Supporting decision-making for sustainable development: Social Network Analyses and Social Network Theory as a tool for policy advice

-- Work in progress --

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Abstract

As of late, scholars of diverse disciplines observe the growing importance of social networks for sustainable development processes. However, in the social sciences concepts of Social Network Analysis (SNA) have been frequently used metaphorically for another purpose (Hwang and Moon 2009, 7). At the same time, metaphorical uses of models can be harmful. "Relying on metaphors as the foundation for policy advice can lead to results substantially different from those presumed to be likely" (Ostrom 2010). This paper argues that empirical techniques of SNA can support evidence-based decision making and policy advice. On this note, results of a theoretically based empirical study are introduced that illustrate why and how SNA provides innovative tools to foster learning processes and synergy effects, bring together key resources and technological know-how and promote advancements and the diffusion of innovative ideas. Furthermore, it is argued that SNA helps to interpret existing networks and to identify innovation potentials in order to generate new information and to reveal new options for further developments.

Introduction

> "Many norms are learned from interactions with others in diverse communities about the behaviour that is expected in particular types of situations" (Ostrom 1998).

The globalized world is faced with an unavoidable transition. Political and educational systems around the world are confronted with considerable problems due to issues of growing social disparity, climate change, demographic change and other societal and ecological developments. The dominant idea of economic growth has lost support by the public and decision-makers due to severe problems originating from the logic of

uncontrolled systems themselves. Simultaneously, new societal visions, ideas, norms and concepts are developed and turned into real action by social networks or movements. However, while social networks play a decisive role in legitimizing and establishing innovative ideas, there is a considerable lack of theoretically based empirical research with respect to the chances and limits of social networks in processes of innovation as well as political and societal change. This paper addresses the research gap, searching for answers to the questions of how Social Networks Analysis (SNA) can support decision making in the area of sustainable development. On this note, results of an empirical study are presented which draws on quantitative and qualitative techniques of SNA in order to generate new ideas for development processes.

The contribution is divided into five sections. Subsequent to this introduction the paper discusses the chances of SNA to support changes and innovations as well as learning and decision making processes. Thirdly, the methodological orientation of an own study is pointed out. The fourth section looks at how social networks in the field of sustainable development can be analyzed and mapped. On this note, empirical findings of the study and graphical representations are depicted and discussed exemplarily. Fifthly, the article refers to how empirical results of SNA, graphical representations and network maps serve as tools for supporting decision making and policy advice.

Change and innovation through learning in social networks

While the influence of structural properties of governance networks on individual and collective learning processes in social sciences has been analyzed so far (Newig, Günther et al. 2010), there is still a lack of studies on the contribution of SNA for political and societal development processes (Kolleck 2012). At the same time, perspectives and results of SNA may provide us with useful insights with respect to processes of establishing and adapting

innovative concepts such as sustainable development. This is also because SNA helps us to uncover those elements of influence or general activity that have often been described as invisible in the scientific literature. Accordingly, this paper assumes that informal relations and actions that take place behind the scenes should not be ignored by looking only at visible effects and behaviour. While empirical studies on social change have often been concentrated on the analysis of official documents, speeches and interviews, this paper assumes that invisible relations are not irrelevant, but need to be revealed by applying such methods as SNA. However, what are the possibilities of SNA to analyze and promote innovation processes? Before discussing results of an own study, it makes sense to explain some assumptions, aims and benefits of applying SNA, based on basic concepts of Social Network Theories.

In general, it is assumed that social networks have the potential to overcome uncertainties that come along with change processes. The chances of innovations to get accepted increase significantly, if they are not only represented by singular individuals but by interconnected actors. Social networks foster learning processes and synergy effects, bring together key resources and technological know-how, and promote advancements and the diffusion of innovative ideas. With this in mind, methods of SNA help us to interpret existing networks and to identify innovation potentials. In many cases, the chances of SNA to promote social changes can be considered with regard to the following issues:

- *Identification of innovation networks (existing, missing, possible and realistic cooperation) and investigation of actors, structures and network boundaries:*

  By drawing back on methods of SNA, network structures are determined in previously defined fields. Thus, techniques of egocentric SNA provide us with necessary information with respect to the questions of who is member in the

network and where are the network boundaries. Furthermore, the relations revealed by SNA are interpreted and assessed. Structural properties detected in the context of the empirical project that will be presented in this paper are, for example, centrality, weak/strong ties and cliques.

