Sustainable Groundwater Management

Action and Implementation Strategies for Uttar Pradesh

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EDITORIAL SUMMARY

The rapid growth in population with widespread extension of irrigated agriculture and industrial development are putting stress on the natural ecosystems. Groundwater is one of the most critical and vulnerable natural resources prone to quality and quantity deteriorations. Sustainability of groundwater resources for utilization by future generations must therefore be a high priority, not only for the purpose of fulfilling needs for water usage but also for bringing people into harmony with their natural environment.

The state of Uttar Pradesh (UP), having a geographical area of 240 million hectare and a population of 166 million inhabitants accounting for 9% of India's total land area, and 17% of its population, is endowed with rich natural resource potential, lies in the fertile Indo-Gangetic plain with high natural soil fertility, abundant rainfall, and surface and groundwater resources. Five major rivers the Ganga, Yamuna, Ramganga, Gomti and Ghagra flow through the State. All the rivers are part of Ganga Basin and ultimately drain into the Bay of Bengal. Physio-graphically, the state is broadly divided into two regions, the southern hills, plateau, and the vast alluvial Gangetic Plains. After the recent bifurcation of UP into two states (UP and Uttaranchal), the state has four major regions viz. Southern UP (Bundelkhand), Western UP, Central UP, Eastern UP. Administratively there are 71 districts in the state. The major part of the State of Uttar Pradesh falls in Indo-Gangetic plain, which is not only known to have vast Groundwater Resource potential but also comprises one of the largest aquifer systems in the world. But, over the last 3 decades, Groundwater Scenario in the state has completely changed, mainly because of indiscriminate exploitation and improper and unscientific management practices both in rural and urban segments, leading to the stage of 'Hydrogeological Stress'.

The fact is that groundwater has attained the position of a 'Democratic Resource' in the State, because it is a dependable and assured resource can be exploited with greater ease and flexibility. Therefore, the resource has gained a vital position in overall water resource development plans and programmes of the State. Around eighties, Uttar Pradesh became the centre of "Irrigation Tube Well Revolution" in the country. It is noteworthy that more than 40% of private minor irrigation tube wells in the country i.e. about 39 lakhs are located in the State, extracting very huge quantity of groundwater. As such, the resource is providing almost 75% irrigation in the State. Besides 80-90% of drinking water and almost all industrial needs in the State are also met by groundwater resulting into its

continuous escalated abstraction and declining water levels, thereby affecting its sustainability in many areas. Whereas, its non- integrated and unplanned use mostly in Canal Commands has led to various geo-environmental problems like waterlogging and soil sodicity. The reported occurrence of Arsenic in groundwater of some districts has also emerged as a new threat on drinking water front. So, due to such alarming situations, groundwater domain of various rural and urban sprawls has reached a critical state, both quantitatively and qualitatively.

The reason for these groundwater problems is poor management. Therefore, effective interventions and suitable groundwater management plans are urgently needed in the state of UP to overcome these critical situations. The imperative need is to initiate, formulate and prepare a long term strategy plan with a sustainable framework for the effective management of groundwater resources in the State.

Following four major groundwater related problems have been identified in the State:

1. Over-exploitation/indiscriminate extraction of groundwater in both the rural and urban areas, resulting into significant decline of groundwater levels, mostly affecting the western U.P.
2. Water logging /shallow and rising water levels and soil sodicity affecting the agricultural productivity in Eastern and Central parts of the State.
3. Contamination/pollution hazards related to groundwater resource are now widely reported from different districts. It is emerging as a major problem.
4. Poor availability as well as relatively poor development of groundwater in Bundelkhand- Vindhyan area.

The impacts of over-abstraction and water-level declines have been reported widely in the state. It is sufficient to note here that over-abstraction can lead to a wide array of social, economic and environmental consequences including:

- critical changes in patterns of groundwater flow to and from adjacent aquifer systems;
- declines in stream base flows, wetlands, etc. with consequent damage to ecosystems and downstream users;
- increased pumping costs and energy usage;
- land subsidence and damage to surface infrastructure;
- reduction in access to water for drinking, irrigation and other uses, particularly for the poor;
- in many arid and semi-arid urban areas, local aquifers are often the water resource of last resort and also the ultimate pollution sink.
- increases in the vulnerability of agriculture (and by implication food security) and other uses to climate change or natural climatic fluctuations as the economically accessible buffer stock of groundwater declines.

While not denying the severity and urgency of the problems facing groundwater management in Uttar Pradesh, there does arise the question as to how broad macro generalizations translate into specific management responses. The problems have to be addressed within the specific contexts of the hydrogeological settings (and particularly the hydrodynamics of the aquifer systems) and the patterns of human use to which they are subjected. Failure to recognize the variability and range of these physical limits (and the range of services that groundwater and aquifers provide), together with the breadth of social demands placed upon aquifer systems, will continue to result in ineffective management responses. In this sense, groundwater management is required to be highly localized, and to a far greater degree than that applied to surface water management.

- The reliance on groundwater has turned to 'dependency' and the establishment of perceptions of access and use that are intensely 'private' irrespective of the legal status of the groundwater.

- However, groundwater and the aquifers that host it are inherently vulnerable to a wide range of human impacts, including the depletion of the all-important shallow aquifers.

- The disposal of human and industrial waste and the percolation of pesticides and herbicides have degraded many aquifers beyond economic remediation.

- The largely unseen nature of groundwater has resulted in development initiatives that are unaware of the hydrodynamic limits of the resource and unable to regulate the resulting patterns of abstraction.

The State Water Resources Agency (SWaRA) established as an Apex Institution in water sector, has taken initiatives to identify and evaluate different groundwater related problems and also finding the possible gaps in resource management process. It has been also discussed at different levels that the findings of various studies and the experiences of various water related departments/organizations should be brought to a common technical platform to identify the priorities for formulating a comprehensive groundwater management policy in the state.

Following key management strategies emerge from the various chapters included in this volume:

(i) Effective management of groundwater is highly dependent on appropriate reliable and up-to-date information. Currently there are several local and regional databases storing information related to aquifer types, depth, quality etc. in a very unsatisfactory manner. An absolutely fundamental need for effective groundwater management and protection is a comprehensive, publicly accessible, groundwater database.

(ii) The planned mining of an aquifer is a strategic management option if the full physical, social and economic implications are understood and accounted for over time. Groundwater mining time-frames should account for both quantity and quality with criteria set for use priorities, and maximum use efficiency, particularly in agriculture; care should be exercised to minimize the detrimental impact to existing communities; consideration should be given to the creation of economical low water consuming activities.

(iii) Hydrogeological constraints need to be defined for both landuse planners and the end users (builders, people, and governments).

(iv) Appropriate guidelines for delineation of protection zones around public groundwater supplies and their management policy is required (We can study the British model of Critical Aquifer Protection Zoning).

(v) Research in the following areas needs immediate funding/greater attention: mapping and modelling of large-scale aquifer systems; the nature and variability and recharge styles; the scale and intensity of groundwater degradation; and techniques for enhancing recharge.

(vi) There appears to be a reluctance to view groundwater resource management from the perspective of the *de facto* regulator, i.e. the individual user with a mechanized pump. This suggests a need to approach groundwater management as a socio-economic issue together with a sound technical perspective. The institutions responsible for managing and regulating groundwater resources need to focus on social mobilization as a priority.

(vii) Effective methodologies for enhancing communication between water specialists, decision-makers and communities to strengthen public participation in groundwater protection should be developed.

Sustainable groundwater management therefore, requires, first of all, deeper understanding of an aquifer's hydrological and environmental properties in order to delineate appropriate eco-hydrological scenarios and recommend corresponding operational management activities. This requires looking at larger management questions, including the development of alternative surface water supplies, reallocation among economic uses of water, and regulatory limits on abstraction based on projected demand. This has to be area-specific. Development of area-specific groundwater management plans requires an understanding of geology, hydrogeological settings, hydrodynamics, environmental water requirements, historical water use practices and local water use, present and future. Understanding of the variability and range of hydrogeological settings and UP's demands on aquifer systems are crucial to effective management practices. Sustainable allocation of groundwater resources will require catchment and aquifer management plans that clearly integrate groundwater and surface water systems. This will require an accurate catchment and aquifer water balance to develop management plans which recognize the long timeframes of aquifer and catchment/landuse interaction. For groundwater to provide a buffer against drought, storages cannot be depleted; allocation must be considerably less than the average annual sustainable yield. Finally, integrated management plans must allow for sufficient environmental flow in groundwater systems to maintain groundwater dependent ecosystems.

The purpose of this book is to establish links between the social and technical aspects of groundwater management against the current scenario of rapid groundwater depletion and aquifer degradation in UP and search for guiding principles and criteria for establishing more sustainable paths to groundwater management through practical actions; and indicate implementation strategies for a better system of groundwater regulation. It also proposes a research agenda to plug gaps in groundwater management. Rather than providing complicated technical solutions, the purpose is to determine principles for policy responses and institutional mechanisms in promoting sustainable groundwater management. The several chapters included in this book bring together experts in the field of groundwater, and explore contemporary issues in groundwater management, and look at it through the multiple lenses of hydrology, economics, participatory management, and the environment. The ideas presented here are not meant to be comprehensive descriptions, but rather focus on key management issues that UP is faced with and is in the process of addressing in the light of current Groundwater Management Bill. The authors discuss generic groundwater management issues particularly the importance of groundwater planning and management, importance of aquifer typologies, participatory processes of groundwater management, groundwater regulation and groundwater linkages with watershed development, markets and policy reforms.

We hope the present volume on sustainable groundwater management provides some concrete strategies for action and implementation in UP.

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Groundwater Management in Uttar Pradesh: Recommendations and Strategies for Action

SWARA Resolution, STATE WATER RESOURCES AGENCY, U.P.

ABSTRACT

The haphazard development of groundwater in the state of U.P. has led to over-exploitation resulting into depletion of groundwater regime and scarcity in resource availability, while due to improper irrigation practices in canal commands, problem of rising water levels and water logging has emerged in some areas of the state, whereas deterioration of groundwater quality is also an issue of concern. Because of such situations, the issues of Groundwater Management and its Governance have come to the forefront. Unless, appropriate groundwater management policy and efficient strategies, (supported by suitable regulation and, economic and administrative systems) are brought into implementation, groundwater related problems will continue to rise in the state. This paper envisages diversified recommendations and suggestions covering almost all the issues related to groundwater management and its governance and focusing, in particular, the future management needs for the state of U.P. As the state is presently facing set of multiple problems, this is the high time that we should now act seriously to manage our stressed resource, both in terms of quality and quantity. The efficient implementation of suggested recommendations and strategies may hopefully change and improve the present groundwater scenario, which is quite alarming. In the background, it is relevant to mention that though groundwater resource has attained a vital position in the overall water-resource development plans and programmes of the state, on the other side, it is also important to mention that groundwater is one of the most neglected, unregulated, indiscriminately exploited and non-conjunctively utilized natural resource in the state.

This paper was prepared by R.S. Sinha, Groundwater Expert, SWARA, UP

- The issue is obviously the poor management of groundwater resources in our state. The diversified groundwater problems viz. depleting aquifers, water level lowering and also groundwater quality concerns, rising water levels vis-a-vis water logging have posed several challenges. And, these are the prime reasons why the issue of groundwater management and its governance has come to the forefront.
- This two-day workshop was primarily organized to identify and evaluate different groundwater related problems and issues in the state, to find the possible gaps in resource management process and to have experiences of various water related departments and organizations in identifying the management priorities, so that concrete recommendations and some useful action plans for managing groundwater resources in U.P. could be suitably documented as "SWaRA Resolution for Groundwater Management in Uttar Pradesh". This document will certainly be helpful in formulating appropriate
  and action-oriented practical groundwater management policies and long-term strategies for the state with effective interventions.

1. THE OBJECTIVE

"Sustainable management of groundwater resource in the state of U.P. should be envisaged through conservation and protection of aquifers ensuring regulated extraction and judicious development of groundwater and minimizing its wastage and controlled utilisation in problem areas of the state by initiating conjunctive use applications and adopting concept of Integrated Water Resources Management (IWRM), wherein, IWRM, an interdisciplinary and multi sectoral concept, is based on perception of water as an integral part of ecosystem, a natural resource and economic good".

> Management Goals for Groundwater resources in the state of U.P. shall be:

- To fix allowable withdrawals based on sustainable use of aquifers for irrigation, domestic and industrial water supplies as well as for the ecological needs.
- To integrate groundwater quantity and quality in decision making.
- Focused attention to overexploited/critical areas (Urban stressed and Rural stressed Areas).
- To practice rainwater harvesting and aquifer recharging.
- To adopt conjunctive use management of surface and groundwater.
- Deepening and rejuvenation of wells and protecting water bodies

2. MAJOR ISSUES DELIBERATED IN THE WORKSHOP

The important groundwater issues and respective management options, discussed and deliberated during the two-day workshop for evolving a sustainable groundwater management mechanism in the state of U.P., are being given as follows-

- Probable strategies for Groundwater Management in U.P.
- Crisis of governance in Groundwater Management of Stressed Urban sprawls.
- Effective management options in Over-exploited/ Groundwater Stressed Rural areas.
- Option of Canals as a major source of recharge for transforming depleted groundwater areas.
- Initiative for Aquifer Mapping and Lithological framework for sustainable development and management of Groundwater Resources in different hydrogeological set-ups of U.P.
- Watershed based approach for Groundwater conservation in Bundelkhand.
- Drinking water supply scenario in U.P and challenges of potable supplies.
- Prospects of promising alternatives for augmenting urban water supplies through periurban aquifers and surface water resources.
- Policy initiatives and interventions required for Conjunctive use management of Surface and Groundwater in Basin Planning.
- Prospects of deep exploration in alluvial plain of Ganga basin in U.P.
- Importance of Integrated Water Resource Management (IWRM) in canal commands by applying Decision Support System.
- Water saving cultivation practices through area specific changes in existing cropping pattern/ crops for Overstressed and Water- logged areas.
- Scope of Sprinkler/Drip irrigation practices in stressed areas, as promising alternatives.
- Initiatives, challenges and scope of Rain Water Harvesting and Groundwater Recharge in U.P.

- Importance of Isotopes in Groundwater Recharge and resource estimation studies.
- Scenario of Groundwater Quality in U.P and emerging trends of groundwater pollution and causes.
- Challenges and options for Groundwater Quality Management in U.P.
- Importance of Water Quality Index and identification of keys for development of Groundwater Quality Framework in U.P.
- Status of surveillance mechanism of Groundwater Quality.
- Social, economic and administrative trends effecting Groundwater Irrigation in U.P.
- Status of legal and institutional framework and related issues for Groundwater Management in U.P.
- Water crisis – and issue of governance and management in U.P.
- Groundwater management practices and different scenarios in industrial sector.
- Productive involvement of Rural and Urban Communities and Role of I.E.C. in Groundwater Management.
- Scientoon (science cartoons)-as a potential communication tool for creating awareness in masses.

3. RECOMMENDATIONS AND STRATEGIES FOR ACTION

The state of Uttar Pradesh, characterized by varied hydrogeological situations, is presently facing diversified groundwater problems, which led to almost imminent threats in certain areas of the state as far as ecological protection of groundwater resource is concerned.

So, the immediate challenge is to effectively manage groundwater resources of the state in a holistic manner. Therefore, co-ordinated efforts of all major groundwater players, both at government and non-government levels, are needed to evolve and initiate a sustainable and comprehensive "Groundwater Resource Management Process" (GWRMP) in the state for understanding the-

- Dynamics of groundwater system under different hydrogeological setup,
- Interaction between groundwater and surface water,
- Quality of groundwater and its environmental effects.

3.1 Groundwater Planning

- As, groundwater can not be treated as an isolated resource and hence, integrated/conjunctive planning for groundwater and surface water resources including the rainfall component is essentially required in the state of U.P. and accordingly separate planning process must be evolved for Eastern, Central, Western and Bundelkhand regions within a definite time frame.

a. The extensive data for groundwater aquifers is an important requisite for the planning and management process and to have **basic understanding of confined (deep) and unconfined aquifers in urban and rural segments.** Therefore, it is significant to carryout detailed aquifer mapping involving hydrogeomorphic mapping and sub-surface lithostratigraphy through well logs and geophysical findings.

b. **Hydrogeological research** and applications are needed to yield information on the concurrence and dynamics of groundwater system as a contributing factor in water resource management.

c. There should be **policy framework for using groundwater from deeper aquifers** after due rethinking and framing economic extraction limits that would not damage the aquifers.

d. There should be specific guidelines for groundwater **withdrawals from urban aquifers**.

e. For sustainable water supply needs, shallow aquifer zones should be separately managed from deeper aquifers in the areas of high exploitation.

f. Trends of over-exploitation of aquifer particularly in western U.P. have been observed, urgent steps are therefore needed **to enhance recharge of aquifers** through rain water harvesting along with measures to promote water use efficiency.

g. **Institutional mechanism** is needed to be developed for effective implementation of conjunctive use management process of surface and groundwater in commands areas as well as in those urban areas where groundwater quality is a problem.

h. **The capacity building** of government and civil society for sustainable development and management of groundwater has become an inescapable necessity. The objective is to enhance and utilize skills and capabilities of people, institutions and various levels to achieve sustainable development through joining of partners.

i. There is need for inter-agency and inter-sectoral **coordination** of groundwater progammes in Uttar Pradesh to take place at various organizational levels.

j. There should be **regular interactions** between state level organisations like Groundwater Department, Minor

Irrigation Department. Agriculture Department, SWaRA, Irrigation Department, U.P. Jal Nigam, Land Development and Water Resources Department, Housing Department, Forest Department, U.P. Pollution Control Board, Remote Sensing Application Centre and Central agencies like Central Groundwater Board, Geological Survey of India, Central Pollution Control Board, Central Water Commission, Indian Institute of Toxicological Research Institute, NABARD, NIH Roorkee, IIT Kanpur and Varanasi, Agriculture and other Universities, and also agencies like UNICEF and Water Aid.

k. Establish priority **"Groundwater Management Areas" (GWMA)**. These are areas that are **experiencing or expected to experience** in near future critical groundwater problems resulting from groundwater under mining, contamination of groundwater reservoir and/or water logging problem due to high water table.

l. Formulation and enforcement of **Groundwater Act** should be the topmost priority to effectively manage and regulate the groundwater resources and control its indiscriminate exploitation in the state. Provisions **to manage groundwater pollution/contaminated aquifers, water-logging and conjunctive use** should also be incorporated in the proposed legal instrument.

m. Every village must be encouraged, and accordingly supported, to make its **Water Security plan** keeping in mind the drinking and domestic water needs of human and livestock population in long-term.

n. Central Government Schemes like NREGA may be utilized to create and sustain water conservation schemes. Such schemes may decentralized, with adequately resourced community participation and ownership, and support in the form of technical assistance from Irrigation Department, Groundwater Department, Minor Irrigation Department and SWaRA.

3.2 River Basin/Watershed Approach for Groundwater Resources Management and Planning:

> **River Basin/Watershed** approach is the need of hour.

> All the groundwater related studies/activities should therefore be initiated basin/water-shed wise in the state.

- There are 07 Major river basins identified in the state of U.P., therefore it is recommended that the assessment, management planning, development, utilisation and conservation processes for groundwater resources, including demarcation of hydrogeological/geomorphic characteristics, alongwith aquifer mapping should essentially be carried out **by adopting river basins/sub-basin approach for Alluvial Region** and **watershed/micro-watershed approach for** hard rock terrain of **Bundelkhand-Vindhyans.**
- IWRM and conjunctive use planning should be the integral part of River Basin Planning.
- For the administrative as well as decision-making purposes, in the river basin/ watershed planning-process, groundwater related informations/GIS layers of district/blocks and urban sprawls should be superimposed within the basin/watershed boundaries.
- For overall planning of River Basins of U.P., **Indian Standard Guidelines** for groundwater component, framed by BIS, March, 1991 should be taken care of.

3.3 Groundwater Resources Budgeting/ Assessment

> In order to have **refinement in the existing methodology**, the recommendations of the **"Report of the Group for suggesting New and Alternate methods of Groundwater Resources Assessment"** October, 2009, and the Protocol, suggested therein should be adopted on priority basis:-

- The state level Groundwater Estimation Committee, headed by Principal Secretary/Secretary, Groundwater Department, Govt. of U.P. with members from CGWB, Groundwater, Irrigation, Agriculture, Minor Irrigation, U.P. Jal Nigam, Command Areas shall take steps to refine the existing methodology with incorporation of useful methods as suggested by the Central Group SWaRA, Housing department and Rural Development department should also be nominated as member in the state level committee for better interaction and inputs.
- As recommended in the report, **Groundwater Resources Assessment Cell in GWD, U.P.** with dedicated manpower should be established on priority basis to take- up the assigned tasks.
- Field Validation of various parameters viz. Specific yield, Base flow, unit draft should essentially be taken-up for realistic estimation.
- Remote Sensing application and Tracer techniques should be incorporated to refine the existing norms of assessment

with better inputs by delineating the Aquifer Recharge Zones and groundwater movement as well as recharge/seepage rate under different conditions.

- Interaction of groundwater and surface water flows within hydrogeologic/basin boundaries should be studied, particularly in canal commands.

> **Initiate Urban Groundwater Assessment**

The GEC-97 norms may quite well be applicable only for the rural-agricultural areas.

