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**The commons as (demanding) social constructions:
The case of aquifers in rural Karnataka**

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“Instead of bemoaning the tragedy of the commons, however, pragmatic policy-makers would do well to embrace it and use it to organize their thinking for at least the short to medium terms – the pitch to a farmer for saving water cannot be a vague appeal to the common good, but a demonstration that doing so is likely to carry real economic benefits, in the shape of better produce, fewer pests or savings in other inputs.”

(Hasanain et al. 2013, p.22).

“Commons” has become a trendy word for the last two decades that has almost replaced the “common pool/property resources” in the dominant academic narratives. Paradoxically, whereas most of research results highlight the decline or the disappearing of commons because of globalization, privatization, land use change, etc., the notion is more and more used. What is this word that has become so trendy for describing something that is so threatened? Can we still speak of “commons” if there is no more common management and shared representation of it?

In Hardin’s famous article (1968), any village grassland seems to be a “commons” by nature, and so is the air we breathe or the forests where we go for hunting. (It is only because of population growth that their management should stop being “common” and be replaced either by a control by the state, or – rather – by privatization). Indeed, it is often argued that resources such as air, water or forests have specific traits, which naturally lead them to be considered less ownership-prone than, for example, cars or houses. Yet, is there really

something consubstantial, inherent or inborn in air, water or biodiversity that makes them to be obviously considered as a commons? The answer is negative. It is even more so if we question their situation as a “common”, that we propose to write without final s in order to emphasize the importance of collective action and social construction in this notion. This contrasts with “the commons”, as used by Hardin, which is a word coming from ancient English and designating the common land of a community, i.e. a physical, material piece of land. In this paper, “commons” shall refer to the thing more or less commonly appropriated, while “common” shall refer to the social construction that manages and reflects it¹. For example, groundwater has always existed beneath our feet. It might be considered as a natural “commons”, since as we shall see the resource is impacted by neighbours’ use. Yet it does not become “a common” until individuals understand that they are interdependent from this resource and organize their collective action accordingly. Things have to be *constructed* as a common for having such a status. As Dardot and Laval (2014) argued convincingly, a common is a common if a society *wants* it to be; it is a “political principle for the reorganization of society” (p.47). A common is a voluntary action, a construction, a collective work, a *praxis*, based on social relations and institutions. Water, air can be commons only if society works for it to be so. And cars or houses can be commons too. Commons are social constructs.

If there exists no commons and even less *common* by essence, we can understand more easily why in India (as elsewhere) the status of water or forests are sources of conflicts. There is nothing in the basic nature of water that makes it fundamentally prone to be a common. It needs a social collective agreement for it to be managed “commonly” and in a sustainable way. The example of groundwater in Chamrajanagar district, Karnataka, is a good illustration of this statement. Our collective research in the ATCHA project² (<https://www6.inra.fr/atcha>) has proved that the depletion of aquifers is not directly due to any decline in annual rainfall, but is explained by the dramatic mushrooming of borewells (Robert et al., 2017). Individualistic use of water, without collective rules, has dried up many borewells, to the extent that some entire villages are coming back to rainfed agriculture. Why has groundwater not been used with more caution by farmers? Is it due to the lack of education and information about aquifer evolution? Is it because the farmers know that, sooner or later, after dry years good years shall replenish the aquifer? Or is it due to the lack of long-term management, because of poverty for the lower social classes, because of availability of other

¹(See also the distinction in the conclusion of this paper between substantial and normative commons). In French, there exists the same distinction between “communaux” (village common lands) and “le commun” (a more abstract word referring to collective action). Unfortunately, most of the French academics who read Ostrom and others lazily translated *commons* as “communs” instead of keeping “communaux”. This was all the more pitiful since “les communs”, in good French, means the subaltern buildings attached to a castle or manor (stables, etc.). Only recently “le commun” has been born and disseminated with a very voluntary, leftist, often revolutionary meaning (Dardot, Laval, 2014).

² This Indo-French project brings together biophysical scientists (hydrology, agronomy, geosciences, remote sensing, etc.), modelling economists and social scientists. The ATCHA project (2017-20) is the follow up of AICHA project which already was assessing and modelling the relationships between climate, water availability, cropping systems and decision making in Berambadi watershed, Gundlupet taluk, Karnataka. It is associated to the SUJALA project of the Government of Karnataka-NBSS. This work was funded by the French national agency ANR. The Berambadi watershed belongs to the Environmental Research Observatory BVET (<http://bvet.obs-mip.fr/en>) and the French Critical Zone Research Infrastructure OZCAR (<http://www.ozcar-ri.org/>). We thank the Indian Institute of Science, Bangalore, for its support to this study and Mr. Giriraja and Mr. Sanjeeva Murthy for sharing groundwater level data and maps. Deepti U., Roma Hooge, Avinash R. and Shantha Murthy contributed to field surveys and workshops. Dr. A.R. Vasavi made illuminating comments. Farmers are acknowledged for their kindness, patience and support.

irrigable lands for the higher classes? Can the new Indian legislation on underground water bring some solution? While analyzing this “tragedy of the non-common” (Dardot, Laval, 2014, p.14), this paper shall try to explain why the “social construct” of a common aquifer did not take place in Chamrajanagar, and what lessons should be drawn. We focus on Gopalapura village. In 2018, two students conducted in total 8 months of research (about 110 households were surveyed), living in the village. This was added to about 40 working days by senior researchers, during when one participatory workshop and one game were organized with villagers. Additional research took place in 2019.

The first section describes the agrarian “tragedy” of a region where groundwater decline is dramatic. The second part explains the lack of collective action both by the type of agricultural development and diversification for the last decades and by an analysis inspired by Ostrom (1990). The present legislation and State interventions are also responsible for this situation, the third section argues, even though rays of hope are appearing on that matter.

I. A tragedy of non-commons : Groundwater decline in South Karnataka

« In the next 20 years, a good deal of what can be done with India’s groundwater resources will have been done – by some 30 million private well owners. If this process of appropriation is to be made orderly, equitable and sustainable, the time for action is *now*”.

T. Shah, 1993 (on the book cover).

At an elevation of about 850 m, the twin villages of Gopalpura and Kunagahalli (further: Gopalpura) are located in Gundlupet taluk, Chamaraajnagar district, at the extremity of the Maidan plateau, a few kilometers away of the Bandipur National Park and the first heights of Western Ghats (figure 1). Only 20% of the landowners own more than 5 acres. Half of the farmers have borewells for irrigating at least part of their land. The other half practices rainfed agriculture only, with more than 800 mm of rainfall in yearly average. 67% of the 1925 inhabitants are Lingayats or upper castes, while 23% are Scheduled Castes and 10 % Scheduled Tribes.

