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Water-networks and the actor: the case of the Save River catchment, Zimbabwe

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Introduction

The Save River catchment in eastern Zimbabwe comprises a physical space in which the waters of a large region are interconnected. In a physical sense, the Save catchment is therefore a 'real' entity. With the promulgation of the new Water Act of 1998 and the beginning of its implementation in 2000, the Save catchment also exists institutionally now: at least in the minds of some of the policy makers and other actors. In this spatial expanse, many more realities are enacted: geographically, socially, culturally, economically, and politically. But these realities are highly diverse and fragmented.

In order to build networks and secure livelihoods, people have sought to combine in all manner of ways, the different resources (natural, material, technological, human, legal, institutional, financial) that occur in the Save expanse (see e.g. Roder, 1965; Campbell *et al.*, 1989). A water use system for agriculture, for instance, involves one or more farmers consciously combining water (rainfall, river water, and groundwater) and land resources (soil particles, stones etc.) in a specific way. Such a system only works if tightly linked to other material resources, such as crops, fertiliser, pumps, siphons, electricity lines, documents (e.g. title deeds, water rights), court buildings, and of course money and account statements, and with other, less tangible resources such as unwritten rules, wisdom, knowledge and information flows. This network also links human actors, both as an intended strategy (e.g. a farmer dealing with an extension officer, a sales representative of a seed company, a Headman, etc.), but also unintentionally, since the water cycle itself links actors together (e.g. up- and downstream irrigators).

A water use system can therefore be understood as an actor-network (Law, 1994).[1] Networks of human and non-human actors emerge around water use that have a sense of order, enabling actors to take further action, further ordering the networks and their environments in the process. Water-networks, as we will call

[1] Law (1994) draws on strands of the sociology of technology and actor-network theory; see also Callon (1986, 1987), Latour (1987, 1991), Callon and Latour (1981) and Law and Bijker (1992). Kortelainen (1999) convincingly shows how actor-network theory can be applied to water.

them in this paper, are therefore recursive, emergent forms.[2] They cover different spans of space and time, and produce different outcomes in terms of (agricultural, industrial and mining) productivity, environmental sustainability and social equity.

Zimbabwe's water reforms explicitly seek to address the (historically based) inequitable access to water that exists between the commercial and smallholder farming sectors. At the same time, it is an attempt to improve productivity and environmental sustainability of the water sector as a whole, while basing the entire project on a sound financial footing. The reforms are therefore aimed at fundamentally changing the existing water use systems and water-networks.

Zimbabwe's water reforms exhibit quite a few characteristics of a top-down prescriptive process, drawing heavily on ideas from classic public administration and neo-institutional economics (North, 1990, Ostrom, 1992). The initial emphasis of the reforms has been on drafting new legal frameworks (Water Act 1998 and Zimbabwe National Water Authority (ZINWA) Act 1998) and crafting new institutions (ZINWA and Catchment Councils). It is then assumed that the planned implementation of new legal stipulations and operational rules, as well as the rational pursuance of new economic and normative incentives embodied in the new institutions, will result in the desired policy outcomes, i.e. re-distribution, accountability, stakeholder participation and cost-efficiency.

Long and Van der Ploeg (1989, 1994, 1995) criticise such a mechanical model of the relationship between policy formulation, implementation and outcomes. They argue in favour of a more process-oriented analysis of policy change by focusing on the capacity of social actors (i.e. water users and government personnel) to transform policy outcomes during implementation. Social actors actively pursue their own strategies and projects by drawing on existing knowledge, resources and capabilities, together with emergent organisational forms. Thus policy implementation, in this case, is conceived as an ongoing, socially constructed and negotiated process. A process that is contingent rather than planned.

Whilst sharing a view that favours a process orientation, we nevertheless note that the above mentioned approaches overlook the material dimension of water use practices. In this paper we intend to overcome this lacuna by analysing several cases of water-networks in the Save river catchment that operate alongside and within the colonial state engineered water administration. We then try to extrapolate the findings and see whether or not the new legal and institutional reality would enable these water-networks to arrive at more productive, environmentally sustainable, and equitable practices of water use. Our main contention is that the existence and transformation of water-networks as found in Save catchment cannot be explained by focusing on legal and institutional incentives alone, nor by focusing exclusively on the agency and strategies of social actors engaged on the waterfront. It is critical that the material dimensions of water use practices are engaged, since they constitute an essential part of these practices.

[2] Norman Long has likened the emergence of ordered forms to how ants build their hills. The deposit of clay by the first ant enables the next to position more clay: 'each deposit sets up a kind of sense element. In other words they become foci of concentration. And so then the structures begin to emerge!' [Norman Long, 17 December 1987, Autlán, Mexico]

Much of the case material used in this paper was collected earlier within the context of a research programme that was initiated by Norman Long.[3] The paper attempts to synthesise some of these materials that were inspired by the actor-oriented perspective developed by Norman Long (Long, 1984, 1989, 1990, 1992). In the conclusion a plea is made to extend Long's actor-oriented approach by bringing in the material dimensions of water use practices, using the actor-network perspective. Technology and material dimensions of social practices are constitutive elements of social intercourse, and not exogenous to it.

Contrasts in the catchment

The Save catchment in Zimbabwe (covering an area of 40,000 km^2 before the confluence with the Runde River at the border with Mozambique) is a region of sharp contrasts. The lush, cool upper reaches of the catchment with its mountainous ecology (some 2,000 meters above sea level) differs markedly from the barren, dry and hot *miombo* woodlands lower down (500 m.a.s.l.). The high rainfall areas with 2,000 mm/yr are set against the dry areas that receive less than 500 mm/yr on average and are subject to large annual rainfall variations. The urban settlements (such as Mutare) form a contrast to the pristine parks, which may be publicly owned (such as Chimanimani and Gonarezhou) or private (such as the Save Conservancy which is a joint venture between a number of commercial farms). The exotic tree plantations in the mountains differ greatly to the sugarcane plantations in the lowveld. The commercial farming areas look markedly better than the communal areas and importantly, people living under poor conditions with few assets and little access to basic services are juxtaposed against affluent farmers with light aircraft in their backyards.[4]

The catchment area has been 'scarred' by many interventions, some of which date back to the 1930s. These include the forced establishment of contour ridges in fields, the voluntary establishment of terraces in some places, the complete removal of trees from arable land upon recommendation of the agricultural extension agency, and the carving out of areas for exclusive commercial farming with the resulting creation of communal areas. Recently, large fenced private parks have been established, consolidating many commercial farms where nature is being produced for the tourist market. More recently still, the boundaries of these parks have been breached by people seeking land. And finally, dams, furrows and pipelines have been constructed (private, public, legal and illegal) with some of these pipelines even crossing the watershed, connecting catchment areas that were previously unconnected.

