Emerging Problems in Groundwater Regulation and Governance, and the Need for a Groundwater Database—A Case Study from Orissa

N.C. Nayak, R. Nayak and S. Mohapatra

Central Ground Water Board, SER, Bhubaneshwar

Abstract: Central Ground Water Authority is constituted under section 3(3) of the Environment Protection Act, 1986 to regulate and control development and management of groundwater resources in the country. CGWA under its capacity has declared a total number of 673 as over-exploited and 425 as critical blocks in the country, the list of which is being circulated to the State Pollution Control Boards and Ministry of Environment and Forests which refer the proposals of establishment of new industries/projects in critical/ over-exploited blocks to CGWA for obtaining permission. Due to the rapid growth in mineral and metal sector, numerous mineral based industries/companies have established their plants and started mining operation in Orissa since last few years. Most of them depend directly on ground water for their water requirement and others indirectly by tapping the base flow from the nearby rivers. As most of them fall in safe areas, CGWA is ignorant of such activities and vice versa. But the adverse impact of such projects on ground water especially bigger ones will crop up sooner or later, which will be of great concern to CGWA afterwards. Thus, there is an urgent need for creation of a database on ground water for such projects, so that impact on ground water before, during and after the implementation of the project can be ascertained and corrective measures can be taken from time to time in order to safeguard the precious groundwater resources. The onus should lie on the industry/project, and the regional offices of CGWB should be consulted for the same. This will not only help CGWA but also safeguard the industry/project especially large ones from wrong notions and spreading false propaganda.

INTRODUCTION

Central Ground Water Authority (CGWA) is regulating the withdrawal of ground water by industries and projects in critical and over-exploited blocks by making it mandatory for them to obtain necessary permission before installing groundwater abstraction structures. The lists of these priority blocks have been circulated to the Ministry of Environment & Forest and State Pollution Control Boards, which refer the new industries/project proposals to CGWA for obtaining permission. Out of a total number of 673 over-exploited and 425 critical blocks in the country, only eight blocks fall in Orissa state where the use of ground water is being regulated. But all these blocks are situated in the coastal tract of Orissa where there is little industrialization and agriculture is the main occupation. Hence, large tracts of industrial belts remain out of the purview of CGWA and ground water is either being over-exploited or being wasted. This has not been reflected in the groundwater resource estimation either due to the lack of sufficient data on ground water abstraction by these industries or the overshadowing effect of the vast groundwater resources of the block or both. However, the local population staying at their periphery has got affected due to the decline of water level which is leading to the drying of dug wells and shallow bore or tube wells. The same is the case in urban areas where uncontrolled extraction of ground water has started giving adverse effects like deep water level condition, which is declining further. Encouraged with the presence of potential freshwater aquifers in the coastal belt, more dependence on ground water has led to their over-exploitation. This causes the decline in water level in some pockets where water level is lying below mean sea level during summer seasons or throughout the year. This will cause upconing of the saline water if fresh water is underlain by saline water or sea water ingress into the aquifer system which will cause its permanent damage. So some mechanism is to be adopted to bring these areas under the control of CGWA in order to protect the groundwater resource effectively.

CRITERIA FOR DEMARCATION

Presently blockwise groundwater resource position estimated on the basis of GEC-1997 norms is taken as the main criteria for groundwater regulation. Blocks having stages of groundwater development more than 100% are taken as over-exploited and those between 90 to 100% are taken as critical from groundwater development point of view. Though not a single block out of 314 blocks in Orissa state falls in these categories, on the basis of limited nature of the existing aquifer, relative high groundwater withdrawal and the presence of saline water interface, eight blocks have been demarcated for groundwater regulation (Fig. 1 and Table 1). But there are some serious observations against the criteria for demarcation, as given below:

