High use value common resource for equity and sustainability: the experience of groundwater regulation and management from Andhra Pradesh, India

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ABSTRACT
Groundwater has the attributes of extremely high use value common resource with feasibility for private access. In India, groundwater is treated as de facto private property since land and water rights are linked as per Indian Easements Act of 1882, hence often resulting in over exploitation and inequity in its access. The Andhra Pradesh (AP) state with about 900 mm average annual rain fall and 85% of the area underlain by hard rock formations has 143 over-exploited and critical ground water assessment units out of 1229 as per 2008-2009 assessment for groundwater estimation. Groundwater irrigated area crossed 50 per cent of the total irrigated area. Competitive drilling of bore wells at closer spacing led to well interference, failure of functional wells, lowered yields and groundwater over-extraction. Moreover, social equity issues in accessing and utilizing groundwater water became a major concern for the state. The paper discusses the ground water situation in India with special reference to Andhra Pradesh, existing and proposed legal provisions, policy issues, possibility for collective action, experience of implementing various participatory groundwater management practices by the state and NGOs with special focus on comprehensive land development programme with focus on equity issues, and the outcomes arising out of the experience. Information available with the state government, third party evaluation studies and other sources of literature are used for analyzing the relevant details. The paper concludes that as long as water rights are linked to land, sharing and networking of wells through coordinated participatory groundwater management by combining social and formal regulations besides building capacities of farmers is the best option to achieve equity. The paper strongly recommends for revisiting the legal systems also keeping the sustainability and long term implications in view.
Key words: participatory groundwater management, high value common resource, equity, groundwater law, groundwater sharing, groundwater collectivization.

INTRODUCTION

The value of water in alternative uses is important for the rational allocation of water as a scarce resource, whether be regulatory or economic means. Value is related to availability and expected benefit. Where good quality ground water is abundant, it tends to get undervalued. In situations of scarcity, whether due to absence or pollution, the value to the user is much higher and can be linked to economic outcomes of the use. Groundwater has attributes of common resource with greater feasibility for private access and management. In most situations, it is considered as a common property resource (CPR) with extremely high use value (Burke, 1999). Features of groundwater are; relatively unrestricted resource area, technically complex, low drought vulnerability, high cost and significant uncertainty in resource allocation, generally modest development cost, both private and public development for utilization. Groundwater is a considerable (29.9 per cent) component of the total global fresh groundwater. Climate change is likely to lead to a greater dependence on groundwater as a cushion against drought and increasing uncertainty in surface water availability. There is wide spread recognition that water resources, including groundwater, are coming under pressure from increasing demand and declining yields (Owen *et al*., 2010). UN Millennium development goals lay importance on groundwater and Dublin statements and principles stated that; fresh water is finite and vulnerable resource, essential to sustain life, development and the environment, water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels and water has an economic value in all its competing uses and should be recognized as an economic good. An article published in Deccan Chronicle (2013) emphasized about the switch over from private management of water sources to the public in most parts of the world and with the exception of U.K, where privatization has taken place from source to supply since Margaret Thatcher era. Technically speaking, balancing groundwater recharge against abstraction is the main emphasis of management and key risks are climate change variability, water regulation, extraction and interception activities and future groundwater availability is dependent on both the existing stores within aquifers and the level of recharge resulting from rainfall infiltration as per 'Northern Region Sustainable Water Strategy" (DSE, 2009). John Kerr (2007) stated that encouraging collective action is easiest at the micro-watershed level but optimal hydrological management requires working at the macro-watershed level. Watershed development seeks to manage hydrological relationships to optimize the use of natural resources for conservation, productivity, and poverty alleviation. Watershed management discussions might cover two hectares to (White and Runge, 1995) 30 000 ha (World Bank, 2007). Calder *et al*., (2006) refers to "catchment closure", whereby water harvesting upstream concentrates groundwater locally and then intensive pumping exhausts the shallow aquifer. In this case watershed development prevents both surface runoff and groundwater from moving naturally downstream (Batchelor *et al*., 2003). Rhoades (1999) questioned regarding the scope for replicating the participatory approaches widely and the need for better science, better methods, and better organizational skills along with donor money and patience. Govardhan Das and Somasekhara rao (2000) emphasized that sustained participatory use of groundwater resources is definitely an important aspect of drought proofing.

In the above context, this paper attempts to review and analyze; the existing groundwater management practices at policy and implementation levels, and the possibility of bringing in participatory management practices and addressing equity and sustainability issues. Relevant legal provisions, policy issues, possibility for collective action and the status of such attempts so far, are broadly discussed to arrive at an understanding of the existing scenario. Information available with the state government, third party evaluation studies and other sources of literature are used for giving the relevant details.