- *Fostering learning processes*: In the past, several social scientists have already argued that the social context has a fundamental impact on learning (for example Lave and Wenger 1991). At the same time, the construct "social context" has often remained in the abstract, empirically incomprehensible. However, applications of SNA allow us to map and to describe social structures of learning processes. Data on individual properties (knowledge, trust, motivation) are combined with data on structural relations so that learning and development processes come to the fore.
- *Innovation potentials through network development strategies:* Watching one's own network structure from the outside in may not only cause learning processes and new strategies for capacity building. It can also become evident where and how innovations and alterations may be desirable and possible due to structural conditions. Furthermore, revealing network structure with SNA give answers to the questions of where and how cooperation within social networks can be optimized and where and how alterations are possible and reasonable. Presenting empirical results of SNA combined with insights of Social Network Theories within the communities can evoke structural changes.
- *Identification and solving of problems of coordination, information and motivation:* Analyses of social networks provide us with useful insights in streams of knowledge. By drawing back on SNA it is analyzed where streams of knowledge

exist and how "well" they function. Also, problems of coordination, information and motivation may become evident and provide us with knowledge related to development potentials.

- *Development of strategies with the aim to solve uncertainties that come along with processes of innovation:* Not least, the costs of information exchange are not only material (money, time), but also social. That is to say, uncertainties, a lack of confidence, and fear of a loss of reputation can bring about that information and knowledge are not shared. Results of SNA help us to identify weaknesses in knowledge transfer.

Analyzing Social Networks in the context of sustainable development

In order to better understand how techniques of SNA can support evidence-based (policy) advice, this paper introduces results of a theoretically based empirical study which has been carried out at the Freie Universität Berlin. The main aims of the study are to analyze and to foster the establishment of social networks and their impact on the quality development in the field of Education for Sustainable Development (ESD) (Kolleck, De Haan et al. 2011). The research design of the study combines quantitative and qualitative techniques of SNA with assumptions of Social Networks Theories and theoretical insights of governance perspectives. Five communities were selected which have already been awarded by the UN Decade ESD until the year 2010 (see German Commission for UNESCO 2009) to enable them to identify organizational development objectives. The decision was based on deep case studies about the sustainable performance of eleven communities. Further criteria for the selection were the variance of the cases with respect to size, total population, structure of the population, different distinguished projects, and the potential for further improvements of the ESD performance. All in all, the research design followed four steps

(see figure 1).

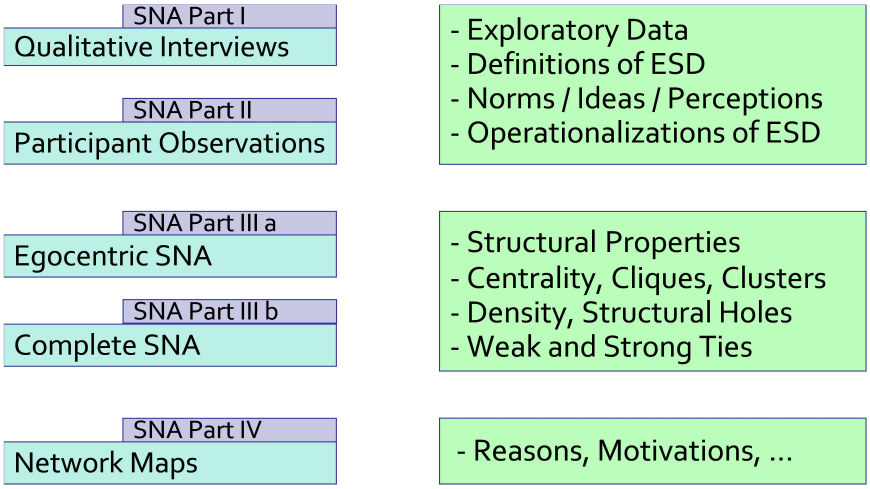

Figure 1: Research Design

Qualitative data (Part I and Part II) were conducted in order to elaborate hypotheses for quantitative studies (Part III). Quantitative results and networks visualizations (Part III) were complemented with concluding qualitative data, based on 25 network maps and expert interviews. In a first step, semi-standardized interviews with crucial actors in the communities were carried out with the aim to get deeper insights into the quality level of ESD within the projects and in order to detect weaknesses and structural deficiencies. All in all, 15 qualitative interviews with representatives of educational organizations, political institutions, civil society or private economy were conducted over a fixed period (November 2010–December 2010). Interviews lasted at least one hour. They were transcribed and analyzed using qualitative content analysis as it has been described by Mayring (2003).