- The blockwise groundwater resource is commonly estimated through ground water fluctuation method. As there are some 1000 odd monitoring stations (dug wells) spread over an area of 1,55,707 sq. km of Orissa, the water level data is quite insufficient for blockwise groundwater recharge calculation. Moreover the specific yield values recommended for different geological formations for rainfall recharge calculation vary over a specified range. Taking the lower or higher value may lead to underestimation or overestimation of the groundwater resource, respectively. As an example, for the laterite and weathered zone, which form the main repository of ground water in the hard rock terrain of Orissa, the specific yield value is recommended between 0.02 and 0.03. Hence it gives a variation of resource at the tune of 33%.
- The groundwater draft is calculated on the basis of numbers of different groundwater abstraction structures present in a block. The amount of ground water commonly withdrawn by different types of such structures is recommended in GEC-1997. But due to a lack of proper well census data, a correct picture of groundwater draft cannot be obtained. Thus, the stage of groundwater development of a block gives only a first approximation of the groundwater situation of that block.
- In most of the coastal blocks of Orissa, confined aquifers of variable thickness have been preferred over the phreatic aquifer for meeting water supply demands including irrigation due to the high

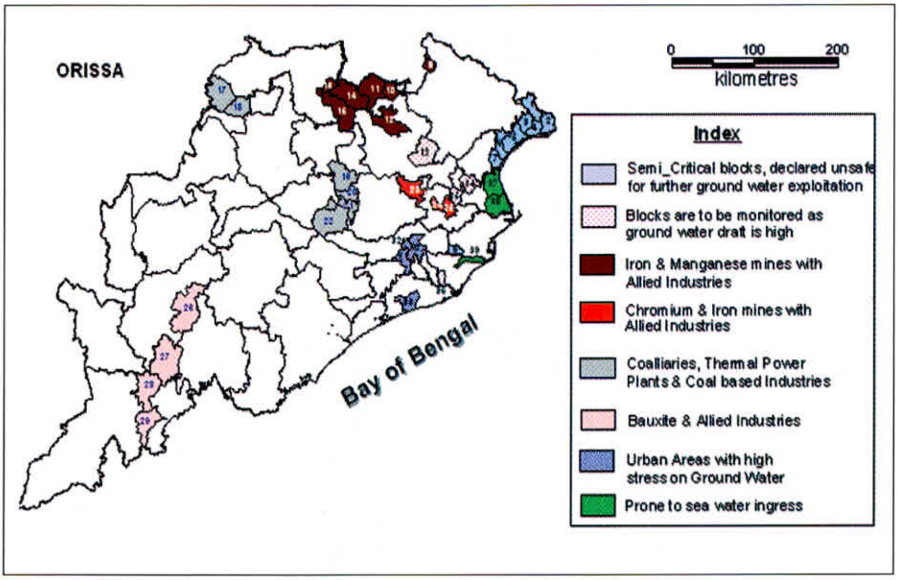

Fig. 1. Blocks recommended for groundwater regulation.

