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Interactive Actor Analysis for Rural Water Management in The Netherlands: An Application of the Transactional Approach

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Abstract Recent developments in the policy sciences emphasize the social environment in which decisions are made. The 'network metaphor' is often used to describe the key role of interactions between interdependent actors involved in decision making. These interactions take place in a policy arena drawn up by actors with an interest in and control over decisions on the issues addressed. Interdependencies, caused by the need for actors to increase their means of realizing objectives, are the driving force behind these interactions. Dependency relations are of special interest to water management and river basin management because of the fundamental asymmetrical interdependencies that exist in river basins between upstream and downstream stakeholders. Coleman's linear system of action models decision making process involving dependencies between multiple stakeholders as exchange of control over issues, while interactions are required to negotiate exchanges of control. We developed an interactive method for actor analysis based on Coleman's linear system of action and applied it to the national rural water management policy domain in The Netherlands. The method is firmly rooted in mathematical sociology and defies the criticism that methods for actor and stakeholder analysis do not specify a theoretical basis explaining the causal relations between the variables analyzed and policy change. With the application to the rural water management policy arena we intended to increase our insight into the practical applicability of this analytic method in an interactive workshop, the acceptability of the approach for the participating actors, its contribution to the process of decision making and our understanding of the rural water management policy arena in The Netherlands. We found that the Association of Water Authorities, the Ministry of Public Works and the Ministry of Agriculture are the most powerful actor in the policy domain, while governance and cost and benefits of rural water management are the most salient issues. Progress in policy development for rural water management is probably most promising for

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the issues governance, costs and benefits, safety and rural living conditions through improved interaction between the Association of Water Authorities, the Ministry of Agriculture and the Rural Credit Bank. Besides these analytic results the interactive approach implemented increased the participants understanding of their dependency on other actors in the rural water management policy domain and supported them in developing a sound perspective on their dependency position. We concluded that the method developed is acceptable to real-world policy decision makers, can successfully be applied in an interactive setting, potentially contributes to the process of decision making by increasing the participants understanding of their dependency position, has the potential to delivers valuable advice for future decision-making and increases our understanding of policy development for rural water management in general.

Keywords Actor analysis · Stakeholder analysis · Policy making · Coleman's social theory · Transactional approach · Negotiation support · River basin management

1 Introduction

Policy development for water management in The Netherlands is organized at three levels. At the national level the Ministry of Public Works and Water Management drafts the Integrated National Water Management Policy Plan. This plan is guiding and binding for the Integrated Provincial Water Management and Spatial Policy Plans, which are translated by the regional water authorities into Regional Integrated Water Management plans. In the formal policy making process the influence of the Ministry of Agriculture is limited to the national level, where it acts as an adviser to the Ministry of Public Works and Water Management in developing the Integrated National Water Management Policy Plan. The entire procedure, including the responsibilities and roles of the other ministries, the provinces and the regional water authorities is formally enacted in the Water Management Act.

Historically water management in rural areas in The Netherlands has been shaped by the demands of the agricultural sector. Farmers and farmers associations dominated decision making in the regional water boards, provinces carried out extensive works to improve the infrastructure for agricultural water management and the Ministry of Agriculture through her program on agricultural land reform and land reclamation dominated the policy cycle in rural water management from the 1950s onward. Although ecological and recreational interests gradually strengthened their influence in the eighties and nineties of the twentieth century, only through the recent decline of the position of the Dutch agricultural sector, especially diary farming and arable crop cultivation on the world market, a significant shift in thinking about rural land and water management took place. According to the Ministry of Agriculture, *The rural area in The Netherlands is under constant pressure. It should provide room for people to live, work and relax in. But it should also provide opportunities for economic production and transportation. At the same time valuable nature areas and unique landscapes should be preserved for future generations. It is therefore of great importance that the right balance is struck between the various uses of the rural area* (LNV 2000).

In reaction to current and anticipated developments the ministry drafted two policy documents. These documents are titled 'Rural Development Program The Netherlands 2000–2006' (LNV 2000) and the 'The Agenda for a Living Countryside' (LNV 2004). The first document addresses agricultural issues and focuses on issues of sustainability and animal health, landscape development and management and also addresses non- agriculture economic activities. The report highlights the importance of cooperation with other ministries, authorities and organizations. In addition the second policy document describes the government's policy for rural areas for the years to come. A living countryside and a sustainable agricultural sector are central to this policy. The Agenda highlights a shift in thinking about rural development and the role of Ministry of Agriculture and government at large. Before embarking on the substantial issue of rural development, in this document two chapters out of seven are used to describe the Dutch and European context and to discuss the shift from governing to governance in rural development. This shift in approach is clearly illustrated in section titles like *everyone plays a part* used in the document (LNV 2004).

The change in perspective on decision making on rural issues of the Ministry of Agriculture described can be depicted as a shift from unicentrism to pluricentrism. According to the unicentric perspective on decision making authorative decisions are made by one decision maker or by a coherent group and the process of decision making develops in accordance with the rational comprehensive method (Lindblom 1959). In the network or pluricentric perspective, policies are not seen as the result of a linear rational process at a central level, but as the result of strategic interaction processes between multiple interdependent actors (Braybrooke 1974; Kunreuther et al. 1982; Teisman 1995). These interaction processes do not develop in accordance with predefined stages, but are better modeled as a series of decision making rounds played between the actors in the policy domain. A policy domain is a set of actors with major concerns about the substantive area, here rural water management, whose preferences and actions on policy events must be taken into account by other domain participants (Laumann and Knoke 1987). An issue area and a policy arena characterize each decision making round. An issue area is a recognized cluster of concerns involving interdependence not only among the actors involved but also among the issues themselves (Haas 1980) while the policy arena is that part of the policy domain where interaction relating to the issue area takes place (Teisman 1995).

As a result of the developments described above the Ministry of Agriculture felt a need to increase its participation in the rural water management policy domain. To facilitate this increased participation the author was hired to implement a participative actor analysis for the national rural water management policy domain using the transactional approach (Timmermans 2004; Schouten et al. 2001; Timmermans and Beroggi 2000).

The use of stakeholder analysis in water management has increased considerably in recent years and most publications on stakeholder analysis in water management stem from 2004 onwards (Hermans 2005). However, methods for actor and stakeholder analysis are often criticized for not specifying a theoretical basis explaining the causal relations between the variables analyzed and policy change (Crosby 1992; Meltsner 1972). Also actor and stakeholder analysis in water management are vulnerable for this criticism. For example, Mylopoulos et al. (2005) incorporate a stakeholder analysis in their combined approach to transboundary river basin management. They identified the main stakeholders in the region and their potential

contribution to river basin management but remain silent on the method for stakeholder analysis used and how possible contributions of stakeholders are evaluated (Mylopoulos et al. 2005). Similarly, Olsson and Andersson (2007) discuss the advantages of model based discussions between stakeholders and how the results of such focused discussions can be improved, with out bringing concept from politics like power and dependence into the argument.