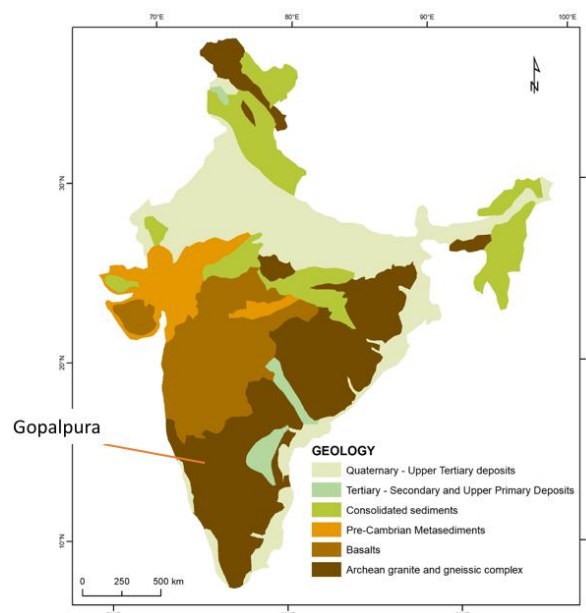


Figure 1: Geological map of India and location of the case study (source: French Institute of Pondicherry)

Since the Deccan Plateau is composed of hard crystalline bedrock with low hydraulic conductivity, water storage is poor. Groundwater transmissivity and borewell yields decrease with groundwater table depth. In consequence continuous pumping causing groundwater table drawdown leads to a disproportionate decrease of the amount of groundwater available for irrigation (Sekhar et al., 2016). This feedback loop makes predefined land-use scenarios difficult to determine since farmers are continuously adapting their actions following groundwater availability (Robert et al., 2017).

Gopalpura is far from being the only area in peninsular India suffering from such a decline (Shankar et al., 2011). Because of a spectacular and steady increase of groundwater irrigation since the late 1960s, India has become the biggest consumer of groundwater in the world, with the highest number of borewells (figure 2). Such a trend benefited the national agricultural production, not to speak of the access to drinking water, but in many regions it was achieved at the expense of groundwater resources. In Gopalpura, groundwater pumping for irrigation started only in the 2000s, and the groundwater table dropped from a depth of about 5 to 10 meters in 2010 to about 25-35 meters in early 2018 (Figure 3).

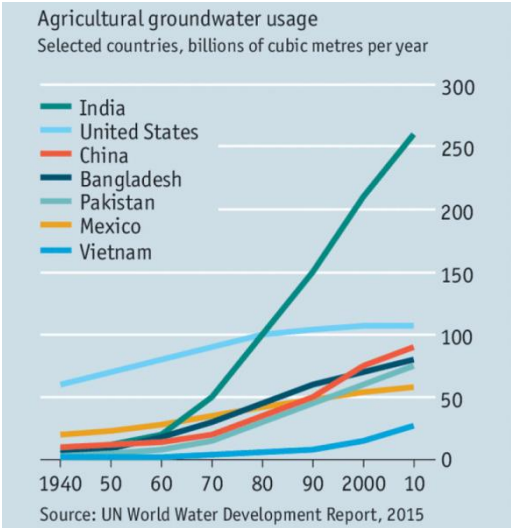


Figure 2: The dramatic increase of groundwater irrigation in India

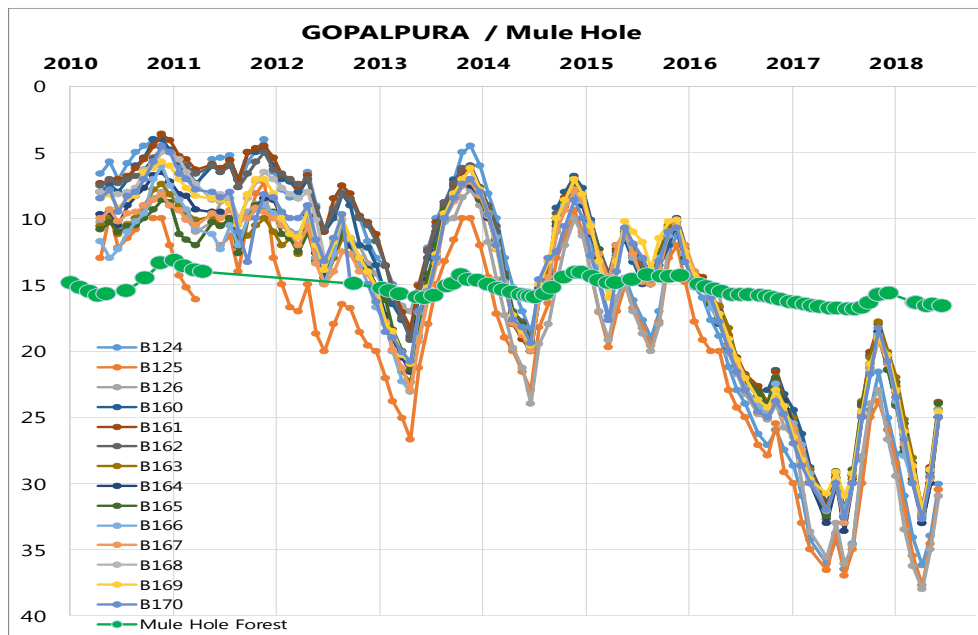


Figure 3. Evolution of groundwater level in various borewells in Gopalpura and in the neighbouring Mule Hole forest (Source: ATCHA project).

Such a trend is not due to the decline of annual rainfall, contrary to what many local farmers argue (cf. Aubriot, 2011 for similar narratives in the Pondicherry region). As proven by fig.3, the level of groundwater is declining in the irrigated area whereas in the neighbouring Bandipur National Park (Mule Hole) its level remains more or less constant. Rainfall data in the neighbouring Gundlupet town do not show a visible trend (Fig.4). Many farmers also argue that they are forced to dig borewells because of an increase in the seasonal variability of rainfall (rains delated, etc.). Long term statistics are missing for confirming this. Whatever this variability, our hypothesis is that the increasing uncertainty of the dates and amounts of rainfall has just *accelerated* (not generated) the proliferation of borewells, which is due mostly to the socioeconomic factors to be reviewed below.

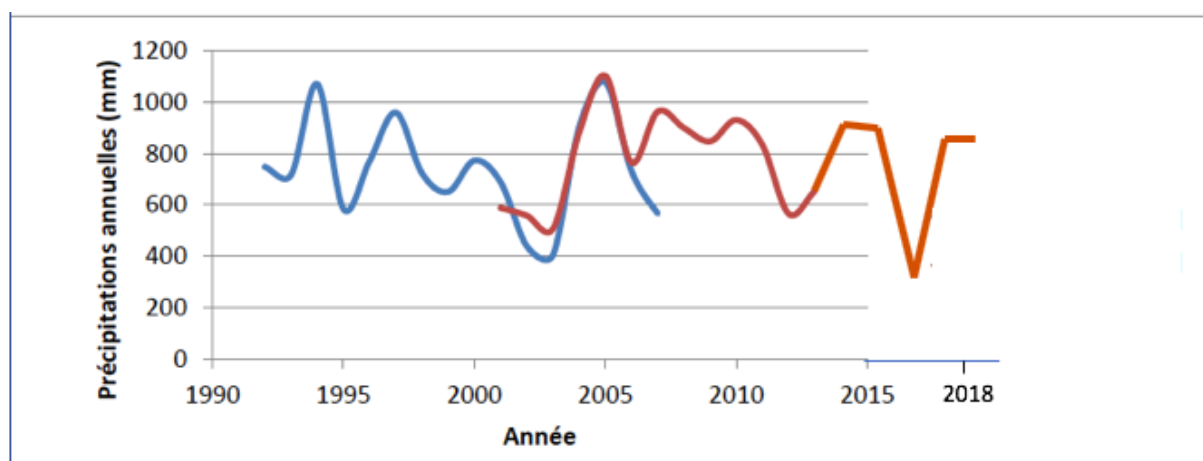


Figure 4. Rainfall in Gundlupet (1992-2018) (blue line: Indian Meteorological Department; red line: Chamrajnagar District Statistics).