These contrasting elements co-exist within the same physical space. The catchment knits water users together through the water cycle and the actors are

[3] This collaborative programme between the University of Zimbabwe and Wageningen University and Research was known as ZIMWESI (1993-2000), and was mainly funded by NUFFIC. ZIMWESI has yielded many case studies, which have been published in, among others, Andersson (1999, 2001a, 2001b), Bolding et al. (2001a, 2001b), Magadlela (1997, 2000), Magadlela and Hebinck (1995), Manzungu (1995, 1999b, 2001), Manzungu and Van der Zaag (1996), Manzungu et al. (1999), Mutimba (1997), Vijfhuizen (1997, 1998) and Vijfhuizen and Makora (1998).

[4] In one district it was calculated that the average income of commercial farmers was nearly 400 times that of communal farmers (Wanmali 1992 cited in Roe 1995: 834).

interdependent: the action of one person predicates upon another's, sometimes hundreds of kilometres downstream.

Water-networks in the catchment

People have developed a variety of strategies in order to cope with this interdependency. Some have embraced the formal legal-institutional set-up. Obtaining a water right for irrigation, in accordance with the Water Act of 1927 (revised in 1976) requires that certain procedures be followed. An entire suite of actors and devices has to be enrolled. For instance, a report would be required from a hydrologist from the Department of Water Development to ascertain whether the water applied for is available. A report from the agricultural extension officer in the Ministry of Agriculture would be required to assess the viability of the soils, the crops to be irrigated, as well as the volume of water required. The construction of canals, gauging weirs and often the building of a storage reservoir might be necessary. This again involves engineers who can produce designs adhering to dam safety regulations. In order to construct the required works, the applicant would have to mobilise funds with commercial banks, and most likely attempt to access highly concessionary loans from the farm investment fund, requiring a business plan indicating the market opportunities for the intended produce. In all, to obtain and exercise a water right and for a water-network to function, an actor would have to enrol a host of physical devices, monetary resources, legal documents and human actors. This assemblage of mobilised resources can be understood as a water-network, which, if successful, would prove a highly profitable alliance. Often, then, such a network was stabilised and sustained over time, and could subsequently be drawn upon for even more ambitious projects.

However, formally recognised water projects in the communal farming sector often followed a different route. Here, projects such as smallholder irrigation schemes were parachuted from the centre. Staff from the Department of Native Agriculture would closely supervise and prescribe the operations of the carefully selected irrigators or so-called 'plotholders'. Staff of the Department of Water Development would be in charge of supplying water to the scheme, whereas the agricultural staff would supervise water distribution and irrigated production. In this set up, the assemblage of resources that a plotholder had to manage was no less complex than that of a commercial water right holder, and often more unpredictable because of unreliable water supplies, distant markets and unscrupulous middlemen or monopolistic marketing boards. Plotholders would have to play the game of submission, while exploring the margins of the possible. They would also have to deal simultaneously with competing fellow irrigators.

For the majority of communal farmers, irrigation was but a pipe dream. They had to cunningly deal with the capriciousness of the rains. For them, however, it was not enough to appease and anticipate the forces governing the rain. They also had to contend with outside institutions, rules, regulations and enforcement officers who spoke the language of conservation. For state actors, conservation became a key justification for intervention (Anderson, 1984: 327; Beinart, 1984). The colonial command-and-control discourse found fertile ground here and a

complex set of legal, institutional and technical prescriptions were designed in an attempt to harness the behaviour of the communal farms. The Natural Resources Board was established and the Natural Resources Act of 1941 was promulgated. An army of NRB officers were enlisted to enforce the Act by prohibiting stream-bank cultivation and imposing penalties, while Land Development Officers forced farmers to construct contour ridges. Research stations mushroomed where soil erosion was quantified and extrapolated and an entire suite of state actors and new scientific insights and technologies were unleashed on the communal areas. What strategic response could have been provoked in this environment, other than synchronised sabotage?

Despite strong legal backing and the mobilisation of various technological and financial resources to monitor and evaluate conservation and water use, the resultant state-engineered water-networks proved not to be durable in the communal sector. Enforcement proved difficult, because the interventions justified by these self-referral water-networks, lacked legitimacy. In response, counter-discourses developed resulting in the emergence of various 'informal' water-networks that challenged the legitimacy of the command and control network that was in place.

After independence, and more particularly, after the adoption of neo-liberal structural adjustment policies, a need for change was felt in a number of areas that had facilitated reforms in the water sector since 1998. Concerns of equity and cost-recovery, as well as the need to include the non-commercial sectors in the decision-making process, led to the adoption of a new Water Act in 1998. A new institutional reality was thus created, with the establishment of catchment councils in which all water users were represented, to take joint responsibility for water allocation and the issuing of water permits.

This paper describes five cases of water-networks. The first focuses on rainfed agriculture, capturing rainfall on marginal lands. The second deals with a farmer-managed irrigation scheme where networks follow royalty and crop contracts. The third case looks at the competing claims of water between formal and informal small-scale irrigators. The fourth case shifts attention to competing claims between large and small operators. The first four cases are all set in Chimanimani district in Eastern Zimbabwe. The fifth case concerns a large water supply scheme for Mutare City. The diversity of the cases presented allows us to draw some generalised conclusions on water-networks, what they consist of, how they tend to operate and what this means for administrative reform.

Stones and rainfall on the hills in Biriwiri (Van der Zaag, 2001)

Biriwiri is a small valley in Chimanimani district, where from time immemorial people have used the waters of the Biriwiri River, a small tributary of the Nyanyadzi River that flows into the Save. They have used it for domestic purposes and for cultivating crops, on ridges along the riverbed or with the use of irrigation furrows. However, most communal farmers do not have access to river water to irrigate their crops, since their plots are located on the steep hills, away from the river. These farmers use rainwater instead to raise their maize, beans, pumpkins and other crops.

