ISSN: 0976-3376

Available Online at http://www.journalajst.com

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

Asian Journal of Science and Technology
Vol. 08, Issue, 10, pp.6283-6289, October, 2017

RESEARCH ARTICLE

GROUNDWATER GOVERNANCE IN ANDHRA PRADESH- POSSIBILITY TO MOVE TOWARDS NESTED GOVERNANCE STRUCTURES

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ARTICLE INFO

Article History:
Received 10th July, 2017
Received in revised form
25th August, 2017
Accepted 15th September, 2017
Published online 30th October, 2017

Key words:

Groundwater Governance,
Common Property Regime,
India.

ABSTRACT

The open access nature of groundwater has resulted in the over-exploitation of the resource. Negative externalities are encountered by the users due to the self-interest maximising behaviour of individual agents which increases the social cost of extraction. There is excessive groundwater exploitation occurring in the country, which had led to a policy concern that there is a need for shift of groundwater resources to a Common Property Rights regime. We review the Andhra Pradesh experience in evolving governance mechanisms and suggest certain mechanisms to evolve nested governance mechanisms that could be piloted in the state and there should be a continuous process of learning to refine the governance regime and sustain the gains achieved.

INTRODUCTION

India is the world's largest groundwater users in terms of both absolute volumes pumped and the total number of users. The estimated useage is around 230 cubic kilometers per year, more than a quarter of the global total and 85 % of drinking water supplies are dependent on it (World Bank, 2010). There are approximately 20 million wells which are increasing at approximately at one million per year (Mukherjee and Shah, 2005 and Scott and Shah, 2004). Irrigation by Groundwater accounts for 60% of the irrigated area in the country and approximately 85% of the additional irrigated area since 1970 is accounted for by groundwater (Kulkarni and Shankar, 2009). Irrigation through groundwater sources, besides increasing the cropping intensity and productivity of crops, the timely access that it provides, increases the demand for agricultural labourers and the wage rates. The increased affordability of food grains due to the higher wages that they earn help the rural poor to cross the poverty barriers (Narayanamooorthy, 2007). Many of the irrigation systems constructed in Asia over the past four decades, it is explained would have became unproductive investments, were it not the dynamic pump irrigation economies which support them by recharging the groundwater aquifers (IWMI, 2009). Further, they act as insurance against drought and facilitate stabilization of agricultural production and enhance employment generation; They also help the non-well owning farmers, through the operation of the water market (Shah, 1993). Groundwater could be classified as a common pool resource, since it possesses the characteristics of (a) difficulty in exclusion and (b) subractability (Ostrom and Ostrom, 1977). Since each user gains from the harvest, but imposes a cost which is borne by all the users, users tend to harvest more than it is economically or ecologically desirable (Gordon, 1954; Scott, 1955; Dietz *et al*., 2002). It is well recognised that efforts by external authorities to impose similar solutions to CPR management issues have only lead to institutional problems and failures (Ostrom, Gardner and Walker, 1994). When rules are crafted, it is rightly argued 'these rules, frequently turn out to be incompatible with the specific physical characteristic of the resource' Schalager, Blomquist and Tang (1994, p.294). In the Groundwater governance context, even before, any rules are even thought of, there is a clear need to understand the differential nature of aquifers and the likely behaviour of the individual agents based on the socio-ecological conditions for the given aquifer. The following category of users could be classified based on the rights that they possess.

- Authorized user-Individuals holding operational rights of access and withdrawal.

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- Claimant-Individuals who have the same right as authorized users plus the collective choice right of management.
- Proprietor- Individuals who possess collective choice rights of management and exclusion

The rights associated with these set of users are as follows.

Table 1. Bundles of Rights associated with Positions

	Owner	Proprietor	Claimant	Authorised User
Access and withdrawal	X	X	X	X
Management	X	X	X	
Exclusion	X	X		
Alienation	X			

Source: Schalager and Ostrom, 1992, p.252.

