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Simple material relations handled by complicated organisation by or ”How many (organisations) does it take to change a lightbulb?”

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Abstract

The (biophysical, material) environment is often missing in environmental management research. In an attempt to bridge the 'great divide' between studies of humans and culture and studies of nature and artefacts (Latour 1993) and to better understand how organisation influences the environment, scholars exploring organising processes and their interaction with the environment got together in the *Organisation for the Environment* research programme. Their studies collect multiple situations relevant for environmental management (e.g., the maintenance of water supply in apartment buildings, the changing of light bulbs in a grocery store, and the reformation of water administration in Sweden). Each activity has its own organisation, yet takes place in a context of many organisations. The action (of e.g. changing a defect light bulb) is a result of a series of actions performed in a net of actors (Czarniawska 2000, 2005). Comparison of the studies has led to the introduction of new terms to facilitate discussion around organisational-environmental relationships in environmental management.

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Is it even possible to know what organisation is better or worse for the (natural) environment? And, how can we understand our influence on the environment, and vice versa? In a more practical vein, what environmental effect does environmental management have? What can we learn if we study organisation and ”stuff” in combination and in an environmental context?

These are questions that interest us in our research programme on *Organisation for the Environment*. This programme (Baumann 2004; 2006) was set up in reaction to shortcomings in much research concerning environmental problems – if research was not too technocratic, then the (biophysical, material) environment was actually missing, even in environmental management research! In real life, there is an obvious link between these two realms: technological systems (with environmental effects) are operated by humans and their organisations. We think that organising leaves physical traces, yet there is little research on how the interaction between organisation and technology influences the biophysical environment.

The programme brings together a number of field studies that explore organising processes in industry and society and their interaction with the (biophysical) environment. With time, we hope to be able to contribute to discussions on theories that deal with both organisation and the physical environment in our different areas of interest. What is presented here is my first attempt at drawing together some of the findings and insights from the different projects and from discussions in our group.

Some backgrounds

This interest in combined organisational and environmental studies came out of, on one hand, a realisation about environmental improvement possibilities and, on the other hand, from the identification of a blind spot between environmental management research and environmental science and engineering research.

Blind spots…

Starting with blind spots in general, Latour (1993) describes gaps rooted in the division of knowledge into academic disciplines. The gap between studies of humans and culture and studies of nature and artefacts is described as the "great divide". This is true even for much of the research concerning how we deal with environmental problems, although research has been going of for almost two decades by now. Very little work examining the influence of environmental management on environmental performance has been found.

On the side of environmental science and engineering research, environmental systems studies have become common way of describing the environmental impacts of industrial systems. In such studies, material flows are followed and their quantities (volumes) are described and compared. With methods such as life cycle assessment (LCA), the environmental performance of a product system is described from raw material extraction to waste management in order to see what steps in the product's chain are the most/least polluting ones. In material flow assessments, the flows of a particular material (e.g. copper or paper) are described for a region to find out where the flows are greater and smaller. However, the focus in these studies is usually on the environmental performance of technical systems. They rarely take account of the organisational dimension (e.g., Mac 2000), but the studies have led to the development of methodologies that can describe environmental impacts of systems in parts or its entirety. Similarly, the endeavour for greater 'eco-efficiency' can be characterised as the promotion of eco-efficiency via successful examples

(e.g., von Weizsäcker et al. 1997; Schmidt-Bleek 1998; Hawken et al. 1999), not by the systematic analysis of what the necessary organisational and managerial conditions are.

On the management side, environmental management research has not seriously addressed the (biophysical) environmental impacts (Kolk & Mauser 2002; Heiskanen 2002; Korhonen et al 2004; Kallio & Nordberg 2006). The reason for this is that management research focuses mostly on environmental issues from the perspective of human perceptions, decisions and actions, and stakeholder processes, without evaluating the environmental effectiveness of the strategies and practices employed in industry. Hence, studies have, e.g., identified national differences in the focus on environmental work: e.g., an international comparison revealed that there is more emphasis on undertaking technical measures in Switzerland whereas Swedish industry tends to focus on environmental management systems and environmental reporting (e.g., Belz & Strannegård 1996). However, as such studies have not addressed the environmental performance of the companies, the effectiveness of these different management approaches is not known.

