



Accessibility, equity and the sharing of water resources

A critical analysis of community governance models based on a case study of the irrigation channels of the Valais

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Accessibility, equity and the sharing of water resources

A critical analysis of community governance models based on a case study of the irrigation channels of the Valais

Rémi Schweizer

- 1 The processes of climatic and socio-economic change currently affecting the hydrosystems of the Alps are resulting in an already perceptible increase in the pressure on water resources (heat wave of 2003, dry spring periods of 2007 and 2011). In the future, changes in availability and the probable increase in mankind's needs are fuelling fears of a multiplication of localised situations of competition and shortages (see, for example, OFEV 2012 for the case of Switzerland). In this difficult context, questions concerning the equitable sharing of water resources represent a challenge that is all the more delicate in that the social dimension of sustainability is often under-estimated (Dubois, Mahieu, 2002, p. 78) and not sufficiently well defined (Dempsey *et al.*, 2011), appearing as the poor relation in analyses torn between economic and environmental considerations.
- 2 The purpose of the present article is to contribute to a better understanding of this issue from both a conceptual and empirical point of view. To achieve this, we examine a system of sharing that has a long experience in managing scarcity and whose equitable character has frequently been underlined in the literature (Crook, 1997; Wiegandt, 2008; Ruf, 2011): the community models traditionally linked to the operation of the Valaisan *bisses*, irrigation channels that are typical of this canton of the Swiss Alps. The models are evaluated in terms of accessibility and equity, two dimensions that we used to operationalize the notion of "equitable sharing". The models are also compared with empirical data provided by three case studies. Focussing on three irrigation channels of the Valais (bisse Vieux de Nendaz, Torrent-Neuf de Savièse, and bisse de Tsa Crêta at Mont-Noble), these studies were conducted as part of a project financed by the Fonds National Suisse de la recherche scientifique (Swiss national science research fund) (Schweizer *et al.*, forthcoming), and also serve as the basis for a doctoral thesis. The

empirical elements presented are both part, and a continuation, of reflections conducted within the context of this research.

- 3 Our discussion is presented in four phases. After an introduction focussing on the characteristics of the channels and their governance models, the notion of equitable sharing is operationalized in terms of accessibility and equity. The systems of distribution that have been put in place in each of the areas are then presented with a view to identifying certain empirical patterns with regard to these two aspects. Finally, analysis shows that the equitable nature of these distribution systems is not so evident, thereby challenging the positive vision generally found in the literature.

The *bisses*: common-pool resources managed collectively

- 4 Supplying water in mountain regions with a dry or arid climate has always been a major challenge. This struggle for water manifested itself in a more concrete form with the construction of sometimes spectacular irrigation channels and, on a social level, the setting up of community governance models that have often been regarded as exemplary (Wade, 1988; Ostrom, 1990; Ruf, 2011). In the heart of the Alps, in the driest of the Swiss cantons, the Valaisan *bisses* (*Suonen* in German) provide an eloquent example of such channels and systems of organisation. It is generally accepted that, since their beginnings, they have always been operated in common, not only because of the costs involved (construction, maintenance) but also because of their importance in an agro-pastoral canton. Built and then operated collectively by the local communities, they have provided water for crops and shaped the landscapes of the canton for several centuries – the first traces of them in the archives date back to the 12th century (Ammann, 1995)¹. In forest and pasture areas, channels have been dug out of the ground, while in some areas of more difficult terrain, they are found clinging to the sides of vertiginous slopes. Somewhat neglected throughout the 20th century during the periods of agricultural decline and modernisation, since the 1980s they have experienced a revival, being recognised as a multi-functional object (E. Reynard, 2005) at the interface between agriculture, heritage, tourism and the environment. Far from simply symbolising the relics of an agro-pastoral past, they represent today the principal method of supplying water in the Valaisan hydrosystems (OFAG, 2007), as well as a major asset for summer tourism.
- 5 This longevity and multi-functionality of the *bisses*, together with their community engineering heritage, have fascinated the social sciences for more than a century (history, geography, economics and, more recently, political science (for example, Collectif, 1995, 2011)). These channels bear witness to not only a certain technical know-how, but also a multi-secular institutional experience in terms of resource renewal and sharing (Lehmann, 1912; Vautier, 1928). In a society where agriculture represented the main source of income, rivalry for access to irrigation water developed very rapidly, posing a serious problem, exacerbated by the fact that it was difficult to exclude users (everyone potentially has access to the network) and because of the subtractability of resource use (water used by one farmer is no longer available for the next). In this respect, the *bisses* and the water flowing in them constitute a common-pool resource in

the sense used by Elinor Ostrom (1990), as opposed to public, market or club goods (Figure 1).

