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CONTENTS

President's Column

Mineral sector in India has suffered maximum due to poor infrastructures. But, recently bureaucratic delays in forest and environment clearances and land acquisitions have seriously affected the mining and mineral industries. There are many instances when these issues have given rise to violent public oppositions which have been pioneered by few small local groups for certain short term gains. When many such development projects have been stalled, the general mass and Nation has remained silent spectators. Even, truth, knowledge and scientific perceptions could not prevail.

As population growth has given rise to expansions of habitational areas, per capita availability of land for agriculture & food has reduced. Simultaneously with the widespread deforestations, encroachments, depletion of water and natural resources, the air and water pollutions have also increased. All these are clearly visible even in the areas where there is no mining or industry. So, mining and mineral sector should not be only targetted which could have provided basic needs to the society besides long term economic growth.

Sustainable development is the need today and there is no second opinion. Ecofriendly operations of mines and industries can be achieved with minimum required land, conservation of resources, reclamation of waste and waste land, extensive afforestations and local area developments. This will be possible if industries, Government, public and private institutions join hands and work for the common objective.

In many seminars and workshops these issues have been discussed and suggestions have been communicated. Unfortunately, implementations are very rarely seen. The intelligentsia have to come forward to make these a reality or else we would continue to remain poor as subjects for exploitations.

Fortunately a comprehensive resettlement and rehabilitation policy has now been introduced on 14th May 2006 covering all types of development projects i.e. industry, mining, infrastructure and urban development. Hopefully, this should bring good results. In the recent workshop held by UCCI, while appreciating the genuine interest of Govt. apprehensions have been expressed about its success due to lack of proper Govt. machineries and a system for implementation.

Only two months have passed and implementation is yet to start. Let us wait and evaluate the result in our proposed seminar to be held during December 2006.

(R.C. Mohanty)
President

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A STUDY ON MATHEMATICAL APPROACH TO AIR POLLUTION INDICES

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ABSTRACT:

Mathematical representation in form of environmental pollution index of any locality reflects the quality of environment and characterstics of its constituents. In the present work, attempts have been made to follow the mathematical approach of various air pollution indices which can signify the degree of pollution load at that locality. It covers Air Quality Index, Air Pollution Index (API) , Pollution Standard Index (PSI) representing the integrated air quality . From literature survey of other similar works, comparative study has been made with the Index evaluated in case of a mineral processing plant involved in manufacturing of alumina from bauxite ore by Bayer's method of refining. The study reveals that locality considered for comparison as per mathematical modeling has tolerable pollution load.

***Key Word**: Air Pollution Index, Air Quality Index, Pollution Standard Index. ,*

INTRODUCTION

Industry is the integral part of global economy and can not be ignored because of environmental considerations. Rather industrial manufacturing process can go hand in hand with environmental protection. There exist possibilities always in maintaining a balanced environmental quality, which can always be quantified as an integrated approach of all its constituents. Various indices have been formulated to assess the quality of environmental parameters like air quality, water quality and overall environmental quality. Significance of quality indices has been considered as a prime factor of pollution management studies to give an impression about the pollution load. Such an attempt to evaluate the pollution load has been made to assess the load due to air pollution caused by M/S NALCO alumina plant around its locality with a comparison to various mathematical models available in terms of Air Quality Index (AQI), Air Pollution Index (API), and Pollution Standard Index (PSI).

AIR QUALITY INDICES

Air quality index is the simplest form for reflecting the air quality in very rational way by reducing a large quantity of data into one. Thoms et al defined such index as a scheme that transforms the weighted value of related parameters into a single value. Further the overall ambient air quality of the locality can be quantified and categorised in terms of Air Pollution Index (API). Pollutants responsible for affecting air quality usually posses synergetic effect. Concentration of SO_2 gas is more corrosive when combined with dust particulate. So cumulative and

combined effect of pollutants in terms of Air Pollution Index (API) can be taken as the average of all possible pollutants under question and their safer limits prescribed. Environmental Protection Agency (EPA), USA developed **Pollution Standard Index (PSI)** in order to integrate the several complex factors that make up air quality. It combines the concentration of five major pollutants, that is, Carbon monoxide (CO), Sulfur dioxide (SO_2), Ozone (O_3), Total Suspended Particulate, and Nitrogen Dioxide (NO_2) to represent integrated impact.