Many studies investigating the relationship between the economic and environmental performance of firms use awkward measures of environmental performance. For example, attempts to correlate changes in economic parameters over time to pH (which is a "constant") or to dependent environmental parameters (such as BOD and TSS) as if they were independent have been found in the literature (e.g., Freedman & Jaggi 1992). When the parameters used are not totally wrong, they are still often lacking (e.g., the constant use of Toxic Release Inventory data as a measure of environmental impact in US studies). Thus, studies on the links between economic and environmental performance are confusing and inconclusive, partly due to poorly operationalised measures of environmental performance.

The research that matches our interest more closely is found in a handful of studies that explore, for example, whether or not efforts with environmental management systems (e.g.

ISO14001) lead to actual environmental improvements (e.g. Kuisma et al. 2000; Ammenberg 2003) and whether or not ecodeisgn efforts in product development led to "greener" products (Al-Okush et al. 1999). A couple of studies studies have addressed the environmental implications of, for example, lean production (King & Lenox 2001) and foreign ownership (King & Shaver 2001), but unfortunately without elaborating on the mechanisms that link specific organisational characteristics with specific material outcomes. Most interesting we've found sofar in relation to organisation and environment are the works of British sociologists Simon Guy and Elizabeth Shove and anthropologist Richard Wilk. Guy & Shove (2000) brought sociological ideas about practices and technology to the issue of energy use in buildings and later on to the issue of water consumption (ongoing). Wilk's anthropological analysis (2006) show how it is possible to makes sense of the phenomenon of 'bottled water' in a social science way without it making any environmental sense.

Examples of management's influence of environmental impact

A few examples can perhaps illustrate the influence of management on environmental impact.

At Scott Paper, they made an environmental comparison of their 40 pulp suppliers. This showed that the difference in carbon dioxide emission (per tonne pulp) varied by more than a factor 100 (ENDS 1992) (see figure 1). Although all the suppliers deliver the same type pulp for paper tissue that Scott Paper produced, the environmental performance varied greatly. Basic pulp production technology is in principle quite similar wherever it takes places. Technological differences between the suppliers' pulp production, differences in their respective energy sources or discrepancies in the environmental calculations are not great enough to account for the whole variation in environmental impact. This means that there must be differences in organisational conditions in order to account for the large variation.

This includes the way companies operate, maintain and manage their technical systems as well as how they relate to environmental regulation.

