

ENVIRONMENTAL IMPACT ASSESSMENT OF POTENTIAL MINING CONCERNS AT THAR COAL FIELDS AND THEIR REMEDIES

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ABSTRACT

The research covers the Tharparkar district situated in the south east of Sindh province of Pakistan. This research identifies the impacts of ongoing coal mining activity on ground water quality of Thar coal mines area and propose mitigation measures for management of the excessive water from continuous dewatering at mining area. On the basis of different EIA studies anthropogenic impacts on ground water quality of the Thar Coal mining area is determined. Removal of massive quantities of overburden will most likely alter the mass balance at the mining site and hence the sand, and overburden as well water from dewatering of aquifers must be retained within the ecosystem of the Coalfields. Ground water abstraction of about 25 million m³/year will yield abundant volume of brackish water, which will have to be desalinized for cooling purposes of the power plant and for the other beneficial use. Assessment of environmental impact shows that the overall significance of impact is of medium intensity, while the severity of impact is quite significant. Suggestions are proposed on the premise of the present investigation for the administration of Sindh and other partners. The dewatering surplus can straightforwardly be utilized as a part of the power era process as being drilled in different areas of the world. The dewatering surplus can be utilized in growing of the halophytes. The dewatering surplus can be treated with public private partnership to serve the water needs of the Thar District people, flora and fauna.

KEYWORDS: *Environmental Impact Assessment, Coal mines, Thar Coal, dewatering, pollution control*

INTRODUCTION

The district of Tharparkar lies in the south east arid zone of Sindh province of Pakistan at 24-26 North Latitude and 69-51 East Longitude. It comprises of two sub-divisions; Mithi and Chachro and four sub-districts (Talukas) of Mithi, Nagarparkar, Diplo, and Chachro. The presence of carbonaceous material inspired the Geological Survey of Pakistan (GSP) to carryout Thar Coalfield exploration. The coalfield is located in the desert in the eastern part of Sindh Province of Pakistan, and it lies between latitude 24°30'N to 25°N and Longitude 70°30'E. This discovery of estimated deposits of over 175 billion tons has uplifted Pakistan's coal resources to more than 184 billion tones giving its eleventh position in the list of 12 major coal producing countries of the world. The Thar coalfield encompasses about 9,100 sq.km² with dimensions of 140 kilometers (N-S) and 65km (E-W). It is spread over Mithi, Chachro and Nagarparkar talukas of Tharparkar district (GSP, 1996-2002; ADB 2002; IBRD 1998). The distribution of various Thar blocks is shown in Figure 1.

Extensive exploration activity has been undertaken to

evaluate the quality and estimate the quantity of deposit. Detailed studies have been carried out by Sino Sindh Company, Sindh Engro Company, and Carbon Energy Limited for Sindh Coal Authority (TRDP 2002; JTP, 1994) Exploration studies suggest that exploitation of this coal field is faced with a number of environmental and socio-economic constraints such as the following:

- The mine concessions are spread over a wide gentle syncline that is over 9100 km².
- The undulating coal seam substrate results in occurrence of lower coal-bearing strata with low to moderate variations.
- Removal of massive quantities of overburden is likely to alter the mass balance at the mining site. Seismo-tectonic conditions are not favorable since the Thar coalfield is part of the synclinorium that withstands the tectonic pressure.
- Sustainable mining at the Thar Coalfield will need to consider in maintaining or partly reducing the

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buffer capacity of the coalfield.

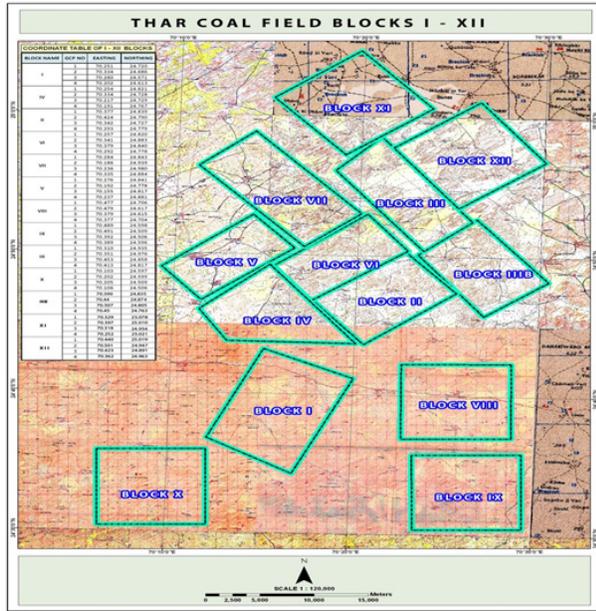


Figure 1: Thar Coal Field Blocks I- XII.