INDIAN CONTEXT

Classically, India is divided into eight groundwater provinces. India has the dubious distinction of ranking top among 10 countries where 72 per cent of the global groundwater abstraction takes place. UN World Water Development report 2012 states that India's groundwater abstraction is 225 cubic km per year followed by China and USA with 112 cubic km each and Pakistan at 64 cubic km. With surface water supply remaining stagnant, nearly 84 per cent of the total addition to the net irrigated area comes from groundwater (UNwater, 2013). In countries like India, groundwater is treated as de facto private property, though other precious resources like minerals etc., lying beneath the private land are treated as state property. Regulation is the most commonly used instrument for managing groundwater use. Regulation mechanisms include restrictions on digging new wells, well depths and volumes pumped; demarcating groundwater protection zones etc., which are generally enforced by state administrative process (Shah, 2009). The Indian Easement Act of 1882, which mentions about the private property rights over groundwater use, forms the basis for groundwater regulation in India and the persons who own the land own the groundwater and the rights can be transferred along with the ownership of the land (Saleth, 2005). The number of groundwater structures in India is estimated about 23-25 million (World Bank, 2010). The resource has been extracted to a great extent by the big farmers in rural areas for agriculture and horticulture. Hence, it becomes difficult for the small and marginal farmers, especially those from marginalized communities to extract ground water mainly on two counts; one being the prohibitive cost of drilling a bore well with the probability of failure being high, the second one is that the Law is indirectly in favour of those who have already drilled bore wells and it is difficult to drill a new bore well under given circumstances.

ANDHRA PRADESH (AP) SCENARIO

AP has about 85% of the area underlain by hard rock formations (Rama mohan, 2012). The state is divided into 40 drainage basins and 81 sub basins of major and minor rivers. These 81 sub basins are further sub divided into 1229 groundwater assessment units of 100 to 300 sq. km size based on local drainage, geomorphology and hydrogeology. Based on stage of groundwater development, basins or villages are grouped into four categories (Table 1). As per 2008-2009 assessment year for groundwater estimation, there are 94 over exploited (OE) basins and 2123 OE villages besides 49 basins falling in the critical category. Percolation to groundwater bodies is estimated to be 2.2 m ha m (Table 2) and present utilization of groundwater is 1.75 m ha m. Infiltration is proposed to be enhanced from 9 per cent to 15 per cent to augment the available annual groundwater sources. The norm prescribed for declaring a well as successful is 1000 GPH in hard rock areas and 3000 GPH in soft rock areas (GOAP, 2013[1]).

Table 1: Groundwater availability categorization

Stage of Ground Water Development[1]	Depth of Water Table in metres[2]	Category
< = 70%	< 10	Safe
> 70% and < = 90%	10 - 15	Semi - Critical
> 90% and < = 100%	15 - 20	Critical
> 100%	> 20	Over Exploited

Source: Groundwater Estimation Committee Report, 1984, Ministry of Water Resources and APSGWD.

1. *Officially adopted approach 2. Assessment informally being followed*

Table 2: Hydrological details of AP

Normal rainfall per annum	900 mm
Total quantity of water received through rain fall	24.4 m ha m
Surface run off	9.8 m ha m
Percolation to groundwater bodies	2.2 m ha m
Evapo-transpiration	10.0 m ha m
Retained as soil moisture	2.4 m ha m

Ref: Water resources of AP (GOAP, 2003[2])

As per the data published in "*Water and You*" in 2010, the groundwater extraction structures have changed from dug wells to dug-cum-bore wells to bore wells and now, deep bore wells. The yields of the wells have reduced from 150 to 600 LPM to 50 to 150 LPM and 79 per cent of open wells became dysfunctional. The well density increased from five wells per sq. km to 20 wells from sq. km. The data available with APSGWD (2013) shows that the well population in AP increased from 0.8 million to in 1975 to 2.6 million in 2012 and the gross area irrigated through groundwater increased from 1.0 million hectares to 3.6 million hectares. Net and gross area irrigated by wells stood at 49 per cent and 51 per cent of total irrigated areas respectively during 2010-11. The stage of groundwater development has increased from 16 per cent to 45 per cent. Increase in well density coupled with limited connectivity of the wells to water bearing fractures is causing lowering of yields and failure of functional wells, especially during drought years. Seasonal drying of bore wells and failures are not only confined to over-exploited villages but also are widely prevalent. Higher well density and closer spacing lead to well interference as well as over exploitation of groundwater resource in the basin and water is shared among these competing wells. Initial sign of well competition and interference is lowering of yields from some of the wells, which are ill connected and not able to suck water in competition followed by partial or total drying-up of weaker wells, particularly in post winter and summer months when the rainfall is deficit during previous monsoon season. When pump sets run under dry conditions, they get heated up and burnt resulting in a huge financial burden to the farmers.

GROUNDWATER REGULATION

In India, groundwater is treated as de facto private property since land and water rights are linked as per Indian Easements Act of 1882. Government of India introduced a model Groundwater Bill during 1972 constituting a groundwater management agency at the state level, which is responsible for registrations and control of larger groundwater users. The model Groundwater (Control and Regulation) Bill of 1992 proposed a kind of groundwater permits system (GOI, 1992) which was revisited in 1996 and 2005 with few modifications. National Water Policy of 2002 also made certain provisions on control of groundwater extraction. Different states followed different Rules and during the late nineties, AP had enacted groundwater legislation imposing restrictions on groundwater exploitation by making registration of wells and rigging technologies mandatory. However, the doctrine of prior appropriation reinforced the access rights of existing well owners while curtailing new wells to come up in over exploited areas. The Andhra Pradesh Water, Land and Trees Act (APWALTA), 2002 was enacted to check and regulate indiscriminate exploitation of groundwater and soil erosion in the state. The Act provided highest priority to protect drinking water sources and bans sinking of new bore wells within 250 metres distance from the existing drinking water sources without prior permission. There is provision to regulate or prohibit pumping of water from the existing bore wells also if it is found to be adversely affecting any public drinking water source with suitable compensation to the well owner. The Act made it mandatory for the rig owners or operators to obtain license from the licensing authority and follow the rules and regulations for digging bore wells and provides for stringent punishment, including seizure of vehicles for flouting rules. Contamination of groundwater in any manner would attract a punishment of imprisonment of one to six months or fine or both (APWALTA, 2002).