- The Horizontal Flow for the urban areas has to be treated differently. Thus, the role of Horizontal Flow in determining the resource may be quite significant.
- All the urban features render the GEC-97 norms unsuitable for computing the Horizontal flow.
- There are 630 Urban local bodies, where groundwater is being extensively exploited for **drinking water supplies and aquifers are being depleted heavily.**

Separate methodology/norms for 'Urban Groundwater Assessment' should be formulated on priority basis.

3.4 Mapping of Aquifer Systems and Aquifer Management:

> Uttar Pradesh is characterized by diversified hydrogeological situations, so **mapping of aquifer systems** is of utmost importance for proper assessment and evaluation of groundwater resources and to **prepare Aquifer Management Plans** for different areas.

> **The extensive data for groundwater aquifers is an important requisite for the planning and management process** including management of groundwater extraction and artificial recharge and also to have basic understanding of aquifer geometry in both rural and urban segments of the state.

It is therefore recommended:

- Detailed 3-D Aquifer Mapping envisaging hydrogeomorphic mapping and sub-surface lithostratigraphy delineated through well-logs/bore-well data and Geophysical methods should be carried out separately for Alluvial and Bundelkhand-Vindhyans, as aquifer geometry differs significantly form area to area, depending upon the local hydrogeological/ geomorphological settings.

*(**3-D Aquifer Mapping** refers to collection and collation of subsurface lithological information in terms of vertical and horizontal extension/disposition and water beaing properties including quality of formation water especially salinity.)*

- As a first step, a **State Inventory** of all available litho-logs, geophysical survey findings, well-logging results etc. should be developed so as to prepare **Micro level Aquifer Maps**/ Aquifer geometry for the planning process.
- For demarcation of **Regional Aquifer System**, aquifer mapping at basin/sub-basin level should be taken – up.
- Gaps related to aquifer data should be identified to generate sub-surface lithostratigraphy coupled with geomorphic data through appropriate methods in a phased manner.
- For managing groundwater resource more judiciously and to formulate a sustainable groundwater development plan, management of Aquifer System based on a proper Hydrogeological frame work has now become an imperative need. Hence, an **Aquifer Management Authority** is required to be established in the state as envisaged in the Action Points identified for State Water Mission.

3.5 Groundwater Management in Stressed/Problem Areas:

- Separate management goals for Stressed rural and urban areas (where groundwater is either being extensively exploited or water levels are continuingly declining) should be framed.
- Mechanism should be evolved to **periodically review groundwater situations in stressed areas.**
- Simple and **usable Groundwater Maps showing critical zones** of water levels decline, over-exploitation within the stressed blocks should be prepared regularly to make the local people, user departments and the administration apprise of the alarming situations.
- In the Shallow Water Level areas, **maps of critically water logged locations** should also be prepared and made available to the concerned departments.
- Scientific studies/monitoring for **water logging/problem of shallow water level,** affecting the agricultural productivity, especially in eastern U.P., should also be given due place in the planning and management process of groundwater resources.
- Sincere efforts are needed to prepare **problem specific Micro- Plans** for stressed blocks of western U.P. and

for stressed urban sprawls of Lucknow, Kanpur, Agra, Ghaziabad and other similar cities.

- More **effective steps** are required for use of sprinkler and drip irrigation (Micro-Irrigation) in stressed groundwater areas.

- Strategy for Lucknow City

- A thoughtful groundwater management strategy, covering all practical aspects, is needed for Lucknow city, which is one of the most highly stressed urban agglomerates of the state.
- Besides initiatives for effective conservation, **withdrawl** from the existing tubewells situated with in the city **should be restrained** and further exploitation should only be done from **potential peri-urban aquifers** in order to give respite to city's heavily depleted aquifers.
- A strong policy initiative with promising alternatives for controlling groundwater withdrawl is urgently required to save and protect the Lucknow's aquifers from further damage.

3.6 Groundwater Conservation:

> For the success of groundwater recharge programme, concept of 'I I I'i.e. **Initiative, Implementation and Impact** is required to be given due recognition as a promising tool for getting fruitful results.

- **Roof top rain water harvesting** should be **promoted only in urban areas.**
- It is advisable that in urban areas **Recharge Pit and Recharge Trench methods** should be mostly taken up **to protect aquifers from pollution. Direct injection/recharge well methods should not be encouraged.**
- For rural areas, area-specific **water spreading methods** and on-farm techniques should be largely promoted with adequate participation of farmers.
- **Direct recharging** of aquifers from open paved/unpaved areas should not be encouraged, because of greater risk of pollution, **as already banned by the state government**.
- There are various government orders and guidelines issued for rain water / roof top rain water harvesting, but the implementation and monitoring mechanism is extremely weak. The **bottlenecks in implementation** of rain water harvesting schemes need to be identified and an enabling legal, institutional, technological and economic framework should be developed and executed by the State Groundwater Department (Nodal Agency). But, for achieving such new task, **the department needs comprehensive strengthening.**
- Guidelines for rain water harvesting issued by state Groundwater department should be strictly followed.
- A regular inspection schedule of these schemes be made by expert, to check if these are not polluting groundwater reservoir.
- Checking of quality of water to be applied for recharging should be ensured.
- To have better results, the recharge/water harvesting structures should be regularly maintained.
- Effective mechanism for **Impact Assessment** of groundwater recharge should be evolved in the state to know the techno- economic benefits of recharge programmes.
- Declining **trend of Rainfall** should be taken into consideration, while preparing area specific recharges plans.
- Appropriate mechanism should be developed to utilize and reuse waste water including primary and secondary treated sewage, domestic grey water and industrial effluent. **In any case these should never be allowed to be discharged in any surface on groundwater body.**
- Effective steps are required to be undertaken to reduce **unaccounted water losses in urban water supply systems**, particularly **in areas where supply is made from groundwater resources**.
- For the **industrial areas**, separate provision are urgently needed for managing and protecting groundwater resources/aquifers.
- A rolling programme of **water audit** for all industries should be initiated with compilation of register of industrial water use.
- All **water intensive industries** using groundwater should be required to install water meters and undertake geo-scientifically recommended groundwater recharge activities.
- The sustainable and socially acceptable cropping pattern for specific area based on the available resource for conjunctive use of surface and groundwater, climate and nature of soil

in the area, be evolved and encouraged by SWaRA and Agriculture department.

SUGGESTED STRATEGIES FOR BUNDELKHAND

- Only Micro-watershed based approach be adopted for recharging instead of fragmented methods of executing schemes.
- Saturate one micro watershed first with small and site specific RWH structure. Objective is to check the high run-off in hard rock areas.
- A study revealed that 3000 Micro catchments of 0.1 Hect. capture 5 times more water than a single catchment of 300 Hect.
- In Bundelkhand, RWH in water shed up to 50 Hect. would yield good results.
- Small rain water harvesting structures should be given priority in Bundelkhand, as this may adequately check excessive run-off and allow more percolation of rain water.

3.7 Conjunctive Use of Surface and Groundwater:

- Sole dependence on groundwater needs to be replaced by conjunctive use of groundwater and surface water.
- Basin, sub-basin-wise surface and groundwater conjunctive use development plans should be prepared by State Water Resources Agency (SWaRA) with stake holder's participation.
- Effective policy decisions with suitable provisions are required to be taken at government level **for effectively implementing conjunctive use plans**.
- Concerned department should be given the responsibility of '**Nodal Agency**' for monitoring the execution of conjunctive use plans.
- Equitable distribution of canal water among all farmers of the command areas should be of utmost priority. Truthfull implementation of canal rosters and regulations is needed.
- Precise measurement, control and monitoring of discharges in main branch distributor and minor canals to keep them in accordance with canal roster/regulation orders is required.
- Strict measures are needed to prevent all illegal water extraction from canal to that authorised water discharges reach to the tail ends of canals. Osrabandi to decide individual share of farmer from the outlet is a must.
- The farmer shall use his canal water share in conjunction with the groundwater for his crops. For better productivity, timely irrigation is a must which can be certainly provided by groundwater. It is necessary to sensitize and educate the water users with the adverse impacts of using more than his share (as per Osrabandi) in canal water vis-a-vis the benefits of conjunctive water use for this purpose.
- For successful implementation of conjunctive use practices, **dual roster for groundwater and surface water use should be** prepared for execution **even at command of minor level.**
- The **DSS model** developed by SWaRA should be applied in canal commands for balanced use of surface and groundwater as well as for sustainability of environment.

➢ Following measures are required for widespread acceptability of the concept among the water users located in different reaches of canal system :-

i. Water Users Associations (WUA) are to be formed on canal systems and should be sensitized and educated for practicing for equitable distribution of canal water as per Osrabandi and use of water from authorised outlets only and promoting conjunctive use of surface and groundwater.

ii. Disadvantages of using more than their share of canal water in the form of soil degradation, loss of nutrients to adjacent fields and poor productivity vis-à-vis the benefits of optimum irrigation at critical stages of plant growth, flowering and maturity of different crops and consequential rise in quality and quantity of the produce and thus additional net income are to be demonstrated through extension activities and field demonstrations.

iii. In order to encourage the conjunctive use, equity in cost of irrigation is necessary. The Government has to consider the upward revision of canal irrigation tariff to bring it at par or more with respect to actual cost of groundwater irrigation through diesel pump sets with the provision of legal actions.

iv. Intensification of community, private tube wells should also be encouraged in upper reaches by providing higher subsidies for community boring and pump sets installation for development of an effective vertical drainage - cum-intensive groundwater irrigation system.

v. Secondly, by way of incentive, power supply to the private tubewells located in head / middle reaches of the canal system should be provided to discourage and illegal canal water extraction in head reaches.

vi. In order to help in mitigating the problem of chronic water locked areas it is recommended to provide financial sup-

port to irrigation through groundwater alone through solar pumps under non conventional energy development programme.

vii. Design projects for stabilising declining groundwater table areas particularly in western and central U.P. through increased Kharif irrigation canals from surface water and rainwater harvesting, and promoting micro irrigation (sprinkler and drip system) in groundwater uses. **In over-exploited district Badaun, such management strategies i.e. construction of large scale kharif channels for increasing extensive recharge** should be taken-up **on priority to De-stress the area.**

3.8 Groundwater Quality

- A review of basic groundwater quality and analytical public health facilities should be taken up at the district level in collaboration with urban local bodies and State Groundwater Department. A pro gram to improve water analysis capability at the district level should be initiated which should have provision for :
  - (i) Monthly, bi-monthly, quarterly, half yearly or yearly monitoring and analysis of groundwater quality for critical areas be worked and implemented through a properly designed monitoring network,
  - (ii) Institutional arrangements and proper coordination for water quality data sharing and development of data retrieval system,
  - (iii) Demarcation of vulnerable groundwater quality zones of whole U.P.
  - (iv) Delineation of safe deeper aquifers underneath the contaminated aquifers and assessing the scope of their tapping,
  - (v) Developing groundwater quality thematic maps in GIS-environments,
  - (vi) Groundwater quality modeling studies to ascertain direction and transport of pollutants in the aquifer system,
  - (vii) Deriving scope to tap top-most shallow aquifer by suitable devices like radial collector wells.
  - (viii) Undertaking large scale mass awareness campaign and social empowerment programme to enhance knowledgebase about groundwater quality/pollution hazards.
  - (ix) Consider setting up of "**Groundwater Citizen Advisory Committee**" particularly with regard to quality and health aspects of groundwater management.
  - (x) Increase surveillance over Nitrate, Pesticides, Arsenic and Fluoride rich groundwater areas.
  - (xi) Study, measurement and disseminate cheap and easy methods to remove injurious iron, fluoride, arsenic, etc. from groundwater at local levels.
  - (xii) Groundwater **abstraction from known polluted aquifers** should **be banned through public notices**.

3.9 Data Collection and Dissemination

- Practically, the state of U.P. in very rich in groundwater data but such data is not available under single umbrella. However, huge data, maps and diversified information on groundwater related to U.P. are available with Groundwater Department, Minor Irrigation, U.P. Jal Nigam, CGWB, Remote Sensing Application Centre, Irrigation (Mechanical), Project Corporation, Housing Department, Pollution Control Board, NIH, IITR Universities, IITs and various institutions, but all such data/informations remain un-utilizied and lying unnoticed in these organisalions due to isolated approach and non-sharing of data and therefore, reliable picture and true scenario of groundwater domain of the state could not be evolved so far, affecting the whole planning process. So, an **effective administrative arrangement** should be in place for development of a **state level Groundwater Data Repository** for analysis, sharing and dissemination for the state's welfare.
  - A useful database for general usage may be developed by State Water Resources Data Analysis Centre (SWaRDAC) for dissemination and sharing, which will include hydro-meteorological, hydrologic, ground water level and its availability, water quality, water user, demographic and social data, while adhering to confidentiality.
  - Adequacy of basic data station networks should be reviewed by SWaRA and Groundwater Department, whether network of rain gauge/ weather station and bore well / tubewell, piezometers is adequate.
  - Instrumentation for data collection throughout the state should be reviewed by SWaRA and State Groundwater Department for reliability, observe resourcing (payment, training and mobility), instrumental efficacy, their protection, timely maintenance and other factors.
  - An inter-departmental interactive **Information Sharing System (ISS)** should be developed by SWaRA. This **ISS shall be integrated with a decision support system (DSS)**.
  - Protocols should be developed for online data sharing on hydro-meteoro-

-logical, surface and groundwater data with water user associations/ groups and intermediate level local institutions , Panchayati Raj In stitutions at block and district level keeping in view Ganga Basin Water Resources Data Security guide line of Government of India. Provision of prompt supply of hard copies on demand at nominal cost should also be made.

3.10 Information, Education and Communication (IEC)

(i) Information, Education, Communication and adequate capacity building about the groundwater management technology must be catered to the urban and rural communities as an integral component of the Water Policy / Act.

(ii) Educate water operators, water stakeholders, rural and urban home owners and institutions regarding groundwater impacts due to various types of landscape amendment practises.

(iii) Industry segment must take it as its obligation to inform, educate and communicate about the impact of the specific industry on the water levels and its impacts on quality of surface and groundwater in the specific area and also that what is the balancing Act being rendered by the particular industry. This particular aspect of the industrial behavior must be an integral section of the water policy / Act.

(iv) Key recommendations/outcomes of all national workshops organized by any water sector/ sub sector should be **compiled by one nodal agency, preferably SWaRA, for planning and allocation of water**.

(v) Government needs to initiate large-scale awareness campaign on water conservation in view of natural variation in hydrologic cycle, example **Drought year etc. to avert situation like Bundelkhand in long run**.

(vi) Communities must also put in their efforts in water conservation at their own levels.

(vii) Long terms stochastic studies for sustainable water use and measure taken to sustain human and cattle / animal life in a healthy status be made for such frequently drought prone areas.

(viii) Adopt scientific methods of bore hole abandonment because they form a vertical contamination pathway, and a potential danger for children/animals failing in these.

(vii) To sensitize the common people and to educate the different users of groundwater about its various invisible geo-scientific aspects, anindependent state level "**Groundwater Training, Research and Management Institute"** on the lines of Rajiv Gandhi National Groundwater Training and Research Institute **should be created established in**

2

Strategies for Ground Water Management in State of Uttar Pradesh

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1. Introduction

Ground Water is a strategic resource due to its high quality and perennial availability. This however lacks sustainability because of declining and rising ground water levels deterioration of water quality. Ground water is recharged locally and its sustainable management is vital. The paper discussed ground water management problems and issues, scientific tools and aquifer-based water conservation and management strategies.

2. Ground Water Resources Management : A Concept

Mnanagement of water resources is concerned with balanced and equitable of water resources. Water resource management has all along focused on assessment of water resources with the objective by meeting water demand without realizing that the water is a finite resource, which is particularly true in the case of ground water. The planning and assessment of water resources is a significant element in integrated water resources management (IWRM) where ground water is concerned as it is a hidden and invisible protion of water cycle. Hydrogeological research and applications are therefore importmant to yield information on the concurrence and dynamics of ground water system as a contributing factor in water resource management.

3. Availability of Ground Water in Uttar Pradesh

a) Ground water Yield Potential of State :

The ground water yield potential of the state by geographic region is briefly outlined below:

i. **Bhabar Zone :** Fringing the foothills, the aquifer are intergranular deposits capable of yielding m3/day by tube wells to a depth of 250m.

Ground water table is deep the maximum being in the range of 80 to 90 meter below land surface.

ii. **Tarai Zone :** The plain in front of bhabar belt has capacity to produce a yield potential by tube wells, of the order of 20-40 lps between depth of 150-300 mts.

iii. **Central Ganga Plain :** The aquifers within 100m depth produce discharge of 10-12 Ips, and those beyond 300 m and upto 450 m are multi layered aquifers with higher yield of 40 Ips and above

iv. **Marginal Alluvial Plain :** This zone provides moderate yield by tube wells to a depth of 100-150 mts.

v. **Bundelkhand Region:** It is an area of relativity low ground water yield potential but sufficient to meet drinking water supply needs.

b) Aquifer Systems of Uttar Pradesh State :

An illustration and description of major types of Aquifer Systems of the State is given below :

i. Regionally Extensive Porous Aquifer :

A sub-surface disposition of multi-layered Alluvial Aquifer System of Rural areas extending over Central Ganga Plain is show in **fig.1.**

ii. Urban Aquifer System :

Though various satellite towns form part of the same Central Ganga plain Aquifer described to above, it needs special mention as separate urban area aquifer system as the development potential and recharge techniques differ from those with rural area quifers. A three dimension (3D) urban aquifer illustration for Lucknow urban area is shown in fig.2. The multi layered aquifer system distinguishable covered with 20 m thick clay layers. First aquifer occur within 100 m depth, the 2nd between 130 and 155 m depth ; the 3rd between 200 to 460 and 4th between 500 & 753 m depth. The aquifer beyond 100 m are semi-confined to confined and yield large quantity of ground water ranges from 1000 to 3000 liters per minutes. The first aquifer is under stress and needs its sustainable yield level to be fixed for longevity of aquifer. Ground Water modeling of urban aquifers, therefore should receive priority over other area aquifer in view of greater use of these for daily drinking water consumption.

a. Dynamic and Static Ground Water Resources of the State

Dynamic Ground Water

The annually replenishable ground water resources is 70.18 BCM and ground water extraction for all types of uses is 48.78 BCM. Out of total 803 blocks is the state, 37 are categorized as overexploited and 13 as critical blocks. The gross ground water draft for irrigation alone has increased by 20.58% between years 1991 and 2004.

Static Ground Water Resources

As per CGWB assessed Static ground water resources in the state are 1780506 for alluvial aquifers to a depth of 450 mts and 29628 MCM for hard rock aquifer within depth of 100 mts. The saline ground water resource of deeper aquifer system is 193949 MCM.

1. Ground water Management issues:

I. Declining ground water level.
II. Brackish ground water in close proximity to fresh ground water.
III. Problem of arsenic and fluoride in ground water
IV. Ground water monitoring network and methods currently is use to monitor ground water level and ground water quality.
V. Policy for planned development and use of deeper ground water resources.
VI. Water pricing.
VII. Water logging and salinity induced by irrigation

2. Basic pre-requisites for Managing Ground Water :

Basic Information

The following information is invariably useful for managing aquifers. Since aquifers are natural units of management of ground water, an aquifer-based gound management is desirable :-

o Aerial extent of aquifer system and ecological information
o Basic understanding of confined (Deep) and unconfined aquifers
o Real time data of water level and water quality of aquifers
o Orientation of contamination enclaves with respect to physical deposition of aquifer.
o Data about location and total annual yield of domestic and public ground water supply wells.

Management Goals

Following goals are to be considered :
? Fix allowable withdrawls based on sustaining the use of aquifer for water supply and ecological needs.
? Integrate ground water quantity and quality in decision making.
? Practice Rain water Harvesting and Aquifer Recharging.
? Adopt conjunctive management of surface and ground water.

3. Elements of Ground Water Resource Management

I Principle of Integrated Water Resources Management (IWRM) :

The process of water resource management (WRM) is of inter-disci-

plinary and multi-sectoral inclusive of private uses. The first step is the WRM in the assessment of supply and demand in which important aspect is forecast of future water uses based on projection. The second step in the process is matching supply and demand though evaluation of different development sceenarious. The third step is the design and implementations which ranges from individual well inventories to large infrastructure like large well fields and operational recharging works. Management, above all, is the operation and maintenance of the ground water supply system.

(ii) Key Elements of Ground Water Resources Management

Dynamics of ground water system as basis for evaluation of different development scenarious and effects of future changes in conditions.

? Interaction between surface and ground water for evaluation of stream depletion volumes consequent upon ground water pumpage.

? Quality of ground water and environmental effects.

? Monitoring of changes in ground water levels and quality in time.

? Feedback on ground water information for planners, decisions makers and water users.

4. Scientific Tool and Methods

Relevant tools and methods with contribute towards better understanding of ground water system and from the very basis for management of ground water resources are briefly as follows:

a) Ground Water Models :

Both ground water flow and quality models are powerful tools in prediction and forcasts of the effects of ground water development schemes.

b) Ground water Monitoring :

It is very essential component of ground water management as it provides data to verify predicted changes in ground water level and ground water quality;

I. Data monitoring includes declines of ground water table in shallow aquifers and ground water head in deeper confined aquifers.