The constraints noted above are likely to pose moderate to major hazards at and during the pre-mining, mining and post-mining stages. Thar Desert involves roughly 75,000 km² zone in South East Pakistan. A significant part of forsake is secured by sand ridges. Fassett (1994) recognized three assortments of hills, which included longitudinal, transverse, and Barchan sort. A significant part of the southern piece of the land includes stable longitudinal hill (Hindel, 1980). As far as width, the longitudinal ridges are 200 to 250 meters wide with topographic alleviation of up to 100 meter. The area of Tharparkar lies in the south eastern dry zone of Sindh territory of Pakistan at 24-26 North Latitude and 69-51 East Longitude. It includes two sub-divisions; Mithi and Chachro and four sub-locale (Talukas) of Mithi, Nagarparkar, Diplo, and Chachro (Afridi, 2006).

MATERIALS AND METHODS

Air quality examining was done at five areas. The accompanying contaminations were chosen for the checking program in light of the normal emanations from the arranged operations and the level of hazard to human wellbeing postured by these poisons:

- Sulfur dioxide (SO₂)

- Nitrogen dioxide (NO₂)
- Respirable particulate issue (PM10 and PM2.5)
- Dust affidavit
- Dust flux.

The levels of PM10 and PM2.5 is higher noticeable all around because of the leave condition. (Zaigham 2000a; Zaigham, 2000b).

Water quality specimens were gotten from the 40 wells and were broke down for basic synthetic parameters and substantial metals. The outcomes are abridged in Table 1. The objective gauges are characterized as the more stringent of the NEQS for drinking water and the World Health Organization (WHO, 2001 & 2004) drinking water rules. In 16 of the 40 wells, the aggregate hardness is over as far as possible. Correspondingly, press, aluminum, lead and nickel additionally surpass as far as possible in a few wells (Abedin 2002; Abernathy, 1998).

Table 1: Stratigraphic Sequence in the Thar Coalfield.

Formation	Age	Thickness	Lithology
Dune Sand	Recent	14m to 93m	Sand, site and clay
Unconformity			
Alluvial Deposits	Sub-Recent	11m to 209m (variable)	Sandstone, sitston claystone, mottled.
Unconformity			
Bara Formation	Paleocent to Early Eocene	+52m (variable)	Claystone, shale, sandstone, coal Carbonaceous claystone
Unconformity			
Basement Complex		Pre-Cam-brain	Granite and quartz diorite

RESULTS AND DISCUSSIONS

For the purpose of this study is to identify the impacts of ongoing coal mining activity on ground water quality of Thar Coal Mines Area and propose mitigation

measures for management of the excessive water from continuous dewatering at mining area. Different EIAs has been conducted by different proponent in the study area. The data from these studies is used to determine the hazards of the mining activities on ground water. On the basis of these studies anthropogenic impacts on ground water quality of the Thar Coal mining area is determined. A cumulative stress induced by different factors like geological, geomorphologic and hydrological is also discussed. Based on the findings of EIA, mitigation measures are proposed for management of the ground water hazards occurring or likely to occur in the Thar coal mining area.

Environmental Assessment recognizes the environmental and human health consequences associated with the mining of lignite at Thar Coalfield. The severity of impact will be quantified at the environmental impact assessment (EIA) stage. This assessment will be a comprehensive examination of the cumulative stress induced by different features including geology, geomorphology and hydrology. Therefore the outcome of EIA process would enhance the interpretation of results of the probable environmental impacts of underground water. Based on the findings of EIA, mitigation measures would be proposed.

