GROUNDWATER MANAGEMENT AS A POSSIBLE SOLUTION TO COMBAT WATER LOGGING AND SOIL SALINITY IN MAHANADI DELTA STAGE-I COMMAND AREA, ODISHA.

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ABSTRACT

The Command Area Development Programme in Mahanadi Delta Stage – I project, Odisha was implemented in 1976 – 77 harnessing the water of the river Mahanadi and its Distributaries. A study has revealed that the seasonally water logged area in the four doabs (Mahanadi-Kathjhori-Debi, Mahanadi-Chitrotpala-Luna-Birupa-Brahmani, Luna-Chitrotpala, Area to the East of HLC) which was 29330 Hectare during 1988-89 has increased to 38998 Hectare during 1998-99 and is still increasing. In Jagatsinghpur and Kendrapara districts 12318 Hectare and 30291 Hectare land area have been affected by slight and moderate soil salinity respectively. The total irrigation efficiency for the area is about 34.7%. The major problem for drainage in the area is the very flat topography and meagre master slope of around 0.02% in the upper reaches reducing to about 0.01% in the coastal proximal areas. The pre and post monsoon water table in the area is very shallow and the seasonal fluctuation is of very minor magnitude. The overall stage of ground water development in the area is a meagre 18.17 %. The aquifers are already saturated, which causes a huge amount of rejected recharge. The extensive water logging condition in both pre and post monsoon season is mainly due to drainage congestion. As a result no effective natural flushing mechanism is taking place inside the aquifers. The coastal areas are affected with salinity problems – both in terms of ground water as well as soil. This in turn results in poor agricultural yield. People, near coastal areas, resort to prawn cultivation which causes further degradation of water quality. Possible remedial measures which could mitigate the problem are – 1) Improvement of drainage conditions in the area by constructing artificial drains, which could manage the drainage congestion problems by effectively channelling the excess surface water as well as the rejected recharge to the sea. 2) Encouraging people by lending them technical and financial support to judicious usage of water from phreatic aquifers and shallow confined aquifers (by dug wells and shallow filter point tube wells) for minor lift irrigation usage and adoption of cultivating salinity resistant crops to lower the water table for effecting recharge leading to flushing of the entire aquifer system and thereby reducing the problem of water logging and soil salinity to some extent. 3)People near the coastal sand dunes resort to prawn / shrimp cultivation pumping the brine inland and thereby further degrading the land. They should be counselled and monitored properly and periodically to prevent the inland salinization menace. 4) Creating a regional scale subsurface dike mechanism (large clay screens / dykes) all along the coastal areas in this part – to check salinity ingress and allowing scientifically designed ground water draft programme in a industry – agriculture – domestic sector coordinated manner to create a substantial drawdown in the lower reaches on the fresh water side. This can aid the upper reaches in taking up a substantial amount of rainfall recharge which can accelerate the ground water flow towards the bottom reaches. This in turn will facilitate the flushing mechanism and freshen up the brackish water in the middle reaches.

INTRODUCTION

After independence, high priority was given for irrigation development in the country to bring self sufficiency in food production and save precious foreign exchange. This was mainly to negate the dependency of agriculture and food production from the vagaries of rainfall. Subsequently a large number of Irrigation projects were taken up and completed which created a phenomenal irrigation resource. In spite of these measures the agriculture and food production could not keep pace. These were a part of the Command Area development programme introduced by the Govt. of India. This lead to a number of studies to identify the problems as well as for suggesting suitable remedies. The Command Area Development Programme in Mahanadi Delta Stage – I project was taken up by the Govt. of India in 1974 – 75 and was actually implemented by Govt. of Orissa in 1976 – 77. In this project, the water of the river Mahanadi and its Distributaries have been harnessed for Irrigation. A study was carried out by Central Ground Water Board, South Eastern Region, Bhubaneswar in Parts of Mahanadi Delta Stage – I Irrigation Command spanning across Cuttack, Jagatsinghpur, Kendrapara districts of Orissa Project was taken up under the sub-head of conjunctive use studies. The above mentioned study area is bounded within the latitudes of 19° 59' to 20° 31' north and longitudes of 85° 46' to 86° 47' east and covers approximately 3815 sq. Kms. The Location map of the study are is shown in Figure 1.