The model draft Bill of Government of India for the protection, conservation, management and regulation of groundwater (GOI, 2011) mentioned about equality and equity saying that every person should have access to groundwater without any discrimination, including as to caste, creed, economic status and importantly land ownership. The state at all levels is the public trustee of groundwater while proposing the local village government as implementing authority for developing aquifer based plans for groundwater conservation and augmentation measures, and socially equitable use and management of groundwater. Constitution of groundwater committees was proposed to examine groundwater related issues including sanctioning permits for extraction of groundwater, violation of provisions in the Act at different levels but vesting more powers with the committee at village level so as to ensure more participation of the local communities in conservation, management and protection of ground water sources. Constitution of a state groundwater advisory council, establishing groundwater information and monitoring system, conducting social audit at village level, offences and penalties and grievances attendance mechanism were some other measures prescribed in the model Bill. Though different states adopted different rules based on the consequent model Bills of GOI, implementation in true spirit had not taken place till the date.

GROUNDWATER MANAGEMENT

Surface water is often managed on participatory basis with strict regulations on but groundwater sharing arrangements have not been that systematic and regulated. However, traditionally there had been some sharing arrangements based on the ownership of the wells. Neighboring small farmers joined together and shared the cost of construction as well as shared water equally among them. Brothers or kin inherited a well from their parents and continued to share water among them. Brothers or kin invested jointly in constructing a well and shared water. Practice of “paying crop for water” was also prevalent. It was also derived that sharing farmers used water more sensibly and efficiently, while farmers having their own individual well tended to exploit ground water to the extent permitted by subsidized power supply. Most of the money spent on drilling came from private money lenders at exorbitant interest rates, farmers were often pushed into irrecoverable debt trap and distress (Rama Mohan, 2012). Participatory approach to groundwater management in India is based on the western United States experience of the management of aquifer by the communities (Villarroya and Aldwell, 1998). Community management implies creation of self-governing water user organizations who take the responsibility of sustainable management of aquifers through collective action (Shah, 2009).

EQUITY ISSUES

Valencia statement, 2004 mentioned that groundwater was being managed privately despite being a common resource leading to inequity and groundwater development required relatively smaller investment and short implementation periods when compared to traditional surface irrigation system. The analysis of the previous watershed programmes revealed that the most vulnerable and marginalized groups often lacked the decision making rights and access to natural resources. Landed sections cornered most of the benefits and landless did not evince much interest in the programme since they got only the wages and the village political system dominated by the rich and powerful always influenced the watershed committee decisions. Further, wherever the government lands were assigned to marginalized sections of the community, and they were not as fertile as the lands of the rich, being mostly confined to the ridge area of the hydrological unit. Even after the land was allotted by the government, the poor farmers lacked finances to invest on that, hence there had been instances where land has been kept fallow for 20 to 50 years. Where the land was under cultivation, the productivity had been very low due to lack of investment in land development, and lack of irrigation besides farmers not being aware about agronomic practices. Since most of these lands do not have access to any surface water irrigation, groundwater is the most high value resource for them. Since, social equity in water management is primarily about people but not water, a loss of economic efficiency is acceptable if it leads to greater equity. The state’s legal and macro-economic policy framework should promote the equitable allocation of benefits as well as the control. Local level institutions should be set up to ensure the effective participation of all interested groups in water related decision making. The initial inequality of different social groups, which leads to different level of benefits and access to benefits, should be recognized and programmes should be designed to overcome it. In some cases this may mean the application of subsidies on behalf of poorer sectors (GOAP 2004). Technical support is required to reduce the productivity gap in weaker sectors, especially agriculture, and minimize trade-offs among equity efficiency and environmental sustainability (GWP, 2012).

GROUNDWATER SHARING PROGRAMMES

Shah (2009) stated that community management implies creation of self-governing water user organizations who take the responsibility of sustainable management of aquifers through collective action. It was noted that big farmers of other communities prefer their own wells which might be due to their investment and risk taking capabilities while sharing practices were accepted easily among SC/ST farmers (World Bank, 2010). The guiding principles for groundwater sharing programmes had been sharing the responsibility and sharing the benefit mandating everyone to act to secure water, to share the risk of reduced water availability caused by climate change and to treat shareholders equitably. The right to a share of the available resources would have to be protected, even if reliability is reduced due to climate change. Informed decision making coupled with adoption of technical strategies for demand side interventions (micro irrigation, crop change, reducing irrigated area, agronomic practices), supply side interventions (water harvesting, soil moisture conservation measures, appropriate recharge enhancement structures) are essential for shift from competition to cooperation among the farmers and showing visible benefits.

AP Groundwater bore well irrigation project (APWELL)

Andhra Pradesh is one of the first states to initiate the joint well programme way back in 1987 (APWELL, 2002). The Netherlands government funded project was launched by the government in seven districts in 1995 with the objectives of participatory groundwater resource management, sustainable agriculture and water utilization, institutional development and capacity building of the stakeholders, and gender integration. Bore well User Associations (BUAs) and Water User Groups (WUGs) were established and facilitated for construction, operation and maintenance of irrigation systems. Groundwater development was taken up where it was feasible. Hydro-geological studies, groundwater prospecting, drilling, yield testing and construction of the distribution systems, and artificial recharge were done in a scientific and participatory way. Importance was given to extension and training, on management of land, soil and water with the facilitation of NGOs. Communities were involved in water budgeting, soil and water quality analysis, hydrological monitoring and evaluation. However, there was no groundwater distress during that period as we could see fifteen years later. But the positive results gave a boost to propose some other such programmes.

