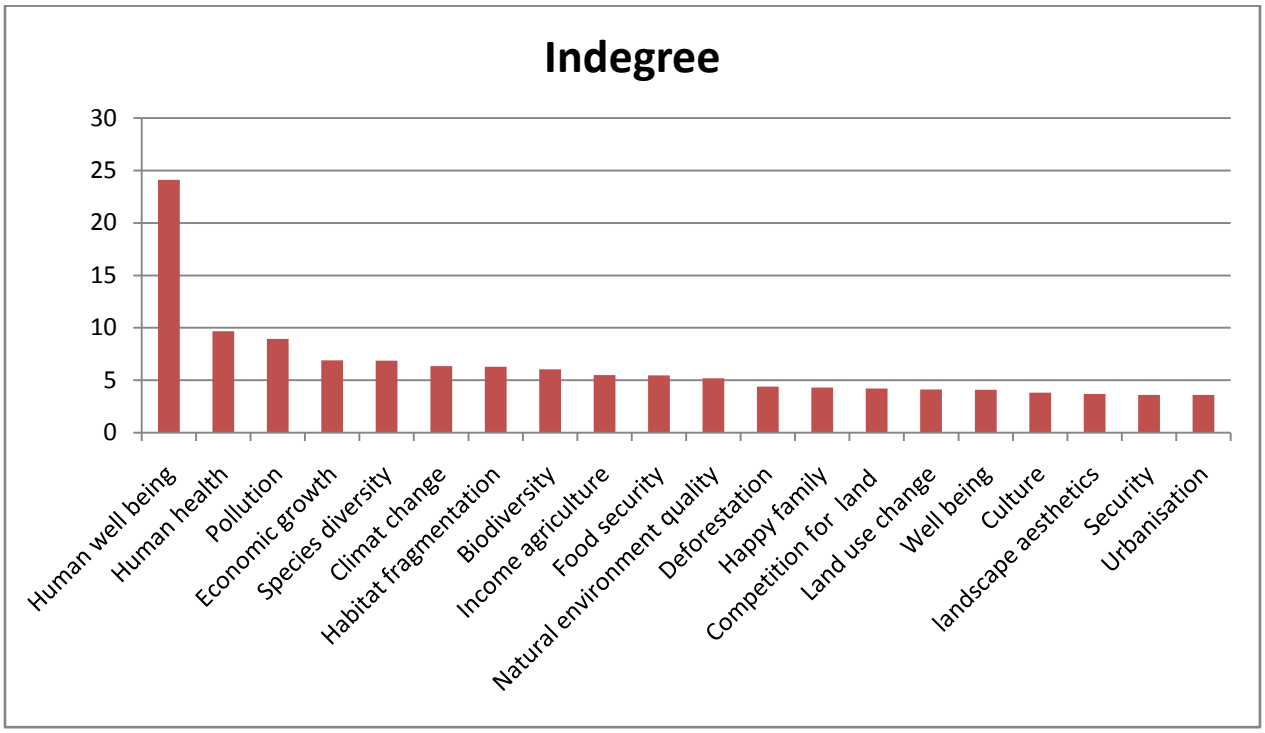


Figure 11: Concepts with the highest indegree in the aggregated map.

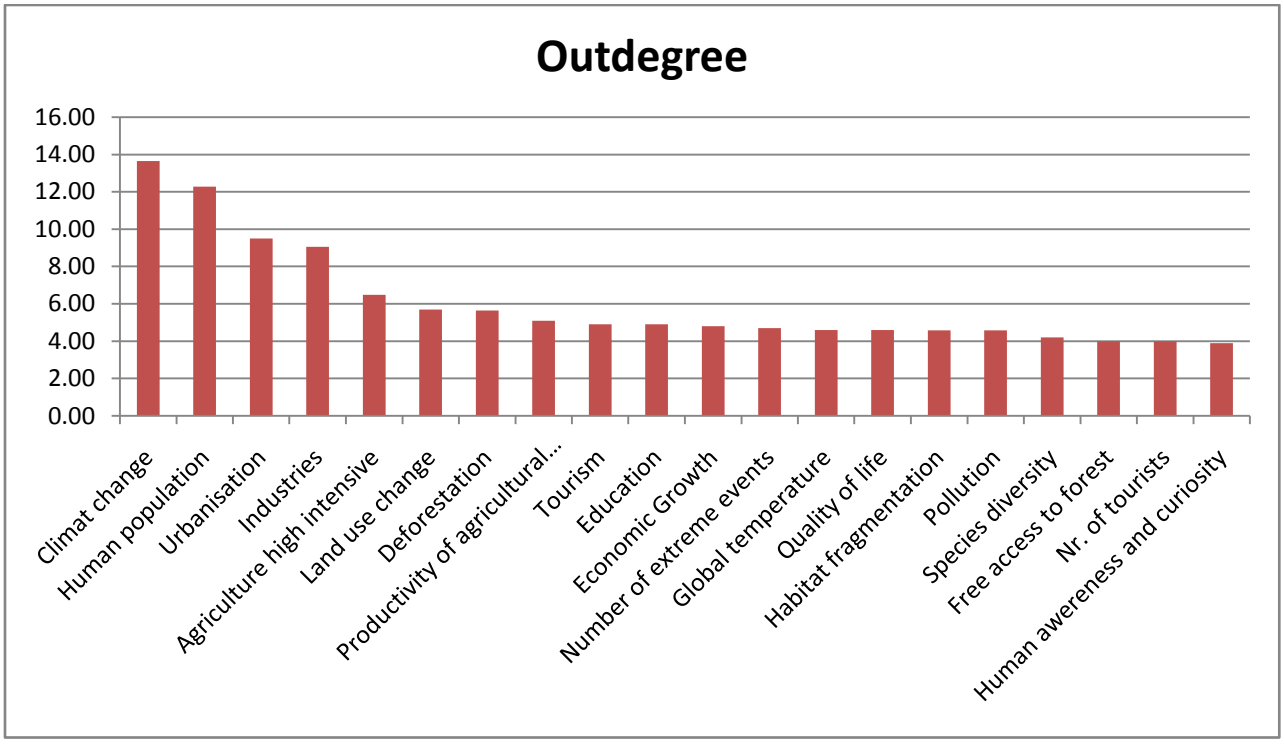


Figure 12: Concepts with the highest outdegree in the aggregated map.

Some details of the social map

Figure 13: All neighbors directly influencing and influenced by the concept "Human well being" and there inter-linkages. Red arrows indicate negative black positive relations. Colors are used as in fig. 9.

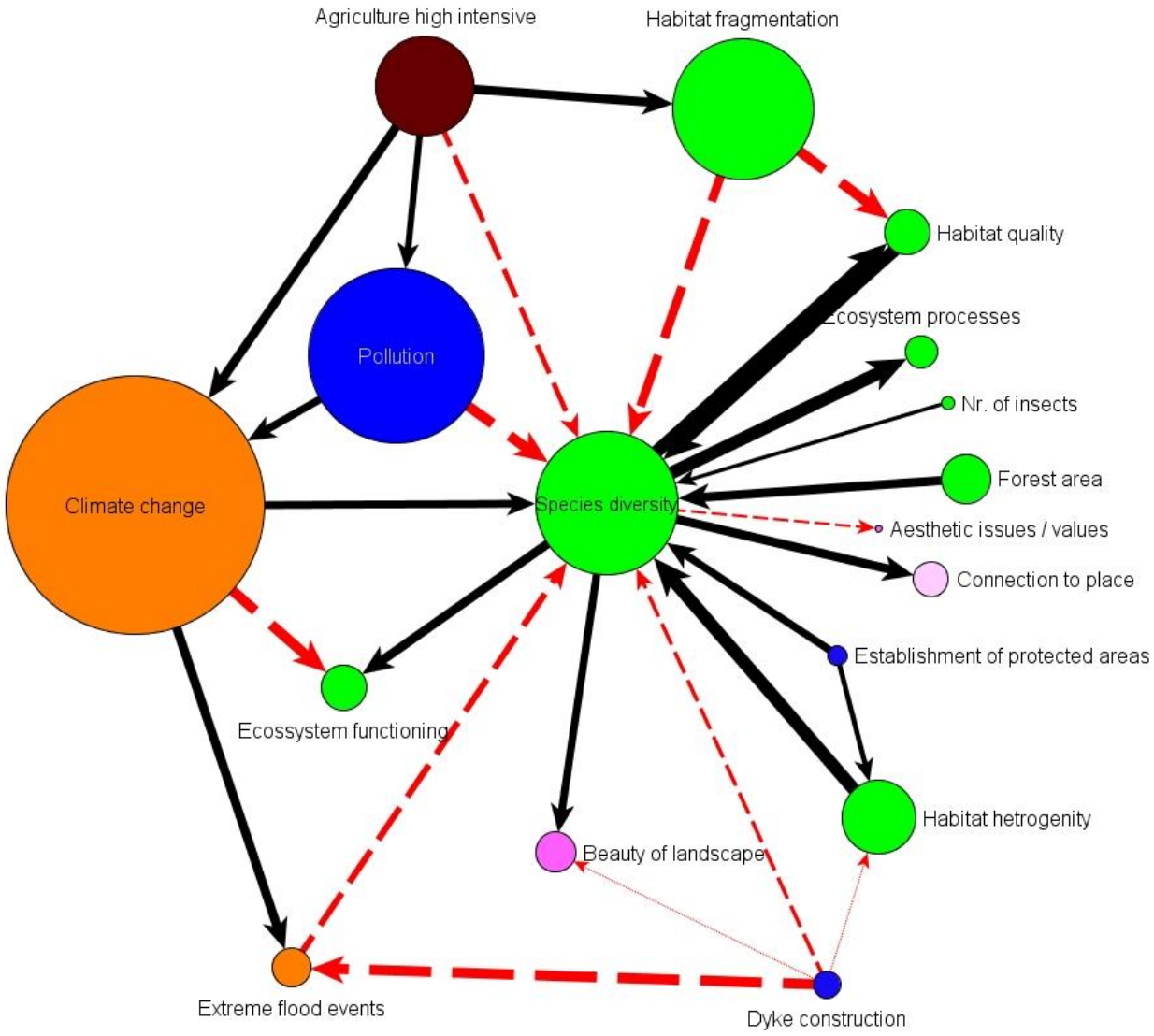


Figure 14: All neighbors directly influencing and influenced by the concept "Species diversity" and there inter-linkages. Red arrows indicate negative black positive relations. Colors are used as in fig. 9.

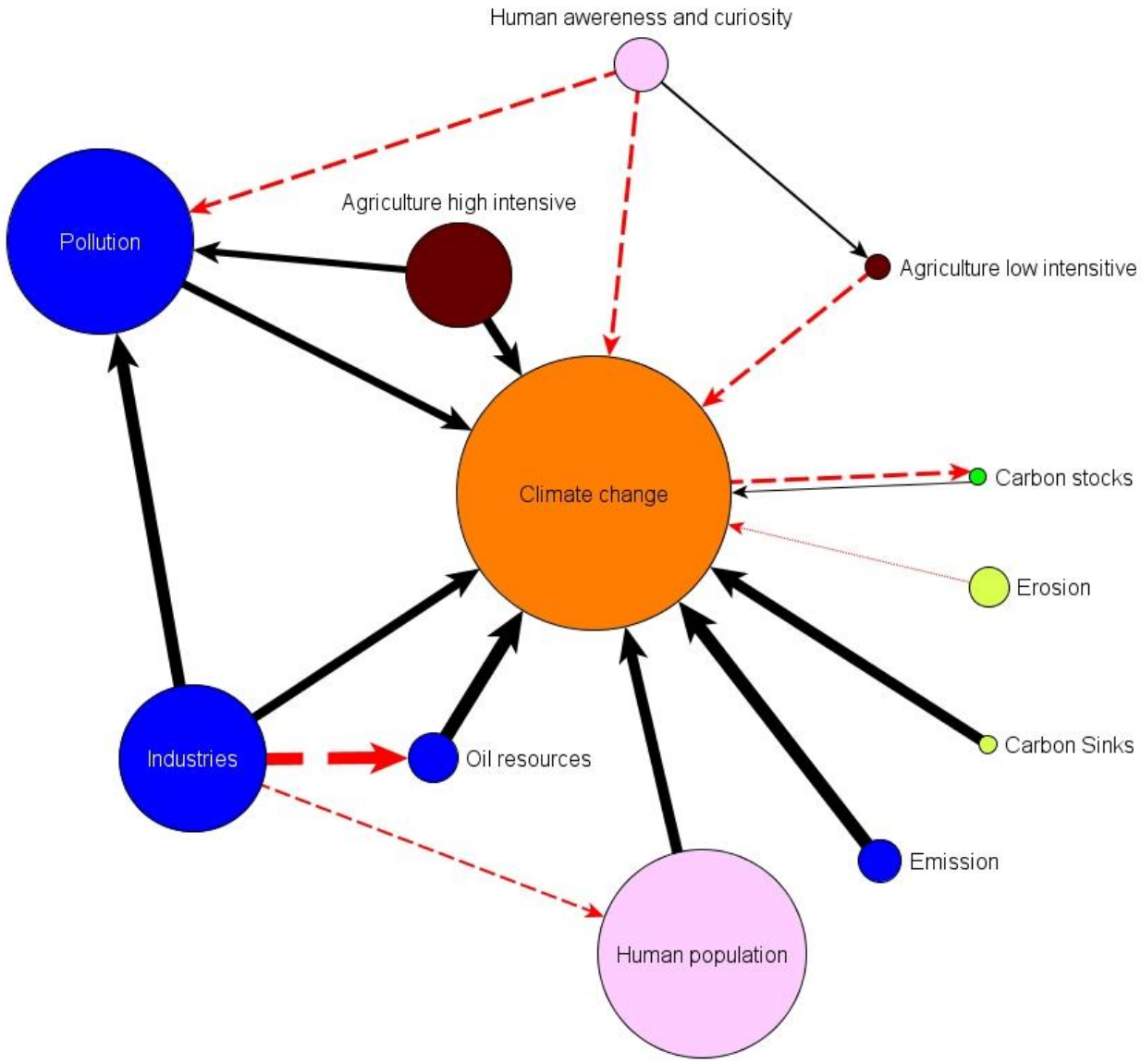


Figure 15: Direct neighbors influencing the concept "Climate Change". Red arrows indicate negative black positive relations. Colors are used as in fig. 9.

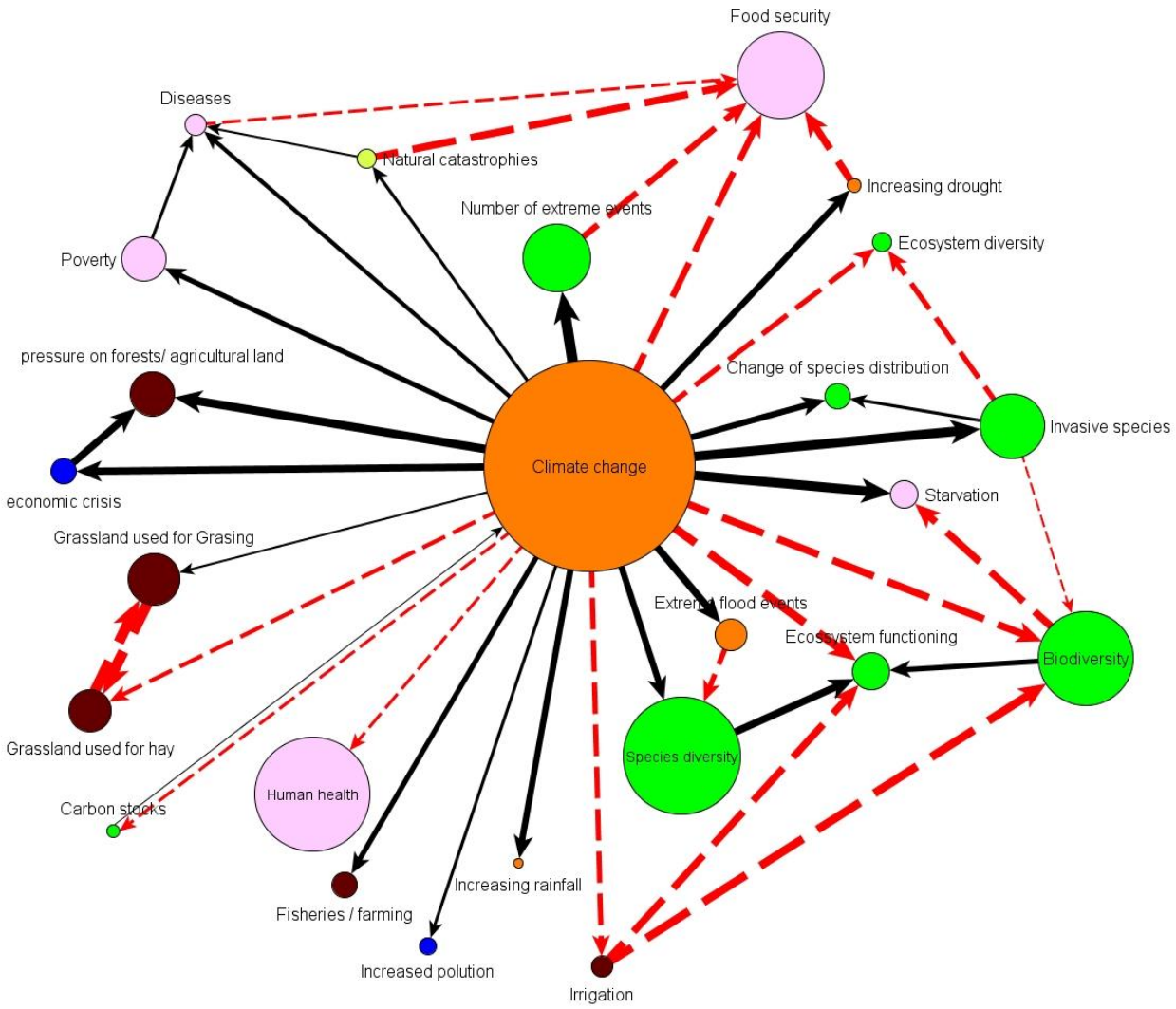


Figure 16: Direct neighbors influenced by the concept "Climate Change". Red arrows indicate negative black positive relations. Colors are used as in fig. 9.

The Scenarios:

The results of the scenario runs for the Peyresq-Social-Map show relative meaningful results. Nevertheless there are also some concepts showing strange trends as one might aspect considering the relative un-facilitated mapping process and the different focuses of some of the maps.

"Lets grow!"

Storyline: Well we have all heard the talk of Martin Sharman. So what trends does the fuzzy cognitive model show if we assume that economic development, economic growth and human population will continue increasing? Will "Human Well Being" rise or will we face some serious problems?

Table 2: Factors manipulated in the scenario "Lets grow!"

Economic development	Set to 1
Economic Growth	Set to 1
Human population	Set to 1

Table 3: Results of the scenario "Lets grow!". Factors with a positive trend are listed in the left column, factors with a negative trend in the right column. +++ / - - - (red color) indicates a strong change, ++/- - a medium change (blue), + / - a weak change (purple) and ~ (grey) a very weak change.

Positive Changes	Strength	Negative Changes	Strength
Abandonment of area	+++	Beauty of landscape	- - -
Climate change	+++	Economy	- - -
Deforestation	+++	Ecosystem services	- - -
Degradation	+++	Environment	- - -
Education	+++	Food security	- - -
Food production	+++	Habitat heterogeneity	- - -
Forest Degradation	+++	Material for life	- - -
Forest fire	+++	Natural environment quality	- - -
Generalist species	+++	Natural resources	- - -
Habitat fragmentation	+++	Security	- - -
Habitat homogenization	+++	Specialist species	- - -
Income agriculture	+++	Species diversity	- - -
Increased pollution	+++	Biodiversity	- -
Industry pollution	+++	Carbon Sinks	- -
Infrastructure	+++	Connection to place	- -
Invasive species	+++	dependency on imports	- -
Land use change	+++	Desire to increase farm productivity	- -
Low productivity	+++	Ecosystem functioning	- -
Need for energy	+++	Ecosystem diversity	- -
Pollution	+++	Ecosystem processes	- -

Spread of pathogens	+++	Fertilizer use	- -
Unsustainable resource extraction	+++	Fresh water scarcity	- -
Urbanization	+++	Globalization	- -
Using / spending time	+++	Grassland used for Grassing	- -
Ability to increase production	++	Ground water new building	- -
area consumption	++	Habitat quality	- -
Change of species distribution	++	Human happiness	- -
competition for productive/ arable land surface area	++	Human health	- -
Culture	++	Intensive land use	- -
Decrease of species	++	Irrigation	- -
demand for rural ("stadtnah") recreation	++	landscape aesthetics	- -
Disaster	++	Habitat loss	- -
Diseases	++	Loss of natural resources	- -
Economic crisis	++	Peace	- -
Economic loss	++	Productivity of agricultural landscape	- -
Emission	++	Quality of life	- -
Extreme flood events	++	Recreation	- -
Fisheries / farming	++	Settlement materials	- -
Food shortage	++	Stability of Society	- -
Generalist populations	++	Tropical forest cover	- -
Good government	++	wildlife-watching	- -
Grassland used for hay	++	Buildings & Pavement	-
Ground sealing	++	Carbon stocks	-
Happy family	++	conservation efforts	-
Hard landscaping	++	Economic productivity	-
Increasing drought	++	Erosion	-
Increasing rainfall	++	Global temperature	-
Loss of biodiversity	++	Landscape	-
Nature Protection	++	Multifunctionality of land	-
Number of extreme events	++	No. of insects	-
Out-migration loss of livelihood	++	No. of tourists	-
Perception	++	Political security	-
Poverty	++	Sad people	-
Snow gliding	++	Air Quality	~
Soil degradation	++	Climbers	~
Starvation	++	Income from tourism	~
Surface runoff	++	Nature consumption value	~
Tourism	++	No. of mushrooms	~
Water availability	++	Oil resources	~
Aesthetic issues / values	+	Potential investor	~
Agriculture high intensive	+	Subsidies incentivizes	~
Crime & societal unrest	+	Tourism plan	~
Desire to love farm lifestyle	+	Vector driven diseases	~

Farmers	+	Water quality	~
flood risks	+	Well being	~
Good relationship	+		
Human population density	+		
Illegal logging	+		
Industrializing agriculture	+		
Land clearing	+		
Natural catastrophes	+		
Open Landscape	+		
Over-grazing	+		
pressure on forests/ agricultural land	+		
Probability of halting the loss of BD	+		
Rural settlements	+		
Shortage of food	+		
Sustainable consumption	+		
Arable land	~		
Benefits of the area	~		
channels/ dams	~		
Clean Water	~		
Agriculture	~		
Fish resources	~		
Food supply	~		
Forest area	~		
Growing mobility	~		
Human occupation	~		
Hunting & Fishing	~		
income grows	~		
Increasing consumption	~		
Increasing street consumption	~		
Industries	~		
Infiltration	~		
Jobs	~		
Land available for agriculture	~		
Land cover change	~		
Land used for agriculture	~		
Mushroom collectors	~		
Noise	~		
Pesticide use	~		
Poisoned food	~		
Timber production	~		
Tourist attraction	~		
Transportation	~		
Water resources	~		
Water use	~		

"Science, Conservation & sustainable development"

Storyline: Let's assume that we manage to convince policy makers, and – may be even more important - the general public, that sustainability and nature conservation are really important. Science on the other side works well in predicting changes and in communicating important issues. All this is backed up by subsidy incentivizes and mechanisms that help to successfully enforce policies.

Table 4: Factors manipulated in the scenario "Science, Conservation & sustainable development"

Change was predicted	Set to 1
Communication and information programs	Set to 1
Conservation efforts	Set to 1
Establishment of protected areas	Set to 1
Natura 2000	Set to 1
Scientist	Set to 1
Subsidies incentives	Set to 1
Success of policy enforcement	Set to 1
Sustainable agriculture	Set to 1
Sustainable consumption	Set to 1

Table 5: Results of the scenario "Science, Conservation & sustainable development". Factors with a positive trend are listed in the left column, factors with a negative trend in the right column. +++ / - - - (red color) indicates a strong change, ++/- - a medium change (blue), + / - a weak change (purple) and ~ (grey) a very weak change.

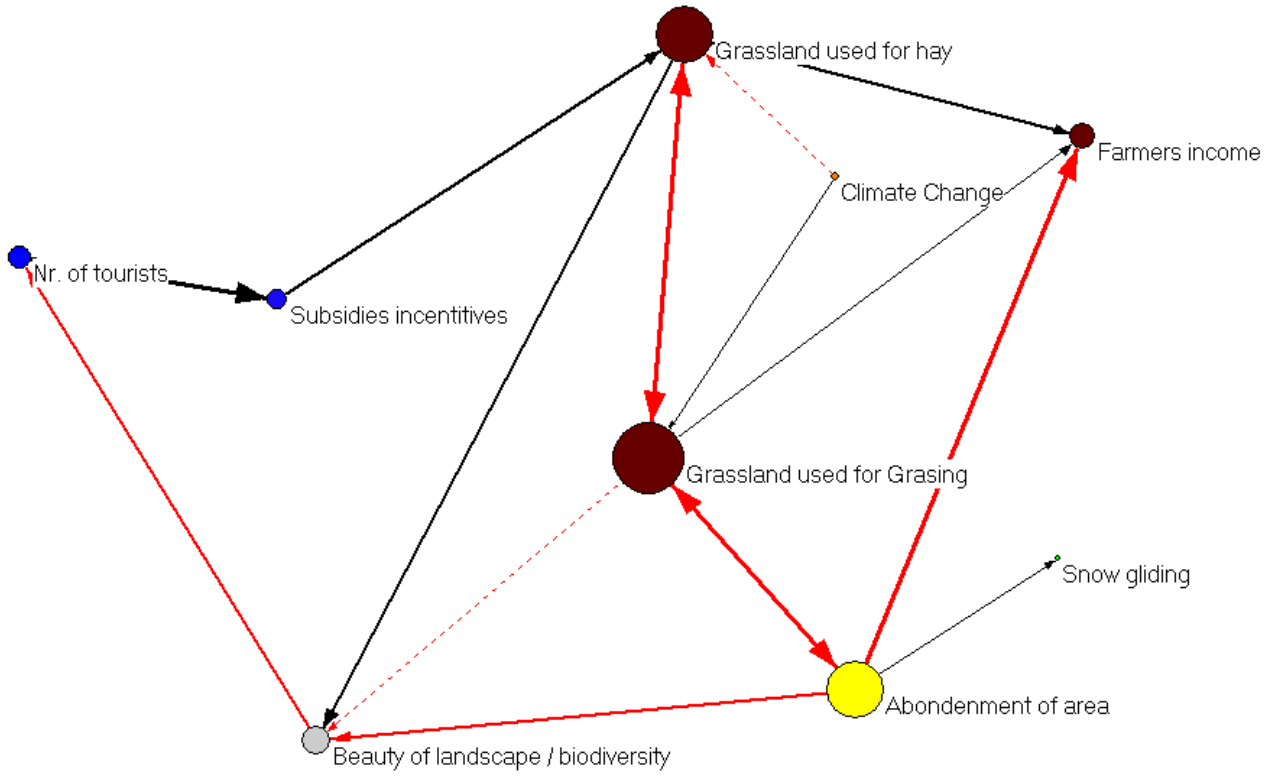
Positive Changes	Strength	Negative Changes	Strength
Beauty of landscape	+++	Climbers	- - -
Benefits of the area	+++	Diseases	- - -
Connection to place	+++	Economic Growth	- - -
demand for rural ("stadtnah") recreation	+++	Habitat fragmentation	- - -
Ecosystem functioning	+++	Hunting & Fishing	- - -
Ecosystem processes	+++	Intensive land use	- - -
Grassland used for hay	+++	Mushroom collectors	- - -
Habitat quality	+++	Pollution	- - -
Habitat heterogeneity	+++	Urbanization	- - -
Human health	+++	Abandonment of area	- -
Landscape	+++	Aesthetic issues / values	- -
Marketing the change as positive	+++	Agriculture high intensive	- -
Multifunctionality of land	+++	area consumption	- -
Natural resources	+++	Climate change	- -
NGO power	+++	competition for productive/ arable land surface area	- -
No. of mushrooms	+++	Education	- -
Peace	+++	generalist populations	- -
Potential investor	+++	Grassland used for Grassing	- -
Probability of halting the loss of BD	+++	ground sealing	- -

Quality of life	+++	hard landscaping	- -
Recreation	+++	Infrastructure	- -
Specialist species	+++	Soil degradation	- -
Species diversity	+++	Starvation	- -
Strongly regulated market	+++	surface runoff	- -
Water availability	+++	Tourism	- -
Well being	+++	Using / spending time	- -
Wild boar & roe dear	+++	Decrease of species	-
wildlife-watching	+++	Deforestation	-
Biodiversity	++	Disaster	-
Change of species distribution	++	economic crisis	-
Clean Water	++	Economy	-
Culture	++	Emission	-
Desire to love farm lifestyle	++	Erosion	-
Ecosystem services	++	Extreme flood events	-
Environment	++	Fisheries / farming	-
Farmers	++	flood risks	-
Food supply	++	Good government	-
Fresh water scarcity	++	Human population density	-
Globalization	++	Increasing drought	-
Government	++	Increasing rainfall	-
Human happiness	++	Industries	-
Human population	++	Land clearing	-
Income agriculture	++	Habitat loss	-
landscape aesthetics	++	Natural catastrophes	-
Loss of biodiversity	++	Number of extreme events	-
Loss of natural resources	++	Perception	-
Material for life	++	Poverty	-
Natural environment quality	++	pressure on forests/ agricultural land	-
People conscious	++	Rural settlements	-
Perceived desirability of change in nat. environment	++	Snow gliding	-
Productivity of agricultural landscape	++	Arable land	~
Tourism plan	++	channels/ dams	~
Ability to increase production	+	Crime & societal unrest	~
Buildings & Pavement	+	Economic loss	~
Carbon stocks	+	Agriculture	~
dependency on imports	+	Fertilizer use	~
Desire to increase farm productivity	+	Fish resources	~
Economic productivity	+	Food shortage	~
Ecosystem diversity	+	Forest area	~
Food security	+	Growing mobility	~
Generalist species	+	Human occupation	~
Global temperature	+	Illegal logging	~
Habitat homogenization	+	income grows	~

Income from tourism	+	Increasing consumption	~
Invasive species	+	Increasing street consumption	~
Irrigation	+	Infiltration	~
Land use change	+	Jobs	~
Need for energy	+	Land available for agriculture	~
No. of tourists	+	Land used for agriculture	~
Over-grazing	+	Noise	~
Political security	+	No. of insects	~
Security	+	Open Landscape	~
Spread of pathogens	+	Pesticide use	~
Stability of Society	+	Timber production	~
Tropical forest cover	+	Tourist attraction	~
Unsustainable resource extraction	+	Transportation	~
Vector driven diseases	+	Water resources	~
Air Quality	~	Water use	~
Carbon Sinks	~		
Degradation	~		
Food production	~		
Forest Degradation	~		
Forest fire	~		
Good relationship	~		
Ground water new building	~		
Happy family	~		
Increased pollution	~		
Industrializing agriculture	~		
Land cover change	~		
Low productivity	~		
Nature consumption value	~		
Oil resources	~		
Out-migration loss of livelihood	~		
Poisoned food	~		
Sad people	~		
Settlement materials	~		
Shortage of food	~		
Water quality	~		
Stability of Society	~		
Water quality	~		

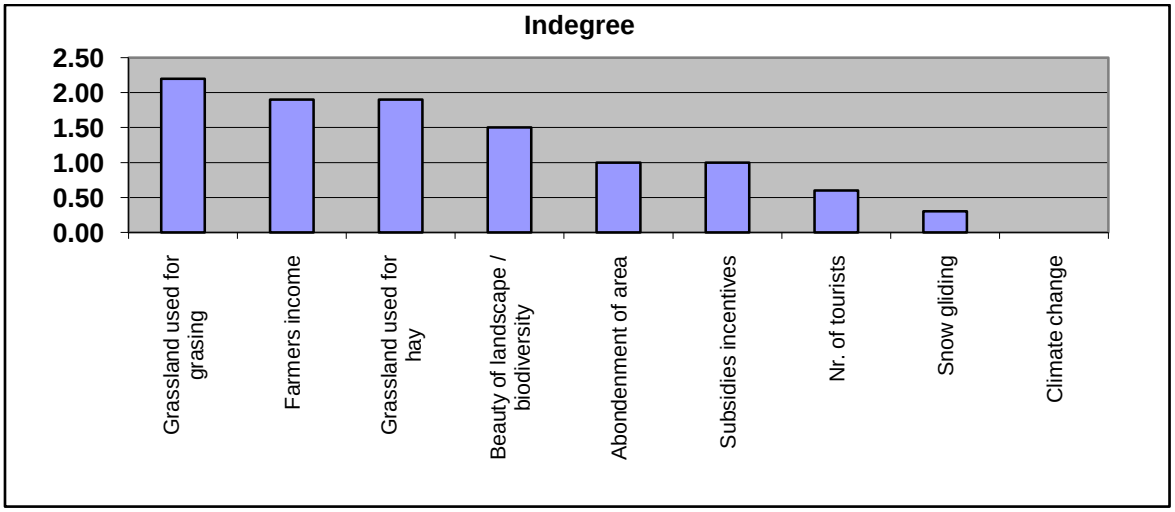
The individual maps:

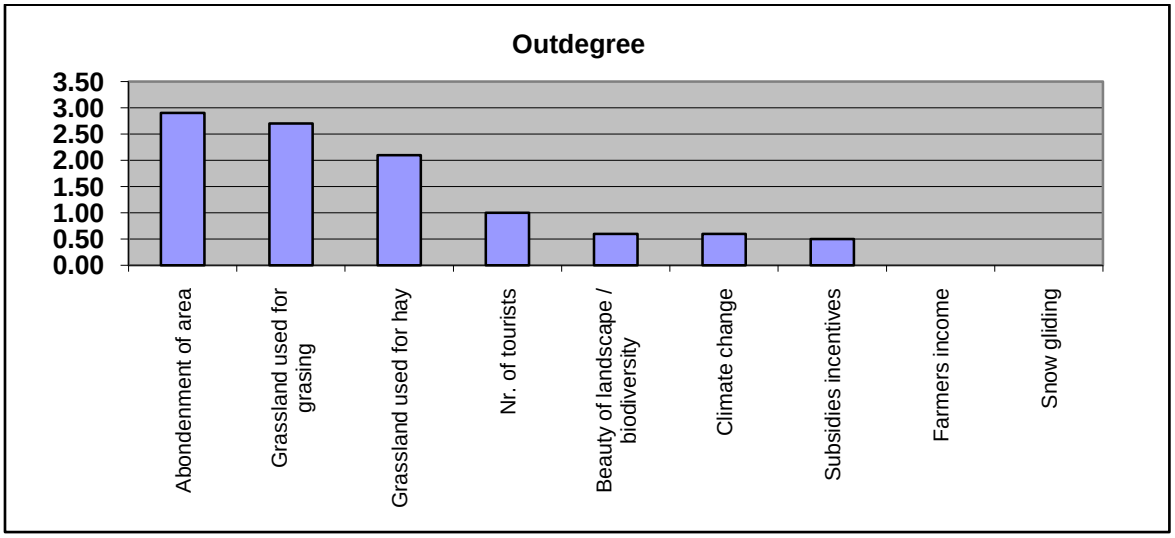
Map 1

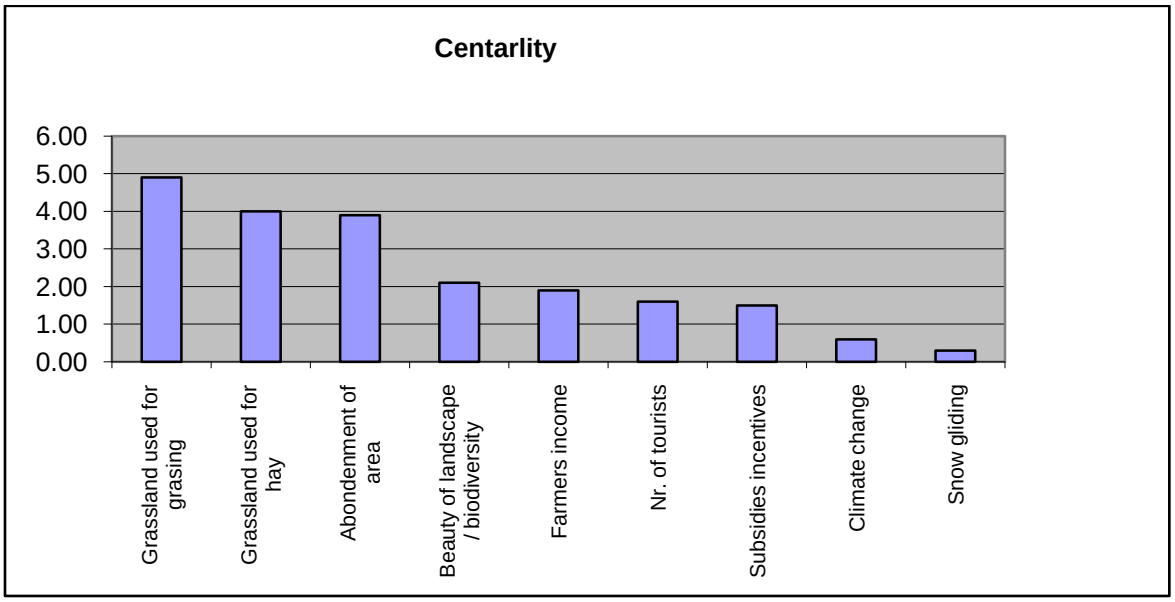


Density	TotalFactors	TotalConnections	NoConnection	Self Loops	Regular Connections	Complexity
0.20	9	16	**0**	**0**	**16**	**2**