A specific process is visible at the regional level. Areas in the eastern side of the Beramambadi watershed suffered earlier from the drying up of aquifers, while the western

side, where Gopalpura is located, has been concerned later. This is because the rise of groundwater use started later in the west, where rainfall is slightly higher (Sharma et al., 2018). In Puttanapura, a surveyed village in the centre-east of the watershed, the situation is spectacular. About one thousand borewells were dug since the 2000s in a desperate race for water. In 2018, only 15 were yielding water. Mr. N, a rich Lingayat farmer owning 40 acres, had drilled 10 borewells which were all dry in 2018. Today he grows rainfed sunflower on 20 acres, the rest being sorghum and coconuts or let fallow. For this type of farm, admittedly the process has been very damaging (less annual income, non-profitable investment in borewells) but investment in education and in some (rare) non-agricultural activities provide possible resilience. For small farms, this is another matter. Rainfed crops are insufficiently profitable for making viable the holdings with less than 2 ha.

As in many other Indian regions, a spectacular process is taking place (Landy, 2018): the *reversal* of the centuries-old process of agricultural intensification (more inputs per hectare providing more output per hectare), that in South India had started with ancient diversions of the Kaveri river, the medieval creation of irrigation tanks, and continued with the green revolution. What famines and wars had generated in history, groundwater depletion is generating today: a process of abandoning irrigation for less intensive, rainfed farming systems. Today the trend is a U-turn process of “agricultural extensification”, with less inputs (notably labour) and less annual gross income per hectare. In Tamil Nadu or Kerala, the process is rather positively triggered, since the main factors are the rising cost of labourers’ salaries and the diversification of the rural economy which leads to the abandon of labour-demanding crops such as paddy, to the advantage of coconuts or casuarina. Yet, in this region of Karnataka, many farmers have to survive with only one crop a year, and cease the cultivation of irrigated garlic, banana or vegetables. Some new rainfed crops, like sunflower or marigold, bring good profit; but often the income per worker remains below the “reproduction line” (about 45,000 Rs per annum) given the small size of holdings and the low level of local off-farm activities (Fischer, 2016). Investing in dairy cows is not easy for small holders who cannot grow a lot of fodder. Hence, small farmers and agricultural labourers try to compensate their loss of income by migrating seasonally to neighbouring Kerala - or to other villages with remaining underground water. This is the case of Puttanapura labourers who are hired in villages like Gopalpura, where indeed some groundwater is left.

Is this one more example of the tragedy of the commons? At the first glance, it is. In India, unlike surface water that is under the control of the state with a few exceptions, groundwater belongs to the owners of the land. Farmers have started digging borewells in their owned land without collective concertation on the reserve of the aquifer. When their borewells dried up, either they tried to deepen their depth, or they dug another well nearby. Short term individual interest seems to have been the major engine in this race for underground water. The figure 3 above clearly shows that all the borewells react similarly, whatever the individual irrigation practices of the farmers: this proves that *de facto* the water table functions like a commons; all the borewells are interdependent and doomed to a common future. Nevertheless this is not sufficient for making the water table managed as a commons ; and even less for making it perceived as a *common*.

Yet it remains to be proven that in the past water has ever been seen as a “commons” for the villagers (Mosse, 2003; Shah, 2003). Before the borewells, except a few open wells the only source of irrigation was the village tank, which was somehow managed collectively (Fischer, 2016). However, for irrigation purpose, it mostly allowed only a few fortunate farmers having land downstream (*ayacutdars*) to cultivate water intensive crops by buffering the variability

of rainfall and expanding the cropping season by a few weeks. Furthermore, these tanks had suffered from the takeover by the Government, which even reduced the “common” nature of their management. As for the use of groundwater, it used to be limited to open wells, of which the “area of influence” was very weak (figure 4). The situation was the type of those described by Shah: « Well interference was non-existent and only a fraction of the utilizable groundwater potential was used » (Shah, 1993, p.129). Our case study does not present a situation of current degradation vis-à-vis a past period when collective action would have properly managed and protected a natural resource, before population increase or takeover by the Government eventually ruin the long term, common management. On the contrary, from the beginning, the resource was not considered as a commons, even less a “common” in the sense of a resource perceived to be managed collectively. There is no “golden age” to regret or to recreate. In the absence of such reference, constructing commons is all the more difficult.

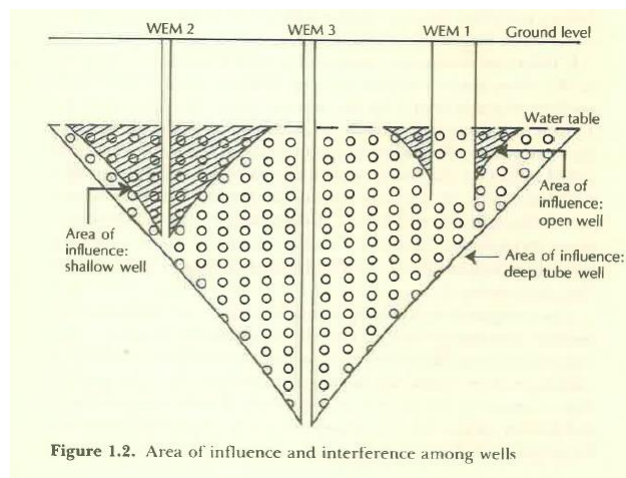


Figure 4: Forcing to collective action? The respective areas of influence of shallow and bore wells. (Source: Shah, 1993).

II. Why no collective action regarding groundwater?

From an external perspective, there is a paradox: there hardly exists any collective action, even though farmers have a practical knowledge of the negative effects of using groundwater in a “free-for-all” way; and even though they seem to have a direct interest in cooperating with one another in order to limit the number of borewells and to reflect upon their location in order to avoid a general lowering of groundwater levels. (We will see that this interest is indeed more complex). For example, we could imagine a farmer renouncing to digging a borewell since it would dry up his neighbour’s well; in exchange his neighbour could offer him a compensation.

A first explanation for this absence of concertation and collective action is provided through a historical approach, in terms of the evolution of agrarian systems. A second, complementary explanation is provided through political economy perspective, inspired by the works of Ostrom. A third is brought by an analysis of the groundwater policy of the state.

1. The history of the agrarian system :

The recent agrarian history of India, at least since the green revolution, has increased individualism and broken social patterns that would “cushion” the vagaries of rains and

prices: marketization, reduction of the family size, individual indebtedness, collective irrigation replaced by holding's borewells, etc. lead to an "individualisation of risks" that may largely explain the growth of suicides (Vasavi, 2009) and the present so-called "agrarian crisis" (Reddy, Mishra ed., 2009). The green revolution brought a very individualistic approach to agricultural activity. Before it, farmers were used to help each other on rainfed fields during sowing or harvesting times. With the mushrooming of borewells, demand of work in the irrigated fields increased and farmers could no longer find time for mutual help between neighbours or relatives. Borewell agriculture is a private and commercial activity. In the past in Karnataka, a negative village *karma*, such as the non-performance of some rituals by the collective, was believed to entail possibly a drought due to "linkages between human moral order and larger ecological conditions" (Vasavi, 1999, p.56). Such beliefs are disappearing with the advent of the new agricultural technologies: today getting water depends on the level of the water table in one's individual borewell. Water is just a private resource, used as an input in the agricultural process of production. It is so precious that many farmers told us: "Nobody can ask not to dig a borewell, not even the government!"