Figure 1. Typology of goods

	Rivalry (Subtractability)	
	high	low
easy	Market goods	Club goods
Exclusion difficult	Common-pool resources (CPR)	Pure public goods

ADAPTED FROM OSTROM, 1990

- 6 These rivalries led to the creation of a governance regime traditionally oriented towards dealing with them *ex ante* through a strict water distribution system. The *consortage* (*Geteilschaft*)², or common-property irrigation corporation comprising all the users (Ostrom, 1990, talks about CPR Institutions), represented the central player whose role it was to develop, maintain and operate the network. More specifically, each member (*consorts/Geteilten*) received a certain number of water rights expressed in “hours” (*droits d’eau/Wasserrechte*), which were then exercised according to a strict schedule (*tour d’eau/Wasserkehr*) and for which the beneficiary was obliged to fulfil certain maintenance (*corvées/Gemeinwerk*) and financial obligations. The *corvées* (workdays) referred to the time to be spent on maintenance tasks, which were generally carried out before the channel was flooded and, more rarely, during the season (extraordinary duties). For maintenance and general surveillance, a guard was generally appointed. Such a system with rights and obligations organised on a collective basis can be found throughout the canton, although the exact methods used might vary from one *bisse* to another.
- 7 In any event, the involvement of users – in defining operational rules, network development and maintenance, and in the actual running of the network – is the corner stone of the governance models introduced in this way. Founded on a series of arrangements that are both endogenous (*i.e.* coming from the users) and customary (*i.e.* based on non-written multi-secular practices)³, these models are not therefore dependent on a state-run or private exogenous organisation aimed at regulating operations in a top-down structure. On the contrary, they represent an example of the third way identified by the CPR theories between traditional state regulation and the utopia of mechanical regulation through the markets (see, in particular, Ostrom, 1990). It is hardly surprising in this context that the positive vision portrayed by these schools of thought, whose aura and potential for diffusion are considerable⁴, has filtered into a literature that already had a tendency to give the *bisses* an emblematic status – Bernard Crettaz (2011) goes as far as to speak of “Disneylandisation”.
- 8 Thus for several years there has been a whole rhetoric around the sustainable character of their governance models (Crook, 1997; E. Reynard, 2008), but the notion itself has never really been defined and operationalized in a rigorous manner. Despite some more critical studies (Netting, 1974), the overall vision that was imposed portrayed the distribution systems as representative of a model of equitable sharing. This vision is reflected, for example, in the work of Darren Crook (1997, p. 293) – “equity is achieved through a well

managed system of resource allocation” –, Ellen Wiegandt (2008, p. 77) – “the coexistence and interaction of both common and private property regimes has been identified (as a key factor in) the equitable distribution of resources”, and Thierry Ruf (2011, p. 207, our translation) – “the rules governing associations of irrigation users were based on equitable sharing among small operators”. It is precisely this conventional wisdom that we propose to challenge in this article.

The notion of “equitable sharing”

- 9 It is important to firstly determine the qualities that characterise an equitable system for sharing water resources, a theme in keeping with the social dimension of sustainability. Should one reason in terms of equality or equity? What criteria of discrimination appear socially acceptable? Should analysis focus only on members of the community (the *ins*), or also take into account those excluded (the *outs*)?
- 10 Given that the literature cited above eludes these questions for the most part and provides no rigorous definition, we propose (figure 2) an original interpretation grid that puts the emphasis on clarity and parsimony. Basing our proposal partly on the work of Dubois and Mahieu (2002) on the relationships between social sustainability and poverty, and partly on our own thoughts on the sustainability of irrigation systems (Schweizer *et al.*, forthcoming), we identify the principles of accessibility and equity with a view to understanding the notion of “equitable sharing”. More specifically, we conceptualise these two principles in the following manner:

Figure 2. Principles of equitable sharing

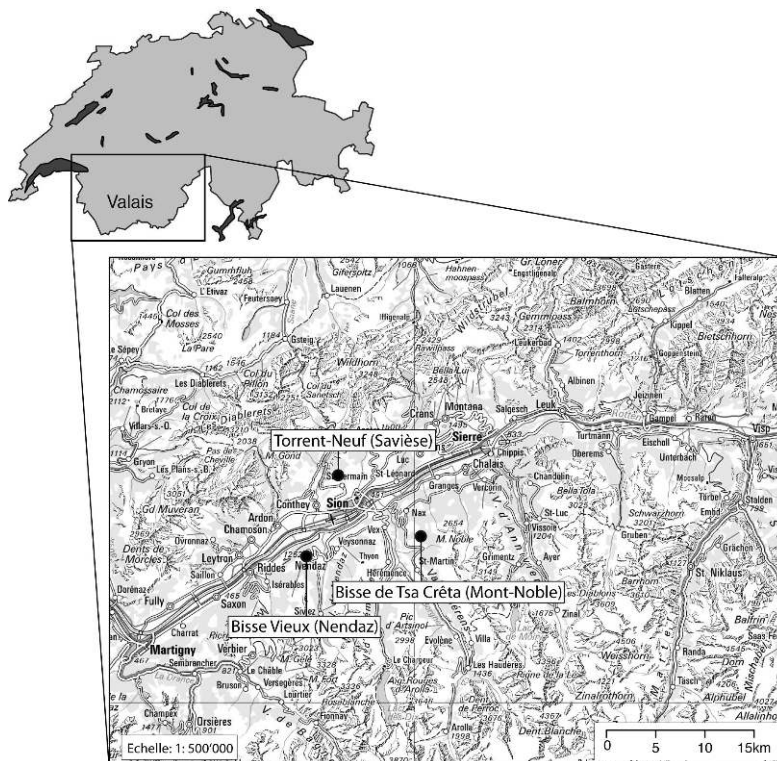
Principle	Definition	Criteria
Accessibility	Accessibility concerns exclusion, which is “the fact of systematised non-access” (Dubois, Mahieu, 2002, p. 81, our translation)	- presence of people excluded (<i>outs</i>), to whom network access is refused
Equity	“the aim of the search for equity is to regulate, if not reduce, inequalities” (Dubois, Mahieu, 2002, p. 82, our translation)	- equity in the attribution of rights within a consortage (among <i>ins</i>) - equity in the distribution of maintenance and financial obligations

- 11 While the CPR theories (Ostrom, 1990) and the literature on the *bisses* tend to focus their analyses on the members of the community (the *ins*), we consider that it is essential to also take into account those who are excluded (the *outs*). In our opinion, this stance is the only sensible one from a holistic perspective, since the presence of people who are excluded raises questions that an approach in terms of sustainability cannot ignore, except by reducing the social dimension to an unsatisfactory minimum. It is in this regard that the principle of accessibility was formulated. As for the second principle, it reflects a desire to link the arguments in terms of equity and equality by defining the first in relation to the second.

Case studies

- 12 The three criteria identified will be compared with empirical data from three case studies (bisse Vieux, Torrent-Neuf, bisse de Tsa Crêta, cf. Figure 1)⁵. The approach is therefore comparative and case-centred, based on a qualitative process of data collection that as far as possible seeks to triangulate the different sources used (archive analyses, interviews, historical literature). It should be noted that, although the question of the insertion of community governance models in a changing socio-economic context undoubtedly has to be raised – indeed, this is a topic addressed recently by Schweizer *et al.* (forthcoming publication) –, the temporal horizon here is delimited by an historical analysis (19th – early 20th century). The information presented and the conclusions drawn are consequently limited to the governance models as they existed traditionally.