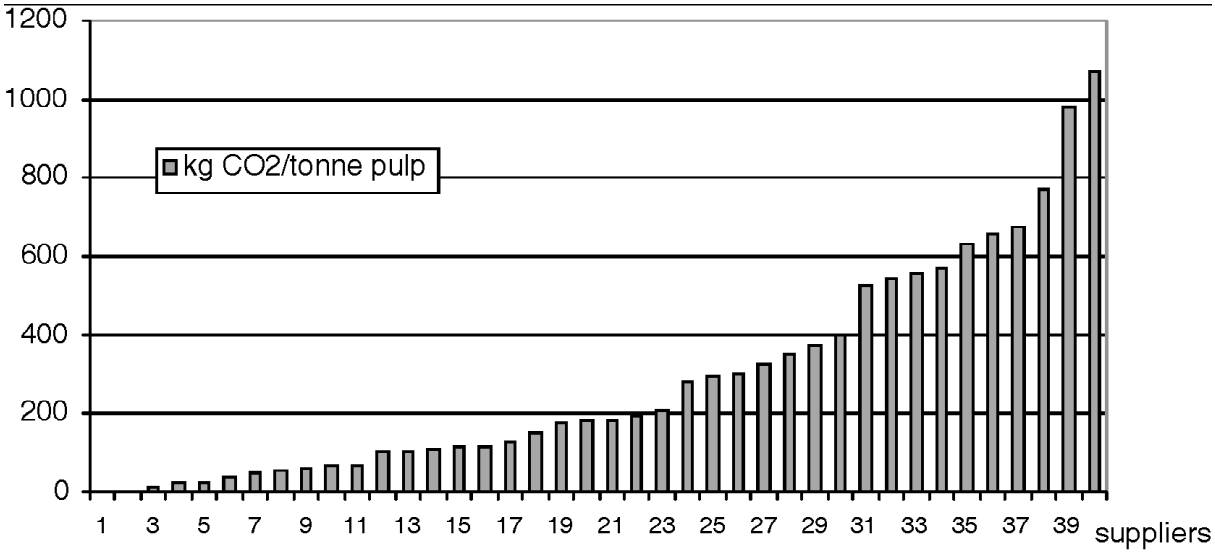

Figure 1: *CO2 emissions for 40 pulp suppliers. In 1992, Scott Ltd benchmarked their 40 pulp suppliers. Using LCA methodology, emissions for pulp manufacturing from 'cradle-to-gate' were collected. The differences turned out to be "staggering" (ENDS 1992).*

Another example is found in a study von Bahr et al. (2002) who compared the environmental performance of five cement plants in Sweden. Although the plants produced more or less the same type of cement, they found significant differences in the level of SO2, NOx and dust emissions per tonne product that could not easily be explained by different technologies. Furthermore, Hunt (1992) has examined variations in data for similar industrial processes in environmental databases used for making LCA studies. He reports that emission data can vary by ±40% for similar type of industrial processes.

Such variations in environmental impact from similar technologies indicate that environmental performance is influenced by something else than technology – that something else being organisation. The importance of understanding the organisational dimension of environmental problems can be illustrated with the existence of great improvement possibilities that for some reasons remain untapped.

The potential for greater efficiency is perhaps greater than one would expect. Azar and Lindgren (1998) explored the potential for greater energy efficiency in their study of the future energy consumption in Sweden ("Energiläget 2050"). According to them, relatively conservative estimates indicate that there is a great potential for improving energy efficiency. For transportation an efficiency improvement between 30% and 70% is possible depending on the type of transportation; for buildings between 30% and 55% depending on the type of building and installations; for industry between 30% and 65% depending on the type sector. The mere existence of a potential for greater efficiency is not enough for improvement to take place. Azar and Lindgren (1998) concluded that there are no technical or economic obstacles in the way for achieving greater efficiency since technology already is available (for similar examples in the US, see Hawken et al. 1999). I concluded that there is a need for looking into the organisational dimension to understand the obstacles to greater efficiency and environmental improvements.

About 'Organisation for the environment'

In an attempt to better understand how organisation relates to the environment and to do something about the 'divide', a research programme on *Organisation for the Environment* was set up beginning of 2007. The programme draws together a handful of interdisciplinary researchers and their projects that all explore various organising processes and their relation to the (biophysical) environment: Petra Adolfsson (PhD, GRI/Göteborg University), Birgit Brunklaus (LicEng, Chalmers University of Technology); Örjan Lundberg (MSc, Chalmers); Emma Rex (LicEng, Chalmers), and myself (programme leader, Chalmers and GRI). Two economic historians have been invited to join us, and we wait for decision on funding… We crossbreed – environmental engineering researchers with an interest in the social and social scientists with an interest in material flows and the environment. Basically, we explore in

some different ways the relationship between organisation and natural environment through comparative study of technically operations/naturally similar phenomena, but with different organisation (e.g. ownership, management).

In earlier publications (Baumann 2004; 2006), I worked on some of the basic notions for this interdisciplinary research and programme, but since then we've added empirical work to our experiences and, with that, new terms to our vocabulary. One such term is *socio-material interaction*. It has become a focal concept in our discussions about our projects, especially when relating their content to other research, since it covers both the influence organisation and management may have on the environment, and vice versa.

Property management is studied in two doctoral projects, one concerning residential housing management (Brunklaus 2005; 2008), the other commercial property management in grocery retailing (Lundberg 2008). These two projects mainly go into the organisational influence on the environmental performance of the studied organisations. A third project deals more with the environmental influence on organising, more specifically on when letting the waters decide for the reform of water management authorities (Adolfsson 2005; 2007). Together these projects deal with both directions in socio-material interactions. A fourth project (Rex 2007) concerns the competition for shaping the environmental issues in a truck company, and where one type of management favours certain environmental problems over others.

Another concept we've found useful is *organising in action nets* (Czarniawska 2000; 2005), where activites such as the changing of a light bulb in a grocery store is accomplished through a series of actions performed in a net of actors. Often, such an action net involves many organisations (property owner, maintenance or service provider, tenants' organisation or store owner, to name some of the involved organisations) and many such action nets are studied in our projects.