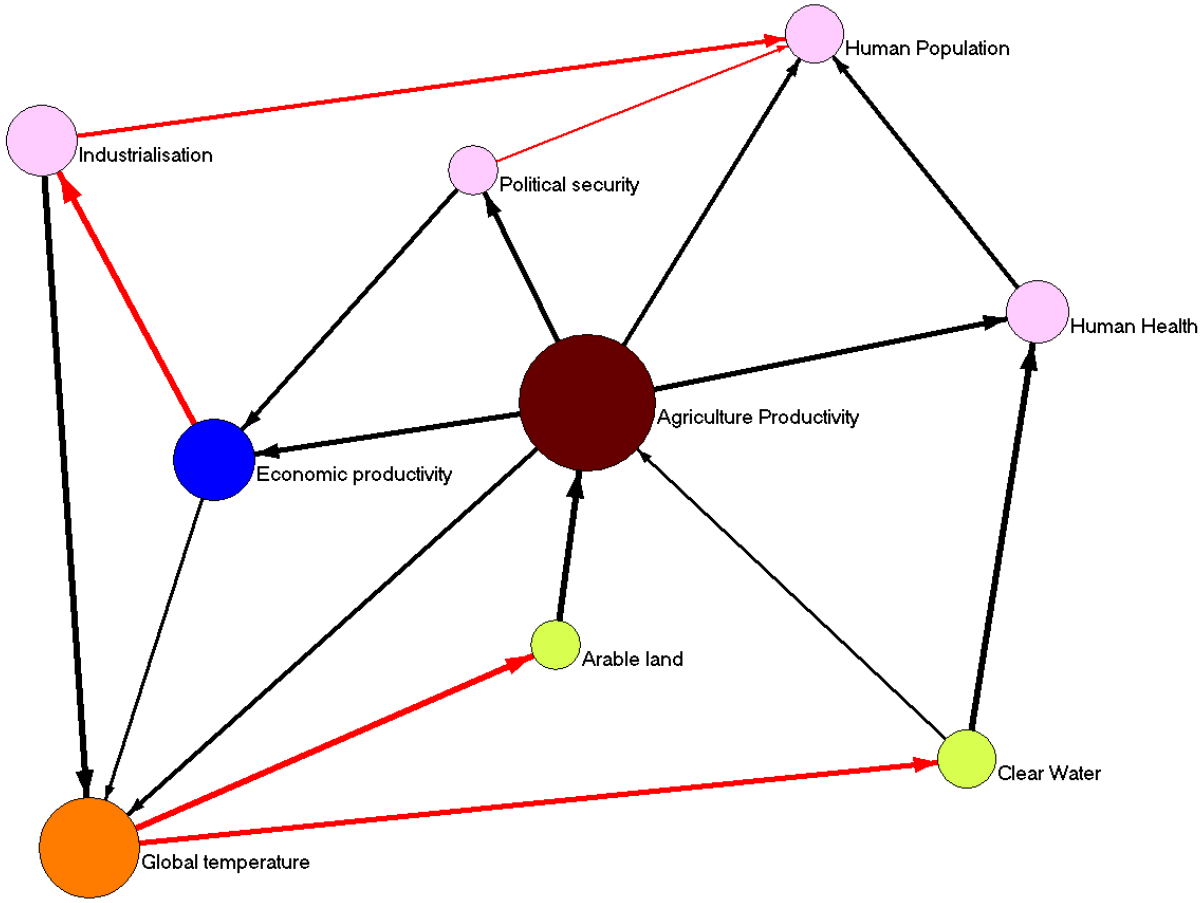
Concepts	Transmitter	Receiver	Ordinary	Centrality	Outdegree	Indegree
Abandonment of area			**1**	3.90	2.90	1.00
Beauty of landscape / biodiversity			**1**	2.10	0.60	1.50
Climate change	**1**			0.60	0.60	0.00
Farmers income		**1**		1.90	0.00	1.90
Grassland used for grassing			**1**	4.90	2.70	2.20
Grassland used for hay			**1**	4.00	2.10	1.90
No. of tourists			**1**	1.60	1.00	0.60
Snow gliding		**1**		0.30	0.00	0.30
Subsidies incentives			**1**	1.50	0.50	1.00
Sum	**1**	**2**	**6**			
%	11.11	22.22	66.67			


Indegree
2.50
2.00
1.50
1.00
0.50
0.00
Grassland used for grasing
Farmers income
Grassland used for hay
Beauty of landscape / biodiversity
Abondenment of area
Subsidies incentives
Nr. of tourists
Snow gliding
Climate change


Outdegree
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Abondenment of area
Grassland used for grasing
Grassland used for hay
Nr. of tourists
Beauty of landscape / biodiversity
Climate change
Subsidies incentives
Farmers income
Snow gliding

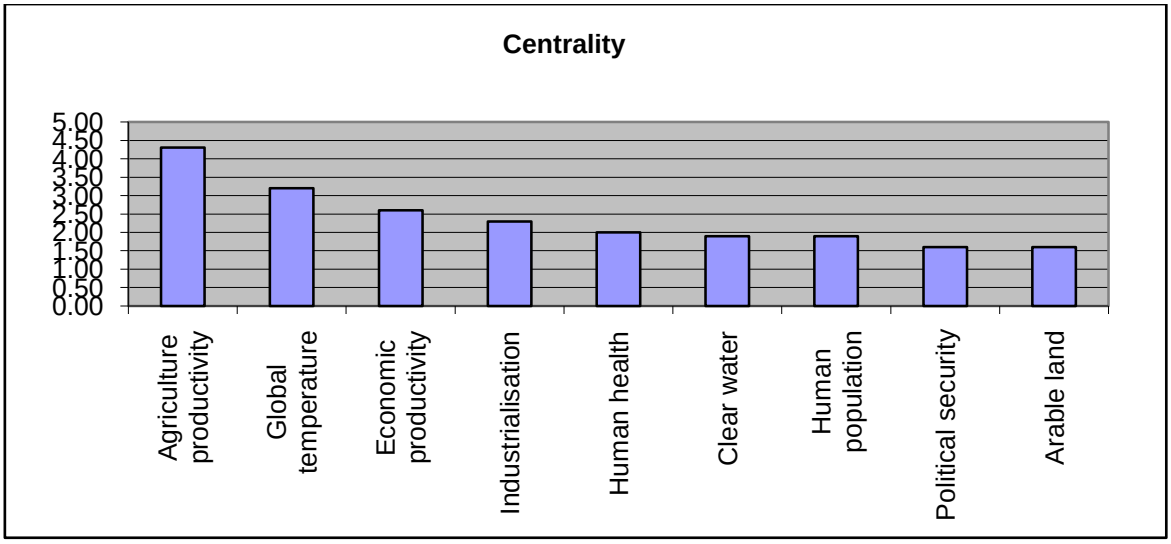

Centarlity
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Grassland used for grasing
Grassland used for hay
Abondenment of area
Beauty of landscape / biodiversity
Farmers income
Nr. of tourists
Subsidies incentives
Climate change
Snow gliding

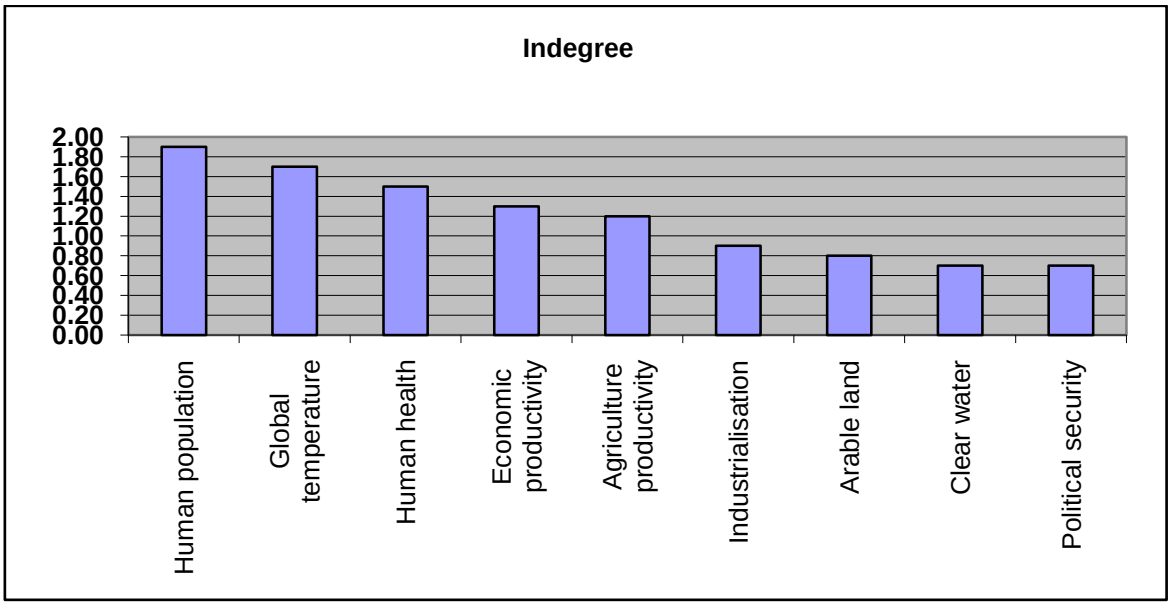
Map 2

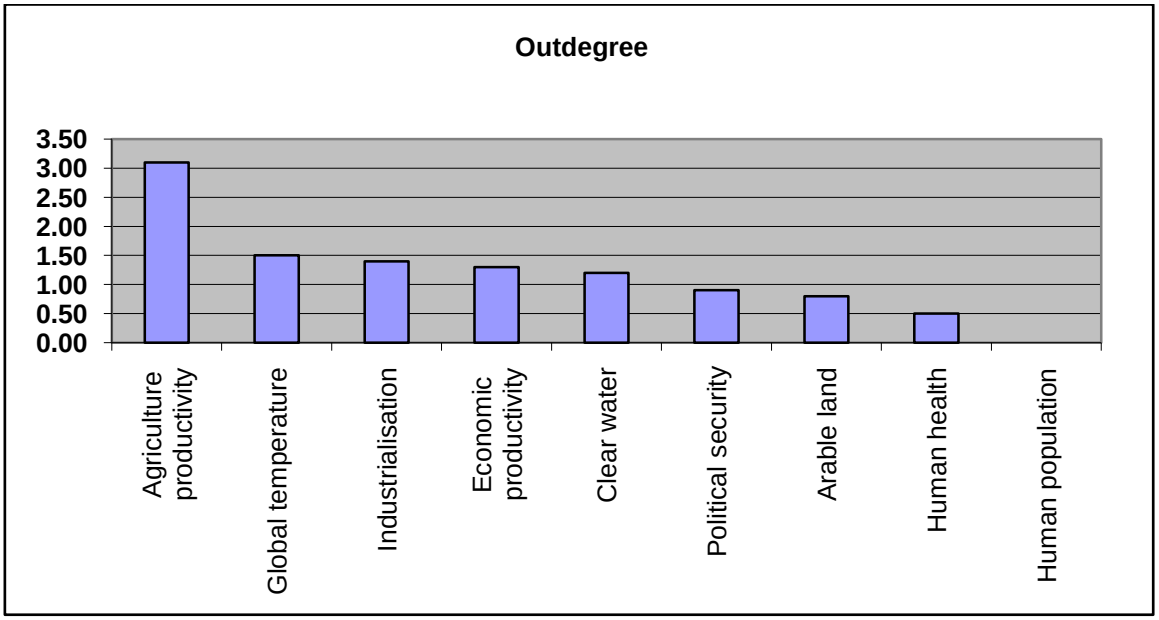


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.21	9	17	**0**	**0**	**17**	**1 to 0**

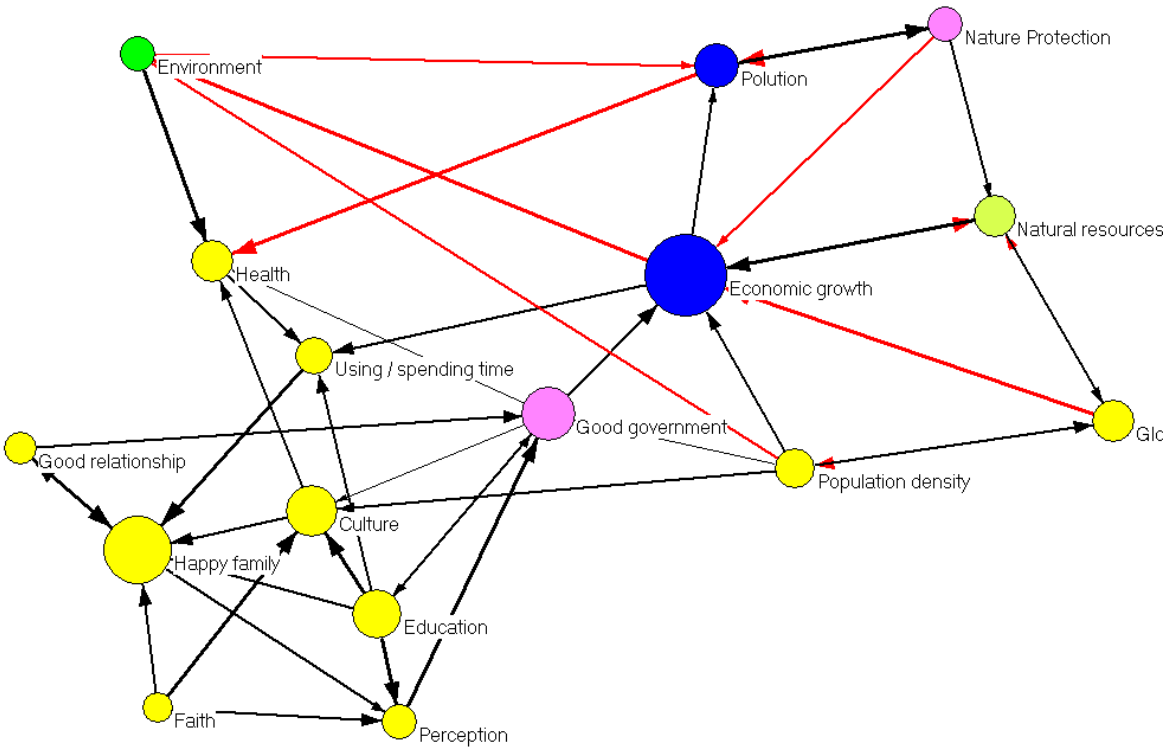
Concepts	Transmitter	Receiver	Ordinary	Centrality	Outdegree	Indegree
Agriculture productivity			**1**	4.30	3.10	1.20
Arable land			**1**	1.60	0.80	0.80
Clear water			**1**	1.90	1.20	0.70
Economic productivity			**1**	2.60	1.30	1.30
Global temperature			**1**	3.20	1.50	1.70
Human health			**1**	2.00	0.50	1.50
Human population		**1**		1.90	0.00	1.90
Industrialization			**1**	2.30	1.40	0.90
Political security			**1**	1.60	0.90	0.70
Sum	0	1	8			
%	0	11.11	88.89			




Indegree
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Human population
Global temperature
Human health
Economic productivity
Agriculture productivity
Industrialisation
Arable land
Clear water
Political security

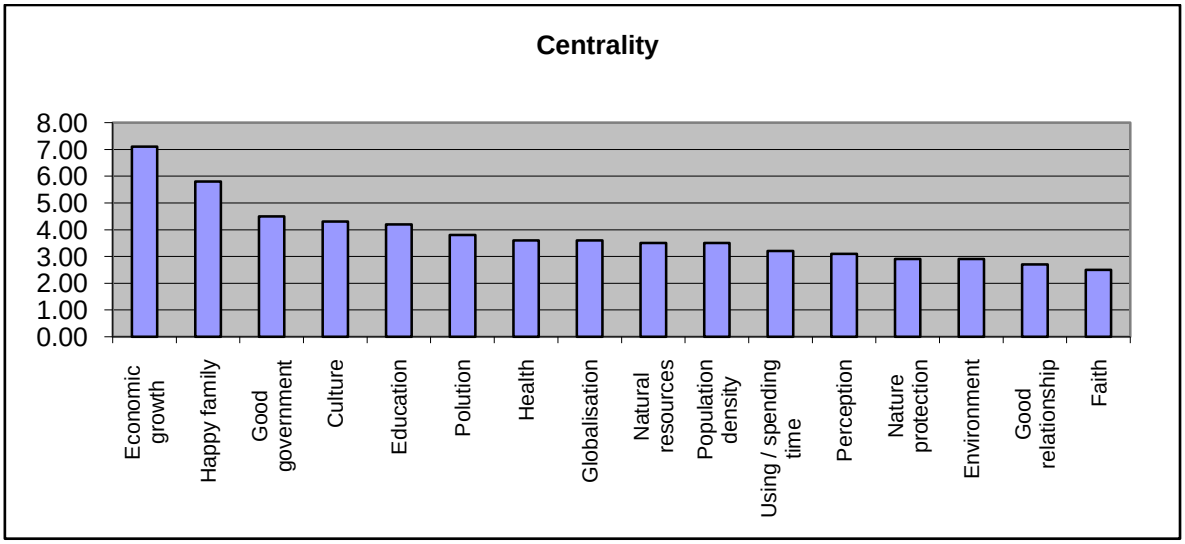

Outdegree
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Agriculture productivity
Global temperature
Industrialisation
Economic productivity
Clear water
Political security
Arable land
Human health
Human population

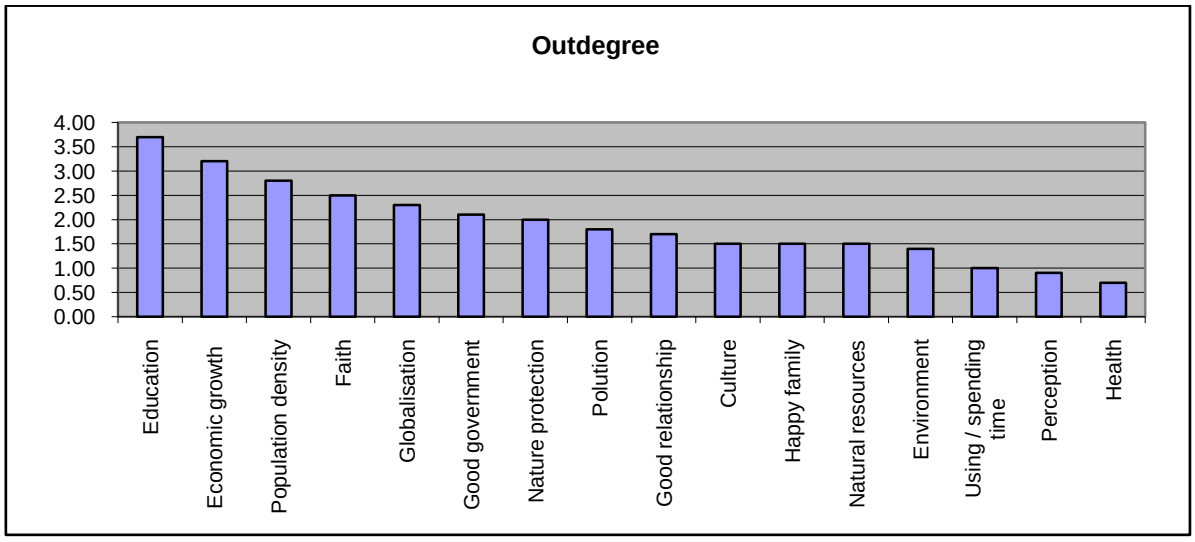
Map3

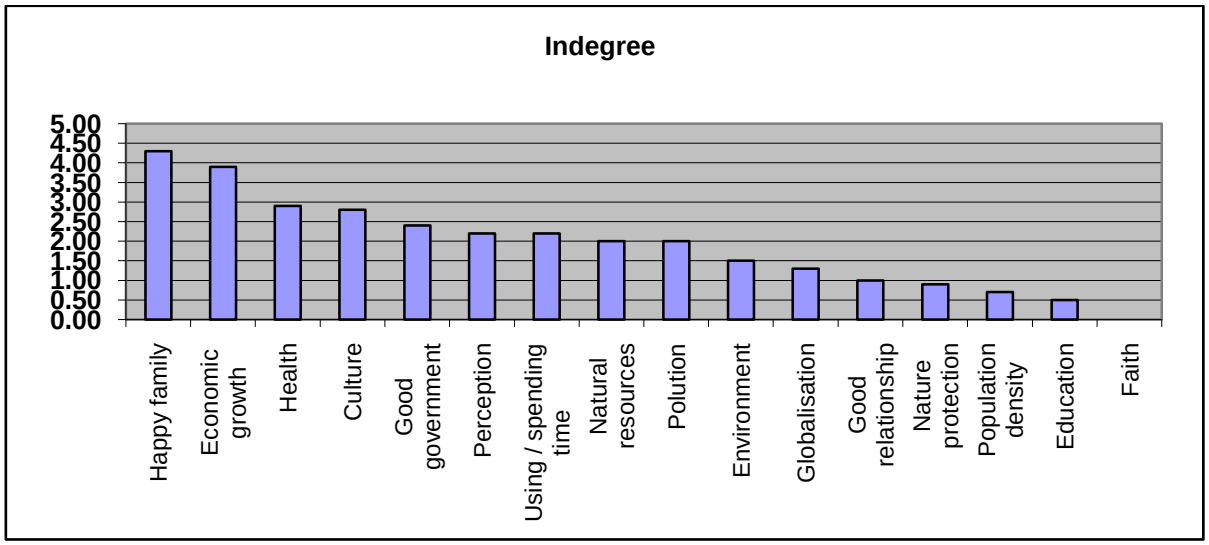


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.16	16	42	0	0	42	0

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Culture			1	4.30	2.80	1.50
Economic growth			1	7.10	3.90	3.20
Education			1	4.20	0.50	3.70
Environment			1	2.90	1.50	1.40
Faith	1			2.50	0.00	2.50
Globalization			1	3.60	1.30	2.30
Good government			1	4.50	2.40	2.10
Good relationship			1	2.70	1.00	1.70
Happy family			1	5.80	4.30	1.50
Health			1	3.60	2.90	0.70
Natural resources			1	3.50	2.00	1.50
Nature protection			1	2.90	0.90	2.00
Perception			1	3.10	2.20	0.90
Pollution			1	3.80	2.00	1.80
Population density			1	3.50	0.70	2.80
Using / spending time			1	3.20	2.20	1.00
Sum	1	0	15			
%	6.25	0	93.75			


Centrality
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Economic growth
Happy family
Good government
Culture
Education
Polution
Health
Globalisation
Natural resources
Population density
Using / spending time
Perception
Nature protection
Environment
Good relationship
Faith


Outdegree
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Education
Economic growth
Population density
Faith
Globalisation
Good government
Nature protection
Polution
Good relationship
Culture
Happy family
Natural resources
Environment
Using / spending time
Perception
Health

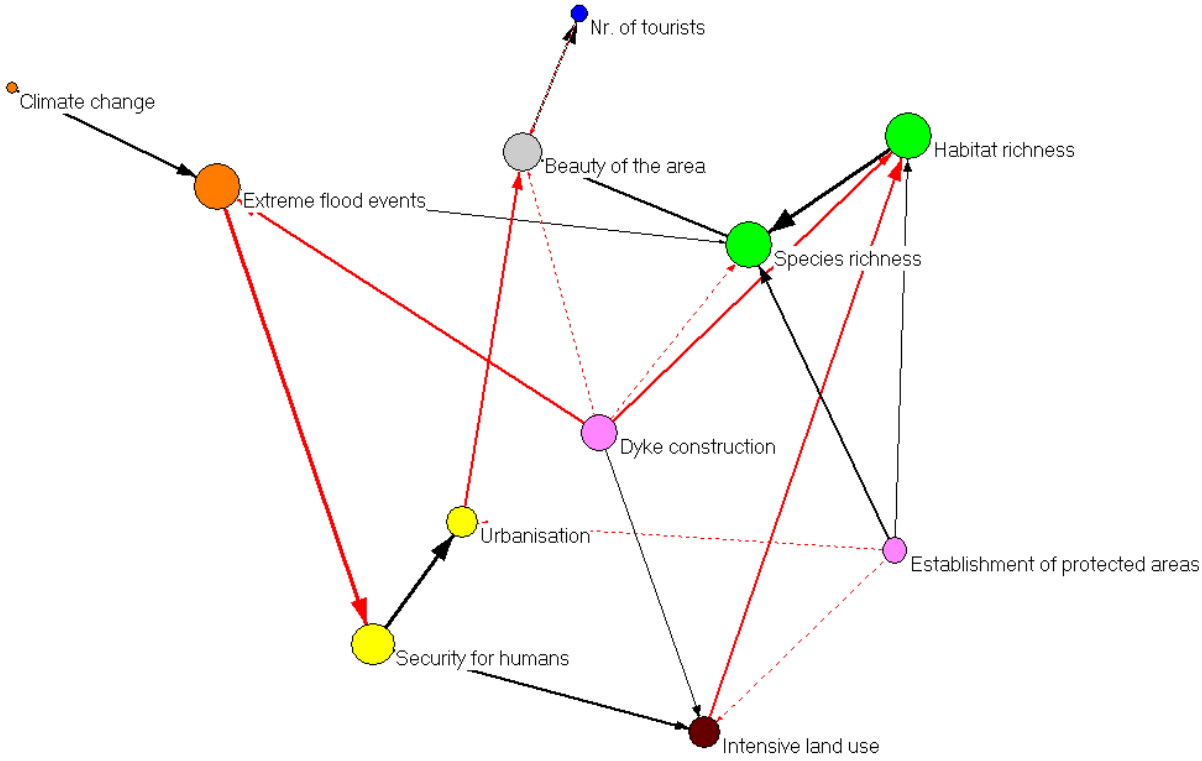

Indegree
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Happy family
Economic growth
Health
Culture
Good government
Perception
Using / spending time
Natural resources
Polution
Environment
Globalisation
Good relationship
Nature protection
Population density
Education
Faith

Map 4

- No values between lines…

Concepts	Transmitter	Receiver	Ordinary
Agriculture			
Climate change			
Deforestation			
Forestry exploitation			
Human well being			
Landscape			
Natural environment quality			
Pastoralism			
Tourism			

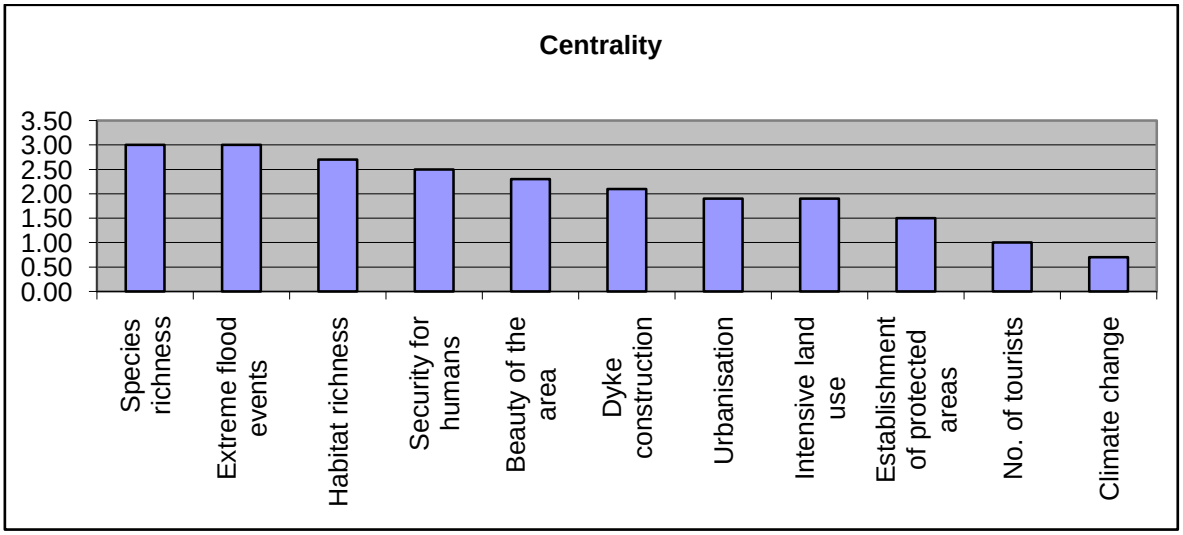
Map5

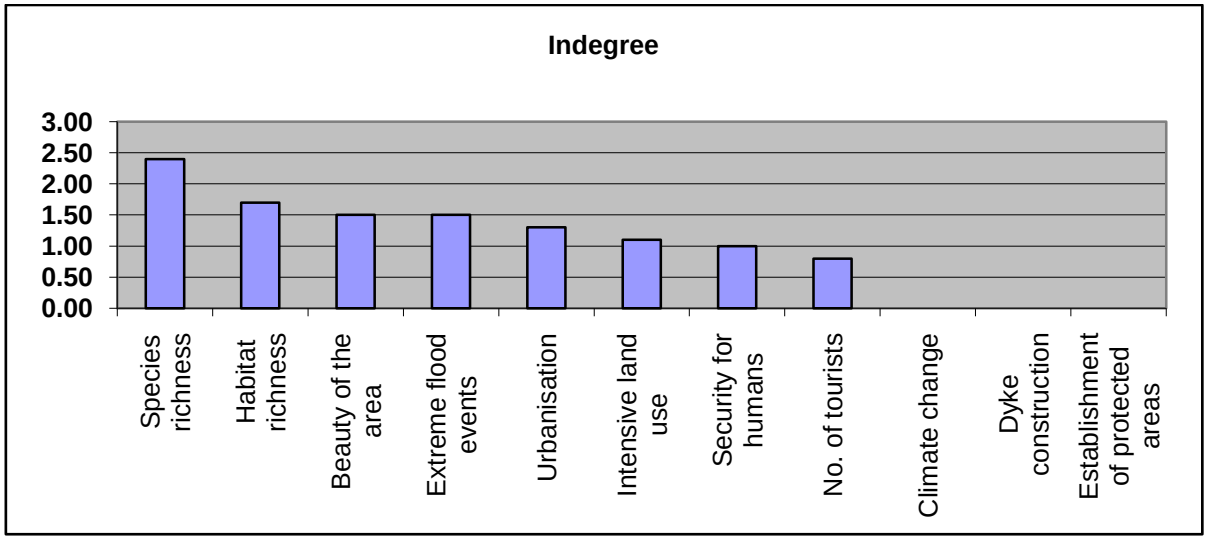


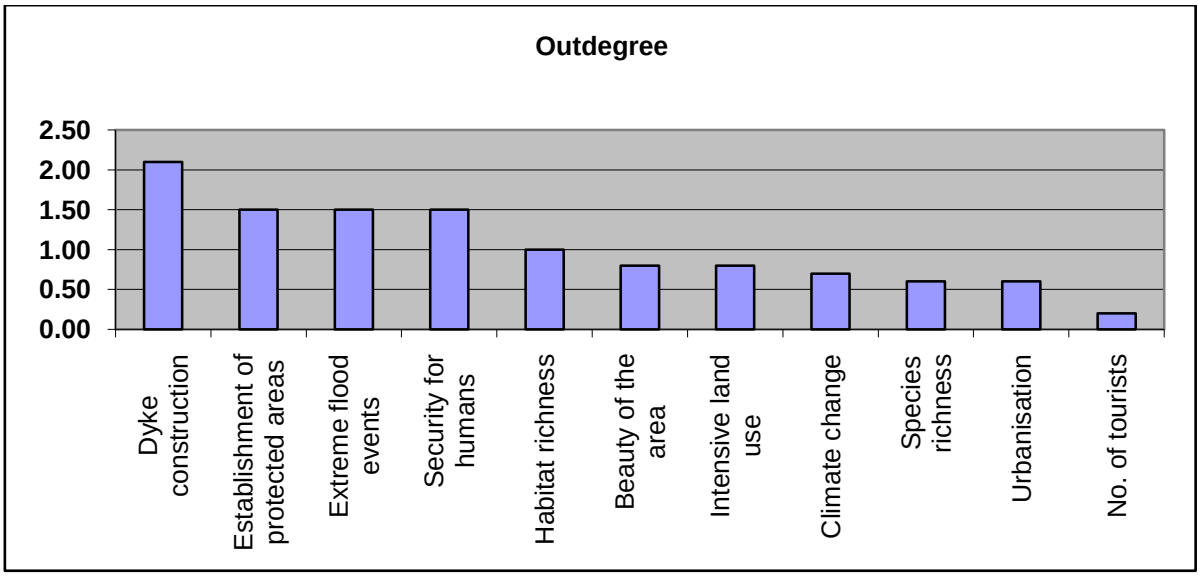
Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.17	11	20	0	0	20	0

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree

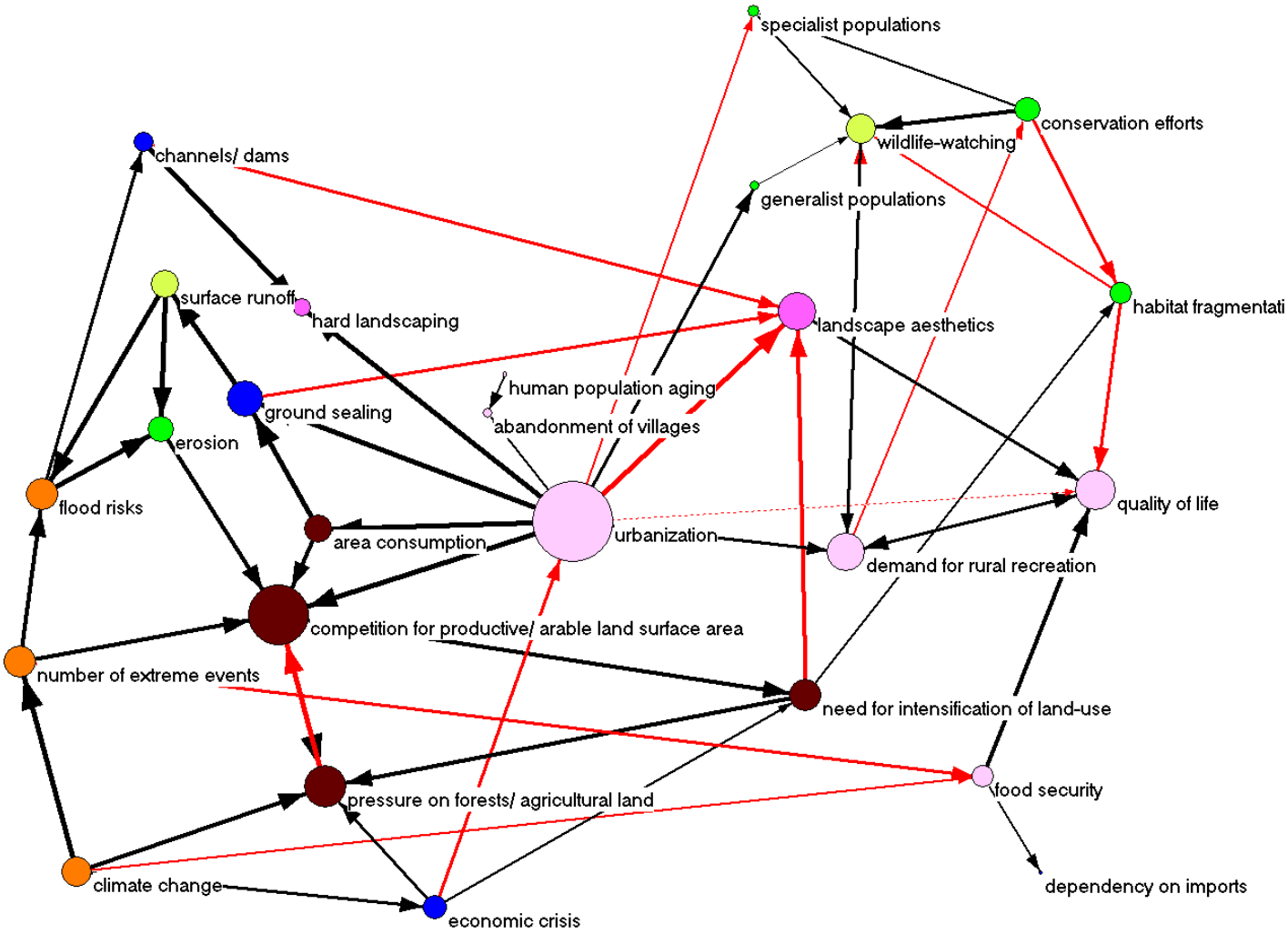
Climate change	**1**			2.30	1.50	0.80
Extreme flood events			**1**	0.70	0.00	0.70
Dyke construction	**1**			2.10	0.00	2.10
Security for humans			**1**	1.50	0.00	1.50
Urbanization			**1**	3.00	1.50	1.50
Intensive land use			**1**	2.70	1.70	1.00
Habitat richness			**1**	1.90	1.10	0.80
Species richness			**1**	1.00	0.80	0.20
Beauty of the area			**1**	2.50	1.00	1.50
No. of tourists			**1**	3.00	2.40	0.60
Establishment of protected areas	**1**			1.90	1.30	0.60
Sum	3	0	8			
%	27.2727273	0	72.72727273			




Indegree
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Species richness
Habitat richness
Beauty of the area
Extreme flood events
Urbanisation
Intensive land use
Security for humans
No. of tourists
Climate change
Dyke construction
Establishment of protected areas

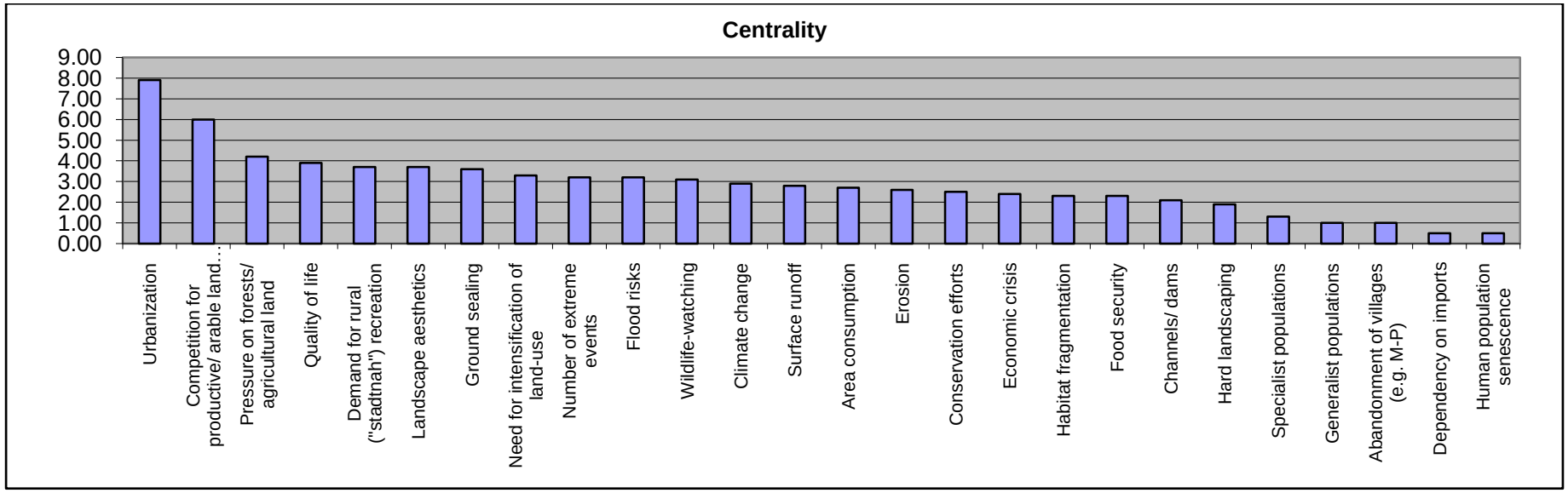

Outdegree
2.50
2.00
1.50
1.00
0.50
0.00
Dyke construction
Establishment of protected areas
Extreme flood events
Security for humans
Habitat richness
Beauty of the area
Intensive land use
Climate change
Species richness
Urbanisation
No. of tourists

