Social networks and Institutions in Self-Governance Systems: Water Supply Management in Northwestern Senegal

Malick Faye
MSW – Zentrum für Methoden der Sozialwissenschaften
Carl von Ossietzky Universität
Oldenburg
Germany

Abstract
The present paper describes the management of a Common Pool Resource through a group characterized by distrust among actors, and discrimination or disadvantages of actors with regard to the infrastructure and positions in an elected institution. A community of seven villages in the Northwestern of Senegal manages its water supply through an elected board representative of each village. The villagers are composed of Wolof and Fulani. The former are mainly peasants, while the latter nomads. The Fulani complained about disadvantages in the use of the resource and a weak representativity in the board. Although they threatened repeatedly to depose the board, they still cooperate in the management of the resource, paying regularly the water use fees. The question is also to find out why subgroups that are or feel segregated contribute positively to the management of Common Pool resources. Results of this paper are that: the discriminated subgroup cooperates fully because the fragmentation observed on the group level is not reflected in the institution; the discriminated subgroup hardly succeeds in implementing its interests, because it is characterized itself by intern discrepancies; segregation occurs at the level of the whole group, but the institution remains rather integrative. The group structure is derived from social networks collected in the whole group (462 respondents) and in the institution (33 members) to compare subgroup behaviors according to language background and location at both levels.

Keywords: Biased Net Theory, Social Networks, Common Pool Resources, Community Governance, Institutions, West Africa.

Introduction

The problematic of the management of Common Pool Resources (CPRs) in the Sahel zone has in the course of progressive decentralization politics (s. Diop 2006), by serious deteriorate life conditions and increasing demand on scarce natural resources, an existential dimension. Communities are managing their Common Pool Resources like water and forests (s. Agrawal 2003) and are confronted through this transition from a centralized state management to a community based management with complex demands. These challenges are based not only on the formal management, but also on the questions of mobilizing actors, and of their participation in the provision of collective goods. This fact is a well-recognized problem in studies dealing with the management of Common Pool Resources.

The relevant problem in this paper is that, in a community of seven villages, a particular subgroup, namely Fulani villagers, feels discriminated in the provision of water supply they manage together with Wolof villagers. The Fulani complain about disadvantages in the use of the resource and about a weak representativity in the board. Although they threatened repeatedly to depose the board, they still cooperate in the management of the resource, paying regularly the water use fees. The main question of this paper is also to know why subgroups which are or feel segregated contribute positively to the management of Common Pool resources.

The analysis of this problem in this paper takes the particular structure of the village community into consideration because of two reasons:
On the one hand, the group[1] is composed, based on economic and language characteristics, of two different subgroups (e.g. herdsmen and peasants). These subgroups which are found in most West African regions are living in conflicting conditions with regard to the common use of natural resources (s. Gado 2000; Mope Simo 2000, and Traoré 2000)[2]. The main reasons are differentiated cultural characteristics as well as contrasting claims and expectations. Conflictual questions can also occur within the respective subgroups (see Lavigne-Delville and Toulmin 2000, and Faye 2011) or even concern institutions that are set up to solve collective action dilemmas (s. Dia 2004).
On the other hand, decentralisation politics takes effect in the investigated region with a progressive retreat of state instances from the management of natural resources like water in rural areas. Consequently, collective decisions concern wider domains of socio-economic life, e.g. not only the relations between extreme fractions (s. Traoré 2000, pp.264-266), but also the regulation of the common use and management of natural resources.

The main assumption of this paper is that groups composed of competing and conflicting subgroups manage successfully their natural resources as collective goods if sufficient trust is observed between subgroup members. Now, trust is strengthened by social capital in form of institutions, trustworthiness, and social networks (Ostrom and Ahn 2010). These fragmented groups need, in other words, institutional arrangements to solve discrepancies and achieve social optima. Further, social interactions between group members have to show a structure that demonstrates enough trust and social integration.

The present paper rectifies a problematic aspect of previous studies on the Commons. What most of previous studies on the Commons namely underexposed, is that collective action of groups mostly occur through collective decision making institutions (Nullmeier et al. 2008). These are even so embedded in social structures that accompany or, rather, condition their functioning. Because groups carry institutions, social interactions of their members, like social networks, build the framework for collective decisions. Taking the social interactions and the institution into consideration is therefore necessary to explain collective action in general and the management of Common Pool Resources, in particular. The present paper aims therefore to instigate a new approach in the analysis of the management of Common Pool Resources: the structural embeddedness of institutions in collectively acting groups.

The paper is so structured that in a first step, the theoretical background will be explained with regard to considerations that rest on the social capital literature on the management of Common Pool Resources. These considerations will be narrowly intertwined with Biased Net models that describe social integration in groups. Hypotheses will be then formulated. In a second step, the data collected and the methodology adopted will be described, before the results are presented in a third step. In a fourth step, the results will be discussed in an interpretive way. In a final step, the main points will be summarised and avenues for future research proposed.

[1] In this paper the group is referred to the community of the seven villages.
[2] See also Fratkin (1997) who analyses the relationships between peasants and pastoralists in East Afrika, China, and Mongoly.

Theoretical background: social capital in collective action dynamics

The present paper is to be considered in the same line as the various studies focussing on the role of social capital in the management of Common Pool Resources. It parts from the fact that the structure of most collectively acting groups is characterised by asymmetries among users which can incur free riding or hinder the willingness of actors or subgroups to cooperate. These asymmetries can be overcome through institutional arrangements that, consequently, regulate collective action.

Institutions and the resolution of social dilemmas in Common Pool settings

The social dilemmas that Commons goods face (free riding of users or compromised cooperation of subgroups) lie, beside self-interest, in asymmetries between collectively acting actors (Ostrom and Gardner 1993). These asymmetries are attributed to divergent preferences, interests, and motivations, and can result, in the end, from a distribution of resources (endowments of the individual actors) and constraints (time horizons and investment capacities) within groups. These inequalities are, however, shown to have various effects on collective action in decentralized settings in which individual decisions are contingent to other users (Baland and Platteau 1999, pp.775ff).

Group structure is unfortunately derived in most studies on the Commons not from structural patterns (concrete social interactions like social networks), but on physical characteristics or other attributes of the actors. The aim of this present analysis is to take both levels into consideration, showing, on the one hand, whether the collectively handling group is characterized by segregation behaviours or fragmented patterns of social relations, and comparing, on the other hand, the structure of the whole group with that of the institution in order to find out whether the subgroup behaviours in the first are reflected in the second.
The reason why institutions are relevant to be taken into consideration is that they help surmounting the social dilemmas groups face in their collective action. If communication is possible, individuals are namely able to find arrangements, to coordinate, to estimate the behaviour of other individuals, to generate trust, and consequently, to achieve a social optimum (see Ostrom et al. 1994; Ostrom 1999; Cox et al. 2009). Since the use of Commons goods is not preserved from free riding among users (Ostrom 1999, p.498), efficient use and maintenance of a Common Pool Resource are effective mainly through institutional arrangements. Groups need also institutions to regulate, and control the use of Common Pool Resources, i.e., to overcome social dilemmas **(**Ostrom et al. 1994, pp.47f; Baland and Platteau 1999, p.780), and achieve social optima (see Ostrom et al. 1994; Ostrom 1999; Cox et al. 2009; Ostrom and Ahn 2010).

The regulation of the resource use through institutions is considered as a form of governance. Governance is defined as „ *a suite of procedures that use decision-making processes at different levels and among different sectors, stakeholders, and jurisdictions to enact […] water resources management*“(Hooper 2006, p.1). A community governance is seen as local governance insofar as it results from a: „*réorganisation des techniques de gouvernement, par le transfert de compétences de régulation jadis étatiques vers des acteurs non-étatiques, […] collectifs, auxquels on confère des qualités de responsabilité et de rationalité*“(Blundo 2004,

p.3).[3] In other words, a self-governance system describes a group of people that manage themselves collectively the use of their natural resource. This resource is a Common Pool Resource, i.e. a good that is freely accessible for all users, and is not-renewable (see Ostrom and Gardner, 1993; Ostrom et al. 1994).