II. Rising of ground water table.

III. Upconing of brackish ground water.

IV. Migration of human influenced pollution.

V. Ground Water information and GIS

The information on ground water has to be presented through Maps, Graphs and Tables with the help of Geographical information System (GIS). Time dependent variables such as ground water level fluctuation and water quality variations be presented through hydrographically as these will benefit and facilitate efforts of data integration and use.

c) Satellite Remote Sensing & GIS:

The high resolution imagery provides comprehensive unbiased information view of a terrain. The GIS tools and techniques and imagery analysis offers strong mapping capabilities for delineating the water bodies, water logged areas, aquifer and data integration. Indices of geomorphology, geological studies and geo-botanical indicies facilitate interpretations and analysis of ground water resources and availability. Interpretations and analysis of ground water resources and availability.

d) Environmental Impact Analysis (EIA) :

The research and integration are reqired to be focused especially on aspects of ground water quality and pollution besides ground water depletion. Both are part of environmental impact analysis package. The efforts should be to select alternatives which integrate adverse effect on environment.

8. Ground Water Resources Sustainability Indicators.

Indicators considered necessary and those provide focus on ground water resource policy and sustainable management of ground water are listed below :

(a) Ground Water Indicators :

Indicatros are based on measured and observed data which provide trends in ground water quantity and quality.

A check-list of 10 important indicators is discussed :

1. Total annual amount of renewable ground water resource per capita in the State/regions.

2. Total ground water Abstraction/Ground Water Recharge.

3. Total ground water abstraction/Exploitable ground water resources (exploitable resource optimum quantity that can be annually extracted from aquifer under socio-economic and ecological conditions).

4. Ground Water as percentage of total use of drinking water on State level.

5. Ground Water Depletion (Regional ground water level decline) Ground Water level decline can be identified in association with high density production tube wells, change of base-flow and change in ground water quality.

6. Total exploitable non-renewable resource/annual abstraction of non-renewable ground water resources.

7. Vulnerability to Ground Water

? Highly vulnerable aquifers shallow aquifers

? Aquifer vulnerable to lateral saline intrusion (e.g. 2nd aquifer in Lucknow)

? Moderately vulnerable aquifer: deep water table aquifer or semi-confined aquifers.

? Low vulnerable aquifers : deep confined non-renewable aquifers (use DRASTIC method for aquifer vulnerability assessment)

8. Ground Water quality indicators :

? To visualize and analyze ground water quality problems in space and time with respect to drinking water standards, agricultural and industrial uses.

? Source contamination problems such as nitrate, arsenic and fluoride.

9. Indicator of Ground Water usability with respect of treatment requirements.

10. Dependence of Agricultural population on ground water.

The integration of above indicators are to provide sustainable use of aquifers as well as improve water resource management policy.

9. State Ground Water Policy :

These State should prepare a Ground Water Development, Management and Regulation policy for which some policy initiatives are outlined below:-

? Implementing public knowledge of ground water connectivity while focusing on IWRM.

? Return from a situation of currently overexploited and over-used system to sustainable levels of extractions.

? Fixing sustainable ground water extraction rates in various designated areas.

? Enhancing ground water recharge to depleting aquifers.

? Capacity building of stakeholders including training of new generation ground water Managers and experts.

I. Suggested Policy Instruments for Ground Water Management :

Since water extraction rights are not very explicit the voluntary actions taken need to be evaluated against economic instruments. The water resources agencies can be made responsible for stabilizing ground water levels, scope and promise for which group of farmers and water resource organization work together. The tax, tradable rights and agreements have positive effects in as much as they are effective and technically as well as economically efficient.

(ii) Ground Water Protection Policy framework

Every state needs to ensure having ground water protection policy with the ultimate aim to achieve the right balance between the needs of environment and those of abstractors of ground water. The improving of public understanding of ground water should be integral part of ground water protection programme and policy. The policy should bring out specific statements with respect to different types of threats to ground water. Such statements could be for the control of ground water abstraction, prevention of pollution and contamination to underground aquifers, all with the purpose of stabilizing the declining ground water table and improving ground water availability and quality.

10. Technical Options in Ground Water Management:

There are wide choices of options but only few and those are pertinent are discussed-

(i) Aquifer Recharging Programme

Trends of over-exploitation of aquifer particularly in western UP have been observed with a view to ensuring sustainability of ground water resources. Urgent steps are needed to enhance recharge of aquifers along with measures to promote water use efficiency. The investment plan for recharging can be supported with help of pooling in the resources available under ongoing programmes of rural and watershed development. The programme of ground water must be stepped up to cover all 800 plus ground water over-exploited and critical blocks of the state.

(ii) Role of Deep and Artesian Aquifers

Evolving framework and policy for using some percentage quantities of deeper/artesian aquifers after due rethinking and firming of economic extraction limits that would not damage the aquifers. The multilayered deeper aquifers in Ganga basin are capable of yielding discharge more than 42 liter per second and are under semi-confined to confined conditions.

(iii) Conjunctive use Management

Implementation of conjunctive use of surface and ground water be mage effective in all canal command areas as well as urban area where ground water quality is a problem. Conjunctive use of surface and ground water will ensure the reach of canal water to the tail ends as well as prevent the water logging conditions. Feasibility studiesin Sai-Gomti Doab of Sarda Sahayak canal command had been worked out suggesting the implementation of conjunctive use plan will reduce the water logged area from 52% to 27%.

(iv) Designing of River-bed and River-bank filtration system:

There is dire need to set up surface and ground water interaction studies to establishing the effects of ground water pumpage from river side aquifers on stream-volume depletion as well as the aspect of induced recharge on aquifer. The quantification of ground water and surface water in riparian system is there fore recommendable. Such studies would help designing the ``Bed-mounted'' and `On-shore' infiltration galleries. Industries and completely water dependent plants where water requirements are being met from streams should be directed to adopt such practices. One example of the utilizing stream-aquifer interaction for meeting the water requirement by power plant in Shahjahanpur District, Where Reliance have put infiltration galleries on river bed in about a kilometer long portion of river bed feeding the water to Ranny well for development of ground water.

(v) Participatory ground water management

Large number of population depends on ground water for daily water supply needs. Agriculture economy also depends on ground water. Falling ground water level and deteriorating water quality is already paying price. In this context the participatory ground water management has definite role to address issues. Training kit material and modules can be prepared to educate stakeholders.

Capacity Building of water stakeholders :

The development of capacity of government and civil society for sustainable development and management of groundwater has become an inescapable necessity. The objective is to nurture, enhance and utilize skills and capabilities of people, institutions and various levels to achieve sustainable development through joining of partners. The over-arching objective is building for

integraged water resource management.

(vi) Inter-sectoral and inter-agency Coordination :
There is need for interagency and inter-sectoral coordination of ground water programmes to take place at various organizational levels. Both formal and informal networks should exist to coordinate activities and share information. For doing this establishing of committees for coordinating ground water efforts related to research, resource assessment, information exchange, data dissemination, technology demonstration, technical assistance, training and education is foremost need. The membership of committees could be drawn from departments of agriculture, pollution board, Central Ground Water Board, Central Water commission, Departments of rural development etc.

The purpose of such committees is to increase overall effectiveness and productivity of research and information effects related to ground water by assisting the local administration in setting priorities and evaluating alternative course of actions.

Following standing committee can be set up:
1. Hydrology Sub-Committee : for coordinating and standardizing hydrological and hydro-meteorological data.
2. Water data & Information Exchange for State level/Regional level water data exchange.
3. Sub-committee on Ground water : Identification and dissemination of ground water information and analysis, standardization of ground water data collection methods and facilitating use of ground water data by State and local agencies.
4. Sub-Committee for water use information.
5. Sub-Committee a water quality.
6. A committee on Ground Water Modeling Assessment to recommend guidelines concerning how models be developed and applied in ground water management process.

(vii) Trans-Boundary Aquifer Assessment:
Managing Trans-Boundary aquifer is relatively a new field in the harmonious and peaceful development and management of shared aquifers. The state of Uttar Pradesh share aquifer with neighboring state of Nepal, the latter having upper riparian aquifer status. The management of such aquifers if governed by the law of trans-boundary aquifers. The law makes its obligations for shared aquifer states to prevent aquifer from any harm, and share data on regular basis.

11. RECOMMENDATION

Ground Water Management Strategies needed to ensure sustainability of ground water development are (i) ground water assessment (ii) Monitoring and regulation. Salient recommendable are given as follows:

1. Ground water Management leading to protection of resource be taken up in defined geographic regions disinated as ``Stress Aquifers.”
2. Evolve a State Ground Water policy and address issues of ground water protection through preparation of well structured district level ``Aquifer Management Plans.''
3. Target case studies on:
1. ground water development failures
2. Socio-economic & cultural impacts of over extraction of ground water
3. Assessment of trans boundary aquifers
4. Monitor impacts due to agricultural, industrial and urban ground water pollution
5. Necessity of ``Borehole Abundant Ordinace'' to safeguard against human risk and risk due to contamination framed and promulgated.
6. Do reclamation of water logged areas projects.
7. Socialization of responses to diminishing & Deteriorating ground water quality.
8. Assess flodd water recharge system.
4. Establish appropriate framework & defice priorities to the
I. Establishment of Data bases
II. Monitoring Networks & data collection
III. Strengthen institutional capability
IV. Strengthen Resource & Development Programme.
5. Establish priority ``Ground Water Management Areas'' (GWMA) and ``Ground Water Conservation Districts'' (GWCD). These are areas that are experiencing or expected to experience in next 2 to 3 decades critical ground water problems including shortage of surface or ground water resulting from ground water over-use and contamination of ground water supplies.
6. Programme areas suggested for developing needs for fresh water sustainable development includes:
? Integrated development and management of water resources
? Periodic water resource assessment
? Protection of water resources, water quality
? Water conservation and augmentation for sustainable urban development
? Impacts of climatic change on water resources.
7. Set up Interagency Working Group on ground water management to focus efforts on operational programmes.
8. Set up international Cooperation Division to Seek technical and funding assistance of international agencies. FAO, WB, UNESCO have special country strategy programme including investment in ground water. These

can be provide specific directives on ground water remediation and augmentation measures.

9. Consider setting up of ``Ground Water Citizen Advisory Committee'' particularly with regard to Health aspects of ground water management. Increase surveillance over nitrate, pesticides, Arsenic and fluoride rich ground water areas.

10. Educate water operators, water stakeholders rural and urban home owners and institutions regarding ground water impacts from landscape practices.

11. Evolve policy to use deeper ground water resource based upon concept of ``Usable Ground Water Storage'', which is present in enormous quantity in Central Ganga Basin of the State. Developing usable ground water storage to a depth of 300 m would be good measure.

12. Management strategy components are considered essential and these includes:

? Designating ground water management areas and defining target sustainable water yields.

? Establishing ground water conservation districts and Aquifer Management committees.

? Institutional strengthening

? Programme to address/prevent ground water pollution and contamination to aquifers.

? Provide Community Education.

3

Groundwater Management in Uttar Pradesh: Present Scenario and Emerging Challenges

R. S. Sinha

ABSTRACT

Groundwater resource is a distinguished and vital hidden component of the hydrologic cycle and therefore scientific approach is needed for its comprehensive understanding. Leonardo de Vinci has rightly envisioned this *invisible natural resource* as ***"The greatest river of the earth flows underground"***, which signifies the magnitude of groundwater resource and its availability as well as the importance the planners must envisage for its sustainable development and protection of stressed aquifers. But, the major challenge is the proper understanding of the dynamics of groundwater flow under different hydrogeological conditions both in space and time, with a view to manage the resource more sustainably for maintaining the future water supplies and also the demands of agriculture, domestic and industry sectors. Therefore, the issues of groundwater management and its governance have come to the forefront.

In Uttar Pradesh, groundwater, being a dynamic, more dependable and assured natural resource which can be exploited with ease and greater flexibility, has attained a vital position in overall water resource development plans and programmes of the state, but in the process of unregulated abstraction and development, the increasing groundwater crisis has become an issue of management concern. The groundwater scenario in the state has significantly changed over the last three decades and various critical situations have also emerged related to groundwater quality and quantity. With the mindset that the state of U.P., extending largely over the Ganga basin, is endowed with richest repository of groundwater resource and also comprising the largest aquifer systems in the world, the resource has been indiscriminately exploited in both urban and rural segments without thinking that this may have adverse impact on the sustainability of the resource. The impact is that a glaring imbalance between 'recharge' and 'discharge' of groundwater has occurred within the shallow dynamic zone,

causing widespread depletion of aquifers and also the quality deterioration in various parts of the state. In urban areas like Lucknow and Kanpur, the uncontrolled exploitation of groundwater over the last 20 years has heavily depleted the urban aquifers, almost reaching to an irreversible stage. The situation has already reached to a critical and alarming stage in various parts of the State both in rural and urban segments.

Although, the contribution of this resource in various water sectors of the state can not be overlooked for providing 75% of the irrigation supplies, 80-90% of the drinking water and almost all the industrial needs. But, in spite of ever-growing importance of groundwater resource, the regulatory and management requirements for protecting and conserving this valuable resource in the state have not yet been suitably recognized and also have not been given a serious thought so far. This may be the reason that despite being most sought after resource, groundwater is perhaps the most neglected, poorly understood, poorly managed unregulated and over-exploited natural resource in the state.

As the state is witnessing various groundwater related problems viz. depletion of groundwater reservoirs in both urban and rural areas, sub-surface water logging and rising groundwater levels, groundwater pollution and related quality problem and groundwater induced land-subsidence, the apparent crisis is more of management than of actual resource availability/ scarcity. A scientific development and management of groundwater for the state of U.P. is, therefore, the need of the time to avert any future crisis. Besides, the management strategies should also cover other aspects such as ownership of groundwater, allocation and pricing of resources, data collection and storage, effective regulation and role of stakeholders. As groundwater is likely to become a critically scarce resource in certain regions of the state, particularly the urban sprawls, the imperative need is to evolve a comprehensive scientific policy for effective groundwater management in the state, in order to ensure long term sustainability of this resource, which is gradually becoming stressed both qualitatively and quantitatively.

1. GROUNDWATER RESOURCE SCENARIO IN U.P. / CRITICAL SITUATIONS

Uttar Pradesh is always considered a potentially productive state, as the largest 'groundwater Reservoir' is said to be occurring beneath the Gangetic Alluvial Plain constituting the major part of the state, but on one side, due to uncontrolled extraction and excessive use of groundwater, particularly in irrigation, drinking and industrial sectors, critical situations like declining water levels are now largely affecting even the water rich alluvial region of the state, while in canal command areas, improper management of water resources has resulted into various geo-environmental problems like sub-surface water-logging and salt encrustation rendering vast area unproductive for crops. Further, reported occurrence of poor quality of groundwater in different parts of the state has also become an emerging threat for potable water supplies. Western U.P. is mostly affected with depleted aquifers and lowering of groundwater level, while in Eastern U.P., shallow water level/water logged condition are dominating. Contrary to this, lack of understanding of rainfall conservation and watershed management in Bundelkhand – Vindhyan has led to severe scarcity of groundwater resources.

1.1 An Overview

(a) Diverse Setup: The state of U.P., predominantly covered with Gangetic alluvium, is characterized by varied hydrogeological formations, ranging in geological age from Archean to Recent that have resulted from diversified geological, climatologically and topographic setups. These formations, along with space-time variable annual water cycle, govern groundwater repositories in respective river basins of the state. The major portion of the state is covered by Ganga basin, comprising Yamuna, Ramganga, Gomti, Ghaghra, Gandak and Son sub basins, including rocky terrain of Bundelkhand. The mountain chain of the Himalayas in the north with high run-off plays an important role in passive recharging the vast Ganga basin.

Due to diverse hydrogeolocial and geomorphological setups, spatial and temporal distributions of groundwater availability are non-uniform and range from plenty in alluvial plain to scarce in Bundelkhand. The state can be broadly divided in four major hydrogeological units, characterized by different groundwater conditions, namely Terai zone, Central Ganga Alluvial Plain, Marginal Alluvial plain and Southern Peninsular zone. The small parts of Bijnor and Saharanpur districts fall in Bhabhar zone, which extends south of mountainous range of Himalayas. The alluvial formations comprise Multi-aquifer system, explored down to 600m., promises excessive and productive groundwater resources. The peninsular shield comprises discontinuous aquifers of limited potential in weathered and fissured sediments.

(b) Depth to Groundwater Levels: The depth to groundwater levels also varies widely in different regions of the state, depending upon the variations in aquifer setups and hydrogeological conditions. The general trend of groundwater level is observed from 02 meters below ground level (mbgl) to as deep as 30 mbgl. The wide variation in groundwater level prevails all across the state. In the canal commands, shallow water levels of less than 02 mbgl are reported, where as the deeper water levels of more than 20 to 30 mbgl are observed in ravenous tract along Yamuna river and also in the over-exploited Lucknow, Kanpur cities.

(c) Resource Availability: Rainfall and recharge from other sources replenishes groundwater every year, wherein rainfall is the main source of

recharge to groundwater storage. Most of groundwater development is taken up from the dynamic zone of water level fluctuation in the unconfined aquifers, where normally active recharge takes place. In this active recharge zone, the blockwise annually replenishable groundwater resource for U.P., as estimated by State Groundwater Department, based on 31 March, 2004 data applying the norms of Groundwater Estimation Committee-1997(GEL-97), reveal the average stage of groundwater development as 69.5% with net groundwater recharge of 7.01 million hectare metre (mham) and gross annual groundwater draft/withdrawal of 4.88 mham.

As a practice under GEC-97 recommendations, groundwater estimation is normally taken-up every 4th year. Based on these estimations, , the stage of groundwater development in the state was estimated as 53.32% in the year2000,while in year 2004, it was estimated as 69.51%. The estimation for the year 2008 (data unpublished, as report is under consideration of Government of India for approval) shows the development stage reaching to 71%.

Table 1: Comparative status of groundwater potential in UP

Status	2000	2004	2008
Groundwater Recharge (Net Annual, **mham**)	**8.08**	**7.01**	**6.73**
Groundwater Draft (Annual Gross, **mham**)	**4.39**	**4.87**	**4.78**
Groundwater Availability (Net for future use, **mham**)	**3.69**	**2.14**	**1.95**
Stage of Groundwater Development (%)	53.32	69.51	71.00

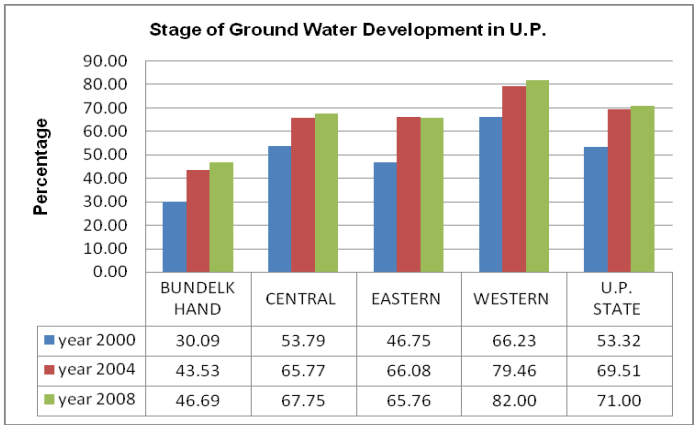
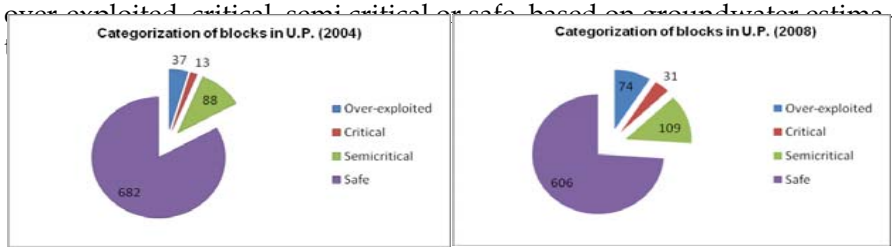


Figure 1: Stage of groundwater development in UP

This clearly indicates that there is an upward increase in groundwater development in the state and therefore, number of over-exploited/critical blocks in the state has also significantly increased from 22 in the year 2000 to 50 blocks in the year 2004, which has almost doubled as 105 blocks in the 2008 estimation. There are 820 blocks in the state, which are categorized as over-exploited, critical, semi-critical or safe, based on groundwater estima-



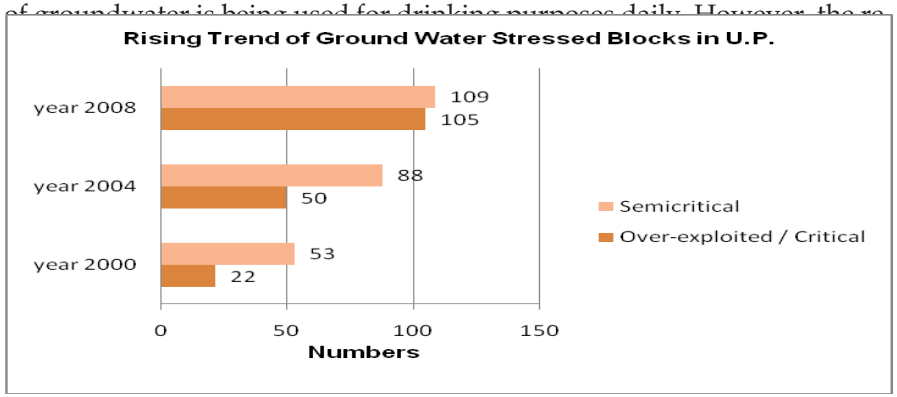
(Total stressed blocks: 138) (Total stressed blocks: 214)

Figure 2: Categorization of blocks in UP in 2004 and 2008

(d) Rising Demands and Depleting Aquifers: Last two decades have witnessed rising demands of groundwater in agriculture, drinking and industrial sectors, making groundwater on important resource in the state. But in the process, the resource has been excessively exploited, causing extensive damage to aquifers. As there have been no effective management interventions, groundwater withdrawals from the dynamic aquifers are going on unchecked in both rural and urban centers of the state.