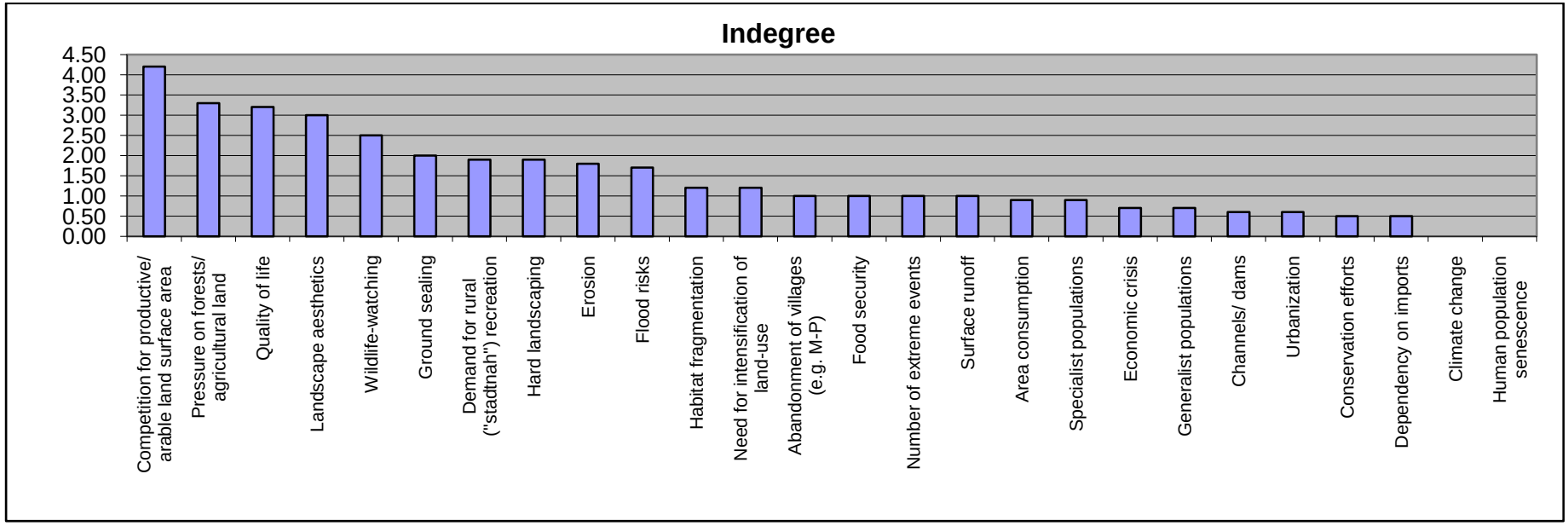
Map 6

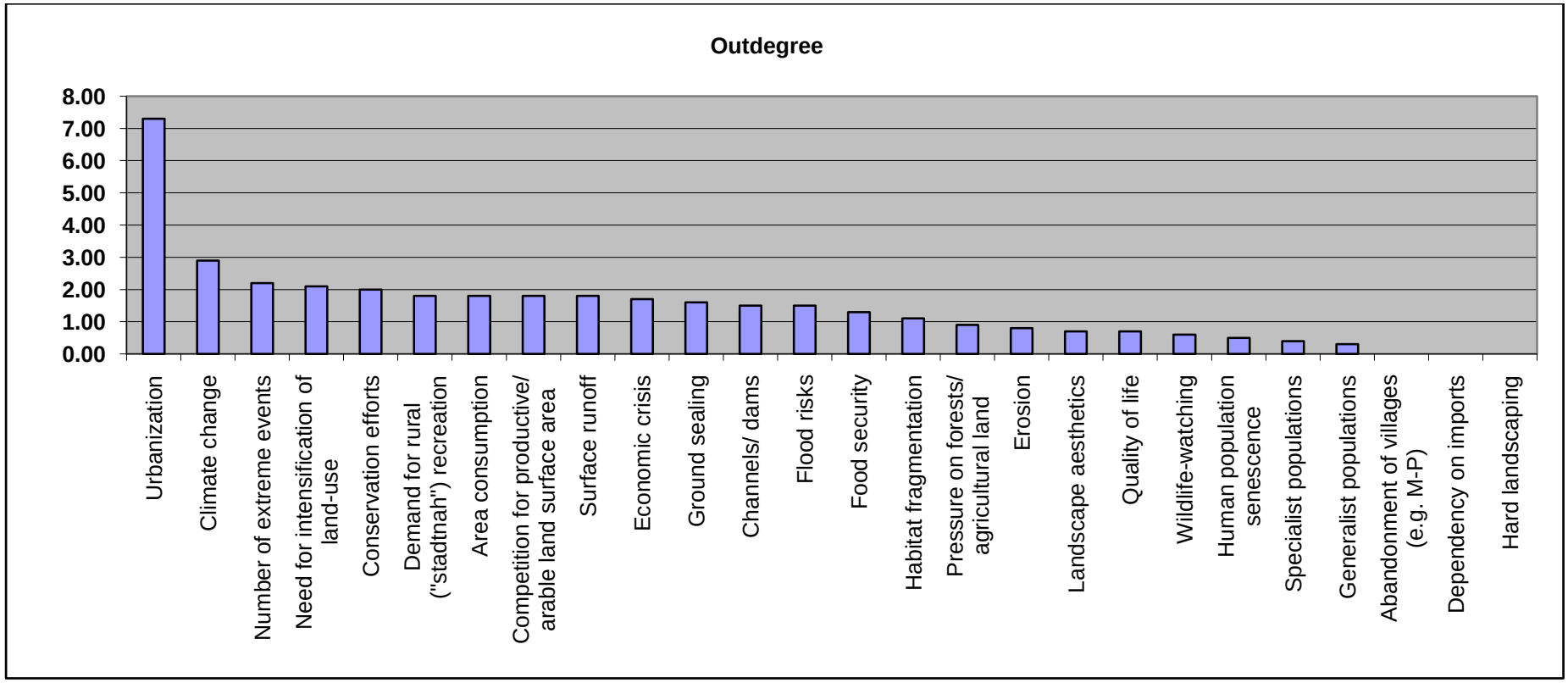


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.08	26	53	**0**	**0**	**53**	1.5

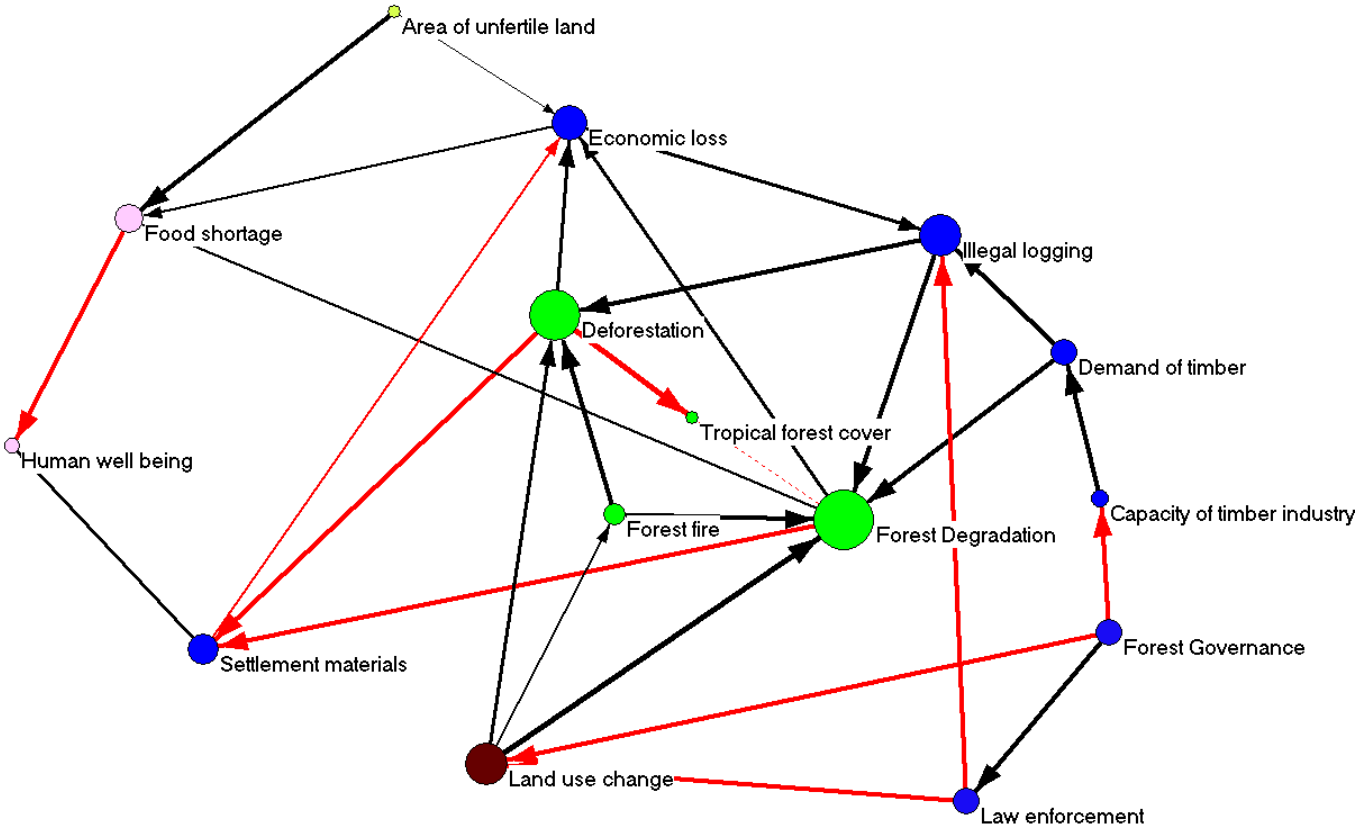
Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Abandonment of villages (e.g. M-P)		**1**		1.00	1.00	0.00
Area consumption			**1**	2.70	0.90	1.80
Channels/ dams			**1**	2.10	0.60	1.50
Climate change	**1**			2.90	0.00	2.90
Competition for productive/ arable land surface area			**1**	6.00	4.20	1.80
Conservation efforts			**1**	2.50	0.50	2.00
Demand for rural ("stadtnah") recreation			**1**	3.70	1.90	1.80
Dependency on imports		**1**		0.50	0.50	0.00
Economic crisis			**1**	2.40	0.70	1.70
Erosion			**1**	2.60	1.80	0.80
Flood risks			**1**	3.20	1.70	1.50
Food security			**1**	2.30	1.00	1.30
Generalist populations			**1**	1.00	0.70	0.30
Ground sealing			**1**	3.60	2.00	1.60
Habitat fragmentation			**1**	2.30	1.20	1.10
Hard landscaping		**1**		1.90	1.90	0.00
Human population senescence	**1**			0.50	0.00	0.50
Landscape aesthetics			**1**	3.70	3.00	0.70
Need for intensification of land-use			**1**	3.30	1.20	2.10
Number of extreme events			**1**	3.20	1.00	2.20
Pressure on forests/ agricultural land			**1**	4.20	3.30	0.90
Quality of life			**1**	3.90	3.20	0.70
Specialist populations			**1**	1.30	0.90	0.40
Surface runoff			**1**	2.80	1.00	1.80
Urbanization			**1**	7.90	0.60	7.30
Wildlife-watching			**1**	3.10	2.50	0.60
Sum	2	3	21			
%	7.69	11.54	80.77			


Centrality
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Urbanization
Competition for productive/ arable land…
Pressure on forests/ agricultural land
Quality of life
Demand for rural ("stadtnah") recreation
Landscape aesthetics
Ground sealing
Need for intensification of land-use
Number of extreme events
Flood risks
Wildlife-watching
Climate change
Surface runoff
Area consumption
Erosion
Conservation efforts
Economic crisis
Habitat fragmentation
Food security
Channels/ dams
Hard landscaping
Specialist populations
Generalist populations
Abandonment of villages (e.g. M-P)
Dependency on imports
Human population senescence


Indegree
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Competition for productive/ arable land surface area
Pressure on forests/ agricultural land
Quality of life
Landscape aesthetics
Wildlife-watching
Ground sealing
Demand for rural ("stadtnah") recreation
Hard landscaping
Erosion
Flood risks
Habitat fragmentation
Need for intensification of land-use
Abandonment of villages (e.g. M-P)
Food security
Number of extreme events
Surface runoff
Area consumption
Specialist populations
Economic crisis
Generalist populations
Channels/ dams
Urbanization
Conservation efforts
Dependency on imports
Climate change
Human population senescence


Outdegree
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Urbanization
Climate change
Number of extreme events
Need for intensification of land-use
Conservation efforts
Demand for rural ("stadtnah") recreation
Area consumption
Competition for productive/ arable land surface area
Surface runoff
Economic crisis
Ground sealing
Channels/ dams
Flood risks
Food security
Habitat fragmentation
Pressure on forests/ agricultural land
Erosion
Landscape aesthetics
Quality of life
Wildlife-watching
Human population senescence
Specialist populations
Generalist populations
Abandonment of villages (e.g. M-P)
Dependency on imports
Hard landscaping

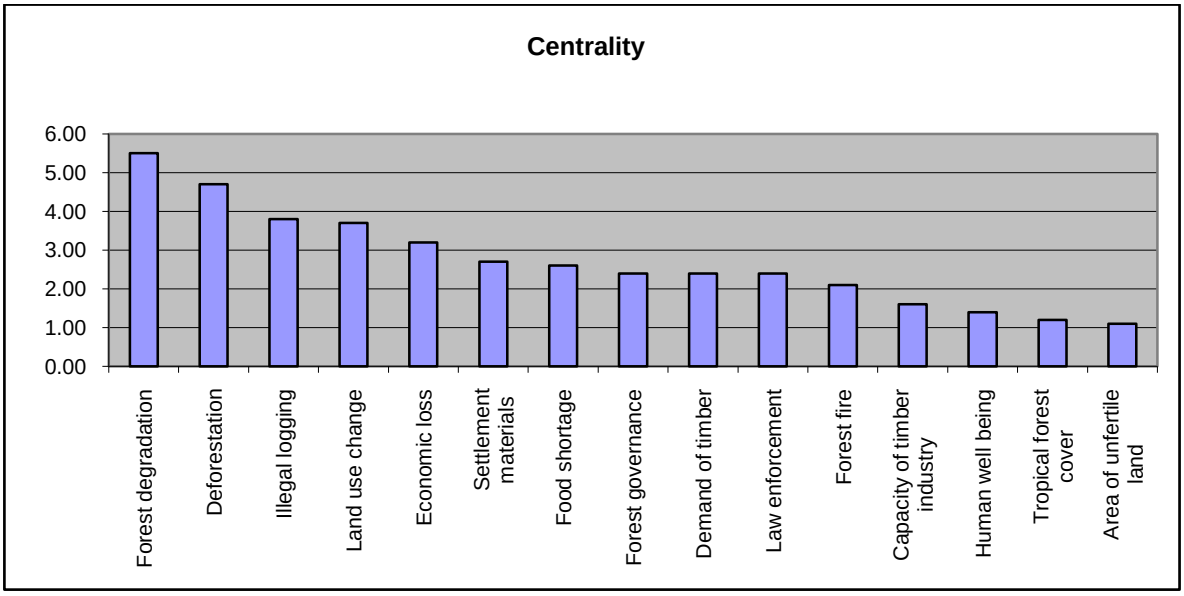
Map 7

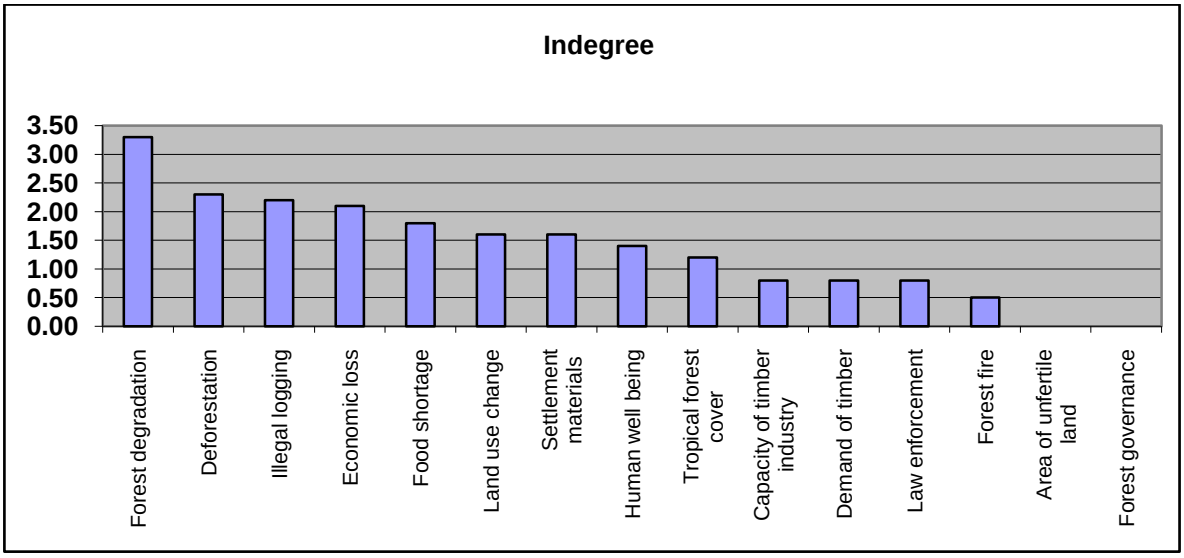


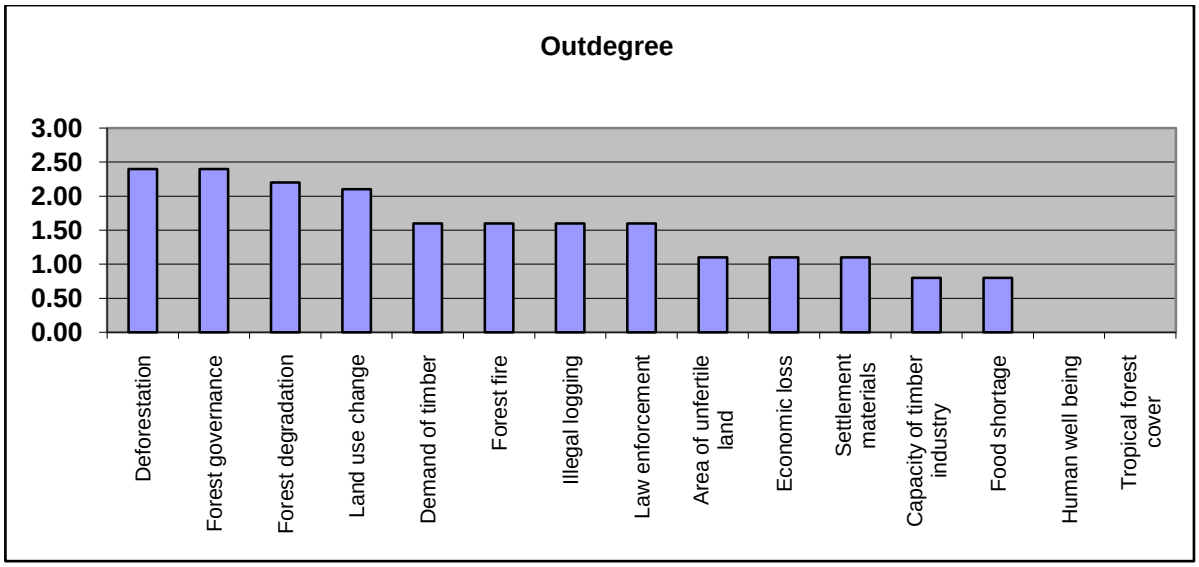
Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.13	15	29	**0**	**0**	**29**	**1**

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Area of unfertile land	**1**			1.10	0.00	1.10
Capacity of timber industry			**1**	1.60	0.80	0.80
Deforestation			**1**	4.70	2.30	2.40
Demand of timber			**1**	2.40	0.80	1.60
Economic loss			**1**	3.20	2.10	1.10
Food shortage			**1**	2.60	1.80	0.80
Forest degradation			**1**	5.50	3.30	2.20
Forest fire			**1**	2.10	0.50	1.60
Forest governance	**1**			2.40	0.00	2.40
Human well being		**1**		1.40	1.40	0.00
Illegal logging			**1**	3.80	2.20	1.60
Land use change			**1**	3.70	1.60	2.10

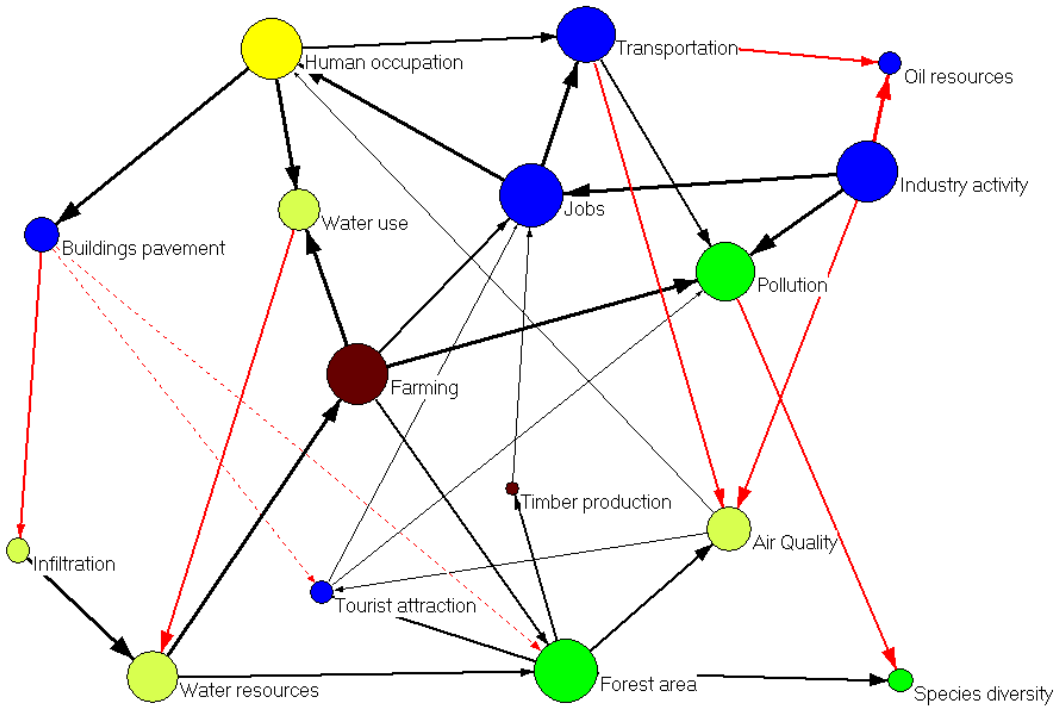
Law enforcement			**1**	2.40	0.80	1.60
Settlement materials			**1**	2.70	1.60	1.10
Tropical forest cover		**1**		1.20	1.20	0.00
Sum	2	2	11			
%	13.33	13.33	73.33			





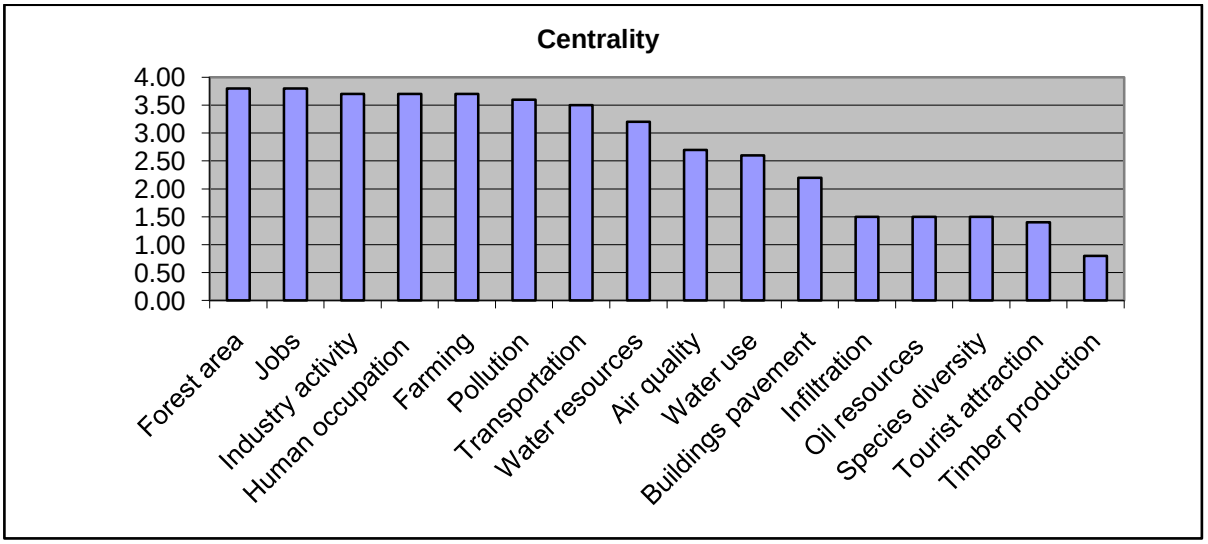


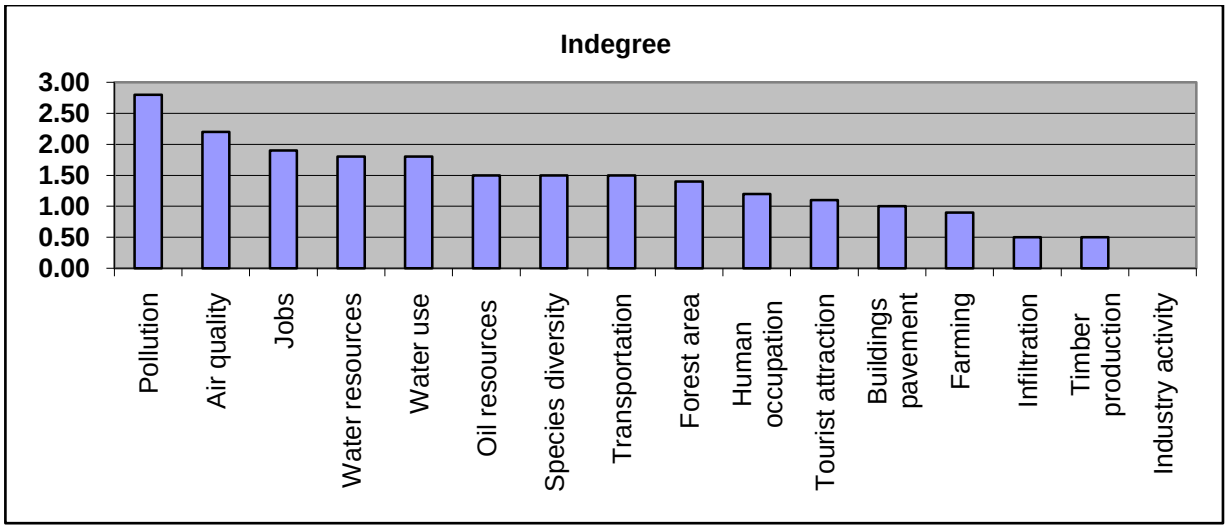
Map 8

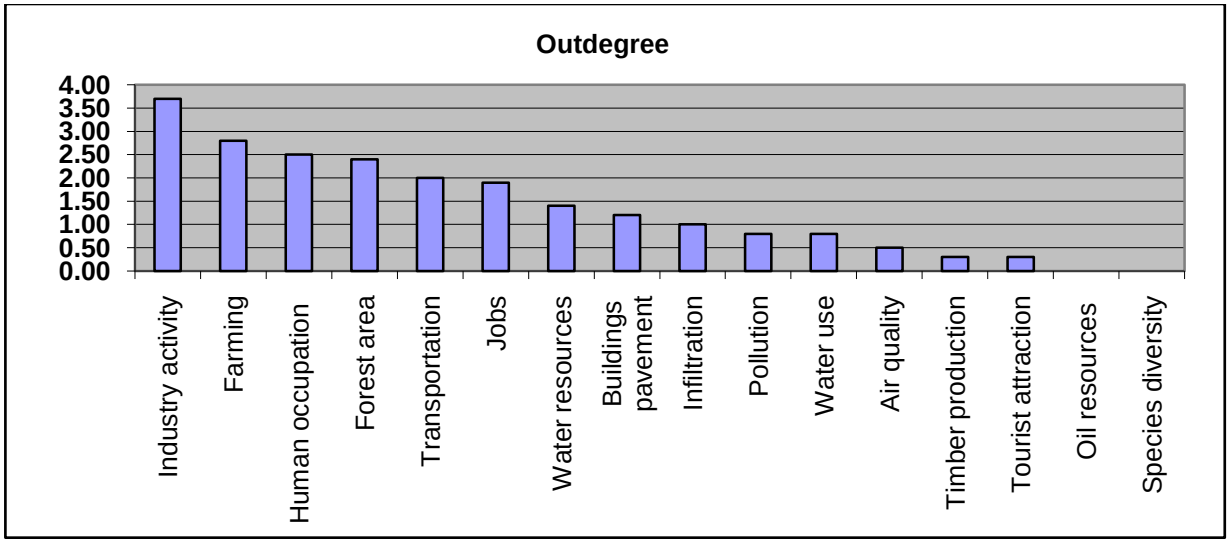


Density	Total Factors	Total Connections	No Connection	SelfLoops	Regular Connections	Complexity
0.13	16	33	0	0	33	2

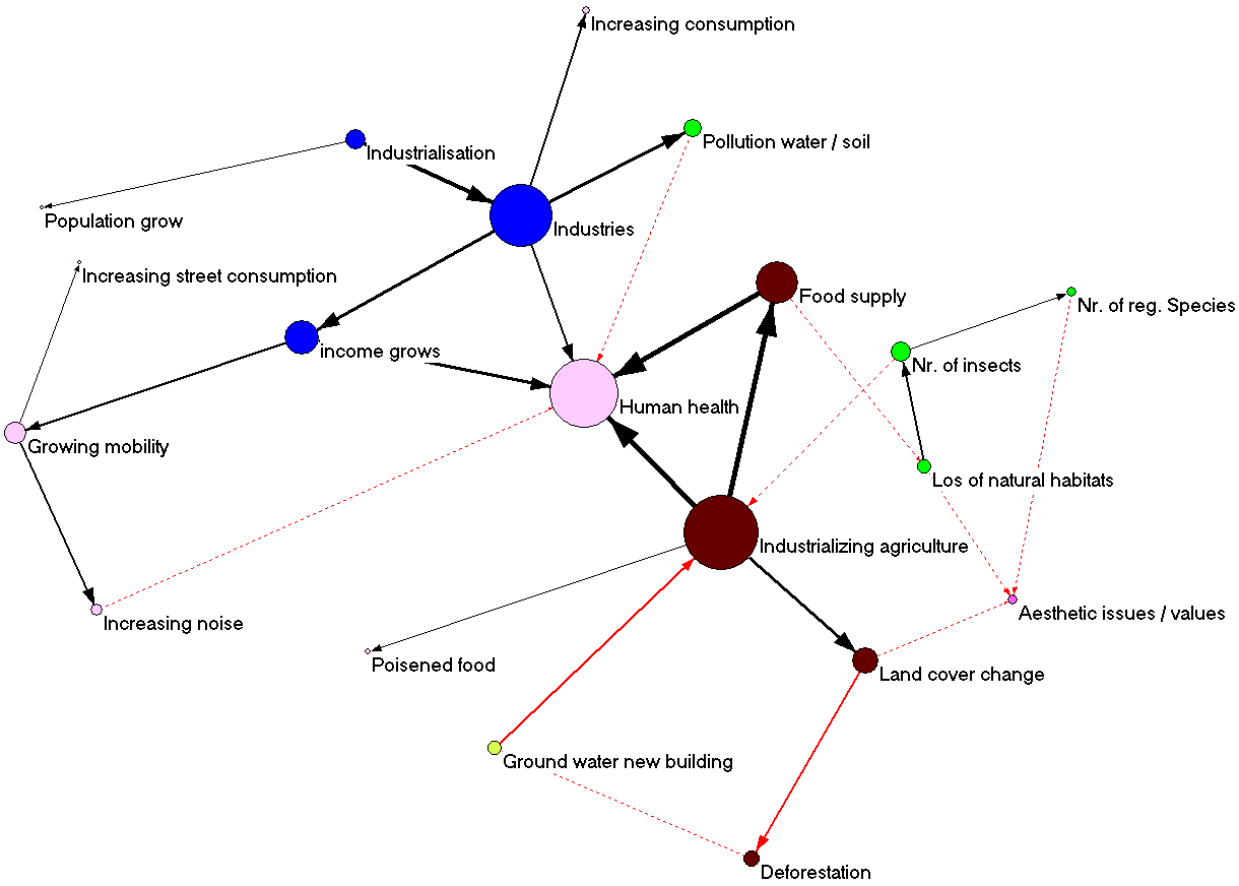
Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Air quality			**1**	2.70	2.20	0.50
Buildings pavement			**1**	2.20	1.00	1.20
Farming			**1**	3.70	0.90	2.80
Forest area			**1**	3.80	1.40	2.40
Human occupation			**1**	3.70	1.20	2.50
Industry activity	**1**			3.70	0.00	3.70
Infiltration			**1**	1.50	0.50	1.00
Jobs			**1**	3.80	1.90	1.90
Oil resources		**1**		1.50	1.50	0.00
Pollution			**1**	3.60	2.80	0.80
Species diversity		**1**		1.50	1.50	0.00
Timber production			**1**	0.80	0.50	0.30
Tourist attraction			**1**	1.40	1.10	0.30
Transportation			**1**	3.50	1.50	2.00
Water resources			**1**	3.20	1.80	1.40
Water use			**1**	2.60	1.80	0.80
Sum	1	2	13			
%	6.25	12.5	81.25			




Indegree
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Pollution
Air quality
Jobs
Water resources
Water use
Oil resources
Species diversity
Transportation
Forest area
Human occupation
Tourist attraction
Buildings pavement
Farming
Infiltration
Timber production
Industry activity


Outdegree
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Industry activity
Farming
Human occupation
Forest area
Transportation
Jobs
Water resources
Buildings pavement
Infiltration
Pollution
Water use
Air quality
Timber production
Tourist attraction
Oil resources
Species diversity

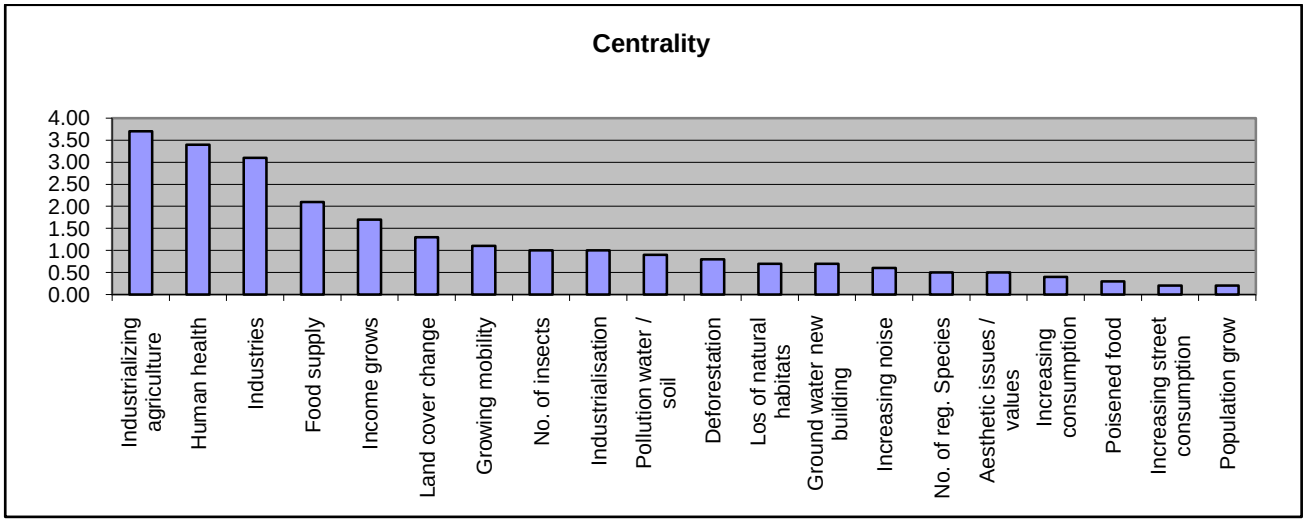
Map9

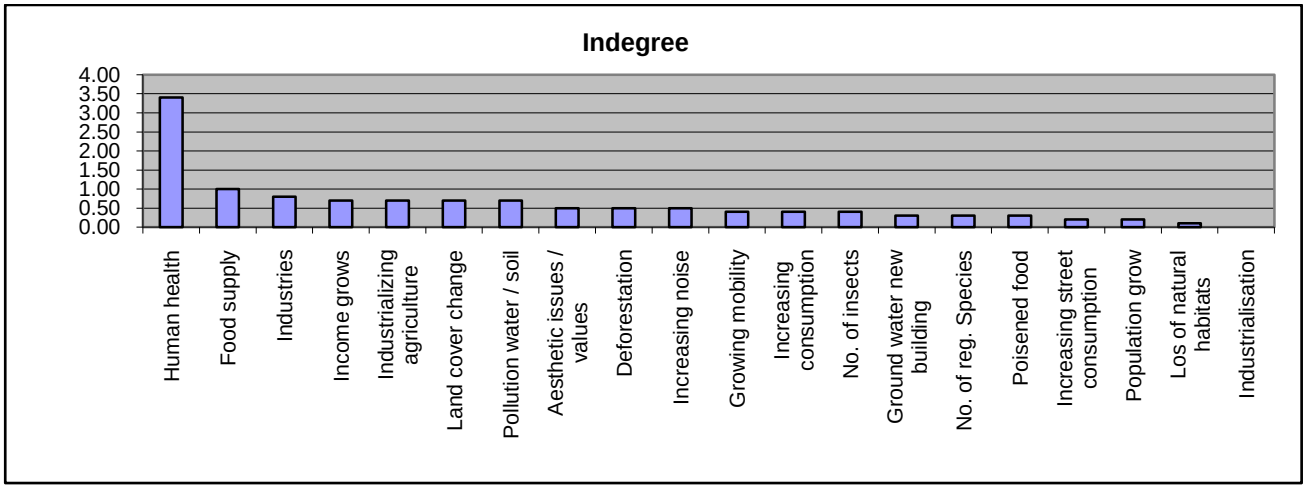


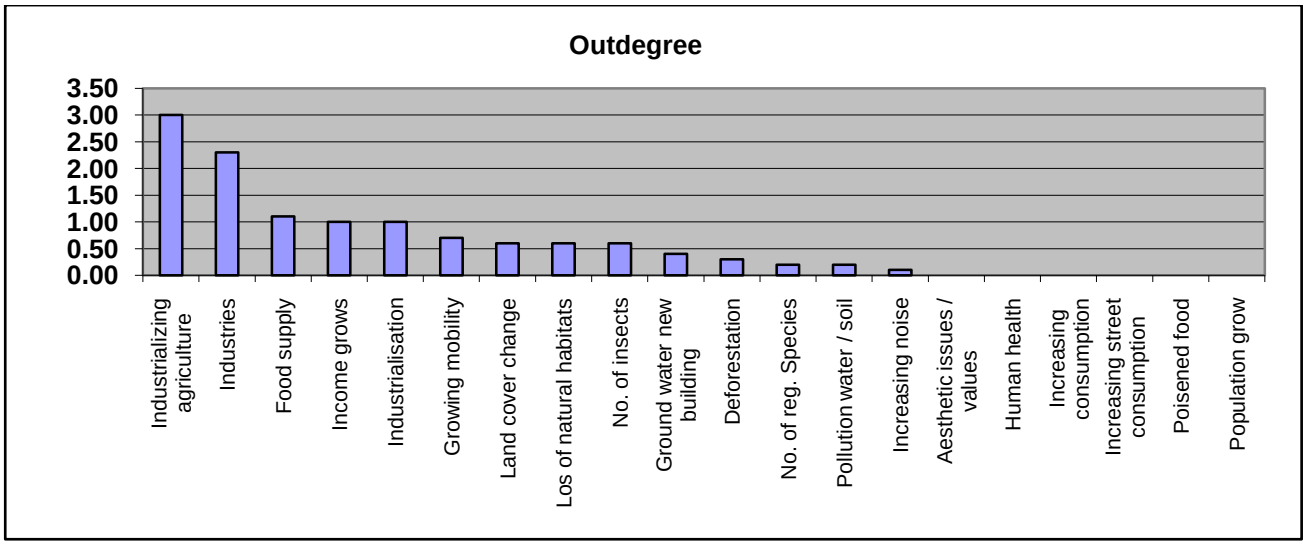
Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.07	20	27	**0**	**0**	**27**	**6**

