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Frames, scales and actors

A case study of collaborative water governance in Southern Ecuador

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Abstract

The management of a river catchment is a technically and socially complex issue in water governance. Technical issues like erosion, pollution, drought and/or flood risks, wastewater treatment, drinking water provision, etc. all require attention. All sorts of actors ask for attention too: farmers, industry, inhabitants of higher and lower areas, water power plants, municipal, regional or national governments, etc. These actors do not only have their interests and priorities, but also use different frames to make sense of the problem domain. In the case of the Paute catchment (Ecuador), the water power plant that provides electricity to a large part of the country is an important actor. Managing the catchment means for them reducing the sediment in the river, provoked by soil erosion, and resulting in rapid sedimentation of the reservoir. For the sand miners in the sub-catchment of the Tabacay river, however, sediment is not a problem but their source of income, and for the drinking water company of the nearby city, catchment management means in the first place providing sufficient drinking water. The different actors thus frame the central issues in diverging ways but are mutually interdependent to tackle the problem domain in which they all have a stake. We analyse the starting up of a river catchment management process in the Paute and Tabacay catchments. We focus on how the involved actors frame and reframe this complex situation on different levels and how this evolves through the interaction process. Differences in how the actors frame the issues between the Paute and Tabacay catchment could be understood by linking them to the differences in scale level, involved actors and interdependencies. Each actor also highlights a specific part of a complex physical process as the problematic issue, which in turn points the attention to specific other actors. Through starting up a series of facilitated multi-actor workshops the connection between these different frames became possible in direct interaction, leading to the elaboration of a catchment management plan and the establishment of an innovative governance arrangement in the form of a multi-actor catchment council for the Tabacay catchment.

1 Collaborative water governance

In an increasing number of studies the concept of *governance* is used, referring to policy arrangements like network management (Kickert, Klijn, & Koppenjan, 1997; Koppenjan & Klijn, 2004), deliberative policy making (Fischer, 2003; Hajer & Wagenaar, 2003) or collaborative public management (Public Administration Review, Special Issue 2006). The focus lies mostly on the limitations of central steering by the government in complex problem domains, and this is contrasted to the possibilities of horizontal steering. In strongly developed governments, governance often takes the form of actively engaging actors in policy domains previously dominated by government agencies. However, governance can also develop in a bottom-up manner, in domains which are relatively unregulated and unstructured and where citizens, companies or societal organizations take initiatives. In both cases, this requires actors with very different backgrounds to somehow work together. These collaborative arrangements have been studied from various disciplines and perspectives, including inter-organizational relations, alternative dispute resolution, multi-party collaboration, public-private partnerships and network governance.

Collaborative arrangements between multiple actors have been suggested to deal with complex and interdependent problem domains, but collaboration is not easy to achieve or manage (Gray, 1989; Huxham & Vangen, 2005). Habits and routines from one's own group or organization, e.g. how decision are made, cannot be simply transferred to the multi-actor setting. To start with, everyone bring his or her own scripts and routines to the multi-actor setting, and these can diverge substantially, especially when actor from different sectors are involved (Taillieu, Schruyer, & Vansina, 1997). Participants in multi-actor collaboration cannot rely on familiar hierarchical structures either (Prins, 2006), because the situation involves mutually interdependent actors, where none of actors alone has the necessary resources, authority or competences to address the issues on its own.

Managing river catchments is an example of a complex and interdependent problem domain. Interrelated physical processes and mutually interdependent actors make it inherently difficult to manage the divergent claims on water. Technical issues like erosion, pollution, drought and/or flood risks, wastewater treatment, drinking water provision, etc. all require attention. All sorts of actors ask for attention too: farmers, industry, inhabitants of higher and lower areas, water power plants, municipal, regional or national governments, etc. These actors do not only have their interests and priorities, but also use different frames to make sense of the problem domain.

In the case of the Paute catchment (Ecuador), the water power plant that provides electricity to a large part of the country is an important actor. Managing the catchment means for them reducing the sediment in the river, provoked by soil erosion, and resulting in rapid sedimentation of the reservoir. For the sand miners in the sub-catchment of the Tabacay river, however, sediment is not a problem but their source of income, and for the drinking water company of the nearby city, catchment management means in the first place providing sufficient drinking water. The different actors thus frame the central issues in diverging ways but are mutually interdependent to tackle the problem domain in which they all have a stake.

In this chapter we study a process of river catchment management as a form of collaborative water governance. We will focus on the Paute catchment, extending over several provinces in the Southern Andes of Ecuador and draining to rainforest areas to the east of the Andes (part of the Amazon catchment). Within the Paute catchment two pilot projects were started at the level of subcatchments. In this study we zoom in on the management of the relatively small Tabacay catchment, close to the city of Azogues.