Such trend is to be seen in our study area. The history of the local agrarian systems (Fischer, 2016), attests that up until the end of the 1960s rainfed agriculture dominated in the studied Berambadi watershed, even though tanks provided additional water to prolong the growing season of paddy, and a few open wells also existed. The green revolution brought borewells and with it sugarcane, and later irrigated turmeric. Crop diversification impacted also rainfed agriculture: the bimodal precipitation regime allows for two harvests a year (in the past, typically millets followed by legumes), but soon rainfed sunflower took more and more space, followed later by rainfed marigold that is grown under contract with industrial firms. Such a dramatic crop diversification is explained partially by the geographic situation of the region which is at a crossroads between the states of Kerala and Tamil Nadu, just 20 km away. In these states entrepreneurs are quite dynamic and some of them set up irrigation-dependent, commercial estates in the Berambadi watershed to cultivate ginger, banana, mango or coco trees.

At the end of the 1980s, nation-wide policies led to the development of village-level dairies and hybrid cows became the norm. Since the early 2000s, subsidies for sprinklers and drip irrigation favour farmers with the means to invest in these techniques. The private agribusiness players expanded their grip, that accelerated the spread of bore-well based commercial cultivation. The changes in irrigation methods did not reduce the decline of water tables, far from it: even though sprinklers appeared, followed by drip irrigation that became the general norm, water is hardly saved. These technologies allow to irrigate more lands; drip irrigation is often practiced with furrows in an almost flood irrigation system; and the recent farm ponds (encouraged by government subsidies) are far to alleviate the pressure on aquifers since farmers pump to fill the ponds and irrigate from them. "Despite the boom of irrigation and the democratisation of wells, inequalities persist. Farmers of the lowest socio-economic classes had to indebt themselves to access irrigation and they are the first to lose, financially speaking, when water levels drop" (Fischer, 2016, p.188).

Despite the dead-end it may represent, the situation at study is relatively simple compared to other regions in India where water markets exist. Many studies have focused on these regions (Shah, Chowdhuri, 2017), where relations exist between farmers due to the sale of water. In contrast, in the study area, the formal or informal exchange of water is rare. The abstraction and use of groundwater is individual. Perhaps this contributes to the absence of collective vision for its management. True, in the study area it exists a system of water sharing (*vaara*):

if a farmer has a borewell with sufficient water, he can decide to share the water with his neighbour. All the expenditures (inputs, labour...) are shared, as well as the benefit of the sale. Yet this type of water sharing tends to disappear because of groundwater depletion. Moreover, its goal is not to save water or avoid digging a new borewell, but to maximise profit by maximizing the use of water. One interviewed farmer even said he was doing *vaara* in order to make money for digging his own borewell.

Vasavi (1999) had found in rural North Karnataka that “though there is a constant emphasis and reiteration of the continuity and identity between nature and society and the need for collective addressing of the larger cosmic order, drought-related stress, especially food scarcity, is experienced on a non-collective basis” (p.68). This is even more true today: in case of crisis the villagers accuse rainfall, or the market prices, or the governmental policy, but they hardly take themselves in hand collectively. The raise of commercial agriculture, with inputs and outputs bought and sold outside the village, made them “move away not only from cosmogonic understandings of loss but also often from the support of fellow kin, caste and village residents” (p.119). The history of the region is one of diversification of agricultural income which was partially based on individual access to groundwater. This diversification took place without a pooling of the modes of production (land, capital, money), nor marketization (with the exception of milk). The political structures of decentralisation (*village panchayat*), which developed very early on in Karnataka, do not seem to have played an important role in the agricultural development of the region. Needless to say, nothing favored a collective management of underground water.

2. An *ostromian* approach:

An analysis in institutional economics can enrich this explanation by focusing on the present socio-political situation. It is well known that Ostrom’s first book (1990) starts introducing three models: Hardin’s tragedy of the commons, the prisoners’ dilemma game, and Mancur Olson’s logic of collective action. These three models recommend actions by external governmental authorities since they highlight the alleged weakness of collective action in situation of incomplete information, population growth, etc. It is less known that their criticism by Ostrom is full of nuances: “Instead of being wrong, these are special models that utilize extreme assumptions rather than general theories. (...). They are useful for predicting behavior on large-scale CPRs [common-pool resources] in which no one communicates, everyone acts independently, no attention is paid to the effects of one’s actions, and the costs of trying to change the structure of the situation are high” (p.183). In other words, models such as those of Hardin or the prisoners’ dilemma could be relevant for explaining our case study, if only the studied village were characterized by such a situation. Now, except for the last point (“everyone acts independently”), none of these traits is present in Gopalpura. On the contrary, in this small farming community discussion and interaction are vibrant, kinship links are intense, and though as we shall see enmity and caste/class inequalities may prevent a fully collective action, the setting is far from larger-scale situations such as the Antarctic blue whale fishery hinted at by Ostrom. Yet, groundwater is declining in Gopalpura, and there is no consensus or even discussion about mitigating the process. How could this be explained?

According to Ostrom (1990, p.211), stakeholders shall improve operational rules if the following criteria are met :

- “1. Most appropriators share a common judgement that they will be harmed if they do not adapt to alternative rules.
2. Most appropriators will be affected in similar ways by the proposed rule changes.

3. Most appropriators highly value the continuation activities from this CPR ; in other words, they have low discount rate.
4. Appropriators face relatively low information costs, transformation, and enforcement costs.
5. Most appropriators share generalized norms of reciprocity and trust that can be used in initial social capital.
6. The group appropriating from the CPR is relatively small and stable”.

In our case study, only criteria No. 3 (about the recognized importance of groundwater) is validated. (Yet it might be possible that for farmers above 40 years, who have lived the period without borewells, a return to rainfed agriculture is not so alarming). As for the other criteria, the situation is much less positive.

- Criteria 1 (they “will be harmed if they do not adopt an alternative rule”) is not fully valid, since most of people consider poor rains, and not borewells, as the responsible of the decline of groundwater. More precisely, everyone knows by empirical knowledge the links between the excessive number of borewells and groundwater depletion; but it is commonly stated that if so many borewells are dug, it is because of the failure of rains. There is no alternative ; if they reduce their pumping then they will lose an income. Irrigation may bring 10 and even 15 times more than rainfed agriculture (Fischer, 2016)! Unless the macro-economic environment changes, there is no way to convince farmers to “stay rainfed”. So, might as well keep pumping and we will see what happens, they think. What would be the point of rationing ourselves now, and changing our crops, or livelihoods? When this was suggested during a workshop we organised, a farmer exclaimed: ‘But I have to do three crops a year to pay back my loan!’. Indeed, we are not in an environmentalist vision where a natural resource has to be protected at any cost ; water is a means of production and most of the farmers have no naturalist, emotional feeling for groundwater (Aubriot, 2006, 2011). They also feel that since good rains allow some rise of the water table, the resource is resilient. Some of them hope that after some years the aquifer will be sufficiently recharged to allow borewells to work again. That is what eventually happened in 2018, when due to good rains the table rose to optimal level (fig.5).

