POLICY INTERPLAY AND TRADE OFFS: SOME ISSUES FOR GROUNDWATER POLICY IN INDIA

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Abstract

The paper examines the current status of groundwater, discusses various policy interplays and trade offs and identifies some issues for the effectiveness of groundwater policy. Water policy is influenced by various related policies, such as agricultural policy, land-use policy, energy policy, food policy, price policy, environment policy, credit policy, subsidy policy, etc and its effective implementation on the ground requires the participation of local institutions, like PRIs, farmers' organization, users' groups and civil society organization, apart from the government departments and agencies. Therefore, interfaces, interplays and interlinks of these policies, institutions, and organizations and groups are crucial for better policy formulation. Region-specific policy risks and tradeoffs and tradeoff among the major policy goals—efficiency, sustainability and equity—are also required to be assessed

1. INTRODUCTION

Water is a state subject as per the provision of Indian constitution. However, central government can also assume responsibility in the mater related to regulation and development of inter-state rivers and river valleys. In case of groundwater, the regulatory and controlling power of the central government is minimal. Except for formulating a Model Groundwater (Control and Regulation) Bill, 1970 (recently revised in 2005) for the adoption of the state governments and some regulations under the Environment Protection Act (EPA) and setting up of the central groundwater Board, the development, regulation and management of groundwater is largely in the hand of state governments. It may be relevant to note that groundwater contributes about 60% of net irrigated area in India. It has emerged as the primary democratic water source and poverty alleviation tool in the rural areas (IWMI, 2002). The green revolution in India (especially in Punjab, Haryana and Western Uttar Pradesh) was mainly due to the advent of tube well technology in 1960s, coupled with government efforts towards providing easy access to farm credit, inputs, high yielding seeds and new technology and rural electrification that helped the farmers to energize their irrigation pumpsets. Apart from the state governments' efforts to popularize tube well irrigation through loans and concessions during the green and post-revolution periods, the World Bank also supported huge investment in rural electrification infrastructure to augment groundwater irrigation and raise agricultural productivity (Shah et al., 2004).

Undoubtedly, groundwater irrigation has made significant contribution in the agricultural development of the country. Unlike canal irrigation wherein investment is mainly from the state and access is restricted by the topographic constraints, groundwater is a decentralized and democratic resource, largely developed and managed by the farmers (Kumar, 2003). Its development has been accorded priority on the equity, efficiency, productivity and private investment grounds. However, due to the government policies related to agricultural credit, subsidy, inputs, and energy; and lack of effective regulation of groundwater irrigation in the country, the sustainability of this precious resource has become one of the major issues for the policy makers. Rising population, income growth, industrialization and urbanization have significantly increased the demand for water for domestic and commercial uses, apart from the agricultural uses. The increasing demand for food grains, vegetables, flowers and livestock products will put further pressure on the groundwater demand, thus leading to conflicts and trade offs among different users and stakeholders; and degradation of environmental resources. As

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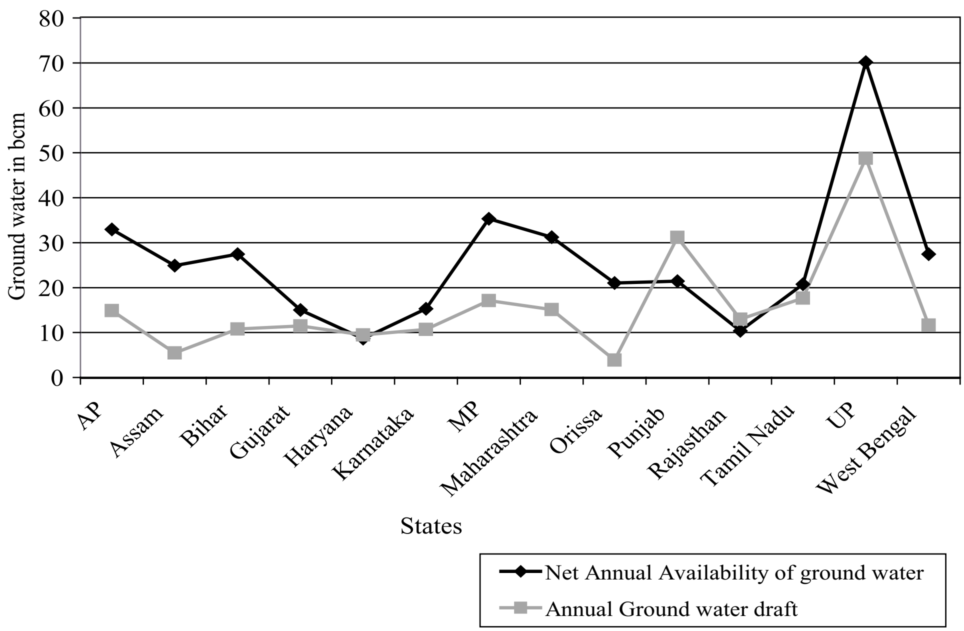
different actors and stakeholders are involved in the development, management and use of groundwater resources, there is need to study various policy interplays and trade offs for identifying some issues for effectiveness of the groundwater policy. Keeping this in the backdrop, this paper is written. The paper is divided into 5 sections. The next section is devoted to the current status of the groundwater in India. This section is written with a view to get some insights into the current status and problems of groundwater in the country. Section 3 deals with the policy interplays and trade off in context of groundwater development and management. In this section, we discuss various conflicts, trade off, policy interfaces and integration. Based on our discussion in this section, we identify some issues for the groundwater policy in the section 4 and then the paper is summed up.