For each of the potential effects the comparing reasonable administration measures will likewise talked about. Given the betray idea of the territory, there is no changeless surface water highlight, or surface water stream anyplace in Thar Coalfield. At times, water is discovered gathered in little tarais and misleadingly burrowed sorrows where water gathers. These miseries are for the most part surface fixed with silty-mud and caliche material. A comprehensive rundown of potential venture related effects will be created. The effects will sorted out in gatherings, potential ecological effects, potential social effects, and dangers with potential to cause natural and group dangers. For each of the potential effects the comparing reasonable administration measures will likewise talked about (Li, 2002; Memon, 2006; Thomas, 2002).

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burrowed sorrows where water gathers. These miseries are for the most part surface fixed with silty-mud and caliche material. There are three aquifers of significance in the Thar Coalfields; the Top Aquifer, the Middle Aquifer and the Bottom Aquifer is confined from above by the Bara Formation clay stones and lignites.

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The Project aims at mining of coal from Thar Coal field Block – 1 for power generation of 900 Mega Watts (MW) s. The main objective of the Thar Coal Mining Project at Block 1 is to develop the coalfield resource for power generation for energy and economic security of the country. Mining of Thar coal has to address the environmental, social and economic aspects of sustainability. Accordingly, an Environmental Impact Assessment Study is carried out to address the environmental and social aspects of the Project and to share information on the likely impacts with all stake holders.

The purpose of EIA Study is to respond to the mandatory requirements of Section 12 of Pakistan Environmental Protection Act (PEPA) 1997- Section 12, which demands an initial environmental examination (IEE) or an environmental impact assessment (EIA) to be carried out before commencement of Project activity and the report to be submitted to relevant Environmental Protection Agency or Department, which has been delegated the authority to review and approve Project findings and recommendations.

The type of coal found in the Thar Coal fields is invariably lignite which is a low-grade, pyritic coal that is generally used in modified industrial furnaces to generate heat for boilers, coke oven heaters, brick kilns, etc.

The following are the average quality parameters of the coal (lignite):

- Coal Quality: Lignite
- Ash (average): 7%
- Sulphur (average): 1.4%
- Moisture (as received): 48%
- Heating Value (as received): 5140 Btu/Lb
- Moisture (final): 12%
- Heating Value (dry): 10280 Btu/Lb

The findings of the exploration programs carried out by the Geological Survey of Pakistan (GSP), and the United State Geological Survey (USGS) John T.Boyd during the years 1992 and 1993, the RE exploration program carried out in 2003, and some additional conditions have been used for the selection and siting of the exploration and mining area. Among these conditions the topography is one of the important factors for the selection of mining area in the Thar region. Some areas are dominated by sand dunes with height up to 100m whereas others show a relatively plane topography. Due to technical reasons the exploration wells of all drilling programs had to be drilled in the valleys and plane areas. Therefore, the down whole stripping ratios of the previous exploration campaigns have to be correlated to the topography in order to pre-select the mining area. As a result the selected mining area may be located in plain topography and this may show relatively good down-hole stripping ratios compared with the southern part of Block-1.

Air and noise pollution at the construction and operation stage will be dealt with at source in conventional manner. Air of the open pit mining area is likely to be contaminated with coal bed methane, which is adsorbed in the coal matrices and will be released on opening the mine surface. The microenvironment will therefore be adequately ventilated. Solid waste from overburden of the mining field will be used to construct water retention galleries or temporary causeway required to intercept intruding storm water from the catchment into the

mining area, and as water and soil conservation works at and around waste dump to control soil erosion, dust pollution, and water loss. Reclamation and afforestation will be initiated in time so that it becomes part of the waste disposal system/ dumping site at the boundary.

Shelter forest belt will be planted at the mining field and dumpsite of the open-pit mine for optimizing the benefits of utilization of excavated soil and debris. Greening factor of the mine compound shall be aimed at above 15 percent. Steady vegetation, greening and ecological restoration shall be undertaken at the site of waste dump and inner waste dump. Effective measures shall be taken at the construction and operation stages to protect the environment and control pollution so that restoration of regional ecology is ensured at the time of demobilization.