The universal problems associated with common pool resources are appropriation problems and provision problems (Ostrom, Gardner and Walker, 1994). The appropriation problem relates to the allocation of the yield of a resource, equitably and efficiently among different users, while provision problems relate to the optimal size of the stock of flow units as well as the productive nature of the resource. Typically any common pool resource management situation would face the following problems, (a) severity of the appropriation and provision problems resource users face, (b) the relative use to which users can resolve these problems, and (c) the kinds of institutional arrangements they are likely to develop and implement. The open access nature of groundwater has resulted in the over-exploitation of the resource. Groundwater exploitation as a concept deals with the negative aspects of groundwater development which includes large and continuous drops in groundwater levels over long time periods, large seasonal drops in water levels and drying up of wells in the summer season and substantial increase in the cost of groundwater extraction (Kumar and Singh, 2008, p.299-300). In India, 839 administrative units have been categorized as overexploited and 226 as critical (Chatterje and Purohit, 2009). Negative externalities are encountered by the users due to the self-interest maximising behaviour of individual agents which increases the social cost. The excessive groundwater exploitation occurring in the country, had led to a policy concern (GOI, 2000) that there was necessity to shift to a Common Property Rights regime. However there are constraints in undertaking such a shift. While policies towards undertaking community management of groundwater as a common property resource have been initiated in Spain and Mexico, this shift in the property right regime has not lead to much success in these countries due to 'resistance' from the stakeholders (GOI, 2007).

The Expert Group of the Planning Commission (GOI, 2007) has undertaken a very comprehensive exercise to examine the status of the groundwater resources in the country and also has reviewed the experience of some of the states in the country in regulating groundwater extraction. A recent report of the World Bank (2010) on Groundwater in India states that there is a need for "home grown" institutional mechanisms to address the governance issues. This paper suggests mechanisms which should lead to the crafting of a nested governance regime that could be piloted in Andhra Pradesh. The reason for the choice of Andhra Pradesh for our enquiry is because of the interesting 'experiments' that are underway to craft governance regimes for groundwater management in the state including a proactive initiative of the government to intervene through the Water and Trees Act.

Groundwater in Andhra Pradesh

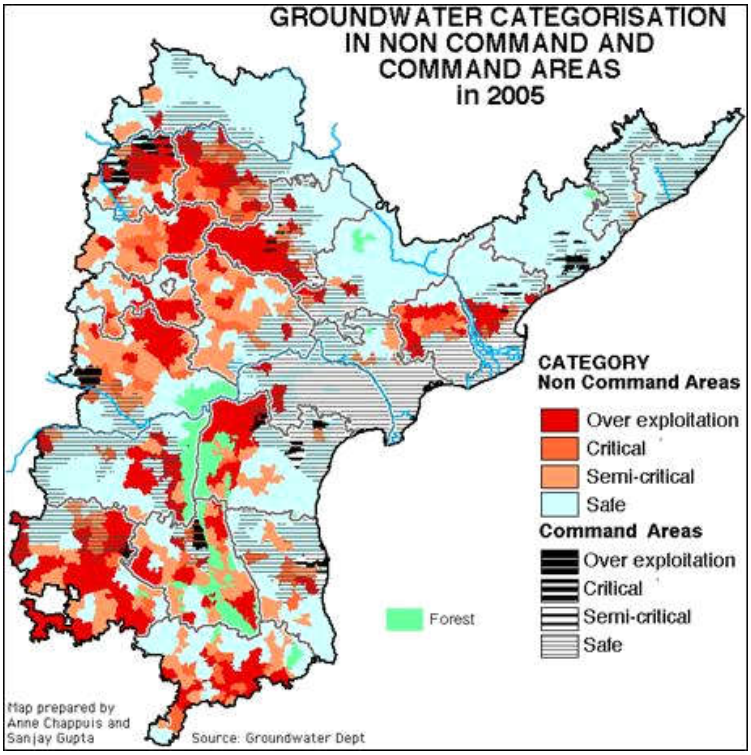
Andhra Pradesh is in the hard-rock region (along with states of Tamil Nadu, Karnataka and Maharashtra). The hard rock aquifier suffers from poor storage and low infiltration rates. The challenge for a groundwater user in this region is to locate a significant water bearing formation and often several only after several attempts at boring water is available. Farmers spend substantial amount of money just to locate water (Shah, 2009). Land fragmentation results in well fragmentation also, which leads to joint ownership of many of the wells in the region. In many cases, more than one pump is installed based on the number of users extracting water from the well. There is a race to chase the groundwater and competitive deepening of the wells is the strategy of many farmers in the region (Reddy, 2005). The behavior of the agents in Hard-Rock aquifiers such as in Andhra Pradesh has been characterized as 'Rivalrous Gaming' (Shah, 2009). In the Telengana region of the state, the expansion of well irrigation using private capital has had adverse affects on the groundwater levels and has had negative effects on the lives of the small and marginal farmers (Vakulabharanam, 2004). Groundwater is categorised as over-exploited in 132, critical in 89, semi-critical in 175 and safe in 833 watersheds. In terms of *mandals* (administrative boundary below the district level), 219 of them are over-exploited, 77 are critical, 179 are semi-critical and the rest 760 are safe (Table 2). The categorization of the groundwater status in command and non-command areas is provided in Figure 1.