2. STATUS OF GROUNDWATER IN INDIA

As per the report of central groundwater Board "Dynamic Groundwater Resources of India (2004), net annual groundwater availability in the country is 399.25 bcm and total annual draft is 230.62 bcm. This indicates that there is further scope of developing the groundwater resource as only 58% of available water resource is being used for irrigation and other purposes. However, if we look at the regional pattern of groundwater availability and its uses, we observe a significant variation across regions. Some states, such as Punjab, Haryana, Gujarat, Tamil Nadu, Karnataka, Western Uttar Pradesh, Rajasthan, have significant development in the groundwater resource and in some blocks of these states, groundwater is being over-exploited, while in others states, especially located in eastern and north-eastern regions, such as West Bengal, Bihar, Orissa, and Assam, development of groundwater has not yet taken place in a significant way.

Figure 1: State wise Net Annual Availability and Annual Draft of Groundwater (in b cm)



In the absence of well defined water rights and with rapidly growing water markets and wide spread use of modern water extraction technologies, groundwater is being over-exploited in some states, as stated above. Figure 1 shows the state-wise net annual availability of groundwater and annual extraction of groundwater. The figure clearly demonstrates that Punjab, Haryana and Rajasthan extract groundwater more than the net annual availability. The gap between availability and draft is also narrow in Tamil Nadu, Gujarat and Karnataka whereas it is quite wide in Assam, Bihar, Orissa and West Bengal. It is evident from the figure that in some states too much groundwater has been extracted, adversely affecting environment and sustainability of livelihoods of rural households.

Table 1: Status of Groundwater in Major States of India

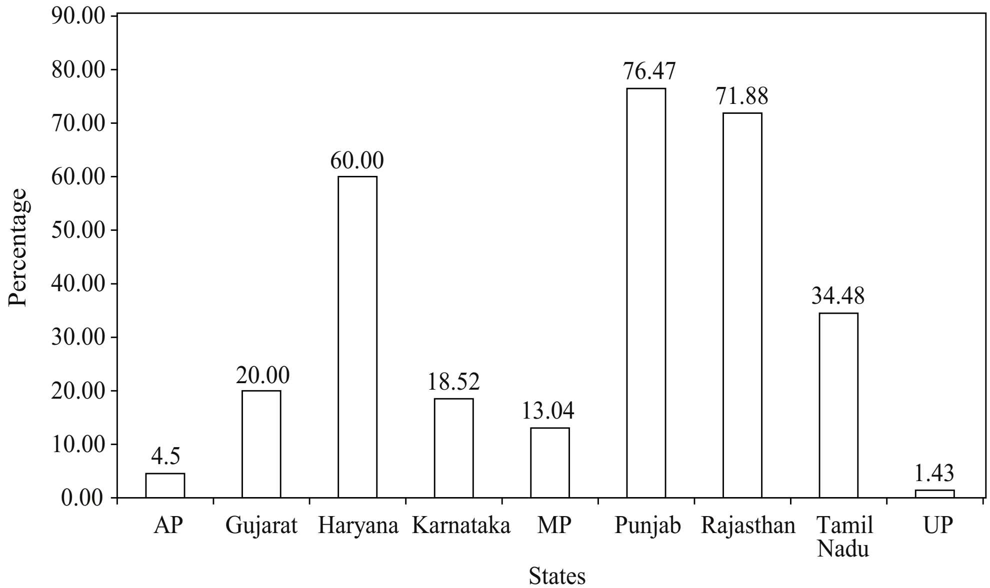
States	Total no. of assessed blocks	Status of groundwater (%)				Stage of GW Dev. (%)	% share of agri in total power	Per capita consump. for agri (Kwh)	Per capita subsidy for agri. (Rs.)
		Safe	Semi-critical	Critical	Over-exploited				
AP	1231	62	14	6	18	45	27.4	172	535
Assam	23	100	0	0	0	22	1.5	2	6
Bihar	515	100	0	0	0	39	16.1	12	74
Chhattisgarh	138	95	5	0	0	20	5.7	29	NA
Gujarat	223	43	31	5	14	76	28.5	272	862
Haryana	113	37	4	10	49	109	28.2	249	908
Jharkhand	208	100	0	0	0	21	1.1	5	NA
Karnataka	175	53	8	2	37	70	28.7	165	482
Kerala	151	67	20	10	3	47	1.5	6	45
MP	312	85	6	2	8	48	20.0	88	528
Maharashtra	318	90	7	0	2	48	12.6	105	326
Orissa	308	98	2	0	0	18	1.1	5	NA
Punjab	137	18	3	4	75	145	19.9	248	928
Rajasthan	237	14	6	21	59	125	14.6	72	393
Tamil Nadu	385	38	15	9	37	85	18.8	147	492
UP	803	83	11	2	5	70	10.9	28	76
Uttarakhand	17	71	18	0	12	66	4.6	36	NA
West Bengal	269	86	14	0	0	42	2.5	9	49
All India	5723	71	10	4	15	58	15.4	53	284

Source: *Compiled from* Dynamic groundwater resources of India (as on March, 2004), Central Groundwater Board, 2006

