Is Water a Public Good?

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1 Introduction

Is water a public good? Both the literature and the general discourse on water management are ambiguous with respect to the good characteristics of water. Water is referred to as a public good, as a common pool or common property resource, and increasingly as a commodity and a private good. Often these references are used in a metaphorical sense, without precisely specifying what is meant by the respective good characteristics, and while they are often used to support certain policy recommendations, these implications are not necessarily made explicit.

When trying to explain this ambiguity, there are at least two sides to the problem. (1) There is no such thing as "water" or "the water problem"; instead, water comes in many different guises and serves very different functions and uses.[1] (2) There is a certain ambiguity in the economic literature regarding the exact definition and categorization of collective goods, and even greater uncertainty with respect to organizational and policy implications of the respective good characteristics.

In view of these ambiguities, this paper maintains that the economic theory of collective goods needs to be revisited in order to enhance our understanding of the structure and diversity of the collective action problems involved in water management, and, if possible, to relate these problems to possible organizational and institutional approaches.

When applying the theory of collective goods to water management problems, theory plays a positive and a normative role. Firstly, it provides the analytical tools to describe the collective action problems involved in water management. In this respect, 'common knowledge' is reconstructed by explicating the underlying analytical categories. Theory thereby also provides answers to the question of why water is managed the way it is. Second, if the underlying assumptions are accepted, the normative part of the theory provides an indication of how water should be managed.

Section 2 revisits the theory of public goods with respect to the characterization of collective goods. Section 3 seeks to summarize theoretical arguments on the relationship between collective goods characteristics and organization. Particular reference is made to an institutional interpretation of the theory of collective goods. Section 3 argues that if we can characterize a good with respect to its good characteristics, we can also make certain

[1] In 1968, Vincent Ostrom described this phenomenon as follows: "The water problem is, in fact, a multitude of problems, but most are problems of fluidity. Wherever water behaves as a liquid, it has the characteristics of (1) a common-pool flow resource, involving (2) a complex bundle of potential goods and bads, which sustain (3) a high level of interaction or interdependence among the various joint and alternative uses. The interrelationships among all three of these characteristics simply compound the difficulties of settling upon stable, long-term institutional arrangements for the economic development of water resources." (Ostrom 1968: 123, i.i.O.).

policy recommendations with respect to the provision of the good. Section 4 seeks to apply these concepts to water. Section 5 draws conclusions and provides an outlook for further research.

2 Collective Goods and their Characteristics

Theories of collective goods refer to those goods which are not or only sub-optimally provided and allocated through the market mechanism, i.e. goods involving non-excludability of benefits and non-rivalry of consumption.[2] Based on these two criteria, different types of goods can be distinguished.

2.1 General Typology of Goods

Rivalry of consumption is a demand-oriented criterion which asks whether the utilization of a good by one person forecloses its utilization by another. Non-rivalry of consumption, indivisibility of benefits, or non-subtractability all mean that "... each individual's consumption of such a good leads to no subtraction from any other individual's consumption of that good" (Samuelson 1954: 387). *Excludability of benefits* is a supply-oriented criterion which reflects whether the provider of a good is able to exclude potential consumers from the utilization of the good at justifiable costs on the basis of private law, and hence to enforce his exclusive property rights and impose a price or charge on the utilization of the good. Exclusion succeeds if those who are not willing to contribute to a good or service are excluded from its consumption (Ostrom and Ostrom 1977, 1999: 76).
Examples of exclusion *techniques* include fences and toll stations. To say that exclusion is infeasible means that no exclusion technology exists *on the basis of private law* (Grossekettler 1991: 77). By defining excludability on the basis of private law, it is possible to distinguish between goods which can be privately provided and those which may have to rely on public intervention.[3] Furthermore, it is not necessary that exclusion is technically impossible; it suffices for exclusion to be uneconomic (Olson 1965: 14). The application of an exclusion technique is economically justified if the costs of exclusion do not exceed the costs of non-exclusion.

[2] I use the term theories of 'collective' instead of 'public' goods, since 'public goods' present only one type of 'collective goods'.

[3] Note that exclusion is always possible on the basis of public law if public authorities have the means to enforce their laws (Grossekettler 1991: 77). With his private law/public law distinction, Grossekettler refers to the fact that in order to define excludability, it is necessary to specify the institutional conditions under which this is done.

