Water Resource Characterization of Underground Coal Working - A Case Study for Part of Jharia Coal Field

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ABSTRACT

Certain aspects of water resource characterization has been attempted for two successive calender years of 1992 and 1993 in area belonging to Tata Steel of Jharia coalfield. The methodology incorporates: Rainfall analysis and hydrological study as surface phenomena; while hydrogeological study covered the impact of underground coal working towards subsurface phenomena. Digital analysis of Landsat TM data carried the delineation of major lineaments, degraded land, vegetation cover, surface water bodies and other coal mining features. The paper describes the underground coal mining background together with geological and hydrological factors for deciphering the recharge, transfer and discharge zones of the area. The monthly groundwater inventory for the occurrence of different aquifer system and their annual variation range has concurred with the rainfall pattern. The water problems due to intensive underground coal working are shortage of drinking water in premonsoon season and excess of minewater pumping in monsoon, outgoing monsoon season. The water utilization and water supply aspects have been outlined for the area, on the basis of carried water resource characterization.

INTRODUCTION

Jharia coalfield, the prime coking coal deposit of India is located in Damodar river basin; which contains 65% of country's demonstrable coal reserve. It has been always facing shortage of drinking water during premonsoon season on one side and excessive underground minewater pumping during monsoon to outgoing monsoon season on another side. It has geographic coverage of 450 km^2. with elevation of 230-150 m above mean sea level in district Dhanbad of Bihar state. The deposits have been worked by organisations like M/S Coal India Limited, Steel Authority of India Limited and Tata Steel since a century. The 25 Km^2 area belonging to Tata Steel of Jharia coalfield is selected for characterization of available water resource emphasising the impact of underground coal working. The purpose of this paper is to investigate Existing surface and subsurface phenomena of the area governing for the occurrence, movement and distribution of available water resource; with documenting the scope of water utilization alongwith water supply status.

CONCLUSIONS

Surface phenomena

It depends upon hydrological character, including rainfall pattern and surface drainage. The rainfall has large variation over the past 30 years, ranging within 180 to 70 cm in Jharia coalfield. About 90% rain occurs during monsoon season [June to September] and excessive minewater pumping is used to be done during monsoon and outgoing monsoon seasons [July to October]. This attributes to high humidity in underground, heavy duty on ventilation system and energy consumption for minewater pumping.

The large scale underground coal mining employing all possible mining methods has frequently degraded surface drainage pattern. The comparison of 1925 & 1975 maps revealed surface drainage configuration degradation trend at the rate of 4 km $year^{-1}$. The surface drainage in the area is through two perennial rivers with +40m H F L variation,two medium jores [Riverlet], two small jores [Stream], about two dozens seasonal surface ponds and two permanent surface ponds along with depression zone.

Subsurface phenomena

The subsurface water regime depends mainly upon on hydrogeological character and underground coal mining practices. It is under dynamic condition for overall six collieries working within 50-600 m depth cover. The workings has developed; delamination, caving of roof mass and fracturing of the overlying strata more than actual underground mine boundaries [1]. The rockmass deformation provides channel for transfer of surface water to further downward. Similarly, the old adits and abandoned workings are associated with minewater accumulation under gravity flow. They are often unapproachable, unmapped and behave as aquitard with unpotable water.

The underground mine workings are in three contiguous coalseams within 300 m depth cover, accounting for nearly 80% coal production. Down below area, eight seams burnt to jhama (affected by igneous activity) and two virgin coalseams are below 450m. The coalseams have been influenced by two prominent strike slip faults with down throw of 300 - 70 m; three major dip slip fault with down throw of 220 - 30 m, besides several cross cut faults with down throw of 80 - 10 m. These faults are the major mode for minewater occurrence; supported by rainwater infiltration, surface drainage seepage and aquifer loss. The minewater is discharged at each colliery level into large sumps and from there, it is taken care through pumping system, with total discharge capacity of 151.47 $Mlday^{-1}$. The underground pumping system and allied mine drainage consumes 60 - 65% of power demand at each colliery level for improving underground working condition and facilitating operational activity.

The litholog interpretation reveals that about 75%

stratigraphic succession has sandstone followed with shale and coalseams in decreasing trend of thickness. The original aquifers composed of permeable to fractured strata belonging to coal cyclothem have been lost within underground mine working boundaries. The adjoining area has unconfined aquifer within subsoil along cultivable vegetation and paddy field. Spring aquifers are around hydraulically sandstowed zone,while the local confined aquifers are within fractured coalpillar, sandstone and shale. The major hydrogeological condition of the area is illustrated as Table 1.