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Aesthetic issues / values		**1**		0.50	0.50	0.00
No. of insects			**1**	0.80	0.50	0.30
No. of reg. Species			**1**	2.10	1.00	1.10
Deforestation			**1**	0.70	0.30	0.40
Food supply			**1**	1.10	0.40	0.70
Ground water new building			**1**	3.40	3.40	0.00
Growing mobility			**1**	1.70	0.70	1.00
Human health		**1**		0.40	0.40	0.00
Income grows			**1**	0.60	0.50	0.10
Increasing consumption		**1**		0.20	0.20	0.00
Increasing noise			**1**	1.00	0.00	1.00

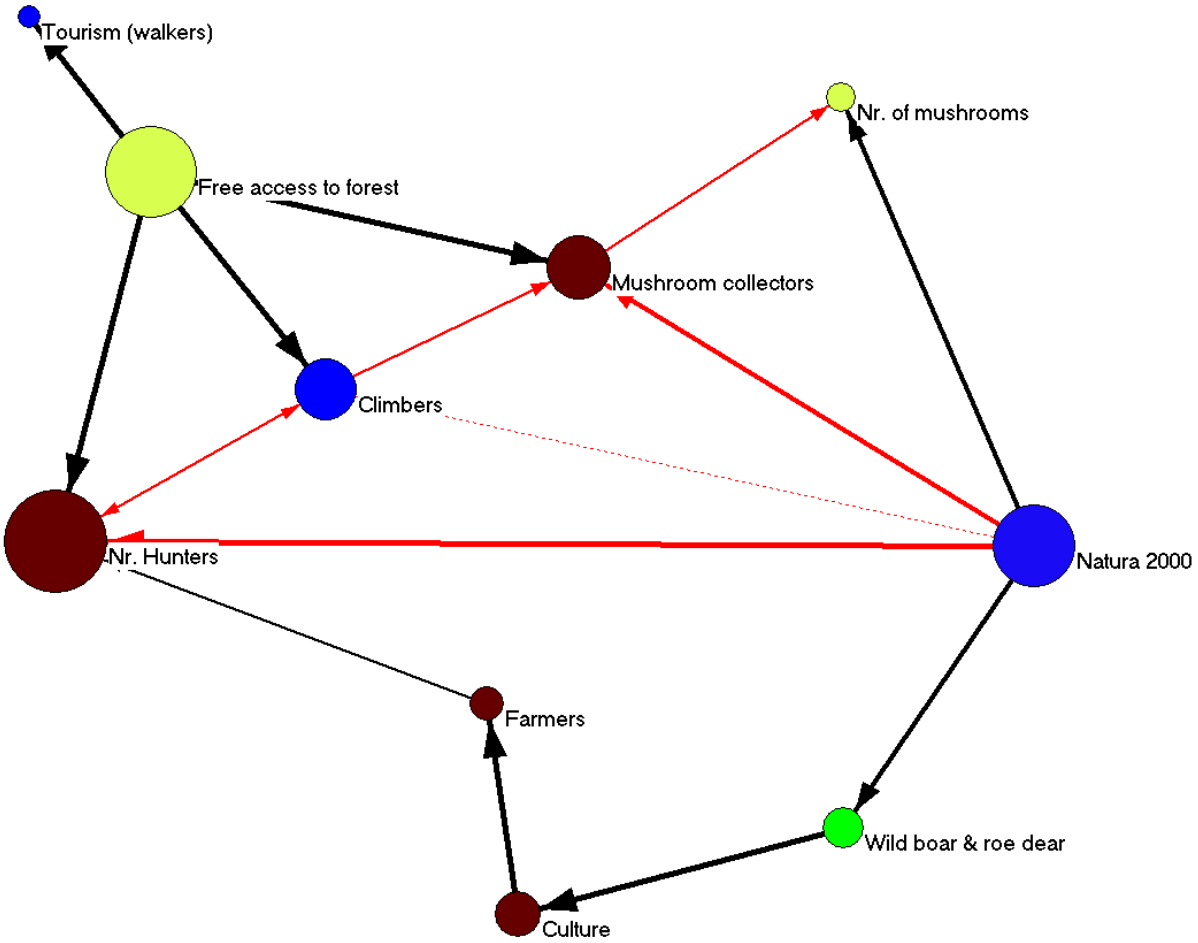
Increasing street consumption		**1**		3.70	0.70	3.00
Industrialization	**1**			3.10	0.80	2.30
Industrializing agriculture			**1**	1.30	0.70	0.60
Industries			**1**	0.70	0.10	0.60
Land cover change			**1**	1.00	0.40	0.60
Los of natural habitats			**1**	0.50	0.30	0.20
Poisoned food		**1**		0.30	0.30	0.00
Pollution water / soil			**1**	0.90	0.70	0.20
Population grow		**1**		0.20	0.20	0.00
sum	1	6	13			
%	5	30	65			





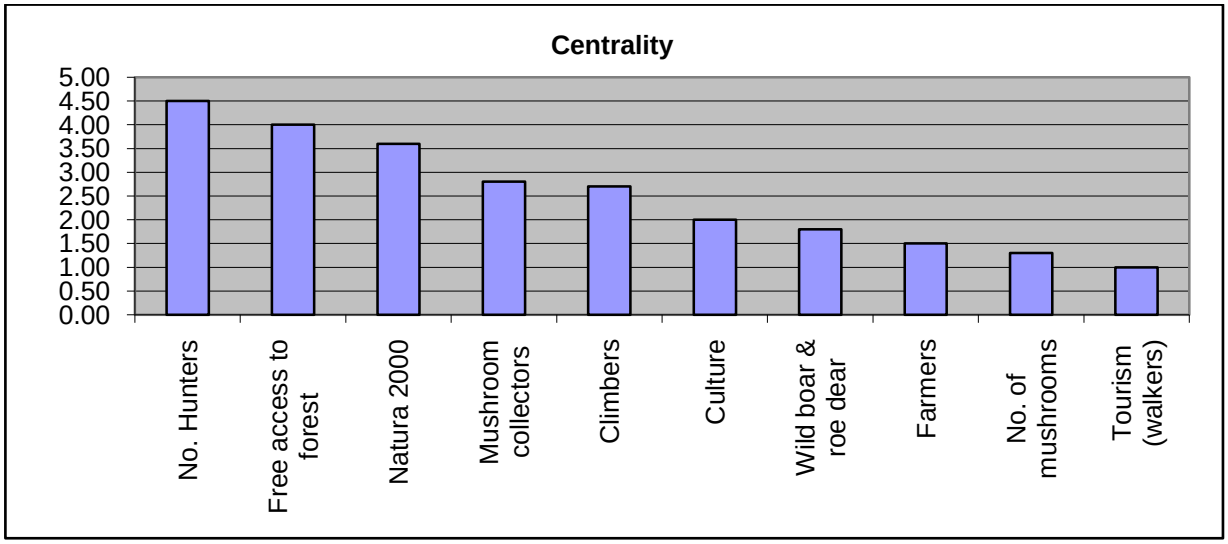

Outdegree
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Industrializing agriculture
Industries
Food supply
Income grows
Industrialisation
Growing mobility
Land cover change
Los of natural habitats
No. of insects
Ground water new building
Deforestation
No. of reg. Species
Pollution water / soil
Increasing noise
Aesthetic issues / values
Human health
Increasing consumption
Increasing street consumption
Poisened food
Population grow

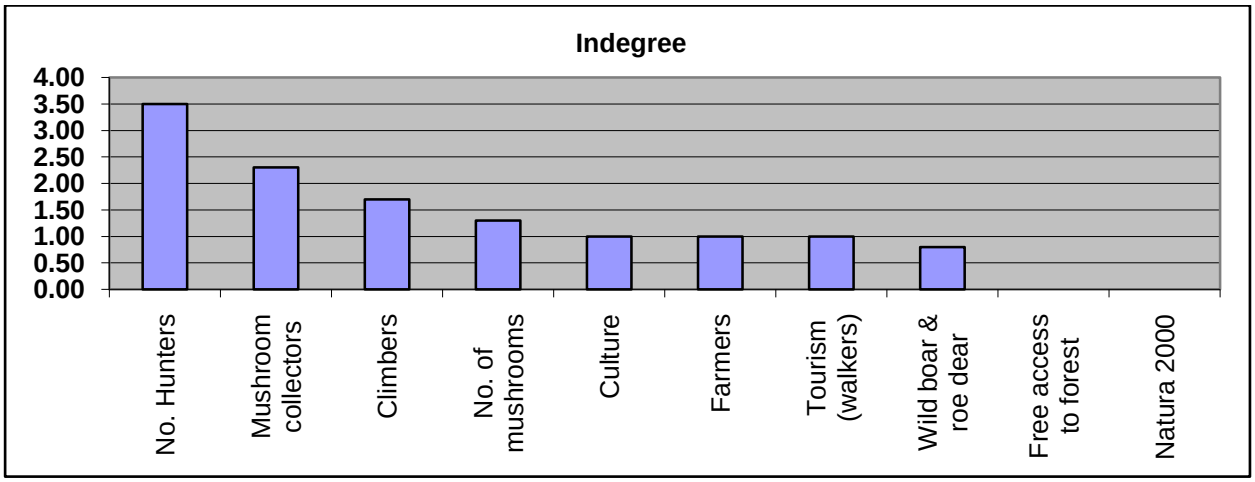
Map10

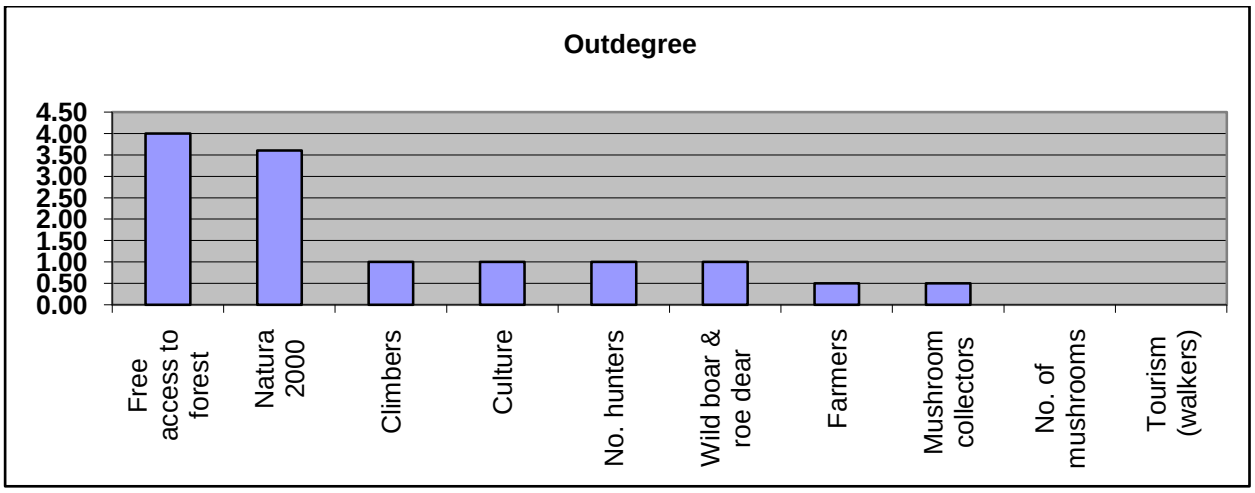

Tourism (walkers)
Nr. of mushrooms
Free access to forest
Mushroom collectors
Climbers
Nr. Hunters
Natura 2000
Farmers
Wild boar & roe dear
Culture

Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.17	10	17	**0**	**1**	**16**	**1**

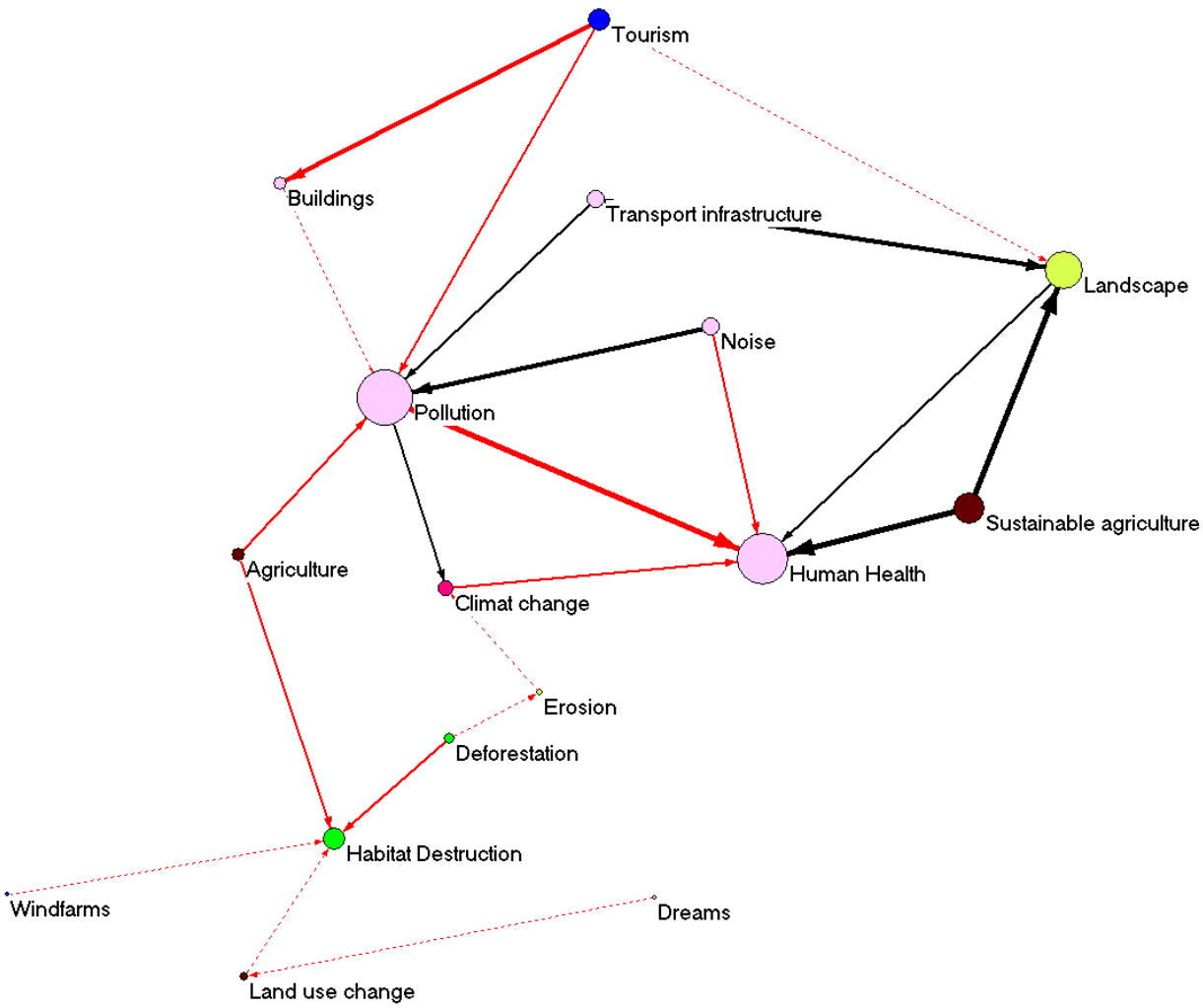
Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Climbers			**1**	2.70	1.70	1.00
Farmers			**1**	2.00	1.00	1.00
Free access to forest	**1**			1.50	1.00	0.50
Mushroom collectors			**1**	4.00	0.00	4.00
Natura 2000	**1**			2.80	2.30	0.50
No. hunters			**1**	3.60	0.00	3.60
No. of mushrooms		**1**		4.50	3.50	1.00
Culture			**1**	1.30	1.30	0.00
Tourism (walkers)		**1**		1.00	1.00	0.00
Wild boar & roe dear			**1**	1.80	0.80	1.00
Sum	2	2	6			
%	20	20	60			




Indegree
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
No. Hunters
Mushroom collectors
Climbers
No. of mushrooms
Culture
Farmers
Tourism (walkers)
Wild boar & roe dear
Free access to forest
Natura 2000


Outdegree
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Free access to forest
Natura 2000
Climbers
Culture
No. hunters
Wild boar & roe dear
Farmers
Mushroom collectors
No. of mushrooms
Tourism (walkers)

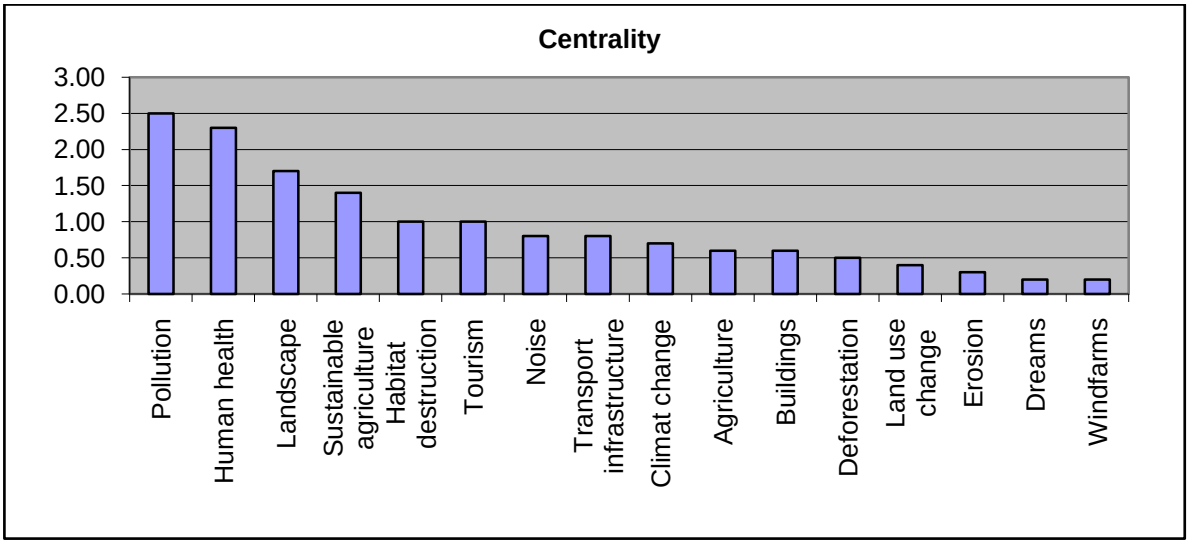
Map11

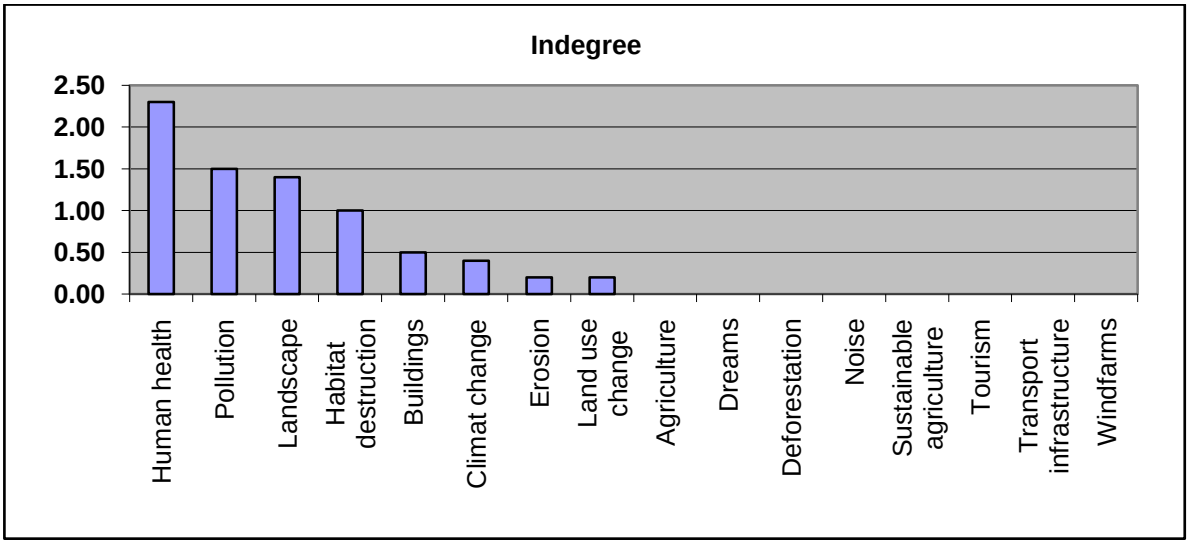


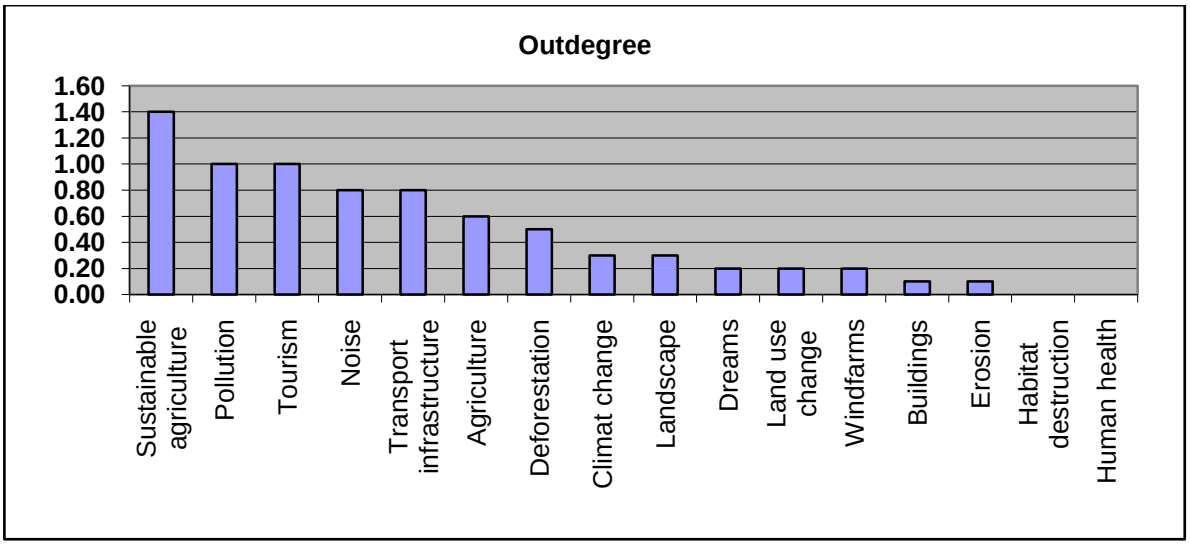
Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.0859375	16	22	0	0	22	0.25

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Agriculture	1			0.60	0.00	0.60
Buildings			1	0.60	0.50	0.10
Climate change			1	0.70	0.40	0.30
Dreams	1			0.20	0.00	0.20
Deforestation	1			0.50	0.00	0.50
Erosion			1	0.30	0.20	0.10
Habitat destruction		1		1.00	1.00	0.00
Human health		1		2.30	2.30	0.00
Land use change			1	0.40	0.20	0.20
Landscape			1	1.70	1.40	0.30
Noise	1			0.80	0.00	0.80

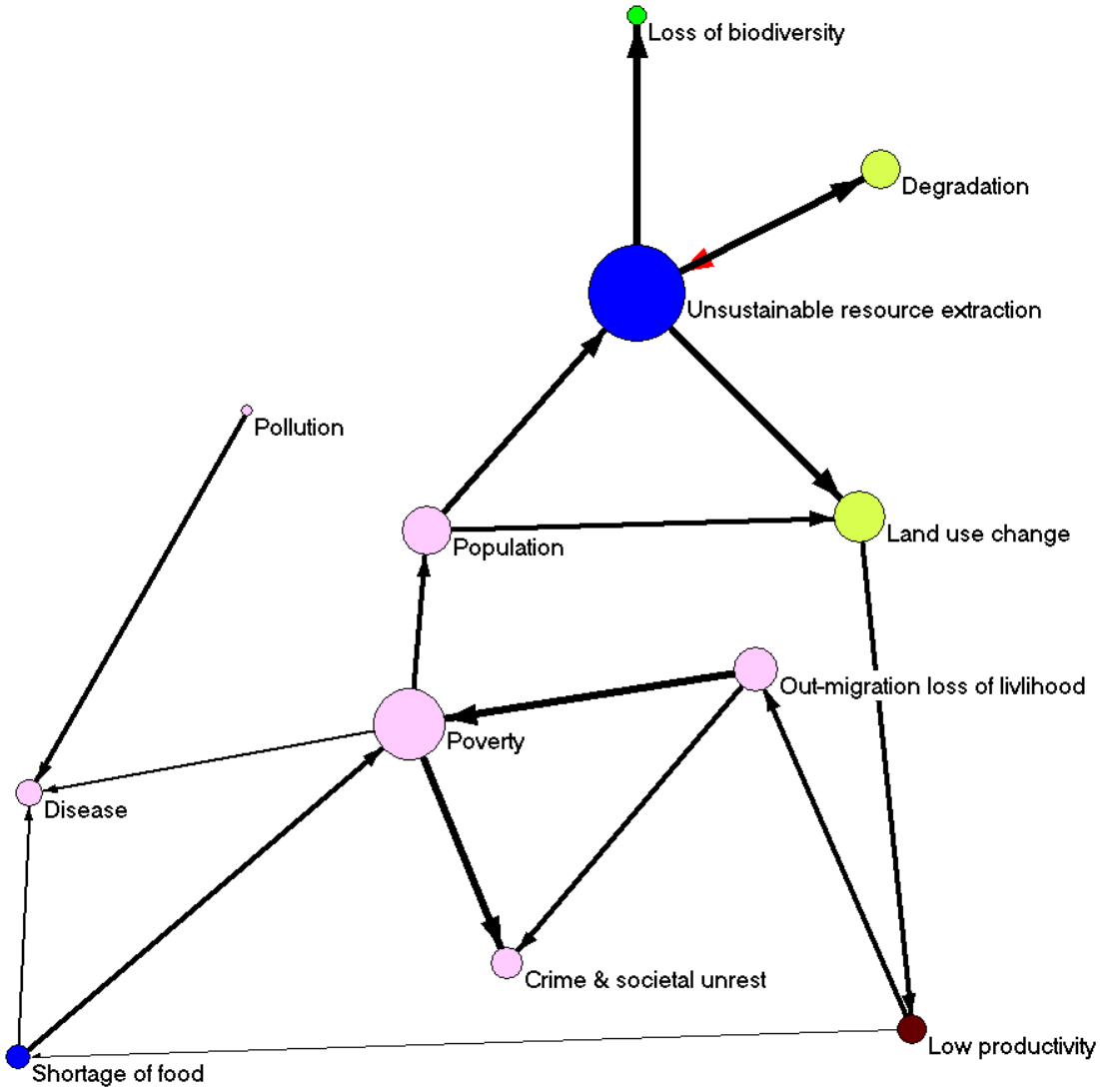
Pollution			**1**	2.50	1.50	1.00
Sustainable agriculture	**1**			1.40	0.00	1.40
Tourism	**1**			1.00	0.00	1.00
Transport infrastructure	**1**			0.80	0.00	0.80
Wind farms	**1**			0.20	0.00	0.20
sum	8	2	6			
%	50	12.5	37.5			






Outdegree
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Sustainable agriculture
Pollution
Tourism
Noise
Transport infrastructure
Agriculture
Deforestation
Climat change
Landscape
Dreams
Land use change
Windfarms
Buildings
Erosion
Habitat destruction
Human health

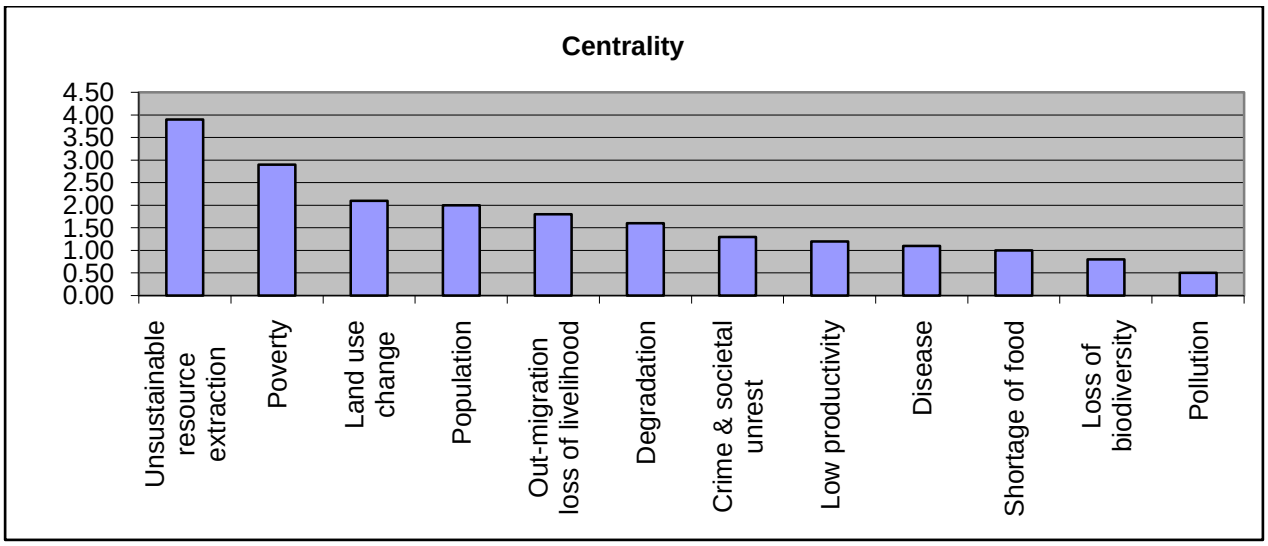
Map12

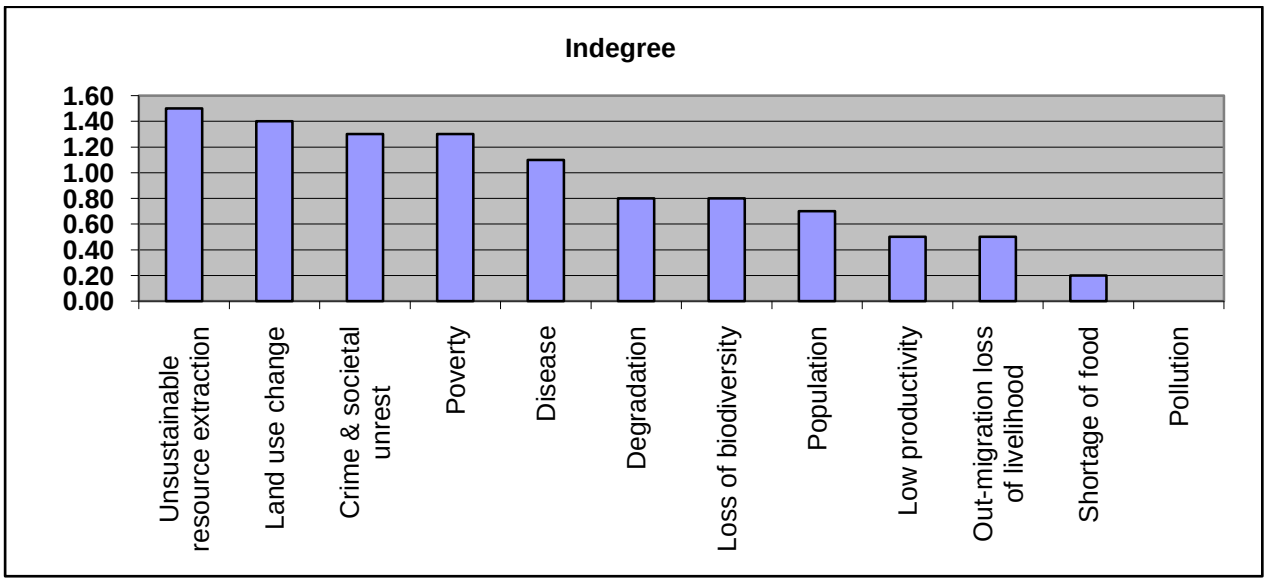


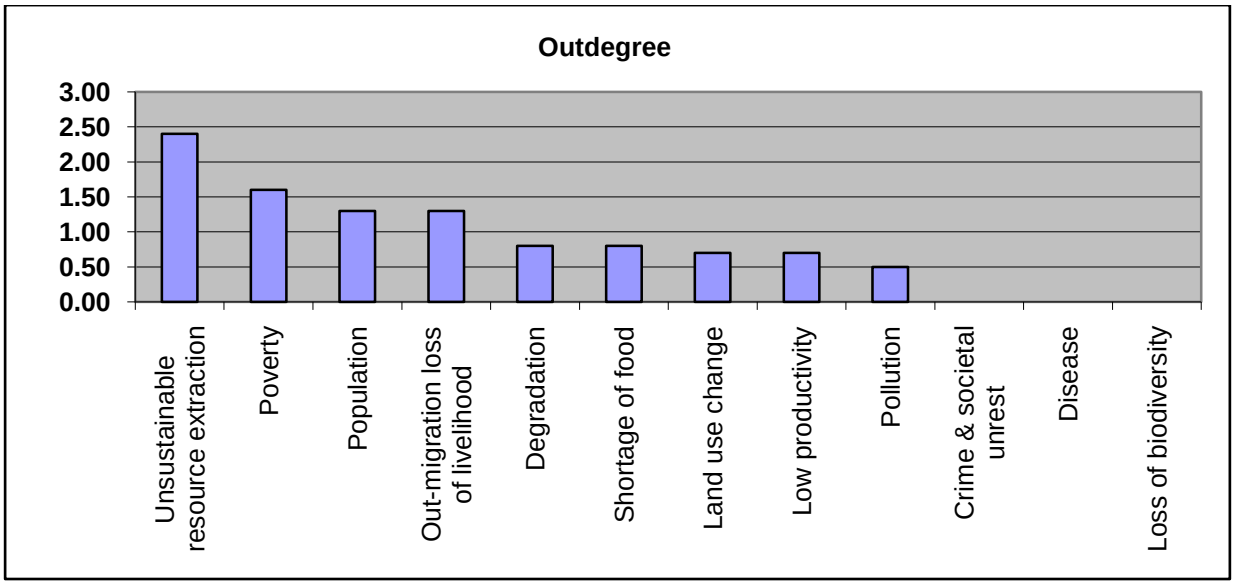
Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.125	12	18	0	0	18	3

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Crime & societal unrest		**1**		1.30	1.30	0.00
Degradation			**1**	1.60	0.80	0.80
Disease		**1**		1.10	1.10	0.00
Land use change			**1**	2.10	1.40	0.70
Loss of biodiversity		**1**		0.80	0.80	0.00
Low productivity			**1**	1.20	0.50	0.70

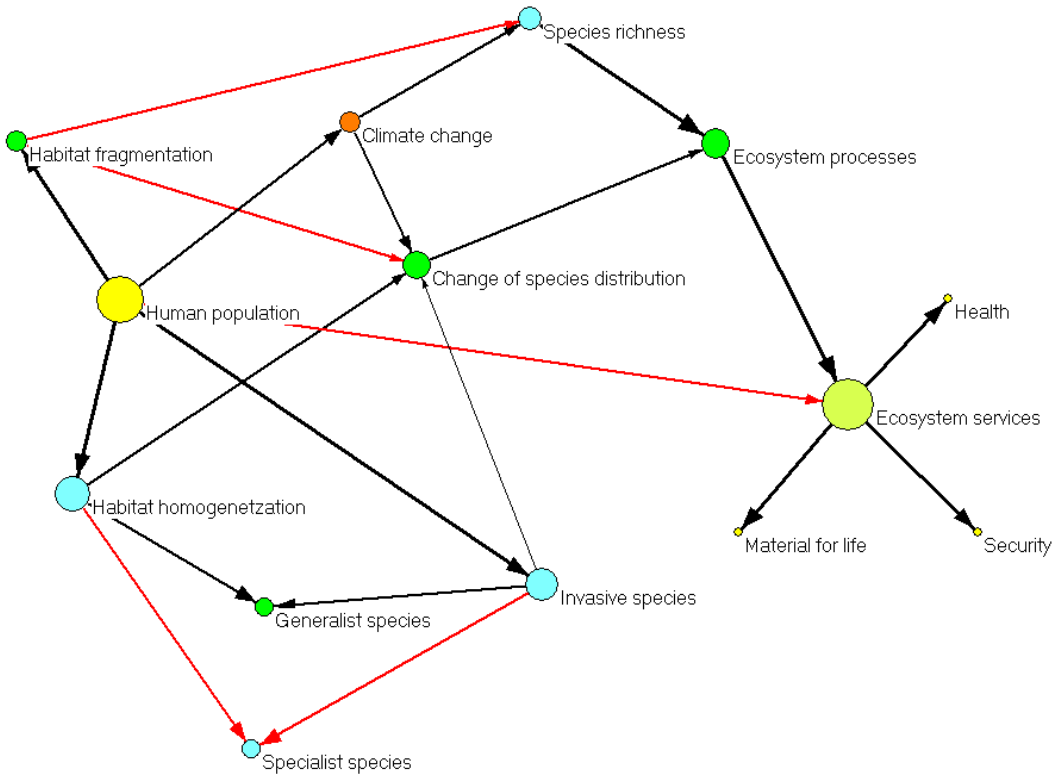
Out-migration loss of livelihood			**1**	1.80	0.50	1.30
Pollution	**1**			0.50	0.00	0.50
Population			**1**	2.00	0.70	1.30
Poverty			**1**	2.90	1.30	1.60
Shortage of food			**1**	1.00	0.20	0.80
Unsustainable resource extraction			**1**	3.90	1.50	2.40
sum	1	3	8			
%	8.33	25	66.66			