Figure 1: General Classification of Goods

		Rivalry in Consumption	
		yes	no
Excludability based on private law	yes	Private Goods	Toll/Club Goods
	no	Common Pool Resources	Public Goods

Source: Own presentation based on Ostrom and Ostrom 1977, 1999: 78

If the rivalry of consumption and excludability of benefits are assumed to be independent attributes, four types of collective goods can be distinguished (Ostrom and Ostrom 1977, 1999: 77): public goods, toll or club goods, common pool resources (CPRs), and private goods (Figure 1).[4] Public goods are characterized by non-rivalry of consumption and non-excludability of benefits; toll or club goods by non-rivalry of consumption and excludability of benefits; common pool resources by rivalry of consumption and non-excludability of benefits; and private goods by rivalry of consumption and excludability of benefits.[5]
Typical textbook examples of public goods include lighthouses, the provision of law and order or national defense; of club goods tennis courts, golf courses or theaters; of toll goods bridges or highways; and of common pool resources fisheries or groundwater resources. The term private good refers to all goods that are privately provided and consumed, from bread to sport cars. However, most of these examples are not pure forms of the four types of goods; instead they feature a higher or lower degree of rivalry of consumption and excludability of benefits respectively, and are thus intermediate (or impure public) goods between the polar cases indicated in the matrix. Given this continuum of possible parameter values, Grossekettler (1985, 1991, 2003) has expressed both criteria as parameters. This formalization is briefly presented in the following sections as it enables the distinction of different types of collective action problems in the provision of public goods.[6]

[4] Samuelson (1954) first introduced the notion of subtractability. Buchanan (1965) added the criterion of exclusion. To my knowledge, Ostrom and Ostrom (1977, 1999: 78) first introduced the matrix presentation, similar to that presented in Figure 1.

[5] Note that in the case of public goods, exclusion is not wanted, and their very purpose is to be accessible to the general public.

[6] To my knowledge, these considerations have not yet been published in English.

2.2 The Degree of Rivalry of Consumption ϱ

The degree of rivalry of consumption ϱ can be understood as the utilization elasticity of the costs of provision, indicating the percentage by which the costs of provision increase if the number of users increases by 1 percent (Grossekettler 1991: 74f.).

$$\varrho = (dC/C):(dn/n)$$

where C: costs of provision and n: number of users

If the term (dC/C):(dn/n) is expanded by the term (dq/q):(dq/q), with q being the quantity of the collective good provided, ϱ can be expressed by a product of two elasticities, the elasticity of quantity of the costs of provision δ, and the utilization elasticity of the quantity provided γ.

$$\varrho = [(dC/C):(dq/q)]\ [(dq/q):(dn/n)] = \delta\,\gamma$$

The elasticity of quantity of the costs of provision δ indicates the percentage by which the costs of provision increase if the quantity provided increases by 1 percent. Values of $\delta<1$ thus betoken *economies of scale* in production.

The utilization elasticity of the quantity provided γ indicates the percentage by which the quantity of the good has to be increased if the number of users increases by 1 percent. If $\gamma=0$, *free utilization capacity, indivisibility of benefits* or *non-subtractability* exists, i.e. the addition of an additional user does not reduce the consumption possibilities of the existing users. If $0<\gamma<1$, free utilization capacity only exists until a certain number of users is reached, after which congestion occurs. For $\gamma=1$, full *subtractability* exists. In this case, consumption by one person excludes consumption by another. [7]

This means that the degree of rivalry of consumption ϱ can be estimated on the basis of the two parameters δ and γ, which are easy to depict, and whose order of magnitude is comparatively easy to estimate. Three broad cases may be distinguished:

for $\varrho=0$:	non-rivalry of consumption
for $0<\varrho<1$:	partial rivalry of consumption
for $\varrho\geq1$:	rivalry of consumption

There may thus be two reasons for partial rivalry or non-rivalry of consumption, economies of scale (values of $\delta<1$) and/or the existence of free utilization capacity or non-subtractability (values of $\gamma<1$).

Swimming pools and water distribution systems are both examples of partial rivalry of consumption where $0<\varrho<1$. In the case of swimming pools, both some free utilization capacity ($0<\gamma<1$) and economies of scale in production ($0<\delta<1$) exist. Thus, both γ and δ are between 0 and 1, and so ϱ will be, too. In the case of a water distribution system operating at full capacity, γ will be 1. However, given the natural monopoly character of water dis-

[7] Grossekettler does not explicitly consider externalities in his conceptualization of ϱ. This raises the question of whether there is a relationship between externalities and ϱ and if so, what this relationship is.

tribution systems, it involves economies of scale in production ($0<\delta<1$), and hence still features limited rivalry of consumption and values of $0<\varrho<1$.[8]
One important advantage of this formalization of the criterion rivalry of consumption is that it hints at two dimensions that are not necessarily borne by the notion non-rivalry of consumption, which is usually only associated with free utilization capacity, but not with possible economies of scale in the provision of collective goods.

2.3 The Degree of Excludability of Benefits on the Basis of Private Law ε

Similarly, the criterion of excludability of benefits can be parameterized (Grossekettler 1985: 222 ff.). As argued above, excludability of benefits reflects whether the provider is able to exclude potential consumers from the utilization of the good at justifiable costs on the basis of private law. The degree of excludability of benefits on the basis of private law ε thus expresses the extent to which the total effects of the provision of a good on the basis of private law can be internalized in its price. In other words, the degree of excludability of benefits ε can be expressed as the relation of the sum of the internalized effects to the total effects. The inverse value of ε, (1-ε), expresses the relation of external effects to total effects.

$$\varepsilon=p_p/p_t \iff 1-\varepsilon=p_e/p_t \quad (0=<\varepsilon<=1)$$

where:
p_e: external effects
p_p: effects reflected in the price
$p_t= p_e+ p_p$: total effects