2 The issue is: what is the issue?

In multi-actor settings, the various stakeholders often voice divergent opinions about what the issue is exactly, or what the whole situation is about (Lewicki, Gray, & Elliott, 2003). From their different backgrounds they direct attention to different aspects of the situation and tell a different story about what is going on and what should be done. In other words, they frame the issue in divergent ways. The way different actors frame the issues and how these differences are dealt with is an important process in multi-actor settings (Dewulf, Craps, & Dercon, 2004). Most theories about framing and reframing talk about how people *see* different aspects of a situation, based on their individual view and mental models. To understand how actors can, despite these differences and thanks to these differences, collaborate effectively, however, we need to look at how people *depict* the situation for each other. We developed a new, interactional approach to framing (Dewulf et al., in press), focusing on interaction processes, how people react to each other on-going framing and the way they use language to the frame the issues. Instead of focusing on what's going on 'between the ears', we tried to better understand what is going on 'between the noses' of people.

Confusion, misunderstanding and disagreement are likely when participants frame the issues in divergent ways. Often it looks like everybody is talking about the same thing, while they frame that 'same thing' in very different ways. People frame issues by bringing certain aspects of a complex problem domain into the picture (a process of selection), by putting certain aspects on the foreground and others on the background (a process of focusing), and by using certain aspects as the overarching elements within which the rest fits (a process of embedding). When different ways of framing the issue encounter each other, ambiguity or multivocality ensues (Weick, 1995). This results from the simultaneous presence of two or more ways of framing the situation.

When multiple actors start defining the meaning of 'integrated catchment management', the possibilities for multivocality are endless. Different ways of framing issues can find their origin at several levels. Frame differences can originate out of different scientific disciplines, like the social and natural sciences. Different levels of government act within different electoral, administrative and responsibility frames. Natural resources may also mean very different things for actors like industries, farmers, tourist agencies or environmental NGO's. Apart from these more institutionalized stakeholders, loosely organized and sometimes transient stakeholders can emerge, for example a group of inhabitants of a frequently flooded region or a protest group against the construction of a dam. On a higher level, cultural traditions or beliefs can inform different ways of making sense of a situation, as can very personal experiences which are part of a personal subjective history. Wherever these differences in framing the issues come from, our focus is on what the relevant frame differences are in the specific situation of natural resources management at hand. As (Pahl-Wostl et al., 1998) observe: "any theoretical

framework … is generally considered merely one possible scheme of classification. … The value systems of people engaged in actual debates are generally agreed to be more hybrid than stereotypes can account for". The framing concept draws the attention to the concrete interactions where actors bring in their conceptions of problems and possible solutions, and how they affect each other's frames in and through a developing relationship. We adopt an interactional approach to framing (Drake & Donohue, 1996; Putnam & Holmer, 1992), understanding issue frames primarily as sensemaking devices used for interacting and communicating with others. This differentiates our frame concept from an alternative concept of frames as mental schemata (Dewulf et al., in press). Bruner (1979: 102-103) states in this respect:

> Decision theory tends to concentrate upon those cognitive processes that operate in the mind of the detached speaker to guide him to a well-informed performance … [however] a social or political decision is not made with these rational considerations as sole or even primary objectives. Rather, it is made as a vehicle for carrying out the intentions of those empowered to make the decision, and the process of reaching a decision among those involved is more like a conversation than like a rational calculus. It usually results from a set of speech acts."

As Dewulf et al. (2004) showed, the frames that stakeholders use to make sense of situations are both a reaction and an anticipation to a specific problem domain and to specific other stakeholders, and are thus dependent on the unique situation of natural resources management at hand.

3 Actors, scales and issues in the Paute/Tabacay project

A first aspect of framing in catchment management is the delimitation of the problem domain which will be addressed. This is a process of selecting and putting boundaries, whereby some aspects are included and others excluded. One way to delimit and define a problem domain is to define the *scale level*. In the case of catchment management this is a particularly important step – the choice for catchment management in itself involves framing the catchment *level* on the geographical water *scale* as the appropriate one. Lower levels (e.g. river branches or segments) or higher levels (e.g. the global water system) could be chosen on the geographical scale, or the problem domain could be defined by using local, provincial, national or international level on the political-administrative scale. From the perspective of water managers, administrative boundaries are often ill-suited for managing water issues. Even if the choice for catchment scale has been made, various possibilities remain. Are we talking about the entire river basin – the whole area from which a river drains the water to the sea? Or are we talking about a sub-catchment of a tributary river? The variety in river basin size – compare the Amazon basin with the river basin of a small river in a mountainous coastal area – makes choices for a scale for water governance far from straightforward.

Defining a scale level has important consequences for the delimitation of the problem domain in terms of actors, problems and interdependencies. Moreover, the delimitation of the problem domain relates to the actors who happen to be involved in defining the problem domain, and the resulting problem domain in turn attracts certain actors and not other (Dewulf et al., 2004).