What is special about the Biriwiri hill farmers, compared to most other small-scale farmers in Zimbabwe, is that they have eked out their farming plots on hill

slopes which are considered, by the agricultural extension service, as being too steep and unsuitable for arable agriculture. To cultivate the steep slopes farmers have developed stonewalled terraces.

The Biriwiri terraces form almost level mini-catchment areas where rainwater is captured for the cultivation of crops. The way in which the stone walls are laid out implies that soil erosion is minimised, even on the steepest cultivated hills (steeper than 20%). They allow a form of permanent agriculture, and most terraced plots are cultivated each year. Farmers manure their fields annually and intercrop maize with beans. Farmers also believe that the terraced fields have an internal source of nutrients that sustain yields: while planting the seed with the hoe, stones that seem to 'grow' to the surface are removed and thrown upon the walls, the soil below being `virgin' and nutrient-rich.

The terraces were developed in the early 1950s when the colonial state began to enforce the Land Husbandry Act and tried to implement contour ridges on the cultivated fields in the Biriwiri valley plain. This proved difficult because of the many stones in the fields. As a compromise, farmers were encouraged to lay the stones along properly pegged contours, forcing farmers to plough along the contour. Gradually, pronounced terraces developed. Local farmers soon found that such terraces were extremely suitable for the cultivation of the much steeper hillsides, rendering more land for arable use. This was a welcome discovery, because more and more people were continuing to arrive in the Biriwiri area, thrown out of nearby Melsetter Intensive Conservation Area but refusing to be resettled in the lowveld. Farmers (knowing that the cultivation of lands steeper than 12° was prohibited) will emphatically point out to outsiders that their terraces have been properly laid out by the *mudhomeni*, or extension workers, thereby implying that they are officially approved. The technology spread quickly and was adopted by new farmers coming into the area. At present, most hills in Biriwiri are terraced, and new terraces are still being constructed.

The development of the bench terrace technology, in which the farmers played a decisive role, facilitated the emergence of a durable network between farmers, soils and stones. The technology has proven capable of capturing rainwater whilst mediating the potentially destructive effects of heavy rainfall on steep slopes. Its downstream effects are therefore limited. Because the water-network captures rainwater rather than water flowing in rivers, its 'span' is limited, as it does not have to mediate with upstream and downstream users. It is has also been proven to be durable: some fields have remained productive for a period of some 50 years. Another reason for its durability is that male and female farmers have been willing to invest enormous amounts of labour in the construction and maintenance of their terraces. This is especially revealing, since the tenure of these arable plots is, at least on paper, insecure because of the prohibition to cultivate steep hillsides. Acknowledging the local headmen and chief, and asking permission for the clearing of new fields, is therefore carefully observed.

Networked water distribution in Mutambara irrigation scheme (Manzungu, 1999b)

Mutambara irrigation scheme irrigates 145 hectares with water diverted from the Umvumvumvu River, gravitating into the canals and furrows. The scheme was started in 1912 by a group of farmers who copied what was happening in the

nearby Mutambara Mission (Rukuni, 1988). The scheme was taken over by the colonial government in 1936, and government control continued until 1974 when the scheme was closed on account of farmer resistance to the colonial administrators. In 1980 the scheme was re-opened as a community-managed scheme.

Water access in Mutambara irrigation is heavily influenced by the socio-history of the scheme. The present scheme is the result of a fusion of two different irrigation initiatives (Manzungu, 1995, 1999b). Thanks to well meaning but ignorant (of the social organisation of the people) colonial authorities, this brought together feuding communities. As a consequence the down-stream irrigation blocks suffer incessant water shortages, even in years with normal water availability.

Water distribution in Mutambara cannot be discussed about without reference to the Chief of the Mutambara dynasty. The scheme is regarded as belonging to the Chief, since he is believed to have started the scheme: a claim which is not backed by archival records (Manzungu, 1999b). A lack of archival evidence however has not stopped the Chief and his associates from monopolising water access. Indeed, water tends to follow people with royal connections. Interestingly enough, the royal circle tends to shrink when there is a severe water crisis, as was the case during the drought of 1994, when the inner royalty completely monopolised the water. The dominance of the Chief and his associates regarding water access is point of contention and is contested. There have been cases where the hegemony has been challenged by a combination of technological, hydrological, legal and commercial factors.

Mutambara irrigation scheme has a history of growing crops like tomato and peas under contract to canning factories in Mutare town, 75 km away from the scheme. This is a lucrative activity that every farmer hopes to be part of but many changes have occurred since the early 1980s when contract farming started. Initially, the contract crop was grown under the auspices of a single 'club' representing a group of farmers who marketed the crop together. In 1996 there were 11 such clubs and in 2001 as many as 24 (Wiskapu, 2001).

The proliferation of clubs is financially related. Each club signs a contract with the company. The contract has to be respected by all club members, and this is achieved through social control. Social control is important because side marketing of the contract crop results in a particular group or club being penalised by the company. A common penalty is that the club in question will not receive seed the following season. Farmers now prefer smaller groups, where social control can be more effectively exercised.

These clubs are more than just marketing clubs. They are also a way of distributing water. The contract crop tends to receive preference during irrigation. Thus securing seed for the tomato crop secures irrigation water. Even members of the royalty have to play the game and place themselves within these structures of clubs if they are to grow the contract crop.

In years with less than normal rainfall, most farmers find it difficult to secure access to irrigation water. When faced with a wilting crop, farmers sometimes visit their holdings to irrigate their crops without permission in the middle of the night. Such thefts tend to go unpunished because of the general breakdown of the spirit of social organisation among the irrigators. A permissive infrastructure helps in the sense that water flows throughout the system all the time and the

numerous leakages make water diversion easy. No–one can with any certainty know how much water goes where. The relatively low operation and maintenance costs means that the Chief can afford to ignore the other irrigators. This would be different if, for instance, the scheme depended on pumped irrigation water. In such cases, regular bills (of electricity or diesel) would have to be paid, and technology would be forcing some solidarity amongst irrigators.

The way water is shared in Mutambara irrigation scheme shows how farmers depend on a number of elements that they combine in particular ways forming different water-networks. For a start, we can safely say that rules are seldom adhered to. In fact the rules only deliver water when things are 'normal', which is very rarely. Farmers therefore take strategic action to secure water, using and constructing different networks such as the royalty and the 'marketing' clubs.