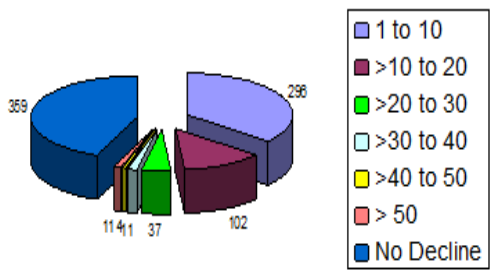
- Lucknow city is glaring example, where the top Aquifer Group (<150 mbgl) is presently under 'High stress'. The granular zone of this aquifer group is gradually drying up, causing irreversible damage to the aquifers.
- In agriculture sector, excessive use of groundwater can be visualized by the fact that in district Saharanpur, groundwater drawl is as high as 48 cm per hectare against state's average drawl of 21 cm per hectare.
- Around eighties, U.P. became the centre of Irrigation Tube Well Revolution in the country. As a result, more than 40% of private minor irrigation tube wells in the country i.e. about 41 lakhs are alone located in the state, extracting huge quantity of groundwater. Thus, providing almost 75 % of irrigation in the state, the minor irrigation sector has become the biggest exploiter of groundwater and this is the main reason, which resulted into groundwater crisis.

(e) Groundwater Withdrawal in Drinking Water Sector: In drinking water sector, majority of water supplies in rural and urban areas are being provided from groundwater resources. As per initial estimates of U.P. Jal Nigam, about 5200 million liters of groundwater is being extracted everyday in the urban centers of the state. While in the rural sector, about 8500 million liters of groundwater is being used for drinking purposes daily. However, the re-



groundwater levels. The monitor... the state is in the grip of ground... resources are rapidly depleting ... 820 blocks, 461 blocks have shown ... in the 63 blocks, water level decli...

Rate of decline (cm/ year)	Blocks showing decline (nos.)
2001-10	296
>10 to 20	102
>20 to 30	37
>30 to 40	11
>40 to 50	4
>50	11
Total	**461**



In urban centers, groundwater situations are much more disturbing. The high pace at which groundwater levels in major cities are going down may possibly be difficult to rejuvenate/recover. The reason being that drinking water supplies are heavily dependent on groundwater.

- Major cities including Lucknow and Kanpur are experiencing high water level decline (more than 50 cm./year) due to over exploitation and resultant stress on aquifer group I (upto 150 mbgl).

Static Fresh Groundwater Resource

Static Groundwater Resource: Dynamic groundwater resource from active recharge zone is being tapped and exploited for various activities, but on the other hand, the Uttar Pradesh has also potential Static Reserve for the future use. This huge potential of static groundwater exists in the deeper confined aquifers, characterized as passive recharge zone.

As per initial estimates of CGWB, the state is the largest repository of Static Groundwater Reserve. Out of country's total reserve, 33% i.e. 3470 BCM is stored in alluvial deposits, while 30 BCM is possibly located in hard rocks i.e. 16.7% of country is total reserve. These estimates pertain to depth of more that 450 m. in alluvial terrain and 100 m. in hard rock area.

Some Critical Observation:

Though, water resources in the State are depleting day by day due to the exponential demand from sectors like irrigation, domestic consumption and industry especially during last 2-3 decades, it has also been revealed by the studies conducted in various parts of the state that there is a marked decrease in the rainfall pattern during last 20- 25 years. In Bundelkhand, significant deviation /decrease in rainfall has been observed.

This decreasing trend in the normal rainfall events may possibly be the major factor affecting the groundwater resource availability.

Non-conjunctive use of surface and groundwater has caused grave hydrological imbalances in various parts of the state.

Contamination of Arsenic in groundwater reported from various districts has come-up as an alarming situation for water supply sector.

Large area in eastern U.P. is affected with the problem of water logging /rising water levels. About 8.1 lakh ha. area in the state is reportedly water logged, whereas about 25% of area is marked with shallow water level conditions, indicating various stages of sub-surface waterlogging.

KEY GROUNDWATER PROBLEMS IN UP.

The diverse situations are responsible for various groundwater related problems which have significantly come-up during last few years. Four major groundwater problems have been identified in the State.

- Over-exploitation/indiscriminate extraction of groundwater in both the urban and rural areas, resulting into significant decline of groundwater levels.

- Waterlogging /shallow water levels affecting the culturable land as well as the crop productivity.

- Poor availability vis-a-vis relatively poor development of groundwater in hard rock areas of Bundelkhand-Vindhyans. The poor management of rainfall component is the key reason for water crisis in the rocky terrain of the state.
- Contamination/pollution hazards mostly in shallow groundwater resource have emerged as a bigger challenge.

City/Urban area	Average water level decline (cm/year)
Lucknow	73
Kanpur	45
Agra	40
Varanasi	23
Aligarh	40
Ghaziabad	22
Mathura	36

GROUNDWATER MANAGEMENT IN U.P- ***A long way to go***

An action without efficient and suitable mechanism is a failure, so the case is with the management scenario of groundwater resources in U.P. The fact is that the importance of the effective groundwater management in the state has so far not been suitably understood and at present there is no mechanism which could own to efficiently manage groundwater resources.

Despite national policy statements and various initiatives taken at state level signifying the need of judicious development of groundwater and its balanced use alongwith need of proper implementation of conservation methods, *suitable management plans and interventions are almost missing in groundwater based development programmes of the state. In rural areas, groundwater is improperly managed, where as in urban area it is almost neglected.*

The richest groundwater repository of Ganga basin is once considered a boon for the U.P. might have become a 'bane' the way it is being misused.

Fragmented Approach:

Reason for poor groundwater management is also the lack of planning and coordination among various water institutions/stake holders which are dealing with groundwater rather in an isolated manner.

The fact is that whole water sector in the state is vertically fragmented and this is primarily affecting the development and conservation processes of groundwater resource in particular. With this approach, the water resources in the state continue to face various groundwater problems.

Key Challenges:

(i) Realistic picture of water resources, its potential and availability and demand and utilization in different sectors, is not accurately known.

(ii) Basin wise estimation of water resources availability, including surface and groundwater, is yet to be scientifically carried-out.

(iii) Occurrence of Arsenic contamination poses new challenges for potable water supplies.

(iv) Conjunctive use management of surface and ground is not being given due importance to overcome the problem of water-logging/rising water levels, and therefore such areas continue to remain unproductive.

(v) Geomorphology based watershed approach for rainwater conservation and groundwater management in Bundelkhand is yet to be effectively adopted.

(vi) Data management is not proper and existing infrastructure is insufficient.

(vii) Lack of initiative amongst different departments for Integrated Water Resource Management in the state. These departments are working in isolation and there is lack of co-ordination.

(viii) Institutional Mechanism in the water sector of the state is missing.

(ix) There is no Regulatory framework for control of groundwater exploitation.

(x) Effective Regulatory requirements with site specific hydrogeologically feasible interventions and suitable policy framework for rainwater harvesting and groundwater recharge are yet to be designed and implemented.

(xi) Increase in sown area, local changes in cropping pattern and high yielding seeds have led to excessive water demand even reaching to the stage of over-exploitation.

(xii) Lack of co-operative farming system.

Critical Issues:

The growing water scarcity and its increasing demand and exploitation of groundwater are posing new management problems for the state. There are certain critical questions which are needed to be resolved through effective management interventions.

- How to ensure systematic and realistic assessment/estimation of water resources availability (both surface and groundwater)?
- How to allocate water among competing users and uses?
- How to manage and integrate groundwater and surface water for their conjunctive use?
- How to control over-exploitation of groundwater which is affecting both the quantity and quality of water used for irrigation drinking and other

purposes?

- Is tube well based irrigation is hydrologically sustainable?
- How to optimize and regulate the continuously increasing dependence of water supplies on groundwater resources in urban area?
- How to accelerate the process of institutional reforms in State, as it has not been yet recognized as one of the important and necessary water management need?

What should be the model for Institutional Reform and how to find out a suitable model conducive to our socio-economic environment?

MANAGEMENT STRATEGIES

Groundwater management deals with a complex interaction between human society and physical environment and presents an extremely difficult problem of policy design. Aquifers are exploited by human decisions and over-exploitation cannot be always defined in technical terms. It may be a failure to design and implement adequate institutional arrangement to manage and regulate people who exploit the groundwater resources. When no one owns the resources, users have no initiative to conserve for the future and personal interest of individual users leads to over exploitation.

The various management options available for amelioration or solving problems related to groundwater quantity and quality can be broadly grouped under two major categories. The first category relates to Supply side management which involves scientific development and augmentation of groundwater resources. For an effective supply side management, it is essential to have full knowledge of hydrogeological controls, which govern the yield and behavior of groundwater levels under abstraction stress, the interaction of surface and groundwater in respect of river base flow and changes in flow and recharge rates due to their exploitation. The effects of groundwater development can be short term and reversible or long term and quasi-reversible which require a strong monitoring mechanism for scientific management. The other category encompasses Demand side management which is user targeted. In demand side management, the socio-economic dimension plays an important role involving managing the users of water and land.

Actions are required for proper resource allocation and prevention of likely adverse effects of uncontrolled development of groundwater resources. For effective management of groundwater resources, there is a need to create awareness amongst the different water user groups and workout area specific plans for sustainable development. In a short, the first category of management options targets policies for 'managing the water' and the second category aimed for 'coordinating the people'.

Scientific Development of Groundwater: The major challenge for effective management of groundwater is the scientific development of available resources. The lack of proper understanding of the local groundwater regime behavior and demand driven development without addressing to management needs aggravates the situation. The need for scientific planning in development of groundwater under different hydrogeological situations in the state is necessary insight for sustainable management of this vital and scare resource.

Management and Development of deep aquifers: Stage of groundwater development is quite high in U.P. However, there is ample scope of groundwater development from deeper aquifers in the state. The studies by CGWB in alluvial parts, of U.P. have revealed the existence of a huge reserve of groundwater in the deeper aquifers, which has not been fully utilized.

The thickness of the alluvium in the area exceeds 500 m and only a small fraction of this is under active circulation due to prevailing shallow groundwater development. The under utilization of the groundwater from deeper aquifers has resulted in near stagnant conditions at depth and provided the necessary time factor for the deterioration in quality of groundwater. It has been observed that calcium bicarbonate type water occurs in quality of groundwater. This water gradually deteriorates to sodium bicarbonate type with depth, indicating a base exchange between the actions of groundwater and the sub-surface clays. Slowly and slowly, the inferior/poor quality water leaks upwards as well as laterally to contaminate the quality of water in shallow aquifers of downstream areas. It is observed that in the southern part of U.P., fresh water aquifers of limited thickness overlie the brackish to saline water in deeper aquifers.

It is evident that the deeper aquifers in alluvial areas are not fully developed in upper reaches and the unutilized groundwater in confined aquifers ultimately is lost to the saline aquifers adjacent to the basin boundary. Even though multiple aquifer system occur in large areas in upper reaches of the river systems. Groundwater development is from shallow prelatic aquifer only, which is reflected in the increasing decline in groundwater level. In these areas the deeper aquifer are not developed which is not only under utilization of resources but also the quality of groundwater deteriorates with time. A large fresh water resource of confined aquifers is ultimately lost to the saline belts.

There is a great scope for development of deeper aquifers in alluvial areas of western U.P. where the confined aquifers have good quality water.

Management and development of flood plain aquifers: The flood plains in the vicinity of rivers are good repositories of groundwater. A planned management of groundwater in the flood plain aquifers offers an excellent

scope of its development to meet the additional requirements of water. It is generally observed that immediately after rainy season, the depleted aquifer fully recoupes. Thus, over-development of shallow aquifers in flood plains creates the necessary sub-surface space for augmentation of groundwater from the river flows during the monsoon. Induced recharge is an effective management tool to meet the gap of demand and supply in areas adjacent to rivers with active flood plains. Development of flood plain aquifers is feasible in various parts of state and should be taken up on a large scale.

Management of water logged areas: The practice of surface water irrigation without much consideration of groundwater status has often resulted in water logging and soil salinity problems in command areas due to gradual rise in groundwater levels with time. The water logged areas in canal command offer scope for sufficient groundwater development by lowering the water table upto six meters or more. Thus, not only additional water resources for irrigation can be created but also the lowering of water table will pave way for natural recharge in the area, which will improve of soil and water quality.

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SOME SOLOUTIONS

To effectively resolve the various water problems/issues for the sustainability of water resources in the state, following efforts are needed:

- Micro groundwater plans for urban and rural areas should be essentially prepared.
- Initiatives for Aquifer mapping and management are urgently required.
- Adoption of the concept of Integrated Water Resources Management (IWRM), as water is treated as an integral part of the ecosystem.
- Effective initiatives to evolve data management/data sharing mechanism in the Sate.
- Preparation of Water Resources Basin Plans incorporating the status of resource availability, various challenges and management strategies.
- Implementation of Area specific geo-scientific guidelines for Rainwater Harvesting and Groundwater Recharge to obtain promising results.
- Adopting micro-watershed approach for water resources development and conservation in Bundelkhand.
- Initiatives for mapping of polluted aquifers and the mitigation strategy. RandD requirements for evaluating interaction between surface water and groundwater.

CONCLUDING REMARKS

Groundwater resources in the state have to be looked into a holistic approach and planning for its development has to be done on a scientific basis. Therefore an effective management of groundwater resources requires an integrated approach in both planning and implementation of schemes.

The imperative need is to enhance the scientific capabilities of related organizations in order to resolve various issues of groundwater management, because without institutional mechanism the target for sustainable management of groundwater can not be achieved. Therefore the state should understand the emerging challenges and workout feasible solutions to cope up the alarming groundwater problems. Rainwater harvesting and groundwater recharge is an important management tool and as groundwater is a community resource, it requires an active public participation.

The looming danger of increasing groundwater crisis has become an area of State concern.

- World Bank, in its report (*India's Water Economy: Bracing for a Turbulent Future*) warned of a serious crisis in the country in the next 02 decades "due to inadequate water supplies and poor management of Groundwater Resource". Report states " Unless Water management practices are changed and changed soon, India will face a severe water crisis within the next two decades and will have neither the cash to build

4

Legislative Governance for Groundwater Regulation

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Groundwater is becoming an increasingly popular resource because of the relative ease and flexibility with which it can be tapped. It can be drawn on demand, making it far more attractive to many groups of users. In India, groundwater is a potential resource for human and livestock consumption, industrial requirements and mainly for irrigation. In spite of the abundance of this resource, it has not been possible to ensure its sustainable development and equitable distribution. One of the major factors responsible for this state of affairs has been the physical distribution of the resource itself. Due to uneven distribution of the resource, in certain areas of the country and in the state excessive withdrawal is causing depletion of the water table whereas in others there is difficulty in drainage and fear of saline intrusion.

Given the gravity of the situation, efforts have been made to formulate a legal framework to arrest further deterioration of the resource and ensure its sustainable, equitable and efficient development, but with little success. This has been because certain relevant parameters have been ignored in making of the law itself. For instance, the appropriate institutional arrangements, the existing nature of rights on the resource, various strategy options available for regulation etc. Mere regulatory interventions like water rights and permits and economic tools of water pricing etc cannot be successful unless the different user groups are fully involved. For effective management of groundwater resources there is a need to create awareness among the different water user groups and workout area specific plans for sustainable development.

Against this context the present article analyzes the need for legislative governance of groundwater, the gaps in the groundwater management and how to fill those gaps. Components of modern groundwater legislation with reference to the provisions made in the groundwater legislations of different Indian States have been described. Initiatives taken by the Government of Uttar Pradesh for the conservation, protection and development of groundwater in the State has also been discussed.

Policy Response and Institutional Adaptation

In some cases, it is already too late to talk about the sustainable development of groundwater because the aquifers are already depleted, polluted or salinized beyond the regenerative capacity of their natural hydro-geological regimes. Some industrialized countries such as United Kingdom are moving toward a re-examination of groundwater management in a broader political and social context. Others, like France, are maintaining a more technical perspective. Elsewhere, many developing countries that rely on pumped groundwater to sustain agricultural output and supply municipalities continue to permit the intensive levels of abstraction with little evidence of pro-active groundwater management being deployed.

Technical regulation, economic incentives and participatory management approaches may offer the means to address groundwater management in the common interest. However, the character of initiatives will be determined necessarily by the local realities of the groundwater occurrences and the associated groundwater economy. Dealing with such diversity involves a different order of adaptability and flexibility than that normally associated with surface water or river basin management. By the time groundwater arrives at the well head and enters irrigation ditches or raw-water pumping mains, it is perceived that groundwater management ceases and conventional water management takes over.

Groundwater tends to be treated as the ultimate source of relatively high-quality water and the ultimate sink of used water. This occurs without any real appreciation of groundwater's regenerative capacity and its buffering role in the hydrological cascade. The management of surface water has fundamental implications for both groundwater quantity and quality at all stages and points of the hydrological cycle. It is essential to examine the scope for groundwater management not only in the strictest sense, but also as a prerequisite for integrated water resources management. This involves appealing to individual groundwater users in ways that have to do with advocacy and demonstration.

It is significant that some political scientists sense a continuing tension between the 'eminence' of the State and the customary user rights of the beneficiaries. How this tension is resolved is critical for groundwater because the management of diffuse abstraction is highly dependent upon the approach local communities take to negotiating the use of a common property. Historically, it has appeared easier, though not necessarily beneficial or cost-effective, for the State to control surface water abstractions

and disposal within a vertically 'integrated' river basin plan where a central authority undertakes all the operational and regulatory functions related to the water cycle.

The purpose of the State's intervention is the protection of the broader public interest in the basin's resources. However, this tendency in river basin management risks ignoring the important but highly distributed physico-chemical and socio-economic buffering roles of groundwater. The approach may also rely heavily on regulatory measures as opposed to economic incentives to achieve desired results. More significantly, the array of users with which basin agencies tend to engage (large sectoral user groups and local government representatives) may differ markedly from the groundwater 'stakeholders'. Millions of individual farmers are not necessarily amenable to the same degree of association that can be recognized among urban utilities, industries and command area authorities

It can be argued that integrating groundwater use within both a physical and a socio-economic framework becomes not only an environmental necessity but also a political imperative where policies of decentralization and subsidiarity are adopted. The choice of water resource management instruments to address specific groundwater issues may still fall within the bounds defined by technical regulation, economic incentives and participation. They can be expected to take on a markedly different character from those associated with conventional surface water management. The quality of the information about aquifers, groundwater and user behaviour will also need to assume a specific character.

Groundwater Conflict Related Issues

Conflicts between groundwater uses and users are likely to grow. The main concerns are irrigation versus domestic use, irrigation versus hydro power and water use versus ecologic flow. Water rights of individuals and group of individuals need better delineation through a legalized process of allocations and review of allocations. This system needs to cover returned waters, water quality, and meeting demand through water of a quality appropriate to the demand.

Fluvial groundwater needs to be brought under the allocation system and the proprietary rights of landowner over groundwater need to cease. Water rights of individuals and groups need to be linked with obligation to return a predetermined quantity of acceptable quality to the system. The 'user pays – polluter pays' principle needs to be adopted.

Water management for hydrological units like basins/sub-basins need to involve stakeholders. For homogeneous areas with only irrigation use, WUA's could be the vehicle for management. For heterogeneous uses, stakeholder committees would have to be formed and empowered to manage the resource, within allocations and financial sustainability.

Legislative Governance of Groundwater

As many as twelve State Governments/union territories in India including Andhra Pradesh, Goa, Tamil Nadu, Lakshwadeep, Kerela, Pondicherry, Maharashtra, West Bengal, Himanchal Pradesh, Madhya Pradesh, have introduced legislations to regulate groundwater development and to constrain activities that might compromise groundwater availability and quality. Other States are also in the process of enacting groundwater legislations. Three State Governments, Maharashtra, Arunanchal Pradesh and Uttar Pradesh have also introduced legislations to regulate overall water resources in their respective States. This trend reflects increasing competition and conflict between groundwater users and increasing threat of groundwater pollution. Initially, these legislations were related to specific water uses or problems as they arose. Subsequently, realization that negative impacts on groundwater may also affect surface water is bringing about the greater integration of legal provisions on water resources.

Advantages of Legislation

Comprehensive groundwater legislation offers considerable advantages, since it provides a legal basis for the effective and sustainable management of groundwater through guidelines for, and limitations to, the exercise of public powers and provision for the quantification, planning, allocation and conservation of groundwater resources, including water abstraction and use rights. A system of wastewater discharge licenses is evolved that helps to protect groundwater against pollution. The rights and duties of groundwater users are well defined and there is a protection of use rights, of the rights of third parties and of the environment. Requirements for the registration and qualification of well drillers and possible administrative intervention in critical situations (aquifer depletion or pollution) are clearly mentioned in the legislation. There are provisions for cooperative interaction between water administrators and water users.