Andhra Pradesh Rural Livelihoods Programme (APRLP)

This DFID funded watershed programme primarily focused on livelihoods and equity issues in five districts. Water audit was done for the first time in Anantapur district which revealed that failed bore well investments as a result of groundwater depletion had become an important cause of indebtedness and poverty. It also stated that growing inequity in access to groundwater was also fueling a process of social differentiation which impacted directly on the livelihoods of some groups and contributed to the consolidation of power relations within communities. Reportedly, high bore well costs of latecomers, competitive well deepening and falling groundwater levels linked poverty with groundwater extraction (Rama Mohana Rao *et al.*, 2003).

AP Farmer managed groundwater systems project (APFAGMS)

The programme funded by FAO of United Nations, was implemented through an NGO network, BIRDS, in 2002 involved about 3000 farmers in seven districts in hydrologic data generation, analysis and decision making, particularly on crop water budgeting. Similar to

APWELL programme, this was also limited to new unexploited areas where bore wells were drilled for a group of farmers not having access to groundwater with clear sharing, monitoring and water use efficiency measures. Participatory Hydrological Monitoring (PHM) concept was introduced which imposed faith in people understanding their groundwater system along with the annual changes happening in it for regulation and use by preparing appropriate water use plans within the annual hydrological cycle. Hydrologists with required academic qualifications were engaged to know optimum number of wells that could safely be operated in view of resource availability, local micro-catchment level rainfall-recharge relationship, and changes taking place in local micro-catchments if additional groundwater structures were constructed. This groundwater knowledge was used in creating awareness on resource availability and going for the best mix of crops matching quantity and quality of available resource (Govardhan Das and Somasekhara rao, 2000).

Andhra Pradesh Drought Adaptation Initiatives Project (APDAI)

The World Bank and Japan PHRD Climate Change funded project was implemented in two districts from 2006 to 2009 by the government with the facilitation by an NGO, WASSAN with focus on rain-fed areas and climate change adaptation initiatives (WASSAN, 2013). It had a component on groundwater pooling where the existing bore wells were networked on pilot basis for groundwater collectivization. Water was pooled and used under certain sharing rules laid down by all the farmers in the block by construction of tanks, laying pipelines, placing discharge points at selected places, thus utilizing the water effectively and enhancing the production and productivity of the block (Figure 1).

Malkaipet thanda Groundwater sharing area land use with Bore wells, pipeline and Outlets

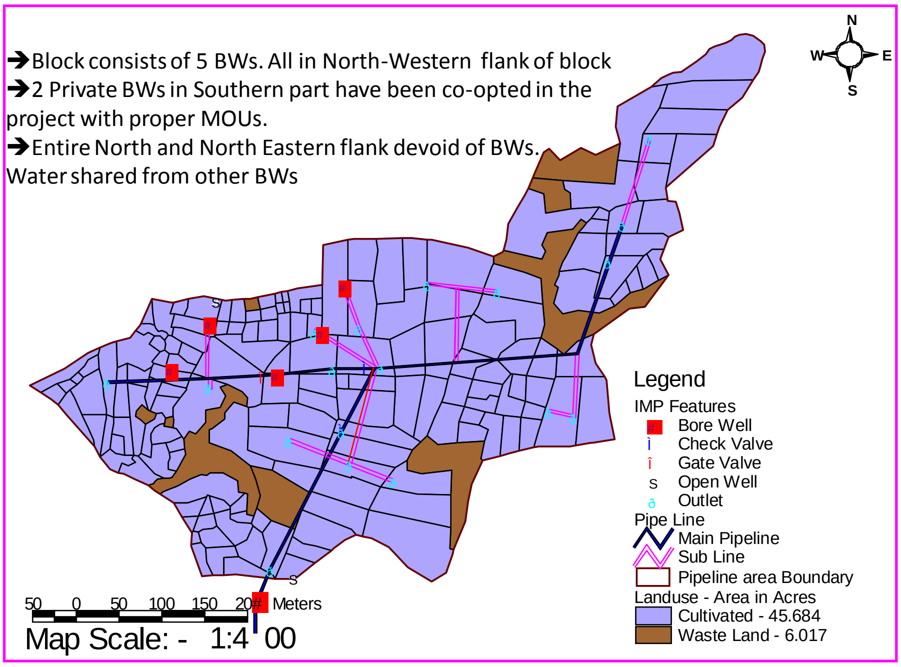

Figure 1: Groundwater collectivization arrangements

Social regulations in water management

This model was implemented in one village by an NGO, CWS and its partners where community resolved for digging no new bore wells and social regulations were adopted in water management for existing bore well owners for sharing water with neighbours and adoption of micro irrigation and suitable agronomic practices. Incentives were offered to farmers of cluster wells to voluntarily close low yielding wells and share groundwater from remaining wells. This was a successful pilot due to intensive monitoring but very limited in its scale.