Thirdly, quality circles were arranged in order to initiate demand-oriented quality development processes with respect to ESD within the model communities (see Kolleck, De Haan et al. 2011). Participant observations (Lamnek 1995; Schnegg and Lang 2002; Häder 2010; Lamnek and Krell 2010) were applied in order to identify different types of networks, network strategies, central network members and types of network relations (Hollstein and Straus 2006).

Fourthly, the insights achieved by carrying out these steps provided a valuable foundation for the development of hypotheses which were tested by implementing techniques of quantitative SNA (Part III). Thus, a precise overview of the structure of the networks has been achieved by carrying out quantitative egocentric SNA (adjusted sample N = 1306; with 8.816 mentions).[1] An online questionnaire was constructed which integrated name generators and name interpretators. Name generators included questions that aim to identify further relevant actors (alters) and to define the network boundaries. Interviewees were asked, for example, to name those actors with whom they commonly solved problems in the context of ESD and with whom they communicate most important information related to ESD. Name interpretators were included in the questionnaire to get more information about the characteristics of the persons within the networks and the relations between the actors involved (Wolf 2010). In this way, personal data of alters and information on the relations between ego and alters were gathered. Data that had been collected by egocentric SNA was aggregated in order to allow for calculations with complete SNA. Data Analyses were supported by the computer programmes UCINET and Pajek[2], applying such measures as density, weak and strong ties, brokerage and cliques. The graphical representations on this paper (see figures 2-6) were made using the procedure of

[1] In the strict sense, the collection of personal data and the determination of the network boundaries have not been exclusively egocentric. Rather, prior to the commencement of the empirical study, relevant persons were systematically gathered. As the research project cooperated with the national committee of the United Nations Decade Education for Sustainable Development (UN DESD), it had recourse to a large database which includes all contact details of projects, initiatives and communities that have been distinguished by the UN DESD so far (at the moment 14 communities and 1513 projects). In the context of the qualitative interviews, participant observations, kick-off events and quality circles that have been initiated and organized for this project, further contact details could be added to the list for the quantitative SNA. With the aim to optimize the questionnaire, 30 pre-tests were performed. "Mixed-mode" surveys were implemented for the data collection, since target groups are differently accessible and because not every network person did have an email address. The majority of the interviewed persons were contacted by email. In case that emails have not been responded, paper-to-pencil questionnaires were sent to the persons and persons were reminded by telephone. Subsequently to the first phase of data collection, the persons who have been mentioned in the questionnaire (alters), but who have not yet been included in the analysis were also approached with the questionnaire. Thus, alters were also asked to fill out the questionnaire.

[2] UCINET and Pajek belong to the most comprehensive programs with the largest number of different SNA routines(see for example Huisman and Van Duijn 2011).

"Spring Embedding"[3] by categorical attribute in NetDraw.

Finally, qualitative interviews and network maps (Part IV) were conducted within the communities in order to capture interpretations and perceptions, allow for deeper insights into qualitative characteristics of the network structures, and find out more about the reasons and motivations of relevant actors within the networks as such (see Emirbayer and Goodwin 1994; Hollstein and Straus 2006).

Anyhow, the collection of data for SNA is also confronted with limits. Egocentric SNA implies that interviewed persons are willing to introduce the researcher to their network. Furthermore, interviewed persons can decide whom to nominate for further interviews. "Formal SNA is not immune to these challenges, as an ego may choose not to reveal all of their alters, or may inadvertently overlook certain network members. This is identified as a problem of informant bias in the SNA literature, and it is often concluded that missing alters are those with weak ties to the ego" (Heath, Fuller et al. 2009). Thus, the network structures and their boundaries analyzed by implementing SNA are always influenced by the willingness of the interviewed individuals and are always faced with problems of gaps and silences.

The Shape of Sustainability: Visualizing Networks

This section aims at discussing some results of the research project, summarizing quantitative and qualitative data and presenting selected findings and visualizations. Results of the study show, for example, that the concept of Education for Sustainable Development (ESD) is mainly realized in regional clusters that consist of strong ties. At the

[3] According to the procedure of spring embedding, nodes are connected with springs that are attracted and repelled in the plane until equilibrium is reached.

same time, there are a high number of weak ties which demonstrate that a wide diffusion of the normative idea takes place. Based on Social Network Theories it can be assumed that strong ties are very important for the positive adaption of new norms and ideas as well as trust building processes, while weak ties are responsible for the diffusion of innovations (see Granovetter 1973).