Questions of exclusion can thus be conceptualized as externality problems.[9] For values of $\varepsilon<1$, the provision of a good leads to externalities which are not included in the price, and which, according to economic theory, are hence not reflected in the decision on the provision of the good. In the case of positive externalities, a good is provided without adequate compensation. This may lead to easy riding and a sub-optimal provision of the good. In the case of negative externalities, not all effects are internalized in the provision decision, which may lead to oversupply and/or costs for third parties. The degree of excludability of benefits on the basis of private law thus gauges the extent to which external effects can be avoided without *specific* public intervention. Non-excludability or partial excludability also implies that it is difficult to define and enforce private property rights. "… [I]f exclusion is impossible or too costly to be privately profitable, an essential precondition for the establishment of effective property rights is absent… The failure of property rights to be

[8] "An industry is a natural monopoly if the total costs of production are lower when a single firm produces the entire industrial output than when any collection of two or more firms divides the total among themselves." (New Palgrave 1998: 603).

[9] At this point, a definition of 'external effect' or 'externality' appears in order. According to Mas-Colell et al (1995: 352): "An externality is present whenever the well-being of a consumer or the production possibilities of a firm are directly affected by the actions of another agent in the economy. [...] When we say "directly," we mean to exclude any effects that are mediated by prices." The standard definition of externalities confines itself to non-pecuniary (or 'technological') externalities.

well defined is, then, an important ingredient of many externality situations." (Cornes and Sandler 1999: 43).

In principle, the degree of excludability of benefits may be quantified by a cost-benefit analysis. This, however, requires the identification and monetarization of all external effects, which may cause substantial methodological problems. Otherwise, the order of magnitude of ε may be assessed by estimating whether external effects are negligible, recessive or dominant. For:

$\|\varepsilon\| \sim 1$:	external effects are negligible
$0 < \|\varepsilon\| < 1$:	external effects should be internalized, but are not dominant
$\|\varepsilon\| \sim 0$:	external effects are dominant.

According to Grossekettler (1985: 226), assessing the order of magnitude of ε is, in principle, an objective task (although it will certainly entail judgment problems). The decision as to when effects should be internalized or which effects are tolerable or even desirable is a political one.

We will now analyze the normative organizational implications of the degree of excludability of benefits on the basis of private law ε and the degree of rivalry of consumption ϱ in greater detail.

3 Normative Implications of Collective Good Characteristics

The characteristics of collective goods, the degree of excludability of benefits ε and the degree of rivalry of consumption ϱ, hint at different problems of collective action in the provision of collective goods. In the following I will argue that ε is related to private versus public, and ϱ to individual versus collective provision. Furthermore, consideration will also be given to the most appropriate provision level in a vertical hierarchy of provision associations.

3.1 Private versus Public Provision

According to above interpretation, the degree of excludability of benefits based on private law ε signifies different degrees of external effects in the provision of collective goods. Low excludability of benefits on the basis of private law implies external effects and *market failure* in the provision of the good and an increasing role for government intervention and public law, if an internalization of external effects is desirable.

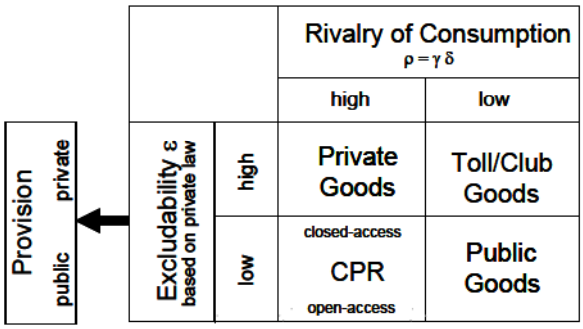
On the other hand, it has been argued that government intervention should only take place if the problem cannot be solved on the basis of private or community action (e.g. Buchanan (1965) and Ostrom (1990)). Buchanan (1965) in his theory of club goods argues that those impure public goods for which exclusion can be organized (e.g. through fences) can also be provided by a private club of users. Private provision is preferred to public provision as it avoids possible inefficiencies due to *government failure*.

Ostrom (1990) develops similar arguments for local common pool resources (CPRs) for which boundaries can be defined, and access by third parties can be denied (so-called closed-access CPRs). She found that in many cases, the self-organized appropriation of

CPRs by communities was more sustainable than regulation by the state. One reason is that users tend to be more effective in overcoming monitoring and enforcement problems. However, for open-access CPRs, for which exclusion cannot be provided on the basis of private law, public intervention, for instance on the basis of tradable certificates, may still need to be necessary (Furubotn and Richter 1997: 103). By defining and enforcing such tradable certificates, property rights are defined and exclusion is provided on a legal basis and the CPR is transformed into a private good. In Figure 2, closed-access CPRs are located in the upper half of the CPR cell and open-access CPRs in the lower, expressing the differences in excludability of benefits on the basis of private law.