Evolution of Groundwater Legislation

Under Roman law groundwater was the property of the owner of the overlying land. Until recently this rule was paramount everywhere that followed the tradition of the French Napoleonic Civil Code (including France, Spain and many African and Latin American countries). The land owner had an exclusive right to use the underlying groundwater, essentially subject only to similar rights of neighboring land owners. In traditional English

Common Law the holder of a land title also had exclusive right to use all underlying waters not flowing in defined channels. For groundwater in defined channels and surface water, use was subject to the 'riparian doctrine', by which the use right rests with whoever held title to the adjacent land, subject to certain consideration of downstream interests. In substance, groundwater largely depended on the legal régime of the overlying land that is private land ownership equated to unlimited private groundwater use rights.

Given the problems created by growing water scarcity and pollution, legislation has been widely enacted to vest all water resources in the State, or to recognize the State's superior right to the management of water resources. The declaration of groundwater as a 'public good' turns the former owner into a user, who must apply to the State administration for a water abstraction and use right. Once the State is the guardian or trustee of groundwater resources, it may (in addition to granting water rights) introduce measures to prevent aquifer depletion and groundwater pollution. Moreover, legislation tends now to require water resources planning at the level of an entire aquifer or river basin.

In some instances, the 'new' legislation has been challenged in courts of law, because of alleged inconsistencies with constitutional provisions protecting private ownership and requiring payment of compensation when rights are compulsorily negated. But such challenges have usually been rejected on grounds that regulating groundwater abstraction arises from the need to safeguard the public interest.

Characteristics of Current Groundwater Governance

The characteristics observed in current groundwater 'governance' leads to different types of management approaches for groundwater. Lack of data and scientific understanding limit the ability of society to predict aquifer functioning and to develop realistic rights systems. Rights systems are difficult to design and implement in most situations for a variety of technical and economic reasons. In most cases, social acceptance of private rights may be problematic. Aquifer management is politically complex because it would require active modification of established use patterns. The dynamic nature of both socio-economic globalization and global climate change makes management complex. People are increasingly mobile and often have little incentive to participate in long-term management initiatives.

From among this set of characteristics, two broad types of management approaches for groundwater emerge. First approach may encompass blunt tools such as power pricing, subsidies for efficient technologies, economic policies that discourage water intensive crops, etc. They can be applied over whole countries or regions. The second set of approach deals with specific aquifers on the basis of command and control management whereby aquifer management targets are set and enforced through a resource regulator. The first approach to resource management may ultimately prove more successful than the second approach to aquifer management.

Components of Modern Groundwater Legislation

Modern groundwater legislation must, in general terms, be flexible, enabling and enforceable. It is thus recommended that the basic legislation be restricted to fundamental powers and concepts, and that the detail is dealt with in associated regulations and implementation plans. It also provides a more unified vision of surface water and groundwater resources, but the particular characteristics of groundwater systems and their close relationship with land-use call for specific legislative provisions in different administrative areas and at different territorial levels. Some of these specific components of modern groundwater legislation, along with the provisions made in the Groundwater Acts of different Indian states, are:

Groundwater Abstraction and Use Rights

These are very important and amongst other things, groundwater rights serve as the basis for abstraction and avoid over-exploitation of groundwater. Section 8(2) of the Andhra Pradesh Act states that the owner of all the wells including those which are not fitted with power driven pumps and water bodies shall register their wells with the Authority constituted by the government for this purpose and Section 9(1) of the Act empowers the designated officer to prohibit water pumping by individuals, groups of individuals or private organizations in any particular area, if in his view such water pumping in such area is likely to cause damage to the level of groundwater or cause deterioration or damage to natural resources or environment. The Chennai Metropolitan Area Groundwater (Regulation) Amendment Act, 2002 becomes more specific and in its Section 5(A) prohibits extraction of groundwater for non potable use by an industry when alternate sources are available from the authorized water supply agencies. It also prohibits extraction of groundwater for use in swimming pool (except when authorized by competent authority) and extraction of groundwater for gardening purposes. Provisions have been made in the Himachal Pradesh Groundwater Act for the payment of a royalty to the State Government for the extraction of groundwater in the notified area.

Wastewater Discharge Control

The control of wastewater discharges (especially those to the ground), which is subject to conditions on mode of discharge and level of treatment, is

designed to protect groundwater against pollution. The 'polluter-pays-principle' is normally embodied within this area of legislation. The Kerala Groundwater Act in its Section 15(1)(j) empowers its Groundwater Authority to take necessary steps for the installation of drainage pipes etc. affecting the water source and to prevent depositing of water materials in the surface water sources if it is likely to affect the groundwater sources. Provision has been made in Section 13(1)(m) of the Goa Groundwater Act, to close the use of toilet/septic tank/soak pit if it is found that it is polluting the groundwater.

Sanctions for Non-Compliance

Almost all Groundwater Acts have the provision of penalties for the non compliance of the provisions of the Act. These penalties may range from modest fines to imprisonment terms, depending upon the severity of impacts and the persistence of the offense. Further, the amount of penalty and the duration of imprisonment may vary for first, second and subsequent offences. For example, Section 35 of the Andhra Pradesh Act has the provision of fine ranging from rupees one thousand to fifty thousand as well as imprisonment of one to six months for non compliance of the provisions of the Act.

Controlling Well Construction Activities

Controlling well construction activities may include licensing of all water-well drilling contractors, so as to ensure better relations with (and information flow to) the water resources administration, higher standards of well construction, improved reports on the hydro-geological conditions encountered, and reduced likelihood of illegal well construction. Water legislation may also introduce controls over the import of pumps and drilling equipment in an attempt to curb excessive groundwater abstraction. Section 14 of the Andhra Pradesh Act has the provision for the registration of drilling rigs by every rig owner with the Authority and also to follow the instructions issued by the Authority from time to time.

Catchments or Aquifer Level Resource Planning

Water legislation tends to provide for water resources planning with reference to surface water basins and/or aquifer systems. Based on the inventory of water resources and of existing uses, plans provide an integrated basis for the assessment of individual applications for water rights. They normally have a legally-binding nature, and decisions on applications must be consistent with their provisions. Section 5(7) of the Himachal Pradesh Groundwater Act states that the Groundwater Authority of the State shall take steps to ensure that exploitation of groundwater resources does not exceed the natural replenishment to the aquifers and wherever there is mismatch; steps shall be taken to ensure augmentation of groundwater resources in addition to regulatory measures.

Conjunctive Use of Groundwater and Surface Water

Acknowledging the advantages of conjunctive water use, one permit may cover both groundwater abstraction and discharge of an effluent of acceptable quality to a surface watercourse, or surface water diversion and use coupled with recharge of an effluent of acceptable quality to the ground. Provisions have been made in the Andhra Pradesh Act to ensure optimum use of surface and groundwater in the irrigation command areas and Section 21(1) ensures that land and water use in the watersheds shall be conducive for efficient utilization of these resources as well as groundwater recharge.

Land Surface Zoning for Groundwater Conservation and Protection

In some countries, legislation provides for the water administrators to declare 'special control areas', where exceptional measures (such as restrictions on new water-well drilling and/or groundwater abstraction rates) become possible in the interest of avoiding further aquifer deterioration. Land surface zoning may also be targeted to serve the purpose of protecting vulnerable aquifer recharge areas and/or groundwater supply sources. In the zones so-defined restrictions can be applied in relation to potentially-polluting activities (such as certain types of urbanization, landfill solid waste disposal, hazardous chemical storage and handling facilities, mining and quarrying, etc.). For the prevention of diffuse pollution from agricultural land use, the above approach has been only locally attempted, and it is more normal to introduce bans or import control mechanisms on certain pesticides and to promote the adoption of codes of good agricultural practices. Provisions have been made in Section (19) of the Andhra Pradesh Act that no groundwater resources shall be contaminated in any manner by anybody including industrial, local bodies and aquaculture waste disposal. Section 14 of the Chennai Metropolitan Area Groundwater (Regulation) Act provides for the augmentation of groundwater storage through rain water harvesting and restricting the use of water bodies, whether public or private, only for the purpose of storing water that will contribute to groundwater recharge.

Facilitating Water-User and Stakeholder Participation

The participation of groundwater users and other stakeholders in groundwater management is a matter of increasing concern to law-makers, who realize that implementable legal provisions are more likely to be defined when they have a say. In addition to local water-user associations, more

widely-constituted 'aquifer management organizations' are needed to discuss implementation of measures across user sectors and between water-user associations and to agree on priority actions in areas with a critical groundwater situation. These organizations generally assist the water resource regulator in the administration of groundwater abstraction. It is important to endow these organizations with formal juridical status and to integrate them into broader institutional mechanisms for groundwater resource management and protection. Section 22 of Andhra Pradesh Act empowers the Water Users Associations to ensure optimum use of surface and groundwater in the irrigation command areas.

Provisions for Groundwater Monitoring

Groundwater legislation should provide for the monitoring of groundwater status (quantity and quality) and of water use, by assigning this task to the water administration at the appropriate territorial level. To be effective, this legislation should set realistic requirements that take into account existing resources and institutional capacity. Section 15(1)(f) of the Kerala Groundwater Act empowers the Groundwater Authority to enquire the user of groundwater to install water measuring instrument in any water supply machinery, when it is necessary for the proper use of water or when the user is not complying with the provisions of the Act or to protect public interest. The Himachal Pradesh Groundwater Act, in its Section 14, ensures that every user of groundwater in a notified area shall install water measuring device on groundwater abstraction structure within a period of thirty days from the date of registration/grant of permit to extract and use groundwater.

Gaps in Groundwater Management

Groundwater acts as the primary buffer against the impact of climate variability and spatial variability in drought. However, as human development has become more susceptible to such variability, three major gaps in groundwater management have emerged, each with significant implications for sustainable development. Firstly, the inability to cope with the accelerated degradation of groundwater by over abstraction, and effective resource depletion through quality changes (pollution, salinity). Secondly, lack of professional and public awareness about the sustainable use of groundwater resources, in general and lack of coherent planning frameworks to guide all scales of groundwater development and the consequent lack of appropriate policy responses and institutional development to prevent degradation of groundwater in particular. Finally, the failure to resolve competition for groundwater and aquifer services between sectoral uses and environmental externalities. These specific concerns hinge upon the central issue of awareness. This relates as much to the groundwater related environmental concerns in industrialized countries as it does in developing countries who depend on locally available groundwater sources.

In this sense, groundwater management regimes may be expected to encompass a set of economic, regulatory and ethical levers that are operated by markets, regulators/state institutions and user associations. Effective institutional approaches need to be aware of these socio-economic realities surrounding groundwater use. They also need to appreciate the inherent risks associated with development, the level of uncertainty, limitations in data quality and the range of social pressures.

Filling the Gaps

In order to start addressing gaps in management, it is important to recognize that institutional innovation and adaptation will need to be more sensitive to the range of influences and management instruments. A diagnostic to develop such adaptations will need to cover – macroeconomic policies, sector policies, rights systems, institutions and capacities, regulatory frameworks, and public involvement.

Against the 'soft' institutional strategies, it is possible to define sets of technical options that relate directly to groundwater. Although these options may present expanded opportunities to manage groundwater, they would have to be applied strategically in circumstances that are amenable and where uptake of technical strategies will succeed. Such technical options include conjunctive management (conjunctive use and aquifer storage and recovery), conservation enhancement and protection, water harvesting, supply enhancement, irrigation efficiency improvement and demand management.

The Uttar Pradesh Groundwater Conservation, Protection and Development (Management, Control and Regulation) Bill

With the view to address the gaps in groundwater management The Uttar Pradesh Groundwater Conservation, Protection and Development (Management, Control and Regulation) bill is under active consideration of State Government which will provide for the management, control and regulation of the conservation, protection and development of groundwater in the State of Uttar Pradesh. This Act, when enacted, will ensure that the strategies for sustainable groundwater management are carried out for proper development of groundwater in the State, both in quantity and quality. Techniques for recharge of groundwater will be enforced and over exploitation of groundwater will be checked.

The Uttar Pradesh Water Management and Regulatory Commission Act, 2008

The Government of Uttar Pradesh has enacted The Uttar Pradesh Water Management And Regulatory Commission Act, 2008 to provide for the establishment of the Uttar Pradesh Water Management and Regulatory Commission to regulate water resources within the State, facilitate and ensure judicious, equitable and sustainable management, allocation and optimal utilization of water resources for environmentally, economically sustainable

development of the State , fix the rates for water use for agriculture, industrial, drinking, power and other purposes and cess on lands benefited by flood protection and drainage works from the owners of lands benefited through appropriate regulatory instruments according to State Water Policy.

The Act has come in force from October 03, 2008 and the Commission has been established on October 23, 2008. Among the many functions that the Commission will perform, groundwater related issues will also be addressed by the Commission. It will determine the allocation and distribution of entitlements for various category of use of water at utility, project level and also between various water user entity within the parameters laid down by the State Water policy on such terms and conditions as may be prescribed for such a distribution and will lay down the criteria for modifications in the entitlements for the diversion, storage and use of surface and groundwater of the State. The Commission will review and accord clearance to new water resources projects proposed at the river basin / sub-basin level by the concerned entity ensuring that the proposal is in conformity with Integrated State Water Plan specially with respect to the water allocation of each entity, that is economically, hydro-geologically and environmentally viable. A system of enforcement, monitoring and measurement of the entitlements for the use of water to ensure that the actual use of water, both in quantity and type of use are in compliance with the entitlements as issued by the Commission will be established by the Commission.

Conservation of environment will be monitored by the Commission and it will facilitate the development of a framework for the preservation and protection of the quality of surface and groundwater resources as per established norms and standards. Withdrawing the entitlement or take any action as deemed necessary in case any water user entity pollutes or causes to pollute any surface or groundwater source of water and thereby infringes the maintenance of established norms and standards for water quality will come under the functions of the Commission. The Commission may impose penalty on any organization or agency, whether government or private, any individual or a group of individuals who changes, alters or cause to change or alter the status of any surface or groundwater resources without the specific sanction or approval of the Commission and it will enforce rain water harvesting to augment groundwater recharge. One of the main and important functions of the Commission will be to fix the rates for water use for agriculture, industrial, drinking, power and other purposes.

Successful Implementation of the Legislation

Successful implementation of groundwater legislation or the water management legislation depends on a number of factors including the administrative set-up and the level of training of water administrators. There should be a clear understanding of the institutional roles and functions at all relevant levels. An adequate level of public awareness and acceptance of legal provisions along with political willingness to promote and attain sustainable groundwater management is must for successful implementation of the legislation.

Groundwater legislation must prescribe an administrative set-up suited to national or state conditions. At national level, management functions, covering both quantity and quality aspects, should be vested in a single authority or ministry or, where this is not considered appropriate, clear institutional mechanisms for coordination between the competent bodies must be established. At river basin or regional level, the specific situation may warrant the establishment of river basin agencies, especially for the performance of some planning and coordination functions. At intermediate or local level, it is important to pay careful attention to local institutional arrangements for water administration, the role of the local authorities in water resources management, since they represent local interest and the establishment of intermediate institutions such as aquifer management organizations having juridical power in relation to specified aquifers and with adequate representation of different water-user associations, various water-use sectors and a clear cut relationship with the water administration.

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Salient Features of the Proposed U.P. Groundwater Conservation, Protection & Development (Management, Control and Regulation) Bill – 2010 and its Implementation

Venkatesh Dutta

The groundwater situation in UP is fast deteriorating. The decline in groundwater levels in many parts of the state has been due to uncontrolled and rapid extraction of groundwater. In the past four years, the areas under stress have almost doubled. In comparison to 138 blocks in 40 districts of UP under stress in 2004, the tentative figure of the blocks under stress has touched 218 blocks in around 60 districts as per the survey done by Ground Water Board in 2008. If groundwater extraction is not controlled/regulated many more blocks will become stressed in future, which will impede the economic development of the State or the cost of development will be much more. While most water resource professionals are trained to manage surface water, groundwater is hidden from view and has received relatively little management attention.

The Ministry of Water Resources had drafted the 'Model Bill to Regulate and Control the Development of Groundwater' and circulated it to States in 1970. It was re-circulated in 1992, 1996 and 2005 to the States and Union Territories to enable them to enact suitable legislation on the lines of Model Bill. The Bill proposes setting up of a Groundwater Authority in every State and Union Territory. So far, 11 States and UTs have enacted and implemented the legislation, while 18 others are in the process of enacting the legislation. But now, in a bid to regulate and conserve groundwater resources, and to provide for protection and development of groundwater in the State, the government has drafted the UP Ground Water Conservation, Protection & Development (Management, Control and Regulation) Bill 2010.

The central element of the proposed Groundwater Bill is the introduction of sustainable and integrated limits on groundwater extraction as well as integrated management of this critical resource as a whole. The Bill has separate provisions for different categories — commercial users, bulk users, rural farmers and common urban dweller. A Ground Water Authority (GWA) will be formed which will notify the areas where ground water resources are under stress. The provisions of the Bill will be strictly implemented in the notified area. However, a unique important feature of the proposed law is that it involves common man in its implementation. Water Users Associations (WUA) and Residential Welfare Associations (RWA) will be formed to regulate groundwater use in their respective areas.

1. Provisions for existing and new bulk users in non-notified, semi-critical, critical and over- exploited areas (S-16, 17, 18)

Any user engaged in use of groundwater in bulk or huge quantity as notified by the authority {sec 2(15)} will be termed as bulk user

- Every existing bulk user to register within 120 days in non- notified and semi- critical areas and within 60 days in critical and over-exploited areas. New bulk users to register before the construction of well in all areas.
- Complete ban on construction of new well in critical & over-exploited areas, however construction of new well for water supply scheme for human consumption/ drinking will be allowed on a case to case basis in consultation and under guidance of registered service provider.
- Authority/Government may charge fee for ground water use annually.
- Existing bulk users to adopt area specific RWH technique mandatorily.
- Mandatory provision for inspection twice a year to ensure and check efficacy of RWH/ R structure, limit of ground water withdrawal, size of pumpset, suction & delivery pipe, quality of water being recharged etc.

2. Provision to extract and use groundwater for commercial users and industries (S-19)

- Every existing user to register with in 120 days in non- notified & semi- critical areas and within 60 days in critical & over-exploited areas. New users to register before the construction of well in all areas.
- Commercial users and industries desiring to sink a well in semi-critical, level-1 and in non-notified area shall apply to any of the registered Service Provider.
- Complete ban on construction of new well in critical & over-exploited areas.

➢Authority/Government may charge fee for ground water use annually.

➢ Mandatory provisions to establish Rainwater Harvesting technique, with in a period, specified by Authority under the supervision and guidance of the Service Providers.

➢Mandatory provision for inspection twice a year to ensure and check efficacy of RWH/ R structure, limit of ground water withdrawl, size of pumpset, suction & delivery pipe, quality of water being recharged etc.

3. Provisions for common farmers in rural area

3.1 Non-notified area

- No regulation for the time being for any user of ground water for installing, pump set of power not exceeding 7.5 H.P.
- All users of ground water will self regulate themselves by installing; pump set of power exceeding 7.5 H.P.
- All users of ground water will adopt the rain water harvesting / recharging activities.
- Mandatory provisions for all sellers to inform the Authority about selling of pumpsets of power exceeding 7.5 H.P.
- Promotion of Mass awareness and sensitisation programme through WUA.

3.2 Semi-critical Area, Level -1

- All users to self regulate themselves through WUA by installing pumpset of power not exceeding 7.5 H.P.
- Installation of pump set exceeding 7.5 H.P. through service provider.
- The limit/rate of ground water withdrawl from one well/tube well with pump set exceeding 7.5 H.P. shall be fixed by the Authority.
- It will be mandatory for seller of pump set to inform the Authority if he sells any pump-set of power exceeding 7.5 H.P.
- To promote Mass awareness program on Rain Water Harvesting & Recharge through WUA's.

4. Provisions for common persons in urban areas

4.1 Non-notified area (S-16)

- No regulation for the time being for any user of ground water for installing, pump set of power not exceeding 0.5 H.P.
- All users of ground water will self regulate themselves through Resident Welfare Association to install submersible pump set of power exceeding 0.5 H.P.
- All users of ground water will adopt the rain water harvesting / recharging activities.
- Mandatory provisions for all sellers to inform the Authority about selling of pumpsets of power exceeding 0.5 H.P.
- Promotion of Mass awareness and sensitisation programme through RWA.

4.2 Semi-critical area, Level-1 (S-17)

- All users to ground water will self regulate themselves through RWA by installing pumpset of power not exceeding 0.5 H.P.
- Installation of pump set of power exceeding 0.5 H.P. through service provider.
- Sinking of new well/bore well/tubewell allowed with the condition that user will declare the installation with mandatory provisions to adopt Rainwater Harvesting/ Recharging technique.
- It will be mandatory for seller of pump set to inform the authority if he sells any pump-set of power exceeding 0.5 H.P.
- To promote Mass awareness program on Rain Water Harvesting & Recharge through RWA's.