The Project area has the topography typical of the deserts and has no natural boundaries such as rivers or lakes. Work is in hand to install the infrastructure facilities such as adequate power supply and an airstrip. Several paved roads, a power supply (11kV) line and a telephone line between Islamkot and Khario Ghulam Shah are located within the envisaged mining area.

Their relocation must be linked to the construction of the connecting infrastructure or the mine and the power plant at the start-up of the project and in the course of the advance of the mining face. As far as the energy supply of the mining is concerned, it is assumed that before the start-up of the mine the 132kV grid extension project for the Thar region as planned by the National Transmission and the Dispatch Company (NTDC) will be completed.

The villages Tilvai, Virvai and Khairo Ghulam Shah are located within the proposed mining area that is home to some 5000 people. A resettlement plan of the villages has been considered and resettlement action Plan devised under RFP in order to allow for mining operation to proceed unhindered.

Normal underground water outflow of the mine is 21840m³/d and the main polluting factors in water are SS and COD. In order to meet the water quality characteristics of reclaimed mine water, coagulation, precipitation and sterilization process will be adopted for treatment.

The water quality after treatment will be $COD \leq 50 \text{mg/l}$, which complies with requirements under the discharge limit value of pollutants in waste water from mining, and emission standard for pollutants from coal industry, as well as requirements of the National Environmental Quality Standards (NEQS) of Pakistan. There will be about 1993.5m^3 of mine water after treatment to be used for the production on ground and underground each day and the residual water will be discharged externally along the side duct outside the yard. This discharge of water can be considered as production water for the power plant in future.

Water-treatment station of this mine consists of comprehensive treatment workshop, pre-sedimentation pond, highly effective flocculants settlement pond with tilted plate, production sump and sludge sump.

Waste gas pollution prevention: Dust pollution control is based on the principle of reducing pollution sources and pollutants. Dust generated during mining, transport and waste dumping shall be controlled by water sprinkling and other measures. Watering cart shall be equipped. Dust caused by punching and blasting shall be prohibited by blasting control technology. Belt conveyor and stage-loading station shall be located inside the enclosed buildings and watering and dust suppression devices shall be equipped inside the buildings.

With the engineering measures of watering, dust suppression, enclosure and blocking taken in the production process, the influence sphere and extent of TSP generated in the process of project construction and production can be reduced. Wastewater pollution prevention will require the sewage and waste water from machine repair shop and oil depot to be discharged into the complex of sewage regulation basin and lifting pump house to be reused to the power plant with general production and domestic waste water after being treated by oil separator and oil- water separator.

Noise pollution prevention will be effected at source. Ventilator and induced draft fan shall be equipped with acoustic hood, noise dampener or other noise-abatement equipment. Crusher and other equipment with strong vibration shall be equipped with vibration isolator to use vibration reducing plate to reduce the attacking intensity of the materials to runner. Noise-abatement effect of the

equipment shall reach 15- 20dB (A) and above. Ventilator, pressure fan and other noisy equipment shall be applied inside the enclosed rooms.

Solid waste treatment: Solid waste of the overburden shall be discharged directly into open waste dump. After the dump reaches the ultimate earth cover over conduit, vegetation and ecological restoration shall be performed. Sludge pressing area shall be established next to water treatment plant. Substrate sludge generated by water purifier and filtration unit will be filter-pressed by pressure filter after lifting; filter cake will be transported outside and its disposal will be outsourced. Domestic garbage shall be segregated and disposed of in the conventional manner.

The overburden at Sinhar Vikian Varvai, Block-1 consists of dune sand, alluvium and sedimentary sequence. The roof and the floor rocks are clay stone and loose sandstone beds. Cultivation is carried out wherever alluvial soil exists and near or along the numerous depressions where rain water is absorbed by the soil and stored. Cattle grazing and wood cutting are the main occupation.