It could thus be argued that the degree of excludability of benefits on the basis of private law ε hints at problems of private versus public provision (see Figure 2). The heuristic suggests that in the case of high excludability, public intervention may not be necessary (and not be wanted), whereas in the case of low excludability on the basis of private law it may be desirable.[10] In the end, the decision on public versus private provision, of course, remains a political one.

Figure 2: Organizational Implications of the Degree of Excludability of Benefits ε



Source: Own presentation

3.2 Individual versus Collective Provision

Going beyond the above argumentation, it can be argued that not only the degree of excludability of benefits ε, but also the degree of rivalry of consumption ϱ is related to organizational questions, namely to individual versus collective provision.[11] In order to show this, I will go through all four cases of the matrix. For ϱ=1 and ε=1 (private goods), private benefits equal social benefits, and following the assumptions of welfare economics, individual provision decisions on the basis of market prices or market-like instruments lead to a welfare-efficient allocation of goods and resources. For ϱ=1 and ε<1

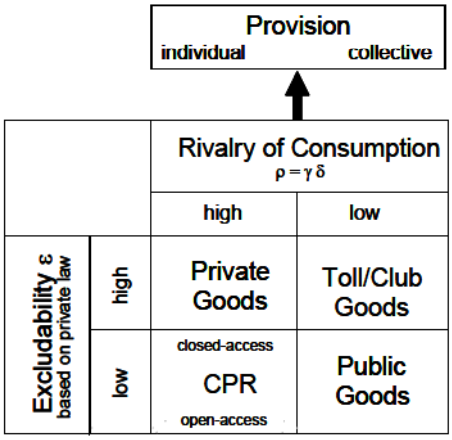
[10] This 'heuristic' obviously does not yet say anything on how public provision should take place.

[11] Grossekettler's (1985, 1991, 2003) sought to show that it is possible to deduct organizational rules from the degree of excludability ε, and financing rules from degree of rivalry of consumption ϱ. While I concur with his argumentation, I believe that ϱ hints not only at financing but also at organizational issues, or more precisely that these two issues are related. Given this, this paper does not focus on financing, and for the sake of brevity his financing considerations are not presented at this point.

(CPRs), individual provision entails external effects. In this case, private benefits do not equal social benefits, leading to inefficient allocation by the market (market failure). However, under certain conditions public intervention may allow for the definition of tradable property rights and hence transform the CPR into a private good which can be efficiently allocated on the basis of individual decisions.

For $\varrho<1$ and $\varepsilon=1$ (club goods), private benefits in principle equal social benefits, given that exclusion is provided. However, provision involves free utilization capacity and/or economies of scale. In the case of free utilization capacity, it would not reduce the provider's benefits if the good was used by someone else too. The provider therefore could reduce his/her private costs if he/she admitted other users and charged them a price for use. In the case of economies of scale, the average costs of users decrease if a higher amount of the good is provided. In both cases, it may thus be rational to organize demand for the provision and financing of the respective good to decrease the average costs per user, and to allow for the provision of goods which would not be provided on an individual basis. This is the essence of club goods such as collective swimming pools or water distribution or sewerage systems, which feature economies of scale ($0\leq\delta<1$) and certain free utilization capacity ($0\leq\gamma<1$).[12]

Figure 3: Organizational Implications of the Degree of Rivalry of Consumption ϱ



Source: Own presentation

For $\varrho<1$ and $\varepsilon<1$ (public goods), it may still be cost-efficient to provide the good collectively, although due to lack of exclusion vis-à-vis third parties, easy riding may occur, leading to an underprovision of the good. In this case, the state may be in a position to enforce provision by compulsory contributions, e.g. through taxes. Provision is then still collective, but takes place on a coercive basis.

[12] It could be argued that for $0<\gamma<1$, an additional user creates negative externalities, leading to congestion when a certain threshold of users is reached.

It can thus be concluded that in the case of ϱ<1 (club goods and public goods), it is rational to provide the good collectively. The degree of rivalry of consumption ϱ thus indicates individual versus collective provision (Figure 3).
Different authors use different terms for such a collective organization of demand: Buchanan (1965)talks of "clubs", Ostrom and Ostrom (1977)of "collective consumption units", and Grossekettler (2003) of "provision associations" (*Bereitstellungsverbände*).[13] The minimum requirement in order to speak of an organization of demand or collective provision is that a group of users *uses and finances* a good jointly, such as the users of a 'public' swimming pool, who pay an entrance fee for the use of the good. In addition, some provision associations also feature collective *decision-making* mechanisms. Examples include water user associations. If users, payers and decision-makers coincide, the principle of fiscal equivalence is met, which calls for those benefiting from a collective good to also pay for its provision (Olson 1969), and in its strong formulation calls for a congruence of users, payers and decision-makers (Hansjürgens 2001: 34). The latter ensures that decision-makers only provide a collective good if its benefits exceed its costs. It is this latter case of a congruence of users, payers and decision-makers that allows 'collective provision' to be spoken of in a narrow sense.