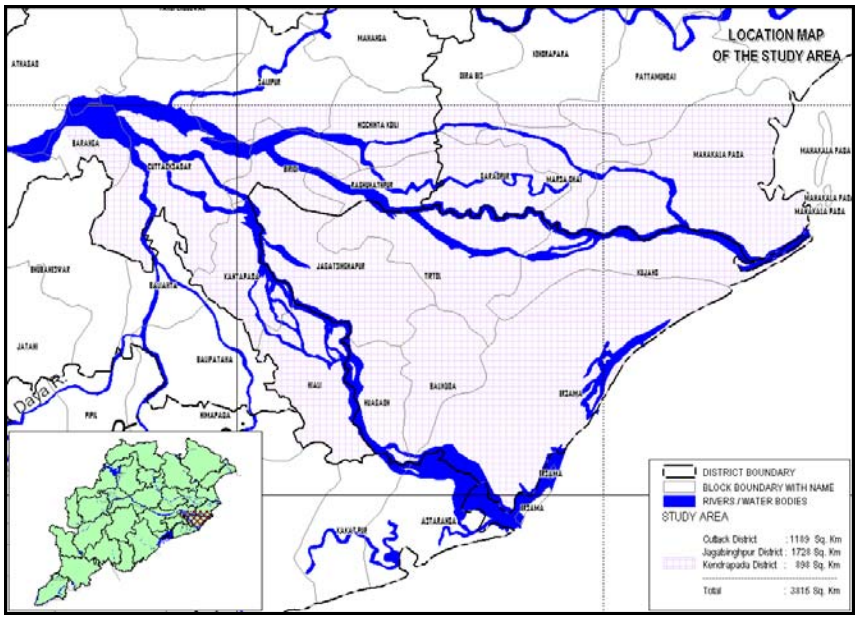

Figure 1 : Location Map of the Study Area

PROBLEMS REPORTED IN THE STUDY AREA

During the course of previous pilot scale studies undertaken by the various State Govt. agencies in collaboration with other scientific agencies like NRSA, Hyderabad(using remote sensing techniques – thermal infrared data) and also from the studies carried out by CGWB, the following problems have been reported to be occurring in the study area.

Water Logging

As per the available data the extent of water logging was delineated and classified based on their seasonal occurrence. These water logged areas were classified as Perennially water logged, Seasonally water logged, marshy lands and mangroves. The details of the same is given below

Table 1 : Status of Water Logging in the Study Area(Historical)
Area in Hectares

Sl No	Doab Name	Seasonally Water Logged		Perennially Water Logged		Marshy / Swampy Land	
		1988-89	1998-99	1988-89	1998-99	1988-89	1998-99
1	Mahanadi-Kathjhori-Debi	12400	18619	4967	2941	217	192
2	Mahanadi-Chitrapala-Luna-Birupa-Brahmani	12894	16116	5576	3362	1503	1479
3	Luna-Chitrapala	2564	2548	NIL	NIL	NIL	NIL

4	Area to the East of High Level Canal (HLC)	1472	1715	327	84	64	64
	TOTAL	**29330**	**38998**	**10870**	**6387**	**1763**	**1735**

Soil Salinity Affected Areas

As per the pilot scale studies conducted by NRSA, Hyderabad, it has been reported that soil salinity affected areas of the command areas are confined to the coastal plain and adjoining low areas. They have classified them into two kinds – Slightly Saline and Moderately Saline. As per their report the development of soil salinity is basically due to the proximity to the sea. The ingress of saline sea water during high tides through creeks and cyclonic storms impregnate the land with sodium chloride which is the primary cause of soil salinity. The extent of area under saline soils is given below in table 2.

Table 2 : Soil Salinity affected areas

Area in Hectares

Sl No	**Block**	**District**	**1988 – 1989**		**1999 - 2000**	
			Slightly	**Moderately**	**Slightly**	**Moderately**
1	Pattamundai	Kendrapara	249	2179	249	21154
2	Marshaghai	Kendrapara	-	283	-	283
3	Mahakalpara	Kendrapara	886	418	886	378
4	Tirtol	Jagatsinghpur	-	122	-	122
5	Kujanga	Jagatsinghpur	683	2752	683	2671
6	Ersama	Jagatsinghpur	4933	15452	5043	15431
7	Balikuda	Jagatsinghpur	950	4349	878	4379
8	Nuagaon	Jagatsinghpur	-	2761	-	2761
9	Jagatsinghpur	Jagatsinghpur	4393	2111	4579	2181
	TOTAL		**12094**	**30427**	**12318**	**30291**

CLIMATE & RAINFALL

The climate of the command area is tropical (hot & humid). There are three distinct seasons like Summer(end of March to mid of June), Monsoon(mid of June to end of October) and Winter(November to February). In general the monsoon is good and the climate is humid. The area receives almost the entire rainfall from the south-west monsoon and is to the tune of 902 mm to 2337.8 mm. The relative humidity varies from 61% to 92 %. The daytime summer temperature often reaches upto 42° C and winter temperature could reach upto 10°C with the annual mean maximum being around 32.1°C and annual mean minimum being around 21.7°C. The area is not only close to the Bay of Bengal but also faces cyclonic storms during hot summer and monsoon seasons. The wind velocity in the study area increases as one proceeds towards the seashore. At Cuttack the wind velocity varies from 2.6 to 9.1 km/hr and its annual average is around 5.3 km/hr whereas at the seashore it varies between 10.2 km/hr to 26 km/hr with the average being around 17.8 km/hr. The annual mean monthly relative humidity in the study area varies from 92 % in the morning hours to about 61% in the evening.

