

# Dynamic actor network analysis for diffuse pollution in the province of North-Holland

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**Abstract** Diffuse pollution problems involve numerous different organizations and this requires decision makers to involve different actors if they want to develop policies that have a chance of being implemented effectively. A first step in such interactive policy development would be to gain an overview of the different actors involved in diffuse pollution problems, as well as their views on the problem, their interests and their means to influence policy development and implementation. Dynamic Actor Network Analysis (DANA) offers a method that helps analysts in providing such an overview, and the use of this method is explored through its application to a case in the Dutch province of North Holland. The described case specifically focuses on the use of herbicides in public space and involves actors from regional water management authorities, municipalities and private sector users. An important finding is that there is an imbalance in the perceptions of actors that needs to be addressed by water management authorities. The paper concludes that DANA is a promising tool for offering new and useful insights to decision makers, although more practical experience is needed to better assess the utility of this analysis tool.

**Keywords** Actor analysis; DANA; diffuse pollution; herbicides; policy development; regional water quality management

## Introduction

Diffuse pollution problems have affected water quality for quite some time and an easy solution is not at hand. The pollution is produced by numerous small sources and addressing these sources requires co-ordination and co-operation among the different organizations and stakeholders who all control a part of the solution. This enhances the need to involve a wide range of organizations in policy development and implementation, as policies can only be successful if several parties are interested to contribute to their implementation. However, past experience suggests that it is difficult to realize effective co-operation among the different parties with their own interests and priorities.

The fact that several parties, or actors, need to be involved in policy development, puts high requirements on the responsible government organizations to find ways to stimulate and organize the involvement of different actors. Numerous actors are present in different areas, resulting in a complex picture. A first requirement for organizing actor involvement therefore, would be to obtain a good insight into the actors in the field by identifying key-actors, their interests, ideas on diffuse pollution problems and possibilities to influence policy development (cf. Weimer and Vining, 1989; Thissen, 2000). Actor analysis seems an appropriate tool to obtain such insight, as it provides decision makers with information on actor networks, supporting them in formulating effective policies that have a higher chance of implementation.

The application of a specific actor analysis method, Dynamic Actor Network Analysis is described in this paper for diffuse pollution problems in the province of North-Holland in The Netherlands. First a short introduction to the case is provided, focusing on policy development for diffuse pollution in the province of North-Holland. Next, the selected analysis method, Dynamic Actor Network Analysis, is introduced. The application of this

method is then described, followed by conclusions on the usefulness of the described method to support policy making.

### **Diffuse pollution policy in the province of North-Holland**

The province of North-Holland is located in the north-western part of The Netherlands and consists of both rural and urban areas, including the Dutch capital city of Amsterdam. The problem of diffuse pollution in the province is addressed by different government organizations, who all have a partial responsibility for water quality management. These organizations co-ordinate their activities in a co-operative body, called the Regional Project Organization for Diffuse Pollution in North-Holland (PODB, 1999). This project organization consists of representatives of the provincial government, the three regional water boards that are present in the province, the regional office of the Dutch Ministry of Public Works and Water Management, and the association of municipalities in North-Holland.

The purpose of the Regional Project Organization is to co-ordinate the activities to address diffuse pollution in the province. As part of this task, the Project Organization is responsible for developing a regional management plan (“Meerjarenplan” in Dutch), stating the issues that have priority in the province. These priority issues are elaborated into specific activities that the government organizations will undertake in the coming years to address diffuse pollution. The priority issues are identified based on monitoring data on water quality standards, calculations and estimations of pollution sources and their loads. Along with this physical picture of water quality standards and the estimated loads, also the possibilities to reduce the loads need to be taken into account. The actors are the key to accomplishing this reduction, and therefore, for an effective policy, also the social picture of the actor network context should be considered.