The competitive deepening results in each user trying to maximize by more well deepening and often end up getting lower yields, while cooperative behavior would have lead to higher yields at lower costs. The user in the hard rock region is caught in the close to zero sum game of competitive deepening and attempts to maximize the net returns from the water utilized. The community in general opposes metering of electricity, lobby for a lower tariff and more power supply and are interested in development of surface water resources and watershed development programmes (Shah, 2009). The groundwater crisis has exacerbated in the state and there is "threatening of the very base of the production system (for e.g., more than half of rice in the state is produced now through groundwater) "(GoAP, 2010). However, possibilities for 'cooperative gaming' also exist. This is based on the assumption that there is a recognition of interdependence of the users and visible benefits of groundwater conservation are demonstrated (Shah, 2009). Such a situation does prevail in at least certain regions of the state, where various 'experiments' in governing groundwater use have been implemented/are being implemented .

Table 2. Categorization of Groundwater Assessment Units in Andhra Pradesh

Category	Number of watersheds	Number of Mandals
Over Exploited	132	219
Critical	89	77
Semi Critical	175	179
Safe	833	760

Source: Andhra Pradesh State Ground Water Department, GoAP



Source: Groundwater Department, Government of Andhra Pradesh

Figure 1. Groundwater Categorisation in Andhra Pradesh

Table 2. Bundles of Rights associated with Positions –2005 Model Groundwater Bill vis-à-vis the Andhra Pradesh Water, Land and Trees Act

Government of India/ State/ Project	Owner	Proprietor	Claimant	Authorized user
Government of India Model Groundwater bill (2005)	Groundwater authority (GWA)	GWA has the mandate of management and exclusion, with the right to transform the resource by making improvements without the right to regulate internal use patterns	The user has access and withdrawal rights, while management is the mandate of the GWA and the user	Person or an institution/ company or establishment (Government or non-governmental)
Andhra Pradesh Water, Land and Trees Act, 2002	Water, Land and Trees authority	Water, Land and Trees authority	Water, Land and Trees authority	Not specified

Review of Andhra Pradesh Groundwater Governance Regime and the 'Experiments'

The Water, Land and Trees act is quite different from the usual command and control approach of the model act of the GOI (GOI, 2005) and other state government acts. In Table 2 we provide a description of the various bundle of rights using the framework of Ostrom and Schalager (1992, p.251). The Andhra Pradesh Water, Land and Trees Authority that has been constituted by the government also envisages the possibility of constituting authorities at the district and mandal level. The crucial nested feature of the act is that the process of registration of the wells has to take place at the *mandal* level, which is administrative unit, below the sub-district *taluk* level. Since the geographical purview of the regulatory authority is smaller, this would mean that there would be a greater possibility for the authority to play a more effective role. Therefore, the size of the regulatory authority in terms of the mandate of the number of villages under its purview is smaller. The prior permission for digging new wells also has to be obtained from the revenue authorities at the *mandal* level. The authority can compel the groundwater user to enhance groundwater by recharge or rainwater harvesting and appropriate directions can also be issued to deal with competition and overcrowding of borewells. A significant feature of the act is that it provides for protection for watersheds, to ensure that land and water use in the watersheds are conducive for effective utilisation of the resource and ensure groundwater recharge. The scrutiny of the efficacy of the act has been very limited. It was found that while the act was successful in registering most existing wells, the disincentive provided by the penalty fees for drilling of illegal wells did not check the growth in the number of new wells (Ramachandrula, 2008).

