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Original Research Article

Groundwater Regulation and Management Practices in Karnataka–Status and Challenges

G. B. Ramesh*, G. B. Lokesh and Kashinatha Dandoti

Department of Agricultural Economics, UAS, Raichur, Karnataka-584104, India
**Corresponding author*

A B S T R A C T

Groundwater resource in Karnataka is under severe stress for years owing to increasing demand and unwise planning. About 30 per cent of the state has been over exploited and the over-draft is estimated to be about 0.22 million hectare meters. The problem is so acute that it is likely to cause severe social stress and strong agitations. The groundwater exploitation went unabated due to absence of any institutional control. The current practice of water management is not supported by legislative control of these adverse impacts. Karnataka is largely dependent on groundwater to meet industrial, municipal, domestic and irrigation needs. This is due to variations in the availability of precipitation and lack of perennial surface water bodies. Government of India had circulated a model Bill for regulation of extraction of Ground Water (Water Resources Department, 2010). The Central Government has since then repeatedly been urging the State Government, to pass an appropriate legislation to introduce regulatory measures to protect sources of drinking water in rural areas. As a result, groundwater extraction in Karnataka has increased very rapidly over the past four decades. It has also witnessed rapid expansion of groundwater irrigation during the last five decades. Groundwater is now used so extensively that we can no longer afford to overlook the consequences. At the local level, an increasing number of districts today have larger areas of land irrigated by groundwater rather than surface water (GoK, 2002). Besides, more than 90 per cent of rural water supply schemes are based on groundwater. With lack of adequate legal safeguards to control extraction and use of groundwater, the issue has become more of a collective responsibility now. The number of mechanized wells and tube wells also illustrates the rate at which groundwater irrigation has spread. At a macro level, there has been a steep increase in the number of wells running dry due to over exploitation of groundwater. Further, nearly 42 per cent of the total area in Karnataka has been overexploited and further groundwater development is creating several adverse externalities.

Keywords

Groundwater regulation, Externality, management, institutional

Introduction

The spread of groundwater irrigation began in the 1950s in Karnataka. Since then, Karnataka has witnessed three distinct phases of groundwater development mainly due to institutional and technological changes. Later, due to aquifer development, the groundwater scenario changed drastically leading to groundwater overexploitation. The first phase that commenced in the 1950s was dominated by traditional dug wells with depths ranging between 25-30 feet and a diameter of 25 feet. In the second phase from 1960s to 1990s. The major mode of water extraction

during this period was the 'Persian wheel' and other labour-intensive devices. There was combined use of groundwater and tank water for irrigation. Ground Water is a major source of water to meet >60% irrigation requirements, >85% drinking water requirements in rural area and >50% requirements in urban areas and industries. Ground Water development is privately owned. More than 25 million Groundwater abstraction structures. Indiscriminate Groundwater development. Decline of Groundwater levels in pockets of 350 districts. Therefore, water quality was not a problem. During first and second phase agriculture was not commercialized and food production was only for domestic purposes. Commercial crops were not cultivated and it restricted demand for water. This phase witnessed more stable and sustainable use of groundwater with overall balance between extraction and recharge.

In the third phase 1990's onwards increase in number of Over Exploited & Critical assessment units from 250 to 1288 from 1985 to 2011 out of 6607 assessment units. Drying up of shallow drinking water sources. Increase in Groundwater lifting cost, Sea water ingress in coastal areas, Deterioration in GW quality Water logging & Soil salinity in irrigation command area. Since water extraction was through shallow dug wells, the extraction rate matched demand and supply has provided aquifer sustainability. Importantly, the distance between wells was beyond the hydrological threshold. Most of the wells were located near water bodies which provided recharging facility.