Comprehensive Land Development Programme (CLDP)

The programme was introduced in 2004 under National Bank for the Agricultural and Rural Development (NABARD) funded Rural Infrastructure Development Fund (RIDF IX) for land development of farmers belonging to poor SC/ST, small and marginal farmers (GOAP, 2004). This was followed by RIDF X, RIDF XIII, RIDF XV and RIDF XVII. Developing irrigation infrastructure by adopting a policy of groundwater pooling started from RIDF X for enhancing the farmers' incomes through improved productivity. Funds for developing lands that had been hither to fallows or lands with low productivity came from Mahatma Gandhi National Rural Employment Guarantee Programme (MGNREGS), which is a massive poverty alleviation programme focusing on providing at least 100 days of wage employment in rural areas. Irrigation infrastructure came from RIDF. Thus, CLDP became a unique programme from 2009 onwards since it looked at the equity issues in groundwater management on a large scale for the first time.

Common Interest Group (CIG)

Farmers were grouped into CIG and land blocks ranging up to 100 hectares with average land holding being less than one hectare on average were established. The CIG members would meet regularly, maintain required records, establish collective group norms and enforcement mechanisms in sharing of resources, and regulating the resource use. CIG would take responsibility for ensuring quality of the works. The records maintained at CIG level are minutes book, asset Register (the list of the names of the land owners, area of land and other resources, survey number etc), and wage register. CIG should coordinate with women self help groups (SHGs)[1] and their networks for establishing savings activities, recommend specific loan proposals to the banks for enhancing livelihoods. The members would share responsibilities in implementation of the plan at individual and collective level and ensure collection of contribution for maintenance of infrastructure established.

Strategic options and planning

CIG with the help of government machinery would decide on the strategic options for development of cultivated and fallow lands through land and water resource management and biomass development. The group would commonly agree on strategic options and established group norms. The individual choices in the action planning process were within these commonly agreed norms which were recorded in a register of the group as common reference point. Experience had shown that intensive investments without proper group control and regulation would not sustain. Maximum emphasis was on food crops as they not only provided food security but also made available crop residues for livestock development. The components typically included soil and moisture conservation, gully control works, removal of scrub vegetation and large stones, diversion drains, drainage line development, water harvesting (especially farm ponds and mini percolation tanks), deep ploughing in fallow lands, compost pits, and bund plantation. Training was imparted on concepts of dry land farming systems and importance of crop-livestock interactions. The gender strategy laid focus on involving women self help groups and their networks to address establishing a balance between men and women in terms of institutional spaces, decision making processes, learning opportunities, and project benefits.

[1] Women Self Help Group (SHG) consists of 10 to 15 members from homogenous socio-economic strata who do savings regularly, rotate the savings at interest rate prescribed by the group, access the bank loan based on assessment of their accounts and records indicating the health of the group and their livelihoods action plans proposed. Here, the group collectivism acts as collateral security for obtaining bank loan. They get networked into Village Organizations (VO) for consolidated action at village level.

Evolving the strategy and scaling up

Government investment was brought into these lands for land development and irrigation besides enhancing the capacities of the farmers on agronomic practices like going for low water consuming species, micro-irrigation, non-pesticide management etc. Several water harvesting structures like percolation tanks and bore well recharge structures were taken up to replenish the groundwater recharge to compensate the extraction. On seeing the positive experiences under the programme, government decided to scale it up to 0.40 million hectares in 2011 for providing irrigation infrastructure to the poor historically marginalized scheduled caste (SC) and scheduled tribe (ST) beneficiaries for developing their lands. Detailed Project Reports were prepared by proposing land development activities under MGNREGS and irrigation infrastructure development under RIDF of NABARD. NABARD sanctioned loan worth $ 80 million in phase I and this was combined with equal amount of MGNREGS fund to cover 0.2 million hectares consisting of fallow lands or lands under subsistence farming. Existing processes were changed to be in tune with the scale of implementation.

Processes

Figure 2 indicates the processes involved in a nut shell and details are given under sub-heads. Participatory resource mapping by using geo-hydro-morphological maps, topo-sheet features interpreted and transferred to cadastral maps, resource inventory, land inventory, bore well yield measurement, erection of display boards, quality control and social audit are important measures in the programme. Geologists conduct yield tests after drilling and arrive at the drawdown and yield based on the yield and depth of bore well for calculating the pump set capacity and pump sets of preferred brands are obtained from standard companies. Proper energy saving mechanisms like installing capacitors are taken up along with providing proper box and key for each pump set. Oil engines are not allowed so as to avoid pollution.