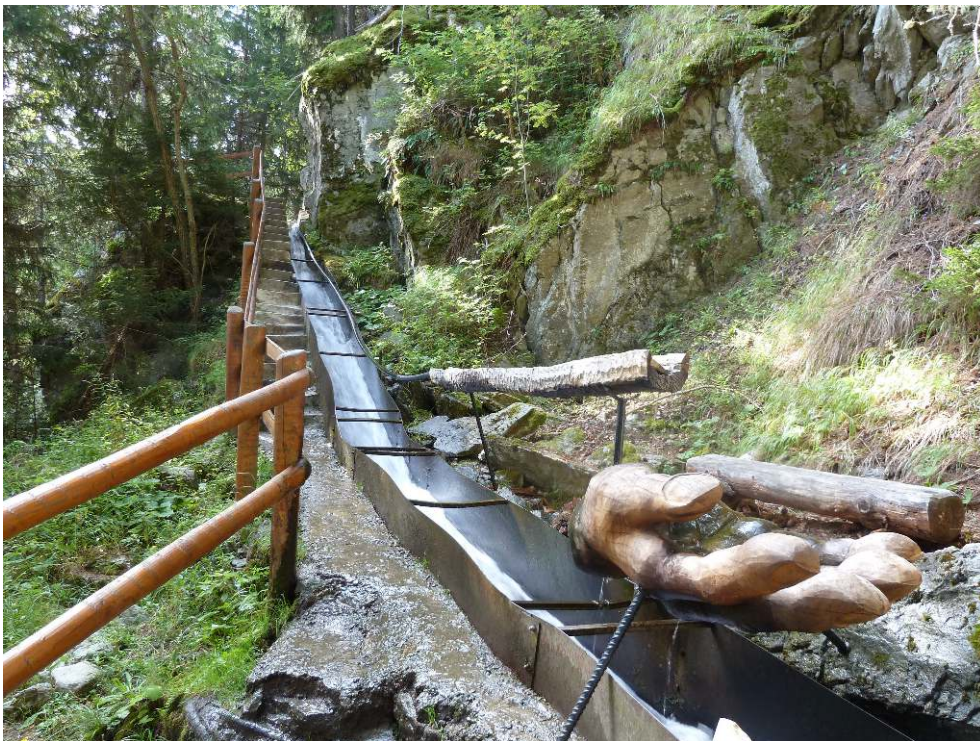
Figure 3. Locations of the three *bisses*⁶



- 13 The bisse Vieux de Nendaz (catchment basin of the Printse river), the bisse du Milieu and the bisse du Dessous form a layered system that irrigates the shoulder of the hill on which the villages of Basse-Nendaz and Haute-Nendaz are nestled. Although the exact date of its construction is not known, the channel clearly dates back several centuries, while the consortage in charge of its operation⁷ has probably existed since the origin of the aqueduct. Both therefore have a multi-secular history. The distribution system remained stable until the 1960s, before agricultural decline resulted in the regulatory aspects of the system being less rigorously applied. A document from the archives of 1924⁸ and the work of Michelet (1977), together with interviews we conducted on site, provided us with fairly precise information on how the system was organised.

- 14 Water was distributed according to user rights that were defined in terms of time (hours) rather than quantities and related to a person rather than a plot of land (water rights and land rights could be disposed of separately). A total of 2760 hours were attributed in this way. Each hour allotted had accessory obligations (maintenance in the form of duties, financial assistance via payment of yearly fees) and rights (vote, election to a committee). Water distribution was then implemented according to a rotational schedule organised in irrigation *tours* or cycles of 23 days divided into five *bulletins* (number of consorts or members irrigating simultaneously). This means that rights could be exercised every 23 days, or five or six times a season.

Figure 4. Bisse Vieux, the “Passage du Dix-Huit”



- 15 Caption: The famous “passage du Dix Huit”, situated along the Bisse Vieux, is today a location much appreciated by the tourists. However, it is above all a modification that proved to be necessary to bring water through this steep section of the Bisse, and whose construction was financed by a 18th cycles to the water schedule.
- 16 The number of cycles was initially fixed at 17, but this was increased over time, partly to take into account growing demand and partly to finance upgrading work. The 18th cycle was added, for example, to finance development work on a 5-6 metre fall known as the “Passage du Dix-Huit” (see photo above), while the 23rd was auctioned in 1894⁹. The same was also true of the number of “bulletins”, which was limited to three or four until the 1920s (creating “two sorts of water rights: cycles by thirds and cycles by quarters” Michelet, 1977, p. 108, our translation), then increased to five in 1923 (in the wake of substantial maintenance works), and finally to six in 1948 (when the first sprinkler network was connected to the bisse).