We can illustrate this process in the case of the Paute and Tabacay river catchments, which forms the empirical basis of this study. As our point of departure we take the

formulation of university development cooperation project in which Belgian geographers, bio-engineers and organizational psychologists are involved, together with Ecuadorian engineers and social scientists. The title of the project is "Towards integrated catchment management in tropical mountain areas: the problem of sediment management, Paute catchment, Ecuador". Here are a few quotes from the project proposal, in which the Paute catchment is described in the following way:

> "The area is facing important land degradation including water erosion (sheet, rill and gully erosion), tillage erosion, mass wasting and fluvial activity"
>
> "The sediment produced causes serious problems with respect to water use"
>
> "At the long term, the high sediment input into the Amaluza reservoir is a major threat to the country's energy production as ca. 60 % of the electricity of Ecuador is at present produced in the 1200 MW power plant at the Amaluza dam"
>
> "Drinking water companies also face problems: the presence of large quantities of sediment increases greatly the cost of drinking water production (extra purification treatment)"

The issues gets described here in terms of a causal chain, starting at land degradation in the form of soil erosion, which ends up as sediment in the Paute river and produces problems for the water power plant and drinking water extraction downstream. The problem tree in the same project proposal defines the core problem as "poor understanding of excessive sediment load in rivers". Again the focus is on the sediment carried by the river and on better understanding how this functions.

At the start of this project a pilot project is started up on a smaller scale: the Tabacay sub-catchment, which produces considerable amounts of sediment. In the project proposal for the development of a management plan for the Tabacay catchment, a much longer list of problems appears as compared to the original proposal. Drinking water provision for the city is mentioned as the first problem, and further the lack of data about water, sediment, water pollution, changes in river bed and flow rate, deforestation, forest fires, floods, droughts, conflicts between water users, lack of regulation and control.

Although the project at the smaller scale level (Tabacay) is seen as a polit experiences for the project and the higher scale level (Paute), we can already notice important implications of changing from one to the other. These differences can be understood by picturing the main actors at both levels. In the Paute catchment, the main actor is the water power plant, given its financial resources, its national importance for power production and its dependence on the Paute river. For these reason the water power plant had been involved in the formulation of the interuniversity project proposal for the integrated management of the Paute catchment. The proposal also mentions that the water power plant is willing to provide extra funding for the project. The focus on sediment can thus be better understood, because this problem frame highlights crucial issues for the water power plant, like the effect of sediment on the turbines and the long term problem of sedimentation of the reservoir.

In the project for the management of the Tabacay-catchment more and other problems get attention. The city and its drinking water company finance the project. The focus is much more on intervention than on research, and drinking water provision figures as a core issue. In effect, all the drinking water for the city comes from the Tabacay

catchment, but the amount of water is insufficient to guarantee a continuous service for the citizens.

The way in which the situation gets framed reflects here the constellation of actors who were involved in drafting the project proposal. In the Paute catchment the perspective of the water power plant is on the foreground, with sediment as the core issue. In the Tabacay project, the issues are framed from the perspective of the municipal drinking water company, with emphasis on the quantity and quality of water for human consumption. In this way, defining a scale level also brings specific interdependencies in to the picture. The interdependencies between erosion producing actors, the water power plant and electricity users is specific for the Paute catchment level. On the Tabacay catchment level the interdependencies between water and forest managers, the drinking water company, the water users in the city and the citizens living in the Tabacay catchment area get into the picture.

Without making claims about what causes what, we find here a complex set of relations between a certain scale level, a constellation of actors and a constellation of issues: actors define scale levels; scale levels bring certain problems and interdependencies into the picture; a certain set of problems points to a certain set of actors; actors put forward specific problems; a constellation of problems implies a certain scale level; and a certain scale level brings a specific set of actors into the picture.

Defining a scale level thus appears as an important way of delimiting a problem domain in integrated catchment management, but is certainly not the only way. The meaning of 'integrated', for example, is also subject to different interpretations. Integrated can be understood as managing all the water in the catchment, managing all the water-related issues in the catchment, managing all natural resources issues in the catchment, managing all natural resources and social-economic issues in the catchment, etc.

In the next section we will analyse in more detail how the different actors in the Tabacay project frame the issues in the course of an interactive process.

4 Actors and issues in the Tabacay project

Once the Tabacay project started, two lines of activity developed. The university partner specialized in soil and water management starts with collecting data about the current situation in the catchment. The cartographic data are updated and various kinds of measurements are taken. The university partner specialized in organizational support for development projects (ACORDES) starts identifying stakeholders, with the aim of a developing a stakeholder map. In a series of interviews, representatives of the actors are consulted about their view on the situation of the Tabacay catchment, important issues and their opinion about the other actors. The goals of Tabacay project consist of delivering a catchment management plan and the constitution of catchment management council.