The networks are comprised of many heterogeneous physical elements such as technology, investment, maintenance (infrastructure), hydrology and climate which all bring into focus the water source, water availability, the delivery infrastructure, and crops. These are combined or re-configured to ensure water access. Thus a drying Umvumvumvu river in Mutambara demands that water-networks be re-defined: they may 'shrink' as royalty is re-defined; but expand to outside companies whereby the commercial route emerges as an effective instrument to access water, circumventing royal claims. In addition, marketing clubs proliferate due to increasing distrust among irrigators. The water-networks also extend beyond the scheme level: in times of low river flows, Mutambara irrigators disclaim the entitlements of upstream irrigators using whatever arguments are convenient (Manzungu, 1999a). These include legal arguments, referring to statutory ('they do not have a water right') or customary law ('the Mission does not own the land, which was given by the Chief, therefore the water it uses is ours').

Competing for Nyanyadzi river water (Bolding et al., 1996, Bolding 1999)

The Nyanyadzi River flows from its origins in the Eastern Highlands of Chimanimani district westward into the Odzi River, which in turn flows into the Save river. The Nyanyadzi and its main tributaries, the Shinja, Biriwiri and Makwe streams, collect water from a catchment area of 800 km^2. On its descent the river passes through extensively used large scale commercial farmlands, resettlement and communal areas respectively, flowing from a lush, high rainfall area (1200 mm of rain annually) into the dry, sparsely vegetated lowveld (receiving 400 mm/yr). At its downstream boundary a government managed smallholder irrigation project (Nyanyadzi, started in 1934) depends on water captured upstream to irrigate the 414 hectares serviced by its open canal system. The river has presented two pressing problems. Firstly, its flow tends to decrease to a trickle during the crucial dry season months. Secondly, it tends to deposit increasing amounts of silt in the Nyanyadzi project, choking its diversion weir, main canal and night storage dam. These changes in the river's behaviour pose a threat to the sustained operation of the project, and are attributed by the irrigators to developments upstream. Many farmer initiated irrigation furrows have been developed across the catchment and compete with the Nyanyadzi project for scarce river water. Other land users have opened up new tracts of land on steep hills and in the close vicinity of riverbeds, thus adding a flavour of silt to the

river's storm floods. Furthermore rain clouds nowadays appear to avoid some of the upper reaches of the catchment, resulting in declining rainfall. Droughts have seemed to occur more frequently during the last 20 years. This has made land users in the catchment even keener to enter into a productive engagement with the river, thus increasing competition over valuable water.

Various networks have emerged in the catchment, responding to the scarcity of water, by mobilising different combinations of infrastructure, land use practices, water sharing arrangements, local authority and legal claims. This case discusses two such water-networks that have emerged within the same catchment. The integrated land and water management practices of informal furrow irrigators upstream are contrasted with the attempts of Nyanyadzi irrigation project beneficiaries to realise their legal claim on river water. During times of water scarcity Nyanyadzi irrigators literally bring the water of the river to their intake, through organised upstream raids destroying intakes of competing irrigation furrows.

Irrigation development in the Nyanyadzi catchment may date back to pre-colonial times, but major developments started early in the 20th century. White settlers took out furrows, and farm labourers, tenant farmers and communal farmers soon followed this example. The government began the Nyanyadzi irrigation project in 1934. By 1938 it had already been discovered that upstream African furrows competed for water with the Nyanyadzi project. The government used the Water Act and Natural Resources Act to squash indigenous irrigation furrows and to declare the wetland cultivation practice of *matoro* illegal. It was believed that informal furrows were wasting water, and that wetland cultivation was destructive, causing siltation.

As the water and agricultural administrative bureaucracy grew in terms of staff, offices and legal instruments, the Water Act and its stipulations had, during the late 1940s and early1950s, become a reality to the white settler furrows as well. The settlers applied for water rights on mass. In 1952 the Water Court sent a team of engineers to investigate the hydrological behaviour of the river (when the first discharge measurements are conducted) and assess the irrigation practices and plans of the white settlers. Again unauthorised African furrows were declared illegal. In addition, the priority right of Nyanyadzi project was made subservient to the upstream water rights of European farms with a more recent priority. Whilst the water administration established a semblance of rigid order (issuing absolute volumes of water, relying on self monitoring of water abstraction by users with help of measuring devices), Nyanyadzi river water and its users did not comply to this order. In the mountainous upper reaches of the catchment, irrigation continued without water rights and measuring devices. The emerging water-network controlling and regulating Nyanyadzi river water did not reach that far.

In 1967 a network of 5 automatic gauging stations was installed to 'calibrate' the decisions of the Water Court with the empirical hydrological behaviour of the river. The immediate necessity for these measuring devices was the possible construction of a dam on the Nyanyadzi River, which would alleviate water shortages in the Nyanyadzi project and allow further expansion of irrigation in the lowveld.

During the late 1970s, at the peak of the liberation war, groups of labour tenants and land hungry communal farmers invaded the empty farms in the

middle range of the catchment and started using the irrigation furrows as well as taking out new furrows. The spatial set-up of these furrows respected the local hydrology. Their management was often mediated by a headman, using the principle of sharing of water during scarcity by means of taking turns, and remaining outside government control.

Water rights were of no concern, until 1983 when the administration was on its feet again. The District Administrator applied for water rights on behalf of many new furrow irrigators in Shinja resettlement scheme and the downstream communal areas. Thus, Nyanyadzi river water was increasingly committed to these water rights, and users were more frequently confronted with water shortages. During such times of water scarcity, the sole river inspector for the entire province of Manicaland could do very little to effect the priority date system of water rights.

In effect, water administration follows the irrigation practices on the ground, rather than the other way round. The Water Act, staff from the Department of Water Development, and flow gauges seem powerless to control and regulate water use. This is evidenced by the fact that more water rights have been issued than the river can deliver in critical dry seasons. V-notch measurement gauges that have been installed at the intakes of some furrows are used as symbols of legality rather than for measuring water abstraction. The official state-engineered water-network surrounding water use is authoritarian but weak, particularly during times of water scarcity.