Karnataka's water sources situation

Karnataka's water resources are fast dwindling due to population explosion and increased utilization of water for the rapidly growing economic activities. Water demand on the one hand for consumptive (drinking, health and sanitation needs) and productive uses (agriculture, industrial production, power generation, mining operations and navigation, and recreational activities) has increased tremendously, and on the other hand, water supply has declined with depletion and degradation of water resources causing water distress or scarcity in the state. Depletion of quantity and degradation of quality of water has restricted the availability of water for consumptive and productive uses and has consequently caused "negative externality" which imposes economic and social cost on society. The declining trend in the economic contribution of water resources has occurred due to physical and economic water scarcity which results in insufficient use, poor management, declining water productivity and increasing environmental and economic costs. Obviously, the outcome is growing imbalance between water needs and supply augmentation capability of the state.

In the meanwhile, the Government of Karnataka has enacted the Karnataka Ground Water (Regulation for protection of sources of drinking water) Act, 1999 (Karnataka Act 44 of 2003) to give priority for drinking water and for protection of drinking water sources in the State. The Karnataka Ground Water (Regulation for protection of sources of drinking water) Act, 2013 bring a general legislation to control in discriminatory exploitation of ground water especially in the notified areas in the State.

The proposed Act also provides for:

The constitution of the Karnataka Ground Water Authority

Restriction and regulation of extraction of ground water in the notified area

Specification of the minimum distance between the bore wells dug for the purpose of irrigation

Declaration by notification any areas as draught hit areas

Certain other incidental provisions also.

Data and Methodology

The Study is restricted to State level in Karnataka State. Data used in this study has been collected from secondary sources *i.e.* water resource department Government of Karnataka. Bureau of Economics and statistic, Govt. of Karnataka, Bengaluru and Economic Survey, 2015.

Results and Discussion

Karnataka is prone to frequent droughts and floods. The agriculture sector continues to be the mainstay of the state and its production and productivity is directly linked to availability of surface and ground water resources Table.1 reveals the sources wise water availability in the state. Water resources in the state has river basins with availability of 3475.2 TMC of water only 1690.30 TMC of water is being used for developmental needs and the state has also reached the stage where it cannot further enhance the utilization of water through construction of storage facilities (dams) by tapping the surface of the rivers, as interstate water disputes are slowing down the developmental activities.

Surface water bodies, particularly rivers and lakes, are highly polluted with increasing pollution load from agricultural discharge, industrial effluents and domestic waste. The ground water table has gone down beyond the natural rechargeable limit in recent years and managing it is one of the biggest challenges for the policy makers. The overdraft of water has reached the stage of 70 per cent in the state indicating growing scarcity of ground water resource. Many districts including Bangalore Urban, Bangalore Rural, Kolar, Tumkur and Chitradurga have exceeded in an overdraft of ground water beyond cent per cent.

There is growing disparity between over exploitation and replenishablity of ground water as the total replenishable groundwater resources have reduced from 16.3 lakh hectare meters (HAM) in 1992 to 15.3 lakh HAM in 2004, with the draft of groundwater increasing from 4.1 lakh HAM to 10.7 lakh HAM during the same period. Consequently, the ground water balance for future development has fallen from 9.7 lakh HAM in 1992 to 6.5 lakh HAM in 2004. The impact of overdraft of ground water has a detrimental effect, as about 124 talukas have reached above 70 per cent exploitation causing severe impacts on the environmental balance of the region.

Structure of Groundwater Authority

Karnataka Groundwater Authority for the whole of the State of Karnataka, with its head quarters at Bangalore. The authority shall be a body corporate by the name aforesaid having perpetual succession and a common seal with power, subject to the provisions of this Act, to acquire, hold and dispose of property both movable and immovable and to enter into contract, and may by the said name nominated. The Authority shall consist of the following members, namely; The Secretary to Government in charge of the Department of Water resources, Minor Irrigation, Government of Karnataka who shall be the chairperson. The Commissioner or Director of Mines and Geology, who shall be the Member Secretary. A representative of the

Finance Department, Government of Karnataka. The Regional Director, Central Groundwater Board, Government of India. One representative from the Electrical Supply Company having jurisdiction over the area, not below the rank of a Chief engineer. The Chief Engineer, RDED, Rural Development and Panchayath Raj Department. The Engineer-in-Chief, Water Resources Development Organization of Water Resources Department. The Chief Engineer, Minor Irrigation, nominated by the Government The Chairman of the Karnataka State Pollution Control Board.