With this interview round a wide range of actors enters into the discussion and the diversity of issue frames expands considerably. Table 1 gives an overview of which actors mention which issues during the interviews. Each cross corresponds to one or more statements by an actor about a particular issue. The issues are sorted from more to less frequently mentioned.

Table 1. Actors and issues in the Tabacay project

	deforestation	erosion / sediment	water shortage	air pollution	agriculture threatens forests and water sources	wastewater	sandmine exploitation	burning	agrochemicals	exotic species	total
Cement plant	x	x		x		x	x		x		6
Municipal drinking water company	x	x	x	x	x		x				6
University engineering center		x	x	x	x		x	x			6
Sandmining cooperative	x		x	x		x	x				5
Consortium drinking water associations	x	x	x		x			x			5
Rural communities			x		x	x	x			x	5
Province	x				x	x			x		4
Local government rural communities				x	x	x		x			4
Ministry of Agriculture	x	x	x							x	4
Landowner (upper Tabacay)		x	x	x				x			4
Urban communities	x		x						x	x	4
Centre for Economical Reconversion	x			x					x		3
Ministry of Environment		x				x		x			3
Municipality	x	x			x						3
Ecology Man Environment Foundation	x	x									2
Paute Catchment Management Unit	x	x									2
Municipal citizens' comite	x		x								2
National council for water sources		x									1
Total	12	11	9	7	7	6	5	5	4	3	69

Some context information is needed here:

- 'deforestation' refers to the cutting of wood in the catchment, for creating arable land, for wood as construction material or for wood as source of charcoal
- 'erosion/sediment' refers to the washing away or subsiding of soil, which ends up in the river as sediment
- 'water shortage' refers mainly to water for human consumption
- 'air pollution' refers to the dust in the air, coming from the cement plan just downstream of the Tabacay catchment
- the expansion of agriculture, especially in the higher areas, often results in deforestation and pollution of the soil near water sources
- 'sand mine exploitation' refers to the exploitation of sand from the catchment as construction material, by digging or capturing sand from the river
- 'waste water' refers to the draining of sewage into the Tabacay river
- 'burning' refers to the clearing of soil by burning bushes or forest

- 'agrochemicals' refers to chemical fertilizers, fungicides and pesticides used in agriculture
- 'exotic species' refers to the planting of exotic species, sometimes as part of reforestation programs, including eucalyptus and pine trees that can disturb water regulation

The table gives an overview of the problem domain as the actors describe it that point in time. The interviewers inquired through an open question about problems in the Tabacay basin, but an empty cell in the table does not automatically mean that this actor considers the element as not problematic. Still we can identify some general conclusions from this overview.

Some of the issues are mentioned by a majority of the actors: deforestation, erosion/sediment and water shortage. For these problems enough common ground or shared meaning appears to exist. Other problems are only mentioned by very few actors.

If we read the table from the rows (or actors), we get an indication of how each actor delimits the problem domain at the time of the interview. Some actors, at the bottom of the table, present a fairly narrow circumscription of the problem domain: they mention but one or two issues. At the other side some actors define a broad problem domain: three actors mention six different issues. None of the actors mentions more than six of the ten issues. We can conclude that although some actors voice a broader perspective of the problem domain than others, each actor individually presents a specific and limited view on the problem domain.

5 Actors and issue formulations

Mentioning versus not mentioning issues gives a rough indication of how a certain actor frames the situation. We can however go a step further by looking at how actors formulate these problems in a specific way. Language plays an important role in framing issues (Dewulf et al., 2004). By using certain words and descriptions an issue acquires a specific meaning. Selecting and arranging issue elements into meaningful frames does not happen in an abstract universe but at the level of discourse or language-in-use, in the way issue frames are forged out of language and the way issue elements are linguistically formulated. Below we take a closer look at the three most frequently mentioned issues (deforestation, erosion/sediment and water shortage), to analyze the differences between the actors in how they formulate these issues (cf. Table 2).

Deforestation. If we compare the formulations of the deforestation issue, we note differences in how strongly the issue is formulated. Some actors the 'deforestation problem' in a fairly neutral way (e.g. Paute Catchment Management Unit), while others use stronger language (e.g. Ecology Man Environment Foundation). Situating the issue on the timeline also differs. The cement plant representative speaks of deforestation "over the years"; the Centre for Economic Reconversion stated "they start cutting the forests"; and the Ecology Man Environment Foundation claims "everything is deforestated".

Erosion/sediment. A first difference is evident in the name of this issue: is the problem *erosion* (the loss of soil) or *sediment* (the soil that ends up in the river). Although these are two sides of the same physical process, actors frame differently what is problematic about it. The Municipal Drinking Water Company visualizes a chain of activities:

"deforestation – cultivating steep slopes – erosion". The Ecology Man Environment Foundation highlights the part "soil erosion – sediment in the river". The Ministry of Environment brings the last part of the chain onto the foreground: "sediment in the river – sedimentation of the reservoir". In this way actors mark a specific part of a complex physical process as problematic and as such put certain actors into the picture. A problem formulation in terms of *erosion* points towards actors who suffer from the loss of soil (e.g. farmers), while *sediment* points towards actors who suffer from the soil that is carried by the river.