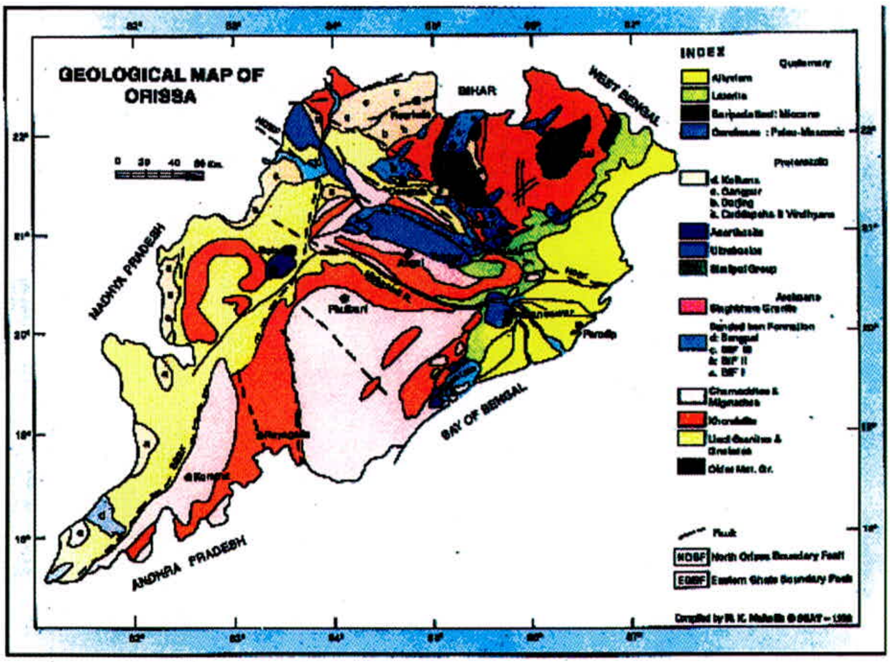

Fig. 2. Geological map of Orissa.

Table 1. Geological formations and groundwater development in Orissa

Sl. No.	*Block name*	*District*	*Geological formation*	*Phreatic/shallow aquifer*	*Deeper aquifer*	*Stages of GW development (%)**
1	Jaleswar	Balasore	Recent Alluvium	Laterite and Recent Alluvium	Not much promise due to clayey formations at depth	62.81
2	Bhograi	Balasore	Recent Alluvium	Recent Alluvium, dug well not used	Good granular zones present but the threat of sea water ingress as water table reaches and in some pockets goes down msl	67.95
3	Basta	Balasore	Recent Alluvium	Recent Alluvium, dug well not used	Moderate granular zones commonly used for ground water irrigation purposes	44.50
4	Balipal	Balasore	Recent Alluvium	Recent Alluvium, dug well not used	Good granular zones present but the threat of sea water ingress	77.61
5	Balasore Sadar	Balasore	Recent Alluvium	Recent Alluvium, dug wells are a few	70 to 90 m fresh aquifer underlain by thick clay layers (Balasore town) or saline upto 270 m beyond which aquifer is fresh (Chandipur). Water Table goes down below msl in Balasore town	45.77
6	Remuna	Balasore	Recent Alluvium	Recent Alluvium, dug wells are a few	Generally 70 to 90 metres with variable granular zone thickness	47.77
7	Bahanaga	Balasore	Recent Alluvium	Recent Alluvium, dug well not used	Generally granular zones upto 50 m or between 180 and 230 m	59.76
8	Garadpur	Kendrapada	Recent Alluvium	Recent Alluvium, dug well not used	Shallow fresh water aquifer (20 m in the North to 60 m in the South is underlain by saline aquifer in the eastern part and fresh upto 60 m in the western part.	54.38
9	Jamda	Mayurbhanj	Singhbhum Granite and Banded Iron Formation	Laterite serves as moderate aquifer	Fractured zone with low to moderate yield potential	16.84
10	Champua	Keonjhar	Older Metamorphic Group and Singhbhum Granite	Laterite serves as moderate aquifer	Fractured zone with low to moderate yield potential	25.96
11	Joda	Keonjhar	Banded Iron Formation	Laterite serves as moderate aquifer	Fractured zone with low to moderate yield potential	33.73
12	Keonjhar Garh	Keonjhar	Singhbhum Granite	Laterite serves as moderate aquifer	Fractured zone with low to moderate yield potential	17.35
13	Anandapur	Keonjhar	Singhbhum Granite	Laterite and river alluvium serve as good aquifer	Since a good volume of alluvium is underlain by hard rock, tapping of both the aquifer gives good yield	40.96
14	Koida	Sundergarh	Banded Iron Formation and Singhbhum Granite	Laterite serves as moderate aquifer	Fractured zone low to moderate yield potential	3.73
15	Lahunipada	Sundargarh	Singhbhum Granite and Simlipal Group	Laterite serves as moderate aquifer	Fractured zone with low to moderate yield potential	7.87
16	Lathikata	Sundargarh	Singhbhum Granite and Darjing Group	Laterite serves as moderate aquifer	Fractured zone with low to moderate yield potential	21.65

(Contd.)