Surprisingly, the network members in each region are hardly connected with each other. Just a few actors possess the function as a broker, building a bridge between two networks (see figure 2). Thus, the whole, trans-regional network is characterized by high closeness and structural holes. Figure 2 depicts the whole ESD network of the model communities of this project, namely Alheim, Erfurt, Minden, Frankfurt/Main and Gelsenkirchen. The nodes represent all individuals that have filled out the questionnaire or that have been named by egos. The graphs are directed but not valued; they are visualized with the help of a spring embedder. They illustrate all ties in the network, that is to say all persons that have been mentioned as to possess a role in the field of ESD. Persons with a high degree are placed in the centre of the figure; nodes with low connectivity are placed at the periphery. Furthermore, person with the same distance from the centre are placed closely together.

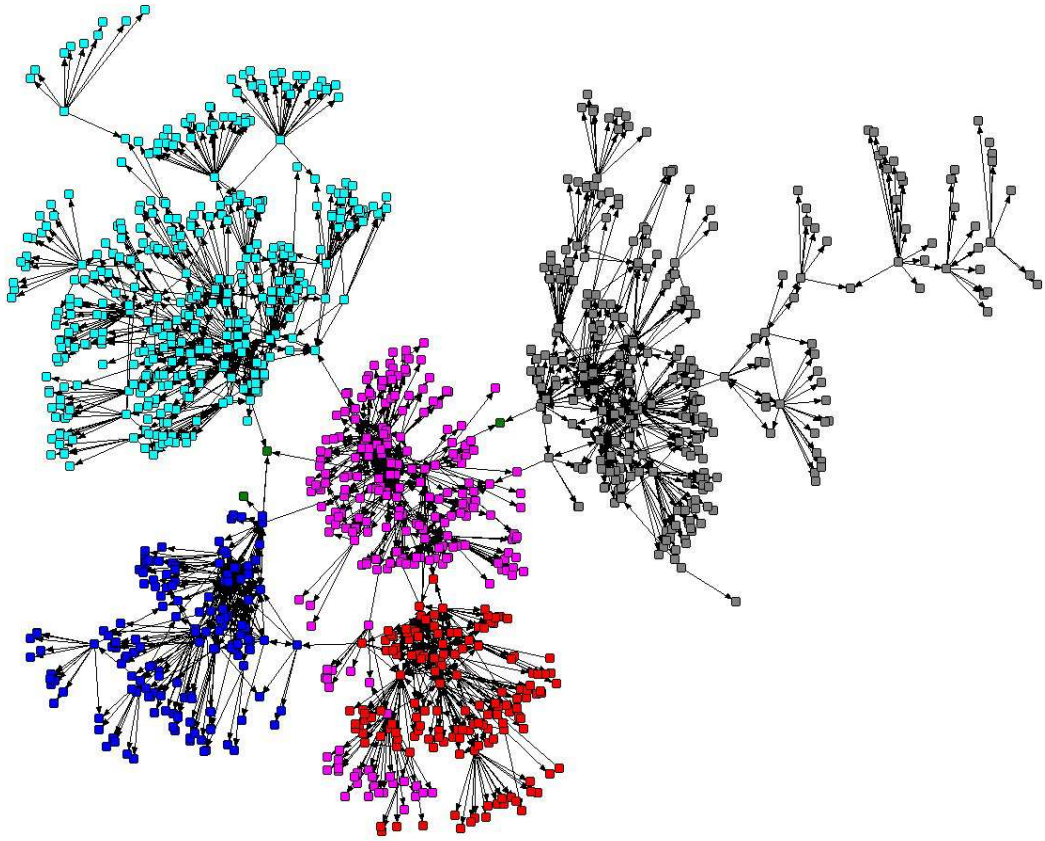

Figure 2: Trans-regional Social Network of ESD Actors (Alheim = red, Erfurt = grey, Frankfurt/Main = pink, Gelsenkirchen = light blue and Minden = dark blue)

Actors who maintain connections with people who do themselves not become interconnected have the ability to mediate between these contacts and to obtain benefits from it (see Podolny and Baron 1997; Scheidegger 2010). At the same time, a lack of exchange between different regions means real problems for the establishment of innovative ideas such as ESD. If social movements are not able to communicate and cooperate beyond their region, their aims, ideas, projects and activities won't be recognized and combined with further ideas, aspects and innovations.