An even more striking contrast can be noticed with the way the Sandmine Cooperative formulates this question: "because we exploit it, there is practically no sediment in the river". Here sediment is no longer a problem, to the contrary, for them sediment in the river is a source of income.

When comparing these formulations we can also see the earlier mentioned scale level being used in the framing of a specific issue. The National Council for Water Sources formulates the erosion/sediment issue clearly at the level of the Paute catchment, as does the Ministry of Environment. The Cement Plant and the Municipal Drinking Water Company formulate the problem at the Tabacay level.

Water shortage. Here also we can see the scale level appearing as an important dimension in formulating the meaning of this issue. The Municipal Drinking Water Company and the Municipal Citizens' Committee talk about water shortage for the city, which surpasses the scale level of the Tabacay catchment. The Consortium of Water Associations, however, speaks about lack of drinking water *within* the Tabacay catchment. The Rural Communities identify the captation of water for the city by the Municipal Drinking Water Company as the problematic aspect of the issue, and thus frame the issue as one that again surpasses the Tabacay level. These problem formulations have important implications in terms of 'responsible' or 'affected' actors. In one formulation the Drinking Water Company is *affected by* water shortage; in another formulation the Drinking Water Company is actor *causing* water shortage.

Table 2. Actors and issue formulations in the Tabacay-project

	Deforestation	Erosion/Sediment	Water shortage
Cement plant	"there has been deforestation over the years"	"because this is a region with steep slopes and there is no control on irrigation, you get erosion""	
Municipal Drinking Water Company	"one can see the wood cutting"	"the wood cutting and the cultivation of steep slopes provoke erosion"	"the amount of water does not allow for an adequate service to the city"
University engineering center		"there is the big problem of sediments, concentrated in a small specific zone of the catchment"	"they are destroying the water sources"
Rural communities			"the captation of water by the drinking water company, they take al the water"
Consortium drinking water associations	"problem of deforestation" "there is no awareness on the part of the big landowners, we have seen very large forests that are cut"	"at the moment we cut and the vegetation is removed, there is no more protection and the pollution of the river will start" "the moment one starts to plough the ground erosion exists"	"lack of water" "our goal is to protect the natural sources so as to never experience lack of water"

	Deforestation	Erosion/Sediment	Water shortage
Sandmine cooperative	"they have processed the three, they have cut them and they arrived as construction material"	*["because we exploit it, there is practically no sediment in the river"]*	"the advantage of water captations is an advantage for the drinking water company, who in turn delivers the water to the whole city"
Urban communities	"production of charcoal for sale in the city"		"lack of water for human consumption"
Land owner		"further down [the river] gets entirely polluted with sediment"	"I have given them the possibilities so they can do what they want because I see that the city needs water"
Ministry of Agriculture	"the lack of vegetation because everything has been cut"	"the sedimentation of the river, the river is very dirty and contains a lot of sand"	"there isn't almost any water left"
Local government rural communities			
Province	"I have seen that there has been random cutting of wood"		
Centre for Economic Reconversion	"they start cutting the forests and they are not reforestating"		
Municipality	"the deforestation is part of the conflict"	"the erosion is in this case apparently concentrated in the Tabacay catchment"	
Ministry of Environment		"large quantities of sediment eventually end up in the Paute reservoir"	
Paute Catchment Management Unit	"the problem of the deforestation"	"soil erosion and pollution of the rivers"	
Municipal Citizens' Committee	"we can also see that there is a lot of deforestation"		"it interests us to improve the quality and quantity of water for the city"
Ecology Man Environment Foundation	"one the worst problems is the problem of deforestation, everything is deforestated"	"the sedimentation of the river, caused by the erosion of the soils"	
National Council for Water Sources		"just as in the rest of the Paute River, we have big problem of sedimentation of the rivers"	

These differences in problem formulation in the initial interview round illustrate the complexity of the process of framing in the integrated catchment management. Important aspects of framing emerged by comparing the *formulation* of problems. The variety of ways to formulate the issues were related to scale level, situation on a timeline and connecting issues to actors.

6 Issue formulations in a multi-actor process

In this section we analyze the multi-actor process that was set up in the Tabacay project and that led to a management plan and a catchment council. We highlight a number of critical moments in terms of problem formulation.

6.1 Technical and actor problem formulations

At the start of the Tabacay project ACORDES made an actor map while the University Engineering Center made a technical diagnosis of the area. Both actors had the roles of consultants in this process, contracted for the execution of the formulated project. To create ownership for the management plan by a yet to be created catchment council, more was needed than just diagnoses. A series of multi-actor workshops was set up, with the validation of the results from the diagnose phase as the first step.