Environmental considerations have been given to development of mining site, installation of mining machinery and equipment and transportation of the coal from the mine deep down. The preferred alternative site responds positively to the aspects of siting the mine and consideration of topography, geology, 100~120 meter thick overburden, roof floor and floor rock comprising clay stone and loose sandstone and land subsidence in case of underground mining, and connectivity to the nearest grid. The Sinhar Vikian Varvai, Block-1 Coal Mine will be operated by the open cast mining procedures, with its design and technologies complying with the environmental requirements as well as safe and sound mining practices.

Khario Ghulam Shah, the largest village among the three villages in the TCB-1 area, has three graveyards in total, out of which one for Muslims and two for Hindus, according to their caste. Conversely, Tilvai has only one graveyard for the infants. In general the dead bodies are taken from Virvai and Tilvai to Khario Ghulam Shah for burial. The graveyard within mining area will be relocated in consultation with local communities and

with the involvement of authorities involved as defined in LAA 1894. This has been done in past in the case of ERRA project in Mansehra and Azad Kashmir.

Major environmental aspects identified during the EIA Study include the following:

- Ground water abstraction of about 25 M m³/year will yield abundant volumes of brackish water, which will have to be desalinated for cooling purposes of the power plant and for other beneficial use.
- Alteration of air quality due to the all sandy environment. Efforts will be made to minimize dust emission and protect health of workers.
- Noise generation by noisy equipment, truck traffic and workshop activities will be minimized by noise level reduction at source e.g. by isolating machines and providing personnel protection equipment.
- Sand disposal will be undertaken at designated site while coal tailings will be placed within special dumps sealed with clay lining and effluent quality continuously monitored with respect to seal permeability and dust emission.
- Flora will be re-established on the disposal site with new dump surfaces by creating adequate soil stratum for local plants and for the needs of the farmers. To this end a mixture of dune sand with Sub recent and Bara Formation Strata will be preferred to increase the magnesium content and the water bearing capacity.
- The fauna will not be impacted greatly by the project, which will adopt measures to support the bird population for nest building with plantation of trees.
- Health, safety and security of the workers and the population all around will receive topmost priority with reference to dust and noise emissions by maintaining work place environment at internationally accepted standards on vibrations, particulate emission levels and electric shock.

The local population will be compensated for relocation of homes and supported during the resettlement

activities by providing housing as well as infrastructure including roads, water provision, schools, mosques and health facilities. A resettlement action plan is being prepared by SSRL through independent consultants.

The EIA process finds that the impacts of the project activities at the pre-construction, construction and operation stages have been adequately addressed and mitigation measures duly proposed wherever needed. The issue of safety has been duly incorporated in the design and operations phases of the project. Adoption of mitigation measures will ensure reduction of impact on the micro and macro environment as well as socio-economic conditions to acceptable levels and discharge of emissions to comply with the NEQS. The development of this project will be compatible with the requirements of the Pakistan Environmental Protection Act 1997 as well as other regulatory requirements of Government of Sindh and Government of Pakistan.

Implementation of proposed measures, if followed up with environmental monitoring and management plan will substantially reduce the severity to acceptable levels, and will make the Project socially, economically and environmentally sustainable. In terms of risk assessment also, the Project has to face heavy odds. The project is highly capital intensive; it will require large investment to deal with the three main issues: Resettlement of population, removal of overburden and dewatering the aquifers taking care for the shifting of mass balance. The enterprise with low financing capacity may not be able to invest on the establishment of the coal mine and the infrastructure therefor and keep waiting for profits. Risk of capital is high because the return on investment will start much after the initial investment at the construction stage.

Despite the odds, the resource risk outweighs all others and that is ample justification for the risk to be well worth taking. Adoption of mitigation measures and strict adherence to the Environmental Management Plan (EMP) and Environmental Performance Monitoring Plan is nevertheless critical for the sustainability of the Project.

