

Overextraction of Groundwater Resources: What Are The Solutions?

OVERCOMING THE “TRAGEDY OF THE COMMONS”

The amount of water extracted from aquifers worldwide has increased threefold in the past fifty years, leading to an aggravated overdraft of these common resources. This “pumping race” brings about major adverse economic, environmental and social impacts. However, economic analysis and evidence-based knowledge teach us that it is possible to overcome this “tragedy of the commons”.

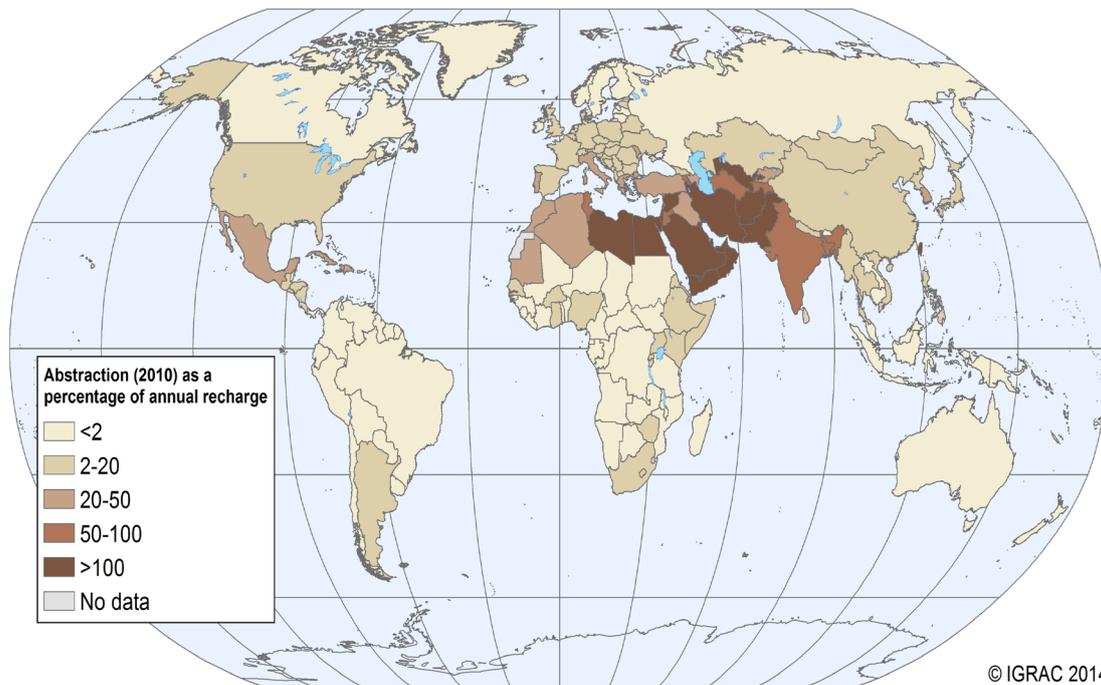
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Underground Aquifers: A Classic Case of the “Tragedy of the Commons”

In certain parts of the world, the strong pressure on water resources leads to an increasing overexploitation of aquifers. Sustainable extraction means withdrawing less water than the amount the aquifers need to replenish. If the withdrawal rate exceeds the natural recharge rate, the water table will gradually drop, as is the case in Mediterranean countries, where overexploitation of the water resource occurs either at a national level (Algeria, Jordan, Libya), or at more localized scales (France, Greece, Italy, Morocco, Tunisia).

Within the classification of economic goods, and with a water withdrawal regime that often amounts to *de facto* open access, groundwater resources belong to the category of common goods: they are non-excludable (*i.e.*, users can not be prevented access to the good), unlike private goods, and they are usually rivalrous goods (*i.e.*, the use of the good by one user can lower the quantity available for the other users), unlike public goods.

The process of overexploitation of a common resource with open access has been described as the “tragedy of the commons” (Hardin, 1968). In a situation of rivalry, so-called congestion externalities occur: water withdrawal in an aquifer by a given user causes the water table to fall, resulting in increased pumping costs for all users. As a result, if each user exclusively thinks in terms of his or her immediate individual costs (the “cost signal”, given by the market) and continues extracting water on such a basis, the continuous increase in costs eventually leads the entire system to become unprofitable, and the resource to be degraded (sometimes permanently). If, in reality, all users are aware of this mechanism, they have no incentive to individually restrict their withdrawals and share the benefits of their virtuous behaviour with all their rivals. The individually optimal strategy of withdrawing water without restraint is a “prisoner’s



Source: International Groundwater Resources Assessment Centre (IGRAC - 2014), Global Overview application, Delft (Netherlands) <http://ggmn.e-id.nl/ggmn/GlobalOverview.html>

dilemma”, where the outcome of users pursuing their self-interest is a collectively suboptimal situation.