At this point the problem emerged that both the actor map as the technical studies led to the identification of certain series of problems. Both project partners decided to make a close comparison of the list of technical problems and the list of problems identified by the actors. A large share of the problems appeared in both lists, although in different formulations. Another part of the problems were identified by the actors, but were not in technical problem list:

- pollution of water sources by waste
- careless management of the protected forest
- the sandmine in the river removes sand but clay particles remain in the water
- pollution of the river by the cement plant
- use of chemical products in agriculture
- use of polluted river water for irrigation
- lack of drinking water in the Tabacay area
- lack of drinking water for the city
- air pollution by the cement plant
- sandmine causes turbulent water

Most of these problems could be added under one of the existing technical problem categories. Other problems were added as new technical problem categories: “drinking water shortage”, “careless management of the protected forest” and “lack of technical exploitation of sediments”. The problem of air pollution by the cement plant did not enter the final technical list of problems, because the University Engineering Center did not consider it to be a water problem.

On the other hand, the technical problem list mentioned a few problems not mentioned by the actors:

- Loss of water regulation capacity in higher grounds
- Irrigation without planning
- Overgrazing

That the first of these three problems was not mentioned by the actors was especially remarkable, because the engineers had put it on top of their priority list. This led to a reformulation of the problem. On the list of problems to be validated in the first workshop, it remains first on the list, but with this wording: "agriculture in the higher areas: the soils of the higher areas regulate the water and this function gets strongly disturbed when these soils are cultivated".

The original formulation of the problem presents the *soils* as problem owners. By this technical delimitation, the problem only contains technical elements and the link with human activities or concerns remains obscure. In the reformulation a human activity is mentioned as a cause: agriculture. In this way an important translation takes place, from technical language to a language that is closer to that of the other actors. In the next section we analyze what happens to this problem formulation further.

6.2 Validation of problem formulations in the first workshop

With the first multi-actor event in the Tabacay project a process of interaction and negotiation was put into motion. The first workshop consists primarily of validating the list of problems resulting from the above-mentioned integration of technical and actor problem frames. Through this workshop the process of connecting technical and actor frames is continued but this time in face to face interaction.

We will focus on the reformulated "problem of agriculture in the higher areas". As part of the presentation by the coordinator of the University Engineering Center, this problem gets introduced as follows:

> A first detected problem is the problem of agriculture in the higher areas. It has already been mentioned that the higher part of the catchment has Andean soils, and these Andean soils are one of the most important natural elements in the regulation of the water. We talk about regulation of the water, not so much about production, because is the regulation that converts variable rainfall in a normal and stable flow rate. Those soils of the higher area are extremely important for this regulation because they a high buffering capacity and then start releasing water slowly and that is flow that gives the river a relatively constant flow rate, despite the great variability in rainfall. The big threat for the functioning of this process is in the first instance agriculture, in particular mechanized agriculture, because when plowing these soils that mechanism is ruptured, while it is one the most important in regulating the water. This problem happens to be a problem that was identified as priority by the technicians and was not mentioned by the actors in the catchment.

This intervention starts again from the technical part of the problem (water regulation in the soil) and also agriculture is mentioned again as cause of the phenomenon. The coordinator does add a consequence: disturbing the regulation process that results in a constant flow rate for the river. Although formulated in very technical terms, the link with 'flow rate' provides a possible connection with concerns of the actors. In this way the technical problem becomes more embedded in a relevant social context.

After the presentation of the list of problems, the participants get the opportunity to react. A respresentative of a rural community in the area mentions the problem of fraudulent colonization of the higher community grounds by people who burn the vegetation and start cultivating. After a question of the technical coordinator about the link of that problem with water, the community representative indicates that they

working there 'on a thin layer of soil'. In this way a social problem, put forward by one of the present actors, gets connected to one of the crucial technical problems.

Later in the workshop the facilitator goes through the list of problems one by one in order to let the actors validate them.

> In this first, which we called "agriculture in the higher areas", the technical research team has detected it and they have put on top of the list. They are not really in order of priority, but still for them, if they do not contradict me, this was identified as the problem of the catchment, as one of the most important water problems of the catchment. To validate this, to see if there are no arguments against this, shall we leave this here as a relevant problem of how do you see this, as a problem that has impact on the water?

Here, the facilitator takes up a mediating role between the technical problem formulations and the actors by posing an open question. A first reaction comes from an environmental n.g.o. (not involved in the first interview round), who call the problem a priority.