### **Dynamic Actor Network Analysis (DANA)**

An actor analysis has been executed using Dynamic Actor Network Analysis (DANA), an approach that has been developed at TU Delft (Bots *et al.*, 2000). The approach is based on the assumption that the behaviour of actors is guided by their own subjective perception of the situation they find themselves in. DANA uses these individual perceptions of the different actors as a starting point for comparative analysis. The perceptions of actors are modelled in causal relations diagrams that show the factors and instruments that actors find to be of relevance, together with the causal relations they assume between those elements. These diagrams can be constructed with supporting DANA software, which is linked to a database that supports further analysis.

One of the benefits of using DANA is that it yields insights into the actors’ perceptions on the importance of specific problems, the underlying factors causing these problems, instruments to address problems and actors that control these instruments. Based on this, one can also obtain an indication of the level of agreement or conflict between actors, relations of dependency and sensitive issues (Bots *et al.*, 2000). This information can be used in organizing actor involvement in policy development and in designing and evaluating alternative policy measures. An additional benefit is that the constructed diagrams provide a visual representation of actor perceptions that may serve as an organizational memory and as a basis for discussion amongst analysts and decision makers.

The use of DANA requires input information on the actors’ perceptions for the construction of diagrams. For the case described in this paper, input information has been collected mainly through interviews with actor representatives. The use of interviews as primary information source means that the DANA diagrams only represent the perceptions of the actors’ representatives and that other persons within the same organization might entertain different opinions. Also, some actors will not be willing to share their strategic thoughts

with an analyst to keep possible hidden agendas out of the public debate. To compensate somewhat for these limitations, the interviews have been cross-checked with written information from available policy documents, and representatives at management level have been selected for interviews. These representatives should be capable of sketching an accurate overview of the dominant opinions in their organization.

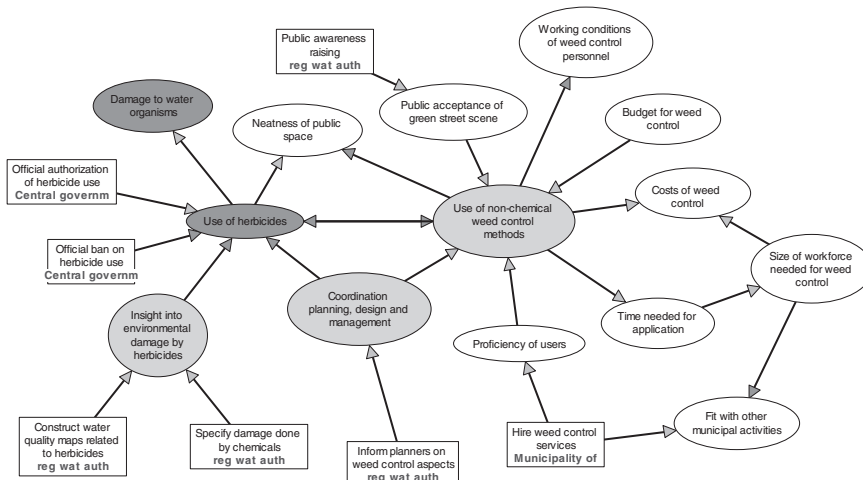
## Results of actor analysis in North-Holland

### Use of herbicides in public space

The actor analysis in North-Holland has been divided into a general and a specific part. The general analysis focused on the actors involved in regional water quality management to get an indication of their priorities. The results gave an impression of the issues that were considered to be important and that could be improved through regional government activities. During a meeting of staff-members of the regional government organizations involved in the Regional Project Organization, the use of herbicides in public space (i.e. the non-agricultural use of herbicides on public roads, pavements, parks and gardens) was selected as a promising issue for further analysis. This further analysis on the use of herbicides served as a case to explore the use of actor analysis in formulating implementable policies, and this analysis is reported in the next sections of this paper.