The Commissioner/Director of Agriculture, Department of Agriculture. The Chief General Manager, National Bank for Agriculture and Rural Development, Bangalore. Four representative of farmers to be nominated by the Government. The Chief Engineer, the KUWS&DB. The Chief Engineer, the BWSSB. Two members who have special knowledge or practical experience in matters relating to groundwater to be nominated by the Government. The conditions shall include mandatory provision of artificial recharge structures of appropriate size to be constructed by the applicant within a period as specified by the authority.

Provided that no person shall be refused of a permit unless he has been given an opportunity of being heard. The decision regarding grant or refusal of their permit shall be intimated by the Authority to the applicant within a period of sixty days from the date of receipt of the application. In granting or refusing a permit, the Authority shall have regard to the following, namely:

The purpose for which the groundwater is to be used-domestic, agriculture, industry, commercial, establishments entertainment,- indicate sale/own use or both;

No permit shall be given for water intensive crops like paddy, sugarcane in notified areas.

The existence of other competitive users

The availability of groundwater and the need to conserve it

Quantity of groundwater to be drawn

Quality of groundwater with reference to use

Spacing of groundwater structures keeping in consideration, the purpose for which the groundwater is to be used.

Long term groundwater level behaviour

Its likelihood of adversely affecting water availability of any drinking water sources in its vicinity

Priority may be given for those who adopt sprinkler and drip irrigation system

Ineligibility to avail financial assistance, power connection

A person, who does not possess a permit in notified area, shall not be eligible:

To get any subsidy, grant or loan by the Government or any other agency, organization or financing institution to dig well and extract ground water

To get from the Electricity Supply Company or any other authority, the power connection and supply of electricity to extract water from a well without obtaining a permit;

For any subsidies or incentives from the Government, who is a former and who does not adopt sprinkler or drip irrigation in the notified areas.

Table.1 Water Sources in Karnataka

Sl.no.	Source	Percentage
1	Canals	36
2	Tanks	6
3	Wells	12
4	Tube	34
5	Lift Irrigation	4
6	Other Sources	9
	TOTAL	100

Source: Water Resource Department, GOK, 2015-16

Table.2 Groundwater overexploiting taluks as per 2015 in Karnataka

Sl.No.	Districts	Taluks	Ground water usage (%)
1	Bagalkote	Badami	161
		Bagalkote	160
2	Bengaluru Rural	Devenahalli	123
		Doddaballapura	136
		Hoshakote	132
		Nelamangala	117
3	Bengaluru Urban	Anekal	131
		Bengaluru East	132
		Bengaluru West	128
		Bengaluru South	175
4	Belagavi	Ramadurga	138
5	Bellari	Hagari Bommanahalli	100
6	Chikkamagalur	Kadur	101
7	Chikkaballapura	Chikkaballapura	145
		Chintamani	168
		Gowribidanooru	190
		Gudibande	165
		Siddlaghatta	143
8	Chitradurga	Chitradurga	122
		Holalkere	131
9	Davanagere	Jagaluru	111
10	Kolar	Bangarpete	199
		Kolar	180
		Maluru	179
		Mulabagilu	213
		Shrinivasapura	176
11	Ramnagar	Ramnagra	129
12	Tumkuru	Chikkanayakanahalli	151
		Koratagere	160
		Madhugiri	128

Sources: Water Resources Department, Government of Karnataka (2015)

Table.3 Ground Water Scenario in 9 critical States (as on 2014)

Sl. No.	Name of States	Stage of Ground Water Development (%)	No. of over-exploited assessment units (Dark Blocks)	No. of blocks notified by CGWA
1	Punjab	172	110	45
2	Rajasthan	137	172	35
3	Haryana	133	71	17
4	Delhi	137	18	3
5	Karnataka	64	63	22
6	Tamil Nadu	77	374	18
7	Uttar Pradesh	74	111	1
8	Andhra Pradesh	37	41	7
9	Telangana	54.8	42	