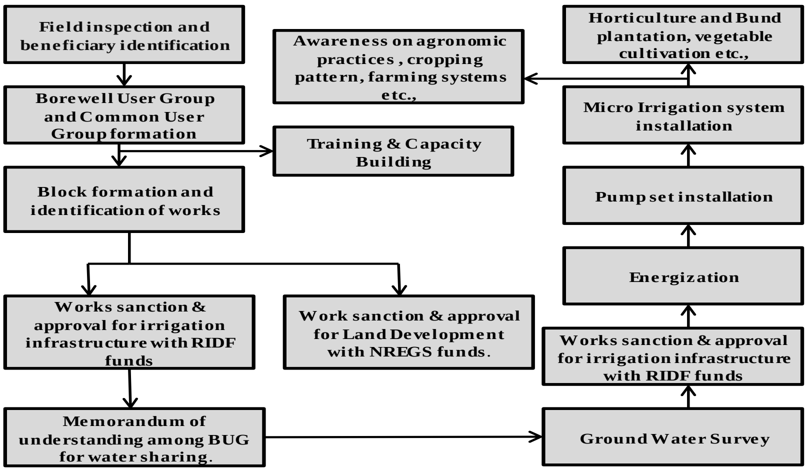

Figure 2: Process flow chart of CLDP

Block formation and group constitution

Each land block is constituted in the range of four to 100 hectares. In case of contiguous land greater than 100 hectares, land is divided into convenient blocks of not more than 100 hectares depending upon the geographical conditions. All beneficiaries in a block constitute Common Interest Group (CIG). Within a block, a group of beneficiaries sharing a bore well source constitute a Bore well User Group (BUG) as seen in Figure 3. Ideally each bug will have four hectares to avoid well interference. Each block or BUG shall have at least two beneficiaries. Each BUG is synonymous with one irrigation source. In case of failed bore wells, the BUGS are regrouped with suitable water sharing agreement. Each BUG has one amongst the members act as a leader of the group. Land development works like boulder removal, bush clearance, land leveling, ploughing etc., are taken up with MGNREGS funds and irrigation infrastructure including drilling of bore well, procuring the pump set and other accessories and energization costs with RIDF funds (GOAP, 2013[1] and GOAP, 2013[2]). A number of geologists are recruited and trained to meet the demand for groundwater survey and quality checks are made mandatory. Water sharing and infrastructure maintenance agreement among BUG members is mandatory. Measures are taken up to share and utilize the water effectively by providing water troughs (Figure 4).

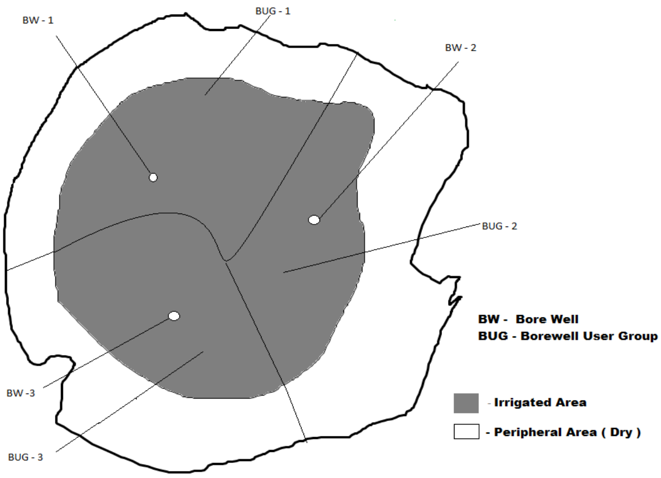

Figure 3: Block covered with 3 borewells (peripheral areas dry)

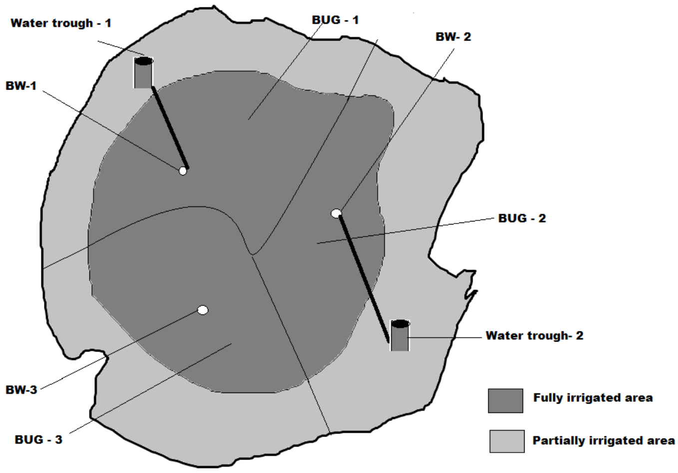

Figure 4: Block covered with 3 borewells (peripheal areas partially covered by storage and supply through water troughs)

Groundwater collectivization

Experience in some parts of the state as seen in APDAI project, has demonstrated that more area can be irrigated through pooling the ground water by linking of bore wells through proper network for equitable distribution of water and assured crop security by providing critical irrigation. Minimum of two bore wells per block are required with a block size of not less than eight hectares giving preference to those blocks in discharge zone. Blocks with area greater than 20 hectares would be split into two blocks. At least one bore well in the network should have sufficient yield which is a minimum of 15 000 LPH. If two bore wells are linked, then the minimum yield of two bore wells has to be 25 000 LPH.

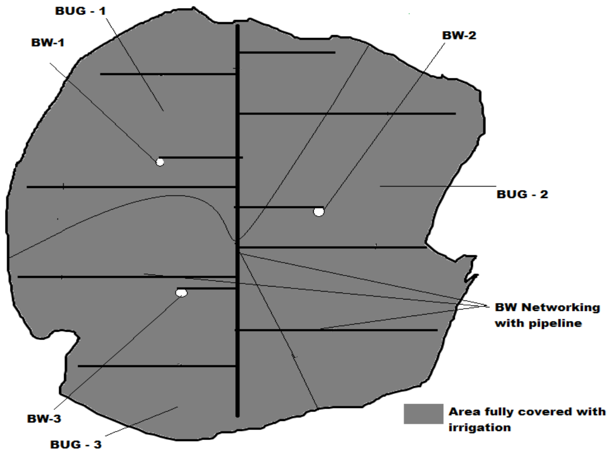

Figure 5: Block covered with 3 borewells (entire block fully covered through bore well networking)

CIGs should contribute ten per cent of the pump set and pipeline cost which would act as maintenance fund to be kept with the CIG. Proper water sharing agreement has to be drafted and minimum area that can be catered for each farmer should be worked out based on the water available in the network. As seen in Figure 5, the networking of the bore wells would be more effective in covering maximum area with life saving irrigation. Groundwater recharge structures are constructed for all feasible bore wells and micro-irrigation practices have to be followed mandatorily. Water should be used only for critical or life saving irrigation and block specific cropping pattern has to be followed by the farmers. This concept is yet to be scaled up in suitable blocks.