In contrast to the thesis of Manuel Castells (2010), who, in his seminal work, observed the diminishing relevance of space at times of the information age, the present study shows that space remains a central element for ESD. Based on quantitative and qualitative results and as figure 2 illustrates, it seems much easier to initiate and establish ESD in the local context with dense network structures and, subsequently, to foster its diffusion through

"weak ties" (Kolleck, De Haan et al. 2011). However, the diffusion of the idea beyond regional borders, as declared and supported by the current United Nations Decade of ESD, has not been yet been realized by German model communities. At the same time, the cooperation related to ESD within the working groups is characterized by effectiveness and confidence. In what follows, this contribution takes Alheim as exemplary for all model communities of this study and presents some findings and visualizations which have similar characteristics and manifestations in the other communities. Figure 3 and 4 show with directed graphs who has been named to have a confident and effective cooperation related to ESD.

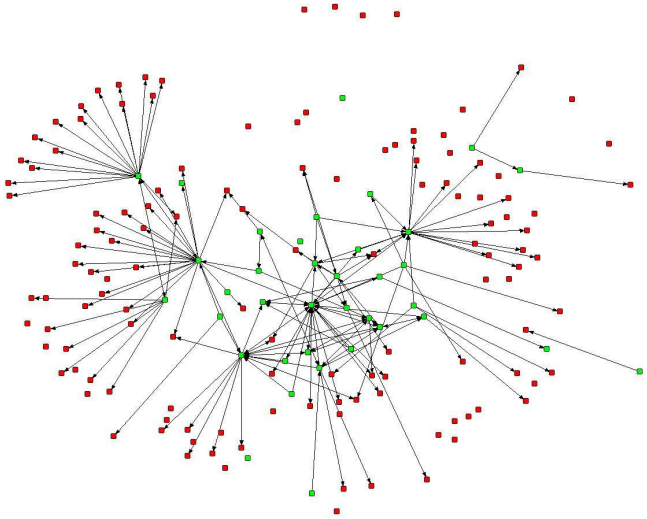

Figure 3: Confident cooperation in Alheim

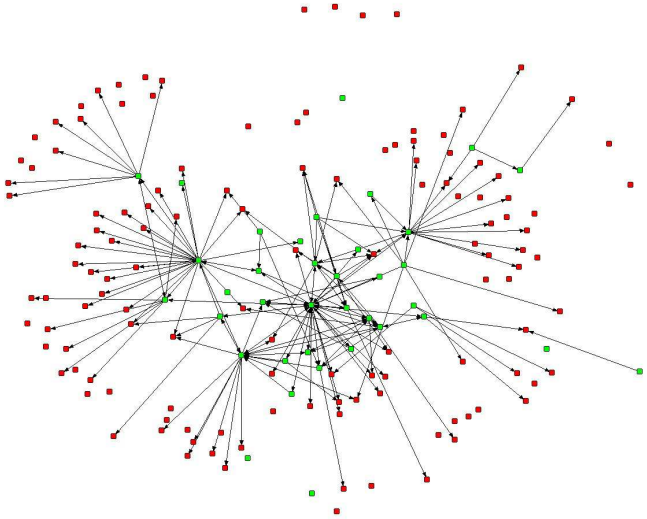

Figure 4: Effective cooperation in Alheim

However, while cooperation seems to work quite well within the communities, it depends on actors with central positions. SNA provides us with different measure to analyze centrality. In order to refer to the role of central actors, this paper implements the measure of betweenness centrality. The central idea is that the node's centrality in a network is characterized by its number of shortest paths from the vertices to others that pass through that node. Hence, "an actor is central if it lies between other actors on their geodesics, implying that to have a large 'betweenness' centrality, the actor must be between many of the other actors via their geodesic" (Wassermann/Faust 2009: 189). Figure 5 shows that some actors are clearly more central than others. The bigger the node, the higher is the individual betweenness centrality of actors involved in ESD activities in Alheim. This gives egos who lie between alters power. Thus, in star networks, ego has the power to mediate all alters. In cliques, egos can communicate with each alter without egos support. Anyhow, while there is only one central actor in star networks, the realization of ESD within the model communities is forced by a few central actors, as the example of Alheim shows. This is also illustrated by the general degree of betweenness centrality among the actors which is fairly low as the network centralization index is 8,25%.