The transactional approach to actor analysis applied in this paper accommodates the point of critic stated above, because it is based on a prominent social theory developed by the American sociologist James S. Coleman (Coleman 1990). According to Coleman's Social Theory, decision making is to be perceived of as a negotiation process in which agreements are reached on the exchange of control over issues between actors in the policy domain. The quantitative implementation of this theory, the linear system of action (Coleman 1990), captures this exchange process in a micro-economic model and can be used to analyze the dependency relations and the exchange process in an empirical policy arena. In addition to qualitative judgments, the quantitative approach of the LSA facilitates the use of mathematical analysis to capture otherwise intractable characteristics of the policy domain analyzed. The importance of dependency relations has also been recognized in relation to transboundary river basin management. According to van der Zaag (2007, p. 2001) *First of all must there be the realization by riparian states and water users groups and individuals that they all are dependent on each other, not only now but also in future.*

The method for actor analyses developed in this paper, starts from Coleman's observation that *exchange in social life can be complicated, for in many areas of social life institutions to facilitate exchanges of social control (especially those exchanges that require more than two parties) are not as well developed as are institutions for the exchange of economic resources* (Coleman 1990, pp. 37–38). Supporting policy decision making should thus focus on a more effective and efficient interaction, in order to increase exchanges of control. A second observation on which the approach developed is grounded is Coleman's realization that in order to implement exchanges, it is important that actors have a good insight into the distribution of interest and control (Coleman 1990). Experimental research on multi-actor multi-issues exchange processes supported these observations. Even in a well-structured experimental policy arena under conditions of full information, LSA based negotiation support significantly improves performance in identifying and implementing profitable exchanges of control and similar models have been applied successfully to predict policy outcomes in Dutch, European and American policy domains (Timmermans and Beroggi 2004; Timmermans 2004; Stokman and Zeggelink 1996; Bueno de Mesquita 1994).

2 Method

2.1 The Linear System of Action

Coleman's social theory explains social development as resulting from exchange of control over issues between actors and belongs to the group of social theories that apply exchange theorizing and rational choice theory (Turner 1998). According to Coleman (1990), any social system exists of actors and issues over which they exercise

control and in which they have some interest. It is each actor's interest in issues under another's control that lead purposive actors (Weber 1958 [1904]) to engage in transactions involving exchanges of control. In these transactions actors maximize their control over issues of their interest. According to Coleman these profitable exchanges of control are the primary explanatory factor for social development. To illustrate the argumentative structure embedded in Coleman's social theory we next present an example from decision making, where decision makers are characterized by their interest in and control over an issue and the decision is framed in terms of exchange of control.

In decision making on the construction of a power plant, the particular electricity company that wants to invest might depend on the banks to finance the plant while at the same time it needs a license from the water authority for cooling water, the provincial government for spatial planning, the local government for environmental and building licenses and the national government and local fire department for safety requirements. Furthermore, the location of the plant in the national electricity network managed by a national authority is relevant, two or three local and regional environmental groups have concerns, a national lobby group fears the nuclear option while a local organization of farmers is planning to invest in the production of wind energy. In this complicated situation the issues at stake reach from environmental and ecological concerns, safety, profitability, financial and technical feasibility, reliability of the electricity supply, spatial planning and maybe more. At the same time these issues are under (shared) control of numerous actors. For examples, the farmer's organization might be willing to sell the land for the power plant if they are granted licenses for the construction of wind turbines and receive the right to connect to the electricity network and a good price for the electricity produced. At the same time the water authority opts for air-cooling instead of water-cooling with reference to ecological concerns, down stream water users and climate change, while spatial planning and local environmental groups are of the opinion that the industrial image of cooling towers does not fit the mainly rural setting.

According to Coleman such a complex decision making process can be described in term of exchange of control. The actors involved need to interact and negotiate to establish the distributions of control and interest and consequently the value of control over the issues at stake to come to a decision (Coleman 1990; Timmermans 2004). At the same time an alternative design for the power plant needs to be developed that incorporates the issues at stake in such a way that the exchange of control can be operationalized through the implementation of this alternative (Timmermans 2004).

The linear system of action (LSA) is the formal implementation of this theory and is based on micro-economic theory and its use of utility theory (Coleman 1990), but deviates from micro-economic theory in its prescription of a specific form of the utility function. Micro-economic theory takes a more general approach and proves that under conditions of positive and declining marginal utility equilibrium exists.[1] In addition, Coleman fixes the general shape of the utility function in the LSA

[1]Micro economic theory does not specify the shape of the utility function. Given the conditions on the first and second derivative of the utility function, positive contribution to utility and declining marginal utility, micro-economic theory proves the general existence of equilibrium, as described in a famous paper by Nash (1950).

Table 1 Matrices of control C and interest X specifying the LSA

$$\begin{bmatrix} c_{ij} & c_{i(j+1)} & \cdots & \cdots & c_{im} \\ c_{(i+1)j} & \cdots & \cdots & \cdots & c_{(i+1)m} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ c_{nj} & c_{n(j+1)} & \cdots & \cdots & c_{nm} \end{bmatrix} \quad \begin{bmatrix} x_{ji} & x_{j(i+1)} & \cdots & \cdots & x_{jn} \\ x_{(j+1)i} & \cdots & \cdots & \cdots & x_{(j+1)n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ x_{mi} & x_{m(i+1)} & \cdots & \cdots & x_{mn} \end{bmatrix}$$

which makes it possible to calculate the competitive equilibrium. The LSA uses a multiplicative utility function:

$$U_i = c_{i1}^{x_{1i}} \cdot c_{i2}^{x_{2i}} \ldots\ldots \cdot c_{im}^{x_{mi}} \tag{1}$$

where U_i is the total utility of actor i, c_{ij} is the amount of control over issue j held by actor i and where x_{ji}, the interest of actor i in issue j, expresses the contribution that this control makes towards the utility of actor i.[2] The variables of the utility function correspond directly to the basic concepts of the LSA: control over issues, c_{ij}, and interest in issues, x_{ji}. Furthermore in the LSA control and interest are relative notions and scaled arbitrarily to 1. In matrix notation a LSA for a social system of n actors and m issues is fully specified by the matrices C and X, the distributions of control and interest over the actors and the issues (Table 1). According to Coleman's' social theory, all actors engage in exchanges of control in order to maximize their utility. This exchange process leads to an equilibrium distribution of control, the competitive equilibrium. The competitive equilibrium for the LSA with initial control distribution C and distribution of interest X is reached at the equilibrium distribution of control, C^*. A method to calculate C^* for a fully specified LSA is presented in Appendix.

When specified for a specific policy arena, the LSA allows for prescriptive advice (Timmermans and Beroggi 2004; Timmermans 2004; Stokman and Zeggelink 1996; Bueno de Mesquita 1994). This advice can however not replace the interaction processes characterizing policy decision making (Timmermans 2004). We therefore use the LSA to model decision making in a policy arena and employ the model as the analytic foundation for an actor analysis workshop. The workshop is designed as a learning process in which actors are supported in improving their understanding of the policy arena they are part of. More specifically we direct our efforts on improving the participants' insight and understanding of the dependency relations characterizing their position in the policy arena. We expect that these insights will contribute to a more efficient identification of profitable exchanges of control and thus to more effective decision making. The interactive process implemented in the workshop described in section three of this paper is based on the calculation

[2]This multiplicative form is also known as a Cobb-Douglas production function and relates production to the input of capital and labor. The utility function used by Coleman in the LSA has the same shape as the Cobb-Douglas production function and control in the LSA is similar to capital while interest reflects labor.

of inter actor dependencies. When C and X are known, the matrix of inter actor dependencies, D, for any LSA can be calculated as:

$$D = C \times X \tag{2}$$

By the matrix operation of formula (2) for each actor i his or her dependence on actor j, the entries d_{ij} in matrix D, is calculated as actor j's control over an issue times the interest of actor i in this issue, summed for all issues; so the higher the control of actor j over issues in which actor i has an interest the greater the dependence of actor i on actor j. The concept of inter actor dependence is especially apparent in river basis management because of the fundamental asymmetrical interdependencies that exist in river basins between upstream and downstream units. Issue linkage has been consistently used and proposed to re-balance asymmetric dependency relations in river basins with erratic success (van der Zaag 2007). An analytic and theoretically grounded approach to analyzing dependencies as proposed in the transactional approach can, at least in theory, increase the success of this strategy.