Due to the upstream developments of informal irrigation furrows, plotholders in Nyanyadzi irrigation project are faced with frequent water shortages. The water administration, however, fails to find a suitable and lasting solution. Hence the plotholders and the project's management have no other option than to take the initiative. They organise raids up the river, destroying the diversion structures of the numerous informal furrows. But the raids have been futile: the effect is minimal in terms of water reaching the project, and the destructive raids are opposed by politicians and extension workers in the middle range of the catchment. The District Administrator has twice brokered a 'fair' water sharing arrangement between the informal and formal irrigators, but these arrangements have proven to be unstable. The deal was that the upstream furrows along the Nyanyadzi River and the Nyanyadzi irrigation project would open and close their intakes on alternate weeks, in this way giving each other equal access to irrigation water. The DA deployed principles of 'sharing' water in a 'fair' manner. Both principles seem to have been derived from the way the informal furrows were being managed in practice, and not from the Water Act of 1976. In fact, 'water sharing' and 'fairness' are concepts foreign to the Water Act, which has been based on an entirely different principle, namely the priority date system. However, the water that left the Nyanyadzi in this arrangement never reached the project intake: the water percolated and evaporated on its way down through the dry riverbed. Consequently, the Nyanyadzi project could not be made to co-operate in this deal. However fair the deal was, it had to fall through.

Interestingly, the new Water Act of 1998 abolished this priority system of water rights, and based itself on principles of equity and proportional allocation. The new Water Act has also established catchment councils constituted by representatives of all water users, who jointly decide on water allocation. The question is whether these legal and institutional innovations are sufficient to

resolve the water conflicts in the Nyanyadzi catchment in a more acceptable and negotiated manner, bridging the gap between legality and practice, and interconnecting the various water-networks. One thing is certain: the new structure will not produce more water or change the characteristics of the riverbed, and shortages are bound to continue. Additional changes will have to be made on the material elements of the existing water-networks, so that diversion weirs, furrows and canals are better tailored to the fluctuating flows and silt loads of Nyanyadzi River.

Trees and irrigators competing for water and land in Chimanimani [5]

The case of competition for water between a transnational forestry company, Border Timbers (a subsidiary of the Anglo American Corporation), and farm labourers engaged in 'informal' furrow irrigation, is set in the Nyanyadzi river catchment, Chimanimani district. The Nyanyadzi irrigation project (the government-managed scheme mentioned in the previous section) also features in the background of this case.

The story starts with white settlers of the Martin trek (1895) carving out large farms in the upper and middle range of Nyanyadzi catchment. In this process, resident African families became farm labourers. The farms were mainly used for cattle ranching, but irrigation infrastructure was also developed for horticulture. However, the area was affected by the liberation war in the 1970s. By 1978 only eight of a total of 105 farms in Cashel and Chimanimani were still occupied by their white owners (Alexander, 1993: 247-48). The rest of them had either been killed or had fled from the freedom fighters infiltrating the area from nearby Mozambique.

This set the scene for John Heynes, one of the few remaining white farmers and chairman of the Cashel Rural Council, to expand his cattle ranching operations to a network of farms which by the end of the 1980s numbered some 80 farms in Chimanimani and his native Makoni district. Heynes was locally known as *Masoori* for his propensity to make farm labourers sorry by using his *sjambok*. Heynes took care of many farms that had been abandoned by their white owners during the war. He put cattle on these farms and employed local *baasboys* and some tenant labourers to look after his steadily growing herd.

After Independence, Heynes and his Hangani Development Corporation (over 7,000 hectares on six farms in the upper Nyanyadzi catchment) did very well economically (mainly cattle ranching). Meanwhile, the government had started the land resettlement programme. Farms designated by the government for resettlement were invaded by more and more settlers from neighbouring overcrowded communal areas. The new squatters managed to make a living by, amongst other activities, taking out irrigation furrows and entering into lucrative tomato and pea-growing contracts with Mutare based canning factories. The Squatter Control Committee of Chimanimani, however, issued alarming reports on the environmental destruction caused by these squatters, but failed to provide an alternative in the absence of more resettlement farms.

In 1995 Heynes decided to sell his Hangani development corporation farms. Border Timbers, the local commercial forestry company and biggest employer of

[5] This section is based on unpublished material collected by Alex Bolding.

Chimanimani district, expressed interest in these farms, which would enable it to expand operations for the planned chipboard factory in a joint venture with Mozambican investors. In January 1996 a team of officials from the Department of Agricultural, Technical and Extension Services (Agritex) assessed the farms for sale on their suitability for resettlement. The team considered all farms unsuitable for resettlement, since they were too steep and hilly for arable farming - this was despite the presence of numerous irrigation furrows on these farms operated by farm foremen and tenant labourers. Subsequently, Border Timbers hired a consultant to conduct an environmental impact assessment on the planned afforestation, eco-tourism and wildlife ranch developments. In July 1996, the Rural District Council was briefed by the consultant that the afforestation with pine trees (90%) and blue gums (10%) would be done in an environmentally friendly manner, such that the trees would have a next to minimal affect on the run-off of the Nyanyadzi river.

In September 1996 a University of Zimbabwe researcher and a Chimanimani Rural District Councillor informed downstream irrigators of the imminent land transfer and afforestation plans, which could affect their already limited access to water.[6] Most furrow irrigators are keenly aware of the effects of exotic tree plantations on the hydrology of their river. The Zimbabwe Farmers Union in Nyanyadzi irrigation project also expressed displeasure with the Border Timber deal, but failed to mobilise its members effectively. Border Timbers hired another consulting company from South Africa for a second EIA, which projected a 10% reduction of mean annual run-off 12 years after the start of afforestation. The Managing Director of Border Timbers, however, claimed that the run-off might even increase due to a phenomenon called 'mist entrapment' by pine trees. Economic arguments (trees are the most productive use of land), environmental arguments (resettlement can only lead to degradation of valuable resources, wildlife ranching enriches local biodiversity), as well as a newly started gum tree out-growers scheme for resettlement and communal area farmers seemed to carry the day. The Councillor proposed a compromise deal: Border Timbers could proceed with its project provided it build a dam capturing storm run-off from the river for the benefit of the downstream irrigators, thus off-setting the increased upstream water use by the trees. However, the alliance built by Border Timbers appeared to be too strong, despite recent presidential elections that were won by President Mugabe on the back of promises to address the land issue.

In 1997 Border Timbers began planting 500 hectares of pines on one of the farms. Halfway through the year the Mozambican investors decided to pull out of the chip board factory joint venture. Towards the end of November, the government designated two of the six farms included in the Hangani land deal under the Land Acquisition Act. The four remaining farms formed a contiguous block located in the rain-shadow of the upper catchment of Nyanyadzi River, and were considered unsuitable for exotic tree plantations.