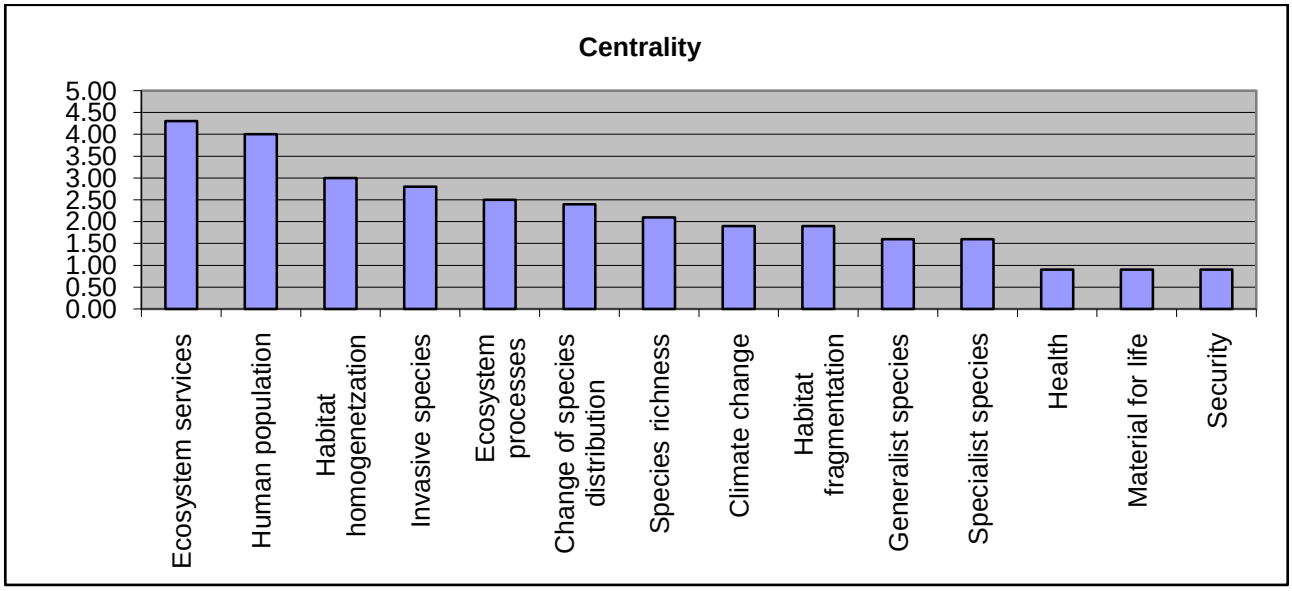


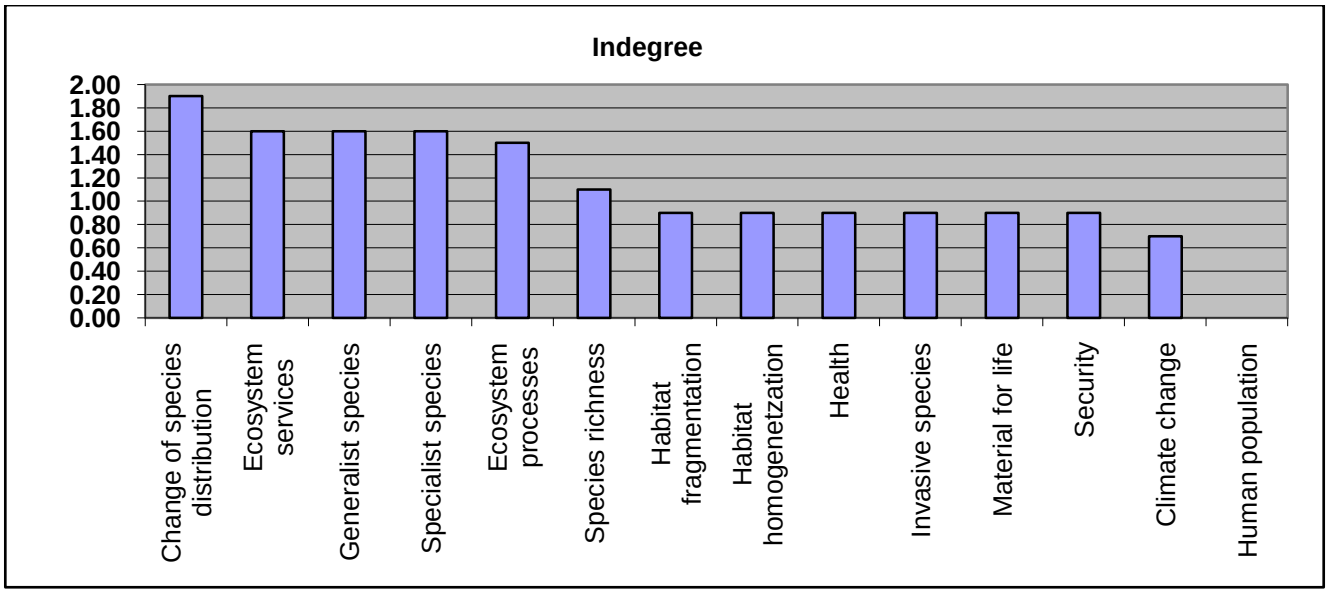
Map13

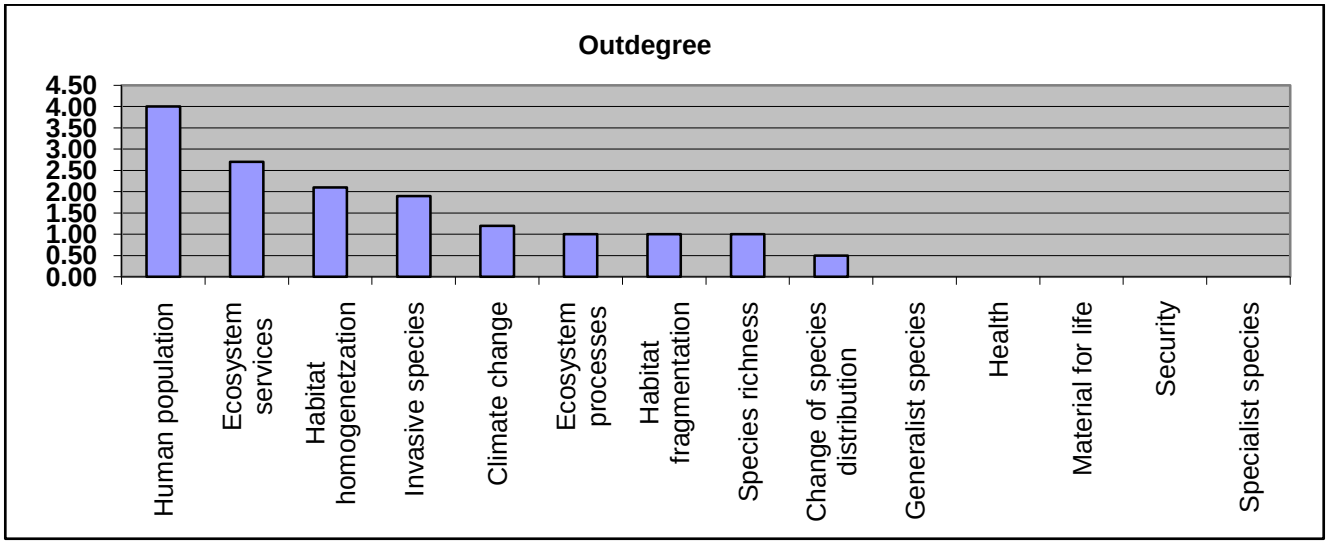


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.11	14	21	0	0	21	5

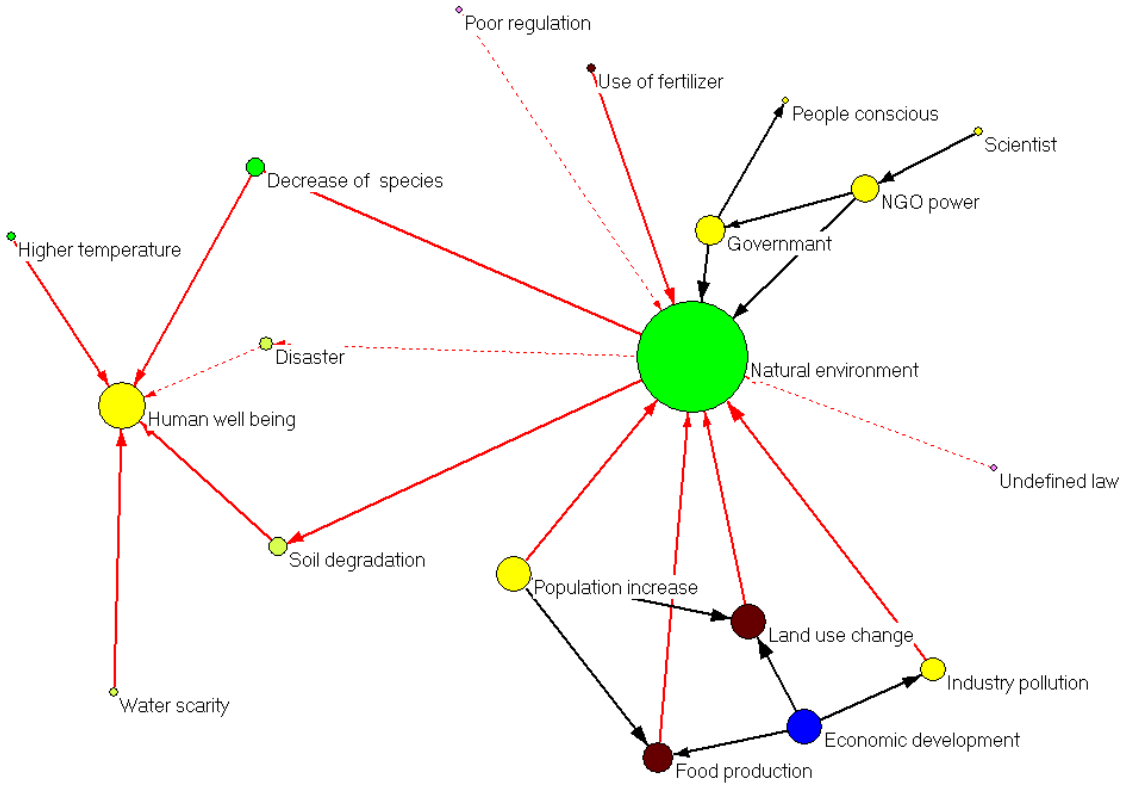
Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Change of species distribution			1	2.40	1.90	0.50
Climate change			1	1.90	0.70	1.20
Ecosystem processes			1	2.50	1.50	1.00
Ecosystem services			1	4.30	1.60	2.70
Generalist species		1		1.60	1.60	0.00
Habitat fragmentation			1	1.90	0.90	1.00
Habitat homogenization			1	3.00	0.90	2.10
Health		1		0.90	0.90	0.00
Human population	1			4.00	0.00	4.00
Invasive species			1	2.80	0.90	1.90
Material for life		1		0.90	0.90	0.00
Security		1		0.90	0.90	0.00
Specialist species		1		1.60	1.60	0.00
Species richness			1	2.10	1.10	1.00
Sum	1	5	8			
%	7.14	35.71	57.14			




Indegree
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Change of species distribution
Ecosystem services
Generalist species
Specialist species
Ecosystem processes
Species richness
Habitat fragmentation
Habitat homogenetzation
Health
Invasive species
Material for life
Security
Climate change
Human population


Outdegree
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Human population
Ecosystem services
Habitat homogenetzation
Invasive species
Climate change
Ecosystem processes
Habitat fragmentation
Species richness
Change of species distribution
Generalist species
Health
Material for life
Security
Specialist species

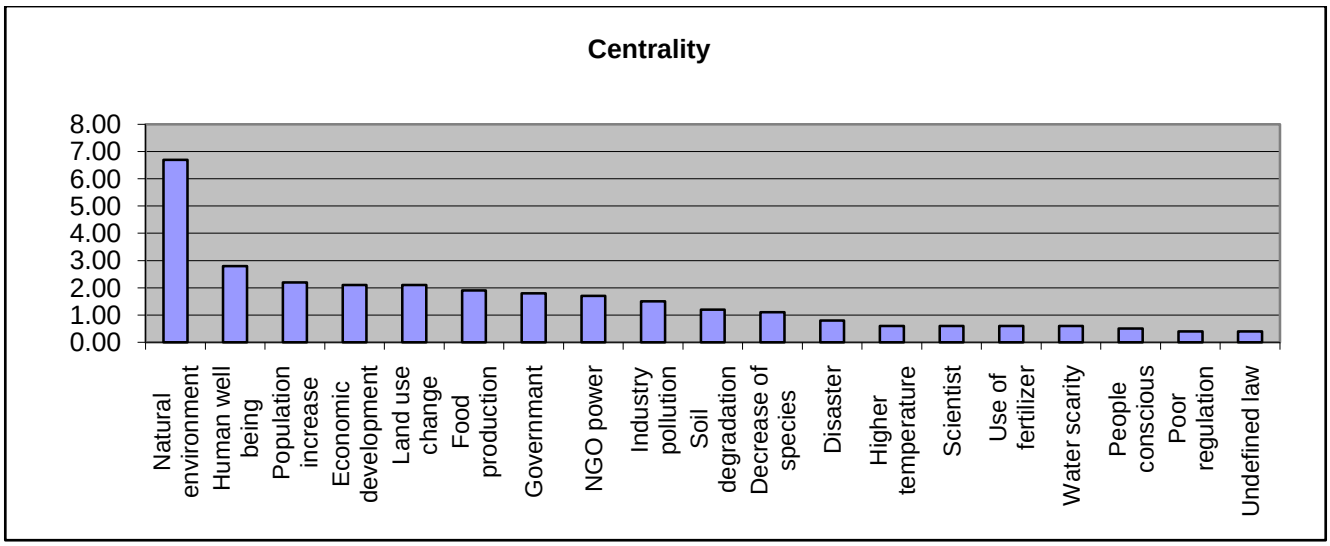
Map14

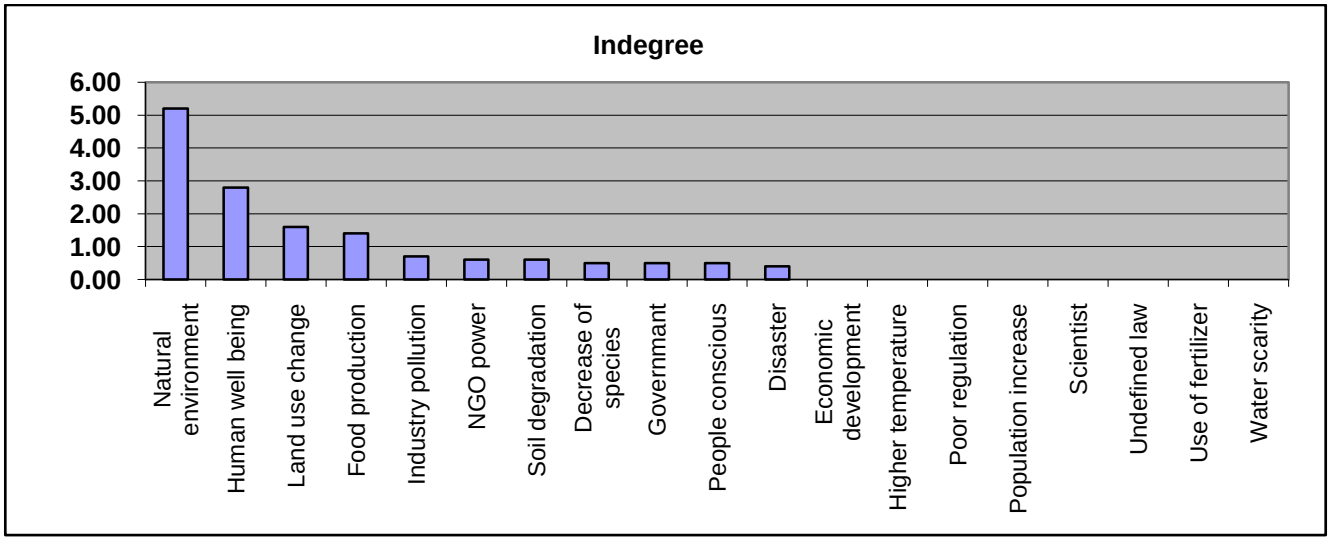


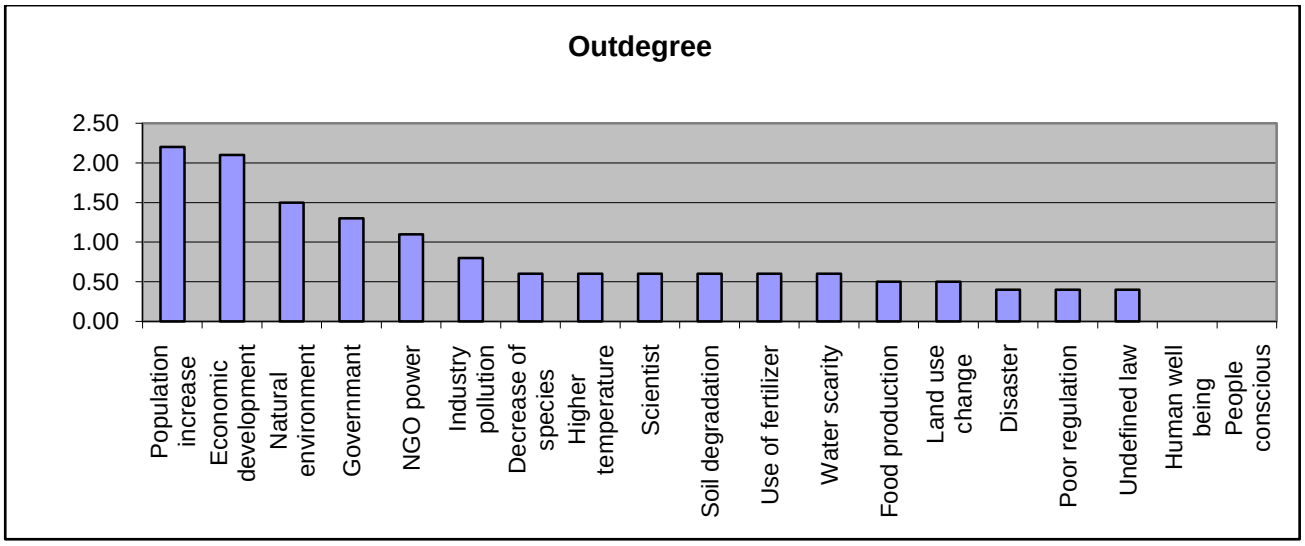
Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.07	19	25	0	0	25	0.25

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Decrease of species			1	1.10	0.50	0.60
Disaster			1	0.80	0.40	0.40
Economic development	1			2.10	0.00	2.10
Food production			1	1.90	1.40	0.50
Government			1	1.80	0.50	1.30
Higher temperature	1			0.60	0.00	0.60
Human well being		1		2.80	2.80	0.00
Industry pollution			1	1.50	0.70	0.80
Land use change			1	2.10	1.60	0.50
Natural environment			1	6.70	5.20	1.50
NGO power			1	1.70	0.60	1.10
People conscious		1		0.50	0.50	0.00
Poor regulation	1			0.40	0.00	0.40
Population increase	1			2.20	0.00	2.20
Scientist	1			0.60	0.00	0.60
Soil degradation			1	1.20	0.60	0.60
Undefined law	1			0.40	0.00	0.40

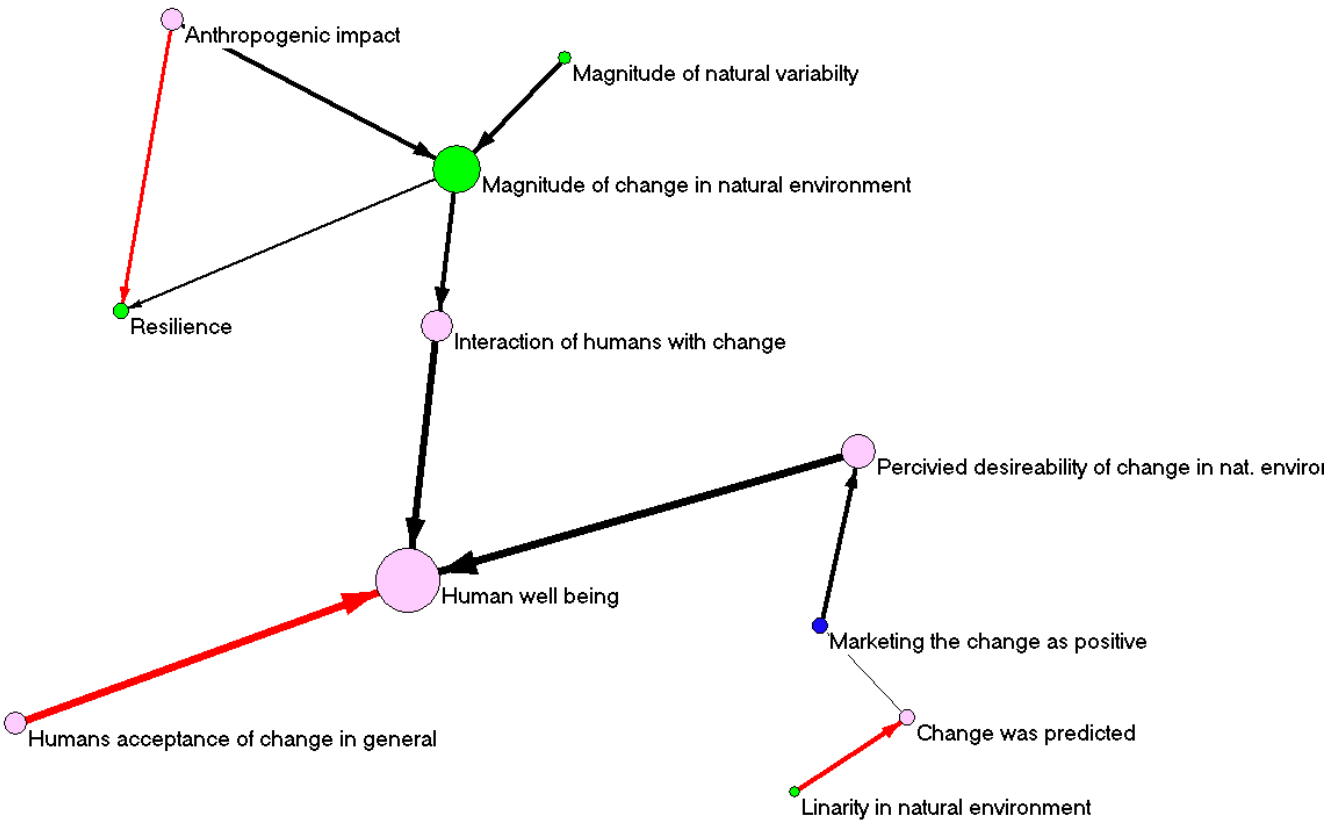
Use of fertilizer	**1**			0.60	0.00	0.60
Water scarcity	**1**			0.60	0.00	0.60
Sum	8	2	9			
%	42.11	10.53	47.37			





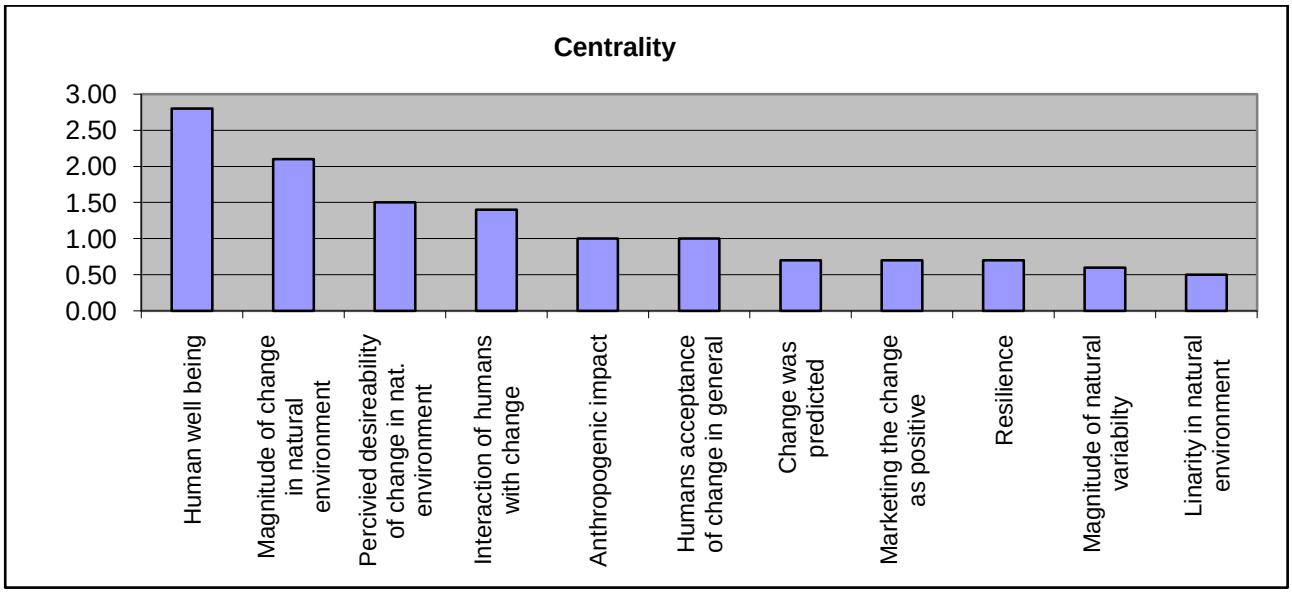


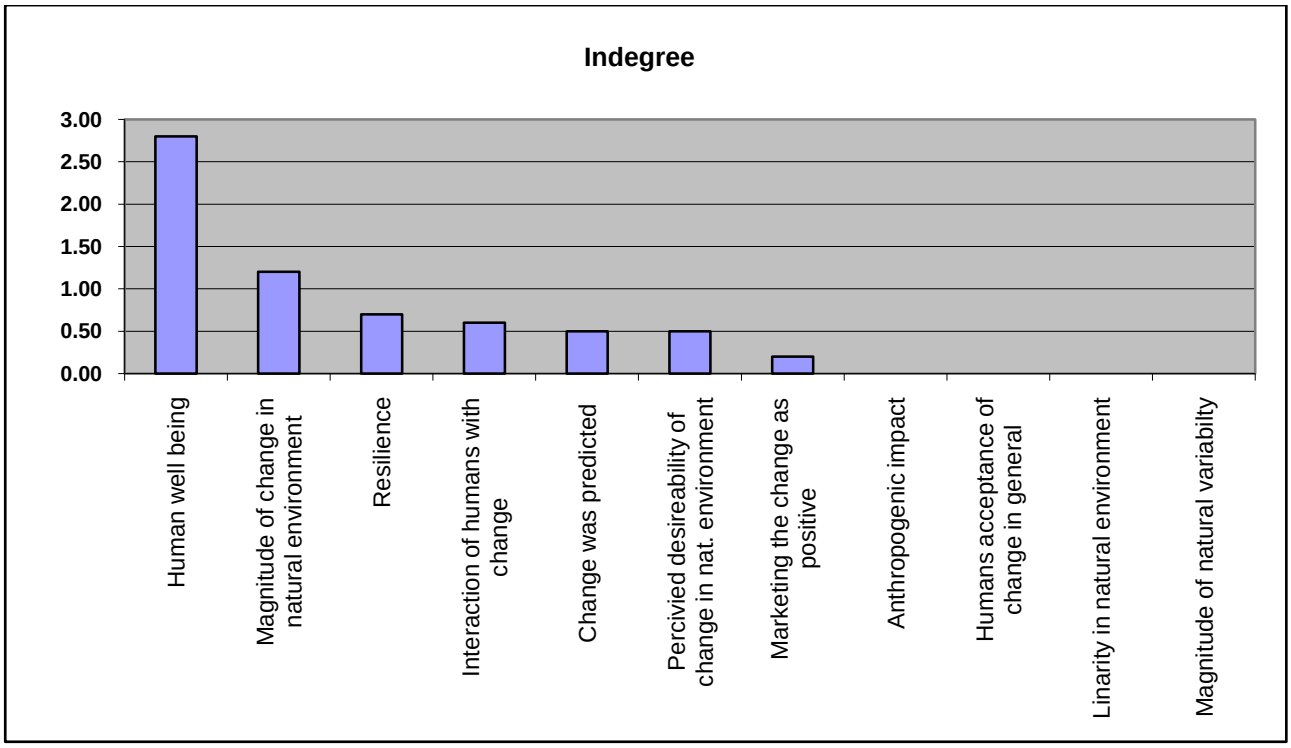
Map 15

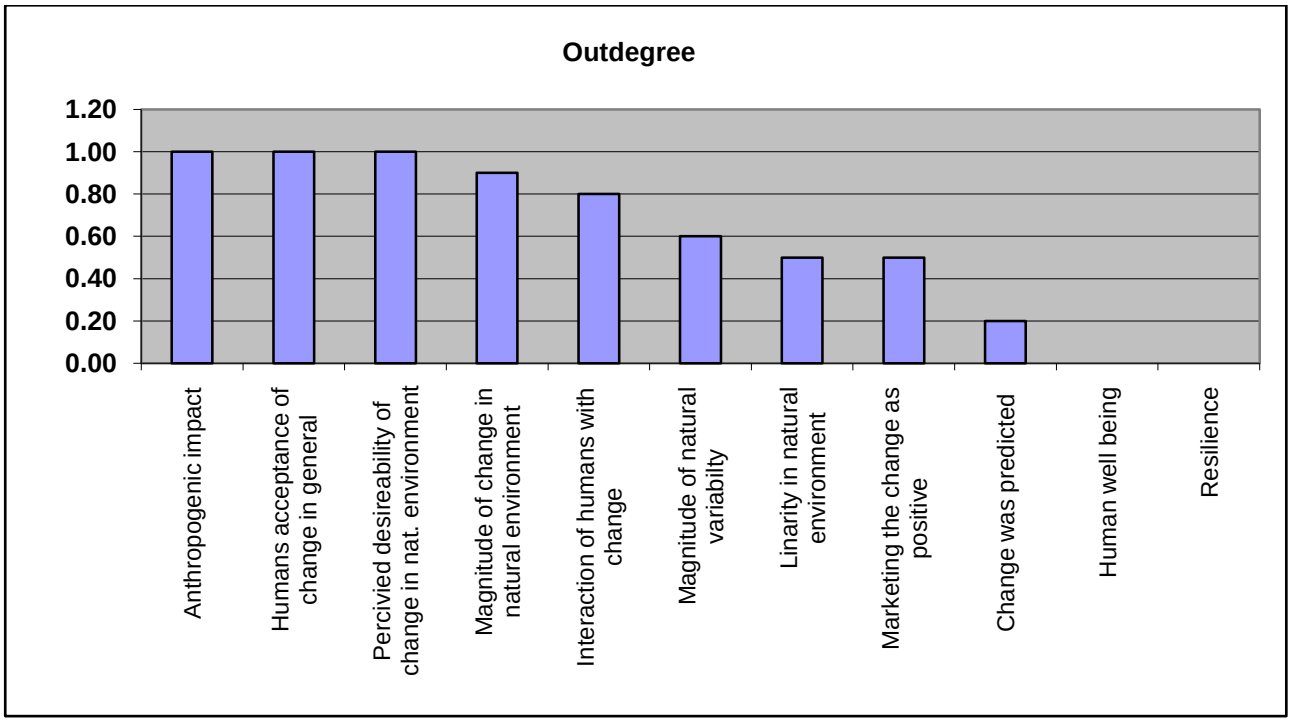


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.09	11	11	0	0	11	0.5

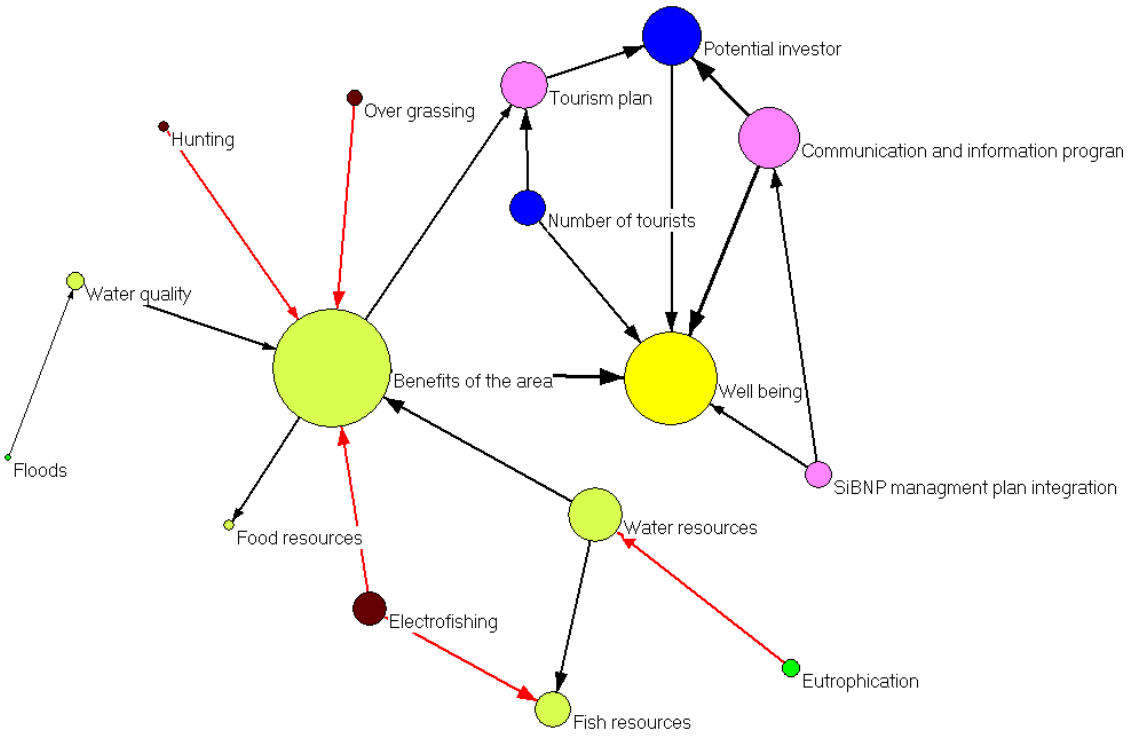
Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Anthropogenic impact	**1**			1.00	0.00	1.00
Change was predicted			**1**	0.70	0.50	0.20
Human well being		**1**		2.80	2.80	0.00
Humans acceptance of change in general	**1**			1.00	0.00	1.00
Interaction of humans with change			**1**	1.40	0.60	0.80
Linearity in natural environment	**1**			0.50	0.00	0.50
Magnitude of change in natural environment			**1**	2.10	1.20	0.90
Magnitude of natural variability	**1**			0.60	0.00	0.60
Marketing the change as positive			**1**	0.70	0.20	0.50
Perceived desirability of change in nat. environment			**1**	1.50	0.50	1.00
Resilience		**1**		0.70	0.70	0.00
Sum	4	2	5			
%	36.36	18.18	45.45			




Indegree
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Human well being
Magnitude of change in natural environment
Resilience
Interaction of humans with change
Change was predicted
Percivied desireability of change in nat. environment
Marketing the change as positive
Anthropogenic impact
Humans acceptance of change in general
Linarity in natural environment
Magnitude of natural variabilty

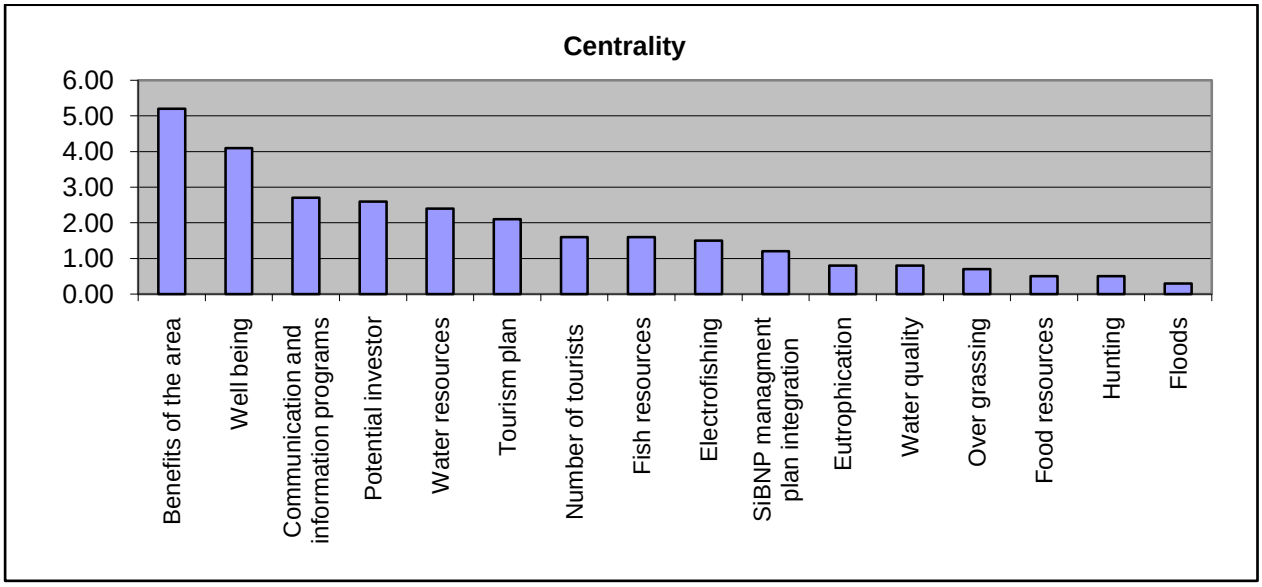

Outdegree
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Anthropogenic impact
Humans acceptance of change in general
Percivied desireability of change in nat. environment
Magnitude of change in natural environment
Interaction of humans with change
Magnitude of natural variabilty
Linarity in natural environment
Marketing the change as positive
Change was predicted
Human well being
Resilience