3.3 Discrete Provision Associations and the Subsidiarity Principle

Based on different legal instruments of exclusion and different financing competencies of jurisdictions and their functional and spatial extension, Grossekettler (1991, 2003) distinguishes different discrete types of provision associations (see Table 1).[14] Each association type is allotted an ordinal number, the 'level of extension' *e*. An extension level of 0 corresponds to the individual (or pseudo club), where user, provider (decision-maker), and payer are the same person. An extension level of 1 corresponds to a club or voluntary association for which exclusion is based on private law. A club may rely on prices or dues as financing instruments. An extension level of 2 corresponds to a compulsory association or single-function jurisdiction, where exclusion is based on public law. The compulsory association may rely on prices, dues or compulsory charges. Extension levels 3 through 5 refer to different government levels: the municipal, state and federal levels, respectively. These are multi-functional jurisdictions, which may rely on taxes, in addition to prices, dues, and charges. (This may include special-purpose associations such as the German water supply associations, *Zweckverbände*). An extension level of 6 refers to supranational organization on the basis of international law, and 7 to a hypothetical world government. The concept of provision associations hints at a further implication for institutional design. An increasing extension level is accompanied by an increasing attenuation of property and participation rights. This causes problems of motivation and information. In

[13] However, as will be argued in Section 3.3, Grossekettler's provision associations comprise not only private clubs but also public jurisdictions. Therefore Buchanan's "clubs" are merely a subset of Grossekettler's "provision associations".

view of the information and motivation advantages of unattenuated property rights, the lowest possible extension level should be chosen. The principle of choosing a provision association with the lowest possible extension level can be understood as an operationalization of the subsidarity principle, which calls for the provision of a good or service at the lowest possible level. This interpretation of the subsidiarity principle also meets the principle of fiscal equivalence if the provision associations are defined in a way which allows for the greatest congruence of decision-maker, payer and consumer.
In conclusion, Grossekettler's parameterization of the degree of excludability of benefits ε and the degree of rivalry of consumption ϱ, and his typology of provision associations are linked to three dimensions of institutional design. The degree of excludability of benefits ε refers to questions of private versus public provision. According to this paper's interpretation, the degree of rivalry of consumption ϱ hints at questions of individual versus collective provision. Finally, the rule of choosing the provision association with the lowest possible extension level represents an operationalization of the principles of subsidiarity and fiscal equivalence.

Table 1: Typology of Provision Associations

Level of Extension	Type of provision association	Exclusion based on	Possible financing instruments
0	Individual (pseudo club)	private law	prices
1	Voluntary association/club	private law	prices, dues
2	Compulsory association (single-function jurisdiction)	public law	prices, compulsory charges, dues
3	Municipal government (multi-function jurisdiction)	public law	prices, charges, dues, taxes
4	Federal state (multi-function jurisdiction)	public law	prices, charges, dues, taxes
5	Federal government (multi-function jurisdiction)	public law	prices, charges, dues, taxes
6	Supranational organization (single- or multi-function)	international law	prices, dues, possibly taxes
7	World government (hypothetical)	international law	prices, dues

Source: Own presentation based on Grossekettler (1991)

After this 'theoretical excursus', I will now be able to discuss collective action problems related to the appropriation of water resources and provision of water services. In order to do so, I will first seek to characterize the good characteristics of water resources and water services, and then discuss organizational implications.

[14] Exclusion is the necessary precondition to implement financing rules among the members or participants. Grossekettler's argumentation is developed for the case of a democratic, federally organized, state.

4 The Good Characteristics of Water and Organizational Implications

When approaching the good characteristics of water and possible organizational implications, we first need to specify what we mean by 'water' and by 'good'.

With respect to 'water', it appears to be useful to distinguish (1) the *resource system and its functions*, (2) the *appropriation of resource units* from the system or *water uses*, and (3) the *provision of infrastructure* for the appropriation of resource units or *water services*. According to Elinor Ostrom (1990: 30), resource systems can be understood as "stock variables that are capable, under favorable conditions, of producing a maximum quantity of a flow variable without harming the stock or the resource system itself." Resource units are "what individuals appropriate or use from resource systems" (ibd.). Examples of *water resource systems* are the combined surface water and groundwater systems constituting a river basin, lake, or isolated groundwater system. A water resources system produces different streams of resource units (the flow variable), such as a certain water quantity at a certain quality, a certain velocity, a certain self-purification capacity, a certain water storage capacity, as well as certain fish stocks and water-dependent ecosystems. As such, water resource systems fulfill different *water resource functions,* i.e. the provision of a certain water quantity for certain uses etc. *Water uses* refer to the actual use of resource units, such as the use of water for drinking, cleaning, agricultural and industrial production, the discharge of wastewater and return flows, the use of the water resource system for recreation, navigation or fishing, the use of electricity generated by hydropower plants, or the appreciation of water resource systems and related ecosystems. In contrast, *water services* can be understood as the human provision of infrastructure for the appropriation of resource units, such as bottles and containers, pipelines and distribution systems, treatment plants, dams and reservoirs, dykes, locks, harbors, hydropower plants, fishing equipment, ships, etc. In this conceptualization, water resource functions and water services reflect the supply side and water uses the demand side.