The use of herbicides in public space was analyzed through a review of available literature and through interviews with three important groups of regional actors: municipalities, water management organizations, and private companies active in weed control in public space. These actors were selected because the municipalities are responsible for the largest use of herbicides in public space, water management organizations can be considered to be the problem owners, and private companies are responsible for the actual use of herbicides, on behalf of the municipalities who hire them. The results of the interviews were documented in a written report and translated into DANA diagrams. Both were sent back to the respondents, together with an explanation, to check for their approval. The resulting DANA diagrams were used as basis for analysis, an example of such a diagram is provided in Figure 1 below.

The diagram in Figure 1 shows the perception of one of the respondents from a large municipality in the province. Important factors are represented as ovals, while rectangles are used for the representation of instruments, including a reference to the actor who controls them. The relations between factors and instruments are indicated by arrows flowing



**Figure 1** DANA diagram of perception of a municipality

from one element to the other. The DANA software uses colours for the arrowheads to indicate the nature of influence: positive (orange), negative (blue), or unknown (black). Objectives and constraints are also represented by using colours: orange factors indicate a desired increase of that factor and blue factors indicate a desired decrease. Drawing these diagrams helps the analyst because the technique forces him/her to structure the information from interviews by identifying and explicating factors and assumed causal relations. Also, the diagrams can be used as a basis for comparative analysis by using the underlying database structure.

#### Identification of relevant factors and instruments

An impression of the relevant factors according to the actors can be obtained by reviewing the frequency with which a factor has been mentioned by different respondents. The results shown in Table 1 are in line with the information from available literature on reduction of chemical herbicide use, which states the importance of factors such as costs and budget available for public space maintenance, the neatness of the street scene and the co-ordination between planning, design and management of the public space (cf. Kortenhoff, 2000). In addition, it also points to the importance of the health and safety conditions for workers in public space maintenance, and the importance of sufficient insight into the impacts of different maintenance practices.

The information on the relevance of *factors* can be complemented by assessing the relevance of *instruments*. The results of this indicate that an official ban on the use of chemical herbicides is widely considered to be a very effective measure. In The Netherlands, the use of herbicides is subject to official authorization and this provides the users with an official excuse for using authorized herbicides. They also indicate that they would stop the application of herbicides if the official authorization would be withdrawn (as this would mean that continued use would be illegal). Besides an official ban, also information and extension activities are widely recognized as useful instruments, where the regional water management organizations should provide information on the specific harmful effects of herbicides and the need to reduce their use, also placed in the wider context of environmental considerations. Knowledge extension on the application of non-chemical weed control methods need not be a priority issue, as both municipalities and private companies indicated that they were familiar with these methods based on past experience and test-application.

**Table 1** Relevance of factors

Name of factor	Relevance (% respondents that mentioned factor)
Costs of weed control	100
Co-ordination between planning, design and management	73
Budget for weed control	64
Neatness of street scene	64
Necessary workforce and time for weed control	55
Health and safety conditions of workers	45
Insight into harmful effects of herbicides	45
Acceptance of green street scene	36
Nuisance and damage to direct environment	36
Political support for non-chemical weed control	36
Damage to the environment	36
Damage to organisms in water and soil	27
Concentration of harmful chemicals in surface water	27
Co-operation of citizens	27
Conc. exceeding standards for herbicides in surface water	27

### Accents in perceptions

The relevance of factors can also be assessed for specific groups of actors, to assess the differences in the perceptions between groups of actors. This reveals that municipalities tend to emphasize the practical consequences that a shift from the use of herbicides to non-chemical weed control would have for their own organization. The use of non-chemical weed control could be difficult to fit in the current activities of those municipalities who still do the weed control themselves. Non-chemical weed control would consume considerably more time than the current application of herbicides, with a peak-pressure on personnel during a relatively short period of the year. Also municipalities recognize that within their organizations, there should be more attention for the co-ordination between planning, design and maintenance of the public space, which is typically done by different municipal departments. Municipalities also point to the importance of having sufficient insight into the specific harmful impacts of using herbicides. Currently, municipalities indicate that their insight into this matter is inadequate, which makes it difficult for them to make a well-informed decision on either the use of herbicides or the use of non-chemical weed control methods. This decision is a trade-off between the good cost-effectiveness ratio of herbicides, against the environmental benefits of non-chemical weed control methods. In this trade-off, the costs and effectiveness are well-known variables for municipalities, whereas specific impacts on water quality are largely unknown.