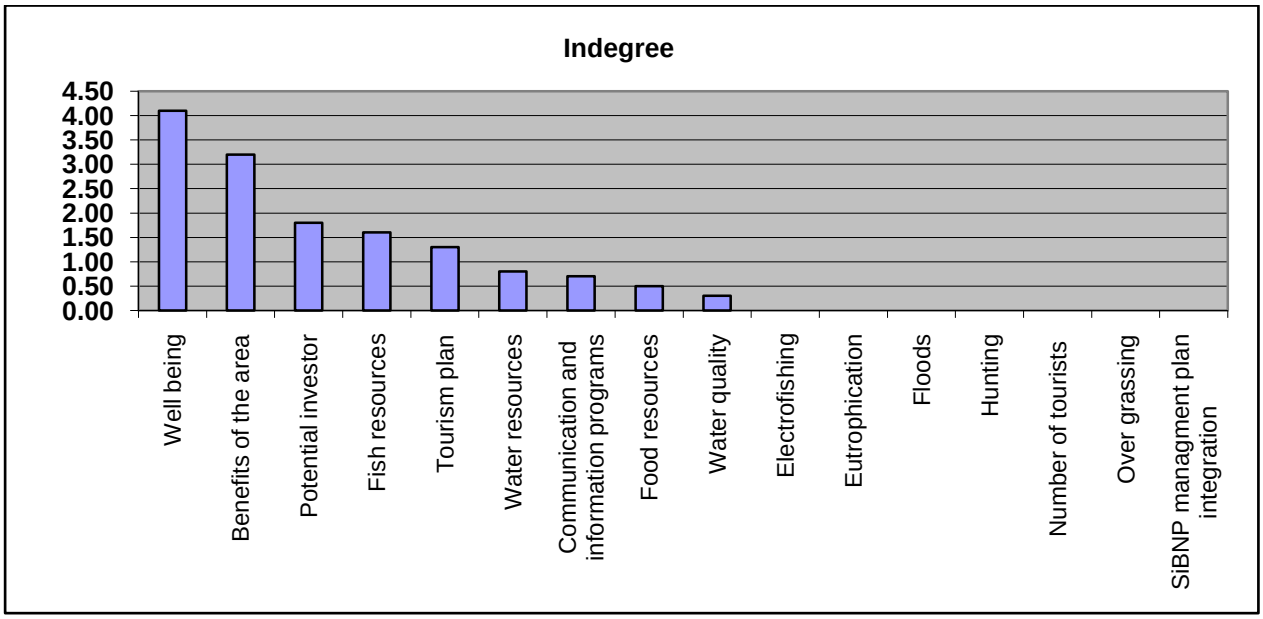
Map 16

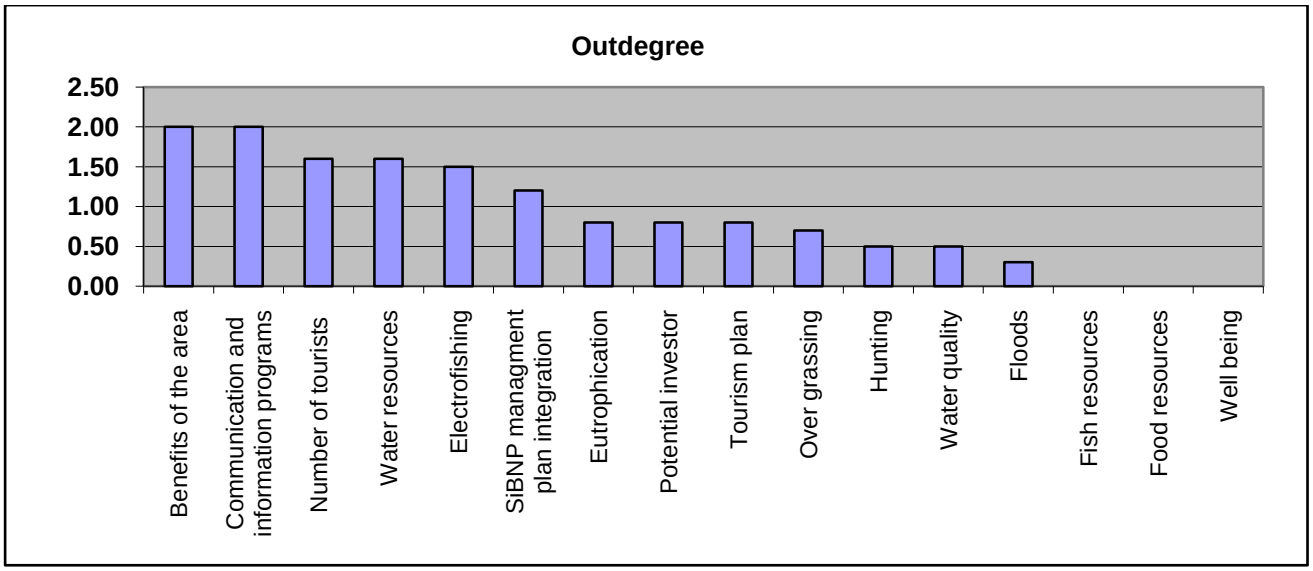


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.08	16	20	0	0	20	0.43

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Benefits of the area			**1**	5.20	3.20	2.00
Communication and information programs			**1**	2.70	0.70	2.00
Electro-fishing	**1**			1.50	0.00	1.50
Eutrophication	**1**			0.80	0.00	0.80
Fish resources		**1**		1.60	1.60	0.00
Floods	**1**			0.30	0.00	0.30
Food resources		**1**		0.50	0.50	0.00
Hunting	**1**			0.50	0.00	0.50
Number of tourists	**1**			1.60	0.00	1.60
Over grassing	**1**			0.70	0.00	0.70
Potential investor			**1**	2.60	1.80	0.80
SiBNP management plan integration	**1**			1.20	0.00	1.20
Tourism plan			**1**	2.10	1.30	0.80
Water quality			**1**	0.80	0.30	0.50
Water resources			**1**	2.40	0.80	1.60
Well being		**1**		4.10	4.10	0.00
Sum	7	3	6			
%	43.75	18.75	37.5			


Centrality
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Benefits of the area
Well being
Communication and information programs
Potential investor
Water resources
Tourism plan
Number of tourists
Fish resources
Electrofishing
SiBNP managment plan integration
Eutrophication
Water quality
Over grassing
Food resources
Hunting
Floods

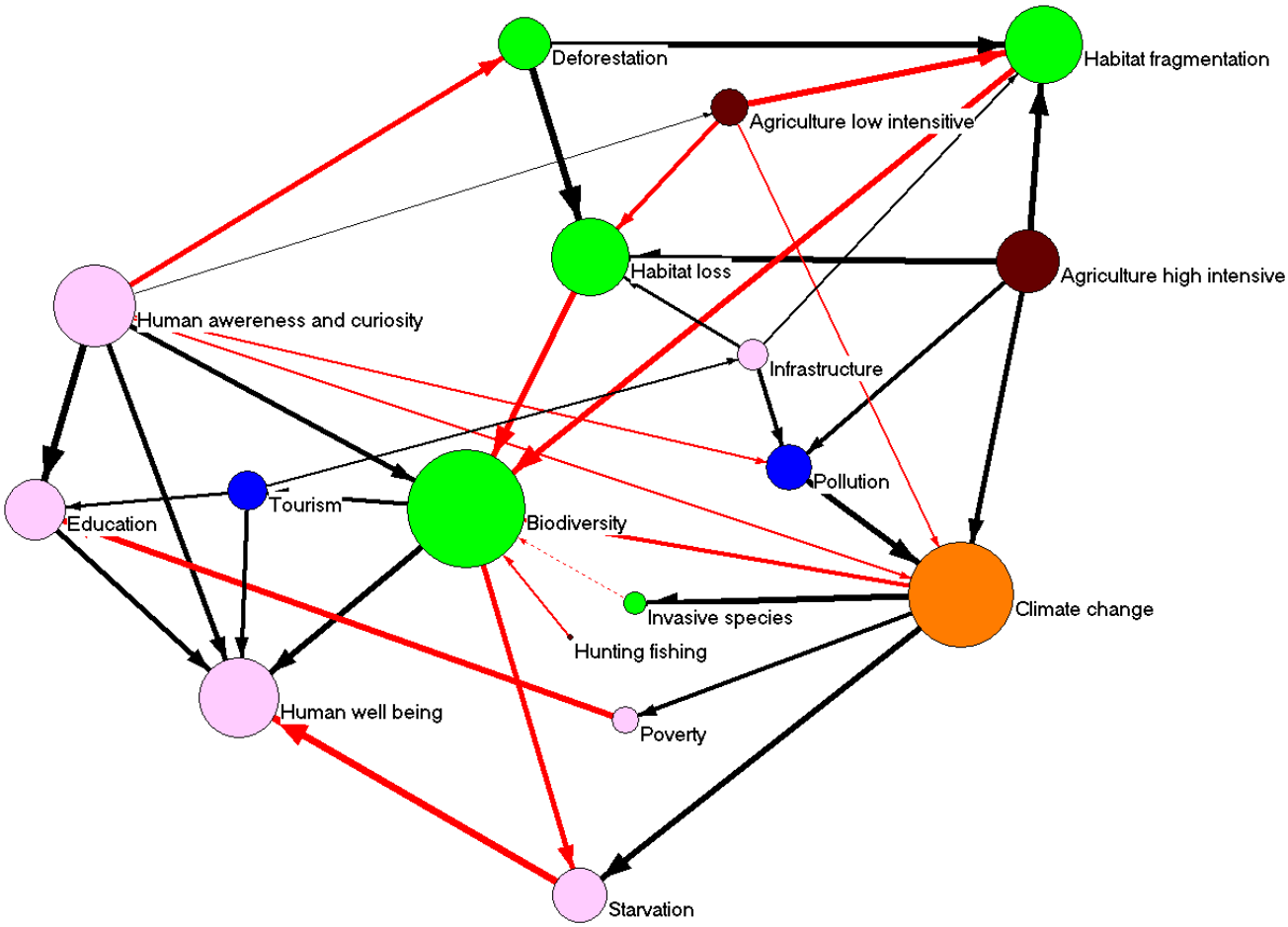

Indegree
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Well being
Benefits of the area
Potential investor
Fish resources
Tourism plan
Water resources
Communication and information programs
Food resources
Water quality
Electrofishing
Eutrophication
Floods
Hunting
Number of tourists
Over grassing
SiBNP managment plan integration



Map 17

Na values on connections

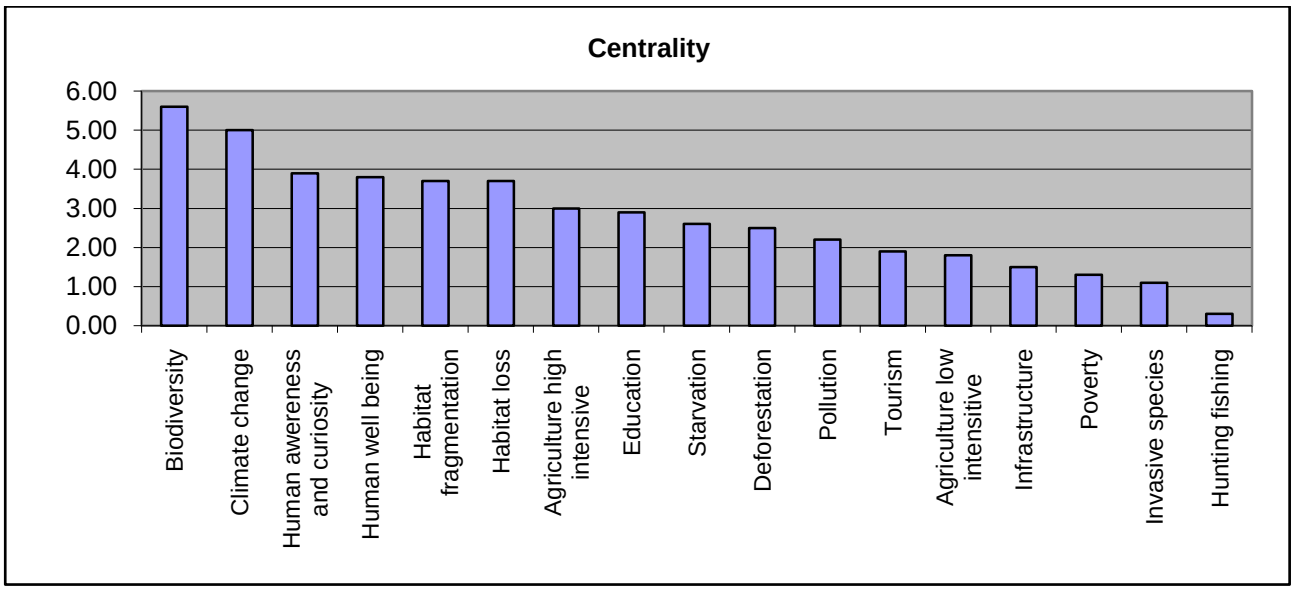
Map18

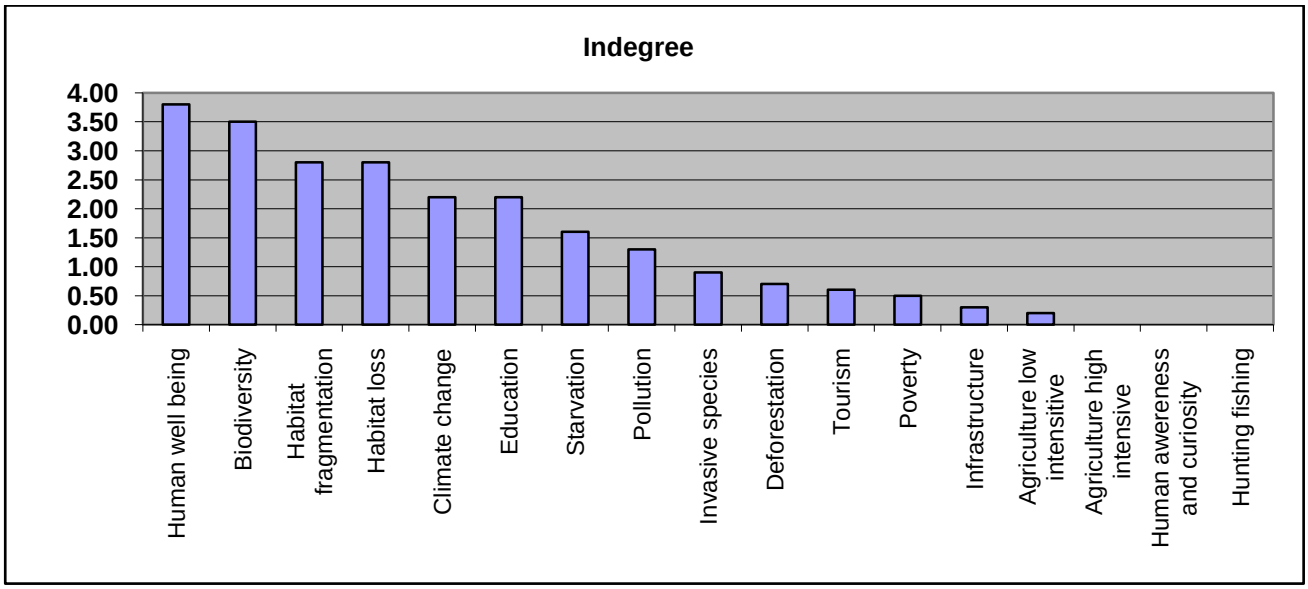


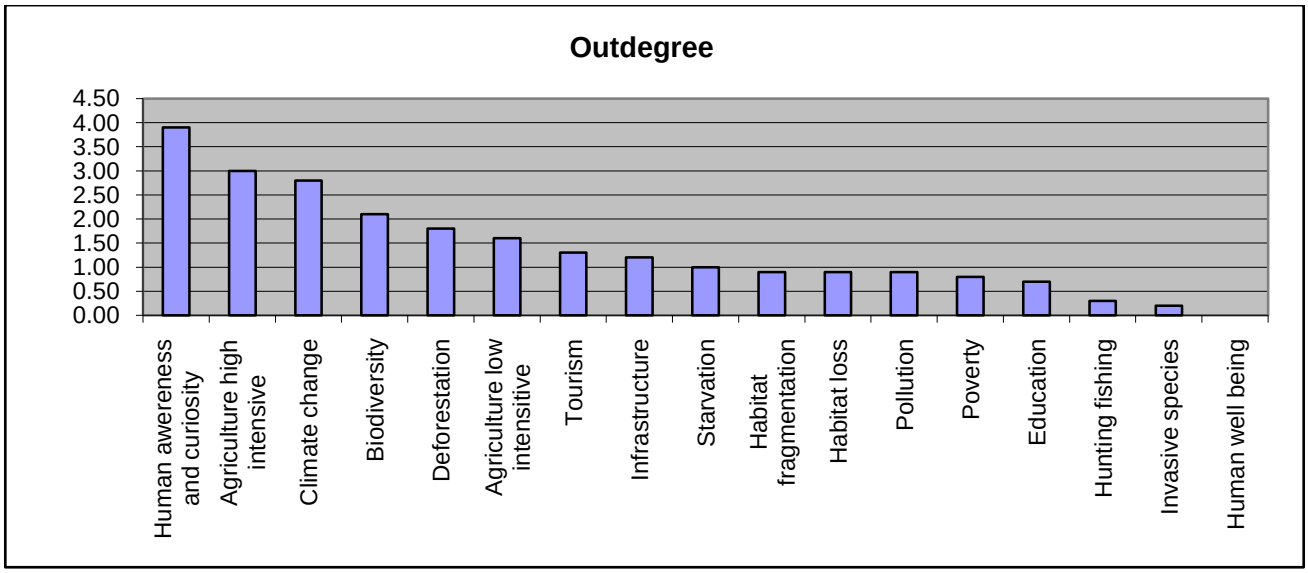
Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.13	17	37	0	0	37	0.33

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Agriculture high intensive	**1**			3.00	0.00	3.00
Agriculture low insensitive			**1**	1.80	0.20	1.60
Biodiversity			**1**	5.60	3.50	2.10
Climate change			**1**	5.00	2.20	2.80
Deforestation			**1**	2.50	0.70	1.80
Education			**1**	2.90	2.20	0.70
Habitat fragmentation			**1**	3.70	2.80	0.90
Habitat loss			**1**	3.70	2.80	0.90
Human awareness and curiosity	**1**			3.90	0.00	3.90

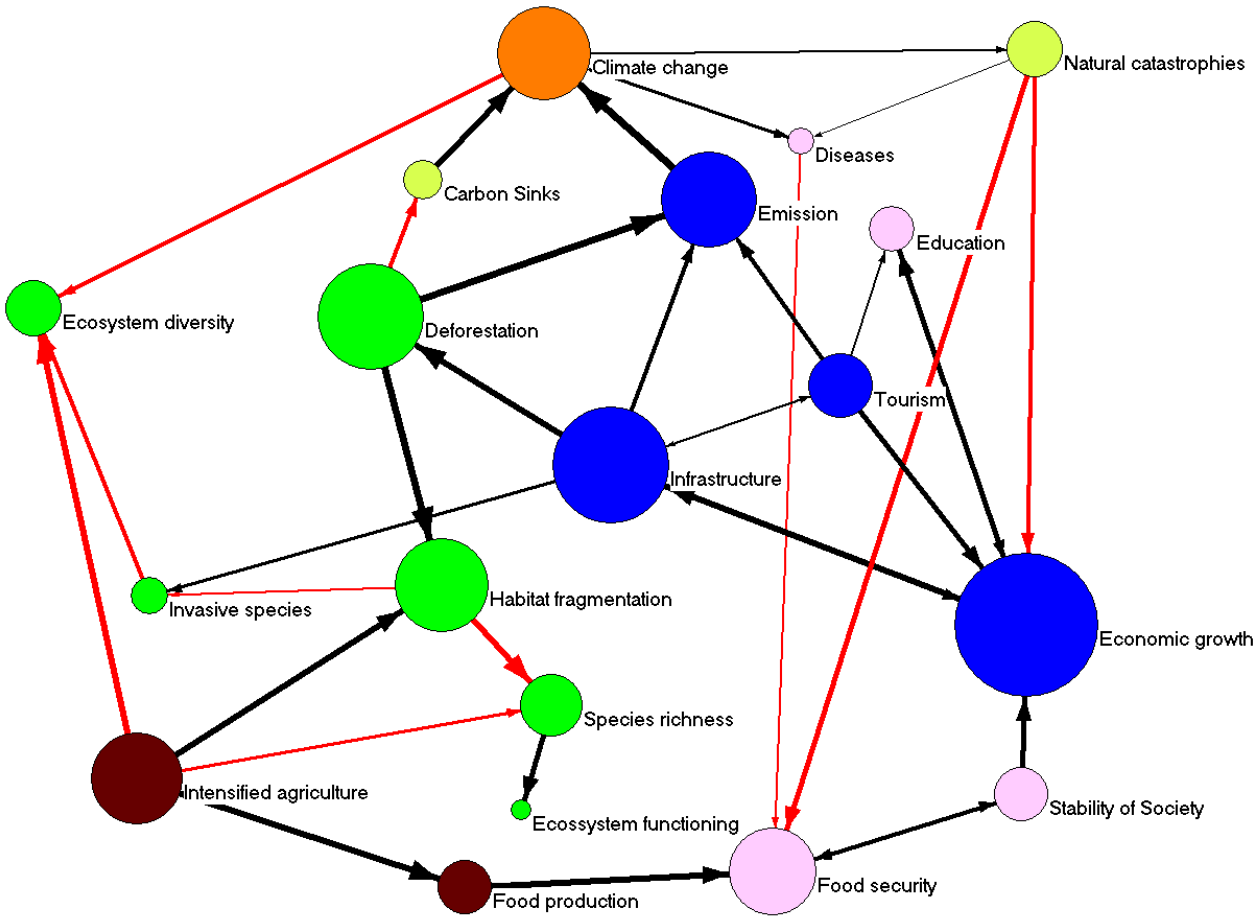
Human well being		**1**		3.80	3.80	0.00
Hunting fishing	**1**			0.30	0.00	0.30
Infrastructure			**1**	1.50	0.30	1.20
Invasive species			**1**	1.10	0.90	0.20
Pollution			**1**	2.20	1.30	0.90
Poverty			**1**	1.30	0.50	0.80
Starvation			**1**	2.60	1.60	1.00
Tourism			**1**	1.90	0.60	1.30
Sum	3	1	13			
%	17.65	5.88	76.47			





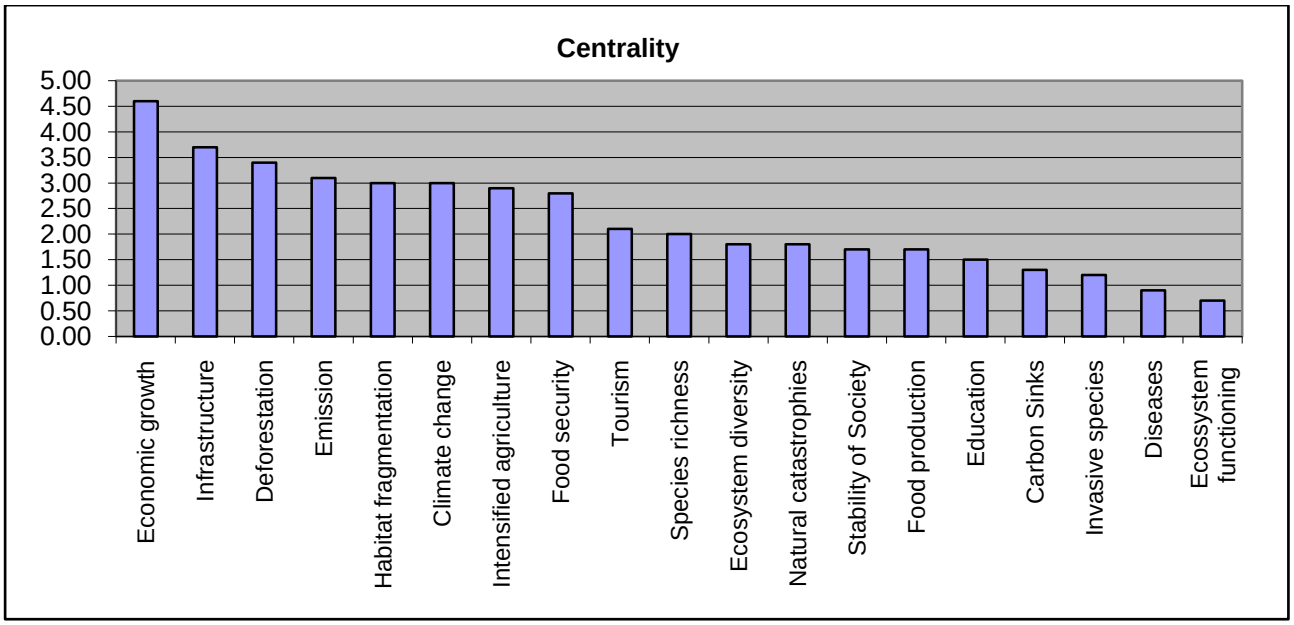

Outdegree
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Human awereness and curiosity
Agriculture high intensive
Climate change
Biodiversity
Deforestation
Agriculture low intensitive
Tourism
Infrastructure
Starvation
Habitat fragmentation
Habitat loss
Pollution
Poverty
Education
Hunting fishing
Invasive species
Human well being

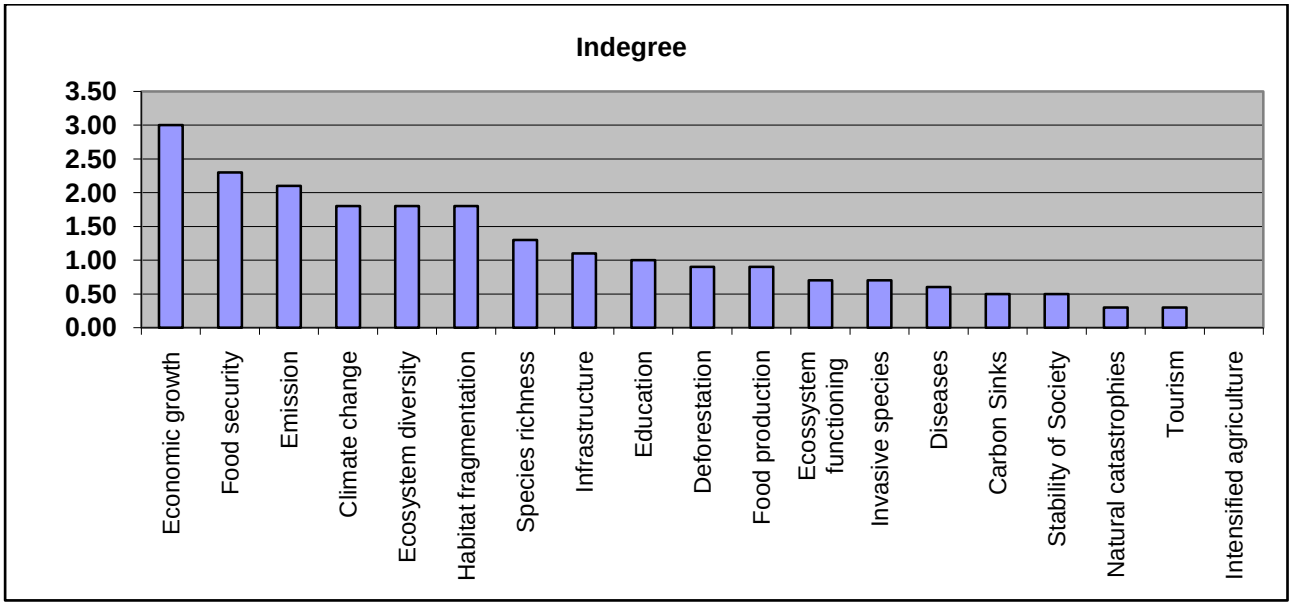
Map 19

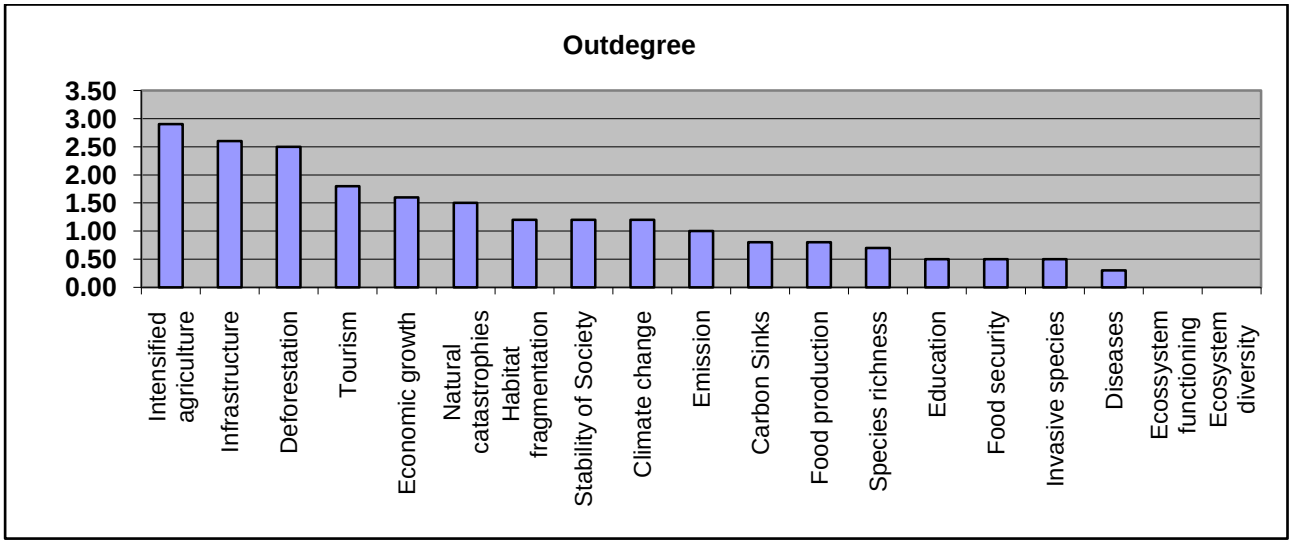

Climate change
Natural catastrophies
Diseases
Carbon Sinks
Emission
Education
Ecosystem diversity
Deforestation
Tourism
Infrastructure
Invasive species
Habitat fragmentation
Economic growth
Species richness
Intensified agriculture
Ecossystem functioning
Stability of Society
Food production
Food security

Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.1	19	36	0	0	36	2

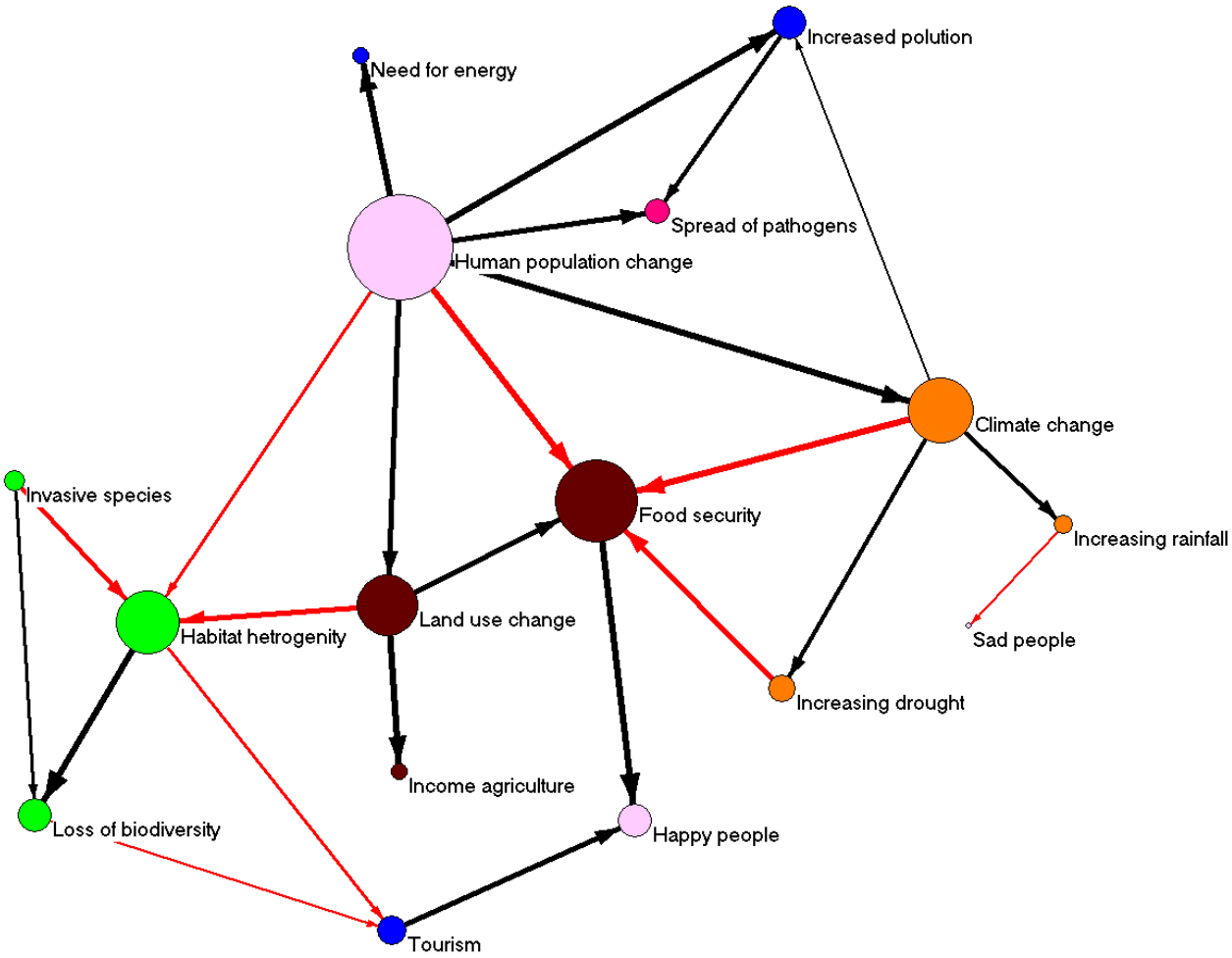
Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Carbon Sinks			**1**	1.30	0.50	0.80
Climate change			**1**	3.00	1.80	1.20
Deforestation			**1**	3.40	0.90	2.50
Diseases			**1**	0.90	0.60	0.30
Economic growth			**1**	4.60	3.00	1.60
Ecosystem functioning		**1**		0.70	0.70	0.00
Ecosystem diversity		**1**		1.80	1.80	0.00
Education			**1**	1.50	1.00	0.50
Emission			**1**	3.10	2.10	1.00
Food production			**1**	1.70	0.90	0.80
Food security			**1**	2.80	2.30	0.50
Habitat fragmentation			**1**	3.00	1.80	1.20
Infrastructure			**1**	3.70	1.10	2.60
Intensified agriculture	**1**			2.90	0.00	2.90
Invasive species			**1**	1.20	0.70	0.50
Natural catastrophes			**1**	1.80	0.30	1.50
Species richness			**1**	2.00	1.30	0.70
Stability of Society			**1**	1.70	0.50	1.20
Tourism			**1**	2.10	0.30	1.80
Sum	1	2	16			
%	3.15789E+11	10.53	84.21			


Centrality
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Economic growth
Infrastructure
Deforestation
Emission
Habitat fragmentation
Climate change
Intensified agriculture
Food security
Tourism
Species richness
Ecosystem diversity
Natural catastrophies
Stability of Society
Food production
Education
Carbon Sinks
Invasive species
Diseases
Ecossystem functioning


Indegree
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Economic growth
Food security
Emission
Climate change
Ecosystem diversity
Habitat fragmentation
Species richness
Infrastructure
Education
Deforestation
Food production
Ecossystem functioning
Invasive species
Diseases
Carbon Sinks
Stability of Society
Natural catastrophies
Tourism
Intensified agriculture


Outdegree
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Intensified agriculture
Infrastructure
Deforestation
Tourism
Economic growth
Natural catastrophies
Habitat fragmentation
Stability of Society
Climate change
Emission
Carbon Sinks
Food production
Species richness
Education
Food security
Invasive species
Diseases
Ecossystem functioning
Ecosystem diversity