Table 1 provides the current status of groundwater in major states of India. It is obvious from the table that except for Assam, Bihar, Jharkhand, Orissa, and Chhattisgarh which have almost all assessed blocks in the 'safe zone', in all other states, some blocks are either in semi-critical or critical or over-exploited condition. In arid and semi-arid areas, the increased demand for water is being met by excessive withdrawal of groundwater, leading to its depletion and quality deterioration. The groundwater status in Punjab, Rajasthan, Haryana, Gujarat and Tamil Nadu is quite poor as is apparent from the percentages of safe blocks in these states. The percentage is as low as 14% in Rajasthan and 18% in Punjab. The percentage of over-exploited blocks is found highest in Punjab (75%), followed by Rajasthan (59%), Haryana (49%), Tamil Nadu (37%) and Karnataka (37). In case of critical blocks, Rajasthan stands first by having the highest percentage of such blocks, followed by Haryana and Kerala, while percentage of semi-critical blocks is found highest in Gujarat, followed by Kerala. The percentage of groundwater development in Punjab, Rajasthan and Haryana has crossed the limit of sustainability. Annual withdrawal of groundwater in these states is much higher than the annual recharge, consequently depleting the water table. Thus, pattern of development of groundwater in these states has created a number of sustainability, equity and efficiency concerns.

In order to identify how many districts in each state have more than 100% development of groundwater, we have calculated the percentage of districts with over 100% groundwater development to the total districts. The results are shown in Figure 2. Out of 18 states shown in Table 1, nine states have some districts with over 100% development of groundwater. This shows that apart from Punjab, Haryana and Rajasthan, some other states too have over 100% groundwater development in some districts under their jurisdiction. This is quite obvious from Figure 2. The percentage is highest in Punjab (76.47), followed by Rajasthan (71.88), Haryana (60), Tamil Nadu (34.48) and Gujarat (20).

Figure 2 State-wise % of districts with over 100% ground water development



Availability of cheap/subsidized electricity and flat rate system of power encourage farmers to install more electric operated tube wells. Consequently, the problem of over-exploitation of groundwater occurs as the marginal cost of drawing water from electric operated tube wells is almost zero, providing no incentive to the farmers to make rational use of water. If we look at the per capita consumption of electricity in agriculture, we find that it is closely associated with the percentage of development of groundwater in the states. Punjab, Gujarat, Haryana, Karnataka, Tamil Nadu and Andhra Pradesh have high level of per capita electricity consumption in agriculture whereas it is lowest in Assam, followed by Jharkhand, Orissa, Kerala, West Bengal and Bihar. These are the states where scope for further development of groundwater is high. Per capita subsidy for agriculture also appears to be highly correlated with the percentage of groundwater development. It is found highest in Punjab (Rs.928), followed by Haryana (Rs.908) and Gujarat (Rs.862). Input subsidies that encourage the over-exploitation of groundwater have serious implication on environment.

In order to study up to what extent the per capita power consumption in agriculture explains the variation in the percentage of development of groundwater, we have conducted simple regression analysis, taking the data on these two variables for the 18 states. The F-value (13.37) is found statistically significant at 1% level of significance. The value of R^{-2} shows that 42% variation in the percentage of development of groundwater is explained by the per capita consumption of power in agriculture. The value of slope coefficient is estimated to be 0.261, which is statistically significant at 1% level of significance. This shows that if per capita consumption of power in agriculture in a state increases by 100%, the percentage of development of groundwater would increase by 26%.

State-wise number of electric operated tube wells per 1000 hectares of net sown area (NSA) is also estimated for major states of India to assess whether the over-exploitation of groundwater is related to the intensity of energized tube wells. At all-India level, there are 100 electric tube wells per 1000 ha of NSA. The number of tube wells per 1000 ha of NSA is found highest in Tamil Nadu, followed by Andhra Pradesh, Punjab, Maharashtra, Karnataka and Haryana, while it is lowest in Assam, followed by Orissa, West Bengal and Bihar.