That most of the studies who described the management of Common Pool Resources did not take explicitly institutions as collective decision making units into consideration has been underlined above. The present paper rectifies this aspect and assumes that groups are composed of diverse subgroups with regards to biophysical, social, or structural characteristics. As individuals are driven by self-interests in the provision of collective goods, subgroup rationality can become apparent in the process of collective action since specific subgroups try to satisfy their (own) interests with a probability of compromising the achievement of the goals of the whole group. And because these whole groups build institutions, it is likely for these institutions to have a representative character. In other words, these institutions are composed of members from the respective subgroups. Consequently, subgroups which are driven by subgroup rationality should "elect" those of their members as institution members who are mostly able to implement their interests.
The functioning of structurally embedded institutions can also be conditioned by group structure. Structural characteristics of institution members, and similarly group structure are then captured by the patterns of social interactions, namely the social networks they are involved in[4].
So the **hypothesis 1**:

- *The board members occupy central positions in the social networks in the village community*.

Social networks in collective action

The impact of the structure of social networks on collective action is well acknowledged (see Gould 1991). Large groups can, for example, provide collective goods as successfully as smaller ones (Marwell and Oliver 1993, p.2). Weak ties bounding different groups can also positively affect the political participation of actors (see the small-worlds networks in Siegel 2009). Moreover, Different social networks fulfil different functions for individuals Warr (2005).
As stated earlier, the present paper focuses on the role of social capital in explaining the success of collective action or of individual or subgroup cooperation. Social networks as a form of social capital strengthen trust among actors (Ostrom and Ahn 2010). This means that a certain level of trust can be derived from the structure of social networks as social interactions within groups. In order to show how social networks build trust between actors, we explain first how and why social network ties form.
Suppose an actor *i* has an emotional problem and has to ask another, *j*, for help. The actor *i* asks *j* for help, if *i* starts out from the idea that *j* can help her, and/or *j* will not divulge her emotional matter. These opinions can lie on *i*'s direct experiences with *j*, for example, if *i* interacts permanently – even if in other domains – with *j*, or *i* refers to experiences and opinions of another actor, *k*. In the first case, direct connections play an important role, while in the second case, the reputation of *j* is decisive for the tie building. Based on other direct or

[3] See also Agrawal (2003); Ostrom (2002); Wade (1988);and Baland & Platteau (1996).
[4] Social networks are generally composed of nodes and the links between them (see also Wasserman and Faust 1996; Degenne and Forsé 2004; Bruggeman, 2008). The nodes can be persons, animals, states or institutions. There are also not only "social", but also, biological, economic or political networks. The present paper focuses on social networks that describe social life or social reality among human actors.

indirect actors (*k*, *l*, *m* etc.), *i* can namely decide whether to ask for help (build the tie) or not. The more direct or indirect actors of *i* are directly or indirectly connected to *j*, the more likely and (outgoing) tie is built from *i* to *j* (see Henry and Dietz 2011).
The embeddedness of *j* in the neighbourhood of *i* depicts the visibility of *j* from which the (structural) prestige of *j* results (see the game-theoretic studies of Raub and Weesie 1990, p.628, and Buskens 1998 who show the various effects of the reputation of partners in the cooperative behaviour of actors). The building of a network tie requires then trustworthiness, however not only of the trustee, but also of the trustor itself (Ostrom& Ahn 2010). These considerations mean that building a network tie is, at least, placing trust. So, the more ties are built between actors, in other words, the more dense the social networks are, the more trust is to be derived from these social interactions.
The following other tie configurations can occur between the actors *i* and *j*:
Multiplexity: are the trustworthiness and/or the reputation of *j* still relevant for a tie building, then a connection of *i* to *j* in a relation can incur another connection of *i* to *j* in another relation. In other words, because *i* asks *j* for support, *i* visits *j* regularly.
Reciprocity and exchange: is the trustworthiness of *i* as trustor, though, relevant, then a tie from *i* to *j* can be replicated by *j*, say, in the same emotional relation (reciprocity), or through another social relation (exchange). In other words, *i* ask *j* for support and *j* asks *i* for support in the first case; in the second case, because *i* asks *j* for support, *j* visits *i* regularly.
Reciprocity, multiplexity, and exchange among actors are considered in this paper as structural forces that drive social interactions in groups (see Skvoretz and Agneessens 2007). Multiplexity and exchange are especially important to determine insofar as they show the interplay between various social relations: although actors interact with others because of existential needs, these interactions can be conditioned by other interactions, so that spheres of influence can be captured in multidimensional perspectives.

As stated earlier, groups can be heterogeneous with regard to (various) actor attributes. The considerations above about the tie building between two actors apply anyhow. The reason is that, as well as these connection forms occur between actors, they are also observed between subgroups they compose (see Skvoretz and Agneessens 2012 and the formula for the respective reciprocal, multiplex, and exchange tie building within and between subgroups). And, if tie building between actors is a sign of trust (placing), then connections between subgroups can be considered as such.
Because reciprocity, multiplexity, and exchange require trust among actors, they are expected to occur variously within subgroups (homomorphic form) and between subgroups (heteromorphic form) (Skvoretz and Agneessens 2012 with regard to reciprocity), mainly if the group is fragmented. So the **hypothesis 2a**:

- *There are significant reciprocal, multiplex, and exchange relations within or between the language groups in the social networks*.

Because the function of institutions is to solve asymmetries in collective action, those discrepancies between subgroups are expected not to be found in them. So the **hypothesis 2b**:

- *The subgroup behaviours expressed in differences between the language groups in reciprocity, multiplexity, and exchange in the village community are not reflected in the board.*

Beside reciprocity, multiplexity, and exchange within and between subgroups, an important theoretical model will be treated in this paper: the Differential Inbreeding model from the Biased Net Theory (see Skvoretz 1991). According to the Biased Net theory, (network) connections occur between actors either at random or conditioned by biases. These biases can

be structural or compositional which, if they occur, ensure that the tie forms with probability one.

Structural biases are tie configurations surrounding actors which can influence a tie building between them (like the effect of the reputation of *j* in *i*'s neighbourhood on the probability that a tie forms from *i* to *j*). Compositional biases are, for example, actor attributes (like the effect of sharing the same attribute on the probability that a tie forms from *i* to *j*).

Inbreeding is a form of homophilous behaviour which ensures that a tie forms between two actors because they have the same attribute. Blau (1977) stated early that inbreeding behaviour does not contribute to social integration in groups, but strengthens rather their fragmentation. The reason is that as more ties occur between actors of the same subgroup, fewer connections to other subgroups are to be observed (Ramirez-Sanchez 2011, p.236). Likewise, a local density is negatively correlated with group performance (Buskens and Yamaguchi 1999).

The statements about the Inbreeding behaviour are as follows: a (network) tie originates from the subgroup of the actor *i* with the origination probability o_i and targets in the same subgroup with the probability 1 if the inbreeding bias (with probabilityτ) occurs (see Equation 1);

$$p_{ii} = (\tau_i + (1 - \tau_i)\, t_i)\, o_i \qquad (1)$$

If the inbreeding bias fails to occur (also with the probability $1 - \tau$), then the (network) tie targets in the subgroup of *j* with a probability of t_j (see Equation 2):

$$p_{ij} = (1 - \tau_i)\, t_j)\, o_i \qquad (2)$$

o_i as origination probability is a function of the raw marginals and t_i a function of τ and the *i*'s raw (*r*) and column (*c*) marginals:

$t_i = (c_i - \tau_i * r_i) / (1 - \Sigma \tau_k * r_k)$.

This paper considers that the particular subgroups have different propensities to send ties or to be target of ties between subgroups. The equation (1) will be solely considered in this paper, since the homophily of subgroups is under investigation. We refer to Faye (2012) for results regarding the outbreeding biases of the same subgroups.