Table 1. (*Contd.*)

17	Himgiri	Sundergarh	Gondwana Formation	Laterite serves as moderate aquifer	Fractured zone with low yield potential	8.40
18	Jharsuguda	Jharsuguda	Gondwana Formation and Granite Gneiss	Laterite, low to moderate yield	Fractured zone with low yield potential	24.51
19	Kaniha	Angul	Gondwana Formation, Khondalite, Charnockite and BIF	Laterite, low to moderate yield	Fractured zone with low yield potential	28.70
20	Talcher	Angul	Gondwana Formation	Laterite, low to moderate yield	Fractured zone with very low yield potential	32.81
21	Banarpal	Angul	Gondwana Formation and Charnockite	Laterite, low to moderate yield	Fractured zone with very low yield potential	24.07
22	Angul	Angul	Gondwana Formation and Charnockite	Laterite, low to moderate yield	Fractured zone with low to moderate yield potential	11.94
23	Sukinda	Jajpur	Ultrabasics and Ultramafics	Laterite on Talc and Serpentinite, low to medium yield	Fractured zone with good yield potential	14.04
24	Rasulpur	Jajpur	Granites and Ultrabasics	Laterite serves as moderate aquifer	Fractured zone with moderate to good yield Potential	59.86
25	Jajpur	Jajpur	Granites and Ultrabasics	Laterite serves as moderate aquifer	Fractured zone with moderate to good yield Potential	56.98
26	Lanjigarh	Kalahandi	Porphyritic Granite and Khondalite	Weathered zone and Laterite have moderate yield	Fractured zone with low yield potential	13.38
27	Kasipur	Rayagada	Khondalite and Charnockite of Eastern Ghat Group	Laterite serves as good aquifer	Fractured zone with low yield potential	24.54
28	Dasmantpur	Koraput	Khondalite and Charnockite of Eastern Ghat Group	Laterite serves as good aquifer	Fractured zone with low yield potential	4.35
29	Semliguda	Koraput	Khondalite of Eastern Ghat Group	Laterite serves as good aquifer	Fractured zone with low yield potential	18.41
30	Cuttack Sadar	Cuttack	Recent Alluvium	Recent Alluvium, dug well not used	Generally 70 to 90 metres with variable granular zone thickness, high yield	42.08
31	Bhubaneswar	Khurda	Upper Gondwana and Khondalite	Laterite serves as good aquifer	Fracture zones in Gondwana have high yield potential	16.16
32	Baranga	Cuttack	Upper Gondwana and Khondalite	Laterite serves as good aquifer	Fracture zones in Gondwana have high yield potential	16.05
33	Puri Sadar	Puri	Recent Alluvium	Recent Alluvium, commonly tapped by shallow hand pumps	Shallow fresh water aquifer (35 to 40 m) is underlain by saline aquifer down to 180 m of depth to be followed by second group of fresh water aquifers till 230 m at Puri town	12.90

(*Contd.*)

Table 1. (*Contd.*)

Sl. No.	*Block name*	*District*	*Geological formation*	*Phreatic/shallow aquifer*	*Deeper aquifer*	*Stages of GW development (%)**
34	Bhadrak	Bhadrak	Recent Alluvium	Recent Alluvium, dug wells are a few	Generally aquifers upto 70 to 90 metres is being tapped, have very high yield potential	55.09
35	Bhandari Pokhri	Bhadrak	Recent Alluvium	Recent Alluvium, dug wells are a few	Generally aquifers upto 70 to 90 metres is being tapped, have very high yield potential	73.82
36	Naugaon	Jagatsinghpur	Recent Alluvium	Recent Alluvium, dug wells are a few	Good granular zones but fresh upto 100 m and gradually going saline due to the absence of any impervious layer in between	59.64
37	Basudevpur	Bhadrak	Recent Alluvium	Phreatic zone not promising due to clayey formations	In the eastern part water level going down below msl during summer by extensive use of the top 50 m aquifer. In the western part fresh aquifer is only present at 180 mbgl	23.84
38	Chandbali	Bhadrak	Recent Alluvium	Phreatic aquifer is saline	The only fresh water aquifer is present below 200 m	Saline
39	Kujang	Jagatsinghpur	Recent Alluvium	Phreatic aquifer is thin with low yield	Saline aquifer overlies fresh water aquifer whose thickness increases towards sea.	41.20