PHYSIOGRAPHY

The topography of the area is generally very flat. The higher land elevations are generally located along the river banks which dissects the delta and forms eight doabs(doab 1 – 4 falls within the delta stage 1 command area and doab 5 – 8 falls within delta stage 2 command area). These doabs tend to slope down from river to the interior and from top near the delta apex to the bottom at coast. Slopes in the doab interior are generally in the range of 1:5000 or 0.02%. The Elevation map of the study area is given below in figure 2.

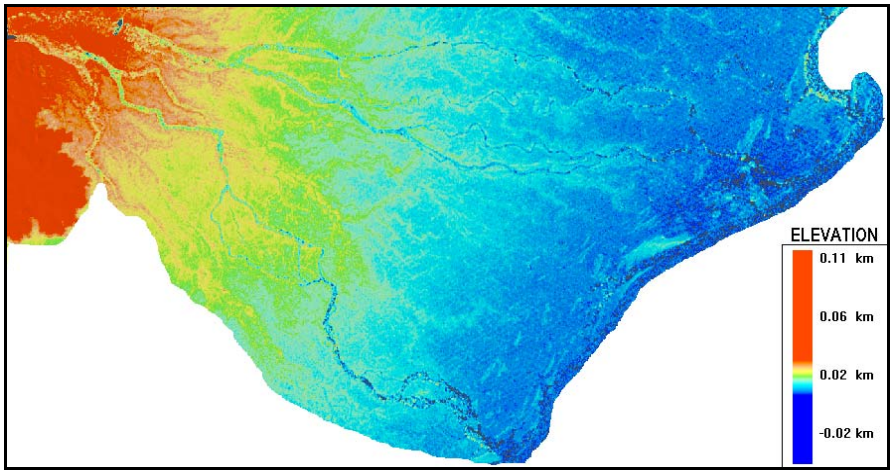

Figure 2 : Digital Elevation Model of the Study Area (modified from USGS STRM data)

DRAINAGE

The river Mahanadi and its distributaries along with numerous drainage channels constitute the study area. The area being very flat, often form an anastomising and juxtaposed drainage network. The drainage channels constitutes of outfall drains, main drains, secondary drains and link drains. The generalized drainage details is shown in Figure 3.

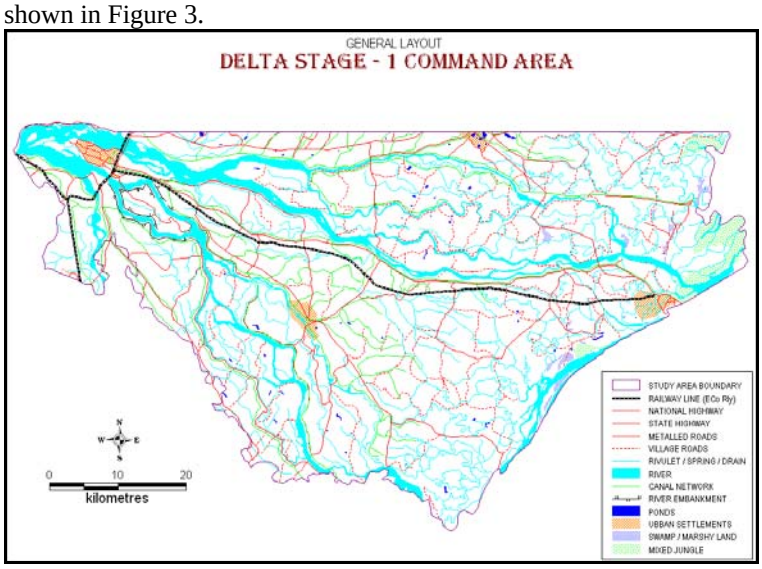

Figure 3 : General Drainage Layout of the Study area

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CANAL SYSTEM

The irrigation system of this project comprises of five canals off taking from the Mahanadi Barrage and Birupa Barrage in Orissa covering four districts(however only three out of four have been considered for our present study) at the primary level. At the secondary level there are seven branch canals operating in the Delta Stage – 1 command area and at the Tertiary level both conveyance and distribution of water is manned through 431 numbers of distributaries and 531 numbers of minors and sub-minors spreading over the entire length of the command area. Most of the canals are unlined as a whole.