Air quality testing was done at five areas (Figure 2). The outcomes are appeared in Table 2. A correlation of the outcomes with the NEQS for the encompassing air quality shows that the NO₂ and SO₂ fixations meet NEQS limits. The level of PM₁₀ and PM_{2.5} is higher

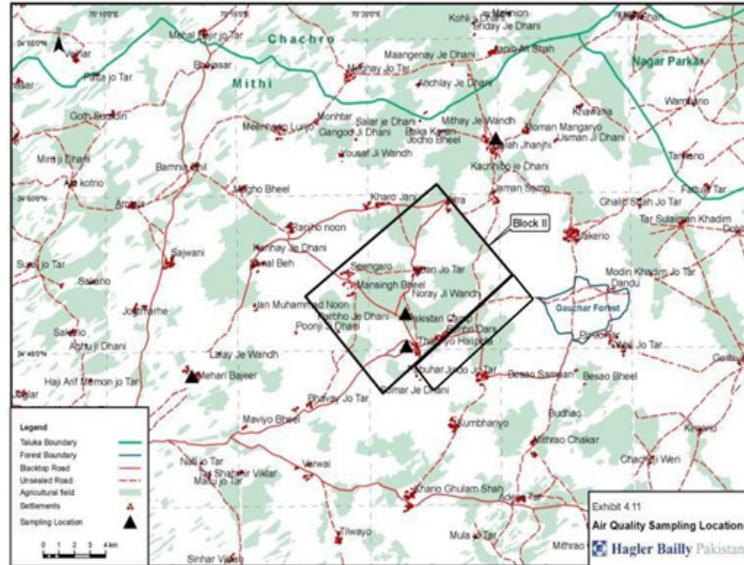


Figure 2: Ambient Air Quality in the Study Area.

Table 2: Ambient Air Quality in the Study Area

Month	Location	Sulfur	Nitrogen	Particulate Matter	
		Dioxide (SO ₂)	Dioxide (NO ₂)	Less than 10 Microns (PM10)	Less than 2.5 Microns (PM2.5)
May	Mehari Bajeer	12.40	6.98		
	Saleh Jhanii	9.14	4.65		
	Pakistan Camp	4.49	2.39		
	Thario Halepota	a	3.23		
	Average	8.68	4.31		
June	Mehari Bajeer	5.83	2.95	138.89	13.89
	Saleh Jhanii	5.93	3.36	180.55	27.78
	Pakistan Camp	2.18	2.81	166.67	27.78
	Thario Halepota	3.37	2.22	222.22	55.55
	Average	4.19	2.84	177.08	31.25
July	Mehari Bajeer	2.99	3.31	83.33	13.89
	Saleh Jhanii	6.77	4.56	97.22	13.89
	Pakistan Camp	8.12	2.66	97.22	13.89
	Thario Halepota	1.6	2.88	111.11	27.78
	Average	4.84	3.35	97.22	17.36
Average	Mehari Bajeer	7.07	4.41	111.11	13.89
	Saleh Jhanii	7.10	4.19	138.89	20.84
	Pakistan Camp	4.93	2.62	131.95	20.84
	Thario Halepota	2.49	2.78	166.67	41.67
Overall Average		5.40	3.50	137.15	24.31
NEQS°		80	40	120	15

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Pakistan’s populace was evaluated to be 177 million out of 2011. Table 3 demonstrates the evaluated populace and populace densities of Pakistan, Sindh and Tharparkar. The populace gauges for Pakistan and Sindh have been

Table 3: Estimated Population of Tharparkar, Sindh and Pakistan in 2011.

	Population	1998 Census	Populaion	Population	2011	Poplation
	000'	%	Density	000'	%	Density
			(per sq.km)			(per sq.km)
Tharparkar	914	23.0	46	1.224	23.8	62
Sindh	30,440	0.7	216	42,180	0.7	299
Pakistan	132.352	100.0	166	177.100	100.0	222

A groundwater gauge study taking a gander at the groundwater table and water quality was led in the Study Area. The groundwater asset study shrouded 13 towns in the Study Area. There are around 150 wells in these 13 towns. Of these, 40 wells were chosen for observing. The wells that were reviewed are largely exclusively claimed. There are no wells claimed by and large by the town or the area. The wells are open burrowed wells; no mechanically penetrated boreholes were found in the Study Area. A large portion of the wells are block lined.