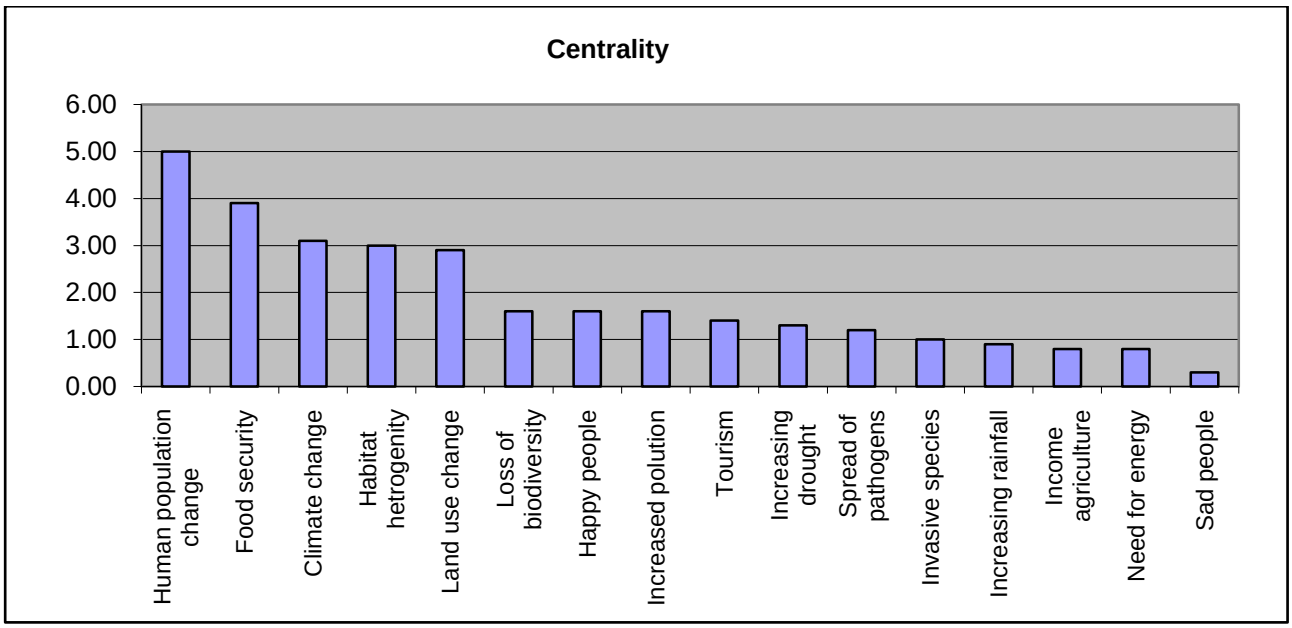
Map 20

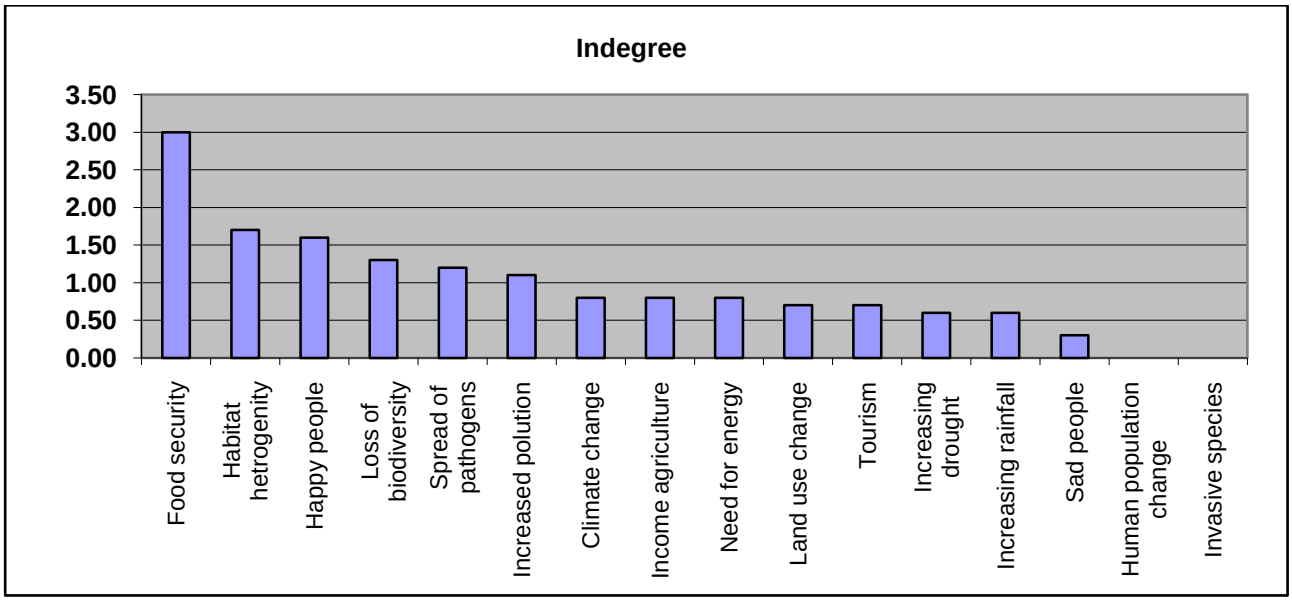


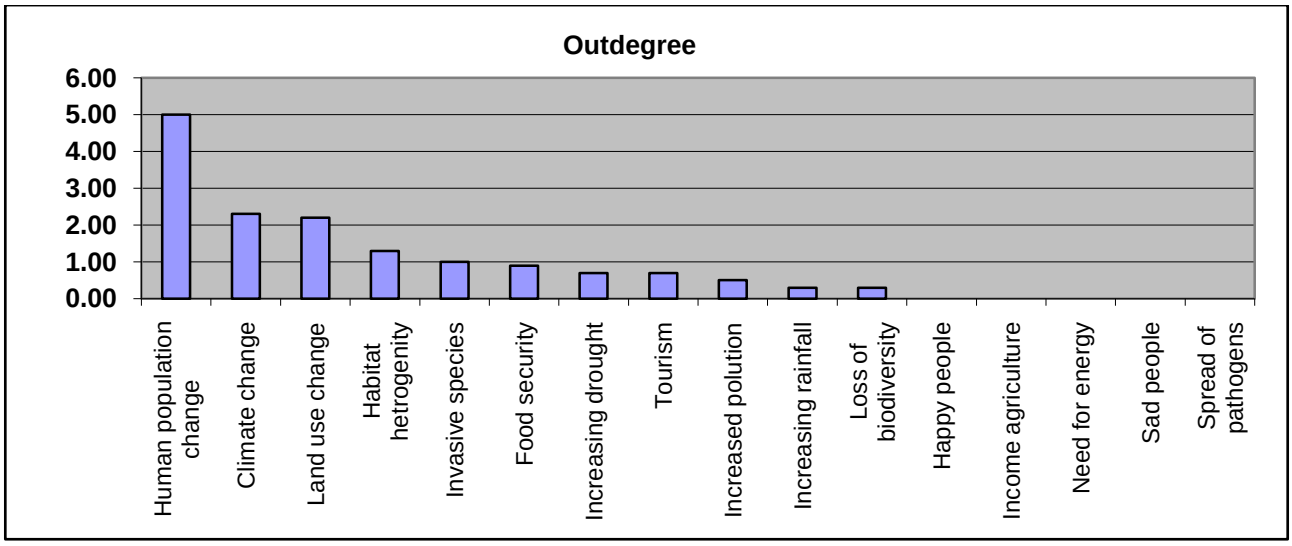
Density	Total Factors	Total. Connections	No Connection	Self Loops	Regular Connections	Complexity
0.09	16	24	0	0	24	2.5

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Climate change			1	3.10	0.80	2.30
Food security			1	3.90	3.00	0.90
Habitat heterogeneity			1	3.00	1.70	1.30
Happy people		1		1.60	1.60	0.00
Human population change	1			5.00	0.00	5.00
Income agriculture		1		0.80	0.80	0.00
Increased pollution			1	1.60	1.10	0.50
Increasing drought			1	1.30	0.60	0.70
Increasing rainfall			1	0.90	0.60	0.30
Invasive species	1			1.00	0.00	1.00
Land use change			1	2.90	0.70	2.20

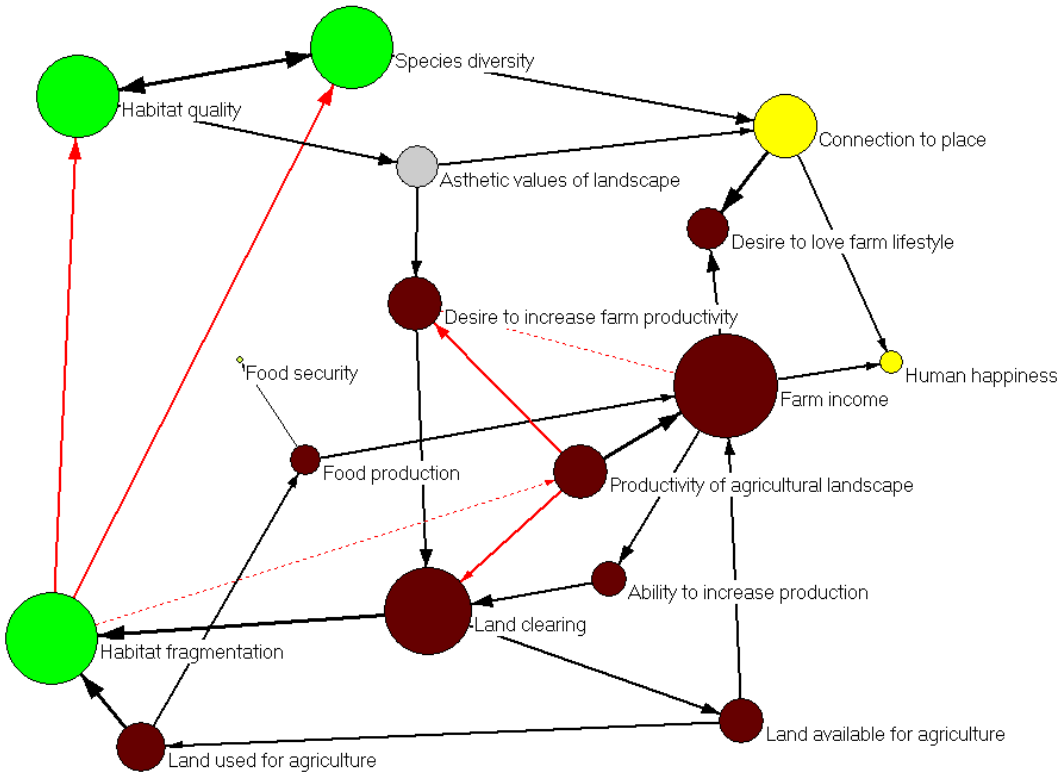
Loss of biodiversity			1	1.60	1.30	0.30
Need for energy		1		0.80	0.80	0.00
Sad people		1		0.30	0.30	0.00
Spread of pathogens		1		1.20	1.20	0.00
Tourism			1	1.40	0.70	0.70
Sum	2	5	9			
%	12.5	31.25	56.25			





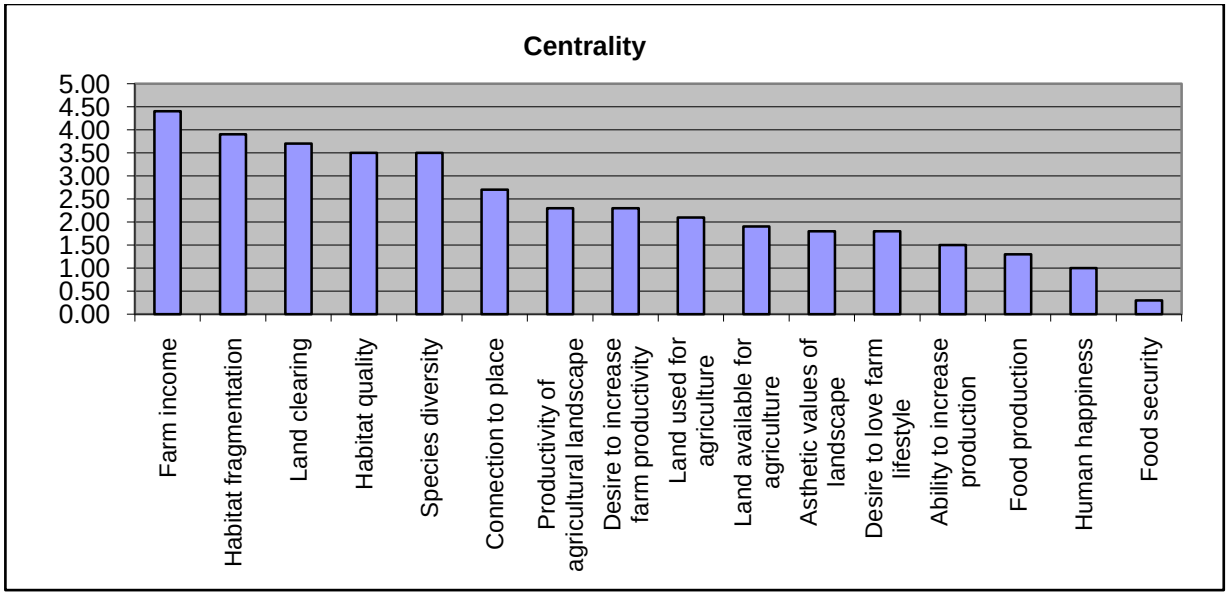


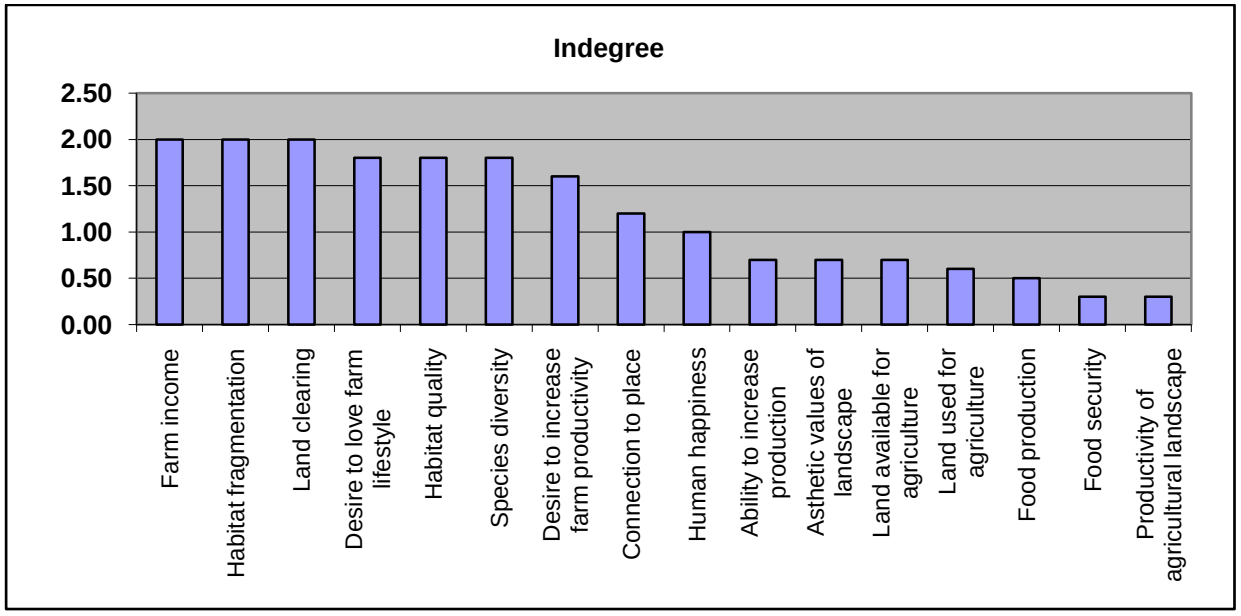
Map21

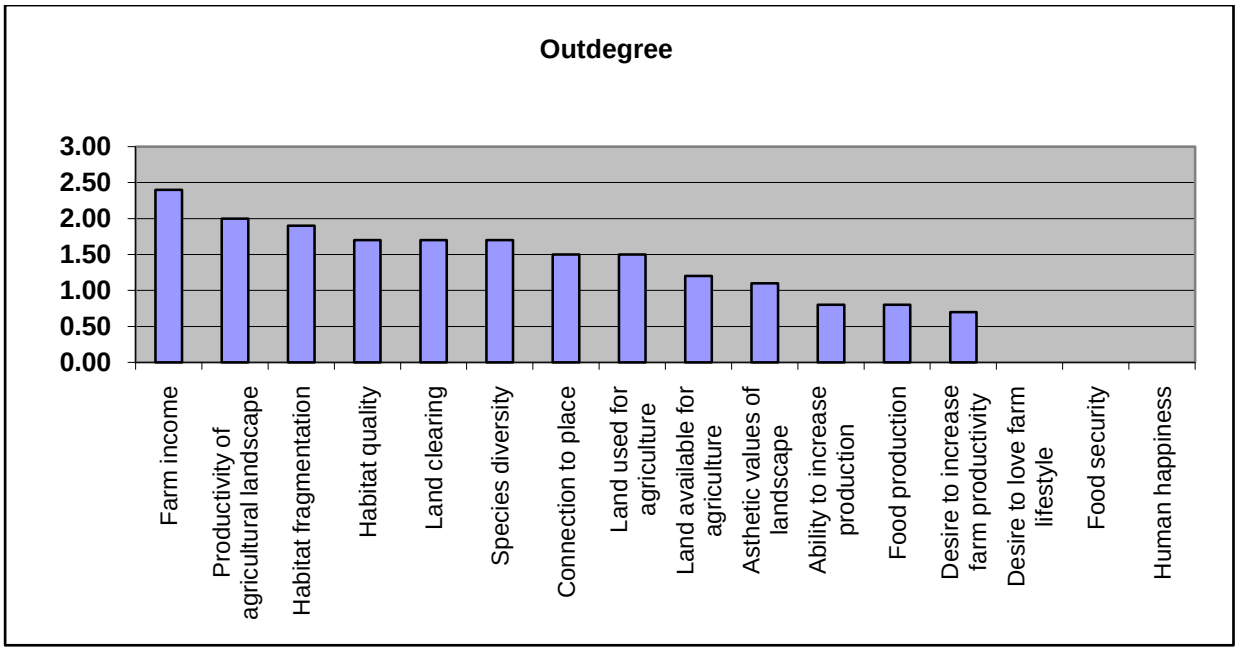


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.109375	16	28	0	0	28	-

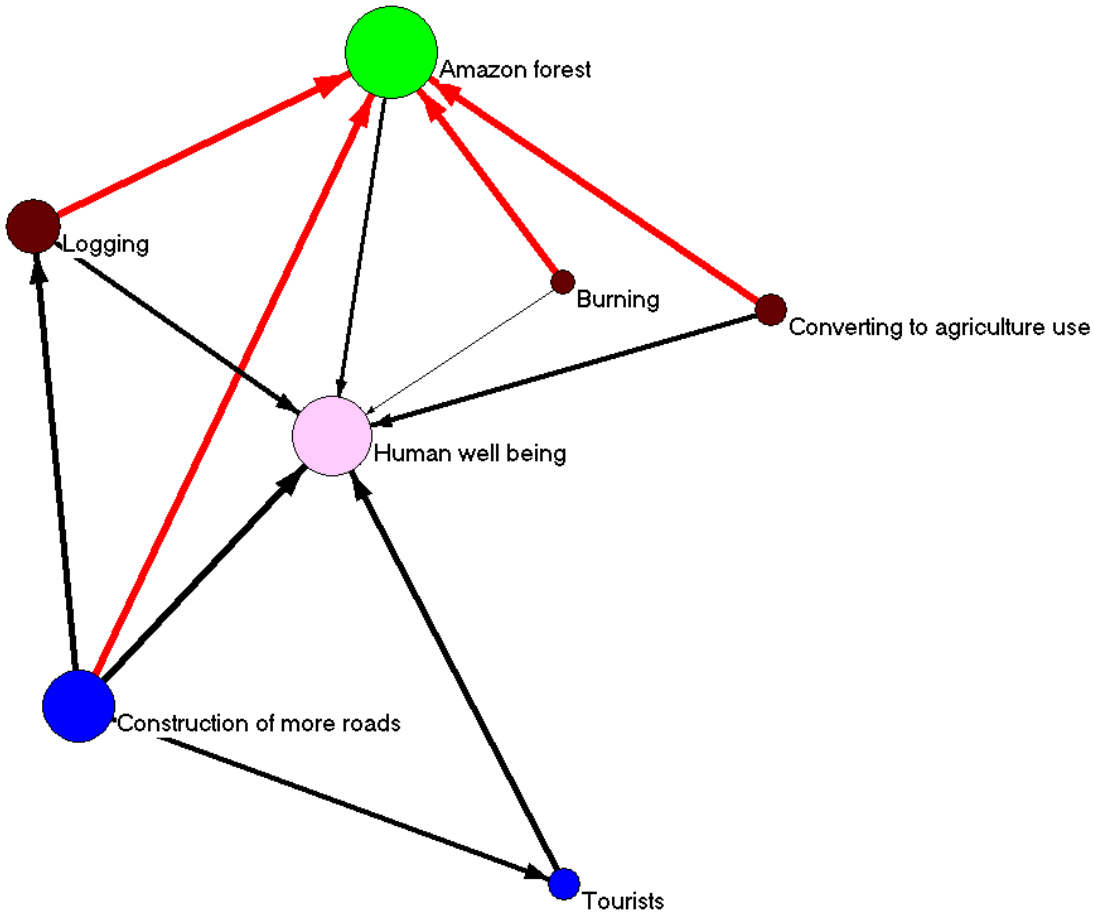
Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Ability to increase production			**1**	1.50	0.70	0.80
Aesthetic values of landscape			**1**	1.80	0.70	1.10
Connection to place			**1**	2.70	1.20	1.50
Desire to increase farm productivity			**1**	2.30	1.60	0.70
Desire to love farm lifestyle		**1**		1.80	1.80	0.00
Farm income			**1**	4.40	2.00	2.40
Food production			**1**	1.30	0.50	0.80
Food security		**1**		0.30	0.30	0.00
Habitat fragmentation			**1**	3.90	2.00	1.90
Habitat quality			**1**	3.50	1.80	1.70
Human happiness		**1**		1.00	1.00	0.00
Land available for agriculture			**1**	1.90	0.70	1.20
Land clearing			**1**	3.70	2.00	1.70
Land used for agriculture			**1**	2.10	0.60	1.50
Productivity of agricultural landscape			**1**	2.30	0.30	2.00
Species diversity			**1**	3.50	1.80	1.70
Sum	0	3	13			
%	0	18.75	81.25			


Centrality
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Farm income
Habitat fragmentation
Land clearing
Habitat quality
Species diversity
Connection to place
Productivity of agricultural landscape
Desire to increase farm productivity
Land used for agriculture
Land available for agriculture
Asthetic values of landscape
Desire to love farm lifestyle
Ability to increase production
Food production
Human happiness
Food security


Indegree
2.50
2.00
1.50
1.00
0.50
0.00
Farm income
Habitat fragmentation
Land clearing
Desire to love farm lifestyle
Habitat quality
Species diversity
Desire to increase farm productivity
Connection to place
Human happiness
Ability to increase production
Asthetic values of landscape
Land available for agriculture
Land used for agriculture
Food production
Food security
Productivity of agricultural landscape

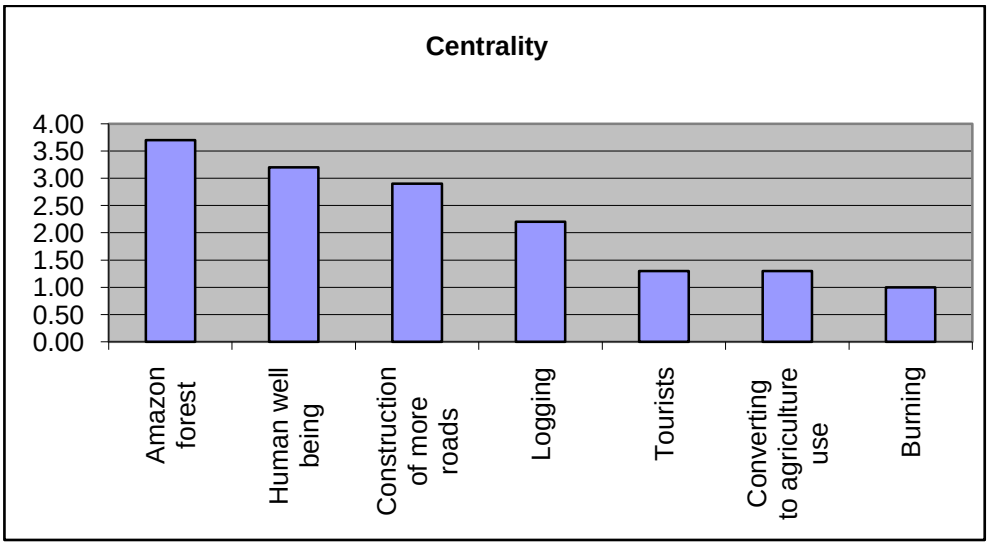

Outdegree
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Farm income
Productivity of agricultural landscape
Habitat fragmentation
Habitat quality
Land clearing
Species diversity
Connection to place
Land used for agriculture
Land available for agriculture
Asthetic values of landscape
Ability to increase production
Food production
Desire to increase farm productivity
Desire to love farm lifestyle
Food security
Human happiness

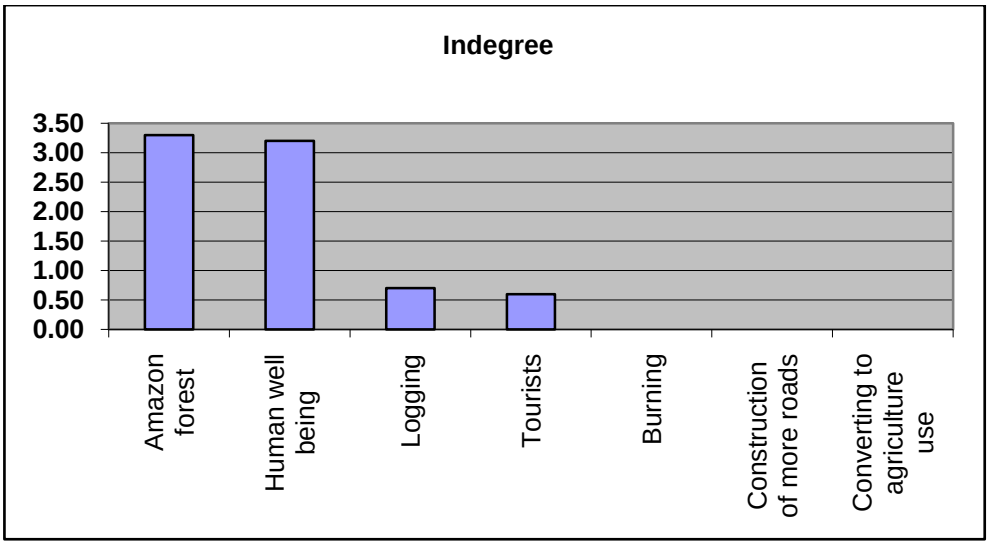
Map22

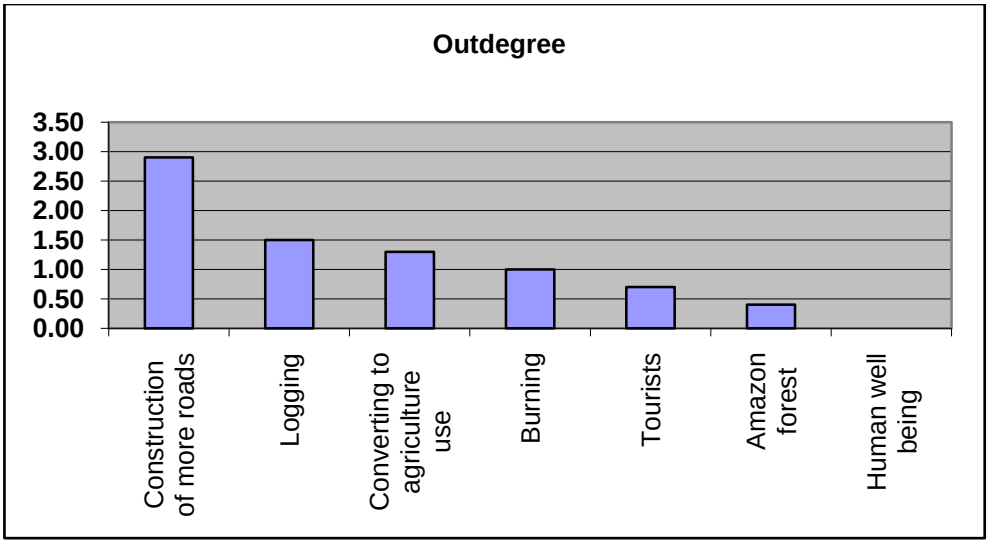

Amazon forest
Logging
Burning
Converting to agriculture use
Human well being
Construction of more roads
Tourists

Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.24	7	12	0	0	12	0.33

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Amazon forest			1	3.70	3.30	0.40
Burning	1			1.00	0.00	1.00
Construction of more roads	1			2.90	0.00	2.90
Converting to agriculture use	1			1.30	0.00	1.30
Human well being		1		3.20	3.20	0.00
Logging			1	2.20	0.70	1.50
Tourists			1	1.30	0.60	0.70
Sum	3	1	3			
%	42.86	14.29	42.86			



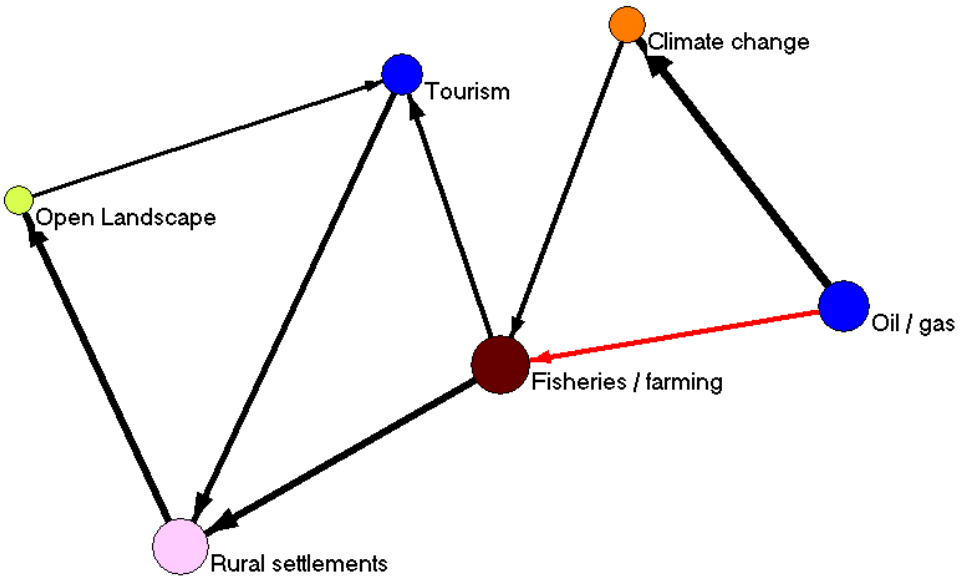




Map 23

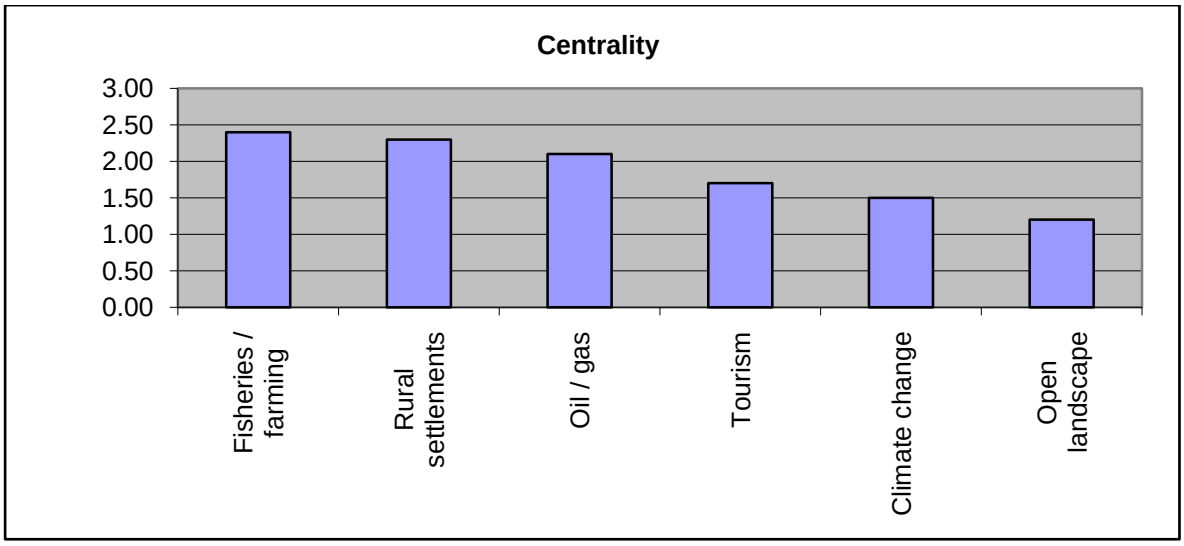
No values on connections…

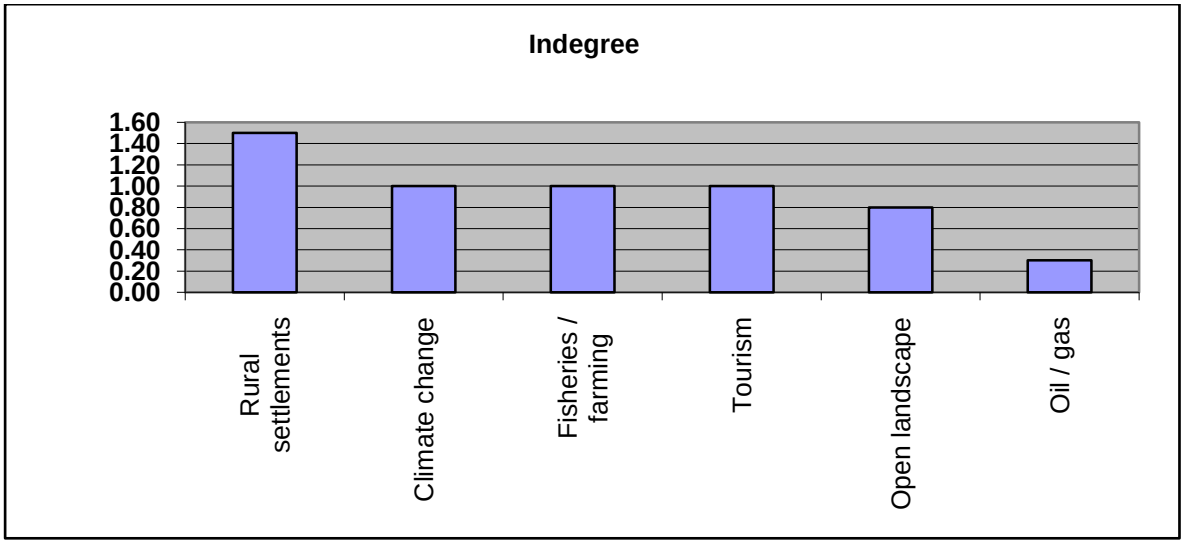
Map 24

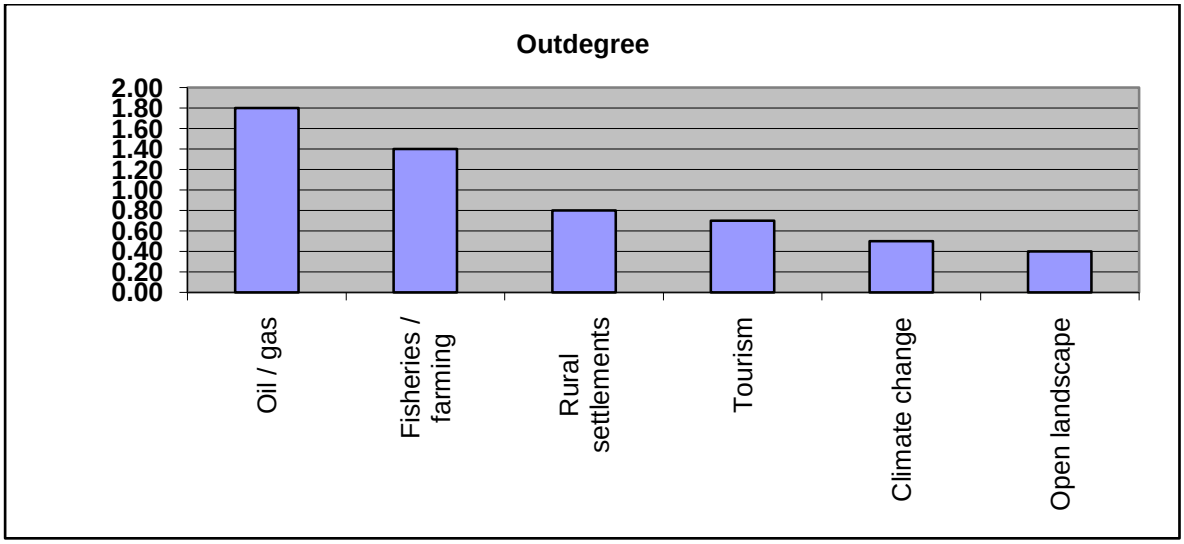


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.25	6	9	**0**	**1**	**8**	--

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Climate change			**1**	1.50	1.00	0.50
Fisheries / farming			**1**	2.40	1.00	1.40
Oil / gas			**1**	2.10	0.30	1.80
Open landscape			**1**	1.20	0.80	0.40
Rural settlements			**1**	2.30	1.50	0.80
Tourism			**1**	1.70	1.00	0.70
sum	0	0	6			
%	0	0	100			


Centrality
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Fisheries / farming
Rural settlements
Oil / gas
Tourism
Climate change
Open landscape

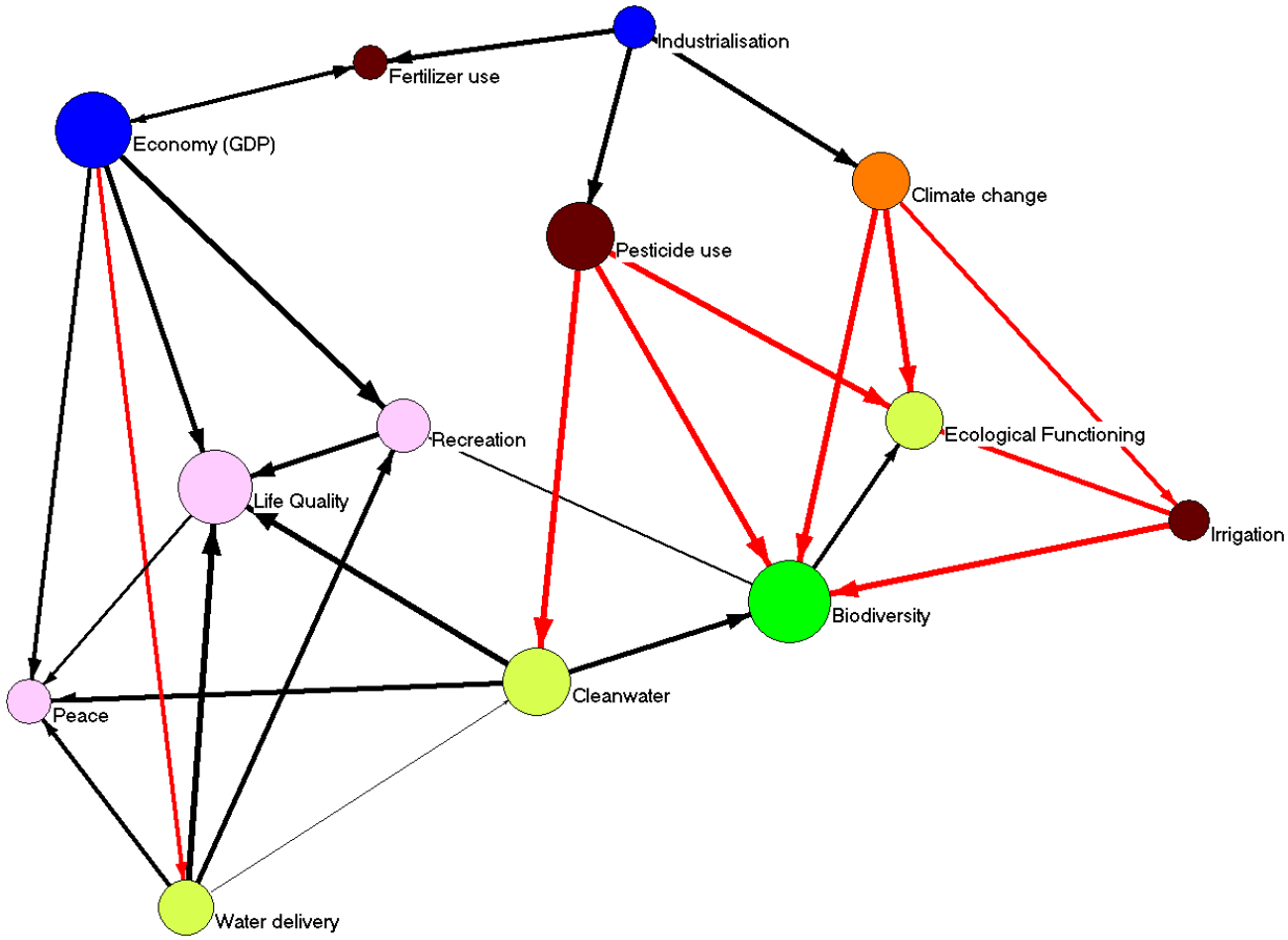

Indegree
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Rural settlements
Climate change
Fisheries / farming
Tourism
Open landscape
Oil / gas


Outdegree
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Oil / gas
Fisheries / farming
Rural settlements
Tourism
Climate change
Open landscape