Table.4 Groundwater Resources of Karnataka as on 2004 and 2015 (lakh ha. m)

Sl. No.	Particulars	2004	2015
1	Net Annual Ground Water Availability	1529660	1481122
2	Existing Ground water draft for Irrigation	974731	859160
3	Existing Ground water draft for domestic and industrial water supply	96581	81981
4	Existing Ground water draft for all uses	1071312	941141
5	Provision for domestic and industrial requirement supply for 2025	140693	124373
6	Net Annual Ground Water Availability for future irrigation development	647580	60372
7	Stage of Ground water development (%)	70	64

Sources: Water Resources Department, Government of Karnataka (2015)

Table.5 State-wise details of funds allocated and incurred under 'Ground Water Management & Regulation' during 11th Plan

Sl. No.	Name of the States/UTs	Approved cost (Rs. in lakh)	Amount released as on 31.1.2015 (Rs. in lakh)	Number of structures approved	No of structures completed as on 31.1.2015
1	Andhra Pradesh	130.02	130.02	29	27
2	Arunachal Pradesh	493.11	493.11	80	80
3	Bihar	96.01	96.01	11	9
4	Chhattisgarh	268.8	258.85	34	19
5	Chandigarh	776.03	774.52	54	52
6	Delhi	43.44	43.44	10	10
7	Gujarat	316.24	266.23	116	100
8	Himachal Pradesh	250.017	248.48	20	4
9	Jammu & Kashmir	143.47	119.1	5	2
10	Jharkhand	191.35	205.96	69	69
11	Karnataka	588.093	588.09	192	192
12	Kerala	94.14	81.65	91	63
13	Madhya Pradesh	860.91	672.13	51	34
14	Maharashtra	15.15	15.15	49	49
15	Nagaland	224.14	224.14	64	64
16	Odisha	464.36	325.04	66	43
17	Punjab	260.33	110.46	86	15
18	Rajasthan	404.777	284.14	52	22
19	Tamil Nadu	526.35	526.35	273	273
20	Telangana	443.39	443.39	90	88
21	Uttar Pradesh	3286.23	2954.11	189	145
22	West Bengal	111.09	111.09	30	29
	Total	9987.447	8971.46	1661	1389

Ground Water Scenario in critical States

According to the Ministry of Agriculture, the number of over-exploited units (dark blocks) are significantly higher (more than 15% of the total assessed units) in Delhi, Haryana, Himachal Pradesh, Karnataka, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and UTs of Daman & Diu and Puducherry. The Ministry of Water Resources, River Development & Ganga Rejuvenation, also stated that the ground water scenario has reached a critical stage in 9 States, i.e. Punjab, Rajasthan, Haryana, Delhi, Karnataka, Tamil Nadu, Uttar Pradesh, Andhra Pradesh and Telangana. The details regarding ground water scenario in the 9 critical States, as received from the Ministry of Water Resources, River Development & Ganga Rejuvenation.

The Central Ground Water Board has undertaken Demonstrative Rain Water Harvesting and Artificial Recharge projects in priority areas such as 'Over-Exploited' (Dark Blocks) and 'Critical' assessment units during 11th Plan under the Scheme of 'Ground Water Management & Regulation'. The project aimed at facilitating State Governments for replicating recharge projects in similar hydro geological environment.

During the 11th Plan, 133 demonstrative recharge projects costing Rs. 99.87crore were approved for construction of artificial recharge structures in 22 States. Out of these 133 Artificial Recharge Projects, 109 projects with an approved cost of Rs. 51.24 crore were taken up in the year 2011-12. During 12th Plan, CGWB has taken up Aquifer Mapping and Management Program, wherein, aquifer-wise ground water resources and quality is to be assessed in priority areas covering 8.89 lakh sq.km. Priority areas include water stressed ('Over-Exploited' areas) and quality vulnerable areas. The aquifer mapping program also envisages 33 preparations of aquifer-wise management plans, which includes component of artificial recharge to ground water and mitigation of ground water quality issues. The management plans will be shared with the State Governments concerned for implementation. During 12th Plan, Rs. 2051 crore have been allocated for the Aquifer Mapping and Management plan. There is no separate scheme for artificial recharge to ground water or contamination of ground water during 12th Plan.