5. Provisions for common persons in over-exploited and critical areas (both urban and rural)

- Every existing user to inform the Authority with in 60 days of the Act coming into being.
- Complete ban on construction of new wells/tube wells. (both private & Govt.)
- Ban to continue till such areas are denotified by the Authority.
- Existing users of ground water (Private & Government) to mandatorily adopt the area specific RWH techniques.
- Mandatory provision for inspection twice a year to ensure and check efficacy of RWH/ R structure, limit of ground water withdrawl, size of pumpset, suction & delivery pipe, quality of water being recharged etc.
- No person shall cause any such activity, which is against the provisions of this act or which is prejudicial or in contravention of the act.

6. Penal provision regarding pollution (S-34):

- Any person/user, institution, industry including small users who contaminates ground water in any manner or directly disposes waste water including sewage into aquifers shall be treated as an Act of Criminal Offence.
- For such offence, the person responsible shall be liable for strict punishment with imprisonment for term, which shall not be less

than one month but which may extend to one year as prescribed by the Authority.

6.1 Other penal provision for groundwater users:

- Any user of ground water except small users in notified area, if fails to comply with any of the provisions of the Act or any rule made or obstructs the Authority or any other person authorized by it, shall be punishable-
  - With fine upto Rs. 5000 for first offence and,
  - for second and subsequent offence with imprisonment for a term, which may extend to six months or with fine upto Rs. 10,000 or with both.
- To implement the provisions of the code of criminal Procedure, 1973 (Act No. 2 of 1974) for any search or seizure.

7. Miscellaneous provisions:

- Service providers (S-10) & Drilling agencies (S-13) to be registered by paying registration fee in every district.

- Authority shall fix water rates (S-20) for selling ground water from private tube wells.

8. Some specific comments and suggestions:

Sustainable management of groundwater resources is imperative to the agricultural, industrial, urban, rural and environmental viability of Uttar Pradesh. Such management requires not only a robust scientific basis but also ongoing monitoring of groundwater allocations, use, water levels, and quality. The rapid population growth and resulting domestic demand for water require rapid and effective decision-making as regards groundwater management and control of the various sources of pollution. Sustainability of groundwater resources for utilization by future generations must therefore be a high priority, not only for the purpose of fulfilling needs for water usage but also for bringing people into harmony with their natural environment. Understanding of the variability and range of hydrogeological settings and UP's demands on aquifer systems is crucial to effective management practices. Sustainable allocation of groundwater resources will therefore, require catchment and aquifer management plans that clearly integrate groundwater and surface water systems. This will require an accurate catchment and aquifer water balance to develop management plans which recognize the long timeframes of aquifer and catchment interaction. This type of knowledge framework is missing from the current reform strategies. Integrated management plans must allow for sufficient environmental flow in groundwater systems to maintain groundwater dependent ecosystems. Per groundwater must be considered less than the average annual sustainable yield.

Important components of a successful Groundwater Bill are to:

- improve our knowledge of groundwater and surface water connectivity, with significantly connected systems to be managed as one integrated resource
- complete the return of currently over-allocated or overused systems to environmentally sustainable levels of extraction
- improve understanding of sustainable extraction rates and regimes, and develop common approaches to achieving sustainability
- develop better understanding of the relationship between groundwater resources and groundwater dependent ecosystems.

However,

1. The draft Bill does not mention water demand management through improved irrigation technology, refocused investment subsidies and irrigation expansion constraints.
2. It is almost weak in substianting and sustaining institutional action, including formalization of water users' association/residents welfare association and formalization of other stakeholder's participation in regulating aquifer's abstraction.
3. Aquifer recharge is always a difficult parameter to quantify. Moreover, confusion may occur when comparing estimates, due to lack of clarity over geographical area and aquifers under consideration, although these will be critical for evaluation of the options for resource management intervention. While the problems and causes of aquifer depletion and contamination are clear, immediate solutions are not. An active aquifer management must be undertaken in the wider context of watershed management.
4. The current mandates rests heavily on the 'mining' of aquifer for both rural and urban areas to 'buy time' for management inefficiency and done in a hurried manner. Such Bill needs proper debate among the stakeholders and policy makers, before being finally notified, so that socio-economic transition to a 'less water-dependent economy and society' could be developed over time.
5. Potability and safety of groundwater quality is not mentioned specially chemical and microbiological quality of groundwater sources, and improvement in existing well protection. The Authority needs to outline "Critical Aquifer Protection Areas" and declare such areas such as floodplains, open low lying areas or ponds/water bodies as "Potential Groundwater Sanctuary". Their land uses should not be altered or modified to suit developers.

6. The Bill does not talk about reduced rights of use in riparian areas of insufficient water availability, nor does it draw the conflicts associated with 'sale' of excess water allocations by the bulk users.
7. The costing system of legal rights for groundwater abstraction is poorly constructed. No distinction is made on grounds of efficiency of the irrigation use nor the level of water-stress in the area concerned. There is a need of "differential charging" in critical areas or groundwater use restriction zones, as defined by the Authority. There is also a need to develop charging of a realistic groundwater resource fee, from the bulk users (such as bottled water companies) to generate finance for aquifer management monitoring and to serve as an incentive for reducing groundwater abstraction.
8. It is also important to make a more detailed assessment of the current process of groundwater salinisation/quality reduction, which could, reduce the future value of groundwater for drinking/irrigation if not carefully managed or influence the preferred approach to aquifer artificial recharge.
9. Water sector institutional arrangements and other potential regulatory issues such as actual cost of over-extraction and cost of groundwater pollution etc should be clearly defined in drafting the proposed Bill.
10. In areas where groundwater is low, the Bill should allow to establish groundwater management areas and plan how much water can be sustainably withdrawn from aquifers. The Bill should emphasize local control, flexibility, conservation, and science-based management of water.

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GROUNDWATER REGULATION

Towards a new Framework (with Special Reference to Uttar Pradesh)

Philippe Cullet*

I. Introduction

Groundwater has become the main source of water for all the main uses of water, including in particular domestic use and agriculture in Uttar Pradesh as well as throughout the country. This tremendous increase in the use of groundwater has had significant impacts on availability of and access to water. This is true both in regions where groundwater is available in vast quantities like in the Indo-Gangetic plain and in much drier areas like Bundelkhand.

The current regulatory regime in UP is in large part still based on principles inherited from the colonial period. These are both dated and inappropriate. They are dated because they were developed at a time when groundwater was a marginal source of water and when humans were not able to affect the level of the groundwater table through their use, which was largely limited to drawing water from wells. They are inappropriate because the basic nexus between access to groundwater and land ownership on which these rules are based make common law rules socially inequitable and environmentally unsustainable.

The Central Government has been proposing since the early 1970s to move towards a legal regime based on a specific piece of groundwater legislation. This is commendable because the common law rules introduced in colonial times are inappropriate to address the current challenges faced in the groundwater sector. Yet, reforms based on the Central Government's proposal are insufficient in today's context. Firstly, they fail to sever the link between land ownership and access to groundwater, a precondition for ensuring that groundwater law contributes, for instance, to the realisation of the fundamental human right to water. Further, they add a layer of governmental control to a largely privately regulated framework but fail to recognise the constitutionally sanctioned rights of the panchayats in

controlling local sources of water. While groundwater is not static, it remains the body of water most closely associated with a specific locality. As such it is the primary body of water over which panchayats have been given rights of control under the decentralisation mandate of the Constitution, as implemented in UP.[1]

The limitations of the 'old' colonial framework and the reforms adopted in various states and proposed in UP through the Uttar Pradesh Groundwater Conservation, Protection and Development (Management, Control and Regulation) Bill, 2010 call for new proposals for the reform of groundwater law. This has been made all the more necessary in the context of disputes like the Plachimada case, replicated in other groundwater-related disputes such as in Mehdiganj, UP. In the Plachimada dispute, the two decisions already taken in this case gave two completely different readings of the rules applying to groundwater.[2] While the Supreme Court may eventually lay a new framework in its future decision on the case, this may not alleviate the need for a broad-based rethinking of groundwater rules, beyond the specific dispute arising in the Coca Cola case.

II. Traditional Rules of Access to and Control over Groundwater

Groundwater has usually been treated separately from surface water.[3] Historically, this can be ascribed in part to a lack of understanding of the connections between surface and groundwater and of the relationship between groundwater abstraction in different places. This also reflected the unavailability of pumping devices allowing large-scale groundwater withdrawals to the extent of significantly affecting the water table level.

These factors contributed to the development of separate legal principles for control over and use of groundwater. Since groundwater has a direct link to the land above, a link was established between land ownership and control, if not outright ownership, of the water found underneath the plot. While no specific groundwater legislation arose until the past decade, basic principles of access and control can be in part derived from the Easements Act, 1882. Under these principles, landowners have easementary rights to collect and dispose of all water found under their land.[4] There is thus an indissociable link between land ownership and control over groundwater. This implies that groundwater is mostly controlled by individuals or legal entities that own or occupy land. Where the common law principle is strictly applied, landowners are not restricted in the amount of percolating water they can appropriate.[5] It can, however, be argued today that, even under common law principles, owners cannot exploit groundwater beyond the replenishable level.[6]

The link between groundwater and land ownership is important for different reasons. Firstly, groundwater has been and is an increasingly important source of drinking water. This is due both to the existence of increasingly powerful pumping devices as well as to an increasing bias against the use of surface water as a source of drinking water to ensure that it is of better quality. Secondly, groundwater has been an increasingly important resource used by landowners in different types of economic activities. In fact, groundwater has now become in certain regions as important or even more important than land itself.[7] Besides agriculture, large-scale water abstraction is also carried out by certain industries, as in the case of water or soft drink bottling plants.

Where control over groundwater is linked to land rights, there are neither any incentives for individual landowners to sustainably use the resource nor any way to implement policies that take into account the welfare of a broader community and the environment. In what is for all practical purposes an unregulated system, there is, for instance, no authority that can determine how many wells, handpumps and other tubewells can be sunk in a given area. Some form of regulation that takes into account the broader aspects of groundwater use is thus necessary. Regulation is also required because the increasing use of groundwater controlled by private individuals may shift away control over water from communities. Thus, in the case of tank irrigation in Tamil Nadu that are often largely community managed,

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1 UP Panchayat Raj Act, 1947, s 15.

2 *Perumatty Grama Panchayat v State of Kerala* 2004(1) KLT 731 (High Court of Kerala, 2003), available at www.ielrc.org/content/e0328.pdf and *Hindustan Coca-Cola Beverages v Perumatty Grama Panchayat* 2005(2) KLT 554 (High Court of Kerala, 2005), available at www.ielrc.org/content/e0515.pdf.

3 This also holds in other parts of the world. For southern Africa, eg L.A. Swatuk, 'The New Water Architecture of SADC', *in* D.A. McDonald & G. Ruiters (eds), *The Age of Commodity – Water Privatization in Southern Africa* (London: Earthscan, 2005) 43.

4. *Halsbury's Laws of India Volume 29(2)* (New Delhi: Butterworths, 2000) 447.

5. M. Moench, 'Approaches to Groundwater Management: To Control or Enable?', 29/39 EPW A135 (1994).

6. Ground Water Management and Ownership Report of the Expert Group (NewDelhi: Government of India, Planning Commission, 2007) 23.

7. S. Janakarajan & M. Moench, Are Wells a Potential Threat to Farmers' Wellbeing? The Case of Deteriorating Groundwater Irrigation in Tamilnadu (Chennai: MIDS, Working Paper No. 174, 2002).

8. ibid 2.

increased use of groundwater and the lesser importance attached to tanks seems to have shifted the determinants of water access away from communities into the hands of individuals.[8]

The dramatic increase in groundwater use and importance of groundwater as a source of water have led to significant debates but relatively little by way of concrete policy decisions. To date, the most significant initiatives at the union level have been the drafting of a model bill for adoption by the states and the setting up of the Central Groundwater Authority mandated to regulate and control the use of groundwater.[9] Its mandate includes the notification of 'over-exploited' and 'critical' areas and the regulation of groundwater withdrawal in such areas but it does not have a broad mandate to regulate groundwater in general. The Authority is not credited with having had much impact in its decade of existence.[10]

This amounts to relatively little since, unlike irrigation water where the introduction of formal legislation started more than a century ago, groundwater was largely governed by principles that assumed self-regulation. The dramatic changes that have taken place in the past few decades and turned groundwater into the major source of water are not reflected in the existing legal framework, including in the states that have adopted the model bill as a prototype for their legislation, since this is not a comprehensive regulatory response. This can be partly ascribed to the fact that falling water tables can be 'fixed' for some time by simply digging further down. This has provided an opportunity for governments to avoid facing some difficult political choices. In fact, in a number of states, the answer to falling water tables has been not to address the issue itself. State governments have thus often chosen to increase power subsidies to make extraction of ever deeper layers of groundwater possible rather than tackle the underlying cause of depletion. The limits of an approach that not only refuses to control access to groundwater but seeks to encourage it with specific subsidies have been clearly understood. The unavoidability of a different response has dawned on most states but the fact that it is a politically extremely sensitive issue implies that some states may still further delay necessary measures by a number of years.

9 Ministry of Environment and Forests, Gazette Notifications SO38 and SO1024 of 14 January 1997 and 6 November 2000.

10 eg T. Shah, 'Groundwater Management and Ownership: Rejoinder', 48/17 *EPW* 116 (2008).

11 eg S. Koonan, 'Legal Regime Governing Groundwater', *in* P. Cullet, A. Gowlland-Gualtieri, R. Madhav & U. Ramanathan (eds), *Water Law for the Twenty-First Century: National and International Aspects of Water Law Reform in India* (Abingdon: Routledge, 2010) 182.

I. Ongoing Law Reforms concerning Groundwater

Groundwater regulation is one of the areas that are most in need of reforms.[11] This is due to the fact that groundwater is now the main source of water for most water users and that the current outdated framework can do little more than adjudicate claims that may arise between two landowners over their respective use of groundwater under their plot and in its vicinity. The challenge that groundwater poses has been recognized for quite some time, as witnessed by the fact that the union government already put out a model bill for adoption by the states in 1970. This relatively early date of adoption of the model bill is reflected in its approach to groundwater regulation. Indeed, in the early 1970s, there was comparatively little discussion of the need for control by panchayats over natural resources or water and environmental concerns had only just made an appearance on the agenda of policy makers. It is thus not surprising to find that the 1970 model bill reflects the concerns and perceptions of that period. What is more surprising is that, despite several revisions, the model bill (re)proposed in 2005 is still based in the same premises.

Groundwater law reforms are noteworthy for several reasons. Firstly, the proposed changes conform to a model that is neither directly in line with ongoing policy reforms in the water sector seeking to turn water into an economic good nor influenced by the 73rd/74th constitutional amendments, nor influenced by human rights and environment principles. Secondly, they perpetuate the sectoral treatment of surface and groundwater, perpetuate a system that links access to groundwater and land and fail to acknowledge that groundwater is the primary source of drinking water and thus primordial in the realization of the human right to water. Thirdly, ongoing reforms are based on suggestions for reforms that date back several decades. This implies that they are not directly influenced by new notions such as the idea that water should be seen as an economic good. This may be positive because it constitutes at least some sort of an alternative to the current policy framework for water law reforms,[12] but at the same time is not a solution that can be recommended because of its lack of social and environmental perspective and because it perpetuates a sectoral model of water law development.

A. The proposed reform model

A model bill for groundwater regulation was first proposed by the union

12 On water law reforms, *see generally* P. Cullet, *Water Law, Poverty and Development – Water Law Reforms in India* (Oxford: Oxford University Press, 2009).

13 Kerala Ground Water (Control and Regulation) Act 2002, available at www.ielrc.org/content/e0208.pdf.

government for adoption by the states in 1970. It has been revised several times but the basic framework of the latest 2005 version retains the basic framework of the original bill. Recent legislative activity by states indicates that they are generally ready to follow the framework provided by the model bill. This is the case of states adopting general groundwater legislation like Kerala,[13] or states focusing on its drinking water aspects like Karnataka, Madhya Pradesh and Maharashtra.[14]

The basic scheme of the model bill is to provide for the establishment of a groundwater authority under the direct control of the government. The authority is given the right to notify areas where it is deemed necessary to regulate the use of groundwater. The final decision is taken by the respective state government.[15] There is no specific provision for public participation in this scheme. In any notified area, every user of groundwater must apply for a permit from the authority unless the user only proposes to use a handpump or a well from which water is drawn manually.[16] Wells need to be registered even in non-notified areas.[17] Decisions of the authority in granting or denying permits are based on a number of factors which include technical factors such as the availability of groundwater, the quantity and quality of water to be drawn and the spacing between groundwater structures. The authority is also mandated to take into account the purpose for which groundwater is to be drawn but the model bill does not prioritize domestic use of water over other uses.[18] Basic drinking water needs are indirectly considered since, even in notified areas, hand-operated devices do not require the obtention of a permit.[19]

14. Karnataka Ground Water (Regulation for Protection of Sources of Drinking Water) Act, 1999, available at www.ielrc.org/content/e9905.pdf; Madhya Pradesh peya jal parirakshan adhiniyam, 1986, available at www.ielrc.org/content/e8603.pdf and Maharashtra Ground Water Regulation (Drinking Water Purposes) Act, 1993, available at www.ielrc.org/content/e9301.pdf. On the Maharashtra Act, S Phansalkar & V Kher, 'A Decade of the Maharashtra Groundwater Legislation', 2/1 *Law Environment & Development Journal* 67 (2006), available at www.lead-journal.org/content/06067.pdf.
15. Model Bill to Regulate and Control the Development and Management of Ground Water 2005, s 5.
16. ibid s 6.
17. ibid s 8.
18. ibid s 6(5)(a) only provides that the purpose has to be taken into account while Section 6(5)(h) which is the only sub-section referring to drinking water only considers it as an indirect factor.
19. ibid s 6(1).
20. ibid s 7.

The model bill provides for the grandfathering of existing uses by only requiring the registration of such uses.[20] This implies that in situations where there is already existing water scarcity, an act modelled after these provisions will not provide an effective basis for controlling existing overuse of groundwater and will, at most, provide a basis for ensuring that future use is more sustainable.

Overall, the model bill extends the control that the state has over the use of groundwater by imposing the registration of groundwater infrastructure and providing a basis for introducing permits for groundwater extraction in regions where groundwater is over-exploited. It is the brainchild of an era that promoted governmental intervention without necessarily thinking through all the checks and balances that needed to be introduced alongside. As a result, the model bill is not adapted to the current challenges that need to be addressed.[21] It fails to include specific prioritization of uses, does not specifically address the question of domestic use, does not differentiate between small and big users, commercial and non-commercial uses and does not take into account the fact that non-landowners/occupiers are by and large excluded from the existing and proposed system which focuses on the rights of use of landowners. It is thus surprising that states are still drafting acts based on this outdated model. What is required is legislation that recognizes that water is a unitary resource, that drinking water is the first priority as well as a human right and that panchayati raj institutions must have control over and use of groundwater.

B. Reforms in Practice

The Uttar Pradesh Groundwater Conservation, Protection and Development (Management, Control and Regulation) Bill, 2010 is the first response that UP has given to the call for groundwater legislation put out by the Central Government since 1970. It follows efforts by several other states that have already adopted groundwater legislation in the past decade.

While most states are yet to adopt legislation, the need for one now seems to be generally acknowledged. However, in an interesting twist, a state like Punjab that has 85 percent of its land under cultivation is not contemplating the adoption of groundwater legislation because of the impacts it would have on farmers.[22] Instead, Punjab is proposing to give incentives for crop

21. For additional comments, Ground Water Management and Ownership – Report of the Expert Group (New Delhi: Government of India, Planning Commission, 2007).
22. ibid 29.
23. Puducherry and Lakshadweep have also adopted groundwater regulation instruments, respectively in 2002 and 2001.

diversification, to invest in artificial groundwater recharge, to meter electricity supply in critical areas and to promote micro-irrigation.

The states that have already adopted legislation that specifically focuses on groundwater include Goa, Himachal Pradesh, Kerala, Tamil Nadu and West Bengal.[23] They differ in their coverage since some apply only to notified areas while other apply to all groundwater. As noted above, Karnataka, Madhya Pradesh and Maharashtra have adopted limited groundwater legislation focusing on drinking water.[24] The only state that has consciously put groundwater in a broader framework is Andhra Pradesh where the groundwater legislation directly links surface and ground water in a general context of environmental conservation.[25] Apart from a conceptually broader framework for groundwater regulation and specific consideration of drinking water issues, the Andhra legislation addresses groundwater in a similar manner to other groundwater acts.

The main institutional innovation proposed in the groundwater acts is the setting up of a new authority or cell made of government civil servants and members nominated by the government because of their expertise. The balance between civil servants and other members varies. In Goa, the act simply authorizes the government to nominate members without specifying their origin.[26] In Kerala only four of the thirteen members of the Authority are civil servants while the rest is made of a combination of people with different expertise.[27] In the proposed UP legislation, membership is overwhelmingly drawn from government circles with a couple of other members such as the provision for an NGO member.[28]

The authority set up is tasked with different functions in different states, such as notifying areas of special concern and granting permits to use groundwater in notified areas.[29] Among the acts that specifically focus on groundwater, the West Bengal legislation is the only one that gives the ~~Authority a broader mandate that include~~s the development of a policy to conserve groundwater and organizing people's participation and involvement in the planning and use of groundwater.[30] In this respect, the UP Bill is conservative and limits itself to providing for notification of areas threatened with over-exploitation of groundwater and granting of certificates of registration for use of groundwater.