Map 25

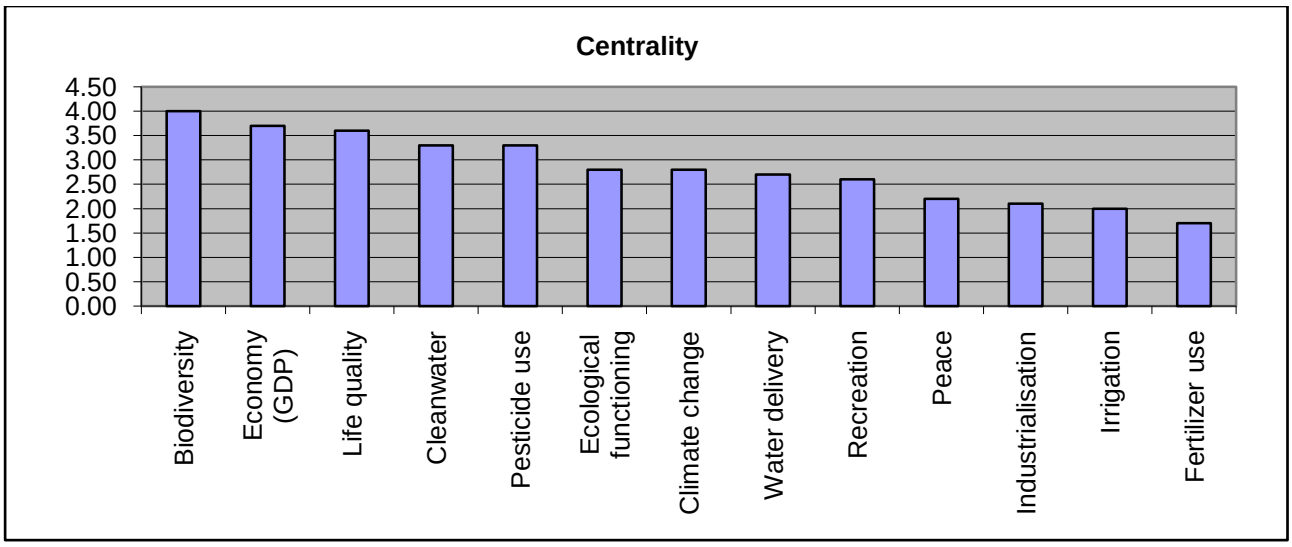
No values on connections…

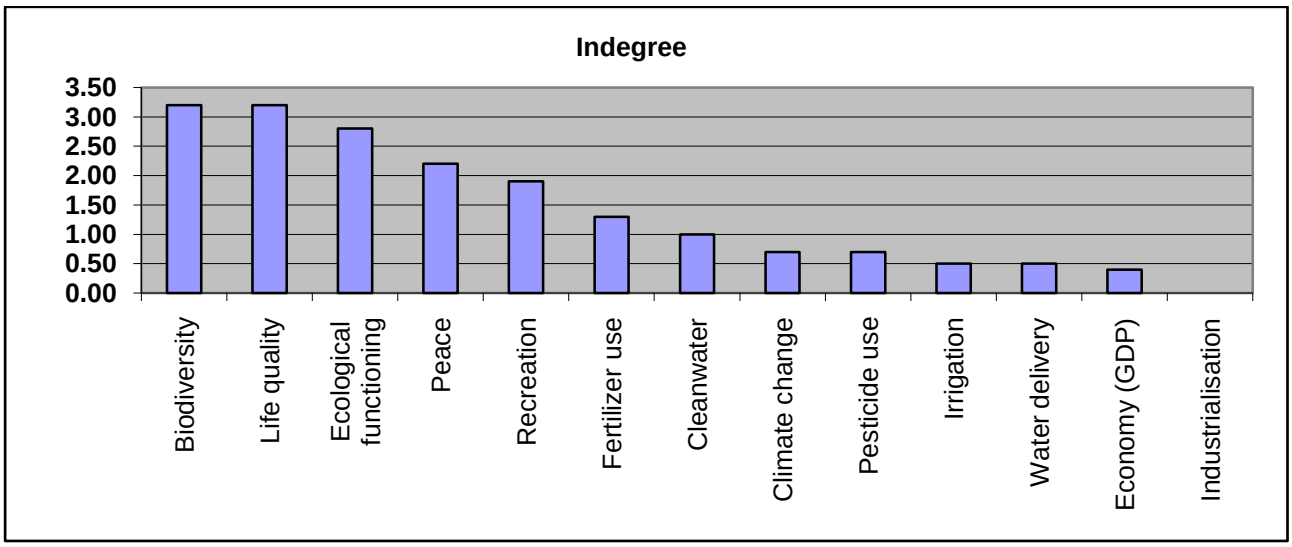
Map 26

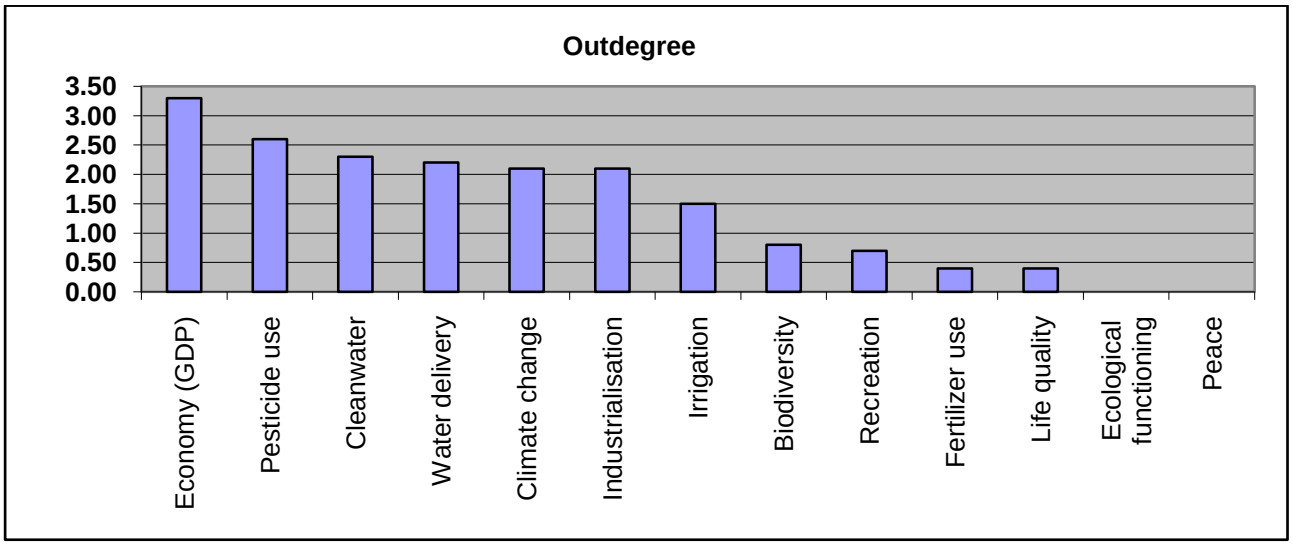


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.17	13	28	0	0	28	2

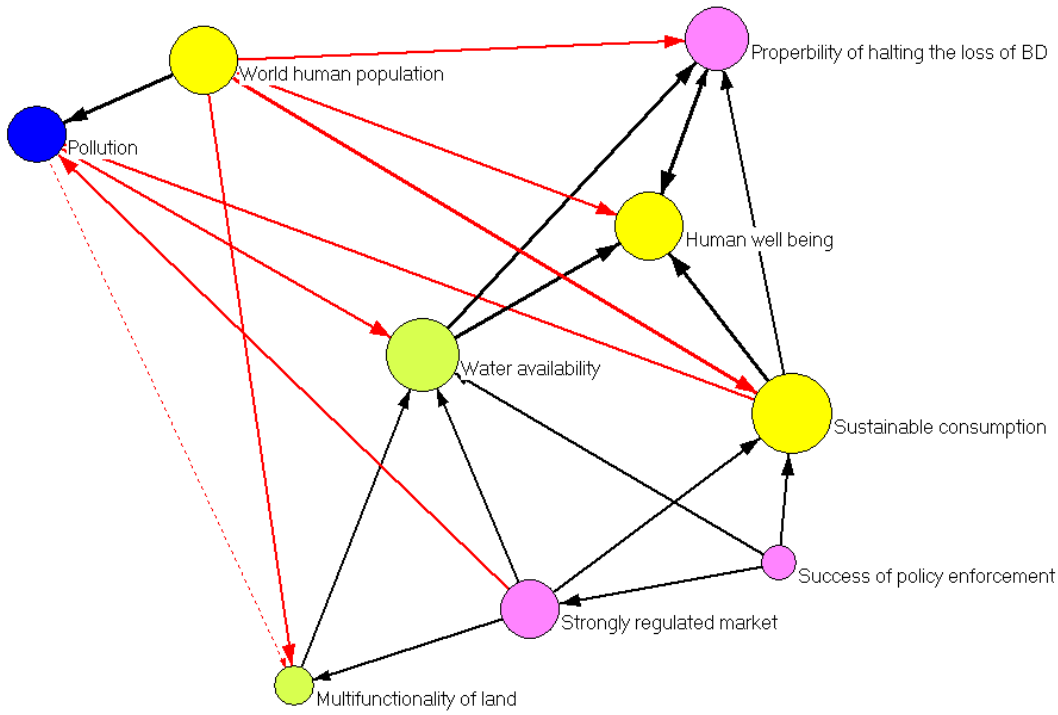
Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Biodiversity			**1**	4.00	3.20	0.80
Clean-water			**1**	3.30	1.00	2.30
Climate change			**1**	2.80	0.70	2.10
Ecological functioning		**1**		2.80	2.80	0.00
Economy (GDP)			**1**	3.70	0.40	3.30
Fertilizer use			**1**	1.70	1.30	0.40
Industrialization	**1**			2.10	0.00	2.10
Irrigation			**1**	2.00	0.50	1.50
Life Quality			**1**	3.60	3.20	0.40
Peace		**1**		2.20	2.20	0.00
Pesticide use			**1**	3.30	0.70	2.60
Recreation			**1**	2.60	1.90	0.70
Water delivery			**1**	2.70	0.50	2.20
Sum	1	2	10			
%	7.69	15.38	76.92			




Indegree
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Biodiversity
Life quality
Ecological functioning
Peace
Recreation
Fertilizer use
Cleanwater
Climate change
Pesticide use
Irrigation
Water delivery
Economy (GDP)
Industrialisation

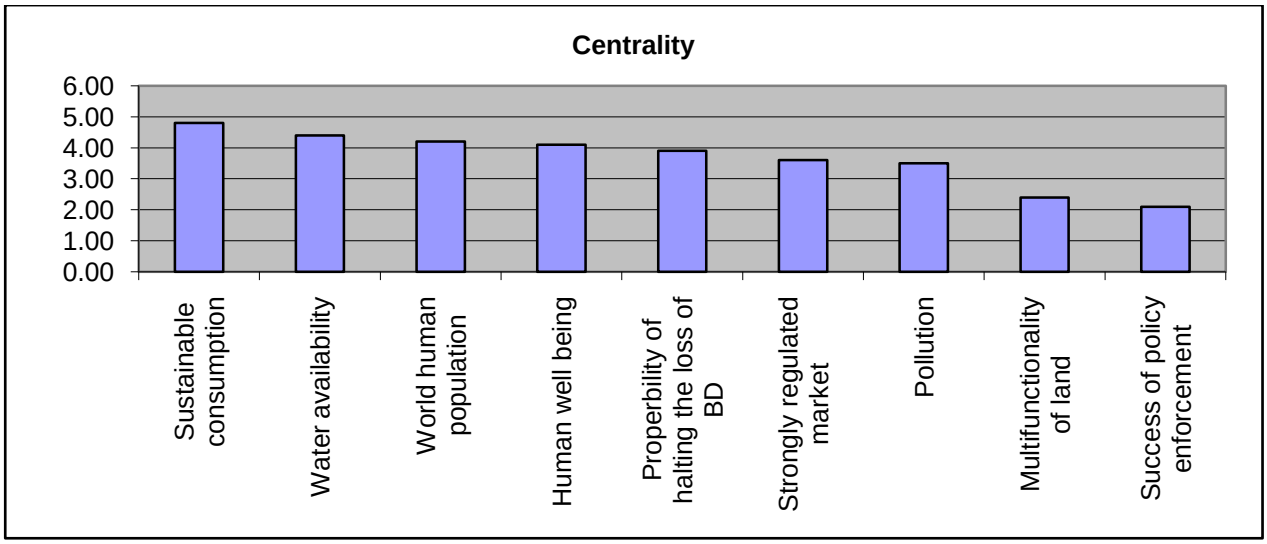

Outdegree
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Economy (GDP)
Pesticide use
Cleanwater
Water delivery
Climate change
Industrialisation
Irrigation
Biodiversity
Recreation
Fertilizer use
Life quality
Ecological functioning
Peace

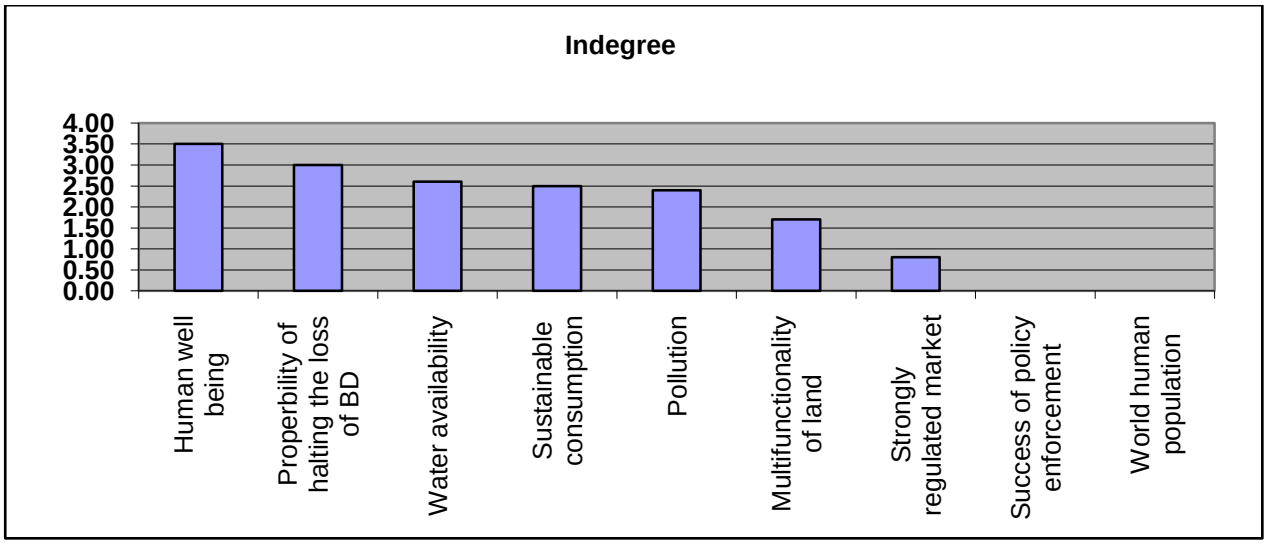
Map 27

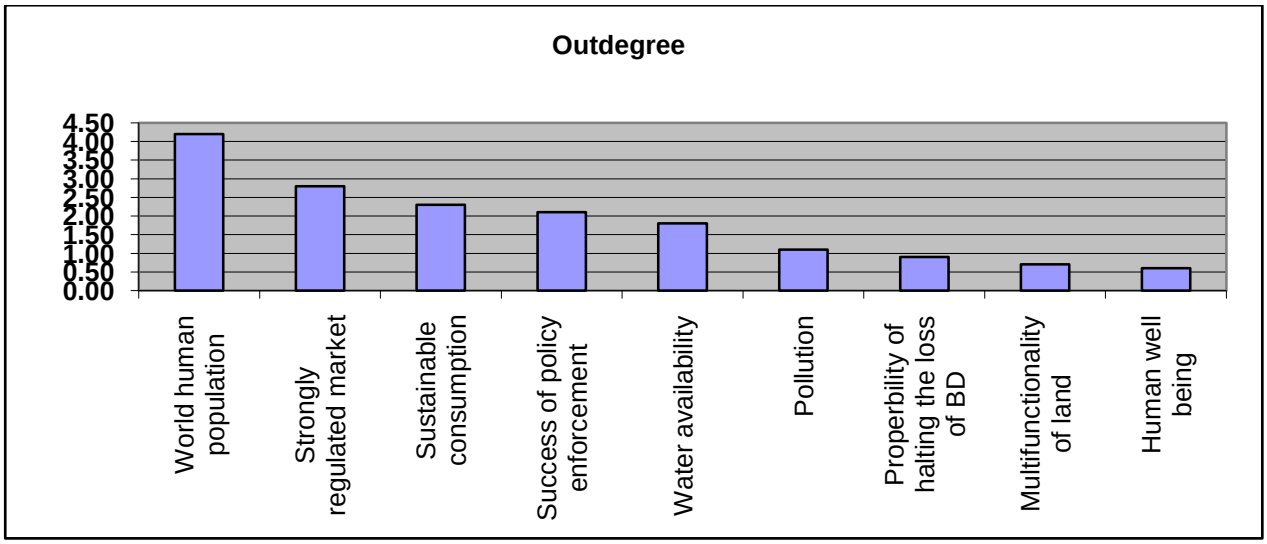


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.27	9	22	0	0	22	0

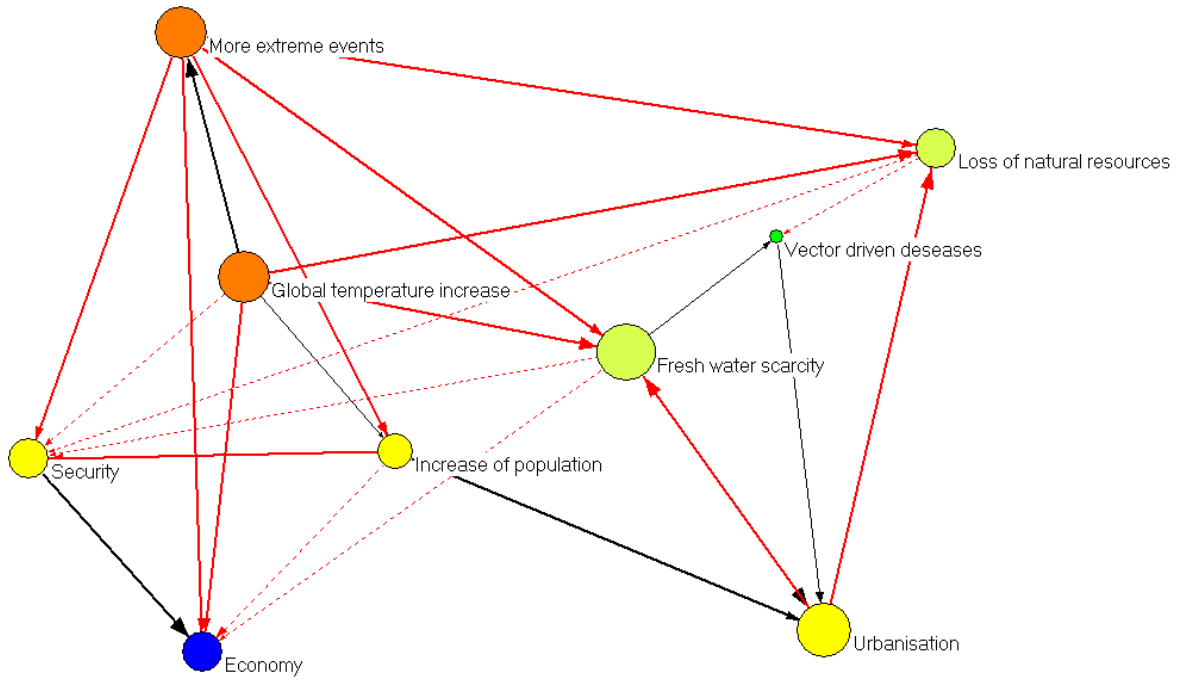
Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Human well being			**1**	4.10	3.50	0.60
Multifunctionality of land			**1**	2.40	1.70	0.70
Pollution			**1**	3.50	2.40	1.10
Probability of halting the loss of BD			**1**	3.90	3.00	0.90
Strongly regulated market			**1**	3.60	0.80	2.80
Success of policy enforcement	**1**			2.10	0.00	2.10
Sustainable consumption			**1**	4.80	2.50	2.30
Water availability			**1**	4.40	2.60	1.80
World human population	**1**			4.20	0.00	4.20
Sum	2	0	7			
%	22.22	0	77.78			


Centrality
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Sustainable consumption
Water availability
World human population
Human well being
Properbility of halting the loss of BD
Strongly regulated market
Pollution
Multifunctionality of land
Success of policy enforcement


Indegree
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Human well being
Properbility of halting the loss of BD
Water availability
Sustainable consumption
Pollution
Multifunctionality of land
Strongly regulated market
Success of policy enforcement
World human population

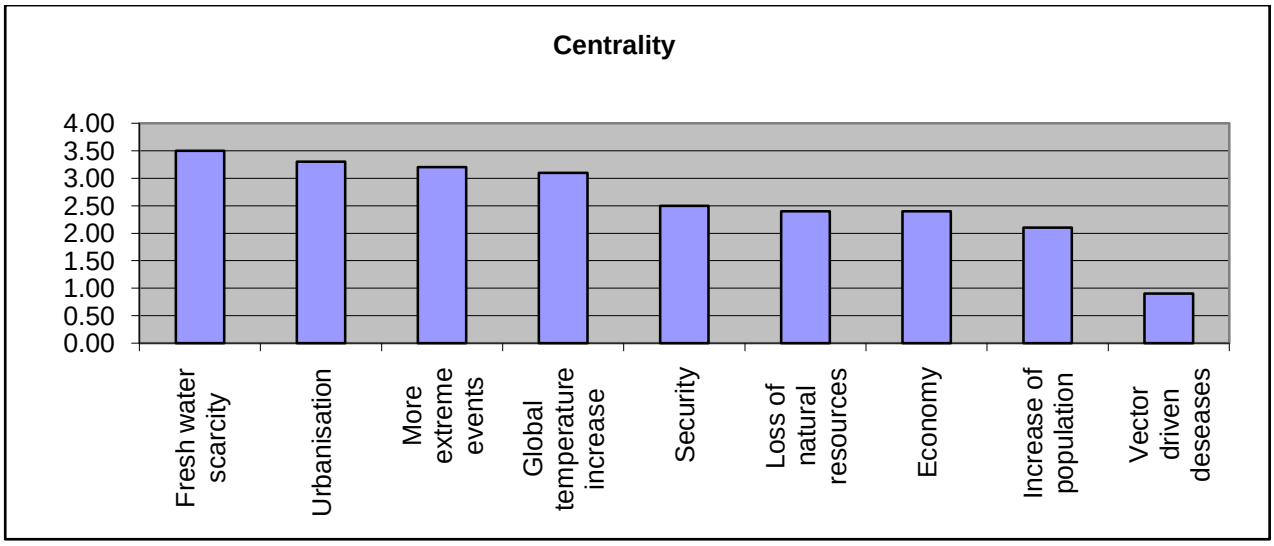

Outdegree
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
World human population
Strongly regulated market
Sustainable consumption
Success of policy enforcement
Water availability
Pollution
Properbility of halting the loss of BD
Multifunctionality of land
Human well being

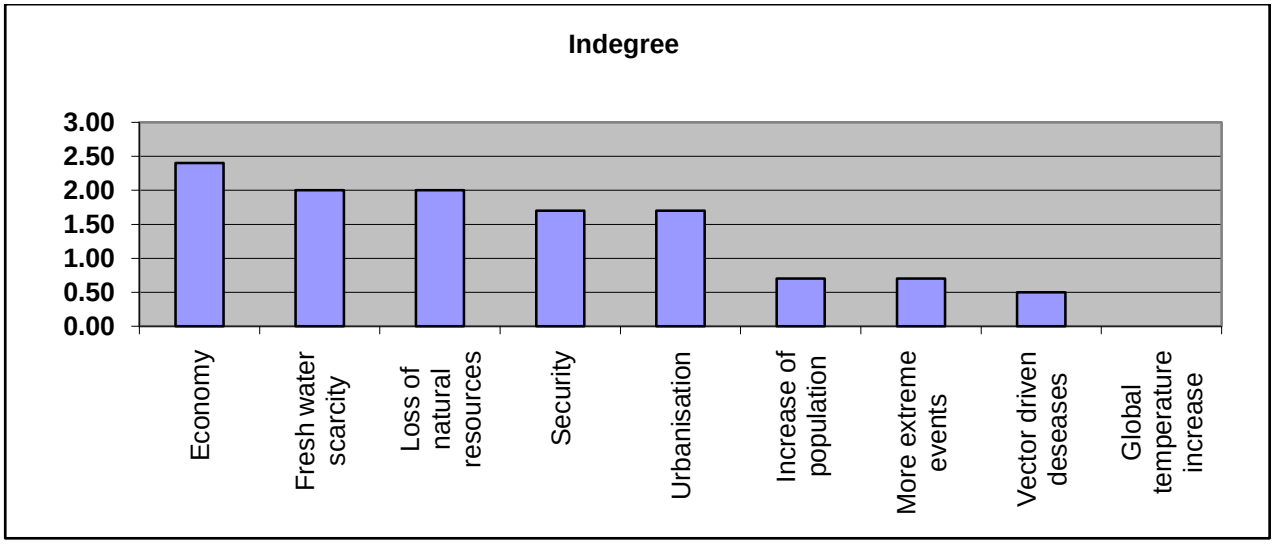
Map 28

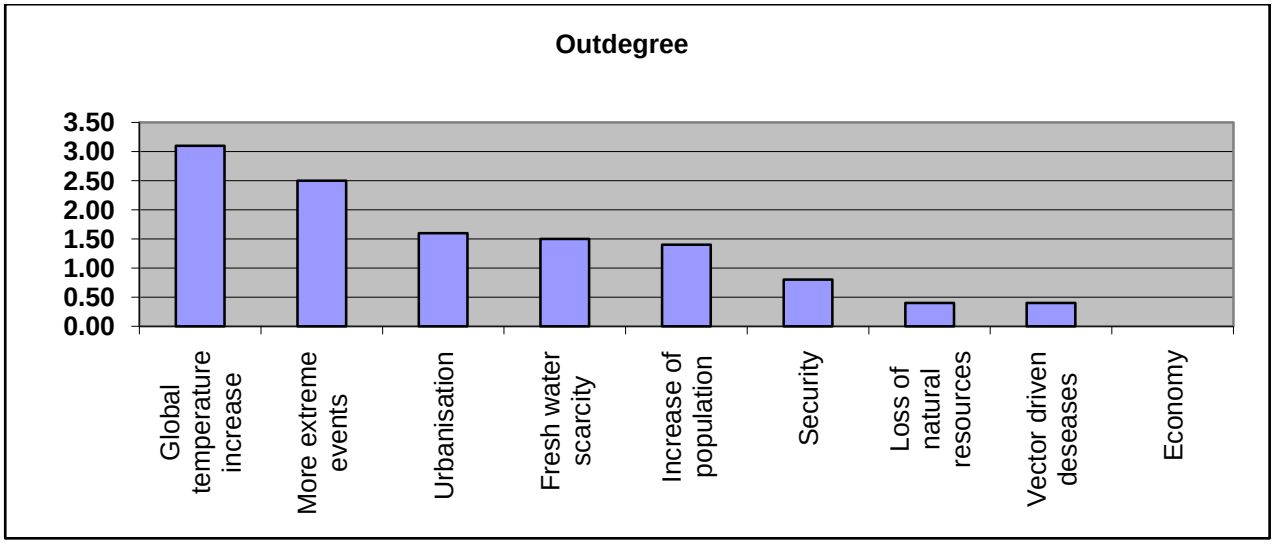


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.3	9	24	0	0	24	1

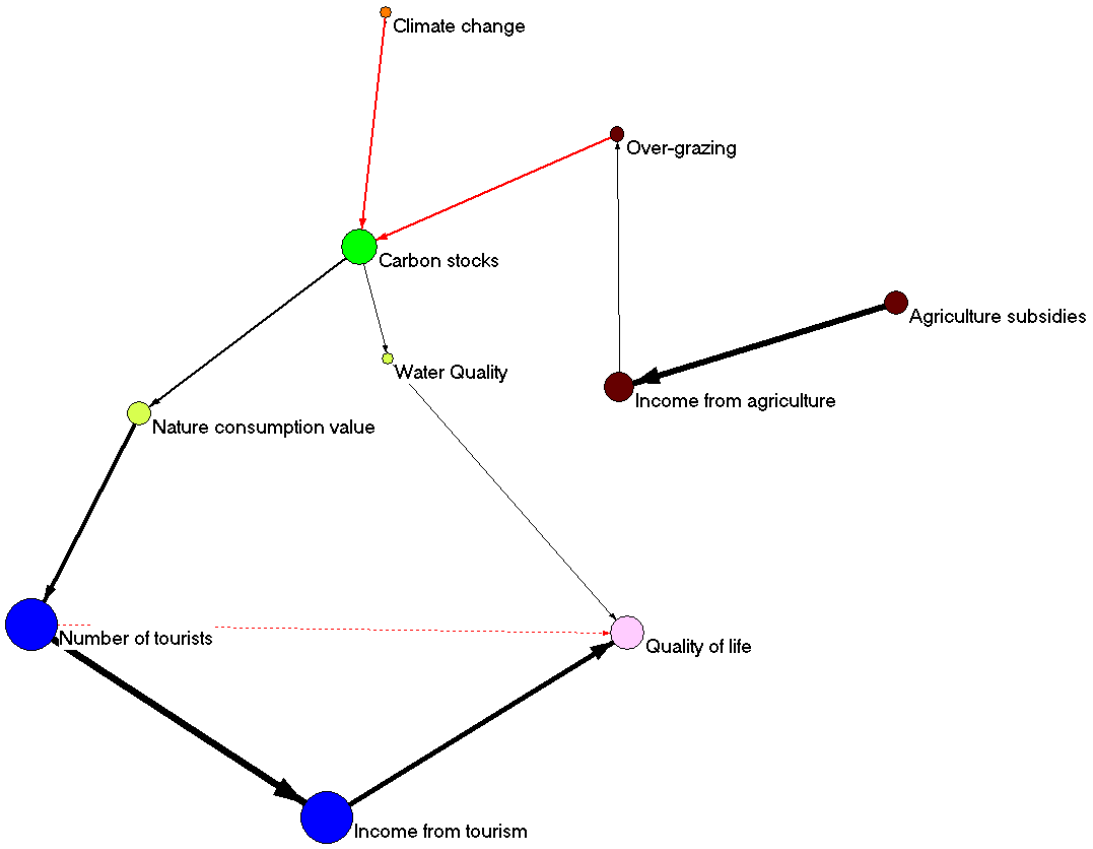
Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Economy		**1**		2.40	2.40	0.00
Fresh water scarcity			**1**	3.50	2.00	1.50
Global temperature increase	**1**			3.10	0.00	3.10
Increase of population			**1**	2.10	0.70	1.40
Loss of natural resources			**1**	2.40	2.00	0.40
More extreme events			**1**	3.20	0.70	2.50
Security			**1**	2.50	1.70	0.80
Urbanization			**1**	3.30	1.70	1.60
Vector driven diseases			**1**	0.90	0.50	0.40
sum	1	1	7			
%	11.11	11.11	77.78			


Centrality
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Fresh water scarcity
Urbanisation
More extreme events
Global temperature increase
Security
Loss of natural resources
Economy
Increase of population
Vector driven deseases


Indegree
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Economy
Fresh water scarcity
Loss of natural resources
Security
Urbanisation
Increase of population
More extreme events
Vector driven deseases
Global temperature increase

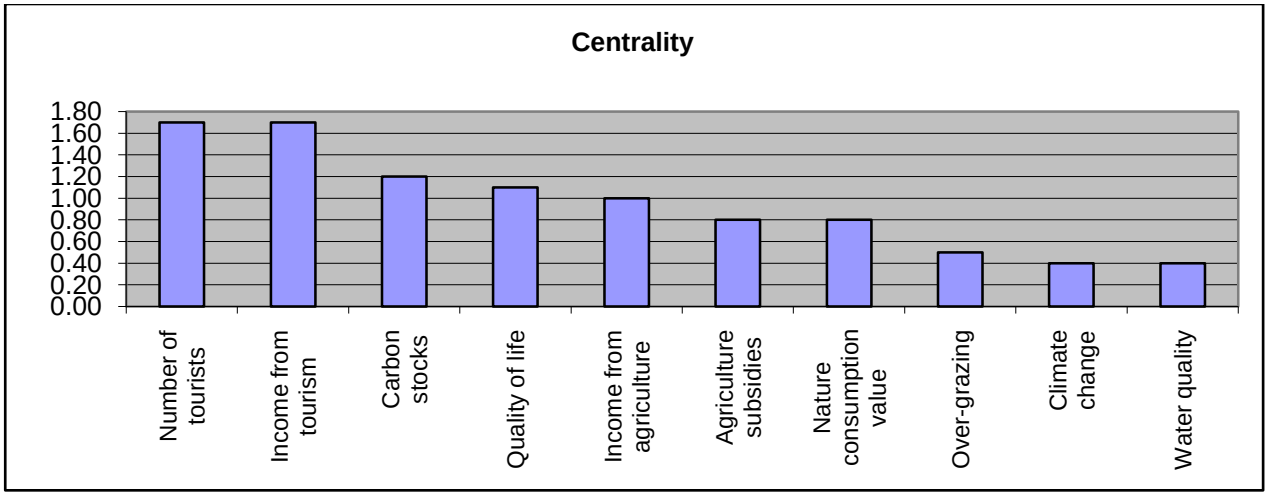

Outdegree
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Global temperature increase
More extreme events
Urbanisation
Fresh water scarcity
Increase of population
Security
Loss of natural resources
Vector driven deseases
Economy

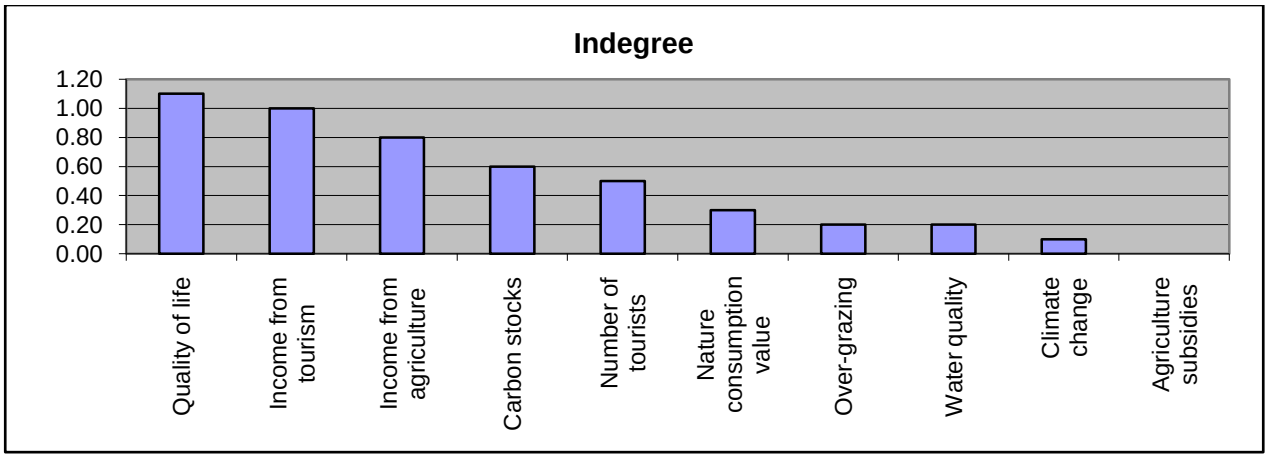
Map29

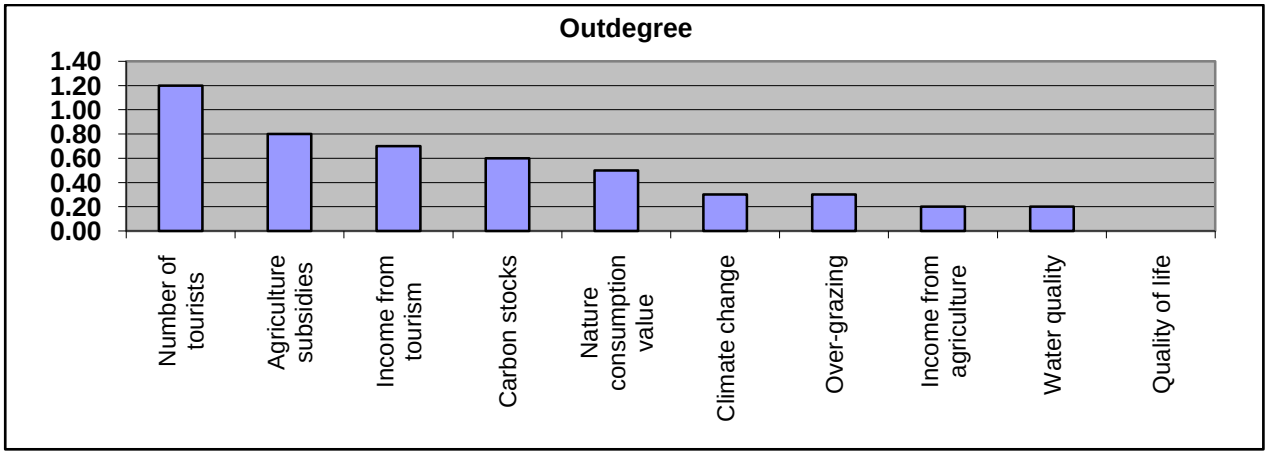


Density	Total Factors	Total Connections	No Connection	Self Loops	Regular Connections	Complexity
0.12	10	12	**0**	**0**	**12**	**1**

Concepts	Transmitter	Receiver	Ordinary	Centrality	Indegree	Outdegree
Agriculture subsidies	**1**			0.80	0.00	0.80
Carbon stocks			**1**	1.20	0.60	0.60
Climate change			**1**	0.40	0.10	0.30
Income from tourism			**1**	1.00	0.80	0.20
Income from agriculture			**1**	1.70	1.00	0.70
Nature consumption value			**1**	0.80	0.30	0.50
Number of tourists			**1**	1.70	0.50	1.20
Over-grazing			**1**	0.50	0.20	0.30
Quality of life		**1**		1.10	1.10	0.00
Water quality			**1**	0.40	0.20	0.20
Sum	1	1	8			
%	10	10	80			


Centrality
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Number of tourists
Income from tourism
Carbon stocks
Quality of life
Income from agriculture
Agriculture subsidies
Nature consumption value
Over-grazing
Climate change
Water quality


Indegree
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Quality of life
Income from tourism
Income from agriculture
Carbon stocks
Number of tourists
Nature consumption value
Over-grazing
Water quality
Climate change
Agriculture subsidies


Outdegree
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Number of tourists
Agriculture subsidies
Income from tourism
Carbon stocks
Nature consumption value
Climate change
Over-grazing
Income from agriculture
Water quality
Quality of life

Acknowledgment

I would like to thank all the students of the 2009 ALTER-Net Summer School for participating in the FCM exercise. Also all the speakers who gave inspiring talks, shared there thoughts or gave furious Scottish dance lessons.

And last but not least: Special thanks to Allan, Sabine and Wolfgang who made this great summer school possible!

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