Are groups fragmented because they are composed of competing and conflicting subgroups, homophilous behaviour of their respective members is expected to be strong. Since they collectively act through an institution to manage a Common Pool Resource, their homophilous behaviour is less expected to be reflected in this institution. So the **hypothesis 3**:

- *The strength of the homophilous behaviour or the respective subgroups (villages and language groups) is not to be found in the institution*

METHODS

Data collection

Basis for the paper are: six social networks in the village community, four social networks in the institution, socio-economic data regarding the population structure, and the opinions about the management of the water supply.
Field research was conducted between November 2009 and March 2010. An earlier realised field research in two of the seven villages (2005 and 2006), the mastery of the Wolof language and joking relationships between the Fulani and the language group of the researcher made the contact easier. Thus, the field research could be carried out without any difficulties. A first contact occurred in August 2008 where all villages involved in the management of the water supply were visited and informed about the planed research. The acceptance was confirmed in a board session in August 2008 by all board members.

The field research (data collection) was conducted in the dry season, between November 2009 and March 2010, since filed work declined in intensity and people had more time to be questioned.
In addition to the collection of social networks within the village community and in the board, board sessions were recorded to analyse processes of collective decision making regarding the management of the water supply. The analysis of the board sessions is not taken in this paper into consideration.
The six social networks collected in the village community concern domains of material, instrumental, and emotional support as well as contact and communication interactions. The four social networks collected in the board refer to the management of the water supply, mainly discussion about general topics before and after the board sessions, as well as contact and advice interactions. All respondents got the same questionnaire in the Wolof language. Since almost all of the respondents in the village community are not alphabetized, the responses were entered by the researcher.[5] Avoiding the enumeration of all respondents (462) by name, the questions referred to the community of the seven villages as the spatially limited investigation unit.[6] The assumption is that almost every (adult) person is familiar to the others.
Female and male respondents were questioned who were present at the time of the field research. Since not all villagers could be once questioned, it came that some of them, mainly Wolof male villagers, migrated in larger cities in Senegal or West Africa, or in Europe before they could be questioned. The same problem occurred with the Fulani herdsmen who migrated to remote pasture lands. While male respondents as heads of households are questioned in studies dealing with the use of natural resources (Crona and Bodin 2011), this paper considers male as well as female respondents. The rationale behind this is that they both female and male adult villagers are eligible in the board and can therefore decide on the collective action in the water supply management. Besides this, many female villagers are heads of households, since their husbands migrate for months or years abroad.

[5] The female respondents were questioned by two female interviewers, since female interviewers have a better access than male interviewers because of socio-cultural conditions.
[6] There are approximately 1010 villagers older than 15 in the village community. The total number of younger villagers is at least one-and-a-half-fold. More than half of the "adult" villagers were not present at the time of the field research because of migration or journeys mainly of Wolof villagers to other Senegalese, west African or European cities. Many Fulani moved with their families, too, to remote pasture lands.

Social networks

Since social networks of actors are difficult or even impossible to limit (Jansen 2006; Knoke and Yang 2008), the unit under investigation is defined under a spatio-thematic perspective: a community of villages which manages itself its water supply.
Although these social networks which refer to various social dimensions do not capture the whole social reality, they constitute important facets of the everyday life (see Günther 2005), which can influence individual behaviour about the use of the resource. The formulated questions belong to the standard questions on social networks (see Schnegg and Lang 2002, p.19), but are adapted to the socio-cultural and thematic context of this paper. Although network questions can be sensitive (Tourangeau and Smith 1996 as reported in Lange et al. 2004, p.353), for example a young researcher asking an older respondent about emotional topics like conflict with the life partner, and incur response refusal (Lange et al. 2004, p.353), all questionnaires were fully answered. This occurred because of the familiarity of the researcher and the fact that he was well-known in the community. Other reasons are the public approval of the respective village chiefs and the fact that questioning occurred in face-to-face conditions.

The four social networks collected in the board are specific to the functioning of the board, but do not refer to the specific tasks of the respective board members, since the most active are those of the executive council. Questions about support in particular tasks should have sense only for these board members. For this reason, general questions about information exchange are collected: with whom are topics related to the management of the resource discussed? Who visits whom und who could influence the opinion of whom in collective decision makings?

Opinions about the water supply management

Opinions about the management of the water supply were recorded to know whether the interests specific to the respective villages are satisfied in the management of the water supply or not.
Since the elected board assumes the management of the water supply, the remaining villagers are not taken into consideration in the board networks. However, the remaining villagers have expectations and interests on the resource and its management because they belong to specific interest groups (peasants, herdsmen, male or female villagers, etc.). The difference between their expectations and the outcomes of the management depict the level of the users‘ or subgroups‘ satisfaction. Consequently, decisions on the water supply management can be tested and corrected, and the legitimacy and the performance of the institution estimated and judged.

In a first step, a correspondence Analysis helps to determine positions of the two speech groups according to their expectations on the water supply management. In a second step, Biased Net Models (Skvoretz 1990; Skvoretz et al. 2004; Skvoretz and Agneessens 2007, 2012) are used to determine the level of subgroup behaviour in the village community and in the institution. They explain mainly homophilous tendencies among members of subgroups, i.e. the extent to which network ties occur within subgroups and not/or between them. In this sense, social homophily is considered in terms of the occurrence of network ties, of reciprocal, mutual, as well as exchange ties within or between subgroups.[7] What are the

[77] The homophily model “Inbreeding” focuses on both the speech background and the location, while reciprocity, mutuality, and exchange within and between subgroups are estimated according to the speech groups.

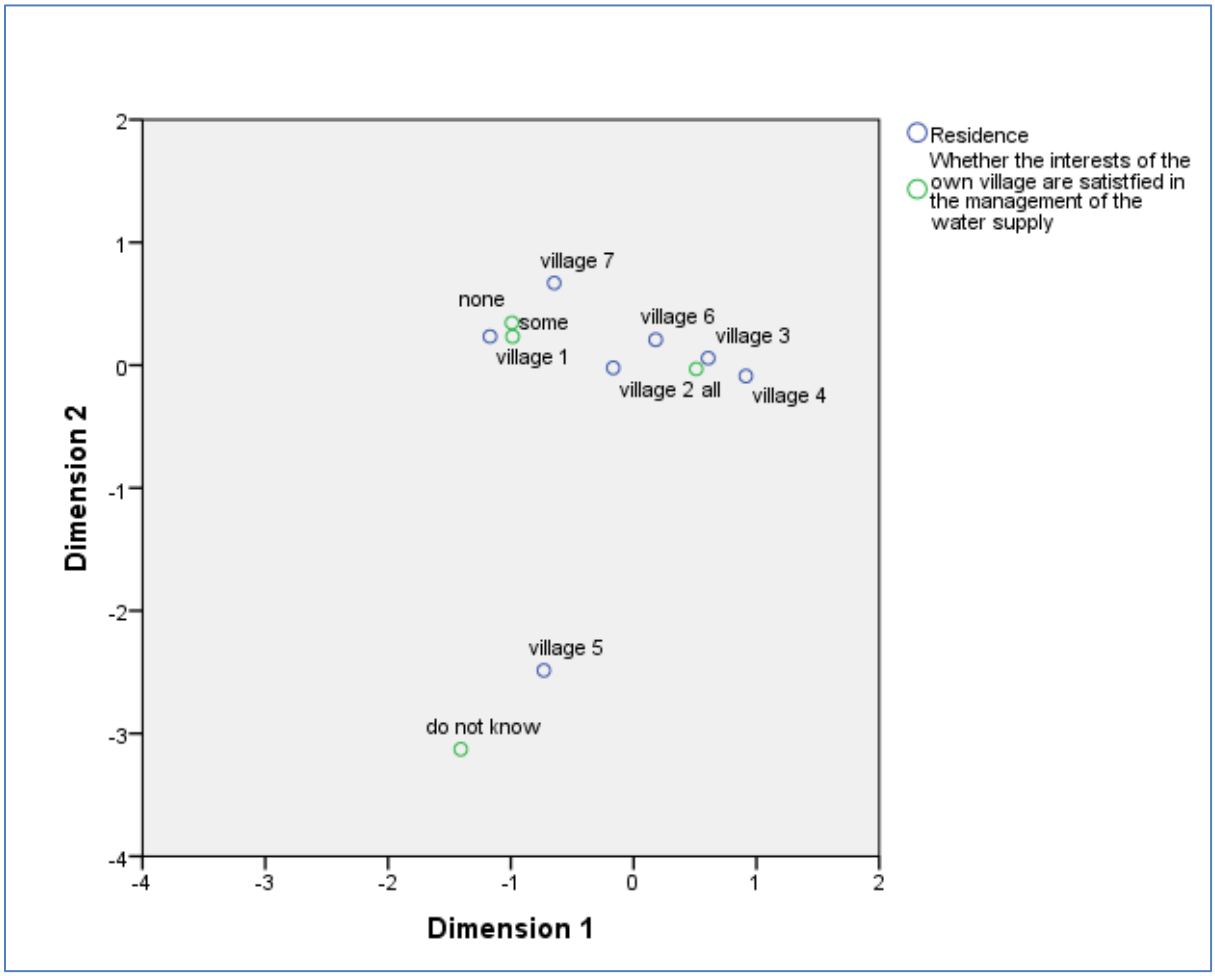
tendencies for the respective subgroups to maintain intragroup ties or ties towards other subgroups?
Reciprocal, multiplex, exchange, and homophilous tendencies are estimated as probabilities which show the strength of these structural forces that drive social interactions in groups. For reciprocity, multiplexity, and exchange, and for the Inbreeding model, respective R codes were provided by John Skvoretz at a Summer School in Advanced Social Network Analysis. They are used to run the estimations. The tests for differences in reciprocity, multiplexity, and exchange between subgroups draw on network simulations (see Skvoretz & Agneessens 2012), while the calculated G-square values in the Inbreeding model test its fitness. The diagrams from the social networks are drawn with the Software program "Pajek" (Nooy et al. 2007).