Given the fluidity of the resource, water uses are highly interdependent. Many water uses and services are associated with physical repercussions on the resource system (Table 2), which might create costs, or sometimes also benefits, for third parties who also wish to use the resource. Where such costs or benefits occur, water uses and services involve resource-mediated ('technological') *externalities*. Many uses and services entail *negative externalities* (indicated by a minus), such as water pollution or the reduction of flows, although some uses involve *positive* externalities (indicated by a plus), such as the regulatory functions of hydropower reservoirs or flood retention areas for downstream users. A distinction can thus be drawn between *conflicting* and *complementary* water uses. Conflict, again, may occur among different users within the same use (e.g. water extraction) as well as between different competing uses (e.g. hydropower production and fisheries).

While the above describes the water resource system and its uses, it still does not answer the question regarding the conditions under which water constitutes a 'good'. The notion 'good' was introduced in neoclassical economic theory by Carl Menger and Alfred Marshall. Marshall defined goods as "… all desirable things, or things that satisfy human

wants..." (Marshall 1920, 1997: 54).[15] These goods may be material, personal or immaterial. Material goods are both material things and the rights to material things:

> "*Material goods* consist of useful material things, and of all rights to hold, or use, or derive benefits from material things, or to receive them at a future time. Thus they include the physical gifts of nature, land and water, air and climate; the products of agriculture, mining, fishing, and manufacture; building, machinery, and implements; mortgages and other bonds; shares in public and private companies, all kinds of monopolies, patent-rights, copy-rights; also rights of way and other rights of usage. Lastly, opportunities of travel, access to good scenery, museums, etc. are the embodiment of material facilities, external to a man; though the faculty of appreciating them is internal and personal." (Marshall 1920, 1997: 54 i.i.O.).

According to this understanding, the notion 'good' refers to physical units and rights at all levels of resource use, in particular the appropriated resource units, but also the resource system, the infrastructure, and the institutional framework which allow for the appropriation of resource units. It does not, however, refer to the use as an act.

Table 2: Examples of Water Uses and Services, Possible Physical Repercussion on the Resource Systems, and Preliminary Evaluation

Resource Use & Services	Possible Physical Repercussions on the Resource System	Type of Externality
Water extraction	⇨ decreases quantity downstream	(-)
Wastewater discharge	⇨ diminishes quality downstream	(-)
	⇨ increases quantity downstream	(+)
Hydropower generation	⇨ base flow regulates river downstream	(+)
	⇨ peak flow increases floods downstream	(-)
	⇨ changes morphology	(-)
Navigation	⇨ keeps water in the river	(+)
	⇨ changes morphology	(-)
Recreational uses	⇨ none	
Fishing	⇨ may destroy fish stocks	(-)
Ecosystem protection	⇨ maintains water quality and river bed morphology	(+)
Erection of dykes	⇨ increases floods downstream	(-)
Provision of retention areas	⇨ decreases floods & sediments downstream	(+)
'Consumption' of forests, wetlands & floodplains	⇨ increases floods downstream	(-)
	⇨ adds sediments & nutrients	(-)

Source: Own presentation

In the following, I will therefore focus on the supply side and firstly address the good character of the water resource system in relation to the different streams of resource units the system produces (resource functions), and secondly the good characteristics of various water services. Since the water resource system is provided by nature, in the case of the

[15] A 'bad' can hence be understood as a thing that is undesirable.

appropriation of resource units the collective action challenge is the maintenance of the natural resource functions. In contrast, in the case of water services, the challenge is the provision of respective water-related infrastructure. Given the multiple water functions and uses, and the complexities involved, I will have to restrict myself to selected examples.

4.1 The Good Character of the Water Resource System and its Functions

Vincent Ostrom (1968) characterizes the water resource system as a common pool resource using the example of an isolated groundwater basin overlaid with individual landowners who have equal and independent rights to tap the water beneath their land. In such a situation, each proprietor is free to exploit the water below his land for his benefit. However, a resource unit used by one party cannot be used by another party, hence γ=1. Assuming that each proprietor maximizes his private benefit, without further action, this may create a situation in which the combined extraction of groundwater exceeds the average recharge of the aquifer (safe yield), leading to falling water tables, and in the long run to the depletion of the resource and a respective reduction of utility for the parties involved.[16] If the parties affected concur that this is an undesirable outcome, it would be collectively rational if they agreed on a pumping regime restricting each individual's pumping rate in order to avoid resource depletion. However, even if the parties involved concluded such an agreement, the incentive not to abide by the extraction rule and to easy-ride on the cooperative behavior of the other users would still persist. Thus, unless the parties come up with an effective monitoring and enforcement mechanism, exclusion will be difficult to achieve on the basis of "private law".

> "The common-pool problem is the classical case of a situation where the rational self-interests of all individuals would suggest a collective solution, but where the prospect of collective action on the basis of the decision rule requiring the willing consent of each proprietor is negligible." (Ostrom 1968: 124).

In this case, the water resource system could be said to have the characteristics of a common pool resource because the appropriation of resource units is accompanied by a high degree of rivalry in consumption (ϱ~1) and effective exclusion is difficult to achieve on the basis of private law (ε~0).