Such a “pumping race” generates many adverse repercussions with negative economic impacts, such as cost increases and the gradual decrease of benefits to users, environmental consequences such as the sinking of the water tables, a risk of deterioration of water quality and saltwater intrusion, and social outcomes including the exclusion of the less-equipped users.

Three Instruments: Regulation, Taxes, and Direct Negotiation

Hardin (*ibid.*) has suggested three solutions: private property rights—while observing that they are difficult to apply to “the air and waters surrounding us”—, “coercive laws” and fiscal measures. In the contemporary approach, which uses a very similar classification, externalities can be managed with three categories of instruments.

Regulation and environmental taxation are the two most common tools for managing water withdrawal. Their use is justified by the fact that the externalities result from

situations where there is no transfers between agents or correction brought about by normal market mechanisms, and therefore requiring an external intervention. Quotas (that is, limits on volumes extracted) and licences (which restrict extraction capacities) are the standard regulatory instruments. Environmental taxation is aimed at having externalities borne by the users who generate them, increasing their costs in order to lead them to change their behaviour, *i.e.*, to decrease their withdrawals. Taxation “internalizes” the externality by incorporating it in the price signal perceived by the user.

The third approach is to treat externalities as commodities (Coase, 1960). According to Coase, externalities are not caused by a market failure but by a lack of appropriate rights. His “theorem” states that if the agents who create an externality and those affected by it are known, if property rights are well defined, and if transaction costs are nil or low, an optimal allocation of resources is then made possible by direct negotiation between agents. This allocation is efficient whatever the initial attribution of property rights. Those should be taken in the broadest sense of user entitlements that do not necessarily entail full property, but which can be

20 % of the world’s aquifers are overexploited

Source: The United Nations World Water Development Report 2015, “Water for a Sustainable World”

ceded or traded, while at the same time safeguarding the rights of the “owner” and, especially in the case of water, its belonging to the public domain. Transaction costs cover all the costs relative to informing, bargaining, and elaborating solutions, and, after that, formalization and implementation costs, as well as those associated to monitoring, control, dispute resolution, sanction and reviewing the arrangements over time.

In the case of underground aquifers, Coasean bargaining is as follows: either the user who wishes to withdraw more water has the right to do so, and it is up to the other beneficiaries to pay the user so that he refrains from using his entitlement; or, conversely, that he must pay the other beneficiaries for the additional pumping costs that are incurred. In the absence of transaction costs, these three instruments are theoretically efficient (in the sense that they make it possible to achieve a “social optimum”) and differ only in the outcome in terms of allocation of resources among agents. In reality however, their application faces transaction costs of all kinds:

- Regulatory instruments and environmental taxation require sound information on aquifers, uses and users, in order to be effectively targeted; the cost of development, control, tax collection and sanctions (measuring volumes or capacities, controlling and enforcing regulations and taxes) are particularly high, especially when their development requires behavioural changes, both for users and for public authorities;
- Coasean bargaining, which offers the advantage of not requiring state intervention, is not used, or to a very limited extent, because it faces many practical hurdles. It indeed requires a situation of perfect information and its feasibility is compromised by the lack of robust rights and the large number of actors, whose situations are often disparate.

A Fourth Approach: A Common Property Regime and Cooperation Between Users

Basing herself on empirical studies on decentralized management systems in a wide range of situations, Ostrom (2010) provides an analytical framework where the management of externalities—by quotas, licences, taxes, market exchanges—can take place with higher

chances of being efficient. The author revisits the question of usage rights while focusing on common property regimes. In the situations she describes, the so-called “common-pool resources” are neither left in open access (as is the case of the common goods described by Hardin) nor privatized: usage rights are held by a group being sufficiently coherent and homogeneous that institutional arrangements, be they formal or informal, emerge between individuals on the basis of common social standards. Customary rights can play an important role, when they are revitalized or adapted to the circumstances. The use of modern law is nevertheless essential because common property entails the exclusion of third parties (external un-entitled parties), which must be made legally binding.