RESULTS

Asymmetries and Inequalities in Resource use

Figure 1 shows that the villages 1 and 7, both Fulani villages, in contrast to the Wolof villages, strongly consider that their interests in the resource are not satisfied in the management of the water supply. They are close to the categories "none" and some". The respondents from the Wolof village 5 are mainly uncertain: they do not know whether their interests are satisfied or not. The respondents from the villages 3 and 4 estimate almost unanimously that their interests are satisfied in the management of the resource, while those respondents from the villages 2 and 6 partly share this opinion. Many of them even think some or none of their village interests are satisfied in the management of the water supply.

Figure 1: Satisfaction of subgroup interests by residence



Board in the village community

This chapter deals with the hypothesis that *the board members occupy central positions in the village community*.

There is a moderate to strong correlation between the centrality in the social networks of the village community and the membership in the board. Board members are central in the emotional help and the contact networks (see table 1).

	Money	Advice	Illness	Dispute	Discussion	Visits
Board membership	0.59	0.60	0.61	0.56	0.59	0.62

Table 1: Board membership and network indegree centrality in the village community

The correlation is weaker in the material and the emotional help, but board members still remains central in these social networks. The diagrams below depict the position of the board members in the six social networks of the village community.

Figure 2: board members in the social network "Visits"

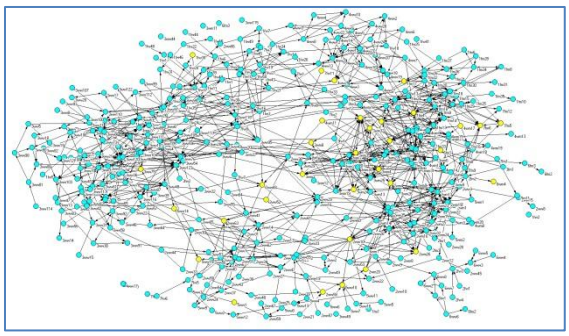


Figure 3: board members in the social network "Advice"

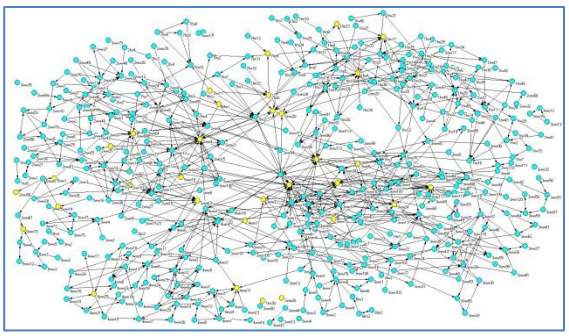


Figure 4: Board members in the social network "Money"

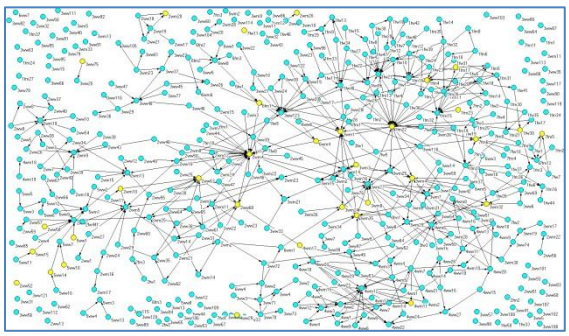


Figure 5: Board members in the social network "Dispute"

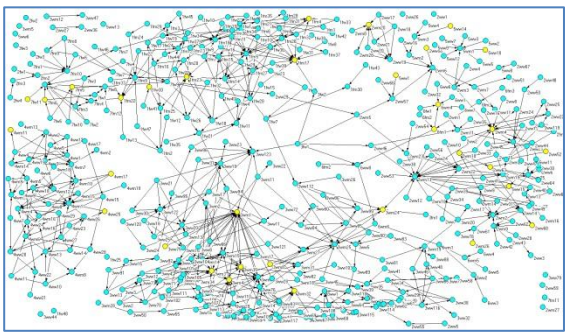


Figure 6: Board members in the social network "Illness"

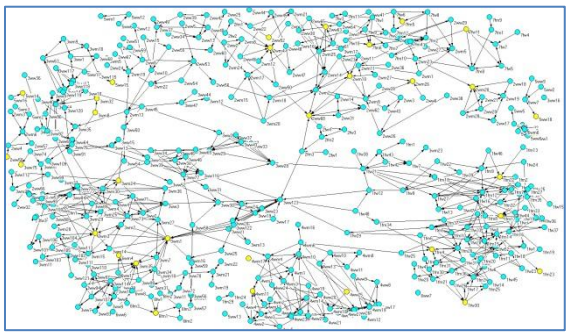
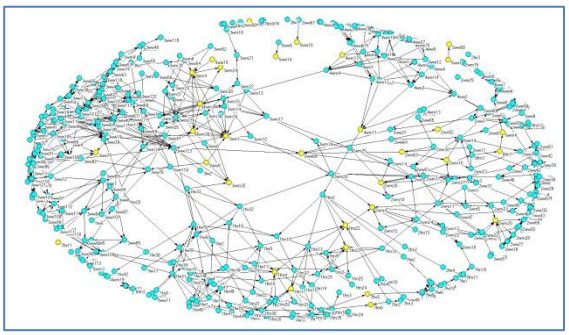


Figure 7: Board members in the social network "Discussion"



There are, however, board members with low indegree centrality, and who even are not asked for help in this social network as well as very central villagers who are not members of the board.[8]

[8] The names on the social networks are anonymous ones. The first number refers to the village number (seven in total); the following character means whether the network actor is Fulani (f) or Wolof (w); the second letter means whether the network actor is a woman (w) or a man (m); the next number refers to the number on the list in each village. For example, the board member 3wm1 comes from the village 3, is a Wolof, male, and stands at the top of the list of male persons questioned in this village.

Table 2 shows the relationship between board membership and the centrality of the board members in their respective villages. The normalized indegrees are considered here to compare the results across social networks (villages) of different size.