Torrent-Neuf de Savièse

- 17 The Torrent-Neuf (Morge catchment basin) was partially replaced by a tunnel in 1935 but is still in operation in its upstream part and irrigates the plateaus and hillsides of the municipality of Savièse. Built in the 15th century, it was first operated by the entire community of Savièse – the *communitates* (Reynard, 2003, p. 93). It was only in 1810 that a separate consortage was created in response to the threat to their communal goods arising from the whims of federal and cantonal authorities wishing to ensure equality between bourgeois and non-bourgeois. For members of the local community, the objective was to “keep their biggest investment out of the hands of outsiders” (Roten Dumoulin, 1990, p. 188, our translation), in other words, to maintain control over their *bisse*. In concrete terms, at this moment the 800 local residents gave up their rights to 800 consorts (the same people), which enabled them to avoid having to guarantee access to all the inhabitants whenever egalitarian intentions became translated into law.
- 18 This changeover to a consortage did not, however, change the organisation of the water distribution system (Roten Dumoulin, 1995, p. 337). This dates back, it seems, to the origin of the aqueduct and it remained stable until agricultural decline set in. More specifically, analyses of the statutes of 1447 (Reynard, 2003) and our own fieldwork reveal a system in which the attribution of individual rights (expressed in hours or poses, corresponding to four periods of 45 minutes) was superimposed by an organisation of 30-day cycles based on six individual ponds. The 800 consorts shared a total of some 2500 hours. As with the *bisse Vieux*, with each *pose* there were accessory obligations (workdays, fees) and rights, while water rights and land rights were independent. Although they could be disposed of separately, the statutes prohibited the transfer of water rights outside the community without express permission.

Bisse de Tsa Crêta

- 19 The *bisse de Tsa Crêta*, which probably dates back to before 1400, was abandoned in the 1970s then reactivated in 2002, providing irrigation for the “*mayen*” or intermediate summer pasture zones that overlook the village of Mase (commune of Mont-Noble, Borgne catchment basin). Historically, it appears that the channel has always been operated on a community basis by a consortage¹⁰. Until the 1970s, the distribution system was thus relatively similar to those described above, with the attribution of water hours and associated rights and obligations. There was also a rotation system of 32 days. A total of 98 consorts shared 637,75 hours of water in 1938. The attribution of rights, however, was related to a plot rather than a person: 720 m² gave the owner the right to one hour of water, and neither one nor the other could be disposed of separately.
- 20 The private archives of the consortage (1930-1974), which have been carefully conserved, are interesting in that they contain information on the changes in the circle of users admitted. Torn between the need to maintain a sufficient supply and that of finding new sources of revenue, the consorts alternated between agreeing (1930, 1954) and refusing (1952) to welcome new members. Accepting new members was related on the one hand to implementing a costly maintenance project (1930), and on the other to the need to find new financial resources (1954). As for refusing new members, this was justified by the lack of surplus water and the limited yield of the plots concerned.

Discussion on criteria

- 21 Figure 5 classifies the observations for each of the case studies according to the criteria to which they refer. This reveals empirical regularities that, apart from the third criterion, call into question claims made regarding the equitable character of these water rights systems.

Figure 5. Empirical elements according to identified criteria

	Accessibility	Equity in the attribution of rights	Equity in the distribution of charges
Bisse Vieux	- numerous extensions to the number of cycles and “bulletins” - new rights auctioned (1896)	- water rights and plots are independent - can be disposed of separately	- maintenance in the form of workdays - financing as accessory obligation related to water rights
Torrent-Neuf	- sale outside the community submitted for approval - creation of consortage in 1810	- no mechanism of adjustment to needs	
Bisse de Tsa Crêta	- agreement to welcome new members (1930, 1954) - refusal in 1952	- water rights related to plots (1h / 720 m ²) - cannot be disposed of separately	

Accessibility: from common-pool resource to club good?

- 22 An assessment of the accessibility criterion gives a mixed picture. Although it is true that the consortages sometimes opened up the resource to new members (increasing the number of cycles, attributing new hours), it is also true that the consorts tended to give priority to economic considerations in their decisions, only opening up the system when there was real need (network developments, to meet financial needs). Otherwise, the consortages tended to be rather reticent in opening up access to the resource, as demonstrated in the direct and indirect exclusion mechanisms documented:

- direct mechanisms: the refusal to welcome a group of farmers by all the consorts of the bisse de Tsa Crêta in 1952, and the creation of the consortage of the Torrent-Neuf in 1810 to protect the resource from outside hands, provide two examples of mechanisms that directly excluded specific groups (certain farmers in the first case, the non-bourgeois in the second);
- indirect mechanisms: these are indirect in that the refusal of access is not expressly formulated but stems from the methods of attributing rights that complicate access

(disposal of rights prohibited outside the community without express permission) or reserve it for the most wealthy (auctioning of rights).