*As on 31st March 2004 msl – mean sea level reliability and yield potentials. However, the resource position computed on the basis of phreatic aquifer gives erroneous picture of the groundwater condition. As for example in Basudevpur block of Bhadrakh district the top aquifers are saline upto 180 metres of depth in the eastern part and in the western part, heavy groundwater withdrawal for summer paddy crop has led to the decline of ground water to such an extent that the water level has gone down below mean sea level during summer seasons. But the ground water resource is estimated as marginally exploited with only 23.84% groundwater draft.

- The lack of actual groundwater extraction data of large industries/industrial belts and data on dewatering during mining activities has led to the under estimation of groundwater resource. Moreover, land degradation leading to the reduction of recharge is not taken into account.
- Over-exploitation of ground water and reduction of recharge to ground water is commonly observed in urban areas. But this is overshadowed in the resource estimation where a block is taken as a unit. A typical example is that of Puri town spread over an area of 16.84 sq. km which is at present experiencing all the adverse impacts of over-exploitation like deep water level condition in sand dunes, drying up of the Temple wells, reduction of yield of tube wells and salt water upconing. Though the groundwater draft is around 106%, the buffering action of the vast area of Puri Sadar block has deeply undermined the real situation with the stage of groundwater development safely poised at 12.90%.

CORRECTIVE MEASURES

Thus the lacunae in the groundwater resource estimation can be corrected by taking the following steps:

- Increase in the number of Network Stations especially in the blocks where these are inadequate in number or not representing them properly. If it is not possible to increase the number of Network Stations in each block where there is doubt regarding the resource position then regular pre and post monsoon survey preferably at five years interval can give a correct picture of the groundwater resource position of the blocks. To get rid of the ambiguity concerning specific yield values, monthly monitoring is necessary. CGWB has already started this in 10 to 15% of Network Stations through outsourcing.
- Proper and scientific data on groundwater abstraction for proper evaluation of groundwater resource.
- Deeper aquifers need to be monitored and the impact of groundwater withdrawal should be studied. Groundwater resources of the deeper aquifers should also be calculated.
- As described in the previous section, all industrial/mining belts and urban areas should be brought under the purview of CGWA.

CRITERIA FOR INDUSRIAL AND MINING BELTS

When an industry or mine is to be established in an area, permission needs to be taken from the Pollution Control Board and Ministry of Environment and Forests. If the area falls in critical or over-exploited block, then permission should be taken from CGWA for the extraction or any other activities related to ground water. Since almost all the industrial and mining hubs of Orissa fall in safe category blocks, no data on groundwater use or wastage is available with CGWA. The data received on request does not contain some of the vital parameters, which are needed for any impact assessment. Moreover the data are not very reliable and CGWA has no authority to verify these figures. As CGWA is answerable for any query on the impact of these industries on groundwater regime, the non-availability of data on ground water is a matter of great concern. So all the blocks having good numbers of medium and large-scale industries and/or mining activities need to be listed under the category of critical areas. Some other blocks where large deposits are available and the 'Memorandum of Understanding' has been signed with big multinational giants for ground water withdrawals should also be declared as critical areas. Generally top saline condition exists in coastal blocks and establishment of industries in such blocks that are generally dependent on ground water should also be brought under CGWA scanner. Based on these criteria it is recommended that the following blocks be declared as critical areas (Fig. 1 and Table 1):

1. Ten blocks having iron, manganese and chromium mining activities and related industries;
2. Six blocks having coal mines and related industries; and
3. Four blocks having huge resources of Bauxite where mining and smelting is going on or going to start soon.