	Village 1	Village 2	Village 3	Village 4	Village 5	Village 6	Village 7
Money	.57	.61	.67	.56	.43	.69	.66
Advice	.54	.52	.64	.52	.33	.57	.52
Illness	.56	.60	.61	.44	.55	.65	.57
Dispute	.56	.57	.61	.44	.45	.65	.57
Discussion	.56	.52	.58	.47	.33	.52	.19
Visits	.54	.59	.59	.40	.54	.25	.52

Table 2: Board membership and centrality in the respective villages

There is a moderate to strong positive relationship between centrality and board membership in the respective villages. In average, the strongest relationship is observed in the Wolof village 3, while the weakest is observed in the other Wolof village 5. So, the hypothesis 1 is confirmed,

Subgroup relations in the group and in the institution

Reciprocity within and between language groups in the village community and in the board

Within the language groups, reciprocity is highly significant among the Wolof as well as among the Fulani. This confirms the hypothesis 2a with regard to reciprocity in the village community.
Reciprocal behaviour is at weakest in the material help (social network "Money") and stronger in the instrumental help (social networks "Advice" and "Illness") (see table 3). There is a stronger reciprocity bias among the Wolof than among the Fulani in all social networks. It means that the Wolof help one another in a stronger tendency than the Fulani do. Reciprocity among the Wolof is highly significant in all social networks, while it is not the case among the Fulani (example of the social Network "Money").

	Reciprocity bias conditional on outdegree distribution					
	1 <-> 1		1 <-> 0		0 <-> 0	
	Index value	z-score	Index value	z-score	Index value	z-score
Money	0.0911***	21.5339	0.1993***	15.5351	0.0029	0.2579
Advice	0.2423***	57.2780	-0.0007	-0.0651	0.1709***	15.2405
Illness	0.3432***	81.2357	NaN	NaN	0.1700***	15.1657
Dispute	0.1032***	24.3735	-0.0004	-0.0194	0.0945***	8.4232
Discussion	0.1668***	39.4943	-0.0004	-0.0366	0.1181***	10.5918
Visits	0.2094***	49.5122	0.1413***	12.5019	0.1711***	15.3655

Table 3: Reciprocity bias among and between Fulani (0) and Wolof (1); ***p<0.01

Significant reciprocity between the language groups is only observed in the social networks "Money" and "Visits". In the material help, reciprocity is even stronger between than within

the language groups. Significant differences between the language subgroups are, moreover, observed in the social networks "Money" (material help) and "Illness" (instrumental help) where the Wolof show stronger reciprocal tendencies than the Fulani (see table 4).

	Tests for differences in tau values based on 1000 draws: z-score (P-value) - Fulani = 0; Wolof = 1		
	11vs10/01	11vs00	10/01vs00
Money	-0.5529 (0.5803)	2.2149 (0.0268)	-1.1075 (0.2681)
Advice	1.5821 (0.1136)	1.3007 (0.1934)	2.5096 (0.0121)
Illness	NA (NA)	2.8431 (0.0045)	NA (NA)
Dispute	0.4439 (0.6571)	0.2296 (0.8184)	0.7130 (0.4759)
Discussion	0.9492 (0.3425)	0.9844 (0.3249)	1.3946 (0.1631)
Visits	0.5748 (0.5654)	0.7454 (0.4560)	0.2843 (0.7762)

Table 4: Significant differences in reciprocity between Fulani (0) and Wolof (1)

Furthermore, there is a significant difference between the reciprocity between the Wolof and the Fulani and the reciprocity among the Fulani themselves in the social network "Advice" (z= 2.5096, p= 0.0121). In other words, the reciprocal behaviour of the Fulani among themselves is weaker than the reciprocity between them and the Wolof.

Reciprocity is in general hardly observed in the social networks of the board. This result rejects the hypothesis 2a with regard to reciprocity in the board. Reciprocal behaviour within the Wolof is observed only in the network „After the session" (τ = .2889 with a z-score of 1.9895). Reciprocal behaviour is observed within the subgroup of the Fulani only in the network "Advice" (τ = .1065 with a z-score of 1.7859) (see table 5).

	Reciprocity conditional on outdegree					
	1 <-> 1		1 <-> 0		0 <-> 0	
	index value	z-score	index value	z-score	index value	z-score
Advice	-0.0787	-0.5008	0.1403*	1.6593	0.1065*[9]	1.7859
Before the session	-0.0847	-0.4189	0.0769	1.0458	0.0223	0.3734
After the session	0.2889**	1.9895	0.0303	0.3069	-0.0099	-0.1627
Visits	-0.0940	-0.4403	-0.1134	-1.1988	0.0416	0.6776

Table 5: Reciprocity bias within and between Fulani (0) and Wolof (1) in the board networks: *z<1.65; **z>1.96; ***z>2.58

Significant reciprocity between language groups is observed in the board network „Advice" (τ= .1403 with a z-core of 1.6593). Reciprocity between the Wolof and the Fulani is weak in the other networks, but however, not significant. There are even less observed reciprocal ties between the language groups than expected, but this tendency is not significant.

[9] $z_{\alpha 0/2}$>1.65

There exist no significant differences in reciprocal behaviour between the Wolof and the Fulani in the board networks (see table 6).

	Tests for differences in tau values based on 1000 draws: Z-score (P-value) - Fulani = 0; Wolof = 1		
	11vs10/01	11vs00	10/01vs00
Advice	-0.7614 (0.4464)	-0.7139 (0.4753)	-0.1887 (0.8503)
Before the session	-0.5862 (0.5577)	-0.5023 (0.6155)	-0.4271 (0.6693)
After the session	1.0957 (0.2732)	1.5779 (0.1146)	-0.3627 (0.7168)
Visits	-0.0175 (0.9860)	-0.4749 (0.6349)	1.4804 (0.1388)

Table 6: Significant differences in reciprocity between Fulani (0) and Wolof (1) in the board networks

To sum up, the results of the reciprocity analysis show that the Wolof have a stronger reciprocal behaviour in the social networks of the village community, while there are no significant differences between these language groups in the board. This is partly due to the fact that reciprocity is weakly observed in the board networks. However, the Fulani show a weaker reciprocity tendency among themselves than between them and the Wolof.
That no differences in reciprocal behaviour between the subgroups in the village community are observed in the board confirms the hypothesis 2b with regard to reciprocity.

Multiplexity within and between language groups in the village community and in the board

Table 7 displays multiplex tendencies within and between subgroups in bi-dimensional interactions. In all bi-dimensional interactions, there is a significant multiplex behaviour within the language groups. This confirms the hypothesis 2a with regard to multiplexity in the village community.
Multiplex behaviour among the Wolof is observed to be stronger than that among the Fulani. For example, the probability that a Wolof villager ask another Wolof villager for advice is 0.4488 if she (the first Wolof villager) borrows her (the second Wolof villager) money. Among Fulani, this probability is 0.19993.
The multiplexity of the Fulani towards the Wolof is in many cases stronger than the multiplexity of the Fulani among themselves. In another side, the multiplexity of the Wolof towards the Fulani is hardly observed.