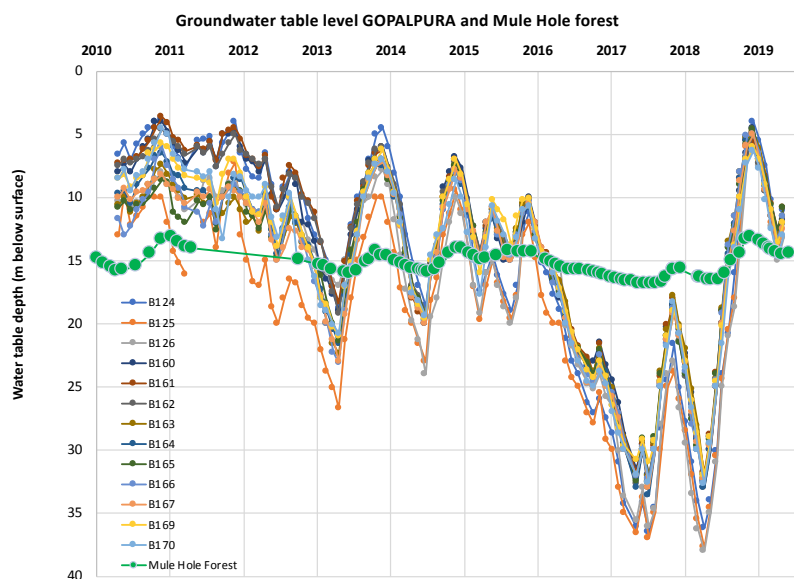


Fig.5. In 2018, very good rains replenished the aquifers.

As Aubriot (2011) noticed, this reasoning might be a legacy of the times of tank irrigation or open wells, when farmers used to use water till the annual stock gets exhausted. Yet, who among small farmers has enough resources to wait for five, six or seven years before eventually aquifers are replenished? The alternative logic to which the majority of external observers subscribe is that farmers would have an individual interest to act collectively to protect groundwater. However, this does not make much sense for the principal stakeholders. Most of them do not, in fact, have a personal interest in protecting groundwater. Why protect a resource which would not serve them, all the more while they could use this resource to increase their profits! Protecting the resource for their children does not make sense either; their offspring will be faced with the same situation. Might as well use the resource entirely if need be... and turn toward non-agricultural livelihoods afterwards (migration to neighbouring Kerala, or education on the long run).

Incidentally, such representation of water as a resource is one more element in the controversy regarding the « nature of nature » (Morin, 1992). Should nature be protected as a resource, or for itself ? According to Ostrom and many authors, the definition of the commons is summarised by the term “common pool *resource*”. This definition has been criticized for its utilitarian and anthropocentric character. Must biodiversity, water, forests, etc., necessarily be considered as resources in order to be protected? Can they not have an intrinsic value? Can't nature be protected for nature's sake ? (Newsham, Bhagwat, 2016). We see here the limits of these critiques: all things natural are not systematically worthy of conservation in the eyes of stakeholders – here, in the eyes of villagers. Indeed, if natural elements are not considered as resources, quite a few incentives for conservation disappear. In order to rigorously analyse this tragedy of the non-commons, we must forget our assumptions that there is an evident necessity to protect natural resources with no necessary or further justification. On the contrary, as explained, this necessity is not obvious for all. The “tragedy” for the farmers is that they indebted themselves to dig and deepen their borewells; the tragedy is not (only) the exhaustion of groundwater.

- Criteria 2 (the farmers will be affected in similar ways by the proposed institutional changes) is not valid either. Farmers know quite well that their existing borewells are impacted by the digging of a new one. Yet, not all villagers understand the complexity of groundwater circulation, in particular of horizontal flows which makes farms interconnected by their pumping actions. Must a commons be visible for it to be considered a commons? Groundwater is mostly hidden from view. It can be seen in broad daylight only when it gushes out from a borewell or when it lies at the bottom of an open well (Richard-Ferroudji, Lassaube, forthcoming). Another reason why the criteria is not valid is that, since power relationships are very hierarchical in most Indian villages, dominated people may fear, rightly or wrongly, that they shall lose more than the dominant groups in case of change.

- That is why criteria 4 (farmers face relatively low information and implementation costs) is hardly validated either:

- Villagers, men and women, do understand the issue. They stated during workshops and focus groups organized by the ATCHA scientists that there was no need to explain them the situation; they just need a solution. Yet communication between different kinships and communities is not very dense. Disinformation and gossips are another major hindrance. There is also a lack of dialogue between extension services and farmers, between science and society (Vasavi, 1999). That is also why criteria 5 on reciprocity and trust is partly validated only;

- furthermore, transforming and implementing a system for rationing groundwater, whatever this system could be, has a not negligible short term cost since it means that many farmers shall have to renounce to the profitable irrigated crops.

-The criteria 6, about the stability of the small group of stakeholders, is more or less validated since almost all the water users are from the same village. Nevertheless, a good part of the relationships between people are led by political interests or private conflicts among farmers, in addition to the strong caste hierarchy. Furthermore, some farmers own, or at least cultivate land in other neighbouring villages; reciprocally, some outside farmers cultivate village lands. As elaborated below, the scale of the village is not the ideal level of reasoning since aquifers ignore administrative boundaries. Lastly, estates, whose size may reach 60 ha and who make about 7 percent of the cultivated area in the studied region, are owned by people alien to this region, sometimes even to the State (Tamil Nadu and Kerala): they are big water users even if they are not numerous (Hooze, 2019). These outsiders tend to break the “stability” of the group. There is little possibility for them to attend village meetings.

At the first glance, the region did not appear far from “the ideal logic of common management: one resource, one type of user, one circumscribed territory » (Dahou et al., 2011, p.16). Yet, after deeper analysis, this situation appears not sufficient for generating such a management. Remember also that « it is essential to consider not only the variables that characterize a particular CPR situation but also the type of external regime under which the CPR is operated » (Ostrom, 1990, p.211). From this angle also, public policies, and their application, do not encourage communal management, even though water legislation is undergoing a process of change in the State of Karnataka.

III. The groundwater regulations : A step forward, but lately

The final explanation of the lack of collective action is the type of policies designed and implemented by the state. The Government has not facilitated any regulation of water use. For the sake of agricultural and rural development, since the 1970s borewells have been subsidized. So has been irrigation electricity. It is free in Karnataka since 1992. Rules are imposing a minimal distance between borewells, but they are not followed, not even by the complicit banks that grant the loans. The only regulation by the State is the rationing of power (between 3 and 5 hours a day – with a target of 7 hours announced in 2019), but less for limiting water use than because in Karnataka electricity supply is insufficient³.

The groundwater legislation is another crucial factor explaining the lack of collective action.