In addition subsequent analytic applications of the LSA described in Sections 3.6 and 3.7 of this paper make use of the calculation of equilibrium control, C^*. In equilibrium all actors have gained maximum control over their most salient issues and no further profitable exchanges of control between actors exist in the LSA. In contrast to the matrix of inter-actor dependencies, D, the matrix of equilibrium control, C^*, incorporates the double coincidence of wants required to make an exchange of control between two actors viable. A method to calculate the matrix of equilibrium control is presented in Annex A.

The workshop both includes an interactive problem structuring and group modeling process in order to define the LSA, as well as feedback and discussions of analytic results to facilitate learning. Subsequent analysis of the model based on the matrix of equilibrium control, C^*, addresses the potential for exchange of control, the distribution of power over the actors and the value of issues. These analysis further increases our understanding of the policy process and possibly delivers valuable insights for a more informed continuation of the policy process. More specific the analysis can be used by the Ministry of Agriculture to develop better strategies for its participations in the RWM policy arena.

2.2 Defining the LSA

Applying the transactional approach to real world policy arenas requires the definition of an LSA. This definition includes both the structure of the model and a quantification of the model parameters. The actors and the issues relevant to the decision problem at hand define the structure of the LSA. Quantifying the LSA entails the assessment of control of actors over issues and the interest of actors in issues. These are the matrices C and X as introduced in the section above.

2.2.1 Structuring the LSA

To establish the members of the policy arena to be modeled with the LSA, we follow a two-step procedure. First the actors belonging to the policy domain are identified. Second actors belonging to the policy arena are selected. The policy arena contains a subset of the actors in the policy domain and a subset of the major concerns addressed. In order to select these actors we first need to define the substantive

area of concern of the policy domain. This can be a short description of the focus of attention of the issue area addressed, in this case rural water management in The Netherlands. Once the substantive boundaries of the policy domain are determined by specifying its focus of attention, the next task is to identify its empirical members. For our purpose these are actors that have some control over and some interest in the policy domain and are thus able and willing to influence decision making.

To identify influential actors four generic approaches, positional, decisional, reputational and relational have been developed (Knoke 1992). The reputational approach comes closest to what is needed for the LSA. Reputational methods identify the actors that are widely believed by knowledgeable observers to actual have the potential power to move and shake the system. Reputational approaches start out from the subjective judgments of actors of the reputation of other actors in the policy domain (Knoke 1992). The approach starts with the identification of a limited number of key organizations and decision makers, based on their involvement in related decision processes or appearances in the media.

Next these key actors are asked in a questionnaire to name other organizations and decision makers with an interest in and control over decision making in the policy domain. The list is further extended by snowballing the questionnaire. Feedback is given by including a list of all the organizations and decision makers mentioned and asking respondents to tick organizations and decision makers they think have an interest in and control over decision making in the policy domain. The snowballing procedure stops when no new actors are added to the list and the social network closes (Scott 2000). The additional criterion to separate organizations and decision makers belonging to the policy arena from the entire policy domain is the relative high amount of control and interest of the actors in the policy arena. Organizations and decision makers named or ticked most frequently as influential or as having considerable interest belong to the policy arena and are included in the LSA.

2.2.2 Quantifying the LSA

Next, we need to specify in more detail the issues covered by the policy arena. In Coleman's (1990) social theory the issues play a role similar to goals or objectives. They are the intended goals towards which the actors act purposively. Value-focused thinking (Keeney 1992) is an interactive problem-structuring method that explicitly incorporates goal- or objective-oriented behavior. In this framework, Keeney defines objectives as a statement of something that one desires to achieve, while fundamental objectives are essential reasons for interest in the decision situation that guide the effort of actors (Gregory and Keeney 1994; Keeney 1992). Both objectives and fundamental objectives are characterized by a decision context, an object and a direction of preference and are contingent to the decision situation (Keeney 1992). Value-focused thinking (VFT) includes a set of methods that can be used to articulate fundamental objectives in decision making through an interactive process of identifying, structuring, analyzing and understanding objectives.

The next step in completing the LSA is to determine the initial distributions of control and the distribution of interest. Both are matrices with entries for all actors and all issues. The entries in the control matrix C, c_{ij}, depict the control of actor i over issue j. The interest matrix X consists of the entries x_{ji}, the interest of actor i in issue j. To complete the LSA we have to elicit values for all c_{ij} and x_{ji}. In contrast to the parameters of a general utility function, the constants x_{ji} in

the LSA have a specific meaning, as they reflect the interest of actors over issues. This makes it possible to elicit x_{ji}'s by asking assessees directly for their interest in issues. Similarly' control has a specific meaning in the context of the LSA, which can be explained to the assessees and thus elicited directly. These characteristics of c_{ij} and x_{ji} make it possible to use descriptive assessment methods to elicit their value. Descriptive methods usually employ variations of paired comparison in order to derive a complete strong preference order of the attributes, are normally computer supported and therefore easy to implement in an interactive group setting. Examples are the analytic hierarchy process (Saaty 1980, 1996) and interactive preference ordering (Beroggi 1999, 2000). We applied Interactive Preference Ordering and used the statistic dominance method (Rietveld and Ouwersloot 1992) to calculate preference intensities from the resulting ordinal data.

3 Results and Discussion

This section describes and discusses an application of the transactional approach to the rural water management (RWM) policy arena in The Netherlands. With this interactive actor analysis the Ministry of Agriculture intended to increase their knowledge of the actors in the RWM policy domain in a systematic and action oriented way. Our intervention included an actor analysis workshop based on the transactional approach. The design of the workshop is to a large extent determined by the use of the LSA. Most of the freedom in the design is related to the way the results of the LSA are conveyed to the actors. We used dependencies between actors as the focus of discussion. According to the transactional approach only after exchange rates are established and profitable exchanges identified can exchanges of control be made. A good insight of the actors in the dependency relations in the policy arena supports them in identifying profitable exchanges of control and establishing exchange rates (Timmermans 2004; Timmermans and Beroggi 2000; Coleman 1990). The importance of dependency relations has also been recognized in relation to transboundary river basin management (van der Zaag 2007 p. 2001).

The workshop included eight activities. The duration and timing of the activities are given in Table 2. The remaining time is used to receive and introduce the actors and for lunch and coffee breaks. Activities 1, 3 and 6 are required to structure and quantify the LSA. Results of activity 5 are used as a reference for the discussion of activity 7. Finally the workshop is evaluated.

Table 2 Workshop program

Nr.	Activity	Timing
1	Selection of actors	2 months before actual workshop
2	Introduction to the transactional approach	9:30–9:55, 25 min
3	Introduction to rural water management	09:55–10:15, 20 min
4	Structuring the issues	10:30–12:00, 1 h 30 min
5	Modeling dependencies	13:00–13:30, 30 min
6	Quantifying interest and control	13:30–14:00, 30 min
7	Discussing dependencies	14:15–15:45, 1 h 30 min
8	Evaluation of the workshop	15:45–16:00, 15 min

3.1 Selection of Actors

The selection of actors was done well before the start of the workshop. It is included in the workshop design because it is an integral part of the transactional approach. The snowballing questionnaire used to identify the actors to be invited to the workshop and to be included in the LSA posed two questions:

1. In the following table, organizations or departments of organizations approached in this questionnaire to date are listed. Please tick the parties who in your opinion have a considerable interest in and influence on the development of the rural water system in the light of current trends in rural development?
2. Which organizations or departments of organizations not listed to date do in your opinion have a considerable interest in and influence on the development of the rural water system in the light of current trends in rural development?