> I would leave this theme as a priority, because really it is precisely changing the land use that provokes the reduction of the flow rate. Recently an analysis has been conducted with students of the school for hydrology and environment about the soils and water retention, in which there were a few results that the natural cover of vegetation has a capacity for water retention of 80% and that in the planted pine trees it was about 35%, and in the affected soils already less than 30% capacity for water retention. The hydrological behavior of the soil has been analyzed frequently, and there has been said that the soil in the higher areas is very fragile soil. When it looses the capacity for water retention, it is very difficult to recover and conserve it, so we should find a possibility to maintain the original vegetation, if that is possible, because it will allow us to store an amount of water, which in the end is our main goal, isn't it?

The representative of this n.g.o. reformulates the issue here as 'reduction of the flow rate', and gives concrete figures about water retention in soils with natural vegetation versus plantations.

The representative of the Drinking Water Company and sponsor of the project reacts enthusiastically and welcomes this information.

> I'm picking something up from this engineer just said. He just spoke of two important parameters, right, he says 80% compared to another kind of land use 35%. I think, one way or the other, this is what we need to orient ourselves. We don't all have the same professional background, I know nothing about soils for example, but if you talk of an indicator that says, for example, 80% compared to 30%, then you show me clearly the importance of the problem to take into account. Because at that moment, if I don't know the subject, I could say "well if the expert says it is a problem, then it probably is, I can't discuss that". But I think we lack a bit of information to orient us towards the seriousness of the problem. I think we should do that. Good, it is not necessarily part of the commitment for the study by the technical team, but there are other actors that could helps us, right? From the different specializations – I don't know – with a few indicators that orient us to focus effectively and not to overlook problems that could be very relevant and important.

With this intervention he makes a argument for concretization ('parameters', 'indicator'); he welcomes differences and not knowing ('we don't all have the same professions background, I don't know anything about soils for example'); and he acknowledges the contribution of the previous actor and invites more such contributions.

This is followed by a positive reaction by the Ministry of Environment, who supports the point of the technical coordinator and provides further arguments.

> Indeed: the natural forests, the native vegetation is the best to capture water and also to regulate it. Because of the fact that plantations have been used, and there will be much more if it's used for agriculture, it seems to me that things will be very very variable. Agriculture in particular also provokes erosion, so these are very negative things for the water issue.

The technical coördinator of the University Engineering Centre reacts to what he calls the "suggestion" of the representative of the Municipal Water Company to "quantify this problem".

> I think we accept the suggestion to quantify this problem, don't we? It is not so easy, but I think we can try to quantify this and hopefully reach more concrete things, more understandable things, like "the minimum flow rate of the river in this areas could drop by this much". It is rather difficult, somewhat risky, but I think we commit ourselves to give it a try.

In this way he expresses a commitment to studying this aspect, with a view to more "concrete" and "understandable" conclusions. His example 'drop of the flow rate in the river' builds on the intervention of the ecological n.g.o. who talked about a 'reduction in the flow rate', but makes it more precise.

The Ministry of Environment introduces a concrete example as well, regarding the comparison of water retention in natural grassland versus pine plantations.

> There has been a small test: in the same area there was natural grassland and next to it pine plantations. We did an excavation of about 1.50 in both spots and you could see that retention in the grassland was much higher, the humidity was more profound that in the forest plantation.

This provokes a reaction by the coordinator of the technical research team. He clarifies the difference between water retention in the soil and the flow rate of the river.

> Often this subject is reduced to the humidity on the spot itself, which is important, but from there to the flow rate of the river is still another step, and it interests us very much to know more about that. The humidity on the spot itself as well, of course, but the most difficult and the scientific part that we miss the most, is from there to the flow rate of the river.

In sum we can observe that this discussion develops in mode of exchanging information, whereby various participants provide concrete contributions to the discussion, which can be questioned by others, and through which the issue gets explored and clarified. The exchange has important relational aspects as well: the conversation about this specific problem is expanded through the involvement of more actors, de various contributions are valued and commitments are expressed.

Although this discussion still takes place largely among professionals, it provides a number of important steps forward in connecting technical and actor frames. A problem that was initially only identified by the technical research team, and which was reformulated before the workshop, now encounters enough connection with various actors to become the topic of a constructive conversation. The connection between multiple knowledge frames that takes place here in direct interaction is not only a content connection but also and perhaps mainly a relational connection between the actors using these knowledge frames.

In this way most of the problems of the presented list get discussed and qualified in this workshop. A number of new problems gets added to the list as well. Noteworthy is the issue of air pollution by the cement plant. This problem was not included in the final list

because it was deemed not to be water related. In the workshop the issue turns out to be of great concern for a lot of actors and one of them also succeeds to make a connection with water: because the air pollution affects mainly the lower area of the catchment, people move towards the higher areas, with all the negative consequences for water regulation.

6.3 Catchment council and management plan

This first workshop was a good starting point for the rest of the process, which we will only briefly outline here. The involved actors got to know each other better and got acquainted with the approach of integrated catchment management and multi-actor collaboration. The modified and validated list of problems was the starting point for a priority ranking in the next workshops, and an important input for the formulation of the problem tree and the elements of the catchment management plan. A limitation here is that in the project proposal a number of technical designs had already been promised, such that for these issues the result of the multi-actor problem definition could not be taken into account.