Social Networks	Multiplexity conditional on outdegrees distribution: Index value (ypsilon[10]) and z-scores (two-side test) – 0=Fulani; 1=Wolof				
	Money	Advice	Illness	Dispute	Discussion
Advice	0: 0,1993***				
	0-1: 0,4249 (NaN)				
	1-0: 1,000 (NaN)				
	1: 0,4488***				
Illness	0: 0,2879***	0: 0.2457***			
	0-1: 0,2452***	0-1: 0.5535 (NaN)			
	1-0: NaN (NaN)	1-0: NaN (NaN)			
	1: 0,4971***	1: 0.4745***			
Dispute	0: 0,1516***	0: 0.2394***	0: 0,2569***		
	0-1: 0,4964***	0-1: 0.3293***	0-1: 0,3975***		
	1-0: NaN (NaN)	1-0: NaN (NaN)	1-0: NaN (NaN)		
	1: 0,3886***	1: 0.4239***	1: 0,3723***		
Discussion	0: 0,1308***	0: 0.2515***	0: 0,2221***	0: 0,1577***	
	0-1: 0,1392***	0-1: 0.3304***	0-1: 0,2830***	0-1: 0,3307***	
	1-0: NaN (NaN)	1-0: NaN (NaN)	1-0: NaN (NaN)	1-0: NaN (NaN)	
	1: 0,3716***	1: 0.4100***	1: 0,4120***	1: 0,3235***	
Visits	0: 0,0861***	0: 0.1392***	0: 0,0873***	0: 0,1799***	0: 0,2089***
	0-1: 0,0788***	0-1: 0.3488***	0-1: 0,1217***	0-1: -0,0075	0-1: 0,3815***
	1-0:-0.0160	1-0: NaN (NaN)	1-0: NaN (NaN)	1-0: NaN (NaN)	1-0: NaN (NaN)
	1: 0,1481***	1: 0.2003***	1: 0,1151***	1: 0,1840***	1: 0,2429***

Table 7: Multiplexity bias within and between Fulani (0) and Wolof (1) in the social networks of the village community; ***p<0.01

Significant differences in multiplexity behaviour exist between the language groups (see table 8): the Wolof are significantly stronger multiplex among themselves than the Fulani among themselves in bi-dimensional interactions concerning the material help (social network "Money"), the instrumental help (social networks "Advice" and "Illness"), and the emotional help (social network "Dispute").

Social networks	Relations	z-score	p
Money-Advice	11 vs. 00	3.5035	0.0004
Money-Illness	11 vs. 00	2.8056	0.0050
Money-Dispute	11 vs. 00	3.5598	0.0004
Money-Discussion	11 vs. 00	3.6334	0.0003
Advice-Illness	11 vs. 00	3.6542	0.0003
Advice-Dispute	11 vs. 00	3.1361	0.0017
Advice-Discussion	11 vs. 00	2.5293	0.0114
Illness-Dispute	11 vs. 00	2.0517	0.0402
Illness-Discussion	11 vs. 00	3.2422	0.0012
Dispute-Discussion	11 vs. 00	3.0674	0.0022
Dispute-Visits	01 vs. 00	-2.1678	0.0302

Table 8: Significant differences in multiplexity between Fulani (0) and Wolof (19 in the social networks of the village community

Despite weaker multiplex behaviour, the Fulani are stronger multiplex among themselves than towards the Wolof.

[10] Upsilon = [Obs N Multiplex - Exp N Multiplex]/[Max N Multiplex - Exp N Multiplex]. Positive Upsilon(> bias) means more multiplex pairs than expected by chance.

In social networks in the board, there is a significant multiplex behaviour within the language groups (see table 9). This confirms the hypothesis 2a with regard to multiplexity in the board. Multiplexity of the Fulani towards the Wolof is also significant.

	Multiplexity conditional on outdegree distribution: Index-value (ypsilon[11]) and z-scores (two-side test) – 0=Fulani; 1=Wolof		
	Advice	Before the session	After the session
Before the session	0: 0.4070***		
	0-1: 0.7049***	---	---
	1-0: -0.1538		
	1: -0.1429		
After the session	0: 0.1816**	0: 0.4240***	
	0-1: 0.5000**	0-1: 0.5135***	---
	1-0: 0.1111	1-0: 0.1504	
	1: 0.5294***	1: -0.1429	
Visits	0: 0.3915***	0: 0.2568***	0: 0.3316***
	0-1: 0.7000***	0-1: 0.7978***	0-1: 0.4545**
	1-0: 0.7778***	1-0: 0.1724	1-0: 0.3271**
	1: 1.0000***	1: 1.0000***	1: 0.5294***

Table 9: Multiplexity bias within and between Fulani (0) and Wolof (1) in the board: *z>1,65; **z>1,96; ***z>2,58

„Perfect“ multiplex behaviour is observed among the Wolof board members according to the board networks „Advice“ and „Visits“: in all cases where a Wolof board member ask another Wolof board member for advice, he visits her regularly to discuss about topics on the water management.

The Wolof board members are significantly less multiplex towards the Fulani board members, while the reverse is not true (see table 10).

Social networks	Relations	z-scores	p
Advice – before the session	10 vs. 01	-2.6192	0.0089
	10 vs. 00	-2.0177	0.0436
Before the session -Visits	01 vs. 00	2.3812	0.0173

Table 10: Significant differences in multiplexity between Fulani (0) and Wolof (1) in the board networks

Moreover, the Wolof board members are less multiplex towards the Fulani board members than the Fulani board members among themselves. Finally, the multiplexity of the Fulani board members towards the Wolof board members is stronger than the multiplexity of the Fulani board members among themselves. But, are both language groups compared with one another, there are no significant differences between them (ingroup multiplexity) in the social networks of the board.
That the differences in multiplexity observed between the language groups in the village community are not found in the board confirms the hypothesis 2b.

[11] Upsilon = [Obs N Multiplex - Exp N Multiplex]/[Max N Multiplex - Exp N Multiplex]. Positive Upsilon(> bias) means more multiplex pairs than expected by chance.

Exchange within and between language groups in the board

In all bi-dimensional social interactions, there is significant exchange behaviour within the language groups (see table 11).

Social networks	Exchange: Index value (ε) and z-scores (two-side test) – 0=Fulani; 1=Wolof				
	Money	Advice	Illness	Dispute	Discussion
Advice	0: 0.0823***				
	0-1: 0.3328***				
	1-0: -0.0007				
	1: 0.1748***				
Illness	0: 0.0868***	0: 0.1104			
	0-1:NaN (NaN)	0-1:NaN (NaN)			
	1-0: -0.0003	1-0: -0.0003			
	1: 0.2172***	1: 0.2623***			
Dispute	0: 0.0250***	0: 0.0982***	0: 0.1110***		
	0-1: 1.0000***	0-1: -0.0007	0-1: -0.0003		
	1-0: 0.3998***	1-0: -0.0004	1-0:NaN (NaN)		
	1: 0.1023***	1: 0.1392***	1: 0.1836***		
Discussion	0: 0.0518***	0: 0.0951***	0: 0.0933***	0: 0.0735***	
	0-1: -0.0008	0-1: -0.0007	0-1: -0.0003	0-1: -0.0004	
	1-0: 0.1996***	1-0: 0.1663***	1-0:NaN (NaN)	1-0: -0.0004	
	1: 0.1542***	1: 0.2052***	1: 0.2104	1: 0.1345***	
Visits	0: 0.0225**	0: 0.0809***	0: 0.0387***	0: 0.0862***	0: 0.1145***
	0-1: -0.0008	0-1: -0.0007	0-1: -0.0003	0-1: 0.0711***	0-1: -0.0004
	1-0: 0.1986***	1-0: 0.1652***	1-0:NaN (NaN)	1-0: -0.0018	1-0: 0.3321***
	1: 0.0818***	1: 0.1056***	1: 0.0656***	1: 0.1077***	1: 0.1148***

Table 11: Exchange bias among and between Fulani (0) and Wolof (1) in the social networks of the village community; ***z>2.58

This confirms the hypothesis 2a with regard to exchange in the village community. Further, the Wolof villagers show among themselves stronger exchange behaviour than the Fulani among themselves in all social networks. For example, the probability that a Wolof villager reciprocates a network tie in the social network "Money" of another Wolof villager through another network tie in the social network "Illness" is 0.1748. Among the Fulani, this probability is 0.0823.

Significant differences exist between the Wolof and the Fulani in exchange behaviour (see table 12): exchange behaviour of the Wolof among themselves is significantly stronger than exchange behaviour of the Fulani among themselves in bi-dimensional interactions concerning the material help (social network "Money"), the instrumental help (social networks "Advice" and "Illness"), and partly the emotional help ("Dispute").