The private companies that are active in weed control in the public space in North-Holland recognize the negative impacts of using herbicides, but they also point to the wider environmental impact of public space maintenance. Pollution by herbicides is just one environmental aspect, which needs to be balanced against other aspects such as the release of greenhouse gases and heavy metals and the use of fossil fuel sources. Public space maintenance in a densely populated country like The Netherlands will always have negative environmental impacts and the challenge is to find the right balance. These companies feel that, given the biodegradability of the current herbicides and the efficiency of using them, using herbicides is still the best option available, also from a wider environmental perspective. These private companies also identify personnel aspects as being important, as they think that non-chemical methods are likely to have less good health and safety conditions for their workers and that these methods require more time for proper application. This is likely to result in an inability to satisfy the demands of their current customers, as the availability of good personnel might become a bottleneck.

The official water quality standards play an important role in the perceptions of the regional water management organizations. Most of these organizations are responsible for upholding these standards, but do not concern themselves with the possible negative consequences of not meeting the standards. They trust that the standards developed by the higher government bodies are adequate and they do not address the question of possible damage caused by exceeding the standards. Of course this is in line with their official mandates, but it does not ease the communication with the users of herbicides. Also, emphasizing water quality standards requires that it is possible to monitor if these standards are met. However, two of the three regional water boards indicate that their monitoring efforts currently focus on locations where they can measure agricultural herbicides, but which are not very suitable for measuring the impacts of herbicide use in public space and urban areas.

### Conclusions on actor analysis for herbicides in public space

There are several conclusions that emerge from the analysis of actors' perceptions on the use of herbicides in public space in North-Holland, three of which are highlighted here. First, the different actors put a strong emphasis on official standards and regulations, either to defend the use of herbicides or to argue for a ban on their use. Different regulations sup-

port these different claims, and it is not easy to decide which is the better argument. This implies that water management organizations cannot just refer to their official standards in convincing other actors that they should stop their use of herbicides. Second, most actors find it far easier to describe the specific drawbacks of reverting to non-chemical weed control than to describe the negative impacts of using herbicides. This points to a possible communication problem, as the current perceptions show an imbalance between the awareness of negative effects of using herbicides and of negative effects of *not* using herbicides, which will not make it any easier to convince sceptic municipalities of the need to reduce their use. Third, each of the currently available non-chemical methods has important drawbacks for municipalities, mostly in terms of well-known bottlenecks such as costs, personnel and effectiveness. Most actors do not expect that this will change in the near future, which means that these negative impacts cannot be ignored by water management authorities, as municipalities and private companies will surely take them into account in making their decisions.

These conclusions can be translated into recommendations to the regional water management authorities, indicating the activities they could undertake to improve the effectiveness of their pollution reduction policy. The regional water management authorities will have to start with clarifying and specifying the problems related to the use of herbicides. They will have to present well-grounded and clear arguments to convince the other parties of the urgency of the problem and to provide the municipalities with sound arguments that they can use to justify decisions to spend more resources on weed control in return for clear environmental benefits. As long as the benefits are not well-articulated, some municipalities will find it hard to make a rational choice for non-chemical weed control. For the same reason, the water management authorities should work on their own exemplary function. Some still use herbicides themselves in maintaining their properties, and although their own use is in quantitative terms far less than that of municipalities, it will not support their argument. Water management authorities are in a weak position if they request considerable efforts and investments from municipalities, while they are not willing to make these efforts themselves.