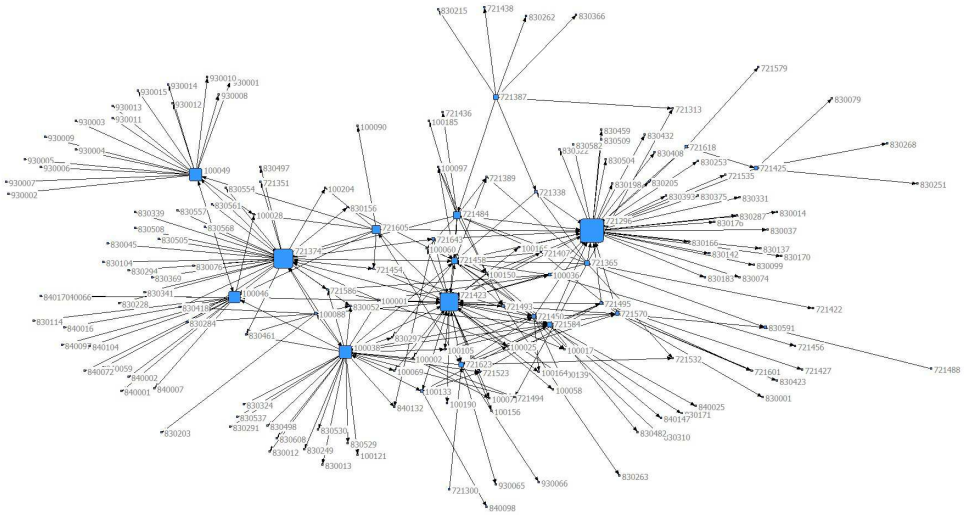

Figure 5: Betweenness centrality[4] in Alheim

Even though the previous findings and figures may give the impression that ESD networks are characterized by efficient innovation flows, communication patterns, cooperation and trust, the strength of the ties has to be considered differently. In figure 6, relations between the network members have been scaled. On this note, an index has been built, composed of the mean score of four variables: contact frequency, frequency of the development of new ideas and projects, frequency of information exchange and frequency of jointly solved problems. The thicker the link, the higher are the index and the strength of the ties. The thickest ties present relations that have gotten the highest assessment for at least three variables (the highest assessment for the variables was: to take place more often than once a month). That is to say, the mean score of the thickest links is at least 3,0.

[4] If g_{jk} is the number of geodesics linking two actors j and k, $1/g_{jk}$ is the probability of the communication using anyone of the actors, $g_{jk}(n_i)$ is the number of geodesics linking the two actors that contain actor *i*, the actor betweenness index for n_i is simply the sum of these estimated probabilities over all pairs of actors not including the *i*th actor: $CB(n_i) = \sum_{j<k} g_{jk}(n_i)/g_{jk}$. This index is based on the assumption that geodesics are equally likely to be chosen for this path (for critical comments on this assumption see Wasserman and Faust (2009)).

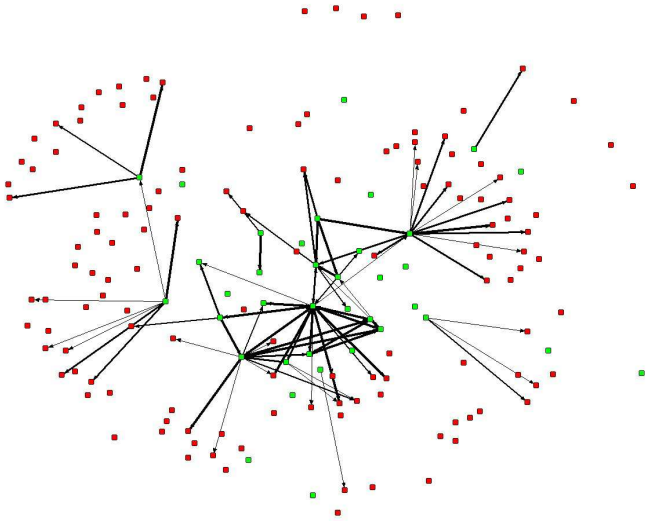

Figure 6: Strength of the ties in Alheim, index between contact frequency, frequency of the development of new ideas and projects, frequency of information exchange and frequency of jointly solved problems

Another hypothesis of the study was that cooperation in the field of ESD is mainly realized within clusters or cliques that are composed of actors working in the same field of activity (e.g. administration and politics, economy, NGOs, schooling, non-formal education, media, church). This hypothesis has been tested qualitatively and quantitatively. Figure 7 shows that it could not be verified. Actors with different affiliations cooperate quite closely and there are no cliques or clusters related to the affiliations of the nodes. The reason why some actors do not cooperate cannot be traced back to their individual belongings, memberships or affiliations. This finding can also be ascertained by combining the affiliations with the strengths of the ties, the mutual trust, the centralities within the working groups and the problem solving capacities.