The first question was followed by a list of respondents that was updated after every new round of the snowballing procedure. The questionnaire ended with a polite request for a reply within ten days of receipt. With the questionnaire, the respondents received a program for the workshop and background information on the selection of organizations and decision makers. The questionnaire was initially sent to three key organizations selected by a representative of Ministry of Agriculture. A total of 21 questionnaires where distributed of which 18 where returned by the respondents (response rate 86%). The organizations listed ranged from agricultural organization and the national organization of water authorities to the Rabobank, a bank rooted in agricultural financing.

To keep the number of paired comparisons and interpretation of the graphical presentation of the resulting dependencies manageable the number of actors and issues, and thus the size of the matrices X and C need to be limited. We therefore grouped all the parties into nine 'actors'. The actor groups are arranged so as to be homogeneous regarding their interest in rural water management. For this workshop all nature and environmental NGO's are clustered in one actor, also actors related to spatial planning are regarded as one actor and so are different institutions belonging to the Ministry of Public Works. Consultants and knowledge organization that function as advisers to relevant actors are not included as separate actors in the LSA model. Table 3 lists the actors drawing up the LSA model of the RWM policy arena. In the workshop all these actors where represented by one individual. All remaining respondents to the questionnaire were invited to join the agenda

Table 3 Actors and issues of the LSA model of the RWM policy arena

Nr	Actors	Issues
1	Spatial planning	Sustainable governance
2	Automotive and Tourism Association	Sustainable management
3	Ministry of Public Works	Sustainable use
4	Agricultural Association	Safety
5	Rural Credit Bank	Rural living conditions
6	Association of Water Authorities	Societal costs and benefits
7	Association of Water supply Companies	
8	Natural and Environment Associations	
9	Ministry of Agriculture	

committee and where dully informed on both planning, program, participants and results of the workshop.

3.2 Structuring the issues

The policy arena was further structured in an interactive setting, using value-focused thinking (VFT). The actors were first asked individually to list at least five objectives prominent in relation to developments in RWM. The participants jotted these objectives on sticky notes. After finishing the inventory of objectives, a second identical set of sticky notes with the objectives was prepared. The participants where than divided into two sub-groups, each group receiving a set of all objectives. Sub-groups were asked to first remove redundant objectives and than to develop a structure of fundamental objectives by clustering. It was explained to the participants that the structure should be based on the reasons why the objectives are important. The goal of the exercise was further stressed by making clear that actors should be able to compare the fundamental objectives in terms of their interest for their organization. The results of the sub-groups where integrated into one set of fundamental objectives in a group-session supported by a facilitator. The VFT process yielded a total of six fundamental objectives (Table 3), resulting from an initial set of 74 objectives. The fundamental objectives ranged from safety against flooding to the societal costs and benefits of rural water management.

3.3 Modeling Dependencies

In this and the next step of the workshop a wireless network of laptop computers with dedicated software is used. All actors are seated behind a table and use an interactive visual tool to model their individual perception of the dependency relations within the policy arena. The modeling tool resembles a centralized bi-directional sociogram[3] as used by sociologists to depict social networks (Scott 2000). The thickness of the arrows indicates the dependency of the actor at the end of the arrow on the actor at the head of the arrow. For an example of the lay out of this modeling tool see Fig. 1. Each participant is confronted with a sociogram in which his or her organization is the actor in the centre. The sociometric star contains in- and outgoing arrows from the centre actor to the outer actor and vise versa. At the start of the modeling session all arrows have equal thicknesses reflecting a fully balanced dependency structure. We asked participants to model their perception of their dependence on the other actors and the other way around in achieving their objectives by using the computer mouse to increase or decrease the thickness of the arrows. The results of the individual modeling of dependencies are saved to the network server for use in step five of the workshop.

3.4 Quantifying Interest and Control

To quantify interest and control we applied Interactive Preference Ordering (Beroggi 1999, 2000). The method uses computer supported paired comparisons and

[3] In fact we use a specific version of the sociogram, namely the sociometric star.

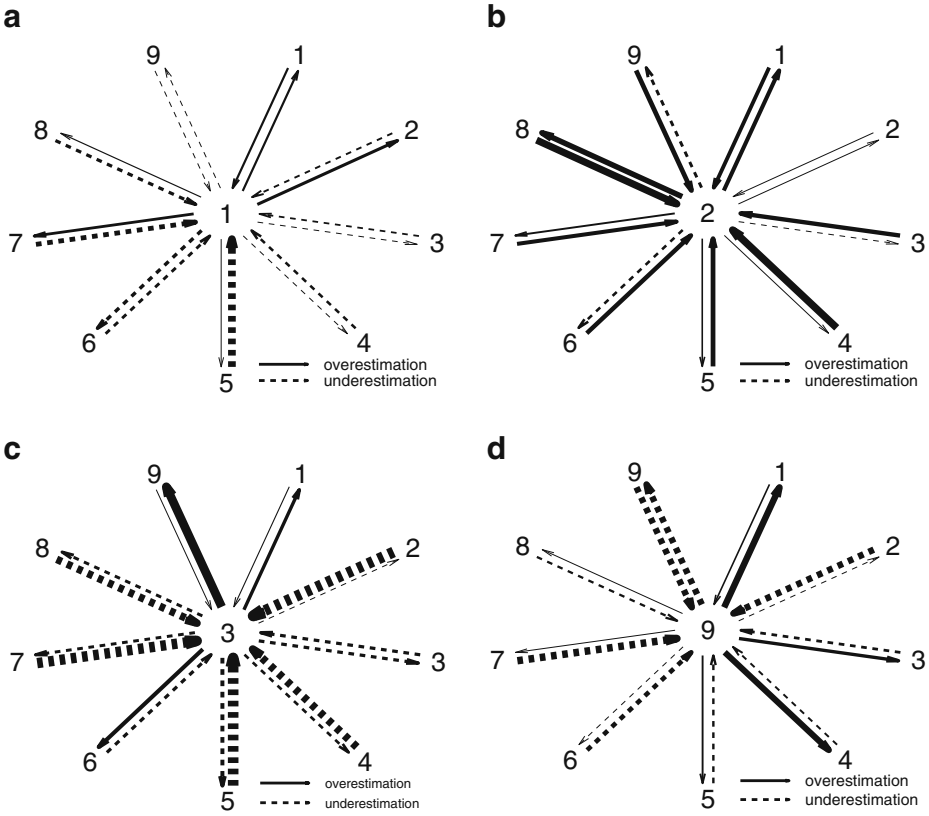

Fig. 1 Individual and system dependencies compared. **a** Spatial planning (1). **b** Automotive and Tourism Association (2). **c** Ministry of Public Works (3). **d** Ministry of Agriculture (9)

transitive inferences to derive a complete strong preference order for both interest and control. The method is integrated in the software used in the previous step and the participants are still seated behind their laptop computers. From the resulting ordinal data, preference intensities are calculated using the statistic dominance method (Rietveld and Ouwersloot 1992). The results of all actors are saved to the network-server and are used to build the LSA model and calculate the equilibrium distribution of control, C^*, and the matrix of inter-actor dependencies, D. The resulting LSA, defined by its actors, issues and the distribution of interest, X, and the distribution of control, C, is presented in Table 4.