Figure 3: State-wise no. of Electric Tube Wells / 1000 ha of Net Sown Area

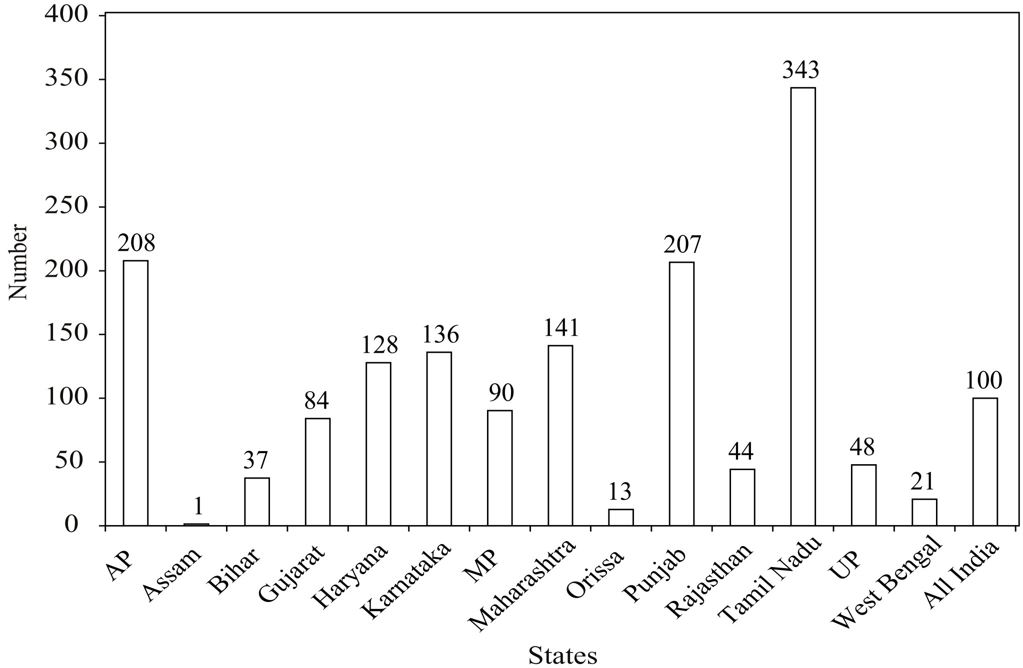


Figure 3 demonstrates that the distribution of electric operated tube wells is not evenly spread across regions. Farmers in eastern and north-eastern states do not have adequate access to the electric operated irrigation pumps whereas their counterparts in Punjab, Haryana and western and southern states have relatively better access to electric operated tube wells. In fact, these are states where sustainability of groundwater irrigation has become questionable. It has been projected that if the number of overexploited 'blocks' continues to grow at the present rate of 5.5% per annum, by 2018 roughly 36% of India's blocks will face serious problems (IWMI, 2002). Over-exploitation of groundwater increases the cost of drawing water and reduces water yields. Rich farmers can afford to deepen their wells and have larger pumps or install submersible wells to draw water while small and marginal farmers, many of whose wells are supported by shallow aquifers, often find it difficult. Therefore, over-exploitation of groundwater makes the accessibility of water to the small and marginal farmers difficult.

It may be pointed out that high intensity of electric-operated tube wells in some part of the country is one of the crucial factors in over-exploitation of groundwater. Other critical issue in this regard is the rapid growth in the number of sallow and deep tube wells experienced during the last one decade. The data shown in Appendix-1 reveal that there has been significant increase in number of tube wells between 1993-94 and 2000-01. Another interesting fact comes to light from the perusal of the data is that on an average, growth of deep tube wells is relatively higher in the water scarce states like Andhra Pradesh, Maharashtra, Karnataka, Rajasthan, Madhya Pradesh, Tamil Nadu, Haryana, and Gujarat, Punjab, where over 75% districts have crossed the sustainable limit of groundwater development, has recorded higher growth in number of deep tube wells than the shallow tube wells. The watertable in the central districts of the state, having 70% of total tube wells, is receding at the rate of 2-2.5% annually. It is estimated that during the next 10 years, practically all the centrifugal pumps will become non-functional and will need to be converted into submergible pumps (GoI, 2006). This clearly shows that the fast depletion of watertable will have detrimental effect on the sustainability of the water resource in the state.

3. POLICY INTERPLAYS AND TRADEOFFS

In the previous section, we have discussed the current status of groundwater in India. Groundwater extraction has increased significantly since the advent of tube well technology. Water being a state subject, the central government has a limited role in its regulation and management. The central government has framed a Model Groundwater (Control and Regulation) in 1970 (revised in 2005). The revised bill proposes, among other things, compulsory registration of bore-well's owners; compulsory permission for sinking a new bore-well; creation of a groundwater regulatory body; and restrictions on the depth of bore-wells. The provisions of the bill have not yet been implemented in many parts of the country. Most of the states have not enacted their groundwater acts in conformity of the central bill. Farmers and local self-government institutions usually do not have access to information about the provisions of the bill and also do not have any stake in the decision-making regarding the control and regulation of groundwater.

National Water Policy, 1987 (revised in 2002), though emphasizes the need to limit groundwater withdrawals, it does not clearly suggest the institutional mechanisms to define and enforce the limit. However, the national policy stresses on the periodical assessment of groundwater potential and regulation of its exploitation, keeping in view the recharge possibilities and social equity; effective prevention of the detrimental environmental consequences of over-exploitation of groundwater; and integrated and coordinated development of surface and groundwater resources and their conjunctive use. It also recognizes the need for a close integration of water use and land policies and a participatory water resource management approach by involving various stakeholders, including the Panchayati Raj Institutions (PRIs). As water policy affects and is being affected by various related policies and programmes, its interface and integration with them is required to avoid overlapping, risks, tradeoffs, and conflicts among various actors and stakeholders and to achieve the policy goals of efficiency, equity and sustainability.

It may be relevant to mention that policy making is a political and economic process. National water policy relates to the declared statements as well as the intended approaches of the central and state governments for water-resource planning, development, allocation, and management (Saleth, 2004). An active participation of stakeholders and end-users of water policy makes the policy more demand-driven and responsive in meeting the intended policy goals. The integration of water policy with land policy and with ecosystem conservation is essential for both environmental sustainability and agricultural productivity.

Water policy is also influenced by various related policies, such as agricultural policy, energy policy, food policy, price policy, environment policy, credit policy, subsidy policy, etc., and its effective implementation on the ground requires the participation of local institutions, like PRIs, farmers' organization, users groups and civil society organization, apart from the government departments and agencies. Effective interfaces and interplays of these policies with the water policy are crucial to assessing the water policy effectiveness. For instance, food policy has interplay with water and other policies. Several policy instruments, such as, subsidized inputs, cheap institutional credit, price supports and subsidized power may be used to achieve food security. As water is one of the crucial inputs in raising the agricultural productivity, these policy instruments would encourage the farmers to install more energized irrigation pump sets to raise the food production, thus adversely affecting the sustainability of groundwater, especially in those regions where public procurement of food grains through Minimum Support Price (MSP) mechanism is relatively high. For instance, FCI procures approximately 95% of wheat from three states: Punjab, Haryana and (Western) Uttar Pradesh and 85-90% of rice from 5 states: Punjab, Andhra Pradesh, Haryana, Uttar Pradesh and Tamil Nadu (World Bank, 2004). In fact, these are the states where problem of over-exploitation of water is quite serious.