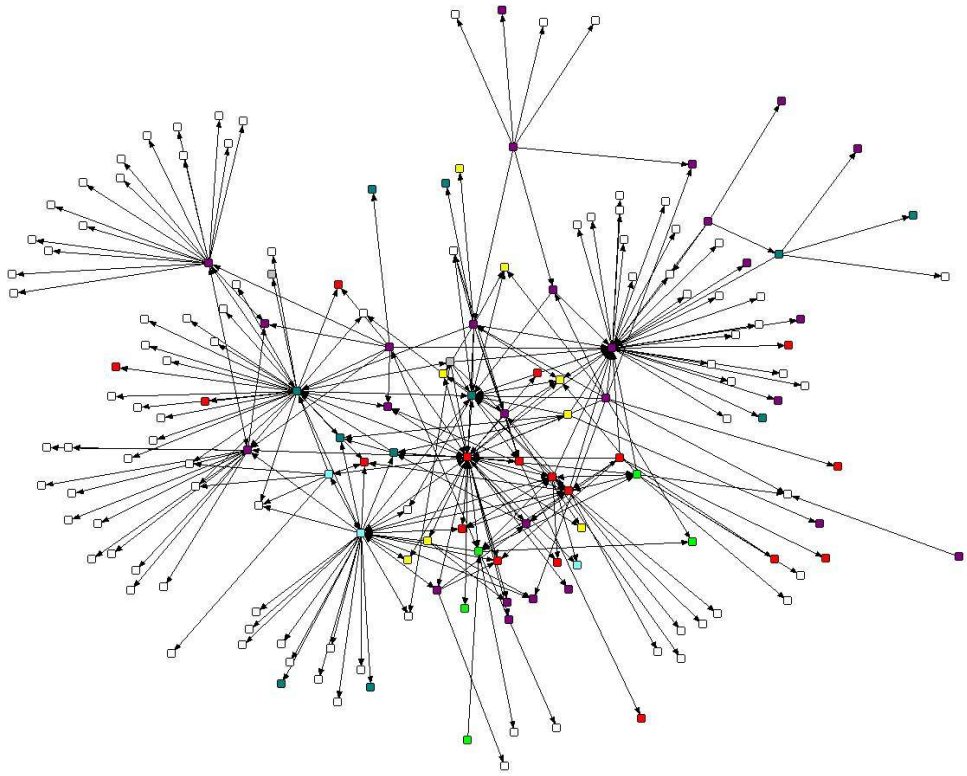

Figure 7: Field of activity of ESD network members in Alheim (administration and politics = purple, economy = yellow, NGOs = red, schooling = light green, non-formal education = dark green, media = dark blue, grey = church, others = white)

Supporting Decision Making

However, the paper has already presented some findings of a broader empirical analysis, but how can SNA support decision making in the area of sustainable development?

First, it has to be stressed that graphical representations of network data provide very informative sources of presenting and communicating empirical insights. Depictions of different types of information can be interpreted easily by target groups. For centuries, the humanities had a difficult relationship to visualizations due to the concern that visual mappings create artefacts (Krempel 2005; Krempel 2011). However, SNA and network visualizations tools like Netdraw and Pajek allow us to overcome this concern by providing "systematic encoding rules to represent numerical information and choose encodings that can be almost automatically decoded. Along with procedures that let us map social space into meaningful planar representations, a new world of scientific images becomes available" (Krempel 2011). Network Maps, developed in the present study, are presented within the

communities in order to provide evidence based policy advice and support decision making processes. Watching one's own network structure from the outside in may not only cause learning processes and new strategies for capacity building. It can also become evident where and how innovations and alterations may be desirable and possible due to structural conditions.

Second, issues of social networks are always accompanied by questions of trust, uncertainty, power and motivation. Costs of information exchange are not only material (money, time), but also social (uncertainty, trust, power) so that problems within social networks may have the effect that knowledge is not shared. SNA helps us to identify weaknesses in knowledge transfer, problems of coordination or motivation. With respect to the present study, for example, a network management is initiated in order to elaborate why trans-regional cooperation is so low. While qualitative data shows that key actors within the communities perceive a high internationalization and trans-regional cooperation in the field of ESD, this perception cannot be verified, taking into account results of quantitative SNA. Hence, Figure 2 shows that cooperation related to ESD is mainly taking place in regional cliques with high density and centrality.

Third, results of SNA can hint at where cooperation can be optimized and additional information is needed. Discussing results of network analyses can help to direct one's attention to domains that need further consideration and, thus, evoke development processes. While quantitative SNA helps us to uncover those structural deficiencies, the question of how to initiate development processes may also be answered by applying the method of network maps (see Emirbayer and Goodwin 1994; Hollstein and Straus 2006; Straus 2010). Based on previous empirical findings, the present study has conducted 25

egocentric network maps, embedded in semi-structured interviews (five interviews in each community). Figure 8 depicts the network map of the mayor in Alheim as an example.