1. A common law that does not encourage commons

In India, the present legal regime for groundwater “is based on the common law notion that groundwater is part and parcel of the land lying above the resource (Water Governance Facility, 2013). Groundwater law in India follows this common law logic and gives uncontrolled power to landowners to use groundwater extracted from their land” (Cullet, 2017, p.6). The *Indian Easements Act 1882* is still valid today whereas it had been written following a colonial model, more or less adapted to Great Britain with its humid climate, little use of groundwater and much larger holdings than the atomized Indian farms of today that are

³ In her similar analysis on groundwater overuse in Tamil Nadu, Aubriot (2006) mentions the dangerous incentive provided by the procurement price of paddy, a water-demanding crop, guaranteed by the Government. This is not the case here since most of irrigated crops (garlic, bananas...) are not under the support price scheme.

so many to abstract from the same aquifer. Furthermore, the systemic relations between surface and ground water were even less well known than today (Cullet, 2014).

Hence, given that this doctrine requires water to be available to everyone equitably, the land-groundwater nexus completely contradicts the public trust doctrine which is theoretically relevant for water (at least for surface water). The stakes are increasingly serious. Due to the demand but also to a deficient management, in India 29% of districts are in a “critical” or “overexploited” situation (Central Ground Water Board). The situation is critical both socially and ecologically.

Since water is constitutionally a State subject, there is a strong suggestion that the States should follow a model bill defined by the central government. In the 21st century, a first bill was published in 2005, but groundwater continued to appear distinct from surface water, and the nexus lining land and water was thus maintained. The law passed in Karnataka reflects this shyness. The *Karnataka Groundwater (Regulation and Control of Development and Management) Act, 2011*⁴ has created a Karnataka Groundwater Authority, with a clear top-down approach. Only in « notified areas » permissions are requested for digging a borewell (section 11). Furthermore, for the moment, these notified areas are limited to the Bangalore region : clearly, the Government is more concerned by the supply of drinking water in cities than by the evolution of rural aquifers⁵.

During our investigation in the studied villages, we were told about the rule prohibiting borewells with less than 200 m between them, but nobody respects it. At the end of 2016, the Government of Karnataka announced that new borewells would be banned after January 2017: instantly, in the whole State new borewells mushroomed in order to get in ahead of the ban. The Karnataka Electricity Board accepted to connect them. It is even said that some people bored wells in January and argued that they had started in December but financial hurdles had slowed down the work.

Hence, the local management of water is not a kind of “anarchy” where the village sphere would be cut off from the government (Shah, 2009): many governmental provisions (electricity, subsidies...) exist, and contacts with administration are permanent. Yet it is even less, at the other extreme, a management by a Leviathan-like, powerful State. It is rather an “hybridization” mixing government regulations with the informal practices of the villagers (Fofack et al., 2015, about Morocco). Most of farmers do not ignore the rules that favour them (subsidies for irrigation). Yet, firstly the latter are not always accessible (bribes may be demanded), secondly the farmers bypass the rules restricting access to water, with the support of officials themselves. Hence must be considered “both the local scale with its various (informal) processes for access to groundwater, and the regional scale where policies governing the agricultural development and groundwater management are implemented. Rather than a stacking of rules, we observed a hybridization of these rules” emanating from various actors and various levels (Fofack et al., 2015).

⁴ [http://www.indiaenvironmentportal.org.in/files/file/ao2011_25of2011\(E\).pdf](http://www.indiaenvironmentportal.org.in/files/file/ao2011_25of2011(E).pdf)

⁵ In 2015, Gundlupet taluk is not listed either among the 12 « overexploited » taluks by the Water Resources Department, G.o.K. (cf. <https://www.ijcmas.com/special/7/G.%20B.%20Ramesh,%20et%20al.pdf>). It is also absent in the data base of the Central Ground Water Authority: http://www.wwfenvi.nic.in/Database/State-wise_4463.aspx

Such is the situation on the field: « The exclusive right of landowners, as recognized by the existing groundwater law, contravenes established legal principles such as the public trust doctrine, the human right to water and sustainable development, because these principles do not approve a system of private appropriation of groundwater on the basis of land rights. It is a visible contradiction in the Indian legal system that while these principles are well recognized, one of the critical sources of freshwater continues to be available only to land owners » (Cullet et al., 2017, p.650). Our study shows that the situation is even more tragic, since in the studied villages even the landowners have a precarious access to groundwater!

2. A step forward

Yet, is not a lot of improvement to be expected? In 2016, the *Model Groundwater (Sustainable Management) Act* was passed in New Delhi. This time, the suggestions to the States are much more original (Cullet et al, 2017). The preliminary considerations of the act are remarkable : « Whereas water is unitary in nature, requiring the *integration of surface water and groundwater*, has integral links to land and vegetation and has an intricate relationship with rainwater (through natural recharge); And whereas groundwater *in its natural state is a common pool resource* and the Supreme Court of India has applied the *public trust doctrine* to groundwater, in recognition that private property rights in groundwater are inappropriate given the emerging status, conflicts and dynamics of groundwater...” (underlined by authors).

The section 9. *Legal status of groundwater* also includes: “1. Groundwater, as a common pool resource, is the common heritage of the people held in public trust, for the use of all, subject to reasonable restrictions to protect the fundamental right to water for life. In its natural state, groundwater is not amenable to ownership by the state, communities or persons. 2. The state at all levels is the public trustee of groundwater”. This implies that the Panchayat Raj Institutions (PRI) are involved : at the level of Gram Panchayats as well as at the Block and District Panchayats, Groundwater Committees shall be formed; they should elaborate a Groundwater Security Plan in the threatened areas and shall recommend the granting of authorisations.

Yet, have we really entered a straight « aquifer-based approach” (Cullet et al, 2017) ?

a. *Aquifer-based or panchayat-based approach?*

Aquifers are very often mentioned in the Act. “The State Groundwater Agency shall, in consultation with the appropriate government and local communities, demarcate natural or artificial recharge areas of an aquifer or aquifers as groundwater protection zones based on the categories – safe, semi-critical, critical and overexploited – with reference to the latest assessment by CGWB”. Yet, because the act wants to give an important role to the PRIs, it tends to see the latter as the basic bricks of the institutional construction, to the expense of aquifers that have no committee planned at their scales. What to do when an aquifer does not match with one only jurisdiction, be it a village or a district? Admittedly, in hard rock settings such as the studied village the surface of water tables follows more or less the topography (when they are not overexploited!). In sedimentary settings, the situation might be more complex.

The act answers by emphasizing spatial integration and coordination of scales: for example, « the functions of the District Groundwater Council shall include(...) coordination of the

preparation of groundwater security plans between panchayats and wards sharing aquifers where their boundaries do not correspond with the boundaries of a single panchayat or ward, *as the case may be*” [underlined by authors]. Yet the fact is there is no institutionalization at the scale of aquifers. « As the case maybe », the act says: this phrase does not sounds very appropriate, since by definition aquifers ignore administrative boundaries. Remaining locked within the grid panchayat/block/district/state allows a simplification of the very complex reality, in order to ease the management as well as for valid political reasons⁶. Some trade-offs had to be accepted between subsidiarity, decentralization, local democracy (that give importance to *panchayat raj* institutions), vs. regulation and integrated approach (that would be rather aquifer-based).

b. Are all stakeholders involved ?

Beside the PRIs’ power, social audits to be organized by the *gram/ward sabhas* are provided in the act. Public hearings are also planned for environmental and social assessments, in case of “projects”. But it has been chosen not to take into account the multiplicity of other stakeholders (associations, firms, users representatives...). Scientific experts are present at the state level only, in the State Advisory Council, whereas they could have been expected at the district level as well (Indian districts have in average 1.8 million inhabitants).