A study has indicated that there have been no mechanisms to communicate the provisions of the act to the farmers and this might lead to arbitrary implementation, which will lead to further resistance, particularly when the farmer's perception is that groundwater is their own property and there has been no attempt to change this perception. Further, the authority does not have the manpower to physically verify if all the wells are registered, which could lead to farmers not taking the initiative to register the wells. While the authority envisages a policing function for it, it was not equipped in terms of the database and infrastructure to achieve it (Narayana and Scott, 2004). Another serious problem is the problem of illegal connections. According to study by APTRANSCO at the transformer level in 1997-98, around 30% of the connected connections are illegal (Narayana, 2002). An interesting 'experiment' was the

Social Regulation of Groundwater at Community Level project initiated in 2004 in 3 villages by the Centre for World Solidarity (CWS). The project aimed to promote local regulation and management of groundwater resources with equitable access to all families. An important realization early on in the project was that there was a need to change the mindset of the farmers from 'competition' to 'cooperation' and to increase the water literacy among farmers. The extent of competition had reached such levels that in Madirepally village in Anantpur district, three neighbouring farmers dug 13 borewells in an area of 0.5 acres over a period of four years in competition to tap the groundwater. The following social regulations were agreed by the community: (a) no new borewells to be drilled (b) equitable access to all the families through well sharing (c) increasing groundwater resources through conservation and recharge and (d) efficient use of irrigation water through demand side management. Small groups of farmers were formed in the project villages which included a borewell owner and 2 to 3 neighbouring farmers who did not posses a well and the owners of these wells were motivated to share the water to others. They were told that if they did not share the water there would be the "competitive" digging of wells and the water table would go down stand and everybody would stand to loose ("loose-loose" situation), whereas if they cooperated, everybody stands to benefit ("win-win" situation).

A significant initiative was the Indo-Dutch APWELL Project, which was implemented in seven drought prone districts of Andhra Pradesh from 1995 to 2003. The project envisaged digging of new borewells for a group of households without any access to water with norms for sharing, monitoring and water use efficiency measures. The project was implemented in 'new- unexploited' areas. In an attempt at replicating and up-scaling, the APWELLS initiative, a basin level initiative at the Upper Gundlakamma Basin was initiated in Prakasam District. The APFAMGs project (Andhra Pradesh Farmer Managed Groundwater Systems Project) grew out from the experience and learning's from the APWELLs project. The APFAMGs project was initiated on the premise that provided communities monitor their groundwater status based on appropriate knowledge (including on appropriate cropping patterns) and appropriate platforms are available for sharing and dissemination of this data, the community will evolve norms for groundwater management (GoAP, 2010). A recent study of APFAMGs (World Bank, 2010) argues the following as possible reasons for 'success' of the model: (a) There is no requirement from the community to reduce their water useage and farmers have the choice to make crop decision and extract groundwater as desired (*ibid*, p.66) and (b) Reductions in groundwater overdraft are:

"not coming from an altruistic collective action, but individual risk management decisions of thousands of farmers. This makes the APFAMGs model *robust and replicable*" (ibid, p.72, emphasis mines)

The assessment by the World Bank (2010) suggests that the effort in developing the capacity of the communities in undertaking participatory data collection and monitoring exercise is a significant causative factor which leads individual farmers to take their own decisions to curtain water extraction rates. It is also pointed out that more than 90% of the funds were spent in developing such community lead initiatives. However, we feel that the mere availability of information on water levels and 'sustainable' levels of extraction leading to change in incentive behaviour of individual agents to adopt more 'sustainable' extractions is not very convincing. It is not clear as to how such free-riding strategy was avoided and is an arena for further empirical enquiry. The FAO evaluation found that farmers were able to understand the seasonal occurrence and distribution of groundwater in their habitations and in Hydrological Units as a whole were able to estimate seasonal recharge, draft and balance. Further it is observed that the project work on the supply side was successful in improving groundwater availability. Based on the above evidence, we would like to state the following hypothesis for empirical testing.

Hypothesis: Effective governance mechanisms could be crafted *only if* demand side governance mechanisms (in terms of negative and positive incentives) are complemented with supply side measures of augmenting groundwater. Only when increased groundwater is available due to the incremental availability, would the individual actor- the farmer (well owning or non-well owning) be interested in curtailing his behaviour with respect to increased use age of water and competitive digging/deepening of wells.

The review reveals that the implementation of the AP Water and Trees Act has not been effective while there are some positive results emerging from the various non-state initiatives in the state. In the next section, we develop a nested governance regime that could support the efforts of the Government of Andhra Pradesh, particularly; the Rural Development Department which has began a pilot project in 100 over-exploited, critical and semi-critical villages in five of the most drought prone districts of the state from 2010 to 2014.