The southern margin of Thar Desert has temporary water bodies which have significant existence especially in the great Rann of Kutch which is at the 60km distance to the south of block VI. The area has the characteristics of desert and has no regular or permanent water bodies’ features or surface water presence in surroundings or near Block VI. Sometimes water can be found in small level trail or also in purposefully dug up water depressions which host the rain water. These artificially dug depressions are usually built of silty clay and caliche material. The climate of Thar region is semi-arid climate along with high temperatures and short rain falling only in the monsoon months, July, August and September. Recharge is lower till 2-3 % of annual rainfall mean because of high evaporation and after every 4 to 6 years the raining during monsoon tends to fail. The drought time lasts two to three years. In past century there were some major droughts at the region during 1951-1956, 1962-1963,

acquired from the Pakistan Economic Survey 2011. The area of Tharparkar is scantily populated with a populace thickness of around 62 people for each sq. km, contrasted with Sindh’s populace thickness of 299 people for every sq. km and that of Pakistan at 222 people for every sq. km. The number of inhabitants in the locale of Tharparkar speaks to under 3% of Sindh’s populace and 1% of the nation’s populace. (Jaleel, 2002; Khan, 2003; Khan et al, 2002)

1968-1969, 1979-1981, 1985-1988, and numerous in the decades of 1990s and 2000s. The project area has average rain fall about 219mm, the actual rain fall during the rainy season may increase twice the average level.

Moreover the following physical impacts are expected: the open pit dewatering operations can be the reason of the dewatering of two aquifers upper side; the deep water aquifer can have impact due to the partial dewatering for local water need based supplies; a lateral change is expected in ground water behavior and formation of a cone of depression because of open pit dewatering. Little impact is envisioned on the deep aquifer as it is very large and extended that any cone of depression will create minimal impact on it.

The top two aquifers will be removed within the phase 1 mine by excavation. The after effect of excavation is difficult to foresee but extension of top irregular aquifer is not expected beyond the limit of the mine which is about 1 km. The middle aquifer is regular but the observation and studies have shown that the nature of the sand lenses is irregular and intermittent and its effects should also be localized and extension is not expected far beyond 1 km of mining. A continuous monitoring of groundwater bore holes is needed to make sure that the ground water should not be contaminated by these operations and moreover the poor water quality of existing water is not affected for worse.

CONCLUSIONS AND RECOMMENDATIONS

The samples of water from various wells located at various villages were collected and they were analyzed for the parameters like electrical conductivity, pH, TDS, BOD, COD, hardness and concentration of various chemicals. It was found that the TDS levels in some of the wells were much above the NEQS limits. The surface water and groundwater that inflows into the mine pit will be dewatered using submersible pumps introduced in sumps at the base of the open pit. The quantity of subsurface water pumped during mine hydro-stabilizing activities is estimated to be around 50 cusecs flowrate of ground water from coal top and coal bed aquifers.

After that the power plant will be using quite substantial volumes of the mine water and also the mine itself will use water for industrial and environmental purpose. The suitable locations for evaporation / infiltration ponds are natural depressions to minimize the need for construction of dams. Furthermore there is no villages inside the ponds to avoid resettlement and disturbance of the local population. Water is being discharged at the rate of 3600 m³/hr.

The area use for the pond was not used for any agriculture or settlement purpose therefore the utilization of the land has not resulted in to relocation of the villages. Groundwater quality beneath and especially downstream of the ponds may be affected by high saline water after a many years. Waste discharged in the pond is of brackish nature, due to high evaporation rate this water will be converted into saline. There might be some positive environmental impact in view of the fact that the water in the pond may attract avifauna. This pond will be converted in salt lake this will help to improve biodiversity.

The Government of Sindh has assured the proponents of the coal power projects for arrangement of adequate source water. But this seems not feasible or a viable approach considering present water shortage in the country specially Sindh Province. The water demand of the agriculture is not being fulfilled properly and if any share for these power projects can potentially bring additional chaos in the already water scarce province.

Following recommendations are proposed on the basis of the present study.

1. The Government should develop a comprehensive plan for water and waste water management in the Thar Coal mines area.
2. The dewatering surplus from the mining activity must not be drained in the nearby water bodies.
3. The dewatering surplus can be treated with public private partnership to serve the water needs of the Thar District people, flora and fauna.

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