The group of actors involved in this series of workshops formed also the basis for the creation of a new catchment council. The interaction process, in which the actors were involved with the topic in usually constructive discussions generated enough energy for the creation of this council. The thorough exploration of the problem domain from different perspectives and the connection of frames in the process made it easier to outline the membership for the catchment council and its sub-commissions.

7 Discussion and conclusion

The management of a river catchment is a complex affair that can be molded into different forms. Technical issues like erosion, pollution, drought and/or flood risks, wastewater treatment, drinking water provision, etc. all require attention. All sorts of actors ask for attention too: farmers, industry, inhabitants of higher and lower areas, water power plants, municipal, regional or national governments, etc. These actors do not only have their interests and priorities, but also use different frames to make sense of the problem domain. In the case of the Paute catchment (Ecuador), the water power plant that provides electricity to a large part of the country is an important actor. Managing the catchment means for them reducing the sediment in the river, provoked by soil erosion, and resulting in rapid sedimentation of the reservoir. For the sand miners in the sub-catchment of the Tabacay river, however, sediment is not a problem but their source of income, and for the drinking water company of the nearby city, catchment management means in the first place providing sufficient drinking water. The different actors thus frame the central issues in diverging ways but are mutually interdependent to tackle the problem domain in which they all have a stake.

We analyzed how the involved actors frame and reframe this complex situation on different levels and how this evolves through the interaction process.

Differences in how the actors frame the issues between the Paute and Tabacay catchment could be better understood by linking them to the differences in scale level, involved actors and interdependencies. The way issues get framed reflects the

constellation of actors who contributed to the project proposal and the scale level on which they operate. Defining the scale level highlights specific interdependencies between specific actors. In sum, a complex interrelationship exists between the delimitation of a certain scale level, a constellation of actors and a constellation of issues.

From the analysis of who mentioned which issue in the interview round for the Tabacay project, we can conclude that some actors voice a broader perspective on the problem domain than others, but that each actor individually presents a specific and limited perspective on the problem domain. A closer analysis of the way different actors formulate these issues yielded even more frame diversity. Each actor highlights a specific part of a complex physical process as the problematic issue, which in turn points the attention to specific other actors. In this case, formulating the issue in terms of 'erosion', for example, bring actors into the picture who suffer from the loss of soil (e.g. farmers), while a formulation in terms of 'sediment' directs the attention towards actors who suffer from the 'dirt' carried by the river. The variety of ways to formulate the issues had also to do with the situation on a timeline, the connection of issues to actors and again, the scale level.

From this analysis we can conclude that scale level is a potentially important dimension of meaning in how issues get framed (see also Kurtz, 2003). Situating an issue on a specific scale (e.g. geographical rather than administrative) and on a specific level (e.g. sub-catchment rather than catchment) is a powerful way of delimiting the problem domain, its actors and interdependencies.

Confronting the problem list distilled from the interviews with the list of technical problems was a first attempt to connect this variety in framing the issues. For one of the crucial problems the formulation in terms of technical aspects obscured the link with human activities or concerns. In a reformulation this problem was connected to agriculture, through a translation of technical language to language that is closer to the language other actors use, and a language in which issues are connected to actors.

Through starting up a series of facilitated multi-actor workshops the connection between these different frames became possible in direct interaction. This connection was not only a connection on the issue framing level but also and perhaps mainly a relational connection between the actors using these knowledge frames. In these facilitated workshops a constructive discussion was initiated in which the problem domain could be explored. The modified and validated list of problems was the starting point for a priority ranking in the next workshops, and an important input for the formulation of the problem tree and the elements of the catchment management plan. The thorough exploration of the problem domain from different perspectives and the connection of frames in the process made it easier to outline the membership for the catchment council and its sub-commissions as well.

The principles of multi-actor collaboration were put to practice here through a series of interviews, interdisciplinary work between engineers and social scientists and a number of facilitated interactive workshops. We can conclude that the attention paid in this process to exploring and connecting different ways of framing the issues in the problem domain contributed to a thorough and jointly validated problem definition. This common ground provided a solid basis (both on the content level as on the relational level) for the development of a catchment management plan and the creation and structuring of a new catchment council.

The importance of connecting technical or scientific frames to frames of other actors emerged as a crucial aspect in this case. More generally in the domain of water governance, that relies heavily on advanced scientific insights, this poses big challenges (Bouwen, 2001; Bouwen & Taillieu, 2004). The translation of technically formulated issues in the direction of the frames used by other actors appear to support this connection. The direct involvement of experts, and the back-and-forth argumentation process and questioning between experts and other actors in a series of formulations and reformulations of the issue can contribute to this often laborious but necessary connection of frames.

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