The National Environment Policy (NEP) is closely related with the groundwater policy. The central government is empowered to regulate the groundwater on environmental grounds. The NEP suggests, among others, to assess the impacts of electricity tariffs and pricing of diesel on groundwater table; promote efficient water use techniques among farmers; and provide necessary pricing, inputs and extension support to feasible and remunerative alternative crops for efficient water use. However, these policy statements are neither supported by institutional infrastructure and mechanisms nor by enabling legislation or by supporting economic incentive structure (GoI, 2007). Due to lack of effective coordination and interface between the NEP and the water policy, the implementation mechanism of the above stated suggestions have not yet been taken place at the grassroot level. However, judiciary intervention through Public Interest Litigation (PIL) system in controlling over-exploitation of groundwater can be quite effective, as has been recently done by the High Court of Kerala in the landmark “Coca-Cola Case”.

It is pertinent to note that the input subsidy as a policy instrument has become questionable on environment, equity, and efficiency grounds. Irrigation subsidy promotes excessive use of irrigation and creates water logging and soil salinity problems. An existing flat rate power tariff system in most of the states causes depletion in the groundwater table; distorts the cropping pattern; and adversely affects the sustainability of agriculture. It benefits the big farmers more as they have relatively lower unit-cost due to larger size of farm. Price support policy is widely used to achieve multiple policy goals, including price stabilization and income support. However, the price policy also interplays with the groundwater policy. For instance, price incentives for wheat and paddy and high procurement rate of these cereals in Punjab induces farmers to follow water intensive paddy-wheat cropping pattern. Price policy, if properly interfaced with the water policy can be used as an instrument to improve the efficiency, productivity and sustainability of groundwater. As we have seen in the previous section, the development of groundwater in eastern and north-eastern states is still in the nascent stage; through appropriate price policy and an effective public procurement system, these states may be made the major source of rice production and procurement for the country. The 11th Plan also focuses on creating groundwater irrigation potential in these states. Rural electrification under Bharat Nirman would help in installing electric operated tube wells in these states. On the other hand, in Punjab where groundwater exploitation has crossed the sustainability limit, cropping pattern may be shifted from water intensive rice crop to less water consuming crops through attractive price policy support and crop-specific subsidy. It may be noted that the central government policy of MSP is uniformly implemented across regions. In context of efficient management of water resource, region-specific MSP policy may be initiated. In a region where groundwater has depleted due to water intensive crops, farmers can be motivated to shift the cropping pattern through the instrument of price policy.

While formulating a water policy, the formulators should clearly identify the policy risks and trade offs. Water policy making process is very complicated because water resource is not only required for agriculture and livestock but also for domestic and industrial uses, tourism and recreation purposes. Moreover, water policy issues are also linked with issues of other ministries and departments, such as agriculture, environment, energy, food and forest, etc. Therefore, inter-group, inter-sector and inter-ministry conflicts regarding the policy perspectives, goals and strategy are evitable, which are to be managed through building consensus. Further, involvement of different interest groups as actors and stakeholders complicates the process. There may be tradeoff between efficiency and equity, between productivity and environmental protection, between agriculture and non-agriculture uses, and between food security and water security. Tradeoffs arise due to the limited water resource and its competitive uses. Policy risks and conflicts become quite apparent when the draft policy is not widely discussed and debated, involving all interest groups and stakeholders in the process, inviting their responses and building consensus on the issues.

Policy makers may also face the risk of policy failure due to interplays and interaction of other sectors’ policies with the groundwater policy. Policy issues of one ministry/department (say energy) may have an effect on policy issues of the other (say environment). Therefore, if the process of policy formulation does not consider such mutual relationships, intended policy goals may not be completely realized. For example, if objective of the water policy is to develop groundwater irrigation in eastern and north-eastern states, it can be done through providing subsidy to the farmers for installation of tube wells and purchasing of electric pumps. However, if energy policy is such that raises the tariff on power, the policy objective for groundwater irrigation would not be effectively achieved. On the other hand, if in a state, groundwater is over exploited and the water policy is aimed to restrict the farmers to install more bore-wells, the intended policy goal may not be achieved if the state provides cheap credit and subsidized electricity to the farmers. Therefore, region-specific policy risks and trade offs are also required to be examined while making the policy. There is also tradeoff among the major goals of the water policy efficiency, environmental sustainability and equity. For instance, improving efficiency of water allocation may adversely affect non-market public goods or environmental protection may constraint some agricultural activities. These aspects are also required to be taken into consideration while formulating the water policy.