This will be helpful for generating a good and reliable database for CGWA.

CREATION OF DATABASE

A simplified format for database is to be devised for providing groundwater data by the users, as the CGWA format is tedious and difficult to be filled up by non-hydrogeologists. The following details are to be provided by the users for the creation of a database:

1. Numbers of bore wells, tube wells and dug wells existing in the premises;
2. Data on the depth of bore well, diameter of the naked bore, depth of casing, depth at which individual fractures are encountered with cumulative discharges, maximum yield taken at the end of drilling (compressor discharge), static water level of the well with reference to the date of measurement, the type, HP of the pump, rate of pumping and the hours of pumping per week and the pumping water level after 2 or 4 hours of pumping of the new wells. For the existing wells whatever data is available are to be provided.
3. In case of tube well, additional data like length of the strainer (slotted zone) and its position with depth are to be provided.
4. For dug well additional data like lining of the well, whether hard rock is encountered at its base and the data on dewatering like approximately how much water was pumped out for deepening the well below water table necessary to determine the possible specific capacity of the weathered formation are required.
5. Weekly monitoring of at least one dug well and one bore/tube well by the industry/mine is necessary to know the correct groundwater resource position of the area. Even Automatic Water Level Recorder can be used for the same purpose, as money is not a constraint for the industries. Thus, any change in groundwater regime with time can be calculated with certainty.
6. Generally user agencies provide groundwater withdrawal data on the basis of pump capacity. However the pumping water level and the rating curve of the pump plays vital role in the discharge. Hence, water meter (which takes reading of the amount of water that passes through

it in cubic meters) should be made compulsory for each pumping station, so that accurate discharge data can be obtained.

7. Authorities can even conduct pumping tests in collaboration with the industries/mines for better understanding of the aquifer systems prevailing in the area.

CRITERIA FOR URBAN AREAS AND OTHERS

The withdrawal of huge amount of ground water in urban areas remains unnoticed during blockwise resource calculation. Hence, any municipality with more than one lakh population or notified area council totally dependent on ground water for water supply purpose should be brought under the purview of CGWA. Based on these criteria three blocks are recommended where urban areas are already facing groundwater scarcity (Fig. 1 and Table 1).

Similarly three blocks are demarcated where there are possibilities of quality problems related to salinity. Another three blocks are taken as critical where the groundwater draft is comparatively high and the dependence on ground water for agriculture is ever increasing due to the availability of shallow and potential aquifers. The Naugaon block of Jagatsinghpur district is having good granular zones and the groundwater draft is 59.64%. But as it is fresh upto 100 m of depth and gradually going saline due to the absence of any impervious layer in between it is included in the critical list.

So a good database generation is necessary for these blocks in the light of the database planned for industrial and mining blocks. The data providing agencies are only the state government agencies like Public Health Departments, Department of Rural Water Supply & Sanitation and municipalities.

CONCLUSIONS

The Supreme Court of India has empowered CGWA for taking corrective measures for the protection of the groundwater resources of India. Under the act on Right to Information the responsibility is even more on CGWA, which is not possible to be discharged without a good database on ground water. Generating a good database of a state is an uphill task, which is far from the reach of a few scientists working under CGWA. So under this changing scenario, CGWB can be diverted from its regular survey and exploration work at least for 2 to 3 years to devote fully for generating a database on ground water by means of detailed survey, data collection, conducting pumping tests in industrial and mining belts and detailed groundwater sampling. These will not only help in answering common queries like the impact of industries and mining on ground water both qualitatively and quantitatively but will also help in devising means to save this precious natural resource.

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