- 23 Clearly, the presence of excluded groups of persons (*outs*) appears inherent in the community governance model: the collectively organised water rights system, however endogenous it may be, comprises direct and indirect mechanisms whose precise aim is to regulate access to the resource. It is discriminatory, and indeed that is its intrinsic aim. Determining the limit between accepted user groups (*ins*) and excluded groups (*outs*), particularly when there is strong pressure on the resource, is an issue that must be addressed if rivalries are to be settled. If the community models are so exclusive, it is mainly with the aim of preserving the economically sustainable nature of the distribution system within the consortage, even at the expense of overall social equity. If, on the other hand, too many users are integrated in the system, the risk is that it can no longer meet the needs of its members, even though it is certainly more equitable. There is therefore evident tension and a need for arbitration that will be based on political and social choice rather than scientific expertise. In the end, the solution chosen undeniably reflects power struggles within, and at the margin of, local communities that are too often presented as non-conflictual structures when, in reality, they are veritable “arenas of competition” (Allain, 2012)
- 24 From common-pool resource, which the *bisse* is in the absence of regulations (Table 1), it tends to become, through the exclusive institutional structure that accompanies its operation, a club good to which only recognised members of the club have access. The exclusion of potential users is difficult when the resource is in a natural (non-organised) state, but it becomes a reality once a system of rights, perceived as obligatory both by the *ins* and the *outs*, develops around the resource. As the total disappearance of rivalries is not very likely (within the club and with respect to the outside), the *bisse* only rarely becomes a club good in the real sense of the term¹¹. This, however, is the inherent logic in the system, given the obvious reticence to open up the resource. In this context, the question arises as to whether, in the end, common-pool resources really exist, or whether the introduction of exclusion mechanisms does not constitute a constant once an intention of production is associated with an object (or once an object becomes a resource, to use the vocabulary developed by Kebir, 2010).

Equity: allocation of rights that reflects, or even accentuates, inequalities

- 25 The evaluation of this second criterion is also somewhat mixed, in that it cannot be affirmed that the allocation of rights within the consortage (*i.e.* between the *ins*) makes it possible to regulate or reduce inequalities – in fact, quite the opposite. Two systems may be identified with respect to this point:
- In the first two cases (*bisse* Vieux, Torrent-Neuf), even if water rights were initially attributed according to the area to be irrigated, they are not linked to the plots and can be disposed of independently. In the absence of adjustment mechanisms, their distribution does not therefore follow changing needs, but constitutes an inherited privilege that reproduces inequalities within the community. As for the methods of attributing new rights (auctions), they tend to accentuate these inequalities by favouring those who already have greater resources.

- The case of the bisse de Tsa Crêta¹² is different in that water rights and plots are linked. However, even when attribution is based on such a criterion (land surface area), our observations do not allow us to assert that “the resources held in common tend to balance the differences between households” (Wiegandt, 1980, p. 155, our translation). Although this criterion may certainly be considered as objective from a purely economic point of view (it partly determines user needs, even though the types of crops and land also play a role), this is not the case with respect to equity in the way it is defined here. On the contrary, in a system underpinned by community values of common property (the water of the bisse) and individualist values of private property (the land under crops), it seems that the existing inequalities in land allocation within the irrigation system, whose existence can hardly be contested (see, for example, Mugny, 2012, p. 57), tend to be reproduced by the attribution of water rights. In other words, the possible social benefits of common property appear to be qualified by the private allocation of irrigated land.

Equity: obligations that introduce a certain social solidarity

- 26 Although the attribution of water rights does not respect the principle of equity, the same cannot be said of the distribution of maintenance and financial charges. This is proportional to the hours of water received and in our opinion introduces a form of social solidarity within the community, and this for two reasons: first, from a purely economic point of view, the system asks those with greater means (generally those who have more water hours) to contribute more; second, more symbolically, it organises workdays in a manner that fits in with community life and thus makes a significant contribution to social integration. All members participate, whatever their status. Such a distribution of obligations helps balance not only the economic but also the symbolic inequalities that occur within the community.