A way forward to facilitate the evolvement of a nested governance regime

Groundwater governance approaches are often classified as Direct regulation through administrative action, economic instruments, community aquifier management, supply augmentation strategies (See Shah, 2009, Chapter 9 for a review). We argue that a combination of at least a few of these approaches is the right way ahead to handle the complexities in governing this 'fugitive' resource. These approaches should not be seen as stand-alone strategies. For evolving nested governance regimes, there is the need for a consensus on the assessment of the resource and how different stakeholders would utilize it (Paranjape, 2008). This would also require that the governance regime crafted should utilize the indigenous knowledge of local water users (Krishnan, 2008). Our argument for the necessity to move towards nested governance regimes in Andhra Pradesh is based on the following rationale (a) Although the state has more nested governance regimes in the form of the AP Water and Trees Act, still there exist organisations that are "too local" or "too supra-local". The synergy and crucially the linkage of the lower level organizations with higher level organizations is required. (b) There is enough evidence of scattered 'successes' through various 'experiments' in the state and prominently from the APFAMGs project. We need to move towards mechanisms to upscale these models and ensure synergy of institutions across the hierarchy. This would not only ensure better governance

mechanisms, but also possibly contribute to learning across different districts in the state, based on further pilot interventions that are underway. The first and most crucial step to be embarked upon is to put in place data collection protocols on various parameters. Only a robust understanding would give us the knowledge to proceed further on issues related to defining the CPR boundary at the aquifer and local level. This would help us in arriving at more accurate estimates of the fuzzy concept of 'sustainable extraction' (see Kumar, 2007). The Groundwater department at the state level in collaboration with socio-economic and technical research institutions needs to put in place the data collection protocols. The first step is aquifers have to be mapped at the right scale. Their actual condition has to be analysed using the required density of wells. For example, in hard rock areas, on an average, the density of monitoring wells should be one well for 25 hectares (Kulkarni and Shankar, 2009). Further, crucially, there is a need for robust analysis and inference of the data, which will provide crucial inputs on decision making on various issues. The other organisations to be involved are the regulatory authority at the taluk level, Electricity board and NGOs.

Defining the norms to define the geographical boundary for a CPR regime for the aquifer and should be the primary responsibility of the groundwater department with the technical support of research institutes. Defining, the "local" CPR regime would be the primary responsibility of the Regulatory authority at the Grama Panchayat level in collaboration with the Groundwater Coordination Committee (GWCC) at the micro watershed level. We suggest that GWCC should compose of the following members- Representatives from the area groups, micro watershed committee, Grama Panchayat members in the micro watershed jurisdiction and regulatory official/s from the Grama Panchayat. However, the synergy or the lack of it between the various crafted CBOs and the PRIs are an area of concern particularly in Andhra Pradesh (see Reddy, 2003). However, while some critique that this are "parallel bodies", we argue that these crafted CBOs are crucial local organizations that are necessary and mechanisms need to be developed for them to work in synergy with PRIs and other higher level bodies in the institutional hierarchy. A crucial task for the effectiveness of a possible CPR regime is crafted is the sensitisation and training of various stakeholders on the possibilities, constraints and challenges in putting in place a CPR regime.

The Groundwater department and research institutions in collaboration with NGOs should take a lead in devising protocols for such continuous interactions and develop feedback and learning mechanisms to improve the governance regime based on the concept of "learning by doing" and "embracing error" concept (Korten, 1980). The definition of "sustainable" extraction levels is a challenging task as discussed earlier. This exercise should be undertaken based on a socially inclusive process of data sharing, reflection and decision making based on consensus. Since this is a highly contentious issue, there are bound to be contextual variations, across communities as to how sustainability is defined. There should be sufficient flexibility for such norms to be evolved. However, due attention needs to be paid to ensure that minimum physical notions of sustainability are ensured, as too much flexibility and autonomy to local communities might lead to "diluted" notions of sustainability.

The process of evolving rules/norms for groundwater access and extraction should be undertaken in a socially inclusive manner with the GWCC taking a lead in this regard with overall norms being laid down by the Aquifer group, groundwater department with the support of research institutions. The monitoring of the norms, should be an inclusive process with the authorised users (those pumping or buying groundwater) involved in peer monitoring to ensure compliance of the norms. The overall monitoring responsibility should be primarily with the GWCC and the secondary responsibility would be with the micro watershed group. The sanctioning power for violation of norms should be the responsibility of the area group, micro watershed group and the GWCC based on the principle of graduated sanctions. The first level of offences should be tackled by the immediate, higher level CBO and progressively moving towards higher CBOs/other organisations in the hierarchy, when there is non-compliance. There is a need to move away from the existing command and control regimes, wherein Criminal Procedure Codes could be potentially invoked upon for violations. We need to evolve mechanisms to facilitate the community to craft norms and sanctioning mechanisms and very useful lessons could be learnt in particular from the APFAMGs project and using the possibilities available in the AP Water and Trees Act.