As for our study area, the case of estates does not seem to be addressed in the act. It states that « every person is entitled to use groundwater for meeting livelihood needs, so long as such use does not adversely impact the right to water for life of any other person »⁷. These big farms must be considered as having a commercial, sometimes speculative objective. The law makes compulsory only the authorizations for industrial or commercial investments in Groundwater Protection Zones, not elsewhere⁸.

It remains, of course, for states, and particularly Karnataka, to legislate according to this model. Then, once the law shall have been drafted and passed, it will remain to be implemented, in the generally unfavorable social and political context of the Indian countryside (caste and class hierarchy, politicization, corruption...). In particular, enacting and implementing a regulation affecting farmers on the short run (e.g. banning new borewells) might have electoral consequences that prevent populist politicians to advocate such measures. The aquifers of Chamrajanagar district are probably not close to be regulated in a sustainable way.

Conclusion

The new Model Act, 2016, states that groundwater is a common heritage of the people and that the state at all levels is its public trustee. But it is allowed to remain sceptic on the power of performative narrative. Stating that groundwater “in its natural state is a common pool resource”, as the Act says, has little meaning since we have seen how much constructed and socially defined are existing commons. They have very little “natural state”.

⁶ “Panchayats/municipalities may not always be demarcated in an ideal manner from the point of view of water resources but they have the advantage of being clearly demarcated in law and have the power to regulate all natural resources together, including in particular land and water. In addition, they have the advantage of being democratically elected and permanent, something that project-based institutions cannot achieve.” (Cullet, 2014, p.70).

⁷Note also that this phrasing says nothing on the needs of future generations.

⁸ Also to be noted: “The authorisation holder shall be prohibited from selling, by whatever name or form, groundwater extracted under the authorisation to someone else for commercial use and/or gain.”

Just consider what a participant to a game organized during a participatory workshop (July 2018) told us with a somewhat disillusioned tone. « In India, to discuss together is not possible: we don't share (sic). If his neighbor has water, the farmer wants to abstract water as well, because he can see there is a resource ». This narrative is very close to Hardin's!⁹ Also note that none of the participants had understood the link between groundwater management and the game, even though that game had been designed for showing to the players how profitable it is to communicate in order to maximize the benefits of all¹⁰.

How to build a *common* in such conditions? Probably by focusing not only on the natural resource concerned, in this case groundwater, but also by seeing more broadly the modalities of collective action. Brédif and Christin (2009) thus distinguish the "substantial common" (grazing land, biodiversity... – what we called the *commons*, with a final s) and the "normative common", the more abstract result of collective action (a common work, a life together...). Sometimes the common "is approached through the status of the environmental good in its relations with the property; sometimes it is viewed from the perspective of the human collective's ability to produce rules" (p.6). In the first case, the Model Act should theoretically make it possible to break the land-groundwater nexus and create a "substantial common". But it remains to create a complementary "normative common", otherwise the substantial common would have little life expectancy. What is the point of creating a groundwater committee if its members cannot collaborate for lack of democracy, sociability, or shared rules?

This is why we would like to argue for aquifer management committees, which we think are missing in the Model Act (Richard-Feroudji, Lassaube, forthcoming). As much as possible, aquifer must be the management unit (Kulkarni, Shankar, 2009). There are two reasons for this: a hydrological reason, since the aquifers do not know the administrative boundaries, as we have seen; and a participatory objective, since ignoring stakeholders other than local communities may seem restrictive. Some environmental, professional and women's associations (the gender dimension of groundwater is essential, see Solomon, Rao, 2018), etc. may be active on the spot: they should therefore be invited to meetings and included as much as possible in participatory and decision-making processes. Under ATCHA project, we are conducting participatory workshops and focus groups in Gopalpura: we forgot our initial

⁹ It is also very close to the narrative of this Tamil farmer interviewed in the documentary film *Bittersweet Waters*: "The tank there belongs to the government. Anything that belongs to the government belongs to everybody. The tank is for the farmers. It can be shared by anyone. But we dig a well for our personal needs. Water is ours. Since it is ours we don't share it with anybody". <http://www.ifpindia.org/content/bittersweet-waters%C2%A0irrigation-practices-and-modern-challenges-south-india-eaux-douces-eaux>

¹⁰ The game is played by a group from 5 to 8 players. Players sit in a circle; in the middle there is a bowl with candy in it. They do not know how many pieces of candy there are. The objective of the game is for each person to get as much candy as they can *but also* for each member of the group to get candy. There are 3 years (with different conditions) and 2 rounds each year.

Year 1: players cannot talk to each other and they do not know how many pieces of candy there are;

Year 2: players *can* talk to each other but still they do not know how many pieces of candy there are (collective action possible);

Year 3: players cannot talk to each other but they know the amount of candy (knowledge of the 'resource').

Year 1 is a regular year - this means there are enough sweets in the middle for each person. The second year there is less: only one per person. And the third year there is a lot: at least 3 per person.

Each person writes on a little piece of paper, anonymously, how many pieces they would like. Then they reveal to the group how much they asked for. If the total asked for exceeds the amount in the bowl, no one gets anything. If the total is equal to or less than the quantity in the middle, then everyone gets some candy.

(Roma Hooge, personal communication).

ambition to have general meetings bringing together all the classes, castes and genders and we accepted to match the social stratification of the local community by inviting only peers for each meeting. The results are encouraging.

We could then take the example of "water table contracts" in France which, imperfect as they may sometimes be in their operation, are established by "local water committees" and define for 5 years an action program. This program is in agreement with the Planning Scheme for Water Management (SAGE) which, at the watershed scale, establishes a "common project for water" with more or less strict rules. These water table contracts are signed by the local bodies concerned, from the village to the district, and by the Water Authority at the regional basin level¹¹. Of course, the basic brick remains the local bodies, as in India the panchayats, but the main scale and the level of action are defined from the start as those of the aquifer. All kinds of stakeholders participate in the "water table committee" (*comité de nappe*). An exemplary case is the *Comité de nappe de la Crau*, in Southern France: it is composed of various members, from local environmental NGOs to government officials, from elected local bodies to farmers's associations, from academic experts to representatives of the neighbouring Marseilles port and Air Force base¹². "Citizen science" is developed, with piezometers distributed to inhabitants, with participatory mapping for defining prohibited areas, etc.

True, each country has its own specificities. There is no question of India imitating blindly the French model (with its strengths and its not negligible weaknesses). We agree with Shah's (2009) criticism of the Integrated Water Resources Management toolkit, which is sometimes poorly adapted to local situations; the water users are also not necessarily very interested in the management of water (Faysse, Petit, 2012). Yet a comparative perspective might be food for thought.

By definition, a commons must be managed primarily by the local people who use it and are the main concerned people. Nonetheless, an institutional framework provided by the Government is, if not necessary, a least an obvious support for facilitating the management of common-pool resources – even more when these resources have never been considered as commons and when everything remains to build. In Chamrajanagar district, the ATCHA project is organizing participatory workshops with the villagers in order to intensify discussions and generate more reflection among the participants, in the hope that some collection action will take shape. But this shall not be enough if a new legislation is not enacted in Karnataka for delinking the land-groundwater nexus. In a second stage, this legislation should also be implemented on the ground efficiently, sustainably and democratically. Environmental education programmes should also improve the knowledge on groundwater of all the stakeholders. The task remains immense, and a lot of groundwater shall have passed under the bridge before its achievement.