SOIL

The soil in the study area is in general moderately sandy along the rivers to sandy clay loam in the low lying areas. In general the soil texture is heavier and deeper from river edges to lower delta in the interior of the doabs and from upper portion of the doabs at the delta apex to lower area close to the sea. The pH of soil varies from slightly acidic to mildly alkaline along levees and upper regions of the doab while along the sea shore and adjacent low lying areas the soil is alkaline and saline. The occurrence of sand casting are both of aeolian as well as fluvial origin. The deltaic alluvium consist of the admixture of soils with well drained features. Soils found in micro uplands as well as moderately to heavy textured soil have poor to very poor drainage characteristics in local depressions. On an average the general soil permeability of the entire study area works out to approximately 0.49m/day and it is found to be directly proportion to the sand content. The soil infiltration varies from 0.40 cm/hr in sandy soil to 0.15 cm/her in clayey loam soil. The soil infiltration in sandy

loam soil also varies from 0.15 cm/hr in saturated condition to 0.50 cm/hr in unsaturated condition. In case of clayey loam soil it varies from 0.15 cm/hr in dry condition to 0.05cm/hr in saturated condition. The Soil Map of the study area is given below in figure 4.

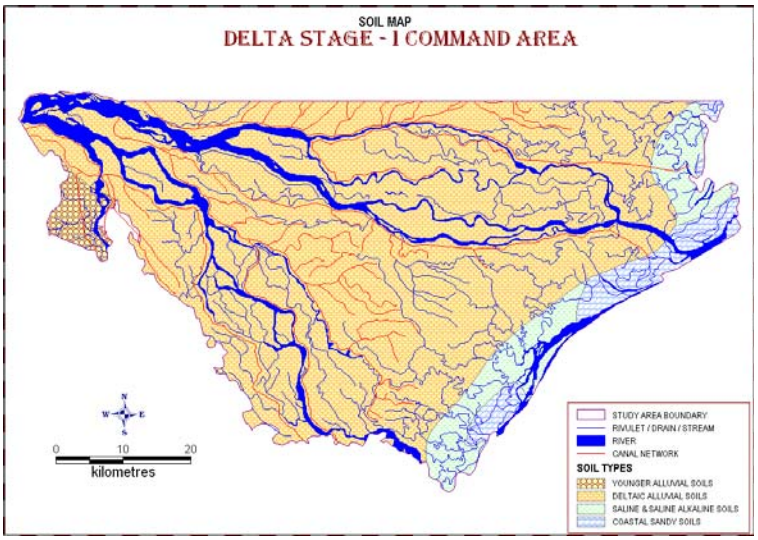


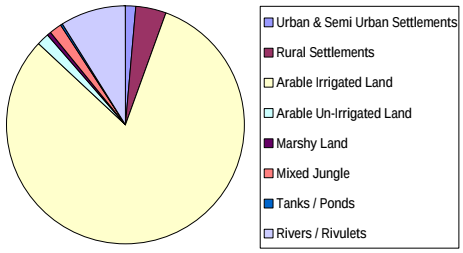
Figure 4 : Soil Map of the Study Area

LANDUSE

As expected in an irrigation command area the main thrust is on agriculture. The land use pattern reveals that more that 80 % of the land in the study area is meant for agriculture. The major land use classes includes urban and semi - urban settlements, rural settlements, arable irrigated land, arable un-irrigated land, marshy land and mixed jungle, rest of the land is covered by water bodies like tanks, ponds, drainage channels and rivers and rivulets. The details of land use are given in given in table 3 below

Table 3 : Land use pattern of the Study area

Landuse Category	**Area (Sq. Km)**	**% of Total Area**
Urban & Semi Urban Settlements	56.75	1.49
Rural Settlements	155.57	4.08
Arable Irrigated Land	3105.43	81.40
Arable Un-Irrigated Land	61.94	1.62
Marshy Land	22.21	0.58
Mixed Jungle	62.64	1.64
Tanks / Ponds	11.75	0.31
Rivers / Rivulets	338.71	8.88
TOTAL	**3815.00**	**100.00**



AGRICULTURE

Agriculture forms the main backbone of the economy in the present study area. Almost 84% of the study area comes under arable land. Agriculture is divided into two seasons in the study area – the Kharif and the Rabi season. In the Kharif season, since water availability is plenty, paddy is the singularly popular choice for agriculture and hence is the principal crop grown here which includes both high yielding and local variety of paddy are grown here. The second most popular choice is vegetables. Other crops include pulses, cereals, oilseeds, spices and sugarcane. The overall cropping intensity is 127 %. In the Rabi season, the principal crop grown here are the pulses(mung) followed by vegetables and oilseeds. Other crops includes cereals, spices and sugarcane.

IRRIGATION

The river Mahanadi is the principal source of irrigation in the command area. It has a peak run-off discharge of 45,300 cumecs and gives an average annual yield of 51061 MCM. The available yield from this river is utilized for irrigation through two headworks in the study area – The Mahanadi Barrage at Jobra and the Birupa Barrage

head at Jagatpur. The percentage of conveyance loss for the study area shows that in the main canal there is a loss of 36.3% and in the distribution canal it is in the tune of 22.9% totalling to about 59.2%. Thus the total conveyance sufficiency is about 40.8%. However since the principal crop is paddy, there is a further field application loss of about 15%. Thus the total irrigation efficiency for the study area is about 34.7%.