Residential housing management

A reason for studying property management is that the building sector has been identified to stand for around 40% of society's environmental burdens. Other reasons for studying the existing building stock also exist. The renewal rate of building stocks is usually very low (at least in Sweden), and it is typically the use of a building, not its construction, that causes the greatest environmental impact (e.g. Adalberth 2000). Brunklaus (2005) elaborates on more such reasons.

In order to be able to identify environmental effects of organising, environmental effects stemming from different technologies or uses has to be kept to a minimum. This is why the properties in Brunklaus' study are all of the same type, approximately of the same age, located in the same neighbourhood and thus with similar households and climatic conditions. The buildings that came to be studied are found in Majorna, on the same street; they were built in the 1920s/1930s; and, they have approximately 100 apartments each. The studied buildings are a number of so-called county-governor buildings (a particular type of apartment buildings typical for Göteborg; in Swedish: landshövdingehus) are studied and compared. They are owned and managed by different organisations. One is the housing cooperative 'Svärdsliljan'; the other is the municipally owned property company 'Familjebostäder'.

The housing cooperative was founded in 1937 and is a member of HSB, a large federal organisation of housing cooperatives. In Gothenburg there are about 35 000 apartments in different HSB housing cooperatives. In this organisation, the tenants own their apartments, while the building and its installations are managed by the cooperative. Although cooperatives can get managerial support and knowledge from the central HSB organisation, each local cooperative is independent and has great freedom in the operations of properties. The municipally owned 'Familjebostäder' (Fambo) was founded in 1950 and has specialised

in county-governor-style buildings. Fambo owns and manages the buildings and the installations for around 18 000 rental apartments in Göteborg. In Fambo, operations are divided in districts of about 4000 apartments.

Three types of data are needed: environmental data, organisational data, of course, but also information on the technical system, where 'environmental consumption' so to say, arises. Environmental data were chosen in accordance with principles of environmental systems studies. This led to the study of consumption data concerning energy and water for the studied properties. Such data is available for long time periods and is also regularly used in the daily work in the organisations. Technical information about the buildings was also collected through observations of e.g. the technical standard of windows (2-glazing or 3-glazing), localisation of insulations (wall and/or roof), energy systems (heat recovery or ventilation system) and water systems (2-grip or single-grip mixer). Also documents e.g. drawings of the properties, internal documents concerning renovations and technical changes as well as records from planning permissions, were studied. For the organisational study, the focus came to be on the local (material) handling in the properties. Local maintenance and operation practices were observed and ations and the personnel was interviewd about their daily work.

Brunklaus's findings show that consumption levels differ considerably between the studied properties. Analysis of the environmental data show that consumption levels are both lower and less variant in the housing cooperative in comparison to the three studied Fambo properties. The HSB housing cooperative shows on an average around 30% lower energy use and even up to 50% lower water use for over more than a decade (see figures 2 and 3). The consumption levels of the housing cooperative are below the Swedish average for energy use and on par for water use. For Fambo, however, during the same time period, all three studied properties' consumption levels exceed Swedish averages.

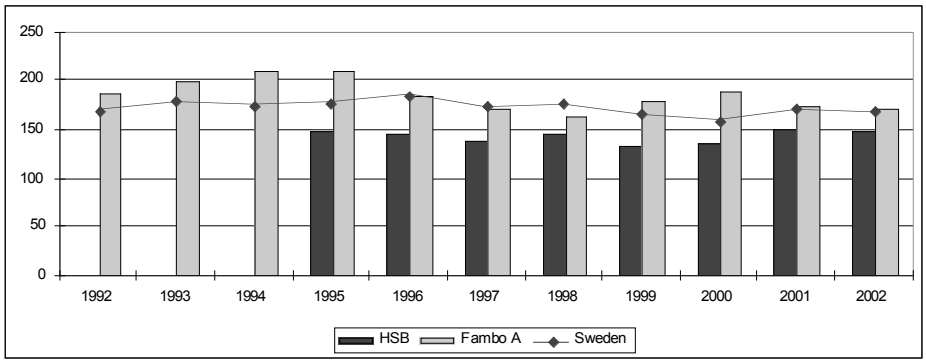

***Figure 2**: Energy use for heating and hot water [kWh/m2*year] in HSB cooperative and one of the Fambo properties (A), in comparison to the national average in Sweden during the years 1992 and 2002 (Brunklaus 2007; 2008).*