Social networks	Relations	z-score	p
Money-Advice	11 vs. 00	2.3625	0.0182
Money-Illness	11 vs. 00	2.9742	0.0029
Money-Dispute	11 vs. 00	2.5378	0.0112
Money-Discussion	11 vs. 00	2.7198	0.0065
Money-Visits	11 vs. 00	2.0637	0.0390
Advice-Illness	11 vs. 00	3.7974	0.0001
Advice-Discussion	11 vs. 00	3.0250	0.0025
Illness-Dispute	11 vs. 00	2.0650	0.0389
Illness-Discussion	11 vs. 00	3.1745	0.0015
Dispute-Discussion	11 vs. 00	1.9031	0.0570
Discussion-Visits	01 vs. 00	-2.2493	0.0245

Table 12: Differences in exchange between Fulani (0) and Wolof (1) in the social networks of the village community

Exchange behaviour of the Wolof towards the Fulani is, moreover, significantly weaker than the exchange behaviour of the Fulani among themselves in the bi-dimensional social interaction concerning the social networks “Discussion” and “Visits”.

Exchange behaviour is hardly observed in the board networks (see table 13). This reslut rejects hypothesis 2a with regard to exchange in the board.

	Exchange: Index value (ɛ) and z-score (two-side test) – 0=Fulani; 1=Wolof		
	Advice	**Before the session**	**After the session**
Before the session	0: 0.0124		
	0-1: -0.0182	---	---
	1-0: 0.2246**		
	1: -0.0959		
After the session	0: 0.0918**	0: -0.0014	
	0-1: -0.0746	0-1: 0.1385	---
	1-0: 0.1273	1-0: -0.0370	
	1: 0.0986	1: -0.0997	
Visits	0: 0.0789*	0: -0.0006	0: -0.0192
	0-1: -0.0746	0-1: 0.0769	0-1: 0.0909
	1-0: 0.1093	1-0: 0.1959***	1-0: 0.0103
	1: -0.0878	1: -0.0922	1: 0.1203

Table 13: Exchange bias among and between Fulani (0) and Wolof (1) in the board networks; *z>1.65; **z>1.96; ***z>2.58

Exchange behaviour is, however, stronger observed among the Fulani than among the Wolof board members. Is exchange behaviour observed between the language groups, then there are the Fulani who replicate a tie from the Wolof through another one in another social network and not reversely. For example, if a Wolof board member discusses with a Fulani board member before the session, then the Fulani will ask him for advice in a probability of 0.2246. This tendency is highly significant.

The exchange behaviour among the Fulani is, furthermore, weak. Significant difference in exchange behaviour is solely observed with regard to the discussion networks „Before the session“ and „After the session“: the Fulani have a stronger exchange behaviour towards the Wolof than among themselves (see table 14).

Social networks	Relations	z-score	p
Before the session- after the session	10 vs. 00	1.7259	0.0844

Table 14. Significant differences in exchange between Fulani (0) and Wolof (1) in the board networks

That no differences in exchange behaviour occur in the board confirms hypothesis 2b with regard to exchange.

In sum, significant differences in multiplexity and exchange are also observed between the language groups in the social networks of the village community: multiplexity and exchange are stronger among the Wolof than among the Fulani, and this tendency is the bi-dimensional social interactions largely significant; the Fulani are less multiplex or have weaker exchange behaviour among themselves than towards the Wolof. This shows discrepancies within the Fulani group.
In the board networks, there are no significant differences between the language groups in their (ingroup) multiplex or exchange behaviour. However, the following results are worth to be mentioned: the multiplex behaviour of the Fulani towards the Wolof is stronger than that of the Wolof towards the Fulani and than that of the Fulani among themselves; and the exchange behaviour of the Fulani among themselves is weaker than their exchange behaviour towards the Wolof board members.
Because the subgroup behaviour regarding the differences in reciprocity, multiplexity, and exchange in the village community are not reflected in the board, hypothesis 2b is confirmed.

Homophily and intergroup relations in the village community and in the board

The strongest homophilous behaviour is observed in the social networks of the emotional help („Dispute“), while the weakest homophilous behaviour is observed in the social network „Visits“(see table 15).

	Money	Advice	Illness	Dispute	Discussion	Visits
Village 1	0,8821 (0,0246)	0,8560 (0.0000)	0,9670 (0.0000)	0,9538 (0.0153)	0,8759 (0.0000)	0,7048 (0.0221)
Village 2	0,9814 (0,0128)	0,7959 (0.0140)	0,9550 (0.0000)	0,9411 (0.0258)	0,8909 (0.0211)	0,7853 (0.0280)
Village 3	0,9369 (0,0248)	0,8906 (0.0315)	0,9750 (0.0147)	0,9434 (0.0134)	0,9466 (0.0280)	0,9095 (0.0170)
Village 4	0,9558 (0,0166)	0,8408 (0.1969)	0,9525 (NaN)	0.9983 (0.0000)	0,8688 (NaN)	0,8428 (0.0276)
Village 5	0,8745 (0,00)	0,7047 (0.1907)	0,8096 (0.2060)	0.8377 (0.0790)	0,7390 (0.2141)	0,6465 (0.1003)
Village 6	0,7211 (0,0939)	0,6913 (0.1526)	0,8078 (0.2330)	0.9360 (0.0426)	0,7184 (0.1840)	0,5183 (0.0727)
Village 7	0,6973 (0,0512)	0,6951 (0.1636)	0,8636 (NaN)	0.8594 (0.0454)	0,7006 (0.2043)	0,3994 (0.0712)
Gsq	28,7441	126,1445***	46,5695**	40,9878*	83,3288***	145,7462***

Table 15: Homophily (Inbreeding bias) by location in the social networks of the village community; *p<.1;p<0.05;***p<0.01**

Except for the Fulani village 7, homophilous behaviour regarding the location is quite strong. The homophilous tendencies are significant in all social networks. The G-square values suggest that the Inbreeding model is fit in all social networks except for the material help (social network "Money").

Compared with the homophilous tendencies of the respective villages in the social networks of the village community, homophily in the board is very weak (see table 16).

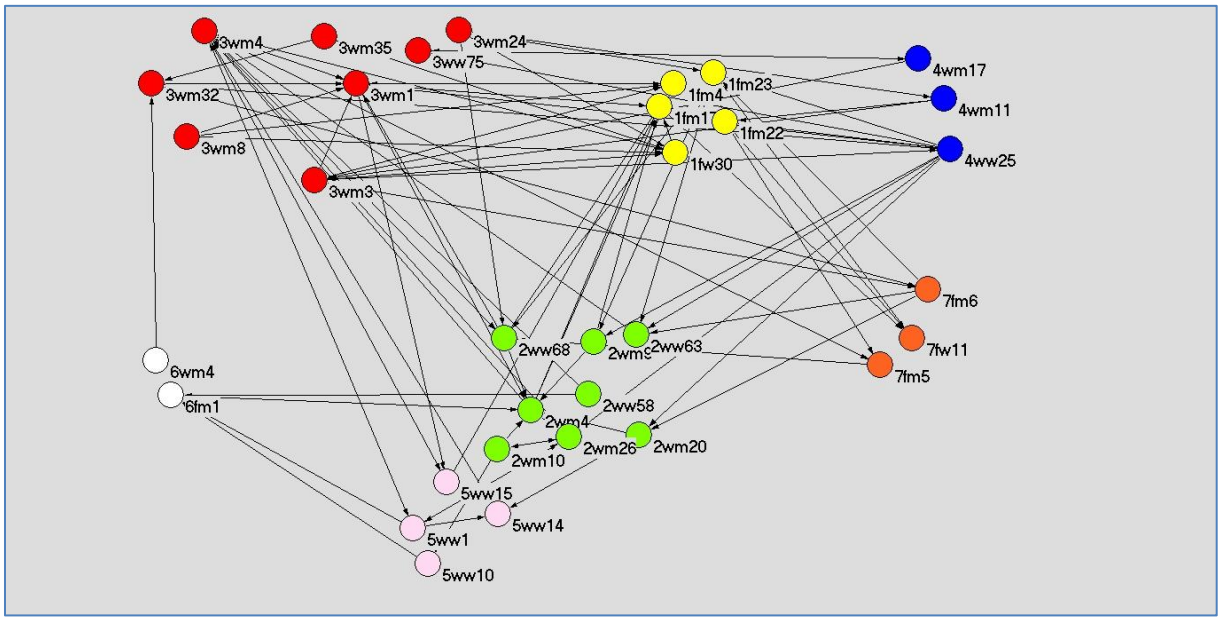
	Advice	Before the session	After the session	Visits
Village 1	0,5093	0,0000	0,0620	0,0537
Village 2	0,1972	0,0505	0,1454	0,1313
Village 3	0,2263	0,0245	0,3212	0,0000
Village 4	0,5479	0,0000	0,0000	0,0000
Village 5	0,0000	0,0000	0,0000	0,4613
Village 6	0,8649	0,0000	0,0000	0,0000
Village 7	0,0864	0,0000	0,0000	0,0000
Gsq	20,0020	63,6327**	69,4456***	42,7251**

Table 16: Homophily (Inbreeding bias) by location in the board networks; *p<.1;p<0.05;***p<0.01**

It is even not observed in the board networks "Before the session" and "after the session" for the villages 4, 5, 6, and 7. In other words, the board members of these villages discuss about topics on the management of the water supply neither before nor after the sessions with other board members from their respective villages.