Groundwater management in Karnataka

Groundwater Management Strategies - Approach Ground Water management is key to combat the emerging problems of water scarcity & quality deterioration. Being a hidden resource often developed without adequate understanding. Need for scientific planning of Ground Water development in different hydro geological set ups to evolve effective management practices. It requires both supply side and demand side management and integration of both as well. Regulation of Ground Water development is component of demand side management. The agriculture sector continues to be the mainstay of the state and its production and productivity is directly linked to availability of surface and ground water resources Table.1 reveals the sources wise water availability in the state. Water resources in the state has river basins with availability of 3475.2 TMC of water only 1690.30 TMC of water is being used for developmental needs and the state has also reached the stage where it cannot further enhance the utilization of water through construction of storage facilities (dams) by tapping the surface of the rivers, as interstate water disputes are slowing down the developmental activities.

High dependence on ground water (85%)

Over extraction of ground water for irrigation

Uncontrolled deforestation

Neglect of traditional practices and systems, including rain water harvesting

Inadequate integrated water management and watershed development

Emerging water quality problems

Management of Ground water

On-Farm Water Management techniques such as Laser Levelling, Zero Tillage, use of Tensiometer in Paddy cultivation, adoption of improved irrigation methods, adoption of micro irrigation (sprinkler & drip), mulching for reduction of evaporation losses, timely 87 transplanting of paddy, conjunctive use of canal and ground water *etc*.

Implementation of a conceptual document entitled 'Master Plan for Artificial Recharge to Ground Water' by the States concerned.

Revamping agricultural power supply and pricing structure, in view of the fact that the use of flat rates or free electricity, combined with unreliable supplies, tends to adversely affect the use of ground water.

The Ministry immediately takes follow-up action with the State Governments of Punjab, Haryana and Rajasthan and provides them technical know-how to adopt and implement the requisite water management techniques.

They also recommend that three States may also be encouraged to implement the 'Master Plan for Artificial Recharge to Ground Water' which has already been circulated to them for effective implementation.

The free supply of electricity to farmers at times indirectly encourages wasteful draft of ground water, the Committee recommends that the States concerned may be prevailed upon to undertake an exercise for revamping the agricultural power supply and pricing structure for implementation to curb wasteful and excessive withdrawal of water by the irrigation sector (Rasul Golam, 2010).

One practical conclusion of this work is that for purposes of assessing the intensity and sustainability of groundwater use, data should not be averaged at the taluk scale, but at a smaller scale that accounts for the distribution of groundwater users within each taluk. The science-based decision support tools that can provide information at village/small watershed scale also need to be developed, which can alleviate the current constraints impeding the planning and decision-making due to lack of data at a smaller scale. Increased consumption of water there is an urgent requirement to address the issue of water scarcity, water quality, poverty and inequality in Karnataka and India to make better policy decisions which will affect its availability in the future. If the conditions remain same, water will turn out to be the world's most precious resource soon. Ground water level has been decreased due to the over exploration this has led to the chemical materials have been contaminated the ground water quality, mentioned chemical composition negatively impact on human health, in this issue government has to take to improve the water quality in the state.

An approach is presented by combining conventional modeling with such auxiliary data sets at village scale to estimate annual

groundwater storage change in each village of a watershed of about 80 km^2. Database is very strong and every user needs license/ concessions for the use and is closely monitored. Adequate infrastructure and manpower is available for regulation. Way Forward Strengthening of-State Ground Water Departments and Central Ground Water Board, Manpower and Infrastructure strong database on the availability of Ground Water, number of abstraction structures, quantity of withdrawal. Registration of Ground Water structures through centralized website with access to all stakeholders. Strengthening of regulatory mechanism at all levels and coordination between State Ground Water Authority and Central Ground Water Authority.

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