3.5 Discussing Dependencies

This part of the workshop is designed to stimulate learning in terms of inter-actor dependencies and facilitate the participants in developing a sound perspective on their dependency position in the RWM policy arena. For the discussion participants are seated behind tables in u-shape with a projection screen in front of the group. The discussions are based on the dependencies calculated with the LSA and the

Table 4 Parameters for the LSA model of the RWM policy arena

	1	2	3	4	5	6	7	8	9	Total
X										
Governance	0.13	0.10	0.41	0.24	0.40	0.13	0.10	0.12	0.40	2.02
Management	0.25	0.16	0.10	0.27	0.15	0.32	0.24	0.23	0.15	1.87
Use	0.17	0.06	0.06	0.27	0.27	0.10	0.16	0.27	0.27	1.63
Safety	0.12	0.41	0.24	0.11	0.03	0.35	0.03	0.07	0.03	1.40
Living conditions	0.21	0.24	0.03	0.04	0.10	0.03	0.06	0.27	0.10	1.07
Costs and benefits	0.12	0.03	0.16	0.07	0.06	0.06	0.41	0.04	0.06	1.01
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	9.00
C'										
Governance	0.21	0.18	0.17	0.13	0.09	0.07	0.06	0.05	0.05	1.00
Management	0.17	0.07	0.16	0.17	0.15	0.10	0.05	0.06	0.07	1.00
Use	0.17	0.21	0.13	0.10	0.10	0.07	0.07	0.08	0.07	1.00
Safety	0.10	0.09	0.14	0.13	0.13	0.10	0.09	0.11	0.10	1.00
Living conditions	0.11	0.18	0.12	0.12	0.10	0.09	0.09	0.08	0.10	1.00
Costs and benefits	0.21	0.20	0.14	0.11	0.12	0.07	0.09	0.05	0.03	1.00
Total	0.98	0.91	0.87	0.77	0.68	0.48	0.46	0.43	0.42	6.00

individual assessments of dependencies derived in step 3. In the following discussion actors are both referred to by their name as well as a number for easy reference to the entries in Tables 4 and 5 and Fig. 1.

3.5.1 System Dependencies

Discussions based on the system dependencies as presented in Table 5 touched upon the importance of spatial planning (1) for rural water management. According to Table 5 the total dependence for all actors is highest for spatial planning (1). These results are in line with the current reframing of water management issues in The Netherlands. In this process of reframing the paradigm shift from sectoral to integrated water management is bolstered by a growing focus on the ecological, cultural and visual quality of the water system itself and the practice that water management facilitates spatial functions gives way for the principle that spatial functions have to adapt to the water system. This new paradigm strengthens the position of the water system and water management, however, the growing ambitions

Table 5 Dependencies for column actors on row actors based on the LSA

D	1	2	3	4	5	6	7	8	9	Total
1	0.16	0.16	0.18	0.18	0.18	0.18	0.16	0.16	0.18	1.56
2	0.15	0.17	0.18	0.15	0.14	0.18	0.16	0.13	0.14	1.40
3	0.15	0.14	0.15	0.15	0.16	0.14	0.14	0.15	0.16	1.33
4	0.13	0.12	0.12	0.13	0.14	0.12	0.13	0.14	0.14	1.16
5	0.12	0.11	0.10	0.12	0.11	0.11	0.11	0.12	0.11	1.02
6	0.08	0.08	0.07	0.07	0.07	0.08	0.08	0.08	0.07	0.67
7	0.08	0.08	0.07	0.08	0.08	0.07	0.08	0.08	0.08	0.70
8	0.07	0.08	0.06	0.06	0.06	0.06	0.07	0.07	0.06	0.59
9	0.07	0.07	0.06	0.06	0.06	0.06	0.07	0.07	0.06	0.57
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	9.00

for the water system at the same time results in an increase in the dependency of water management and the water system on spatial planning. The surprisingly low dependence of rural water management on the Ministry of Agriculture (9) is in line with this development. In the shift from sectoral to integral thinking about water systems, the influence of the agricultural sector is declining and it is not any longer standard practice to adapt the management of water systems to the agricultural function of rural areas only. This development also results in an increase of the importance of the Automotive and Tourism Association (2), representing recreation and tourism ambitions. The high dependence on the Ministry of Public Works (3) is attributed to its position in protecting The Netherlands against flooding from both sea and rivers. Safety remains a strong argument in decision making on water management. It is accepted that the water system can be adapted and transformed to fit diverse ambitions as long as safety is not endangered.

Some remarks made by the participants in the discussion on the system level dependencies reflect the perception of participants on decision making. A number of participants emphasized the role of formal politics and policy and state that these are missing in the model, while others think that the role of the Association of Water Authorities (6) is stronger than depicted as they can influence developments at the level of day-to-day water management and implementation of construction works, bypassing the formal policy and political system. This type of remarks highlight some of the more difficult aspects of the transactional approach used. The model starts from the assumption that subjective perception of the dependency relations are leading. For example, an actor that perceives a high influence of Nature and Environmental Organizations (8) on decision making on rural water management because they receive considerable political support at the national level, will make sure that Nature and Environmental Organizations (8) are involved in the decision making process. The transactional approach does not overlook these influences but incorporates them through the perceptions of the members of the policy arena. For some of the participants this aspect of the transactional approach is difficult to grasp. However, learning in the workshop also included the general notion of dependency relations and their importance for decision making as well as contingent discussions on dependencies in the RWM policy arena.

From the issues addressed, the remarks made by the participants and the progress of the discussion we concluded that the concepts underlying the method for actor analysis used were generally well taken. Participants used the concepts of the transactional approach to discuss specific dependency relations of actors, criticized the results and discussed the approach itself. The implicit representation of the formal policy and political system, however, remained an issue.

3.5.2 Individual Dependencies

The dependencies calculated with the LSA as discussed above are called system dependencies. The individual estimates derived in step 5 of the workshop are labeled individual dependencies. These data are similar to the data of Table 5 but differ in values for each actor as they reflect individual perceptions. The difference between individual and system dependencies gives an impression of the capability of the participants to appraise the dependency position of their organization in the RWM policy arena. By confronting individual perceptions of dependency relations

(individual dependencies) with dependencies calculated with the LSA (system dependencies), we intended to make the participants aware of the presence of diverging perceptions of dependencies and show them how this influences their interaction in the policy arena. In the worse case two members do not interact because they do not perceive a dependency on each other and thus do not have an urge to interact. In addition it is likely that members of the policy arena that perceive a strong dependence on one or more of the other members invests time and effort in a relation that is not reprociated. As a result of this learning process we expect participants to re-evaluate their perception of the dependency relations, identify new opportunities for cooperation and adjust their interaction and negotiation behavior accordingly.

To facilitate the discussion the differences between individual and system dependencies are calculated for each actor and the results are presented on the projection screen using a graphical interface similar to the one used for modeling the individual dependencies. However, in this case the weight of the arrows does not indicate dependence but the difference between individual and systems dependencies and their pattern full or dashed, signifies the under (dashed) or over (full) estimation of dependencies by the individual actors (see Fig. 1).

In Fig. 1 dependence of the central actor on the other actors is represented by the outgoing arrows and the dependence of the other actors on the central actor is depicted by the incoming arrows. Full arrows indicate an overestimation of the dependency relation by the central actor, while dashed arrows indicate an underestimation of the dependency relation. The thickness of the arrow reflects the magnitude of the over or underestimation. So in Fig. 1 a the full arrow running from actor 5 to actor 2 in the centre indicates that actor 2 overestimates the dependency of actor 5 on actor 2. In the continuation of the workshop the discussion focused on the differences between individual and system level dependencies. Underneath we present some of the more interesting results and related discussions.