The monthly groundwater inventory through established keywells of the area for two successive calender years of 1992 and 93 reveals:that recharging of all existing aquifer system is in monsoon season with their decline trend in nonmonsoon season [Fig.1]. The discharge becomes pathetic during premonsoon season, leading to acute drinking water problem. Some of the fracture [confined aquifer] zone wells are artificially recharged through raw minewater for augmentation of ruralwater supply in Sijua group [2].

Digital image analysis

Landsat TM of dated 12 may 1987 has been digitally analysed with preprocessing of CCT, digitization of toposheet,creation of restoration model with 98% accuracy. The unsupervised classification product [Fig. 2] shows a promising improvement in deciphering the water related surface phenomena as surface drainage, vegetation,lineament,coal mining surface features. It serves as reliable supporting tool for delineation of recharge zone, degraded land and major hydrological features prevailing over the area.

Water utilization and water supply status

The water utilization has three categories namely; Industrial, Urban and Rural. The industrial usage for coal washery and allied work is fed through perennial river and raw minewater for hydraulic sandstowing. The urban demand is met through treated minewater and municipal water supply,from perennial river. The rural usage including cultivation as paddy is fed through jore; pond, dugwell. The drinking water for rural area is fed through hand operated shallow depth borewells and municipal water supply. The Sijua group has faced the occurrence of Diarrhoea - a water born disease during monsoon season of 1993; killing several human lives due to contaminated water supply. The details of water supply status for the area is summarised as Table 2.

Limitation and application

The larger quantity of water available from U/G coal working requires normal softening and preliminary treatment and can be useful in water management. The impact of depillaring and secondary porosity within subsidence trough are some of the practical restrictions - which can frequently change the

Table 1 : Major hydrogeological characters of understudied area

Sl. No.	Hydrogeological condition	Jamadoba group		Sijua group	
1	Existing aquifer[m]	Thickness	Depth	Thickness	Depth
	spring	2	3	3	2
	unconfined	12	6	4	4
	confined	5	20	5	98
	Potential aquifer	12	27	better yield	
		moderate yield		5	135
2	Impact of rainfall on aquifer system	unconfined aquifer is analogous		confined aquifer is analogous	
3	Impact of fracture on aquifer system	5 uniform sets under cover depth of 25m		6 inter crossed sets under cover depth of 30m	
4	Impact of under ground working on aquifers	possible impact due to 18m parting composed of shaly sandstone		less impact due to 46m parting of shaly sst.	
5	Premonsoon season				
	recharge	strike slip fault		medium jore	
	transfer	small jore		fractured zone	
	discharge	spring aquifer		spring aquifer	
6	Postmonsoon season				
	recharge	small jore		medium jore	
	transfer	strike slip fault		confined aquifer	
	discharge	spring aquifer		spring aquifer	