DEMOGRAPHY

The present study area spreads over an geographical area of approximately 3815 sq. kms and spans across the districts of Cuttack, Jagatsinghpur and Kendrapara. The total population of the study area is approximately 25.434 lakhs(as per 2001 census) living in 360569 households located in 2866 villages under 181 Gram Panchayats. The total cultivators are approximately 2.653 lakhs and total workers are 10.168 lakhs. There are approximately 229750 agricultural labourers in the study area.

HYDROGEOLOGY

The study area covers part of Cuttack and Kendrapara and the entire Jagatsinghpur district. The entire area is covered by alluvial formation (of Quaternary age). In Cuttack district fresh water occurs in this district down to bedrock or other hard formation (in which further drilling by rotary rig is not possible as it has to pierce through hard formations such as shale etc.) except in Niali block where fresh water zone overlie the saline water zone and also in parts of Nischintakoili blocks. In narrow elongated tract which occurs along the course of Mahanadi river where deposits of younger alluvium occurs, the yield goes upto 40 to 50 lps. Salinity problem occurs in the southern part of Niali block and also in parts of Nischintakoili block. The fresh water bearing zone at Niali block extends down to 90 or 100m depth and below which saline water occurs and extend beyond 300m depth. The entire Jagatsinghpur district is underlain by alluvial deposits and major part of the district in the central and eastern sector (around 70% of total district area) suffers from salinity problem. Non-Saline area occupies the northwestern part covering entire block area of Biridi and Raghunathpur and adjoining major part of Jagatsinghpur and very small part of Tirtol blocks (north west). The fresh water bearing aquifers occur down to 300m depth and prominent aquifer zones are normally restricted within 200m depth and within this depth range the average cumulative thickness of aquifers is around 50 to 60m. The yield from these aquifers generally is more than 40 lps against the drawdown less than 12m. In Kendrapara district, the cumulative thickness of the aquifers which had been tapped by the tube wells varied from 20 to 69m with the average value ranging between 30 and 40m. The yield of these tubewells varied from 22 to 71 lps. The yield was normally found high (>50 lps) in the Pattamundai-Madanpur-Gopalpur-Sansarphal area while in other areas, on an average, the yield ranged between 30 and 40 lps. The boreholes data indicated that the entire district, except a very small portion in the southwest corner, reels under salinity hazard. The hydrogeological map of the study area is given below in figure 5.

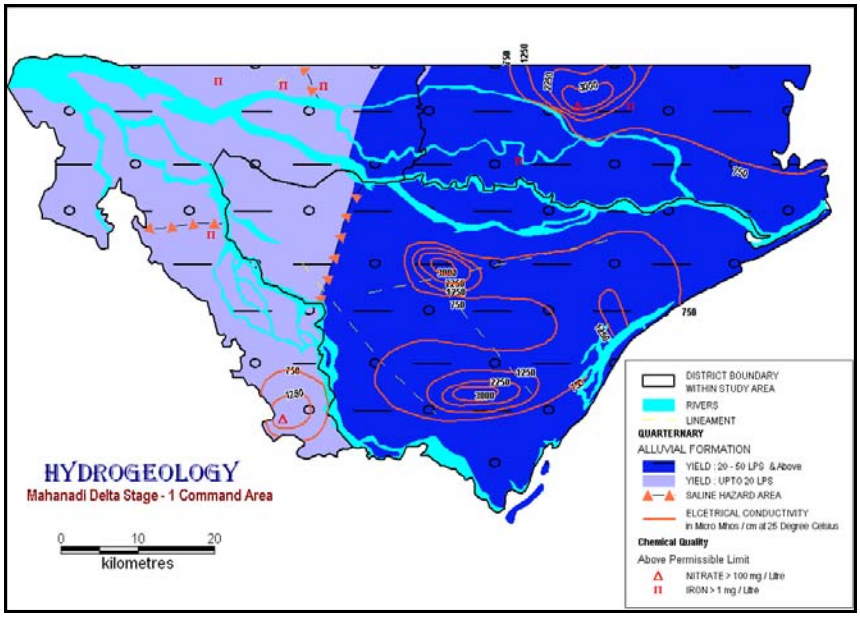


Figure 5 : Hydrogeology of the Study Area

GROUND WATER SCENARIO

Regular monthly monitoring have been carried out for the months of - May, June, July, August, October, November, December of 2008 and of January, February, March, April, May , June, July, August, September,

November in 2009. The monthly monitoring for the month of September 2008 was not done due to occurrence of wide spread flood in the study area. In addition due to its remote location, the area has got accessibility problems for detailed study and data collection. Monthly monitoring of water level shows that most of the area remains affected by water logging. Comparing and averaging the water level data of both the years, in the Pre-monsoon about 858.75 sq. km i.e., 22.5% of the total study area is water logged (depth to water level 0 – 2m) and about 1710.45 sq. km. i.e., 44.8 % of the total study area is prone to water logging (depth to water level 2 – 3m). Maximum of this water logging condition is found in the area that lies between the rivers Mahanadi and Kathajodi and few patches near the coast. Where as in the post monsoon however the extent of water logging increases to 2708 sq. km area i.e., around 70.9%(almost the entire Jagatsinghpur district) and area prone to water logging is about 683 sq. km i.e., roughly 17.9% of the study area. The average Pre and post monsoon water level data is given below in table 4 and the corresponding maps are shown in Figure 5 and 6 respectively.