Convergence arrangements

Energization is done with the help of Transmission Corporation of Andhra Pradesh (APTRANSCO) and New and Renewable Energy Development Corporation of Andhra Pradesh Ltd (NREDCAP). Micro-irrigation infrastructure like establishing pipelines, nozzles, outlets etc., is done in convergence with Andhra Pradesh Micro-Irrigation Project (APMIP) of Horticulture department. Plant material is brought from the nurseries of the Horticulture and Forest departments (GOAP, 2013[2)].

Agronomic practices

Dry land horticulture and agro-forestry along with other cropping patterns including vegetables are encouraged. As seen in Table 3, sustainable agriculture practices are engaged with suitable cropping models like dry land agriculture and horticulture with micro-irrigation methods, non pesticide farming, adoption of dead furrows etc. Seven tier intensive cropping model in a small plot of 36’×36’ with bulbous root plants, creepers, leafy vegetables, vegetables, trap and border crops, short branches plants and fruit plants became a highly successful model and fetched significant income to the farmers. High water consuming crops like paddy, sugar cane, sweet oranges etc., are totally discouraged.

Table 3: Appropriate agronomic practices to be adopted

Options	Specific details
Increasing the Productive use of water	• Selection of appropriate crops and varieties of good genetic material, high water consuming crops to be discouraged • crop nutrition • weed and pest control • crop diversification, cropping systems, cropping patterns and farming systems • Minimising post-harvest losses
Reducing soil evaporation	• Planting early • Maintaining crop cover and mulching • Micro-irrigation
In-situ soil and moisture conservation	• Contour trenches, contour bunding, staggered trenches, dead furrows

Training and awareness

Knowledge and awareness about agronomic practices and maintenance of irrigation infrastructure are imparted time to time through training at village level and at training centres by involving the BUG and CUG leaders and members. Staff involved in implementing the programme has been receiving orientation and technical trainings as and when needed.

Transparency and accountability

Transaction based software and electronic fund management system were put in place to induce transparency and accountability in the work sanctioning process and fund flow mechanism. Details of the groundwater survey (geologist, survey date, location, GPS coordinates, yield estimates) are taken as input data for estimate generation for drilling. CIG presence with at least two members is mandatory for conducting survey and drilling whose signatures are obtained on measurement book and report sheet. For selecting the pump set also, BUG resolution is mandatory and their preferred brand only has to be considered. Bore well depth, diameter of the well, length of casing, guage of casing have to be entered while generating Fund transfer Order (FTO) for making payment through electronic fund transfer management system to the material supplier or drilling agency.

Monitoring

Social audit mechanism is put in place to monitor land development works and random quality control checks are taken up by technically competent officials for ensuring technical soundness in case of land development as well as irrigation infrastructure at the time of execution as well as post execution. Web reports generated by transaction based software give real time data for effective monitoring and the data is accessible to the public.

Groundwater recharge augmentation

Hanumantha Rao (2002) suggested cost effective mini percolation tanks to be constructed in the dips of first order of streams all along the ridge and sub-ridge boundaries of the watershed since the amount of recharge to groundwater through such mini-ponds will be about ten times more than a check-dam constructed in a valley. Besides construction of groundwater recharge structures like percolation tanks and farm ponds at surface level, bore well recharge structures as seen in Figure 6, are also encouraged to be taken up at suitable places so as to augment the groundwater recharging.

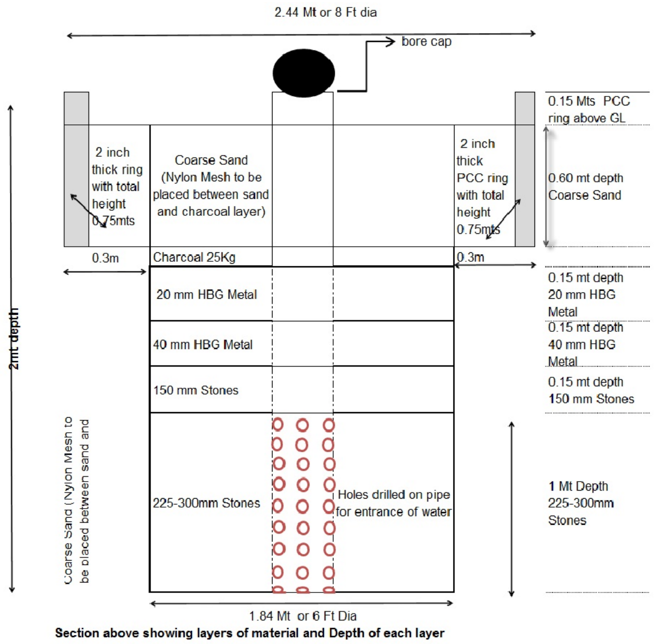

Figure 6: Design of bore well groundwater recharge structure

Current status

Totally 0.18 million hectares land belonging to 0.50 million farmers in 22 rural districts has been covered with land and irrigation infrastructure development under by investing about $ 100 million Women beneficiaries constituted 32 per cent. About 21 352 irrigation sources have been created successfully and the failure rate had been 14 per cent. About 4 356 recharge structures have been constructed so far. RIDF XVII is in brisk progress with groundwater survey done in 0.17 million hectares so far. The water sharing arrangements and maintenance of the infrastructure have been satisfactory though more intense orientation is required for the land owners (in whose land bore well is drilled) and other BUG members so that during times of water shortage, the land owners do not prevail.