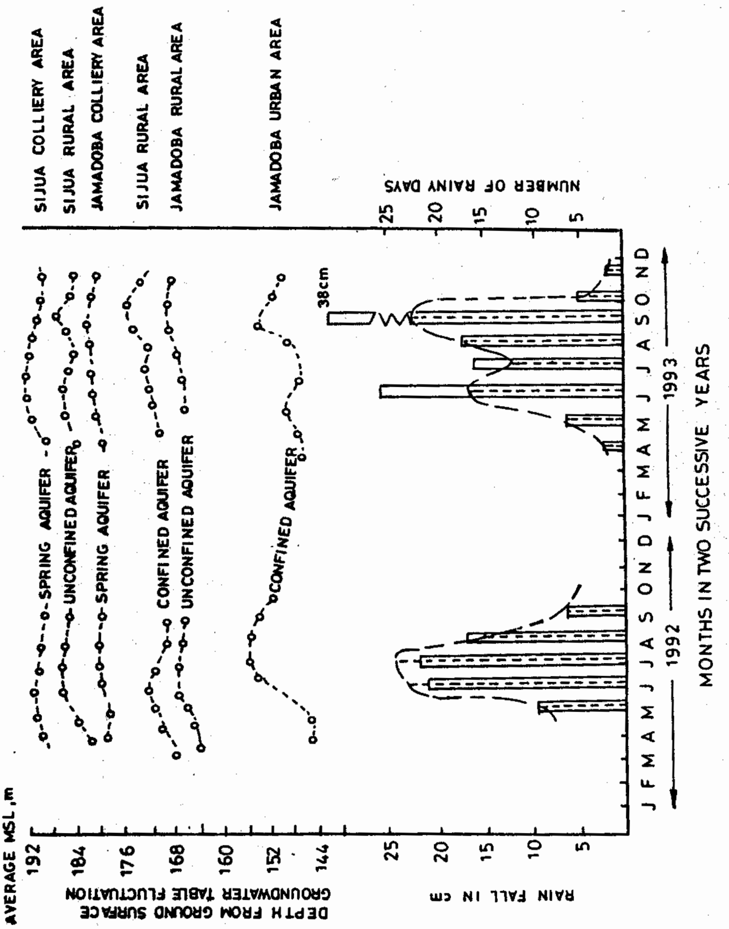

FIG. 1 MONTHLY GROUNDWATER TABLE FLUCTUATION IN RELATION TO RAINFALL PATTERN FOR UNDER STUDIED AREA

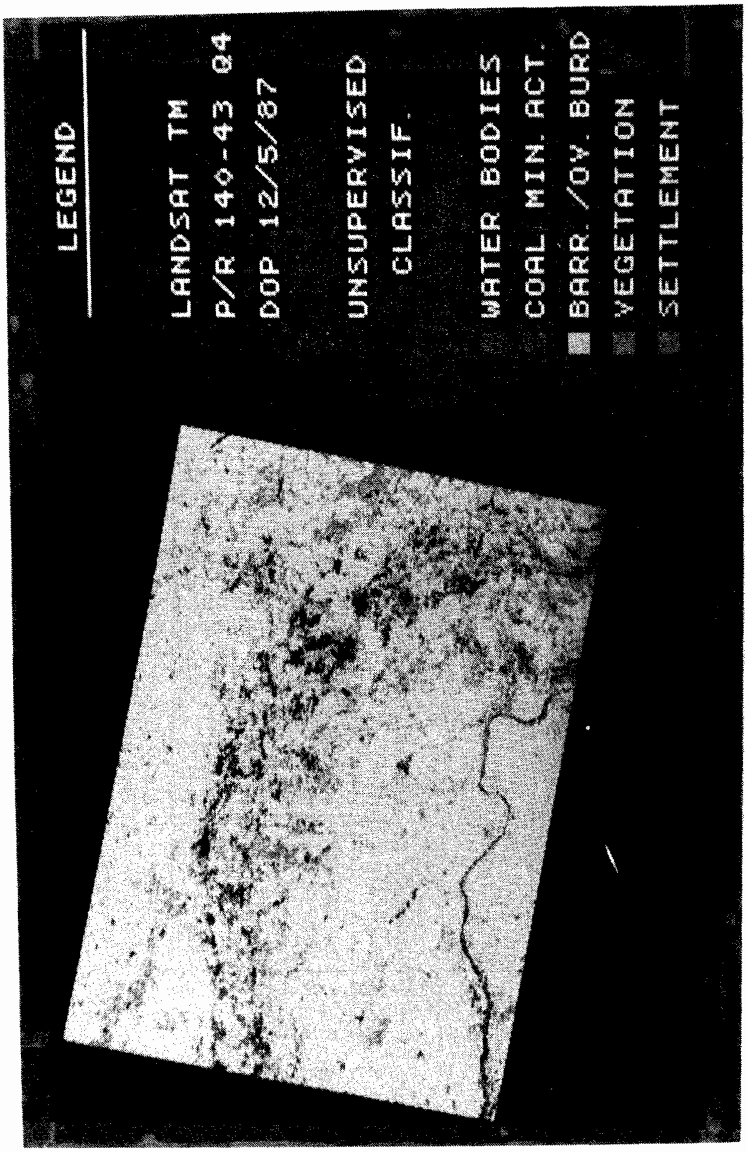

FIG 2 : DIGITAL ANALYSIS PRODUCT

Table 2 : Water supply status and water utilization in understudied area

Sl. No.	Mode of water supply	Jamadoba group	Sijua group	Water utilization
1	Municipality	near medium jore	negligible	Rural area
2	Tata steel pumping station	more to washery	negligible	Industrial area
3	Treated U/G minewater	operation of U/G coal cutters	domestic	Urban area
4	Raw U/G minewater	sandstowing purpose paddyfield cultivation	sandstowing artificially well recharging	Industrial and rural areas
5	Dugwell	less	more	Cultivation in rural area
6	Hand operated borewell	more along fracture zone	less along jore bed	Drinking purpose
7	Miscellaneous	dug wells for vegetation, jore water in paddy crops	minewater for fishery products	Humane eatable items

hydrogeological condition. The monitoring of surface phenomena through digital analysis in conjunction with relevant ground truths may serve as better tool in recharge estimation toward improvement of water availability for sustainable development.

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