Following on the steps of the model bill, most acts fail to clearly give drinking water priority of use even though most acts devote specific attention to the issue of drinking water.[31] The Himachal Pradesh legislation stands out insofar as it imposes on the Authority to give first priority to drinking water.[32] Additionally, some instruments specifically indicate that the use of groundwater as public drinking water source is not affected by any control measures.[33] The UP Bill does not break new ground in this regard and limits itself to giving special consideration to drinking water by, for instance, providing an exception to a complete ban on the construction of new wells in over-exploited/critical areas.[34] This does not specifically put drinking water supply in a hierarchically superior position for groundwater in general, something that is not only desirable but necessary in the context of the recognition of the fundamental right to water.

An important aspect of the majority of existing acts and the UP Bill is to avoid altogether the thorniest question, which is the legal status of groundwater itself. Most instruments avoid direct statements on this issue but the very fact of promoting the setting up of institutions controlled by the government that can regulate groundwater use in indirect and direct ways reflect a conception of water that sees it as being under the control of the government. The Himachal Pradesh legislation is rather forthcoming in this regard since it specifies that users of groundwater in notified areas must pay a royalty to the government for its extraction.[35] Additionally, the government is not even bound to use this royalty for groundwater-related activities, thus reflecting an understanding that groundwater is a resource controlled by the government.[36] This can be understood as an extension of the full control given by several irrigation acts adopted in the twentieth century to the government over surface water. It is, however, surprising for at least two reasons. Firstly, there has been only very limited debate on the

24. Maharashtra is in the process of adopting a broader groundwater legislation. *See* Maharashtra Groundwater (Development and Management) Bill, 2009, available at www.ielrc.org/content/e0917.pdf.
25. Andhra Pradesh Water, Land and Trees Act, 2002, available at www.ielrc.org/content/e0202.pdf.
26. Goa Ground Water Regulation Act, 2002, s 3(2), available at www.ielrc.org/content/e0201.pdf.
27. Kerala Ground Water (Control and Regulation) Act, 2002, s 3(3).
28. Uttar Pradesh Groundwater Conservation, Protection and Development (Management, Control and Regulation) Bill, 2010, s 3(2).
29. eg Himachal Pradesh Ground Water (Regulation and Control of Development and Management) Act, 2005, s 5, 7, available at www.ielrc.org/content/e0507.pdf.
30. West Bengal Ground Water Resources (Management, Control and Regulation) Act, 2005, s 6(2), available at www.ielrc.org/content/e0502.pdf.
31. eg Goa Ground Water Regulation Act, 2002, s 23.
32. Himachal Pradesh Ground Water (Regulation and Control of Development and Management) Act, 2005, s 7(3).
33. Goa Ground Water Regulation Act, 2002, s 9. Also Karnataka Groundwater (Regulation and Control of Development and Management) Bill, 2006, s 1(4), available at www.ielrc.org/content/e0623.pdf.
34. Uttar Pradesh Groundwater Conservation, Protection and Development (Management, Control and Regulation) Bill, 2010, s 18.
35. Himachal Pradesh Ground Water (Regulation and Control of Development and Management) Act, 2005, s 12(1).
36. ibid s 12(2).
37. *State of West Bengal* v. *Kesoram Indutries Ltd*, Supreme Court, (2004) 10 SCC 201.

status of groundwater and such a major change would warrant in-depth consideration. Secondly, if any change is warranted it would be to recognise groundwater as part of the public trust. Indeed, in the context of surface water, the Supreme Court has recognised that assertions of government power over water was not warranted anymore and declared that it was part of a public trust. In fact, the Supreme Court has already recognised at least once that groundwater is a public trust.[37]

Besides strengthening the control that the government claims over groundwater, the various acts adopt a non-confrontational strategy in refusing to tackle existing overuse of groundwater. Thus, in the main, acts provide for the grandfathering of most existing uses. This amounts to refusing to tackle the real problem affecting groundwater. Indeed, as long as it is landowners that have most control over groundwater, there will be no scope for groundwater regulation that is socially equitable and environmentally sustainable. There is no incentive in the common law rules or in the acts that are being adopted for individual landowners to use the water responsibly and equitably. There is also no mechanism to ensure that groundwater is shared with non-landowners. Further, without a broader perspective, no single water user has any reason to recognize environmental needs ensuring that all ecosystem functions are met in the long term.

The limits of the old common law regime and new legislative efforts are well illustrated in the context of the dispute between the Perumatty Grama Panchayat in Kerala and the Coca Cola Company.[38] The controversy erupted after the panchayat that first granted the exploitation licence decided not to renew it because of the lowering of the water table in neighbouring properties, as well as decreasing water quality to the extent that the local government primary health centre had concluded that the water was not potable.[39] The issue was brought to the courts and has been in the Supreme Court for some time. The two decisions given by judges in Kerala gave two opposed views of groundwater regulation. On the one hand, the first judge found that even without groundwater regulation, the existing legal position was that groundwater is a public trust and that the state has a duty to protect it against excessive exploitation.[40] Additionally the judge made the link between the public trust and the right to life.[41] It was thus recognized that a system which leaves groundwater exploitation to the discretion of landowners can result in negative environmental consequences. The next decision took a completely different perspective and asserted the primacy of landowners' control over groundwater.[42]

These two contradictory decisions illustrate the need for a framework that effectively ensures the sustainability of use of groundwater and the prioritization of drinking water over all other uses. Reliance on old common law principles is only able to justify individualized control but cannot in any way provide a broader framework of analysis. The inapplicability of the groundwater legislation to this dispute was noted by the judges. However, what is apparent is not the fact that the new legislation is not applicable but the fact that it would not have provided a framework for a more socially equitable and environmentally sustainable decision. The application of the act to future similar disputes may clarify matters in terms of institutional decision-making but it would likely lead to results fairly similar to the decision of the second judge. What is needed is a radically new perspective, something that the first judge perceptively understood.

IV. Need for a New Framework

Ongoing reforms of groundwater regulation including the UP Bill fail to bring in a regulatory framework that is either adapted to the needs of the twenty-first century or compliant with existing constitutional principles. Firstly, existing groundwater reforms fail to implement basic constitutional principles related to water that apply without doubt to groundwater. This is the case of the fundamental human right to water and the decentralisation amendments (73rd/74th amendments). With regard to the fundamental right to water, its application to groundwater is essential because groundwater provides most of our drinking water. Yet, groundwater legislation has only exceptionally focused on drinking water and never from a fundamental right perspective. With regard to the 73rd Amendment that gives panchayats control water management at the local level and minor irrigation, ongoing reforms conceived before 1992 are simply not in tune with the new constitutional requirements.

Secondly, existing reforms fail to address the core issue of the legal status of groundwater. The failure to abolish common law rules giving landowners overwhelming control over groundwater – as was for instance undertaken

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38. *See generally* S. Koonan, 'Groundwater: Legal Aspects of the Plachimada Dispute', *in* P. Cullet, A. Gowlland-Gualtieri, R. Madhav & U. Ramanathan (eds), *Water Governance in Motion: Towards Socially and Environmentally Sustainable Water Laws* (New Delhi: Cambridge University Press, 2010) 159.
39. C.R. Bijoy, 'Kerala's Plachimada Struggle – A Narrative on Water and Governance Rights', 42 *EPW* 4332 (2006).
40. *Perumatty Grama Panchayat v State of Kerala* 2004(1) KLT 731 (High Court of Kerala, 2003).
41. ibid.
42. *Hindustan Coca-Cola Beverages v Perumatty Grama Panchayat* 2005(2) KLT 554 (High Court of Kerala, 2005) para 43.

in post-apartheid South Africa – does not provide scope for bringing in a legal regime that is socially equitable and environmentally sustainable. The need for a drastic change in legal status is, for instance, illustrated by the fact that the first judge in the Plachimada decision felt that he could not take a just decision without asserting the extension of the principle of public trust to groundwater.

In addition to their failure to implement constitutional provisions, ongoing reforms also fail to take into account important objectives. Groundwater legislation is to date conceived largely as a natural resource legislation that fails to integrate the key social dimension of groundwater. Similarly, groundwater legislation fails to integrate existing environmental law principles, such as the precautionary principle. While water and environment are partly separate branches of law, they are also intrinsically linked as reflected in the fact that the Water Act, 1974 was conceived as an environmental legislation. The dismissal of environmental principles from the rest of water law is thus unwelcome and inappropriate.

The stringent limitations of current groundwater regulation reforms calls for a new conceptual paradigm and a new set of reforms. This goes against the advice of the Expert Group set up by the Planning Commission that 'no change in [the] basic legal regime relating to groundwater seems necessary',[43] but is called for by the limitations highlighted above. The new set of reforms needs to be based on the basic principles of the national legal framework as it exists today rather than what was prevalent in 1970. Two of the important novel aspects are the explicit recognition of the fundamental human right to water and the decentralisation amendments. Integrating both these elements requires a complete rethinking of the basic structure of groundwater legislation. In other words, an entirely new set of reforms is needed to ensure the implementation of these basic principles. Such reforms must, for instance, ensure that delinking land and water rights is undertaken in the framework of the human right to water that requires restricting or eliminating individual entitlements to water.

In addition, further reforms must benefit from advances in the scientific understanding of the water sector. This should lead to the development of laws that do not make artificial divisions between surface and groundwater for instance. This is problematic because the disconnect does not exist in practice and leads today to absurd results because the basic principles governing surface water and groundwater are different.

43. Ground Water Management and Ownership – Report of the Expert Group (New Delhi: Government of India, Planning Commission, 2007) 41.

Finally, the reforms must be based on recent legal developments within water law and in related areas. This includes the need to extend the principle of public trust, which has been repeatedly confirmed by the Supreme Court for more than a decade, to groundwater and the need to integrate the precautionary principle, a basic principle of environmental law that is directly relevant in the case of groundwater.

Overall, the existing Uttar Pradesh Groundwater Conservation, Protection and Development (Management, Control and Regulation) Bill, 2010 is a good start towards moving away from the inequitable and environmentally unsustainable legal regime concerning groundwater prevailing since colonial times. At the same time, it needs to be given much more thought to provide an effective response to the challenges that need to be addressed in 2010 and for the next few decades. The Bill needs to make much bolder attempts at breaking away with the past and at ensuring the integration of the basic principles of water law such as the fundamental right to water and the principle of public trust.

7

Groundwater Management: The Critical issue dealing with Normative Concerns of Equity and Sustainability in Watershed Development in India

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ABSTRACT

The importance of groundwater in India is very highly significant as, around 50% of irrigated agriculture and 85% of rural drinking water supply in India is based on groundwater. Conventionally, by and large surface water is commonly agreed as public good in its limited sense. But, in the case of groundwater, it is totally reversed to surface water-access and ownership regime. In India due to lack of the clarity in various water related laws, the ownership of land carries with it the ownership of the groundwater under it. It has been said that, groundwater is attached, like a chattel, to land property, and 'there is no limitation on how much groundwater a particular landowner may draw' (Iyer 2003). Also, there is no specific reference to groundwater in Indian Constitution, we assume that 'Water' in Constitution also include 'Groundwater'. Entry No.17 in list of state subjects and entry No.56 in list of union subjects give the impression that constitution-makers were primarily thinking about the river waters only.

Right to water is closely linked to ownership of land in India and the person who owns the piece of land has have a full ownership right to use as well as exploit groundwater under his piece of land, as well as from neighbouring land. Basic argument for the paper is that, due to this unfair rule, landless and resource poor are thrown out from various benefits of the groundwater which are generated through watershed development and waters conservation projects. In current national water related legal framework, only those owning land can have right over groundwater, and various communities including landless, tribals and others who may have been using certain natural resources for centuries, have no any legal space and stake in water rights.

Through, few isolated pioneering efforts have been made by local initiatives such as, Sukhomanri watershed project in Haryana by according water rights and share to landless people with strong local institutional base , and Pani-Panchayat in Maharashtra by de-linking surface water rights from land ownership towards equitable and sustainable use of groundwater as well as surface water, but unfortunately till present there is no any connected, nationwide effort to treat groundwater with these principles in India. In this context, the issue of ownership regime and right to groundwater becomes the crucial, because with our watershed development and management approach, we are converting public good into private good. It means current watershed development approach is targeted towards converting surface and rain water in groundwater by various watershed biophysical interventions. This process forces resource poor to deny the benefits of groundwater, as water rights fully depend on land ownership in current legal system.

So the major concern of this paper is the benefits groundwater and specific the watershed management, from the point view of the equity in benefit, sustainability of resources in overall background of human wellbeing, in the present legal framework is unjust, unfair and unjustifiable, because the ownership of water vests in the owner of the land. Challenging this land-water ownership based legal positions and paradigm shift in approach, from groundwater as private good to common pool resources in the context of water as public trust is the only possible solution to critically deal with this type of unsustainable and hegemonic natural resource based development, because these issues are very closely linked with equitable distribution of water rights and the poverty-reduction of resource poor in rural India in wider framework of Human wellbeing.

Keywords: *Groundwater, Equity, Sustainability, Legal Framework, Watershed Development*

1. INTRODUCTION:

Water is perceived with various dimensions by various stake-holder groups, these perceptions varies from water as basic right (human and fundamental right), scared natural resource, common pool resource, sacred resource, commodity to water as economic good to public trust. The conflicting issue around these various perceptions is the questionable shift of 'right-based perspective' to economic good as 'market based perceptive'. 'The major principle behind market based perspective, which is guiding the current water reform process, is that all uses of water should be seen from the perspective of its economic value, because the absence of an economic perspective in the past explains existing unsustainable uses of water' (Philip 2007). As a result, the emphasis is on water as a natural resource, which must be harnessed to foster the productive capacity of the economy, from irrigation water for agricultural production to water for hydropower. Also,

National Water Policy explains its concern that an insufficient percentage of water is currently harnessed for economic development and even calls for 'non-conventional' methods of water utilisation such as inter-basin water transfers and seawater desalination as large-scale, high technology solutions to improve overall water availability. Thus, beyond the relatively old characterisation of water as a natural resource, the underlying proposition for water sector reforms is that water is to be seen as an economic good. This implies an important shift in terms of the rights of control over and access to water. In fact, this leads to a complete policy reversal from the perspective that water is a public trust to the introduction of water rights and the possibility to trade water entitlements.

It is interesting to note that as an economic good, water shares certain noteworthy features such as, 'all water services must be based on the principle of cost-recovery' (Word Bank 1998). In the situation where the provision of drinking and domestic water as well as irrigation water is substantially subsidised, this implies a significant policy reversal. At the national level, the policy is now to make water users pay at least for the operation and maintenance charges linked to the provision of water. This strategy is already being implemented in the context of irrigation water where farmers are made to pay for operation and maintenance costs.

2. WATERSHED DEVELOPMENT IN INDIA :

2.1 Brief history and approach:

'Watershed development programs are recognized as a potential growth-engine for agricultural growth and development in underdeveloped and marginal rain-fed areas' (Joy et al. 2004). Approximately 65 percent of all agricultural land in the country is rain-fed, and it was anticipated that watershed-based eco-restoration programs could effectively meet the emerging and complex challenges of these areas, namely deplorably high poverty, unemployment and acute degradation of natural resources. It was thought that these programs would accelerate the development of a second green revolution in the rain-fed areas. 'The watershed program is a land-based program, which is increasingly being focused on water, with its main objective being to enhance agricultural productivity through increase in moisture conservation and protective irrigation for socio economic development of rural people' (Samuel et al, 2006). An important concern in watershed development is the equitable distribution of the benefits and sharing of the costs of land and water resources-development and the consequent biomass production.

Though the watershed program in India was initiated more than four decades ago, the activities were more vigorous and seriously conducted only during the 1990s, particularly after the worst drought of the 20th century in 1987. The first generation watershed programs focused on soil conservation and catchments protection of reservoirs while second generation watersheds focused more on water conservation and improvement of irrigation and moisture conservation. Successful watersheds projects which emerged in early 1980s, such as Ralegan sidhhi, Adagaon and Pimplalgaon Wagha in the state of Maharashtra, and Sukhmajori in Haryana as well as, PIDOW (Participative Integrated Development of Watersheds) projects in Karnataka laid a foundation for participatory approach in watershed development. These projects also proved that stakeholder participation could lead to better development and management of natural resources and promote village development processes by ensuring appropriate technology choices and incentives for sustenance at farmer level, institutional arrangements for management and maintenance at village and community level.

'The Government of India through different ministries has invested more than US$2 billion during the last 50 years for Watershed development under various programs until 1999-2000' (Joshi et al, 2004). In the past, several useful studies and reviews were conducted to assess the impact of watershed programs, and to examine people's participation and to evaluate watershed impacts, these studies have mixed conclusions on the performance of watershed programs in achieving the expected economic and environmental outcomes. These evaluation studies provided useful insights on the performance of numerous watersheds and examined conditions for the 'success' of the watershed programs across different geographical regions of the country, but many these studies are focused on only increased bio-physical impacts of the watershed projects

2.2 Equity and sustainability concerns in watersheds development:

'Watershed development by its own logic, often promotes inequitable outcome' (Joy et al, 2005). This is so because the nature of benefits is based on the status of landownership and one's spatial location within the watershed. Though few popular 'successful' watershed development programs had succeed in its limited sense on its bio-physical impact-outputs, such as land and crop productivity and soil and water conservation, still most of them are much behind on equity and sustainability concerns as outcome. Resource poor groups as, landless people, women and people from SC/ST communities besides, their contribution and participation in watershed development has no or very less direct incentives and share in

newly developed resources and newly generated benefits such as water. This is mainly due to the lack of clarity about the groundwater issues in National Water Policy and watershed framework, which lead to transmit that, the person who owns the piece of land has have a full ownership right to use as well as exploit ground-water under his piece of land as well as from neighbouring land. This much complicated linkage of ownership rights to land and groundwater-use is important policy and institutional issue in watershed development.

This resource ownership issue in watershed development become crucial, because 'well defined property rights and collective action institutions fundamentally shape the outcomes of resource governance' (Knox and Meinzen 2001). When the water rights are linked with land rights, private investment in water use may lead to depletion of groundwater resources. This is a classic common property externality where the action of any one economic agent increases the social costs of resource use for the entire community and the individual user lacks the incentive to limit his/her level of use. Understanding this linkage is also important because, individual choices have collective consequences in the watershed framework. Even in landholders group, action of one group of stakeholders in one location affects adversely (or favourably) on other groups of stakeholders in a different location within micro watersheds. Often these different stakeholder groups and locations have conflicting objectives with respect to their investment priorities and enterprise choices, for example rain-fed farmers show much interest in on farm or land related watershed treatments as farm bunds, land levelling and contour bundings where as irrigated farmers interest is much upon waters harvesting structures or treatments helping to raise ground water table such as Check dams, earthen bunds, village tanks, and farm ponds. Resource poor, specifically landless people only expects some investment in watershed plus interventions such as loans and other livelihood supports, because generally except labour opportunities in project implementation phase they do not find any direct benefit of land and water based watershed treatments. So, the assured rights to resources as water and land, at least to newly generated resources are important incentives and concerns for the all type of stakeholder groups including resource poor to undertake watershed development work.

2.3 Convergence of Public good into Private good: Questionable Watershed approach:

In National Water Policy, the issues such as, clarity on the rights to groundwater as well as surface water and complete recognition of the rights of communities to manage water resources through collective action are missing completely. 'The policy also fails to address the individual and community rights on surface and groundwater' (Philip 2007). Despite this, surface water is seen and widely accepted at community level, as common pool resource, and generally most of people irrespective of caste, class and gender, except few cases have access to surface water. Thus by and large surface water is commonly agreed as public good in its limited sense. This situation is fully reversed compare to groundwater, because the individual who owns a given piece of land has the full right to use and exploit groundwater under his/her land as well as neighbouring land. In the Watershed framework, the community conserves the rainwater and recharges the groundwater using check-dams and other recharge facilities, but this recharged water is the 'free offer' for only landowners and 'nothing' for landless groups. Thus, in the absence of appropriate regulatory mechanisms and institutional arrangements for distribution of benefits across households including the landless, the private landowners capture the irrigation benefits from increased availability of groundwater.

Due to this unjust rule about linking water-rights to land-rights, landless and resource poor are thrown out from benefits of the ground water, and our traditional approach of water conservation in watershed development becomes questionable in equity and sustainability background of watershed benefits. When rights are properly defined and secured, there is an incentive to invest on fixed assets and optimally allocate these for enhancing productivity and augment income. It is therefore important that the interest of all households in the Watershed is protected and equal rights of regenerated natural resources are accorded to encourage them to participate in conserving these resources. The current watershed framework and approach as well as water policy fails to address this important issue in watershed management.

3. GROUNDWATER AND LEGAL FRAMEWORK:

3.1 The Importance of Groundwater:

Groundwater in India has registered phenomenal growth and development in recent years because of some specific reasons. The highly variable nature of rainfall makes groundwater the most popular alternative for irrigation and domestic water use across India and this dependence on groundwater resources is particularly critical where dry season surface water levels are low or where wet season flows are too disruptive to be easily tapped. Groundwater source of water is also economically cheap, quicker to tap and is more productive than even canal irrigation system. It can be applied exactly when it is required to its extent for the crops. It gives the security to the farmers and confidence on the vagaries of weather. Also, it gives full irrigation to arid and semiarid regions and seasonal supply to other areas to supplement irrigation. Agriculture remains central to the

Indian economy and it therefore receives a greater share of the annual water allocation. According to the World Resources Institute (2000), 92% of India's utilizable water is devoted to agriculture sector, mostly in the form of irrigation. Groundwater alone accounts for 39% of the water used in agriculture and surface water use often comes at the expense of other sectors such as the industrial and domestic supply. For major part of the India, especially rural India, groundwater is the most significant source for drinking, domestic, livestock and livelihood support needs of the people.