Table 4 : Area coverage under Average Depth to Water Level

Depth to Water Level in mbgl	Pre-Monsoon Average		Post-Monsoon Average	
	Area in Sq. Km.	%	Area in Sq. Km.	%
0 - 2	858.80	22.51	2708.00	70.98
2 - 3	1717.00	45.01	683.10	17.91
3 - 5	1134.00	29.72	359.20	9.42
5 - 10	105.20	2.76	64.70	1.70
	3815.00	**100.00**	**3815.00**	**100.00**

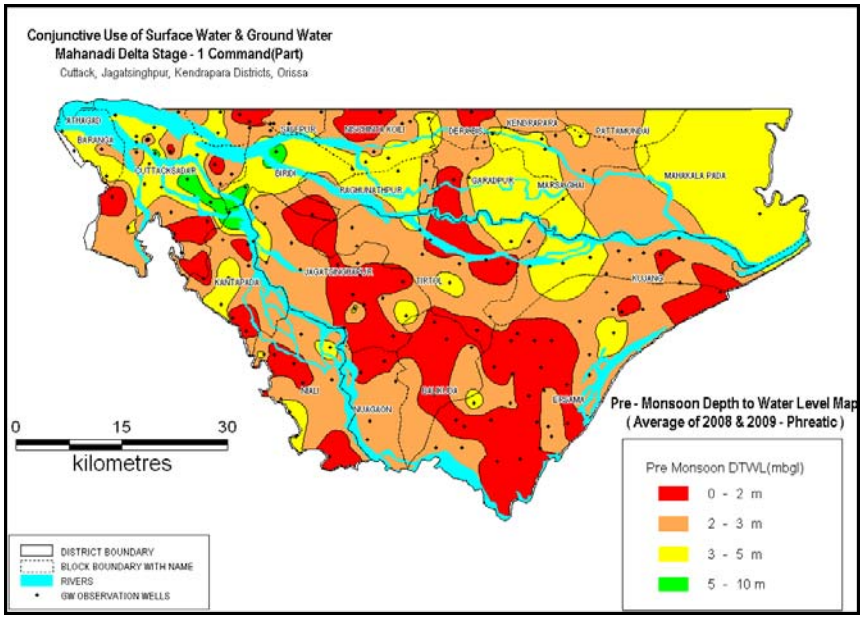


Figure 5 : Pre-Monsoon Depth to Water Level(Average of 2008 & 09)

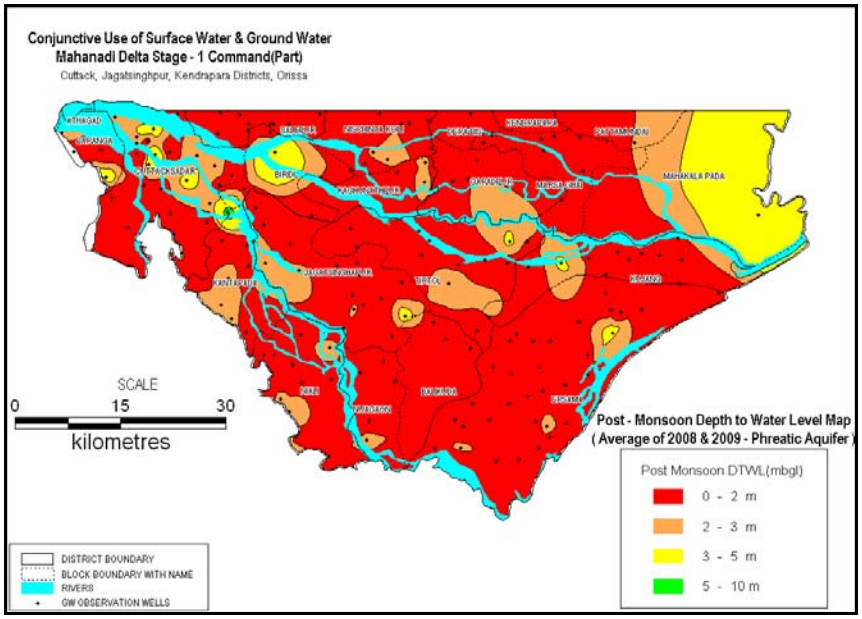


Figure 6 : Post-Monsoon Depth to Water Level(Average of 2008 & 09)