According to Section 3, in the case of open-access CPRs, the policy recommendation is public intervention and issuing tradable use permits or certificates, whereas the management of closed-access CPRs might also be sustained through privately organized collective action arrangements (creating a club or voluntary provision association). Inter-jurisdictional groundwater basins would call for the establishment of inter-jurisdictional provision associations and the definition of respective extraction rights. Experience of water resources management worldwide confirms that such approaches are being pursued. In fact, in many countries the government ensures exclusion through the issuing of groundwater water extraction licenses under public law. (However, these are rarely trad-

[16] This situation can be characterized as a Prisoner's Dilemma game.

able.) At the local level, self-organized CPR regimes have been identified which are able to sustain groundwater resource systems (e.g. Ostrom 1990). At the inter-state level, states are starting to set up respective commissions. However, the limits of existing regimes are also evident, as demonstrated by falling groundwater tables worldwide.[17] Thus, while the policy prescription provided in Section 3 appears to go in the right direction for the case of groundwater extraction, major challenges for monitoring and enforcement remain.

Going beyond the case of groundwater extraction, the question is whether the characterization 'common pool resource' also applies to other water resource systems, such as rivers and lakes, and to other resource functions. While the common pool resource character of the resource system appears self-evident for many situations, such as water extraction, wastewater discharge or fishing from lakes, there also appear to be cases in which this is less clear. For instance, in the case of water extraction from a river, water extraction upstream reduces the volume of water downstream, whereas extraction downstream does not have physical effects upstream. Hence, unlike water extraction from an aquifer or lake, the effects of extraction are not reciprocally or symmetrically distributed among users, but are directed downstream. One may thus speak of *unidirectional* or *asymmetrical externalities* (Rogers 1993). Technically, the upstream user has the power to exclude the downstream from the use of the good 'river water', e.g. by diverting the river into another river basin ($\varepsilon \sim 1$).[18] Whether this is legally 'admissible' depends on the institutional setting.[19] But under 'private law' conditions, i.e. in the absence of any agreement or government regulation, for upstream users, river water has indeed more of the characteristics of a 'private good'. Contrary to the theory considerations in Section 2 where exclusion was associated with the absence of externalities, in this case the upstream user is able to exclude the downstream user and thereby generate a negative externality! However, if this is so, what would the policy recommendation be? It becomes immediately apparent that in this case the 'heuristic' of Section 3 does not work. One reason is that the notion 'private good' presupposes the existence of well-defined private property rights. A second reason is that there appear to be fundamental differences between provision and appropriation problems.

Another interpretation of this situation might be that we are dealing with an 'asymmetrical common pool resource', and therefore within a jurisdiction, public intervention securing the interests of all riparians is even more important than in the case of reciprocal externalities. At an inter-jurisdictional level, this raises the question of how the downstream riparian may motivate the upstream riparian to engage in 'cooperation'. Although we will not be able to resolve this issue at this point, it has become clear that the concep-

[17] For instance, in the Jordanian highlands groundwater tables are continuing to fall despite the issue of extraction licenses (Schiffler 1998).

[18] An example might be Israel's diversion of the water from Lake Tiberias to the Israeli coast and Negev desert.

[19] It could be argued that even under the anarchical conditions of international relations, this would contradict the emerging international law on the non-navigational uses of international watercourses, which maintains the principles of equitable and reasonable utilization and the avoidance of significant harm.

tualization of Sections 2 and 3 is far from providing indications on how to deal with the asymmetries in this case.[20]

Yet another case might be so-called non-consumptive uses, such as river navigation. In this case, there is no rivalry of consumption with respect to water quantity (hence γ=0), and assuming that both the upstream and the downstream riparian benefit from navigation, neither is interested in exclusion (ε=0). Thus, ensuring free river navigability constitutes a public (or club) good, and so does the river for this purpose. According to Section 3, ensuring free navigation within a jurisdiction may be considered a public responsibility, whereas ensuring free navigation between jurisdictions might again be a case for an inter-jurisdictional association. Navigation was indeed one of the first uses for which international river commissions were set up.[21] However, navigation may still compete with other resource uses. For instance, infrastructure measures to enhance the navigability of the river, such as locks, may hinder the movement of anadromous fish swimming upstream. Thus, the structure of the river bed constitutes a common pool resource in relation to navigation.

Based on these considerations, it may be concluded that the good characteristics of water resource systems cannot be defined generally, but only with respect to a particular use and resource function. The reason lies in the multi-functionality of the resource, and in the fact that we are dealing with consumptive and non-consumptive uses. Moreover, the notion of excludability under 'private law' conditions is not conducive to conceptualizing the issues involved in the use of water resource systems. These difficulties also have implications for organization. It seems that we need arrangements for the regulation of each of the individual resource uses, as well as arrangements for coordinating various uses. While the concept of provision associations and the subsidiarity principle provide important points, they lack the tools needed to analyze the incentives for the set-up and the implementation of respective institutional arrangements.