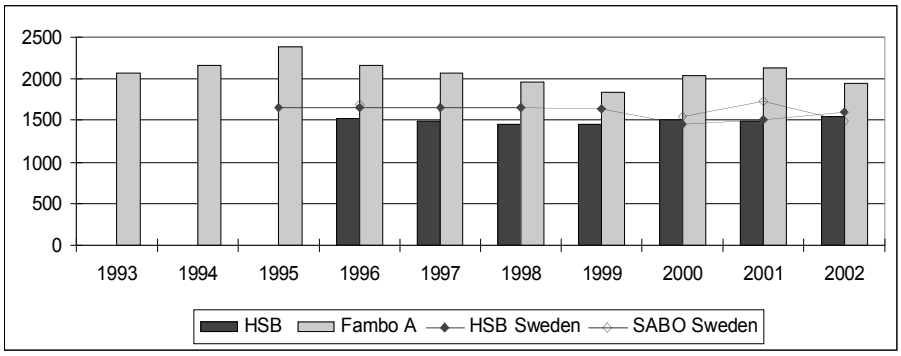

***Figure 3**: Water use [L/m2*year] in HSB cooperative and one of the Fambo properties (A), in comparison to national averages HSB Sweden and SABO Sweden during the years 1993 and 2002 (Brunklaus 2007; 2008).*

The span in the variations is also interesting. The minimum level, representing a better environmental performance, indicates what is possible in such properties, whereas the maximum level, representing a poorer environmental performance, shows what the organisation allows before action is taken to reduce levels. To understand how these different consumption levels arise in basically technically similar buildings, Brunklaus went on to study both operations and renovation practices. She goes into great detail – here only a brief description of the operations management and renovation practices with their socio-material analysis are presented.

In the housing cooperative, there is a caretaker who has been working ther for many years. He has been taking care of all technical devices and installations for the energy and water systems of the building since 1991. To him, the building is not just a building – it is more a 'beloved child' that he cares about. He likes to explain the uniqueness and complexity of the building. He likes to continuously check on both the district heating system and the ventilation system and to every now and then coordinate their regulation. This is tricky and gives him great pleasure when succeeding. Since the caretaker is close to retiring, the board of the housing cooperative is looking for a person with only general technical skills but a 'caring' attitude, preferably someone who lives in the building and can see what needs to be done. When it comes to renovation and the planning of maintenance, the people working with this (both living in the building) go to great lengths to find technical solutions that are adapted to the building's needs and special characteristics from a cultural heritage point of view. For example, extra insulation of windows became a tricky problem, but it was solved by adding a third glass to existing windows, thereby fulfilling both tenants' preferences and cultural heritage requirements.

In the three studied Fambo properties the operations personnel consists mainly of an operations manager, a machinist and a tenants' service official. In the 1990s the organisation went through a rationalisation process and a client-focused management (inspired by hotel management) was introduced shortly after. This led to local caretakers being exchanged to different types of personnel with specialised skills and with responsibility for properties in larger areas. Tenants' service officials for the building and environmental service officials for gardening were introduced. After the rationalisation in the 1990s, the energy management changed from continuous to emergency measures, where time constraints are important.

The machinist's work follows a cyclic scheme that tells him when to check and restore fails of a quite large district with about 3000 apartments. What emergency measures the

machinist undertakes on the energy system are prioritised after what is known as the 'top 10 list'. This is made up of the housing blocks in the district with the worst energy performance at the moment. Also water management has undergone similar changes, from continuous to emergency-driven measures.

Renovation of Fambo properties follows a 30-year cycle. When the buildings underwent renovation to reduce energy consumption, they had similar cultural heritage constraints as the HSB cooperative had, but a series of conflicts stopped the introduction of 3-glazed windows. The suggested new 3-glazed windows altered the appearance of the building too much and the old 2-glazed windows remained. The coming renovation aims a modernising the standard of water systems and kitchen/bathroom/washing machine appliances. Doing something about the windows this time has low priority – modernising appliances is more in line with the present client-oriented management style.