Conclusion

- 27 The approach adopted in this study fulfilled our expectations, contributing to debate and providing insights into the social dimensions of water management Remi Schweizer2014-03-27T11:11:00by focusing on questions that have often been neglected. The principles of accessibility and equity, identified as a means to obtaining a better understanding of the notion of equitable sharing, provided us with an interesting framework for interpretation, the relevance of which was demonstrated by applying it to the irrigation channels of the Swiss canton of Valais. Our analysis identified the limits of community governance models (participative, collaborative), which appeared both to exclude certain potential user groups and to reproduce, rather than reduce, existing inequalities. The main objective of these models is clearly to reserve access to the resource for members of the community, targeting certain individuals for exclusion (direct exclusion mechanisms) or at least making access complicated for them (indirect mechanisms). The presence of excluded groups appears, in this sense, inherent to these models, even if this is not always easy to identify – on this point, it is clear that more detailed historical research would provide further insights into the extent and consequences of these phenomena.

- 28 Finally, these conclusions lead us to suggest that it would be expedient to take a more critical look at CPR theories. The idyllic image portrayed by this literature is clearly called into question by an analysis that tends to show that, because of the exclusive institutional structure accompanying their operation, community-managed bisses were in fact comparable to club goods, where access was reserved for only those persons recognised as members. In this respect, history has since revealed the positive role that state authorities were able to play in opening up these previously secluded areas (namely for tourism cf. Schweizer *et al.* forthcoming), raising the question of a complementarity, rather than opposition, between the values underpinning community governance and state governance.

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NOTES

1. Although climate has played a role in the development of the network, care should be taken to avoid any form of climatic determinism. Several authors (Dubuis, 1995; D. Reynard, 2002) have demonstrated the importance of socio-economic factors, particularly the reorientation of cattle breeding towards more commercial ends in the 15th century.
2. Consortages are community management structures set up to collectively build and operate certain irrigation channels (bisses), mountain pastures and forestry operations in the Swiss canton of Valais.
3. It was only later that the consortages adopted written statutes to meet the requirements of the Swiss Civil Code of 1907 and the law governing its application in Valais in 1912. These statutes, however, did not revolutionise their organisation, doing no more than officialise on/commit to/ paper pre-existing multi-secular practices.
4. Elinor Ostrom became the first woman to receive the Nobel Prize for economics in 2009.
5. The empirical data presented hereafter represent a synthesis of more detailed case studies (see Schweizer *et al.*, forthcoming).
6. Source: own figure, from a map reproduced with the authorization of swisstopo (BA13092).
7. This is still the case today, although the system is more fragmented (Schweizer, 2012).
8. Consigne des droits sur l'eau du bisse (AEV, AC Nendaz, p. 514). (Instructions regarding water rights)
9. AEV, AC Nendaz, p. 417.
10. The commune (municipality) has been responsible since 2002, although the consortage has not been formally dissolved.
11. Barraqué (2011, p. 24) speaks of an "impure public good", between common resource and club good
12. As with numerous other bisses of the Haut-Valais region (for example, the Niwärsch and the Grossa, cf. Schweizer *et al.*, forthcoming).

ABSTRACTS

While the supply of water to dry or arid mountain regions has long been a major challenge, the on-going processes of climatic and socio-economic change currently affecting the hydrosystems of the Alps raise the spectre of renewed pressure on water resources and possible local shortages. In such a context, questions relating to fair distribution of water are all the more sensitive given

the tendency to neglect the social dimension of sustainability. The present paper makes both a conceptual and empirical contribution to this debate by analysing a system of distribution that has a long experience of water scarcity management: the community governance models traditionally linked to the irrigation channels, or *bisses*, typical of the Swiss Alpine canton of Valais. More specifically, we evaluate these models in terms of *accessibility* and *equity*, characteristics that we use to operationalize the notion of 'fair distribution'. We examine these dimensions in three case studies with a view to highlighting the limitations of the aforementioned models. Indeed, despite their cooperative and endogenous nature, they tend to not only exclude certain members of the population, but also to reproduce rather than reduce social inequalities within the community. In general, these results challenge the rosy picture generally found in the literature relating to these community governance models.

INDEX

Keywords: water management, community governance models, fair distribution, irrigation channels, Valais

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