As stated above, two strong groups, politicians and professional experts, are involved in the process of policy formulation. The politicians attempt to fulfill their political agenda while professional experts see rationality of the policy in terms of its economics. As political leaders have more authority and power in the decision-making, politics always remains at the driving seat and economics at the back seat. Bureaucrats and professional experts formulate the policy proposal in such a manner that it satisfies the political aspirations of the political parties in the government. A synergy between professional experts and politicians and convergence in their opinions would help in identifying genuine policy issues and a better process to tackle them and achieving the desired goals. A particular policy options may be beneficial to some stakeholders and may be against the interest of others. This can generate conflict among them. Therefore, their involvement helps in identifying the implications of policy so that the adverse consequences for some stakeholders may be subdued at the policy formulating stage. Therefore, in the policy formulation, possible conflicts and trade-offs need to be identified. To maintain confidence and trust in the process, the trade-offs need to be made transparent through open debate and discussions so that consensus may be built with the active involvement of all stakeholders.

The above discussion clearly indicates that before initiating process of policy formulation, the formulators should clearly examine the interfaces, interplays and interlinks of various policies, institutions, organizations and groups so that their beliefs, perceptions and outlook may be clearly understood and incorporated in the formulation process. The national water policy should also incorporate region and state specific issues in the policy design. This calls for an effective coordination and communication of central government organizations and institutions with the state and local level institutions and organizations. Further, with the spread of education and awareness among masses in the modern democratic system of government, people are better able to articulate their needs and have the confidence to put them forward. In this environment, governments need to consult relevant interest groups if they are to produce the most effective water policy.

4. EMERGING ISSUES FOR THE GROUNDWATER POLICY

Water policy cannot be framed in isolation as it affects and is also affected by other policies related to agricultural development and resource management. We have discussed earlier that percentage of development of groundwater in India varies significantly across regions. Therefore, region-specific policy issues become quite relevant for evolving an effective groundwater policy. It may also be mentioned that the formulation of a suitable policy is necessary but not sufficient for achieving the intended policy goals. The sufficient condition is that the water laws and regulations emanated from that policy be enforced effectively at the ground with the active participation of stakeholders and local self government institutions. Some of the relevant issues related to groundwater policy are summarized in the following points.

1. The government policy to provide easy access to institutional credit encourages farmers to install energized tube wells. Over-exploitation of groundwater in the ‘dark zones’ may be restricted through regulation of institutional credit for this purpose. However, such policy intervention may create inequalities between small and big farmers as resourceful big farmers may finance themselves for installation of tube wells. It has been noticed in western Uttar Pradesh that medium and small farmers, having their own electric pump, use more water per unit of land as compared to the big farmers. It is because of the flat rate of power tariff and lack of existence of formal water market. On the other hand, big farmers have to irrigate relatively large size of farms with the limited availability of hours of electricity and thus make relatively better use of groundwater. Due to non-existence of water market, small and marginal, if they do not have their own tube wells, usually do not get the purchased water in time that compel them to have their own source of groundwater. This may be the reason why these farmers, having only 29% of total operated areas, account for 35% of total electric-operated tube wells (IWMI, June 2002). This shows that over-capitalization in small-scale agriculture and over-exploitation of water goes together. This is not only economically unviable but also environmentally undesirable.

2. Under the flat-tariff system, small and marginal farmers pay more than their big counterparts as unit cost of water per hectare is much higher for them. Therefore, how to make groundwater for them economically viable and environmentally sustainable is one of the major issues for the water policy. In this context, policy intervention for developing an informal institution of 'group farming' for a group of 5-10 small and marginal farmers who can install only one tube well to meet their irrigation water requirement may be a good strategy for achieving efficiency, sustainability and equity.
3. It is necessary to identify types and nature of data and information required for policy making. The information is required not only to assess the existing policy but also to make available necessary feedbacks to the policy formulators. Therefore, information database should be available at block level containing information on rainfall, groundwater recharge and utilization, water demand for different purposes, land use pattern, cropping intensity and cropping pattern, customary water rights, irrigation system and practices, etc. and it should be linked with national level database through MIS in the same manner as is being done in case of National Rural Employment Guarantee Act (NREGA). Access of this database to the policy implementing agency at the grassroots level would help to regulate the groundwater and reduce the environmental consequences of its over-exploitation. It would also help the policy makers to implement region-specific policy to regulate and manage groundwater.
4. Under the 73rd Constitutional Amendment Act, Rural Local Self Government Institutions have been entrusted the responsibility to manage minor irrigation, including groundwater at the village level. The National Water Policy also envisages the role of these institutions in the water resource management. The government should transfer the authority for regulating groundwater use to these institutions at the village level. For this Gram Sabha (GS) has to be made vibrant institution through capacity building measures and developing an in-built accountability mechanism. An active and vibrant GS can effectively involve the beneficiaries and other stakeholders in decision-making related to groundwater development and management. Concerned government departments and civil society organizations can help the GS by disseminating information about the water level, adverse consequences of over-exploitation of groundwater and other aspects related to groundwater economy of the village so that the GS members may be well-informed about the status of groundwater in their village and may take remedial measures to deal with the problems. Kathpalia and Kapoor (2002) suggest that the government should empower local bodies to regulate, manage and development groundwater at the gram sabha level.
5. Groundwater irrigation is largely in the private domain and the farmers bear the entire cost of installing tube well (except for small and marginal farmers who get some subsidy on sinking of bore-well in some states). However, electricity to agricultural sector is highly subsidized, leading to inefficient water use. The subsidized flat rate of power tariff is considered as one of the major reasons for the over-exploitation of groundwater in several states of the country. A rational power supply and pricing policy for pump irrigation could be an effective instrument for groundwater management and energy use. However, political economy aspects must also be taken into consideration while rationalizing the energy policy. Rationalization of prices of electricity and diesel may generate strong opposition of farmers if the canal irrigation rates are not rationalized. The World Bank and several individual researchers have suggested metered tariff for tube wells to solve the problem of groundwater depletion and improve the financial viability of the power sector whereas some researchers (for example, see IMWI, 2003; Shah, et al., 2004 and Shah, 2005) suggest continuing with flat-tariff system with rationalization of existing rates along with intelligent power supply rationing as metering system may lead to high transaction cost and strong farmers opposition. Flat-tariff rate with smaller size of farm per tube well encourages the farmers to over-irrigate the crop and thus increases the groundwater inefficiency. It may be relevant to note that raising the flat-tariff rates may help the SEBs to recover production and distribution costs, but the purpose of improving groundwater efficiency and sustainability will not be served. Moreover, intelligent rationing of power supply may also be opposed by the big farmers, especially in the paddy, wheat and sugarcane growing regions. The viable option seems to be shifting from flat rate to meter-tariff system. However, farmers should be compensated by providing subsidy on procurement of modern water saving