Characteristic for the property management in the HSB housing cooperation is the honouring of the building's constraints, while in Fambo management is dictated by time constraints and tenant demands. Thus, Brunklaus traces the relatively low and stable water and energy consumption levels to a 'caring' management style in the housing cooperative that honours the building itself. The relatively high and variant consumption levels in the three studied Fambo properties, she relates to the emergency driven management style that aims att catering to tenant's demands (and where gardening has become more important the energy savings).

Commercial housing management in grocery retailing

Similarly to Brunklaus, Örjan Lujndberg compared a pair of properties – in his case, it was two supermarket stores of the same retailer. Being a pilot study, the investigation into the environmental dimension was less detailed than in Brunklaus' study, but Lundberg came

across a number of interesting situations during his two days on the field while shadowing the service technicians. Although the two stores are operated by the same retailer (ICA), their buildings have different owners. One of the stores is owned and operated by the retailer's own property division (ICA Properties). They contract a service management firm specialised in servicing grocery stores; eleven of them ICA stores. The head service technician had extensive experience of not only managing supermarket buildings, but also of working in supermarkets – he had done almost all duties in a store, except for being in the checkouts – the service technicians out on the field worked in pairs. The other store's building is owned by a pension fund and operation of the buildings is outsourced to a facility management company who in turns contracts various technical services firms. The pension fund owns many different types of properties, not just retail stores; also the service technician servicing the supermarket attends to many different types of properties, a large IT office, a play centre for children, a bakery to mention a few. This service technician worked on this own when out on the field.

Energy efficiency measures are often being motivated by the fact that they save both energy and money. In the environmental debate, it is popular to argue for exchanging ordinary lightbulbs for low-energy (low Watt) bulbs. In one of the ICA store, stronger (higher Watt, more energy consuming) lights had instead replaced ordinary lightbulbs in the fruits and vegetable section. And these tended needing replacement more often, as the reactor connected to the spotlight broke more frequently than the lightbulbs used to go out.

When a light (or two, or three…) goes out the staff member in the supermarket, who notices this, reports the broken light to the person responsible for the building in the store, who then reports it to the maintenance personnel, who then comes to change the light. At least, this is the case in the store owned and operated by the retailer. Changing one of the special spotlights took some ten minutes. While the two service technicians were replacing

some of these broken spotlights in the fruit and vegetable section, Örjan started counting the number of lights in that section (ca 350 m^2) to keep himself busy while waiting. There were 147 light sources in that part of the store, and 39 of them were of the special kind of spotlight the service technicians were working on. These spotlights were strong, 100 W each. They had a certain yellow light that was specially chosen for fruits and vegetables to make them look more appealing and fresh to the customers. One of the service technicians demonstrated the spotligts' effect by switching the lights on and off for Örjan, who observed a marked difference. He could see the tomatoes switching form lush red to bleak yellowy-red as the technician swithed the light. The technician explained that the sales of tomatoes had increased after the installation of the special colour spotlights. Örjan concluded that any amount of energy savings promotion was likely in vain here. The extra cost of these special spotlights was probably upweighed by the increased tomato sales – doubly bad for the environment, but good for the retailer, tomato growers and spotlight producer, among others.

The special spotlights were not found in the other ICA store. The reason for this is difficult to say, but it may have to do with the circumstance that ICA Properties owned the store with the special spotlights. ICA Properties had studied the effect of different coloured light and specified different uses for them around a store. The other property owner and service company perhaps not knowing what certain light frequencies do to tomatoes, nor caring about tomato sales, happened to be a good circumstance for the environment.

The number of people it took to change a lightbulb doesn't come close to the number of people it takes to pick up cigarette butts outside the store entrance. While paying, a customer points out that the store entrance looks untidy with the many cigarette butts lying around to a person tending the checkout. The person in the checkout then calls the responsible supervisor, who in turn tells the shop owner, who is also responsible for the building on the tenant side. The shop owner calls the property owner to complain about the lack of service. The property

owner having outsourced the management of the building to a facility management company calls them to explain the problem. The facility management firm has the responsibility for the upkeep and maintenance of the building, but they have contracted the service of outdoor upkeep to another company. That company had in turn contracted yet another company to do the cleaning and sweeping of the grounds – it was thus the task of this company to go to the store to pick up the cigarette butts. The shop owner was annoyed with the situation and the long chain of communication that was required for such a simple task – it rarely worked...