Figure 1a compares individual and system dependencies for spatial planning (1). In general spatial planning (1) slightly underestimates the dependence of other actors on spatial planning and the other way around. Only for the Automotive and Tourism Association (2) and Association of Water Supply Companies (7) an overestimation of the dependencies by spatial planning (1) occurs, probably because recreation and mobility and drinking water supply are both sectors with a clear and substantial spatial claim sustained by longstanding policies. A remarkable underestimation is found for the dependence of spatial planning on the Rural Credit Bank. This underestimation is probably due to the relative unacquaintedness of these two organizations. Because spatial planning (1) operates in the realm of government distant from individual farmers, the Rural Credit Bank (5) operates close to individual farmers and the two do not easily meet. Some more insight on the interdependence of spatial planning (1) and the Rural Credit Bank (5) can be found in Table 5. From Table 5 it appears that both actors have a relatively high interdependence, 0.18 for the dependence of the Rural Credit bank (5) on spatial planning (2) and 0.12 for the reciprocal relation. This relatively high interdependence probably results from the intimate relation between the Rural Credit Bank and Dutch farmers. The banks is omnipresent in Dutch rural areas and many farmers depend to a large extend on loans from this bank to finance their activities. In practice this means that without the involvement of and consent of the Rural Credit Bank (5) farmers are unable to invest in new technologies or an increase of scale. For example when farmers need to invest

in manure management to improve ground and surface water quality, the Rural Credit Bank (5) is likely to be called upon in order to finance these investments. Spatial planning makes a nearly perfect estimate of the dependency relation with the Ministry of Agriculture (9), probably because historically planning responsibilities in rural areas have been shared with the Ministry of Agriculture (9).

In conclusion, spatial planning does have a realistic perception of its position in the RWM policy arena, only for the Rural Credit bank (5) a significant underestimation occurs. These results reflect the traditional position of the spatial planning sector and its need to interact with many parties in planning exercises. It seems likely that an increased interaction between spatial planning and the Rural Credit Bank can substantially further rural development in relation to spatial panning and its consequences for rural water management.

Figure 1b presents the individual and system dependencies for the Automotive and Tourism Association (2). This organization is mainly an automotive association, but has a growing interest in recreation and tourism. In the workshop the association is represented by their department of recreation. From Fig. 1b is appears that the Automotive and Tourism Association in general overestimates its dependency on other actors and the dependency of the other actors on the Automotive and Tourism Association (in and out going full arrows). Only for governmental organizations like the Association of Water Authorities (6) and the Ministry of Agriculture (9) the Automotive and Tourism Association (2) slightly underestimates its dependency. The biggest overestimations are found for the dependencies of the Automotive and Tourism Association (2) on the Agricultural Association (4) and the Natural and Environment Associations (8) on the Automotive and Tourism Association (2). While the Automotive and Tourism Association (2) overestimates the dependencies of non-governmental institutions like the Agricultural Association (4) and Natural and Environment Associations (8) on Automotive and Tourism Association (2), it underestimates its dependency on governmental organization like the Association of Water Authorities (6) and the Ministry of Agriculture (9).

It seems that the Automotive and Tourism Association (2) does not have great fate in the influence of governmental organizations on water management in rural areas and that they look at non-governmental organizations to take the lead. An increase of their interaction and trust in governmental institution however could help to realize their goals. It seems that this process has already started, seen their participation in this workshop.

Figure 1c presents the individual and system dependencies in the RWM policy arena for the Ministry of Public Works (3). The Ministry of Public Works (3) is represented by their water management department, which has formal responsibilities in water management and flood protection. The most apparent impression from Fig. 1c is the huge underestimation of the dependence of the other actors on the Ministry of Public Works (3) (incoming dashed arrows) and, to a lesser extend, also its dependence on other actors. Only for organizations that belong to their direct formal network in the government system, like spatial planning (1), the Association of Water Authorities (6) and the Ministry of Agriculture (9) the Ministry of Public Works (3) overestimates its dependency. The representative for Ministry of Public Works (3), confronted with this representation, reacted by stating that the model does not include the political system and that non governmental organization exercise their influence their. The representative of the Agricultural

Association (4) remarked that it could be worthwhile to improve the relation with the Agricultural Association (4) because its members own the larger share of the land in rural areas and are thus an important factor in both water management and spatial planning. Opposite to the Automotive and Tourism Association (2), the Ministry of Public Works (3) has a strong confidence in the influence of the formal political system and does not perceive cooperation with non-governmental organizations or cooperation in general as important. The observations made above will probably result in a defensive or uninterested attitude towards interaction in the policy arena. This conclusion fits the longstanding impression that the Ministry of Public Works (3) is a closed and hierarchical organization. In practice this means that cooperation between the Automotive and Tourism Association (2) and the Ministry of Public Works (3) in the area of rural water management does not seem very likely while their dependence on each other is relatively high (0.18 and 0.14 respectively for the dependency of Automotive and Tourism Association (2) on the Ministry of Public Works (3) and from Ministry of Public Works (3) on the Automotive and Tourism Association (2), see also Table 4).

In Fig. 1d the individual and system level dependencies for the Ministry of Agriculture (9) are given. The ministry represents agriculture as an economical sector and has formal responsibilities for planning in rural areas, including the water system. Traditionally the ministry strongly focused on agricultural interests. Recent development in the economical strength of the sector has caused a shift in focus of the ministry form agriculture to rural development. From Fig. 1d it appears that the Ministry of Agriculture (9) perceives a strong dependence on spatial planning (1) and the Agricultural Association (4), their natural partner in the high days of agricultural development. At the same time the Ministry of Agriculture (9) underestimates the dependence of the Automotive and Tourism Association (2), the Association of Water Authorities (6) and the Association of Water supply Companies (7). As a result the Ministry of Agriculture (2) will not be inclined to react positive on interactions with the Association of Water Authorities (6) and the Association of Water Supply Companies (7) in relation to spatial planning and water management. Furthermore from the dashed arrows between the Ministry of Agriculture (9) and itself, indicating self-dependency, it appears that the Ministry of Agriculture (2) significantly underestimates its own position in rural water management. The Ministry of Agriculture (9) feels that it is not in a position to make a difference in this field. Both from the results of the model of dependencies and the discussions it can be concluded that the Ministry of Agriculture (2) still operates from its historical agricultural perspective and has not really internalized the consequences of a more integrated approach in rural water management. Although it perceives a strong dependence on Spatial Planning it does not incorporate resulting dependencies of other actors on the ministry of Agriculture (9) in relation to water management. It seems that the Ministry of Agriculture (2) regards integrating non-agricultural objectives in rural water management as additional to agricultural water management and not as an objective in itself, requiring substantial adaptations in agricultural practices in rural water management.

From the analysis of the dependency relations for the RWM policy arena we conclude that diverging perceptions on dependencies exist. In the case of the ministry of Public Works (3), this is the result of a difference in perception of the process of decision making. The ministry of Public Works (3) has a unicentric perception of

policy making with a key role for governmental institutions. In other cases these reflect a limited insight in the actual dependency relations in the policy arena. Especially representatives of governmental institutions like the Ministry of Public Works (3) and the Ministry of Agriculture (9) show larger differences between system dependencies and their individual dependencies and in general underestimate dependencies. Besides from a stronger believe in the formal political system this probably stems from a limited sensitivity to the pluricentric features of current policy making. Non governmental organizations, like the Automotive and Tourism Association (2) generally overestimate dependency relations. Spatial Planning generally has an accurate perception of its position in the RWM policy arena, probably because of its need to integrate the interests of many stakeholders affected by spatial planning in rural areas.

The perspectives on the dependency relations in the RWM policy arena diverge to a great extend. Participants in the workshop probably have different ideas on the required amount of interaction and on the practical implementation of this interaction, via the formal political system or in direct interaction with stakeholders. From the pluricentric perspective, it is clear that governmental institution need to open up and increase their interaction with non governmental actors, learn how to arrive at a more realistic perception of their position in the decision making process and open up to a role as co-producer of policies. Some of the non-governmental organizations need to increase their interaction with governmental actors and take the formal structures for decision making more serious.

Further analysis of the LSA in the next section, aims to arrive at a better understanding of the RWM policy arena. First the value of the issues and the distribution of power over the actors are addressed, second we discuss the remaining potential for exchange of control and thirdly the identification of clusters of actors and issues that comprise relatively large amounts of potential exchange of control are discussed. The first two analyses mainly increase our insight in the policy arena while the third analysis delivers practical advice on the continuation of the policy process.