This case, which is much more complex than presented here, shows how a number of actors mobilise networks, selectively drawing on political and

[6] Long term afforestation studies in Erin and Chisengu (Chimanimani district), where Msasa grassland was converted into exotic pine plantations, reduced annual river flow by 26% and 19% respectively. Dry season flow, crucial for irrigation, decreased by 42% and 15% respectively (Andrews and Bullock, 1994).

scientific resources. It is beyond doubt that establishing a plantation of pines and gum trees on the under-utilised farms in the upper reaches of the catchment would significantly decrease the dry season flow of Nyanyadzi river. Border Timbers, however, managed to forge an alliance (both economic and scientific) which succeeded in silencing objections made to its plans. Border Timbers enrolled two companies that produce Environmental Impact Assessment reports indicating that the project would hardly affect the hydrology. It also unveiled a plan to develop eco-tourism and wildlife ranching on the farms considered unsuitable for commercial timber production.

Underlying this story line is the land question. After the presidential elections in 1996, the government of Zimbabwe geared itself towards a second resettlement phase. The white landowner was desperate to sell his farms before they were grabbed by the government under the Land Acquisition Act. Surprisingly, the land speculator and Border Timbers managed to get a declaration of no interest from the government. Objections from the Zimbabwe Farmers Union, the Councillor and the University of Zimbabwe researcher were brushed aside. The livelihoods of scores of labour tenants and their families were sacrificed. However, the final twist in the case showed that a more powerful actor-network, a network of high politics, intervened when two of the farms were finally designated.

The politics of plenty: Pungwe water for the city of Mutare [7]

In 1992, the city of Mutare (130,000 inhabitants) ran out of water. The city council instituted stringent measures, such as water rationing, bans on the use of hosepipes and the filling of pools. Punitive tariffs were also imposed, backed up by awareness campaigns in newspapers and at schools, in a desperate move to curb demand. As a result, water consumption dropped to a third of its level for the previous year earlier. The city was saved at the eleventh hour by rains that replenished the dams from March 1993 onwards. This traumatic experience fuelled local politicians, residents and the Department of Water Development to search for an additional source of water for the city. The additional amount required to quench the thirst of the Mutareans was not an issue that received much attention: the capacity of the city's existing water system (20 Mm^3/yr) simply had to be doubled to cater for it's projected need until the year 2010, by which time the its population would have surged to an estimated 300,000 people.

No questions were raised regarding the demand-side of Mutare's water problems. If the city's water need would be based on, say, half the unrestricted demand, which was still 50% more than consumption during the year of the great drought, the existing system would have sufficed until the year 2010. And what if all efforts would be directed towards reducing system losses? Consumption could either increase to more acceptable levels, or the quest for new supplies could be postponed even further. How much are system losses anyway? Pertinent questions such as these were ignored. The city firmly believed that with more water available, and given its strategic location along the Beira corridor between the Indian Ocean and Harare, the town would attract more businesses and be

[7] This section is based on unpublished material collected by Pieter van der Zaag.

poised for an 'economic boom'. The quest for doubling Mutare's water supply had begun.

Three different supply options presented themselves and one was chosen. This option involved taking water from the Pungwe River.

The advantages of this option were:

1. The water would gravitate through a 4km tunnel and a 46km pipeline to the existing treatment works at Odzani, from where it would further gravitate to the city; this option would therefore not require any pumping.
2. The water drawn from the Pungwe would be pure, hardly requiring treatment.
3. The pipeline would be owned by the city.

The disadvantages were:

1. Only some 16 Mm^3/yr could be securely drawn from this source, so it fell short in providing a supply solution for the coming 15 years.
2. It would be expensive to build (US$ 100 million, nearly three times the next expensive option).
3. It would create problems with Mozambique, and in particular the city of Beira, which depends entirely on Pungwe water.
4. It would negatively impact on the pristine ecology of the Pungwe catchment, located in a popular National Park.

In arriving at its decision, the City Council appeared to have used two major criteria. The first was that it wanted to own the new water system in order to be fully in charge of the scheme, and not depend on central government. The second was obvious; namely that it would prefer the option that was cheapest to the city. The Pungwe alternative, while by far the most expensive in terms of investment, had the lowest running cost. If the city would be able to access government loans on the usual local authority borrowing terms, the interest rate would be lower than the annual inflation rate (~20%) (Zimconsult, 1996). This meant that the best option would always be that option with the lowest recurrent operational costs, whatever the initial investment. The Pungwe alternative was the only option that scored positive on both criteria.

The City Council now had to solve a number of obstacles to get the pipeline constructed. To begin with, the Department of Water Development was in favour of another option. It argued that the Pungwe scheme was too expensive and would yield little water. Since Mutare would require the department's approval for its preferred alternative, it had to make it change its mind. Additionally, the Council had to present the preferred option to the Mutareans as the best, if not the *only* way of solving Mutare's water woes, so the residents would forget to ask difficult questions, such as how much the Pungwe water would cost. The Council would also have to overcome Mozambique's opposition to the Pungwe scheme. And finally, it had to find a suitable financing package.

The City Council managed to overcome these odds within a period of 18 months, through establishing a fruitful relationship with a Swedish construction firm (which backed up the City's preferred option with engineering facts, and mobilised support from Sida, the Swedish International Development Agency), and by carefully exploiting political opportunities within a faction-ridden Manicaland province of the ruling party. But the major feat was that the council

managed to portray the Pungwe project as providing purity (pristine water), security (no more shortages) and prosperity (more business) to its residents, all in one. These powerful positive values became synonymous with the Pungwe scheme, and most people fell for it. Few still wanted to look into the detailed merits and demerits of this option. Once popular support was achieved, the vying politicians could do little else than to follow suit.

One outstanding issue was that a declaration of no objection from the government of Mozambique was required before the project could go ahead. This was a condition set by donors. The Pungwe River, shared by Zimbabwe and Mozambique, is the only fresh water source of the city of Beira (some 500,000 inhabitants). Tedious negotiations at government level finally resulted in an agreement whereby Mutare was allowed to take a maximum of 700 l/s, provided that it would always leave a flow of 500 l/s in the river at the point of abstraction. Engineers subsequently translated this agreement into a specific design of the river off-take. Construction of the Pungwe pipeline started in December 1996, was completed in December 1999 and officially opened by President Mugabe in March 2000.