Homophilous behaviour is stronger observed in the board network „Advice". Furthermore, the Wolof villages 2 and 3, and the Fulani village 1 are those villages which show tendentiously homophilous behaviour of their respective board members.
Figure 8 shows the social network „After the session" where the board members from the villages 4, 5, 6, and 7 are not connected with the board members from their respective villages. Village homophily is also not observed here (τ = .0000 for each village).

Figure 8: Board network "After the session" and location



Homophily is observed among the board members of the Wolof villages 3 (τ= .3212) and 2 (τ= .1454), while it is of lower significance among board members from the Fulani village 1 (τ= .0620).
The Inbreeding model is fit because of the G^2-values of 42.7241, 63.6327 and 67.0443 by 29 degrees of freedoms.

With regard to the language groups, the Wolof and the Fulani show strong homophilous behaviour in the social networks of the village community (see table 17). Homophily strength is slightly equal between Wolof and Fulani.

	Money	Advice	Illness	Dispute	Discussion	Visits
Fulani	0,8570	0,8888	0,9544	0,9398	0,9129	0,7787
Wolof	0,8393	0,8893	0,9543	0,9398	0,9069	0,7081

Table 17: Homophily in the village community by language groups

In the board networks, homophilous behaviour of the language group is very weak, compared with that in the social networks of the village community (see table 18). In the board networks "Before the session" and "Visits", no homophily is observed.

	Advice	Before the session	After the session	Visits
Fulani	0,1036	0,0000	0,0979	0,0000
Wolof	0,1034	0,0000	0,0955	0,0000

Table 18: Homophily in the board by language groups

These results confirm the hypothesis 3: homophilous behaviour of the subgroups is not reflected in the institution.

Since the strength of the homophilous behaviour of the villages and of the language groups is not found in the board, the hypothesis 3 is then confirmed.

DISCUSSION

The following results are found in this paper: first, there is a significant relationship between the centrality in the social networks of the village community and the membership in the board: board members are central actors in the social networks; second, significant reciprocal, multiplex, and exchange behaviour is observed within the language groups, but the significant differences in reciprocity, multiplexity, and exchange between them (Wolof and Fulani) which are observed in the village community are not found in the board; and third, the strong homophilous behaviour with regard to the location and the language groups becomes also milder in the board.

That the board members are central network actors in the village community in general, and in their respective villages in particular means that they belong to the local elites. That Fulani and Wolof board members belong to (their respective) local elites, makes them structurally equivalent, so that they can share common views and, from that point, help surmount discrepancies or conflicting relations between the two language groups. The choice of "representatives" through particular subgroups obeys, moreover, an other logic: the board members are either descendants of the village founders or wealthy villagers. The female board members are mostly wives or daughters of wealthy villagers. Furthermore, there are in each village kinship lineages (patri- or matrilineages) and other socio-cultural interest groups which are represented in the board. This subgroup representation in the institution is a sign of

a fair distribution of resources with regard to the access to the administrative apparatus and benefits which could result from institutional work. This can dampen asymmetries within and between subgroups and foster collective action in general, and the cooperation of the Fulani in particular.

The lack of significant differences in (ingroup) reciprocity, multiplexity, and exchange between the language groups in the board, by comparison with the level of the village community, means that a certain level of (social) integration of the Fulani is observed in the institution or in the management of the water supply. However, the failure of the Fulani to implement their interests, for example to depose the board, lies in the discrepancies within this language group: they have a weaker reciprocal, multiplex, and exchange behaviour among themselves compared with the Wolof. This behaviour is even weaker than that towards the Wolof. These discrepancies can be the basis either of divergent or heterogeneous interests or of lack of a common voice towards the Wolof.

The weak homophily in the board is due to the fact that there is a core of central actors from the villages 1, and mainly 2, and 3 which are mostly asked for help in the board networks. This reduces the homophily of the other villages, since their (less central) members depend more on the core than on the board members of their respective villages. The minimal or weaker homophilous tendencies in the board are advantageous for the central board members from the Fulani villages 1 and 7. Weak homophily indicates integrative patterns of social interactions in the institution that are crucial for successful subgroup cooperation in segregated or heterogeneous groups (see also Ramirez-Sanchez 2011, p.246). In contrast to the level of the village community, there are stronger tendencies for intergroup connections (between speech groups and between villages) in the institution (see also Faye 2012 who finds out that the level of social differentiation constitutes a central explanation for the cooperation of the Fulani).

Another reason why a subgroup which feels discriminated in the management of the water supply, nonetheless, fully cooperates, is that the subgroup relations derived from the wider social structures (social networks in the village community) are not reflected in the institution (social networks in the board). Strong subgroup homophily in the institution could lead to the formation an island structure (Burt 2005) where subgroups form aggregates which are hardly connected to one another.

Because there are still not any studies on the management of Common Pool Resources which deal with reciprocity, multiplexity, and exchange within and between collectively acting subgroups, this paper constitutes a pioneer study. While Biased Net models are up to now used to study marriage connections between socially differentiated subgroups (Skvoretz 2008), reciprocity, multiplexity, and exchange models were used to study formal and informal relations in institutions without an explicit focus on collective action (Skvoretz and Agneessens 2012). There are, however, a wide range of empirical studies on the Commons using a social network analytical approach (see the contributions in Bodin and Prell, 2011), and even studies combining game-theory with field research (Rustagi et al. 2010). These studies relate successful cooperation (of subgroups) with trust, as stated and found in this paper. This paper goes only deeper in the sense that dynamics of collective action is not only located at an “individual” or “subgroup” level, but also in the institution that regulates resource use, enforces individual or subgroup interests in the management of Common Pool Resources.

CONCLUSION

To recap, the discriminated subgroup cooperates fully in the management of the Common Pool Resource because of:

- the level of trust observed in the whole group,
- discrepancies within this group which hinder the enforcement of its specific interests, and
- the integrative character of the institution it carries together with the dominant subgroup.

Social interactions in groups are therefore crucial for the explanation of collective action they are involved in. Subgroup relations depicted in social networks are important to consider since subgroups do not take decisions independently of those decisions or behaviours of other subgroups (see the conditional cooperation in Baland and Platteau, 1999, p.775; Cox et al. 2009; and Rustagi et al. 2010:964).

But, the resolution of discrepancies through institution occurs, furthermore, at another level, namely in collective decision settings which include directly members of the institutions, and regulate as well as accompany the management of Common Pool Resources. This means that social networks are not alone sufficient to explain collective action. Further research has to take institutional work into account: how are decisions concerning resource use taken? What subgroups dominate the processes of collective decision making in these settings? Are the subgroup behaviours again or power relations at the group level reflected in the processes of collective decision making in the institution? This shows that not only a multilevel analysis of collective action is now necessary, but also interdisciplinary research (see Poteete et al. 2012), since, in this case, other analytical tools (Becker-Beck 1997; Auer-Rizzi 1998; Nullmeier et al. 2008, for example; and Faye 2012b) are required to analyse dynamics of or in institutions.

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