3.2 Why Groundwater Legal Framework?

The increasing depletion of water resources, in particular groundwater, has led to the realisation that existing rules concerning the use of groundwater were unable to respond to a situation of water scarcity. As a result, the central government has put significant emphasis on the development of groundwater laws by the states. According to the International Irrigation Management Institute (IIMI), the water table almost everywhere in India is falling at between one to three meters every year. Furthermore, the IIMI estimates that India is using its underground water resources at least twice as fast they are being replenished. Legislative interventions concerning groundwater are significant for two main reasons. Firstly, from a legal perspective they constitute a major organised attempt at redrawing the rules concerning control and use of groundwater, which is still otherwise largely based on common law principles that make it part of the resources a landowner can use largely without outside control. Secondly, they constitute a response to the fact that over time groundwater has in various areas become the most important source of water and provide in particular '80 per cent of the domestic water supply in rural areas and supports around 70 per cent of agricultural production. This strengthens the case for ensuring the sustainable use of groundwater' (Nations World Water Development Report 2003).

Besides legal frameworks, a number of common law principles linking access to water and rights over land are still prevailing in India. These include separate rules for surface and groundwater. With regard to surface water, existing rules still derive from the early common rule of riparian rights. The basic rule riparian right framework was that, riparian owners had a right to use the water of a stream flowing past their land equally with other riparian owners, to have the water come to them undiminished in flow, quantity or quality. In recent times, the riparian right theory has increasingly been rejected due to its inappropriate basis for justifiable and equitable water claims. Further, common law rights must today be read in the context of the recognition that water is a public trust. If this principle is effectively applied in the future, it would have important impacts on the type of rights and privileges that can be claimed over all type of water, including groundwater. Common law standards concerning groundwater have existed longer. The basic principle was that access to and use of groundwater is a right of the landowner. In other words, it is one of the rights that landowners enjoy over their possessions. The inappropriateness of this legal principle has been rapidly challenged during the second half of the 20th century with new technological options permitting individual owners to appropriate not only water under their land but also the groundwater found under neighbour's lands. Further, the rapid lowering of water table in most regions of the country has called in questioning legal principles giving unrestricted rights to landowners over groundwater. Similarly, the growth of concerns over the availability of drinking water in more regions has led to the introduction of social concerns in groundwater regulation. As a result of the rapid expansion of groundwater use, the central government has tried since the 1970s to persuade states to adopt groundwater legislation. It is only over the past decade that some states have eventually adopted groundwater acts. The legal framework concerning groundwater is still in rapid evolution. It is likely that common law principles will be increasingly challenged despite the fact that the Plachimada high court decision seems to uphold landowner's rights to a large extent. Further, groundwater is increasingly likely to be linked to surface water in the context of the setting up of water regulatory authorities that are called upon to manage surface and groundwater. The existing legal framework concerning water is complemented by a human rights dimension in its limited sense. While the Constitution does not specifically recognise a fundamental right to water, court decisions believe such a right to be implied in Article 21 (right to life). In the Sardar Sarovar case, the Supreme Court went further and directly derived the right to water from Article 21. It stated that 'water is the basic need for the survival of the human beings and is part of right of life and human rights as enshrined in Article 21 of the Constitution of India. While the recognition of a fundamental right to water by the courts is much clear, its implementation through policies and acts is not as highly developed.

3.3 Past and ongoing legal-efforts in this direction in India:

3.3.1 Groundwater Model Bill 2005:

Groundwater has until recently largely been governed by old legal principles linked to a large extent to land ownership. 'Further in India, like in many other countries, from a legal perspective groundwater has until now been largely treated independently from surface water even though links have increasingly been acknowledged' (Philip 2007). As a result, until a few decades ago, there was little by way of statutory provisions concerning groundwater use and control and the central government's intervention in this area was even less prominent than with regard to surface water. The increasing use of groundwater has led a spurt of legislative activity, which seems to be accelerating. At the national level, even though the central government would find it difficult to justify groundwater legislation under the constitutional scheme, several attempts have been made over the past

few decades to provide a model law that individual states can adopt. The first attempt dating back to 1970 did not have much success since virtually all states ignored it. More recent versions of the Model bill, including the latest version unveiled in early 2005 are having more influence on legislative activity because groundwater regulation has become a priority in many states. In fact, several progressive states such as Kerala, Goa have proposed groundwater related laws, which are related to the model law.

The basic scheme of the model bill is to provide for the establishment of a groundwater authority under the direct control of the government. The authority is given the right to notify areas where it considers necessity to regulate the use of groundwater. The final decision is taken by the respective state government. There is no specific provision for public participation in this scheme. In any notified area, every user of ground after must apply for a permit from the authority unless the user only proposes to use a hand pump or a well from which water is withdrawn manually. Decisions of the authority in granting or denying permits are based on a number of factors, which include technical factors such as the availability of groundwater, the quantity and quality of water to be drawn and the spacing between groundwater structures. The authority is also mandated to take into account the purpose for which groundwater is to be drawn but the model bill, mirroring in this the acts analysed above, does not prioritise domestic use of water over other uses. It is remarkable that even in non-notified areas, any wells sunk need to be registered. The model bill provides for the grandfathering of existing uses by only requiring the registration of such uses. This implies that in situations where there is already existing water scarcity, an act modelled after these provisions will not provide an effective basis for controlling existing overuse of groundwater and will at most provide a basis for ensuring that future use is more sustainable. Overall, the model bill constitutes an instrument seeking to broaden the control that the state has over the use of groundwater by imposing the registration of all groundwater infrastructures and providing a basis for introducing permits for groundwater extraction in regions where groundwater is over-exploited. Besides providing a clear framework for asserting government control over the use of groundwater, the model bill also shows limited concerns for the sustainability of use. From this perspective, the model bill and the acts based on it are a welcome development that should provide scope for better control over the use of groundwater in general. However, further thinking needs to be put in making the model bill sensitive to social concerns. Some important provisions are currently missing from the model bill. These include the need to prioritise among uses and to put drinking and domestic water as the first priority. Further, the model bill does not differentiate between small and big users of groundwater, commercial and non-commercial uses and does not take into account the fact that resource poor, mainly landless people are by and large excluded from the existing and proposed system, which focuses on the rights of use of landowners.

3.3.2 Water Regularity Authorities: MWRRA -2005:

The Maharashtra Water Resources Regulatory Authority (MWRRA) is set up in August 2005 under the MWRRA Act. Its main function is to fix the waters charges for various water uses such as agriculture, industrial, drinking and other purposes and to regulate the water resources of the State. MWRRA has been established to regulate the water sector in the State, and is the first such Authority in the country, with such a specific mandate. Maharashtra Water Resource Regularity Authority presently has been going through many public-hearings and discussions organised with various stakeholders groups and civil society groups for consultations, but unfortunately it do not clarify and not concerned with water rights to resource poor and particularly with groundwater issues, rather it seems that authority is much eager to make privatisation of all water sources. Authority is also aiming to fix the water charges for all type of water users through the effective 'participation' of Water User Association (WUAs). The major critics of authority among civil society is that with this effective 'participation' of Water User's Association, state is trying to make assured own self for collection of water charges to meet operational, maintenance, management and administrative expenses by displacing or extinguishing existing local rules and arrangements. The significant issue emerges with this generated discussion is that, it is shift in perspective from water as 'right based perspective' to water as 'market-commodity', which has wider implications with resource poor groups. In addition to all these formal past and ongoing laws, rules and regulation that make up water law, there is a substantial body of additional rules and regulations at the local level. These include the multiplicity of written or unwritten arrangements that regulate access to and use of water for domestic purposes or irrigation. An array of different rules govern, for instance, access to existing sources of drinking water. They run in many cases along caste lines even though other rules of access also exist. There are many past and ongoing painful incidences in India, which have caste-based inhuman treatments, denial and exclusion to water sources by upper caste people to dalits (Scheduled Caste and Scheduled Tribes) and other minorities. With regard to irrigation water, all local rules and wisdom related to tanks and check dams such as a system of water allocations, rules of access and control have often evolved over long periods of time but are often unwritten or not formally recognised in the legal system. As a result, they often run in parallel to 'formal' water rules and regulations. Another consequence of the lack of visibility of local level arrangements is that they can easily be displaced or extinguished by new laws that may fail to even acknowledge their existence. While certain principles have remained relatively constant until recently like the assertion of the state's right to use surface and ground water in the public interest, there have been a number of changes over time in the basic structure of water, from the recognition of a human right to water to the introduction of the public trust perspective.

The general picture, which emerges from above discussion, is that there is multiplicity of principles and rules, a multiplicity of instruments and the lack of an overall legal framework concerned with well defined groundwater rights, specifically to resource poor.

4. Conclusion:

Collective ownership of groundwater may be the suitable approach to deal with this groundwater conflicting ownership regime issue. Under such arrangements, indigenous institutions and community norms could be evolved to allocate trade rights to groundwater, so that landless people and labourers could also benefit. Strong local-level institutions can increase the viability and sustainability of watershed management programs by empowering the community to manage and maintain the assets created under the Project. The popular watershed projects such as 'Sukhomanjri' in Haryana , where the rights on Water, fuel and fodder were accorded to each household in the village irrespective of land ownership and each household was allocated equal rights on water, fuel and fodder, even the landless labourers enjoyed such rights, has already showed successful pathway in this direction. The pioneering work by Pani Panchayat, initiated by late Vilasrao Salunkhe in Maharashtra to de-link water rights from land ownership by providing per capita water irrespective to landownership, is a path-breaking experiment in this direction. So strengthening and empowering of water related local institutions, however, needs to be done through a continuous process of capacity building, which includes not only technical training but also human resource development for upgrading communication skills, building confidence and leadership, decision-making and conflict resolution, along with clearly mentioned rights over resources of all the stakeholders including landless .

Thus, the claims that landowners have right over groundwater under common law principles may not be compatible with a legal framework based on the human right to water and the need to allocate water preferentially to domestic use and to provide water to all, whether landowners or landless on a equal basis. So in the background of legal framework, here is the argent need to rethink and challenge current watershed approach and framework in India, for the equitable and sustainable benefits of the watershed projects. However, due to various complexities involved with groundwater issues, we do not claim that, the adoption of any type of comprehensive groundwater legislation is the only precondition to ensure and achieves its social, human rights and environmental goals, but we assert that, this would constitute an appropriate starting point to realise the right to groundwater and the principle of public trust throughout the country.

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8

Today Groundwater Issues: Technical vs. Administrative

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By 2025, the population of India will grow by more than 140 crores. The water required to produce food for this expanding human population will multiply several times that too under intense climatic factors. The multiplying demand of water has to be met through the major share of groundwater. As against the total water demand of 634 km3, the total available utilizable water resource of the country is 1123 km3. Out of which, the surface water resource is 690 km3 and annually replenishable dynamic groundwater resource is 433 km3. At present, the annual groundwater draft is 231 km3. Out of which 213 km3 (92%) is used for irrigation and 18 km3 is used for domestic purposes and industries. On an average, more than half of the 399 km3 dynamic groundwater resource is being utilized. By 2025, the total water demand is expected to increase from 634 to about 1093 km3 . Keeping the same ratio, the groundwater draft will increase from 231 to 398 km3 against the available resource of 399 bcm. That is, almost fully utilizing the available dynamic resource which has to be constrained through immediate measures as the crisis in future may become more serious and complex sooner than what we can imagine. Groundwater resource sustainability requires alterations in governance, social attitude and economic framework. The scientists and engineers will have to work with the local people and come out with simpler techniques to tame the complex issues of groundwater management in time before they take gigantic magnitudes.

As seen the day by - day deepening crisis of water has been compounding the stress upon groundwater. Consequent is the continuously lowering water table over almost two third of Uttar Pradesh. With each passing day the situation has become alarmingly grave in major urban agglomerates of the state. Precisely, today the groundwater management involves four aspects:

- Linking deficient/surplus river basins and rejuvenating old surface water bodies
- Storing groundwater and trapping rain water
- Austerity in useage both in agriculture and human consumption
- Alternate aquifers in terms of depth range & areas

The first and second points are already high in the agenda and serious efforts are being attempted. Ken Betwa link is nearing finalization. Sarda water is planned to be brought for Lucknow city. Now, hopefully practical measures are on formulation for large scale adoption of rain water harvesting in urban sprawls. Farmer Participatory Action Research Programme (FPARP) in coordination with NREGA is another milestone. Success story of Hewre Bazar (Maharastra) is also being tried to be replicated in the profile of FPARP. The cushion of NREGA with FPARP is definitely a very novel idea and shall yield quick results.

But where is the austerity in usage, be it urban centre or a rural side?

Is it not the hard fact that austerity cannot be enforced without appropriate pricing !

Which are the alternate area or / and alternate depth ranges for today & tomorrow ?

Is it not true that alternate area or alternate depth ranges are not tried merely for the reason of convenience!

The formidable issue confronting all the major urban agglomerates of the country is dependency upon groundwater to augment drinking water requirement. The groundwater withdrawals are from the shallow proven aquifers since times immemorable , the zones are impoverishing day by day. Subsequent is the continuous lowering of the water table , resulting into loss of elasticity of the phereatic zones and then another very likely natural calamity land cracks / subsidence to befell , following the first heavy downpour . At this critical juncture if we are really serious to salvage the crisis , following two factors need be addressed by soul & spirit ,

1. Groundwater scientists and engineers do not work in consonance

2. Administration and Judiciary fall out

Groundwater scientists and engineers do not work in consonance

The scientific studies being taken up from time to time by groundwater departments are not taken up at execution level by user departments .The user departments go on exploiting the resource from the conventional proven areas as well as the depth ranges. The myopic vision could not see beyond today. And the situation has been turning from bad to worse. The show has been somehow going on but now the consequences of permanent damage have started manifesting .It must be frank admission that the user deptts have never been considered more financial outlays for deeper withdrawals from tubewells or the cost of transportation of water away from the cities.

In this context select trend-setting studies done by Central Ground Water Board are showcased.

LUCKNOW

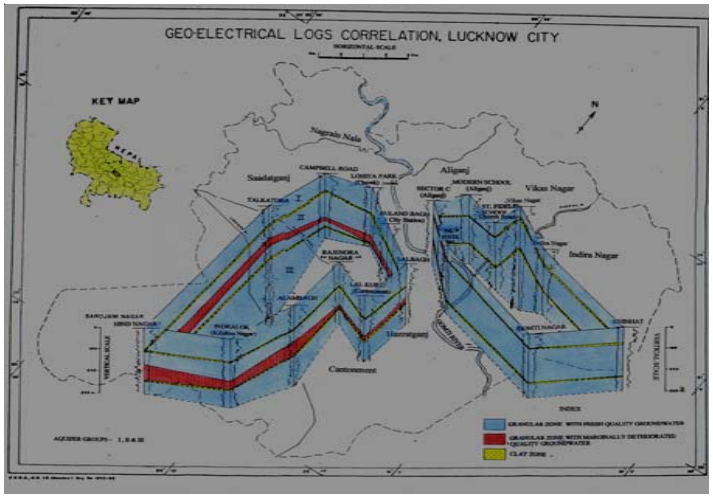
Cis-Gomti

- Stop all the withdrawals from within 100 m bgl.
- All groundwater withdrawals shall be from Alambagh-RDSO-Talkatora tract from granular zones in the depth interval 100 to 400m bgl, taking due care of marginally deteriorated quality water zone. In the central city area the aquifers are poorly developed all through the depth of 400m
- An intermediate zone of marginal to marginally deteriorated quality water, correlatable and varying in the depth interval 140 & 200 m bgl pervades all over the area
- A thin (10 to 30 m) zone of marginal quality (<2000 S/cm) encountered in the central city area Chowk, Aminabad, Lalbagh, Hazaratganj, Hussainganj, Rajendra Nagar and Charbagh not to be tapped but do not need to be effectively cement sealed
- Relatively thick (30 to 70 m) zone of marginally deteriorated quality (>2000 & < 3000 S/cm) water has affected the southern Talkatora, RDSO, Alambagh &HindNagar,south eastern Raj Bhawan & Ganjaria and western tracts Thakurganj & Balaganj. This zone need be cement sealed
- Put back the rain water harvested from the roof tops in the top granular zone disposed between 30 to 50m.

Trans-Gomti

Stop all the groundwater withdrawals from within 75 m bgl

All groundwater withdrawals from Church Road(St.FidelisCollege)-IndiraNagar-Ghazipur-Chinhat and Aliganj (Sec.K) Janakipuram - Mandion



tracts from granular zones in the depth interval 100 to 400 m bgl

- Groundwater quality is fresh all through the depth explored (~ 600 m)
- Put back the rain water harvested from roof tops in the top granular zone disposed between 30 to 70 m bgl.

KANPUR

. Characteristically over whole of the city, the granular zones in the depth interval 200 to 400 m bgl are better developed as compared with those above 200 m bgl and also more wholesome in the proximity of the river Ganga.

· All the groundwater withdrawals from Kidwai Nagar Juhi -Babupurwa Sujatganj Baradevi-Sutarganj and around Jajmau & chakeri area from the granular zones in the depth interval 100 to 400 m bgl.The marginal quality(~1500 S/cm) water column only to be excluded from tapping and may not be cement sealed

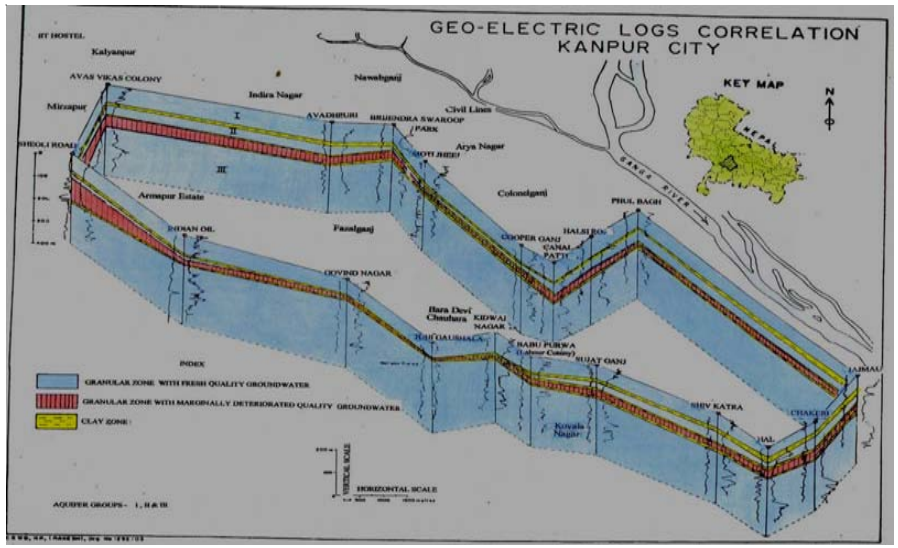
· An intermediate zone of marginal (~1500 S/cm) to marginally deteriorated (~3000 S/cm) quality water pervades whole of the city.The zone is correlatable and occurs in the depth interval 105 and 200 m bgl.

The column thickens (40 to 80 m) as well as relatively deteriorates (~ 3000 S/cm) on the eastern Jajmau, Chakeri- HAL- Shiv Katra and on the western Panki Sheoli Road Kalyanpur tracts.Therefore, need be effectively sealed for development of other aquifers .

The column is marginal in quality as well as thins (10 to 30m) in the central city Kidwai nagar BaraDevi-Juhi SutarganjCooperganj

· Stop all the withdrawals from within 100 m bgl

· Put back the rain water harvested from roof tops in the top granular zone disposed in 20 - 60 m bgl



NCR PART OF UTTAR PRADESH

The National Capital Region (Meerut , Ghaziabad & Bulandsahar) of Uttar Pradesh was scanned for identifying the superior aquifers which can remain sustainable for all the foreseeable years to come to augment drinking water needs of Delhi. Nearly 40 geophysical logs in the area were correlated to evaluate the 4 tier aquifer system . It was found that an area measuring 1000 km2 surrounding Hastinapur (Meerutdist.) encompassing Babugarh,ShatabdiNagar,Macchara,GangaNagar,Lawad Khas & Hastinapur underlies prolific aquifers down to 300 m bgl .Even 50 tubewells of 300 m depth under standard inter-spacing norms can yield 300 MLD water, while Delhi itself is able to augment 500 MLD from groundwater , against around 4000 MLD requirement.

This area was recommended for development in the depth interval 100 to 300 m bgl to furnish 300 MLD water for Delhi.

MATHURA

The area lying between Yamuna river and 1500 ohm-m 2 contour underlies fresh quality groundwater down to bedrock , occurring minimum down to 150 and maximum down to 234 m bgl. This total tract measures 6 sq. kms in area and on an average, underlies 150 m thick fresh water column. The area is getting recharged from the adjoining Yamuna river , which carries full stream of water at least for one to two months in a year.

As per conservative estimates , keeping a modest specific yield of 10% in view of fine sediments , the 6 sq. kms area is computed to house 72 MCM fresh water. Out of this the safely exploitable resource comes out to be 50 MCM. For 20 lacs projected population of Mathura city the net drinking