Letting the waters decide on the organisation of water administration

So far municipalities have had the right to make decisions concerning land and water within their administrative boundaries in Sweden. Also county councils have had for a long time the responsibility for the environmental situation in the counties and to carry out environmental programmes to implement national environmental quality objectives. However, this is all changing with the introduction of a new organising principle for water administration, namely that of river basins. Petra Adolfsson has followed this reformation of water authorities when letting the waters decide on the areas and boundaries for management and control for a few years (Adolfsson 2005; 2007). Her studies concern what happens in two different river basins in West Sweden when trying to fulfil the EU framework directive of 2000, which emphasizes an ecosystem perspective on water management, in the sense that the natural flow of waters should be the basis of the administration. This means that the Swedish authorities and other actors have to organise their work according to river basins instead of traditional organisation boundaries such as the administrative boundaries of municipalities and counties.

A river basin can be described as an extent of land where water from rain or melted snow drains downhill into a body of water (a river, lake, dam, estuary, wetland, sea or ocean).

The basin includes the streams and rivers as well as the land surfaces from which water drains into these. The basin acts like a funnel – collecting all the water in an area, channeling it into a waterway. River basins are separated topographically from each other by a ridge, hill or mountain – this is often called a water divide. As water flows over ground and along rivers it can pick up nutrients (often from farm land), sediment and pollutants (e.g. from industries) and transport them to other places where they can affect ecological processes (e.g. eutrophication of receiving waters) or pollute drinking water intakes.

Previously, there were water conservation associations for watercourses crossing administrative boundaries, but the intention of the directive is that all those affecting or handling the water in different ways should meet, and the reform aims at including more stakeholders than before. The water conservation associations gathered municipalities, companies, interest groups such as the Federation of Swedish Farmers, but with the new water administration, more stakeholders have entered the process.

Previously, Adolfsson (2007) has described the striving for cooperation and the search for activities the actors perceive as appropriate, in part to restore water courses to so called "good ecological status". Activities include the building of databases and joint seminars. With new interests having entered the process cooperation can be trying. New interests are for example those related to tourism, concerning e.g. the beauty of waterways and the possibilities of angling. Also more symbolic values of the waters have been raised – 'closeness to the water' has many charged connotations. Presently she studies the role of guided tours to the waters for the reform process. The guided tours have become a way to get closer to the physical reality for the members of the administrative board. The alternatives are statistics and numbers, or going out to the places and the rivers. These guided tours have become a way for the waters to get "into" the boardroom. Guided tours of one kind or the other take place in both cases she studies. In one case, she says that the reform was in part

enabled through bus tours through the river valley (Adolfsson 2008). The bus tours were organised for the various parties involved in the reformation of the water administration and they stopped at several locations along the river, visiting various environmental projects. In the other case, one of the members of the water administration likes to take various people related to the reform of water administration out and show them around in the river valley. On his birthday, he was given the opportunity to take two citizens of his municipality on a tour (picnic included). In both cases, the guided tours help giving some reality to what is otherwise only read about in reports and statistics. Also, many in the water administration live closely to the water and their talk about the water is full of emotion – the waters are very dear to them.

Discussion and conlusions

Brunklaus' work shows that by centering the organisational study and the environmental study on their meeting point, i.e. the handling of technology, it is possible to study how organisations leaves physical traces in the environment. The study of human-material hybrids, in Latour's words (1993), has taken some "hybrid methodology", so to say – a combination of principles from environmental systems studies and qualitative organisation research methods. In common for the three studies refered to in the previously is that a physical object is at the centre of the study and the actions interacting with the object form a starting point for the organisational study. Tracing and analysing organisational-environmental connections has been possible with a simple comparative design: by centering on similar physical object (be it buildings or river basins) and by keeping other pyscially influencing factors similar and by looking for trend breaks in environmental and organisational data over time. That answers one of the questions is the beginning.