3.6 Value of Issues and Power of Actors

From the LSA model of the RWM policy arena, the value vector, v, and the power vector, r, can be calculated (see Appendix). The value vector v, an $m \times 1$ vector, where m equals the number of issues, expresses the value of each issue in the LSA. From Table 6 it appears that governance, in the sense that the actors involved

Table 6 Distributions of value over issues and power over actors

Actor	Power [–]	Issue	Value [–]
Spatial planning	0.15	Governance	0.23
Automotive and Tourism Association	0.07	Management	0.17
Ministry of Public Works	0.16	Use	0.17
Agricultural Association	0.11	Safety	0.11
Rural Credit Bank	0.06	Living conditions	0.11
Association of Water Authorities	0.18	Costs and benefits	0.21
Association of Water supply Companies	0.07		
Natural and Environment Associations	0.08		
Ministry of Agriculture	0.13		
Total	1.00		1.00

are able to coordinate their actions and make and implement decisions related to rural water management, is considered the most valuable issue. This is in line with current developments in rural water management. The overriding influence of the agricultural sector on water management is diminishing and step by step replaced by a plurality of actors and interests complicating coordinated action. That cost and benefits of rural water management scores second is also related to developments in the agricultural sector. Agricultural interest is historically the prime motivation for investments in rural water management and agriculture income constituted the economical backbone of the rural areas. Now the economical strength of the agriculture sector is waning, the economic future of rural areas and meeting the costs of management and maintenance of rural areas are at stake.

The power vector r, an $n \times 1$ vector where n equals the number of actors, is derived from the value vector. The power of an actor equals the sum the control of an actor over each issue multiplied by the value of that issue (Coleman 1990):

$$r_i = \sum_{j=1}^{m} c_{ij} v_j \tag{3}$$

Power in the LSA thus becomes a subjective concept as it not only depends on the control actors have over recourses but also on the interest of other actors in that resource. For the RWM policy arena the power of the actors are distributed as presented in Table 6.

The distribution of power over the actors can also be analyzed in the light of current developments in the agricultural sector. In line with the high value of governance, the Union of Water Authorities is perceived to be the most powerful actor. Water authorities, traditionally strongly related to the agricultural sector, are rapidly broadening their scope and integrating other sectors in their administrative and financial procedures and in their water management policies. Together with the Ministry of Public Works they are believed to be able to deliver the required integrative and coordinating power required to address current issues in rural water management. The relatively high power attributed to actors in the spatial planning cluster highlights the growing influence of other sectors on rural water management. Traditionally the agricultural sector determined courses of action, while nowadays recreation and tourism, ecological and real estate interests exert a significant and growing influence on rural water management. Actors in the spatial planning sector are expected to solve the tension between these interests by developing and implementing effective spatial arrangements.

3.7 Potential for Exchange of Control

The increase in the number of actors and issues related to rural water management in The Netherlands resulted in a growing complexity of decision making on these issues. In the LSA this growing complexity is reflected as an increase in possible exchanges of control, making the identification of profitable exchanges of control by the relevant actors more problematic. In the LSA this increase is expressed as combinatory complexity. With two actors and two issues, four possible exchange relations exists, while for a model of three actors and three issues this number increases to 36. For the LSA model of the RWM policy arena the number of exchange relations equals 2,160. In general the number of exchange relations, p,

equals the number of permutations of two out of n actor's times the number of permutations of two issues out of m issues:

$$p = \frac{n!}{(n-2)!} \cdot \frac{m!}{(m-2)!} \tag{4}$$

Combinatorial complexity is only one element of total complexity and does in now way reflect complexity of real world decision making. However, experimental research has shown that even in the case that complexity is limited to combinatorial complexity identifying profitable exchanges of control seriously exceeds the cognitive capacity of humans (Timmermans and Beroggi 2004). The same research proved that reduction of combinatorial complexity helps actors in identifying profitable exchanges of control (Timmermans and Beroggi 2004). In real world policy arena's, combinatorial complexity can be reduced by defining sub-arena's of a limited number of actors and a limited number of issues including a relatively large remaining potential for exchange of control. This information can be used to inform the decision making process in such a way that interaction in the policy arena is concentrated in these sub-arena's in order to increase the likelihood of identifying profitable exchanges of control. This can for example be achieved by using these sub-arenas's as focused groups in workshop settings. Table 7 gives an overview of these sub-arenas for the RWM policy arena. The hypotheses behind this approach is that the focused attention will result in alternatives that are not only substantially interesting but also fit the interest of the participating actors and are therefore more promising for further decision making. Further research is required to validate this approach.

The remaining potential for exchange of control is a measure for the distance of the exchange system from equilibrium. At equilibrium all actors have maximized their control over all issues and no further possibilities for profitable exchange of control remain in the system. If this is the case, the decision making process is locked and no further progress on the issues with the available actors can be expected. In such a case 'dialogues of the death' (van Eeten 1999) prevail.

Remaining potential for exchange of control at time t, ${}^{t}c^{\phi}$, is calculated as a percentage relative to the maximum potential for exchange of control, thus:

$${}^{t}c^{\phi} = \left[\sum_{ij} \left| c_{ij}^{*} - {}^{t}c_{ij} \right| \Big/ \sum_{ij} \left| c_{ij}^{*} - {}^{0}c_{ij} \right| \right] \times 100\% \tag{5}$$

Table 7 Sub-arena's with high potential for exchange of control

Nr	C^{ϕ}	Actors	Issues
1	0.024	Rural Credit Bank	Governance
		Association of Water Authorities	Safety
		Ministry of Agriculture	
2	0.016	Automotive and Tourism Association	Safety
		Association of Water supply Companies	Living conditions
			Costs and benefits
3	0.013	Agricultural Association	Governance
		Natural and Environment Associations	Living conditions
4	0.012	Spatial Planning	Governance
		Ministry of Public Works	Living conditions
			Management

where ${}^{t}c^{\phi}$ is the distribution of control when the system is as far as possible out of equilibrium and c_{ij}^{*} is the equilibrium distribution of control. For the RWM policy arena, ${}^{t}c^{\phi}$ equals 31%. This is relatively high. Other applications of the transactional approach resulted in values of 26% (Timmermans 2004), 19% (Timmermans and Beroggi 2000), 23% (Timmermans 2001). A relatively high value of ${}^{t}c^{\phi}$ indicates that the decision making process is far from completed and further progress can be made when the actors continue their interactions, re-evaluate their perceptions of the dependency relations and continue to explore possible profitable cooperation's.

3.8 Evaluation of the Workshop

The workshop was evaluated in an open discussion. Participants where asked about their experience in workshop and their opinion on the transactional approach. Participants stated that the workshop increased their insight in the dependency relation within the RWM policy arena, but did not help them to come to grip with substantial issues related to rural water management. Furthermore the workshop and the transactional approach assisted them in acquiring a systems perspective and a long term view of policy development in the RWM policy arena. The clustering of organization involved in spatial planning at the municipal, provincial and national level in one actor, spatial planning, for the LSA model was not deemed adequate. Participants advised to involve these organizations as separate actors in a possible follow up of the workshop. Furthermore the position of spatial planning as the most powerful actor became an issue. Some participants commented that the power of spatial planning in the RWM policy arena is considerable lower than calculated with the LSA because their activities are not bolstered by budget and that spatial planning is depending on sectoral interests for investments. This discussion is comparable to the discussion on the role of formal procedures in policy-making and the role of the informal pluricentric aspects staged by the representative of the Ministry of Public Works earlier in the workshop. The conclusion however remains that spatial planning is perceived as the most powerful actor because of the subjective perspectives of the other actors. Only when these actors internalize the notion that the power of spatial planning is restricted due to its limited investment power will the power of spatial planning calculated with the LSA decline.