technology, such as, sprinkler and drip irrigation, especially in those regions where water table has significantly gone down due to over-exploitation of groundwater. This would help in improving the water efficiency and raising the agricultural output per unit of water.

6. The issue of the high transaction cost of metering system can be resolved through evolving cost-effective system of billing and collecting water charges. One option could be handing over the responsibility of billing and collection of electricity charges to the Gram Panchayat (GP). The GP should have about 10% share in the revenue collection. This would not only be a source of income for these local bodies but it would also reduce transaction cost and corruption in billing. The problem of tampering of meter, bribing of linemen and over-billing can largely be solved with the active stakeholders' participation through the institution of gram sabha and installing tamper-resistant electronic meters. Since GS represents the entire village community, the collective action of the people in this regard would be more effective.
7. There may be a possibility of failure of GP in discharging its duties of billing and collection of electricity charges, as has been noticed in its other activities, efforts are therefore required to have external intervention in the form of voluntary and civil society organizations to initiate confidence building measures at the village level. The GS and GP should be sensitized to the harmful environmental consequences of over-exploitation of groundwater. Latent social capital of the rural areas should be activated and utilized in groundwater management with active interventions of external agencies. It may be noted that GPs have already been implementing various rural development schemes at the village level, such as, NREGA, Watershed Development Programme. There should be a better synergy between groundwater policy and these programmes. For instance, under the NREGA, GP is the implementing agency of the works related to water conservation and harvesting; drought proofing; micro and minor irrigation works; renovation of traditional water bodies; land development; and flood control and protection, etc. These works also help to restore the environment resource-base and improve the groundwater sustainability through recharging the water table.
8. Both supply side and demand side policy interventions are necessary for the water conservation, development and management. Supply side measures relate to recharging the groundwater table, conjunctive use of surface and groundwater, supply regulation through registration, user's license, rationing of power supply and raising energy prices, while demand-side interventions comprise improvement in irrigation efficiency through using water saving technology and improving irrigation practices, shifting from high water-intensive cropping pattern to low water consuming crops. Integration of water policy with other related policies is required to resolve these issues effectively.
9. Unreliability of power is another issue related to the groundwater withdrawal. Due to erratic and unreliable power supply, farmers pump water whenever power is available regardless of whether crops needs it or not (Narain, 2003). Study made by the World Bank (2001) in Haryana shows that due to erratic and poor quality of power supply, farmers' bear additional cost in terms of unnecessary high-powered electric pumps, alternate back up of diesel pumps and burn out of pumps. The World Bank study finds in case of a representative sample of 584 tube wells with metered electricity connections that these tube wells consume 27% less power than the utilities estimate—and that transmission and distribution losses are therefore correspondingly higher than the utilities claim (47%, compared with the official estimate of 33%). The study further observes that in the short run, small and marginal farmers are more willing to pay for improved reliability of power supply as compared to the medium and large farmers who have their expensive backup arrangements. The groundwater policy makers should also take into consideration these aspects while reforming the policy, apart from focusing on equity, efficiency and sustainability aspects.
10. It has been found that in Gujarat, farmers with metered supply are charged 30-60% more price for water compared to farmers with flat tariff. This restricts water market by raising the cost of hiring water for the adjacent farmers (Shat and Verma, quoted in GoI, 2007). However, it may be noted that since cost of extracting water by diesel pumps is usually higher than that of electric pump, even if tariff raises the cost of purchasing water, it would still be beneficial for the buyers to buy water from electric pump owners. Moreover, flat rate system cannot be justified on the grounds of equity and sustainability. It encourages

the farmers to extract more water for sales to the adjacent farmers in order to earn profit. That approach quite often ignores the environmental consequences of over-exploitation of water because the pump owners attempt to maximize their short run profit rather than assessing the long run effect on groundwater sustainability. Therefore, developing a formal market and regulating water supply through appropriate policy-mix may not only be useful for the water buyers but also for the conservation and protection of the water resource.