There should be a continuous process of data collection from the wells/borewells and therefore flow meters should be installed in each well and data should be collected at periodic intervals (based on data collection protocol requirements that need to be developed). The installation of such meters should be the primary responsibility of the Electricity board at the local level with the assistance of the GWCC. The price at which electricity is made available to the groundwater users is a major variable that influences the extraction levels of groundwater. A study from a watershed in Andhra Pradesh and Karnataka suggests that raising the price of electricity nearer to its true cost could contribute substantially in addressing the problem of overextraction (Somanathan and Ravindranath, 2006; see Narendranath *et al*., 2005 for some interesting arguments as to why farmers want electricity, but are not ready to pay for it). Some have argued with the help of an econometric crop-water productivity model that the levy of different types of water charges would ensure equity in water access with only marginal consequences (Shiferaw, Reddy and Wani, 2008). According to the AP Water and Trees Act, it is envisaged that the Andhra Pradesh State Water, Land and Trees Authority could issue directions to APTRANSCO (electricity utility) not to raise electricity bills when there is stoppage of the pumping of water [Section 9(2)], but more crucial reforms need to take place regarding the appropriate pricing of electricity.

Day-to-day resource management involves the participation of the authorised users in ensuring compliance of the norms and in peer monitoring with the primary mandate being with the GWCC. Water audits needs to be conducted at periodic intervals at the aquifer level and at the "local" CPR level. There should be an extensive and inclusive process of data sharing, reflection and discussion, with corrective steps being taken by appropriate authorities. For the audit at the aquifer level, the primary responsibility should be with the Aquifer group. The water audit at the local CPR level should be the responsibility of the regulatory authority at the Gram

panchayat level with support from the Electricity Board, NGO/s and GWCCs. The Aquifer Group needs to be constituted with representation of members from the GWCC, regulatory authorities at the taluk and district level, electricity board officials, representative of bore well drilling companies, Groundwater department, NGOs and researchers. The intra-group dispute resolution process should be a 'graduated' process with area groups, micro watershed groups being involved in the initial stages, while the inter-group dispute resolution processes could take place at all levels in the hierarchy of institutions. In the CPR based governance regime, we believe that disputes should be settled within the suggested nested institutional set up and there should be no judicial involvement. If such a judicial involvement does take place, we believe that the strength of the governance regime would weaken in due course.

Conclusion

There should be no rigidity in the institutional structure and there should be flexibility to experiment, learn and innovate with the nested institutional set up adopting the principle of "learning by doing" and "embracing error" (Korten, 1980). We need to remember what David Hume said, 'When men are most sure and arrogant, they are commonly mistaken'. Only by getting our hands dirty in working with the institutional set up's would we learn and evolve better and hopefully more robust institutional arrangements to manage the fugitive resource. Based on the discussion in this paper, Prakasham District in Andhra Pradesh could be a useful starting point for evolving the nested governance structure, building upon the efforts of APWELLs (Andhra Pradesh Groundwater Bore well Irrigation Schemes Project) in the district. A useful contrasting pilot could be undertaken in a semi-arid district in the state and we would suggest Anantpur as a pilot district as this district has seen the implementation of the Water, Households and Rural Livelihoods (WHIRL project) in Kalyandurga mandal which also been one of the 'experiments' to devise groundwater governance mechanisms in the state. Further, there are there a few good NGOs in the district, who could play a crucial supportive role in helping the State, particularly the Rural Development Department, which is piloting an intervention to develop and fine-tune nested governance mechanisms.

Faysee (2005) based on the review of literature on the commons has identified certain areas for future research. The issues/dimensions include (a) The need to base CPR analyses on models using a bounded rationality approach (b) models need to be built with a large number of players and (c) There is a need for quantify in a simple way the benefits of several rules for the different rules for different groups of users within a community as well as the transaction costs. There exists enormous scope to continue such enquiry on Common Pool Resources in India and probably in the South Asian context and more crucially we need to learn first-hand from experiments in the field. This needs to feed-back into the theory (in the tradition of the Institutional Analysis and Development (IAD) mode of enquiry over the past few decades) on the possibilities and limitations of evolving nested governance regimes. The interface and the synergy *or the lack of it* between "indirect" measures which influence individual incentives to extract water vis-à-vis more direct community and group based efforts needs more attention.

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