4 Conclusions

In this paper an interactive approach to actor analysis based on Coleman's linear system of action was developed and applied to the rural water management policy arena in The Netherlands. The linear system of action for the rural water management policy arena was structured and quantified in a workshop using a computer network and dedicated software and employed to perform an interactive actor analysis. With this application we intended to increase our insight into the practical applicability of this analytic method in an interactive workshop, the acceptability of the approach for the participating actors, the identification of its contribution to the process of decision making and its contribution to our understanding of the rural water management policy arena in The Netherlands. The importance of dependency relations has also been recognized in relation to transboundary river basin management, especially in

relation to the fundamental asymmetry of dependency relations encountered in river basins.

According to Coleman a complex decision making process can be described in term of exchange of control. The actors involved need to interact and negotiate to establish the distributions of control and interest and consequently the value of control over the issues at stake to come to a decision (Coleman 1990; Timmermans 2004). The linear system of action is the formal implementation of this theory and is based on micro-economic theory and its use of utility theory (Coleman 1990). A linear system of action for a social system of n actors and m issues is fully specified by the matrices C and X, the distributions of control and interest over the actors and the issues. In terms of the transactional approach a policy arena is that part of a policy network that offers opportunities for exchanges of control. The actor analysis is used to support actors in identifying profitable exchanges of control. This support is offered both by discussing dependency relations between the actors as well as by analytically identifying these exchanges in the linear system of action and use the results to inform the decision making process.

Applying the transactional approach requires the definition of the linear system of action for the relevant policy arena. This definition includes both the structure of the model and a quantification of the model parameters. The actors and the issues pertinent to the decision problem at hand define the structure of the linear system of action. Quantifying the linear system of action requires the assessment of control of actors over issues and the interest of actors in issues, the matrices C and X of the linear system of action. Structuring the issues emerged as the most intensive and difficult element of the workshop. Participants come up with a multitude of different structures at the start and redefine them or developed new structures in the process. Quantifying the linear system of action in a workshop setting using a computer network and dedicated software proved to be a straightforward activity. The participants did not experience problems with the paired comparisons of the issues in order to quantify interest and control. From the discussions in the workshop it appeared that the meaning of the issues was clear and that the issues were perceived as sufficiently independent and comparable. The assessment of control turned out to be an intensive but straightforward activity. Questions regarding this activity were mainly related to the meaning of control. A number of participants asked if control should be interpreted as the formal role of an actor in the decision making process. This question was answered by explaining that all kinds of control could be included and that the participants' own perception of their importance should be followed.

In the workshop extensive discussions on the dependency relations based on the linear system of Action took place. In the evaluation of the workshop the participants stated that their insight in the dependency relations in the policy arena increased, that the workshop supported them in acquiring a systems perspective including all actors. These contributions can be attributed to the use of the linear system of action and indicate that its use had an additional value in the workshop. Actors also commented that they did not learn on the substance of rural water management, which is also a consequence of the use of the transactional approach as the issues are necessarily addressed in a general sense.

Other contributions were more concerned with the discussions between the participants. Although these discussions were based on the results of the linear

system of action, they cannot be attributed uniquely to it. Most of these contributions were linked to the roles of the actors in the decision making process and could also have been achieved in open discussions. However, the design of the workshop, the selection of participants and the use of the Linear System of Action seemed to create the right setting for this type of discussion to unfold.

From the further analyses of the linear system of action it appeared that the remaining potential for exchange of control in the rural water management policy arena at the time of the workshop equals 31%, indicating that the decision making process is far from completed and further progress can be made. Other applications of the transactional approach resulted in values of around 20%.

The distributions of power and the value of the issues reflect recent development in rural water management in The Netherlands. Governance, in the sense that the actors involved are able to coordinate their actions and make and implement decision related to rural water management, is considered the most valuable issue. This is in line with developments in rural water management in The Netherlands, where the overriding influence of the agricultural sector on water management is diminishing while the growing plurality of actors and interests complicate coordinated action.

The distribution of power over the actors can also be analyzed in the light of current developments in the rural water management. The Ministry of Public Works and the Union of Water Authorities are perceived to be the most powerful actors. Both are rapidly broadening their scope and integrating other sectors in their administrative and financial procedures and in their water management policies. They are believed to be able to deliver the required integrative and coordinating power required to address current issues. The relatively high power attributed to spatial planning highlights the growing influence of other sectors on rural water management. In the same line, the power attributed to the Ministry of Agriculture is relatively low as the historically decisive role of the agricultural sector in rural water management has declined.

Further analysis of the LSA enables the definition of sub-arenas of a limited number of actors and a limited number of issues including a relatively large potential for exchange of control. This analytic information can be used to design the decision making process in such a way that interaction in the policy arena is concentrated in these sub-arenas and the likelihood of identifying profitable exchanges of control increases. This focused attention can possibly result in alternatives that are not only substantially interesting but also fit the interest of the participating actors and are therefore more promising for further decision-making. This combination of content and process in the transactional approach comprises an interesting focus for further development of the method and extension of the workshop design.

The application of the transactional approach to the rural water management policy arena in The Netherlands showed that it is possible to structure and quantify the linear system of action in an interactive setting. It also appeared that the participants could grasp the concepts used and accepted the transactional approach as the starting point for a discussion on dependency relations. Some participants find it difficult to comprehend the way the transactional approach incorporates formal politics through the subjective perceptions of the actors in the policy arena. Trough the discussion of decision-making in terms of dependency relations the transactional approach contributes to the process of decision making by increasing the participants understanding of their dependency position. Further analytic use of the linear system

of action, has the potential to delivers valuable advice for future decision-making and increases our understanding of policy development for rural water management in general.

Appendix: The LSA and the Calculation of Equilibrium Control

In the LSA, there are two sets of elements, one referring to the decision makers i ($i = 1, \ldots, n$) and the other to the issues j ($j = 1, \ldots, m$). Decision maker i has control c_{ij} over issue j and interest x_{ji} in issue j. Decision makers maximize utilities in accordance with a Cobb–Douglas-type utility function:

$$U_i = c_{i1}^{x_{1i}} c_{i2}^{x_{2i}} \ldots . c_{im}^{x_{mi}}$$

where U_i is the total utility of decision maker i, c_{ij} is the amount of control over issue j held by decision maker i and x_{ji} expresses the contribution of this amount of control over issue j to U_i. In the Cobb–Douglas-type utility function, we have:

$$\sum_{j=1}^{n} xji = 1 \; and \; all \; xji \geq 0$$

Let C be the matrix of control, with entries c_{ij} and let X be the matrix of interest with x_{ji}. Both X and C are scaled arbitrarily and are normalized so that:

$$\sum_{i=1}^{m} c_{ij} = 1 \text{ and } \sum_{j=1}^{n} x_{ji} = 1 \text{ and } xji \geq 0 \text{ and } cij \geq 0$$

The matrix of equilibrium control C^*, where the entry c_{ij}^*, stands for the equilibrium control of decision maker i over issue j, can be calculated as $C^* = D_r X' D_v^{-1}$. The matrix D_r is a diagonal matrix with elements r_i and the matrix D_v is a diagonal matrix with elements v_j.

The power vector r, with elements r_i, and the value vector v, with elements v_j, can be calculated as

$$r = (I - CX + E_n)^{-1} \, \mathrm{en}_1 \text{ and } v = (I - XC + E_m)^{-1} \, \mathrm{em}_1$$

where E_n is a square matrix with elements $1/n$, E_m is a square matrix with elements $1/m$ and the vectors en_1 and em_1 are defined as $n \times 1$ and $m \times 1$ columns from these matrices; I is the identity matrix.

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