Evaluation

Third party evaluation of the CLDP activities was done in 2011 by Sillpro Foundation and the findings were; more than half of assets created were maintained well, cultivated area and vegetative cover in blocks increased and production and productivity levels had gone up tripling the income of farmers. Significant increase in livestock and milk yield were noted. Beneficiaries' role in planning, implementation and maintenance was found to be significant. Land value increased substantially, five to six times to that before the project. 74 per cent beneficiaries underwent various trainings and women represented 47 per cent of the total farmers evaluated. Water was shared equally among 92 per cent blocks while written agreement for water sharing was executed in over 80 per cent blocks and bore wells were maintained well in 82 per cent blocks. Groundwater yield was sufficient for raising two crops in 63 per cent blocks but during water shortage, land owner (in whose land the bore well was drilled) prevailed in 50 per cent blocks. About 40 per cent blocks adopted micro irrigation, however using similar designs for all types of situations was questioned. Convergence with NREGS for land development worked out very well and apparently the programme had become successful in ensuring food, fodder, and nutrition security for the beneficiary households. Most important aspect is the change in perception of groundwater as common asset rather than individual asset among not only the beneficiaries but the neighboring farmers as well.

LEARNINGS

Groundwater sharing process has to be institutionalized by designing appropriate incentives and delivering the same through institutions of local governance. Group based incentives can act as an effective means towards motivating the farmers to cooperate towards coordinated use of groundwater, especially during the times of shortage. Groundwater recharge augmentation measures alone will not lead to rejuvenation of wells but intensive demand reduction and well interference reduction are essentially required. Beneficiary contribution in cash or kind is mandatory for strengthening the collective action besides imparting intensive and time to time training for farmers on water, land and crop management and understanding the groundwater dynamics. Collective action needs time to time monitoring and continuous strengthening of the awareness levels and understanding of the BUGs and CIGs. Policy should also be supportive of the efforts.

RECOMMENDATIONS

Existing water sharing groups need to be supported for revival. Existing groundwater laws should either be amended or strengthened for implementing the regulations in right spirit and delinking the land and water rights should be taken up by the government as long term policy goal. Groundwater pooling, collectivization and sharing under participatory hydrological management should be made applicable to all the farmers, not only to the beneficiaries covered under the groundwater management programmes. Policies and processes in the water sector need to be combined with relevant policies in other sectors like agriculture and poverty alleviation to impact the social equity. Participatory groundwater management should form an important component in ongoing Integrated Watershed Management Programme (IWMP). Documentation of successful collective action in groundwater management and effective dissemination of the information would help in expanding the concepts and strategies for participation of more farmers and their groups. Research studies have to be taken up to know the efficiency of the groundwater recharge structures in replenishing groundwater reserves and also to know whether specific designs are required for specific soils or situations and to develop specific strategies for collective action for groundwater management .

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ABBREVIATIONS

AP	:	Andhra Pradesh
APDAI	:	Andhra Pradesh Drought Adaptation Initiatives Project
APFAGMS	:	Andhra Pradesh Farmer managed Groundwater Systems Project
APMIP	:	Andhra Pradesh Micro-irrigation Project
APRLP	:	Andhra Pradesh Rural Livelihoods Project
APWALTA	:	Andhra Pradesh Water, Land and Trees Act
APWELL	:	AP Groundwater bore well irrigation project
BIRDS	:	Bharat Integrated Rural Development Society
BUA	:	Bore well User Association
BUG	:	Bore well User Group
CBO	:	Community Based Organization
CIG	:	Common Interest Group
CLDP	:	Comprehensive Land Development Programme
CPR	:	Common Property Resources
CWS	:	Centre for World Solidarity
DFID	:	Department for International Development
EFMS	:	Electronic Fund Management System
FAO	:	Food and Agricultural Organization of United Nations
FTO	:	Fund Transfer Order
GOAP	:	Government of Andhra Pradesh
GPH	:	Gallons per Hour
IT	:	Information Technology

IWMP	:	Integrated Watershed Management Programme
LPH	:	Litres per Hour
MB	:	Measurement Book
MGNREGS	:	Mahatma Gandhi National rural Employment Guarantee Programme
MOU	:	Memorandum of Understanding
m.ha.m	:	Million Hectare Metres
NABARD	:	National Bank for Agriculture and Rural Development
NGO	:	Non Governmental Organization
NREDCAP	:	New and Renewable Energy Development Corporation of Andhra Pradesh Ltd.
OE	:	Over Exploited
PHM	:	Participatory Hydrological Management
RIDF	:	Rural Infrastructure Development Fund
SC	:	Scheduled Caste
SERP	:	Society for Elimination of Rural Poverty
SHG	:	Self Help Group
ST	:	Scheduled Tribe
TRANSCO	:	Transmission Corporation of Andhra Pradesh Limited Services and Network
WUG	:	Water User Group