GROUND WATER RESOURCES

The entire area is underlain by alluvial formation. The aquifers are thick and have prolific yields with negligible draw down. However because of very slight fluctuation in the pre and the post monsoon depth to water level, the dynamic ground water resources is moderately good. At the same time since most of the water requirement is met from surface water resources, hence the gross ground water draft is also quite low this results in low stage of ground water development. In the present study area which includes partly or wholly of 21 administrative blocks spanning across three districts, it is seen that the gross annual ground water recharge from all sources is about 263656 HaM, but negating the natural discharge the net available resource works out to be around 239541 HaM. Out of this amount, the existing draft for irrigation usage is 37325 Ham and the domestic and industrial requirement is in the tune of 6210 HaM only. The overall stage of ground water development in the entire study area is a meagre 18.17 %.

GROUND WATER QUALITY

The pH ranges from 6.9 to upto 10 and electrical conductivity ranges from as low as 171 µS/cm to as high as 7940 µS/cm. As such the analysis of water samples reveal that the water is in general of potable nature and fit for irrigation purpose. But pockets of saline water exist. The lower part of the command area, particularly in the Ersama, Kujang block of Jagatsinghpur district and Mahakalpara Block of Kendrapara district have been affected by quality problem of higher EC is It is reported as the after effect of Super Cyclone of 1999, when sea water have entered into the phreatic aquifer system and in absence of proper natural flushing out mechanism is yet to be stabilized. More over it has also rendered vast patched of agricultural land into a barren one. The range of chemical parameters for phreatic aquifers is described below in table 5

Table 5 : Range of Chemical Parameters(Phreatic Aquifers)

Parameters	Minimum	Maximum	Average
pH	7.5	8.5	7.9
EC in µS/cm	110	5000	928.4
Cl mg/L	24.82	1244.30	169.1
NO_3 mg/L	0	35.05	10.2
F mg/L	0	1.43	0.5

HYDROGEOLOGICAL SYNOPSIS

The depth to water table of the phreatic aquifers in the study area are mostly within 2 metres in the post monsoon season and within 5 metres in the pre monsoon season. More over the irrigation system operates to provide surface water almost all throughout the year and more specifically in the end kharif and entire rabi season. As such there is no dearth of water availability. Since most of the water demand is for agriculture and in

the absence of any big industrial unit in the study area there is no problem of water deficit. However certain observation have been made for conjunctive use planning which are as follows:

- The area has very shallow depth to water level with almost non-significant pre and post monsoon fluctuation and suffers from water logging condition – both in terms of surface water as well as ground water. Even the deeper aquifers are under auto flowing conditions almost all through the year. This causes very less amount of recharge to ground water. Most of the water from rain fall infiltration as well as from canal seepage get converted to rejected recharge and adds to the drainage run off component. So in terms of hydrodynamics there is no effective flushing mechanism within the aquifers.
- The topography of the land is very gently sea ward sloping and the master slope of the land is very very low(0.02%). This causes very slow movement of surface run-off. This causes extensive drainage congestion and increases the risk of flooding and extensive damage to life and property as well as of the crops.
- Hydrogeologically the area is entirely composed of un-consolidated alluvial formation of Quaternary and Recent age underlain. The aquifer disposition is very complex in nature. The porous formations open up, merge and get juxtaposed in a very complex manner. There are inherent salinity problems in many of the porous formations due to absence of any flushing mechanism. Some of the wells near the coastal reaches, particularly in the Ersama Block of Jagatsinghpur district, which got affected due to Super Cyclone of 1999 are yet to be restored to its original state in terms of water quality.

GROUND WATER MANAGEMENT

A perusal of depth to water level data reveals that both in the pre and post monsoon the water table is very shallow and the fluctuation is of very minor magnitude. The aquifers are already saturated and hence cannot take in water either from the monsoonal recharge or through the canals. This causes a huge amount of rejected recharge. The present study area suffers from Extensive water logging condition in both pre and post monsoon season which is mainly due to drainage congestion in the study area for which no effective natural flushing mechanism is taking place inside the aquifers. The major problem for drainage is the very flat topography and master slope which is around 0.02% in the upper reaches and reduces to 0.01% in the coastal proximal areas. The coastal areas are affected with salinity problems – both in terms of ground water as well as soil which in turn results in poor agricultural yield - people near coastal areas resort to prawn cultivation – causing further degradation of water quality. For all these few possible remedial measures could be taken up such as:

1. Improvement of drainage conditions in the study area by constructing artificial drains, which could manage the drainage congestion problems and contribute largely to water logging as well as in flood mitigation by effectively channelling the excess surface water as well as the rejected recharge to the sea. A scheme of master plan for drainage development for coastal Orissa is already in progress and once completed this will provide a vital solution to the perennial water logging problems in these areas.
2. Encouraging people by proper counselling and by lending them technical and financial support to judicious usage(with proper periodic monitoring both in terms of water level and quality) of water from phreatic aquifers and shallow confined aquifers(dug wells and shallow filter point tube wells) for minor lift irrigation usage and adoption of cultivating salinity resistant crops to lower the water table for effective recharge leading to flushing of the entire aquifer system and thereby reducing the problem of water logging and soil salinity to some extent.
3. Since the main problem in this area lies not in scarcity of water but plenty of it - creating a regional scale low – cost subsurface dike / clay screen mechanism all along the coastal areas in this part – to check salinity ingress and allowing scientifically designed ground water draft programme in a industry – agriculture – domestic sector coordinated manner to create a substantial drawdown in the lower reaches on the fresh water side; so that the upper reaches can take up a substantial amount of rainfall recharge and the ground water flow can be accelerated towards the bottom reaches. This in turn will facilitate the flushing mechanism and sweeten up the brackish water in the middle reaches.

If needed in future, construction of small farm ponds and other cost effective rural rain water harvesting/conservation structures and utilizing this fresh water for small scale agricultural activities will also help to mitigate water problems as and when required and this will also help in flood mitigation. The excess excavated earth may be additionally used as embankments of the river / water channels and acts as effective shield against floods.

SUGGESTIONS & RECOMMENDATIONS

In most of the Irrigation command areas, cultivators are discouraged to adopt ground water irrigation. As per the existing rules there is no or very bare minimal subsidy / help from the State Government towards individual cultivators for construction of ground water abstraction structures and utilizing them for irrigation purpose. This should be modified suitably to encourage ground water irrigation both from the phreatic as well as from the deeper aquifers wherever possible and feasible.

- For the Community water supply in the semi-urban and rural settlements the source should be ground water.
- There should be extensive development of drainage channels to prevent surface water logging and thus preventing development of soil salinization process.
- Efforts are to be made to reduce the conveyance losses in the system. The current irrigation efficiency is only of the order of 34.7 %.
- If some industrial units come up in the area, they may be permitted to augment their water requirement from the ground water in a controlled and regulated manner in addition to surface water.
- The main essence of all the above mentioned solutions is to create a suitable draw down in the aquifer system. This would ensure periodic recharge in the system and thus an active flushing mechanism would be initiated. This will definitely help to improve the water quality of the areas in proximity to the seas and all those suffering similar problems.
- Desperate problems need desperate cures. If in spite of best efforts, all the above methods fail, suitable measures may be taken to abstract water from these areas and supply them upstream or in water scarce areas as well as constructing large clay screens / dykes near the sea to prevent any additional salinity ingress.
- A lot of people near the coastal sand dunes(allegedly illegal immigrants / settlers) because of the inherent salinity problems and unproductive / barren lands resort to prawn / shrimp cultivation. The so called 'shrimp mafias' pumps the brine inland and thereby further degrades the land. They should be counselled and monitored properly and periodically to prevent the inland salinization menace.
- To properly construct a working simulation flow model, the area may be taken up for extensive ground water exploration with the objective of tapping individual aquifers and testing them individually. They may be kept as sanctuary wells for emergency use, later on and may also be used as ground water observation wells.

CONCLUSION

The study carried out in parts of the Mahanadi Delta Stage-I irrigation command provided a moderately good understanding of the prevailing hydrogeological condition of the area and helped in pinpointing the problems at hand. It also helped update our existing knowledge base of the area. The problems of soil salinity and water logging are mostly related to drainage congestion and excessive dependence on surface irrigation. Because of non-significant fluctuation of water levels, no effective flushing mechanism is taking place and hence there is no significant improvement in ground water quality. Efforts are to be made to improve drainage, create controlled draw down in the aquifers. This will reduce risks and losses associated with floods which frequently create havoc in terms of life and property of the local residents. Thus ground water management evolves as the only effective tool in combating water logging and soil salinity problem in coastal command areas like Mahanadi Delta Stage 1 command area.

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REFERENCE

1. A Report on Ground Water Management Studies in parts of Mahandi Delta Stage -1 Command Area, 2010, Unpubl. Technical Report, CGWB, SER
2. A Report on Ground Water Management Studies in Parts of Jagatsingpur & Kendrapara District, Odisha, 2005, Unpubl. Technical Report, CGWB, SER
3. Hydrogeological Framework & Ground Water Development Prospect in Orissa, 2004, Unpubl. Technical Report, CGWB, SER
4. Ground Water Information Booklet, Cuttack District, Orissa, 2008, Unpubl. Technical Report, CGWB, SER
5. Ground Water Information Booklet, Kendrapara District, Orissa, 2008, Unpubl. Technical Report, CGWB, SER
6. Ground Water Information Booklet, Jagatsinghpur District, Orissa, 2008, Unpubl. Technical Report, CGWB, SER