It is strongly recommended to start with the above two activities, providing clear arguments and setting a clear example, before approaching municipalities with plans for reducing their use of herbicides. In approaching municipalities, the water management authorities should realize that there are currently very little incentives for municipalities to shift from using herbicides to non-chemical weed control. There are several measures that water authorities could take to add more incentives, ranging from offering support through expertise and subsidies to a more strict application of current local water regulations. Useful information on the application and feasibility of such measures can be obtained by consulting water authorities in other provinces, as some of them already have applied some of these measures in practice.

### **Conclusions on the use of actor analysis to support diffuse pollution policy**

The use of Dynamic Actor Network Analysis has been described for a case of regional policy development on diffuse pollution, focused on the use of herbicides in public space in North-Holland. This case description points to some conclusions on the use of DANA to yield valuable information for decision makers in developing policies that have a higher chance of successful implementation. Two issues seem especially interesting: was the information yielded by the actor analysis *new* and was it *useful*?

Prior to the actor analysis, the general feeling among the regional water management authorities, as expressed during a meeting of staff members, was that the non-agricultural use of herbicides would be a fairly straightforward issue, which offered good opportunities

to be tackled quite easily. They sensed that there was a widespread agreement on the need to reduce the use of herbicides, although they were intrigued by the fact that this reduction was not yet accomplished. In the initial plan therefore, the actor analysis should support the preparation of a meeting between the different actors, during which the first steps could be taken towards an agreement between users and water management authorities on the reduction of the use of herbicides. However, the analysis results showed that this plan was too optimistic, and that the feeling that the use of herbicides had to be reduced was less well-articulated and less widespread than initially thought. Also, it pointed to a possible knowledge gap on the negative impacts of the currently authorized herbicides on water quality. Therefore, the analysis suggests that, before starting the preparations of a meeting with all the actors, the water management authorities should first prepare and present their arguments, and should make a start with working on their own exemplary functions.

Another reason to start an actor analysis on the use of herbicides in public space, was that the regional water management authorities had little information about the municipalities and their practices and policies related to the use of herbicides in North-Holland. The actor analysis has certainly enriched this picture. Both these elements indicate that the analysis produced some new insights for the water management decision makers.

The insights produced by the actor analysis with DANA could be translated into practical recommendations, recommending a sequence of activities that the decision makers should consider in developing a new policy. This indicates that, at least in theory, the information produced by DANA could be useful, although the final test for this aspect is still to come by its actual use in policy development. Whether or not the recommendations are taken up by the decision makers in the Regional Project Organization is not yet clear, as this analysis feeds into a decision making process that is not yet finished. However, for the first general part of the actor analysis, which is not reported in detail in this paper but which was also done using DANA, the decision makers indicated in a joint meeting that they planned to use this information as input for the development of the management plan.

The application of DANA described in this paper thus indicates that this analysis instrument has the potential to yield new and useful information to support decision makers in policy development on diffuse pollution reduction. Nevertheless, one should also be aware of the limitations of the approach. DANA analyses perceptions at a certain moment in time, but in reality, perceptions will change over time. DANA also has to deal with imperfect input information, based on the available literature and the persons and time available for interviews, and of course DANA cannot solve the issue of hidden agendas and strategic information that the actors do not want to be made public. This combines into limited accuracy and uncertainty in the outcomes, which should be kept in mind in using analysis results. Notwithstanding these limitations, DANA is thought to provide a useful tool that enables the use of the information that *is* available on actors and their perceptions. This information might be imperfect and incomplete, but using it is certainly preferable to simply ignoring it. The reality of diffuse pollution and its impacts on water quality forces decision makers to include actors in their policy development, and actor analysis seems to offer promising support in this regard. The single case study described here is of course a very limited empirical base that does not warrant general conclusions. More practical experience would therefore be needed to assess the utility and practical applicability of this tool in more detail.

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