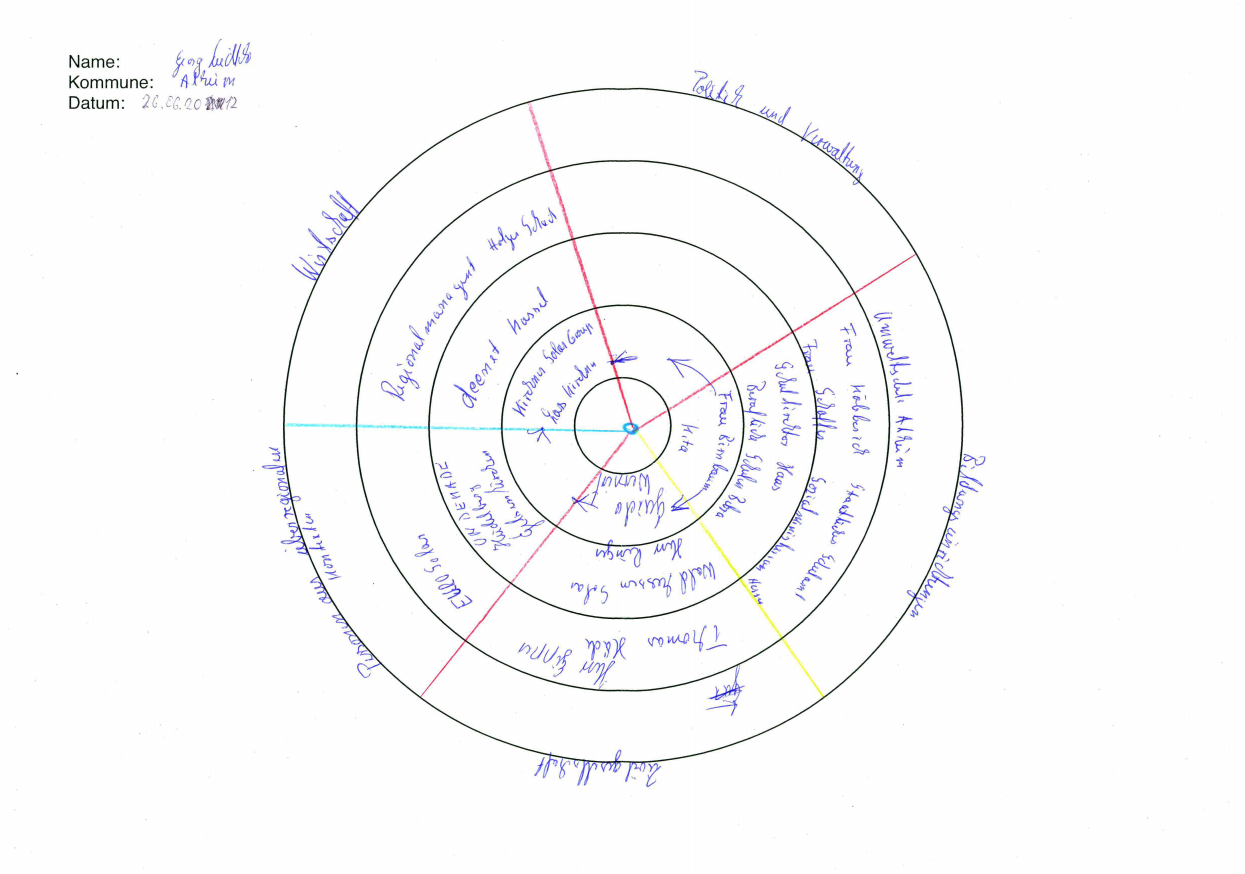

Figure 8: Network Map of the mayor in Alheim

Hence, qualitative network maps have been implemented in order to capture interpretations and perceptions, allow for deeper insights into qualitative characteristics of the network structures and find out more about possible and probable development processes. In this way, mixed methods techniques of SNA can hint at where cooperation can be optimized and, thus, help to direct the attention of researchers and decision makers to domains that need further consideration. Related to the study presented in this paper, empirical findings based on SNA and network visualization provide the foundation for a network management that takes place within the communities. In this way, empirical results are used for key groups with the aims to support development processes, to improve the quality level of ESD and to foster learning processes.

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