The close study of organisation in property management and their interaction with the (biophysical) environment also leads to a discussion on how to communicate organisational-

environmental relationships in environmental management. However, I've noticed that when trying to speak more generally about our studies within our group and to other researchers we tend to search for words, and often end up with long phrases such as 'when they go there handle the ventilation system or other things'. For lack of a better term, I've come to use 'socio-material interaction' for those human-thing contacts where some kind of action takes place. 'Socio-material' came out of discussing and reading the works of environmentally oriented anthropologists and sociologists such as Wilk (2007) and Guy & Shove (2000), and 'interaction' grew out of that action might go two ways. Also, in order to distinguish between different interactions on different parts of the object, 'interaction points' has become useful. Different interactions are for example 'measuring' ("listening" to the things, so to say), 'regulating' (or manipulating it), 'consuming' (as in where the consumption of the environmental goods takes place). Distinguishing between different interactions has allowed us to discuss the organisation between two (or three, or four…) physically related interaction points, and what this organising might imply for environmental problems. The number of people involved between the observation of cigarette butts and the cleaning up is perhaps astonishing, but that episode showed that the action net that was supposed to connect the observation to the cleaning up was not really in place – according to the shop owner it didn't always do what the expected act. The cigarette butt problem might not be a great environmental problem, but the organisation along water pipes in residential buildings could qualify as a more serious one. Brunklaus describes the drinking water's organisation where those who measure water flows and consumption are different from those who regulate it and different, again, from those who consume it, the tenants. The communication between these different actors is minimal (not to say non-existant) in these matters. This might not be a problem for housing management, except it is an environmental problem. The consumption of drinking water requires purification of raw water. Purification and distribution of the water

takes both energy and several chemicals, among them chlorine. It also requires control over the quality of raw water, leading us into the water administration reform that Adolfsson studies. From this it seems that there is more control over the quality of the waters than over the volumes that are consumed.

The term 'boundary object' has attracted a lot of interest in organisation theory, and it is useful for us too, but we've had to add the distinction of different actions performed with the object. Interaction points, types of interaction, the physical relation between interaction points and action nets that possibly connect interaction points – all these terms enable us to discuss the premises for environmental management problems. Through action nets, interaction points along the water pipes can be connected, rendering for example the drinking water's organisation, consisting of many other organisations (water administrations, housing management companies, etc). The relatively simple physical relationhip between interaction points along the water pipe is paired with an organisation of action nets that binds the interaction points together in a complicated way. When it gets too complicated, action nets fail to connect interaction points, as in the case of cigarette butts. In some ways, the organisations became obstacles to the organising of cleaning up, to use the words of Czarniawska (2008).

Something else that has come out of our discussions is the importance of being on site, seeing the objects, dealing with stuff "hands on"... The role of such 'visitations' is not fully clear, but its role for learning and knowing about the physical constraints of e.g. buildings or rivers seems important. These visitations together with the measurements (that in a way is a 'voice of nature') form something that resembles communication between humans and nature (or stuff at least). And it seems that organisations with a close contact with the physical stuff managed to deal with environmental issues more effectively. The management style in the HSB cooperative and the guided tours in the water administration reforms are examples of

what such close contacts mean. What happens without that communication? We came to think of cases when planning and building permits are given without consideration of properties of the place, houses are build and the place "strikes back" with a mud slide, again using the words of Latour (2000). Next, we started to dream up new research projects… and then we realised that we needed to deepen our theoretical understanding of this, but we are not there yet. More can definitely be said about how measurements in a way represent the voice of the environment, but that is saved for another occasions. Also, we have ideas about looking more into what anthropologists have to say about humans and their relationships with the physical surroundings.

Socio-material interaction and distinguishing between different types of interaction with a boundary object might be crude and inappropriate terms, but they have been useful in our discussions for untangling the nets along water pipes and watercourses. These terms have helped us in our understanding how environmental problems arise out of our actions and how they are maintained through our organisations. For sure, there is more work we need to do with regard to discussing our findings and relating them to theories before we feel any confidence in our contributions to organisation and materiality, but this is how far we've come now. With time, we might figure out how energy efficiency ideas can be introduced in the tight alliance between shop owner, property owner lightbulbs and tomatoes.

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