4.2 The Good Character of Various Water Services

At a second level of analysis, the good characteristics of individual water services may be analyzed. The appropriation of resource units from the resource system usually requires certain infrastructure measures (ranging from a bucket to sophisticated water distribution and treatment systems). They often entail relatively high fixed costs and substantial economies of scale in their provision, calling for collective action in their provision.

One example is *piped water distribution systems* for domestic and industrial water supply. Water distribution systems are usually perceived as a natural monopoly, because it would

[20] This situation can be characterized as a Rambo game situation (cf. Zürn 1992: 212). In such an upstream-downstream conflict, it might be very difficult to reach a voluntary agreement on the question of water extraction alone as the upstream user would not benefit from a reduction of his extraction rate, and the downstream user could not threaten to reciprocate his behavior by extracting more water himself. A possible negotiation strategy might be issue linkage.

[21] The Central Commission for Navigation on the Rhine (CCNR) was set up at the Vienna Congress in 1815.

be uneconomic for competing providers to run parallel pipelines.[22] Both the high fixed costs and the possibility of decreasing the average costs per users stand for a value of $\delta<1$. Under these conditions, it may be rational to organize demand for the provision of the good. Once the water has been extracted from the resource, access is restricted to those connected to the distribution system. In this case, exclusion can be ensured through the closed system and individual water metering, hence $\varepsilon\sim1$. It could thus be argued that water distribution systems (with individual metering) have the characteristics of a club good (see also Ostrom and Ostrom 1977). According to Section 3, this calls for the private organization of demand at the community level. In practice, however, water distribution systems are frequently publicly provided, either directly by the state (often the local authority), through state regulation with the private sector, or sometimes also community participation. One argument for state regulation may be to ensure coordination between water extraction (and resource management) and water supply. Another may be that in the case of public provision, the government relieves users of the (often cumbersome) task of organizing themselves. The provision of access to adequate quantities and quality of supply is also often considered as an equity issue. Again, a simple one-to-one translation of the policy recommendations of Section 3 seems impossible.

Similar arguments may be made for the provision of sewerage or irrigation systems. One main difference between water supply and *sanitation* is that wastewater treatment provides a public good. In the case of open *irrigation channels*, there might be issues of restricting access to the resource, in which case an irrigation system might have more of the characteristics of common pool resources.

Once water is *bottled*, exclusion is fully established and there is full rivalry in consumption. It then has the characteristics of a private good and is usually marketed as such. In this case, theory prescription and empirical evidence appear to coincide.

The above examples demonstrate that water services may again involve different good characteristics. While the list of possible water services is by no means exhaustive – nothing has been said yet about the good characteristics of ensuring access to recreational uses, the generation of hydroelectric energy, or protection against floods – the examples mentioned still illustrate how the theory of collective goods can shed light on the character of these water services, as well as on its limitations.

5 Conclusions and Outlook

The starting point of this paper was the question about the good character of water and possible policy recommendations. Section 2 reexamined the typology of collective goods. Section 3 argued that if we can characterize goods with respect to the degree of rivalry in consumption ϱ and the degree of excludability of benefits on the basis of private law ε, we

[22] "... [T]he high capital costs of constructing a distribution system capable of sustaining a continuous flow imply that the first proprietor will pre-empt a marketing service area and a second or third proprietor can be effectively precluded from entry. In short, continuous-flow distribution systems give rise to natural monopolies." (Ostrom 1968: 125).

can also make certain policy recommendations with respect to the organization of the provision of the good. According to this paper's interpretation, ε refers to private versus public provision and ϱ to individual versus collective provision. The rule of choosing the provision association with the lowest possible extension level represents an operationalization of the principles of subsidiarity and fiscal equivalence. Section 4 sought to analyze the implications of these theoretical considerations for water management problems. In doing so, it became clear that the good characteristics of 'water' depend on the aspect of water we are talking about. While the resource system appears to constitute a common pool resource with respect to many uses, in some cases it also has more of the characteristics of a public, club or private good. Similarly, the good characteristics of different water services were found to vary from one service to another. For instance, water distribution systems were characterized as club goods, and bottled water as a private good.

With respect to its explanatory power, the theory presented in this paper was found to provide important analytical categories for the characterization of collective action problems involved in the use of water, in particular with regard to problems of exclusion and externalities, free consumption capacities and economies of scale in provision. However, given that rivalry in consumption is a one-dimensional concept, i.e. only one function is under consideration, the theory faces difficulties in dealing with the multi-functionality of water, i.e. rivalry of consumption among various water uses. Furthermore, the conceptualization of excludability of benefits on the basis on 'private law' was found to be unsatisfactory for the characterization of all water situations.

With respect to its prescriptive power, although the theory of collective goods presented appears to point in the right direction with respect to public versus private intervention and opportunities for organizing demand within provision associations taking into account the principle of subsidiarity, it remains too coarse to provide specific recommendations for institutional arrangements for water management problems. Given these limitations, it would appear to be worth reexamining the issues involved in water resources management from an explicit interaction economic perspective, taking account of the incentives for the actors involved.

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