A group of actors had managed to construct a pipeline that some believed was the least feasible of several options to solving Mutare's water crisis. The group managed to interconnect two river systems, rendering two cities separated by geographical distance and national boundaries, interdependent of each other. They also managed to enrol highly placed ruling party leaders, who for once set aside their differences, and overcame initial opposition from the Department of Water Development. Finally, the group managed to interest a Swedish engineering company and international and local financing institutions. Around the Pungwe, a water-network emerged with a vast span, both geographically and politically. The network proved too strong and effective for the voices of dissent. Mutare residents were blinded by the Pungwe symbol, and made to forget the impending tariff increases. The Mozambican government was made to accept the project. Environmentalists were painted as a 'clique of very few individuals' and small-scale farmers in Honde Valley, who feared they would be affected by Mutare's water abstraction upstream along the Pungwe River, were threatened with eviction. Even Sida staff critical about the project did not dare to come out in the open. All these voices of dissent, clearly with their own different agendas, failed to connect and establish an effective water-network with a global resonance. They did not manage to enrol, for instance, concerned environmental and other groups in Mozambique, Sweden and elsewhere.

By the year 2000, the main proponents of the pipeline were extremely pleased. The Swedish engineering firm could add another engineering miracle to its portfolio (constructed in time, within budget, with minimum environmental impact). Standard Bank was proud to have engineered together with Sida an innovative financing modality, whereby US$ 5 million of aid money could generate another US$ 45 million of local financing from the private sector. (In addition, a Nordic financier provided a US$ 50 million concessionary loan to the Zimbabwe government.) Sida, for its part, was confident it had helped 'to ensure that countries can make their own decisions on their economies and policies and create the conditions necessary for national self-determination'.[8]

[8] African Business, July/August 1999; http://www.africasia.com/ab/jul99/abfn0701.htm

The City Council was also pleased, as it managed to get the option it wanted. It now owned a pipeline that produced water at very low recurrent cost, and did not have to worry too much about the loan repayments, as the interest rates were less than the inflation rate. After the inauguration of the pipeline, the city engineer closed supply from the old source of water, and exclusively used Pungwe water that hardly required any treatment, saving substantial amounts of money. Water consumption could now continue to grow, and in October 2000 raw water abstraction surpassed the all-time record of January 1991, namely 1.6 Mm^3/month. The council treasurer was happy, because more water delivered meant more revenue. And the politicians could look back on a job well done: a job that first managed to influence the people in what they perceived their needs to be, and subsequently satisfied them.

The only problem was that the pipe network within the city refused to co-operate. Pipes kept on leaking and bursting, and more and more water meters mysteriously got stuck. It was now pure Pungwe water that was disappearing and nobody wanted to know that half of this precious water was going to waste (Gumbo and Van der Zaag, 2001).

Discussion

Despite their differences, the cases presented here show what is entailed when human actors attempt to harness a life-giving water resource. The case studies demonstrate, first, that it matters which water source is at focus, and for what purpose it is intended to be used: whether it is rainwater for agriculture, river flow for irrigation, or pristine river water for a city. Clearly, networks are not built for their own sake, but evolve because of the object that has to be harnessed. Consequently, the physical object of appropriation influences the shape of the water-networks that develop. Harvesting rainwater required a network of a limited span, diverting river water for small-scale irrigation required a network that spanned the river catchment, while abstracting water for a large city from an international river necessarily involved a network that ranged across river basins, countries, and even continents.

Secondly, these cases show that it is not always easy to channel, harvest and use water for its intended purpose. It nearly always requires substantial investments, whether in monetary terms, labour, knowledge or in social relations. All cases presented here required, in fact, all four types of capital. The bench terrace was knowledge- and labour-intensive, while Mutambara irrigators had to mobilise commerce as well as forge new social relationships to access water. In all cases, some institutional regulations were breached or set aside. Some actors carefully exploited the fragmented nature of the institutions involved, drawing on those that suited them most and ignoring the rest. For some, the complex, uncoordinated and fragmented institutional and legal reality thus became a resource in itself.

Thirdly, in all cases there were alternative solutions for an intended water use. Biriwiri farmers could have decided to harvest rain somewhere else, where the land would be more co-operative. The City of Mutare could have decided to get water from the nearby and under-utilised Osborne dam, at a much lower investment cost. This option, however, involved high running costs (pumping,

water treatment), and would have made the city dependent on the Department of Water Development, which owned the dam. The Hangani farms in upper Nyanyadzi could have been used for sustained furrow irrigation and wildlife ranching by officially re-settled, former labour tenants and squatters, at no detriment to downstream water users. Alternatively, Border Timbers could have offset the negative flow impact of afforestation on downstream water users by constructing a dam. Since such alternatives existed, actors had to enrol other actors in their projects, strategically establishing coalitions, and convincing others of the benefits of the preferred solution. So landless peasants made Land Development Officers accept the bench terraces on land too steep to cultivate. The Department of Water Development made a surprise about-turn in the case of Mutare. Similarly, the Honde valley farmers were overpowered by threats of brute force, and environmentalists were largely ignored. Border Timbers mobilised economic and environmental arguments and twisted scientific evidence in order to ward off political claims on more land for destitute communal area dwellers, and to dismiss the dam option.

Fourthly, once a preferred solution had been 'stabilised', the physical world had to be transformed and made to cooperate: stones were re-aligned in Biriwiri; Mutambara irrigation infrastructure was allowed to leak in order to oil water (re-) distribution at night; in the Nyanyadzi catchment, furrows were dug at suitable locations honouring the local hydro-geological behaviour of water, and elsewhere exotic tree plantations were established; at Pungwe the intake structure 'concretised' an agreement between Mozambique and Zimbabwe, 'cementing' the connection between two river basins.

At times, however, the physical world and water's hydrological behaviour resisted to comply with the prevalent legal and institutional framework, and refused to honour the claims and needs of state and other actors. Thus the post-independence Water Court administered water-network issued more water rights than was available in the Nyanyadzi River, and the river could not honour these claims. Irrigators from the Nyanyadzi project could not realise their right to the river's water in times when they needed it most. The riverbed did not comply with the water sharing arrangement brokered by the District Administrator, and river flows disappeared. The informal upstream furrow irrigators argued that the little water available could be utilised by them better, as it was otherwise going to waste (i. e. consumed by riverine vegetation, percolated to the subsoil, or evaporated into the air). So the fair deal collapsed.