This configuration particularizes the idea, already put forward by Coase (*ibid.*), that the free market and state control are not the only ways in which economic relations can be structured. In fact, allowing for concerned parties to develop an arrangement by themselves in the context of well-defined usage rights can lead to better results than state intervention. Such a solution to the “prisoner’s dilemma” provides for mutual insurance on behaviours within the group—be it brought about on a voluntary basis or through coercion, according to the social context—and gives an edge to cooperative strategies over “selfish” strategies. Finally, it accounts for the issue of transaction costs: for the solution to work, the group has to locally find the conditions to perfectly know the water resource and its uses, and immediate peer pressure must help with supervision and enforcement.

Although the management systems studied by Ostrom (*ibid.*) are general in scope, they are embodied in varied institutional and legal forms according to the characteristics of the resource and local situations. They are not a matter of standardized models but of “sequential and incremental” processes that lead to the definition of a body of operational, collective and constitutional rules that are set to change over time and according to circumstances. Accordingly, Ostrom has based most of her contribution on the key success factors of systems she studied, where the empowerment and the implication of users, the convergence of individual and collective interests, and the containment of management and conflict resolution costs, are key.



STÉPHANIE LEYRONAS

Project manager, Water and Environment Programme, Research and Development Division, AFD



FRÉDÉRIC MAUREL

Project manager, Water and Sanitation Division, AFD



DOMINIQUE ROJAT

Coordinator of AFD programmes, Centre de Marseille pour l'intégration en Méditerranée [Marseille Center for Mediterranean integration]

Successful Cases of Decentralized Management of Groundwater in the Mediterranean Region

A range of solutions of decentralized management of groundwater in the Mediterranean region have been evaluated in light of Ostrom's principles (BRLi / AFD Study, 2015). This analysis has resulted in operational recommendations that may be used to guide future efforts.

Leading such an effort is most often the central authority, which acknowledges the overextraction, has difficulty in applying taxes, licences and quotas, and is looking to encourage or mandate the establishment of structures (*Comunidades de Usuarios de Aguas Subterráneas* in Spain, *Highland Water Forum* in Jordan, *Groupements de développement agricole* in Tunisia) and/or mechanisms for implementing the principles of local resource management (*Schémas d'aménagement et de gestion des eaux* in France, the so-called *contrats de nappes*, "aquifer management covenants", being developed in Morocco). In most cases, the regulator acts by defining protection zones but until then has not been able to establish sufficient dialogue to ease the initial tensions with or between users with conflicting interests.

To date, the cases that have best succeeded in curbing overdrafting (the water tables of El Bsissi in Tunisia, Eastern La Mancha in Spain, Beauce and Gironde in France) all depend on continuous dialogue between stakeholders, and on awareness and outreach campaigns that reflect Ostrom's principles. Also significant is that there is a certain level of group homogeneity, and that a set of common rules are mutually agreed upon—even when they do not give all users an equal footing. The initial attribution of withdrawal entitlements is crucial and often involves the regularization of earlier practices, something that is essential but can be rather sensitive, especially in a situation where the property of the resource has been transferred from the overlying landowner to the public domain (a relatively recent action in the case of Spain). The successes are built

on a sound knowledge of the renewable volume of the resource, of withdrawals and users, both at the initial stage to define the rules for sharing the resource, and then afterwards to ensure their control by the group. Finally, they are positively correlated with virtuous water conservation practices, either through higher efficiency of drinking water distribution (in Gironde, France) or higher agricultural productivity of water (in Tunisia as well as in Beauce, France). ■

CALIFORNIA WATER TRADING: AN ICONIC LOCAL MANAGEMENT FRAMEWORK

A purely local initiative, the management of California's aquifers is one of the decentralized management frameworks that has overcome the issue of overextraction. It has been extensively described in Ostrom's work and she refers to it to define the key success factors of the management of common-pool resources. After nearly half a century in operation, and having originally been framed in terms of private property, it is also instructive of the opportunity of trading water rights. In principle, the trading process makes it possible to achieve economic efficiency by favouring water allocation to agents who get the best value from it, and who are therefore willing to pay more for it than lower performing agents who then benefit from selling their entitlements. However, water markets lead to a concentration of entitlements with social consequences, in addition to impacting regional development. For example, in the case of the Raymond aquifer in California, half of the farmers have sold their rights in favour of other uses (BRLi, 2015). To avert any such distortion, solutions can be sought for in the control of transfers (restrictions on traded volumes, especially between different uses such as agriculture or drinking water, limitations in terms of concentration and so forth), or in the establishment of compartmentalized markets (for instance according to the size of farms) as has been done for individual transferable quotas in the fishing industry, or in the development of alternative resources (such as the reuse of treated wastewater in agriculture). In spite of these issues, water markets provide a level flexibility that is very valuable as long as they are properly regulated and managed in order to remain focused on collective public interest.

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