REFERENCES

Aubriot, O., 2011, L'eau souterraine en Inde du Sud : un savoir réservé aux nouveaux maîtres de l'eau ? in M.C. Mahias ed., *Construire les savoirs dans l'action. Apprentissages et enjeux sociaux en Asie du Sud*, coll. Purusartha, EHESS, Paris, pp.237-262.

Aubriot, O., 2006, Baisse des nappes d'eau souterraine en Inde du Sud : forte demande sociale et absence de gestion de la ressource, *Géocarrefour*, 81, 1, pp.83-90.

¹¹ In France there exist democratic institutions both at the regional basin and at the watershed levels.

¹² Similarly, the SAGEs are drawn up by a local committee including government officials (25%), local bodies (50%), but also users (25%) such as representatives of consumers, local population, fishermen, environmentalists, etc.

- Baron, C., Petit, O., Romagny, B., 2011, Le courant des common-pool resources : un bilan critique, in T. Dahou, M. Elloumi, F. Molle, M. Gassab, B. Romagny ed., *Pouvoirs, sociétés et nature au sud de la Méditerranée*. Paris-Tunis, INRAT-IRD-Karthala : 29-52.
- Brédif, H., Christin, D., 2009, La construction du commun dans la prise en charge des problèmes environnementaux : menace ou opportunité pour la démocratie ? *VertigO*, 9, 1, on line.
- Cullet, P., 2014, Groundwater law in India. Toward a framework ensuring equitable access and aquifer protection, *Journal of Environmental Law*, 26, pp.55-81.
- Cullet, P., Bhullar, L., Koonan, S. (2017): Regulating the interactions between climate change and groundwater: lessons from India, *Water International*, DOI: 10.1080/02508060.2017.1351056
- Dahou, T., Elloumi M., Molle, F., 2013, « Appropriations et conflits autour des régimes d'accès aux ressources renouvelables », *Études rurales*, 192. URL : <http://etudesrurales.revues.org/9877>
- Dardot, P., Laval, C., 2014, *Commun. Essai sur la révolution au XXIe siècle*, Paris: La Découverte.
- Faysse, N., Petit, O., 2012, "Convergent readings of groundwater governance? Engaging exchanges between different research perspectives", paper CIRAD, <http://onlinelibrary.wiley.com/doi/10.1002/ird.1654/abstract>.
- Fofack, R., Kuper, M., & Petit, O. (2015). Hybridation des règles d'accès à l'eau souterraine dans le Saïss (Maroc) : entre anarchie et Léviathan ? *Études Rurales*, 196, 127-149.
- Hasanain, A., Ahmad S., Mehmood, M.Z., Majeed, S., 2013, *Irrigation and Water Efficiency in South Asia*, GDN Working Paper 68, New Delhi.
- Hooge, R., 2019, "Les estates en Inde du sud semi-aride (Karnataka): des systèmes de production agroforestiers irrigués capitalistes », ATCHA project.
- Kulkarni, H., Shankar, P.S. Vijay, 2009. 'Groundwater: Towards an Aquifer Management Framework', *Economic and Political Weekly*, 44(6): 13.
- Landy, F., « Fragmentation of irrigated family farms in Southern India », in P.M. Bosc et al., *Diversity of family farming around the world*, Springer-Quae, 2018, pp.259-272.
- Morin, E., 1992, *Method: The Nature of Nature*, P. Lang.
- Mosse, D., 2003, *The Rule of Water. Statecraft, Ecology and Collective Action in South India*, New Delhi, Oxford University Press.
- Newsham, A., Bhagwat, S., 2016, *Conservation and Development*, Oxon: Routledge.
- Ostrom, E. 1990. *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.
- Petit, O., 2009, « Un regard rétrospectif sur l'évolution de la gouvernance de l'irrigation en Beauce (1993-2008) », *Science et changements planétaires/Sécheresse*, 20 : 262-270.
- Reddy, N., Mishra S., (2009): *Agrarian Crisis in India*, Delhi: Oxford University Press.
- Richard-Ferroujji, A., 2017, Ambivalence des eaux souterraines dans le journal *The Hindu* : promouvoir leur préservation tout en accueillant des justifications de leur exploitation, *Développement durable et territoires*, Vol. 8, n°1 : <http://developpementdurable.revues.org/11526>
- Richard-Ferroujji, A., Lassaube, G., forthcoming, The Challenge of making groundwater visible: A review of communication approaches and tools in France, in J.D. Rinaudo, C. Holley, M. Montginoul, S. Barnett (Eds.), *Sustainable Groundwater Management: A Comparative Analysis of French and Australian Policies and Implications to Other*.
- Robert, M., Thomas, A., Sekhar, M. Badiger, S., Ruiz, L., Willaume, M., Leenhardt, D. Bergez, J.E., 2017, Farm Typology in the Berambadi Watershed (India): Farming Systems Are Determined by Farm Size and Access to Groundwater, *Water*, January, 21 p.
- Sekhar M., Riotte J., Ruiz L., Jouquet P., Braun J.J. (2016) Influences of Climate and Agriculture on Water and Biogeochemical Cycles: Kabini Critical Zone Observatory. *Proc. Ind. Nat. Sci. Acad.*, 82, 833-846. <http://dx.doi.org/10.16943/ptinsa/2016/48488>
- Shah, E., 2003, *Social Designs: Tank Irrigation Technology and Agrarian Transformation in Karnataka, South India*, New Delhi: Orient Longman.
- Shah, T., 1993, *Groundwater markets and irrigation development*, Bombay, Oxford University Press. EVIEW
- Shah T., 2009. *Taming the anarchy. Groundwater governance in South Asia*. Washington, Resources for the Future Press.

Shah, T., Das Chowdhury S., 2017, Farm Power Policies and Groundwater Markets. Contrasting Gujarat with West Bengal (1990–2015), *Economic & Political Weekly*, vol.III , 25 & 26, pp. 39-47.

Shankar, P.S.V., H. Kulkarni, S. Krishnan, 2011, India's Groundwater Challenge and the Way Forward, *Economic and Political Weekly*, Jan.8, pp.37-45.

Sharma, A. K., Hubert-Moy, L., Buvaneshwari, S., Sekhar, M., Ruiz, L., Bandyopadhyay, S., Corgne, S. (2018). Irrigation History Estimation Using Multitemporal Landsat Satellite Images: Application to an Intensive Groundwater Irrigated Agricultural Watershed in India. *Remote Sensing*, 10(6), 893 <https://doi.org/10.3390/rs10060893>

Solomon, D.S., Rao N., 2018, Wells and Well-being in South India: Gender Dimensions of Groundwater Dependence, *Economic & Political Weekly*, 53, 17, pp.38-45.

Vasavi, A.R., 1999, *Harbingers of rains. Land and Life in South India*, Delhi, Oxford University Press.

Vasavi, A.R. (2009) Suicides and the making of India's agrarian distress, *South African Review of Sociology*, 40:1, 94-108

Water Governance Facility (2013) *Groundwater Governance in India: Stumbling Blocks for Law and Compliance*. WGF Report No. 3, SIWI, Stockholm.