Finally, some of the networks of human and non-human actors that emerged were powerful, some of them were durable, and some were both. The water-network emerging around the Pungwe was powerful: it mobilised US$ 100 million, it managed to eclipse common sense, and could enrol actors on a global scale. The network may not durable but is bound to last, at least in terms of the continuous flow of water from the river to Mutare residents, and the flow of repayments of the loans incurred. Other water-networks, like the one's engineered by Biriwiri dryland farmers and Nyanyadzi furrow irrigators, whilst not powerful in the sense of formal legal and institutional backing or spatial extent, have proven to be very durable.

Conclusion

Water-networks can be understood and described as an outcome of strategic action where actors use whatever is deployable in their bid to secure water. The practices of actors featuring in the case studies were largely informed by the physical and other (including social and institutional) resources available to them. In the water-networks described, essential parts of the social dynamics were focussed on, and to certain extents constrained and determined by, material things rather than people. Networks of human and non-human actors emerge around water use that have a sense of order. The water-networks are recursive, emergent forms that enable further action to be taken by some, while constraining the options available to others. The central point of the cases is that these networks include material elements, which are integral, if not central, parts of them. The material context in which human action is enacted is thus a constituent element of that action. The actor-oriented approach (Long, 1984) has, in our view, underplayed the material dimension in social relationships and human action. As a result, its contribution to some important academic debates, such as those centring on the artificial binaries 'nature-society' and 'actor-structure', has been disappointing, while its potential relevance to development practice has so far been limited.

If it is true that water-networks have materials as constituent elements, changing these networks may pose a real challenge. Zimbabwe at one point made the political decision to reform its water sector through changing the water law (which abolishes water rights and converts them into permits), and establishing new institutions, such as the Catchment Councils. These new legal and institutional forms aim at making the availability of water more equitable, its use more efficient, while protecting the environment and involving stakeholders in the decision-making processes of water allocation and use. These are all laudable objectives. However, the question is whether legal and institutional changes are sufficient to effect a change in the existing water-networks, and whether the actors forming part of these will change their practices and attitudes. The physical parts of these networks are most likely to stubbornly remain unchanged. Since the material things are intricately interwoven in these networks, the actors using the water may find it difficult to adapt their action to the new institutional reality, unless they re-adjust the entire assembly of the network, including its material parts. Only then can water use practices be expected to change substantially.

The Mutare pipeline case provides a clear example of this. The pipeline seems to follow the values enshrined in the old water act, which sought to solve water problems in a supply driven, technocratic manner. With the new water act in place, the pipe now appears a misfit: since it provides plenty of water at low recurrent cost there is little need for the City Council to closely monitor water use and attempt to minimise unaccounted-for-water. As a result unaccounted-for-water has increased to unacceptable levels since the commissioning of the pipeline in early 2000 (50% of water diverted from the Pungwe). At the same time, water tariffs have increased in order to service the investment loan, compromising access to this life-giving resource to the poor. The physical parts in this water-network therefore induce practices that lead to inefficiency and inequity.

If the new legal and institutional forms had been in place, would for instance the Mutare and Nyanyadzi cases have resulted in different outcomes? Referring to the latter case, one can expect Nyanyadzi river water management and development to have been subject to scientific, political, and economic debate in a (sub) catchment council with all the stakeholders represented. Would such a user institution have succeeded in negotiating a decision that was more favourable for small-scale producers, in the face of powerful interests that transcend the local polity? And would it have resolved the clash of interest between the 'formal' and 'informal' small-scale water users? Merely establishing a negotiation platform is most probably not a sufficient condition. It would require relations between people and things to be clarified and changed, and thereby relations between people.[9] It would often also require that the relations between things themselves be changed, so that the assembly of artefacts not only better respects the local hydrology but also the new water regulations and the catchment-wide water-network as a whole.

At a more practical level, in the Nyanyadzi catchment the (user) rights to water of all water users need to be clarified, in an open and transparent process of consultations, thus paying respect to the material reality of the Nyanyadzi water front. Simultaneously alternative sources of water could be considered. Groundwater remains a potential alternative to a dam for the irrigators in the downstream Nyanyadzi project, and requires investigation. If groundwater proves to be a feasible alternative, Nyanyadzi project could rescind (part of) its claims to river water. Finally, the design of diversion structures, measuring devices and furrows need to be evaluated on their effectiveness by technical experts, in close consultation with their users/owners. This could be done in a manner that would allow easy monitoring by both users and catchment council staff, thus calibrating and materialising the discourse of proportional water allocation ingrained in the new water Act (WRMS, *n.d.*; see also Van der Zaag and Röling, 1996) with the prevalent practice of issuing and measuring water in absolute volumes (as embodied in the prevailing V-notch water measurement structures).

Similarly, the intervention package required in the case of the city of Mutare would involve a suit of technical, institutional, financial and other aspects (Gumbo and Van der Zaag, 2001). Irrespective of the fact whether Mutare city uses Pungwe water or water from other sources, the present leaking distribution network begs urgent attention. A demand management strategy combined with efforts to upgrade the distribution network, making it water tight and transparent, can mitigate Mutare's water woes to a considerable extent (pre- and post-Pungwe project). Water meters can be repaired, pressure reducing valves at some points in the reticulation network installed, a monitoring and water audit system established, and the water services provided to some high density areas completely overhauled. In addition, the institutional relationships between the treasury and engineering departments within the city council can be clarified, the flow of information between these departments re-directed and intensified, and new city council regulations established to ensure a reasonable and stable maintenance budget. Finally, the environment, for which water reservations have been made in the new water Act, begs for representation on the newly

[9] Appadurai (1986); for an application to water-networks see Coward, 1986a, 1986b.

established Save Catchment Council. Pristine river valleys, like the Pungwe, do not speak up for themselves, despite legal stipulations favouring their cause.

In both the cases of Nyanyadzi and Mutare we see that holistic intervention packages are called for, if Nyanyadzi and Pungwe waters are to be used equitably, sustainably and efficiently.

In conclusion, a symmetrical treatment of human and non-human actors in the actor-oriented approach has the potential not only to productively engage in some of the important sociological debates, but also to increase the relevance of sociology to the development practice. In addition, such an actor-actant approach would be an open invitation for the non-social scientist to join in, something we would gladly accept.

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