11. In the absence of metered-tariff system, the energy consumption and subsidies on it are overestimated (World Bank, 1998 and 2001). In other sectors, data on consumption of electricity are available whereas in agriculture, electricity consumption is estimated by deducting the consumption of all other sector from the total production. Thus, a significant part of transmission losses and power theft is put in the account of agriculture. If meter-tariff system is introduced, actual power consumption and subsidy on it would be much lower than what is being estimated for agriculture. Further, it may also be mentioned that electricity is the only product whose production inventory cannot be maintained. The electricity department usually provides power to farmers at odd times when its demand in domestic and industrial sector is low. Therefore, estimating cost of electricity for agriculture on the basis of average cost and then estimating power subsidy for agriculture is not appropriate; instead electricity prices for irrigation pumping should be on the basis of marginal cost of production. If metered-tariff for irrigation pumping is fixed on the basis of marginal cost, the tariff would be quite low and acceptable to the farmers. This tariff fixation method would help in achieving the water policy goals of efficiency, sustainability and equity.

5. SUMMING UP

Groundwater sustainability in India has become one of the major issues for policy makers. Rising population, income growth, industrialization and urbanization have put more pressure on its demand, leading to conflicts and tradeoffs among different users and stakeholders. Keeping this background, the paper examines the current status of groundwater, discusses various policy interplays and trade offs and identifies some issues for the effectiveness of groundwater policy.

A perusal of regional pattern of groundwater availability and its uses reveals that the states like Punjab, Haryana, Gujarat, Tamil Nadu, Karnataka, Rajasthan, have a high level of development of groundwater. Annual withdrawal in Punjab, Rajasthan and Haryana is much higher than the annual recharge, consequently depleting the water table. Over-exploitation of groundwater increases the cost of drawing water, reduces water yields and detriments the environmental sustainability. While resourceful big farmers can afford to deepen their wells, it becomes difficult for the resource-poor small farmers to continue getting water from their shallow tube wells. Our study shows a significant association between per capita consumption of power in agriculture and level of groundwater development in major Indian states. The results of regression analysis indicate that a one percent point increase in the per capita power consumption tends to increase the level of groundwater development by a 0.26% point.

Water policy is influenced by various related policies, such as agricultural policy, land-use policy, energy policy, food policy, price policy, environment policy, credit policy, subsidy policy, etc., and its effective implementation on the ground requires the participation of local institutions, like PRIs, farmers' organization, users' groups and civil society organization, apart from the government departments and agencies. Therefore, interfaces, interplays and interlinks of these policies, institutions, and organizations and groups are crucial to be studied for better policy formulation. Region-specific policy risks and trade-offs and trade-off among the major policy goals-efficiency, sustainability and equity-are also required to be assessed. A synergy between professional experts and politicians and convergence in their opinions would help in identifying the genuine policy issues and a better process to tackle them and achieving the desired goals. Further, with the spread of education and awareness among masses in the modern democratic system of governance, people are better able to articulate their needs and have the confidence to put them forward. In this environment, state governments need to consult relevant interest groups if they are to produce the most effective water policy.

The paper has also identified several policy issues related to the groundwater regulation, development and management. Prominent among them are: empowering rural local self-government institutions by entrusting authority and responsibility of managing groundwater water resources at the village level; making gram sabha a vibrant institution through capacity building measures and developing an in-built accountability mechanism; creating information database linked with national level database through MIS on the pattern of database of NREGA; shifting from flat-tariff system to meter-tariff system and compensating farmers by providing subsidy on water-saving modern technology, such as, sprinkler and drip irrigation; reducing transaction cost of metering system by handing over the responsibility of billing and collection of electricity charges to the gram panchayat with a 10% revenue share; fixing power tariff on irrigation pump on the basis of marginal cost of power production; dovetailing water policy with other programmes like NREGA and watershed development programme at the GP level; developing an informal institution of group farming among small and marginal farmers; and developing a formal market and regulation of water supply through appropriate policy-mix.

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Appendix-1

Growth of Sallow and Deep Tube Wells in Major States of India
(As per Minor Irrigation Census 2000-01)

State	Sallow Tube wells (Nos)				Deep Tube wells (Nos)			
	Up to 1993-94	Up to 2000-01	Net Increase	Annual Simple Growth Rate	Up to 1993-94	Up to 2000-01	Net Increase	Annual Simple Growth Rate
AP	246770	656359	409589	23.71	32359	87482	55123	24.34
Assam	8654	78664	70010	115.57	610	760	150	3.51
Bihar	280874	651383	370509	18.84	5193	6190	997	2.74
Chhattisgarh	43557	86575	43018	14.11	3177	5227	2050	9.22
Gujarat	31277	53195	21918	10.01	47990	94182	46192	13.75
Haryana	207819	376352	168533	11.59	11703	24339	12636	15.42
Jharkhand	614	1124	510	11.87	22	28	6	3.90
Karnataka	163168	532348	369180	32.32	11	32	21	27.27
Kerala	2005	4680	2675	19.06	79	227	148	26.76
MP	97659	279024	181365	26.53	11023	36398	25375	32.89
Maharashtra	21191	59420	38229	25.77	21401	77223	55822	37.26
Orissa	12439	43881	31442	36.11	3535	4592	1057	4.27
Punjab	808475	1067117	258642	4.57	5921	9990	4069	9.82
Rajasthan	39413	112856	73443	26.62	14381	46764	32383	32.17
Tamil Nadu	107661	151250	43589	5.78	36462	84010	47548	18.63
UP	1571447	3525543	1954096	17.76	27403	35085	7682	4.00
Uttarakhand	33635	52099	18464	7.84	719	883	164	3.26
West Bengal	256545	603667	347122	19.33	4033	5139	1106	3.92