MATERIAL AND METHOD

Prusty, et al (1992) and Pattanaik and Satyanarayana (1998) evaluated the air quality index of Rourkela and Paradip area of Orissa by adopting the following mathematical approach.

(i) Forming sub indices I_1, I_2, I_3 .....I_n for n number of pollutants (Variables $X_1,X_2,X_3,....X_n$) using sub index function

$I_i = f_i(X_i)$ where i = 1,2.3.....n

A measured value of concentration with respect to the prescribed standard gives sub index. Each sub index represents environmental characteristics of specific pollutants.

(ii) After sub indices are formed, all sub indices are aggregated together in a second mathematical form called aggregate index. $I = f(I_1, I_2, I_3.....I_n)$

Aggregate function f is usually a summation operation or a multiplication operation..

The rating scale basing on which Air Quality Index is assessed can be refereed as given in Table 1.

Table No:1 Rating scale of air quality index

Index Value	Rating
0 – 25	Clean air (CA)
25 - 50	Light air pollution (LAP)
51 - 75	Moderate air pollution (MAP)
76 – 100	Heavy air pollution (HAP)
> 100	Severe air pollution (SAP)

Majhi and Biswal (2001) calculated **Air Pollution Index** (API) with respect to specific pollutant of Angul-Talcher area by using the formulae: $I = \frac{1}{2} \times 1/Sa \times Ca + \{ \text{Summation } n=1 \text{ to } n (Cd)^2 \}^{1/2}$, Where I=Specific Pollutant Index, Sa=Standard for the pollutant, Ca = Annual average concentration, Cd: Daily concentration, n = Number of observations . If API value is greater than 1, it is considered that concentration exceeds the limit and if it is less than 1, it is considered to be within limit. Singh et al (1991), Joshi et al (1992), Gupta and Brijmohan (1995) adopted another method to evaluate the index:

$$API = \frac{1}{n}\left(\frac{X_1}{a} + \frac{X_2}{b} + \frac{X_3}{c} + \frac{Xn}{y}\right) \times 100$$

Where n = Number of pollutants studied ,X_1, X_2, X_3 .....Xn is the pollutant numbers
a, b, c, ...y is the prescribed safer limits of their concentration. Various classification models based on API evaluation is tabulated in Table 2.

Pollution Standard Index is also another method of evaluating air pollution load developed by Environmental Protection Agency(EPA) USA (Table 3). Basing on the available standards by National Environmental Engineering Research Institute (NEERI), Tiwari (1987) calculated the PSI in Indian context and in light of this PSI interpretation , Madras was interpreted as unhealthy city.

Table :2 Zone classifications as per API

Sl.No	API Value	Inference
1.	<100	Safer Limit
2.	100 ± 10	Just on Safer limit
3.	>100 and <200	Moderately Polluted
4.	.> 200	Highly Polluted.

Table No.3 Rating scale for pollution standard Index:

PSI Value	Ranking	PSI Value	Ranking
>400	Very Hazardous	100 - 199	Unhealthy
300 - 399	Hazardous	50 - 59	Moderate
200 - 299	Very Unhealthy	0 – 49	Good

RESULTS

From the observations of various pollutants made during different months around the alumina plant at different sampling stations over a period of five years , it was reported that the SPM concentration varies widely across the months and sampling sites. .The variation may be attributed to positional difference from the plant as well as due to wind direction across various seasons,. . Other gaseous pollutants like SO_2, NO_x, and CO are observed to be below detection level, which is ignored to avoid computational error. Accordingly API calculation for the said study is simplified with respect to particulates only and total number of pollutants (n) is taken as 1 for computing API. With such simplified method, API over a period of five years is computed which is given in Table 4.

Table No.4 Observations of API values around Study Area

Years	API	Years	API
1995-96	46.42	1999-00	45.05
1996-97	26.15	2000-01	42.40
1997-98	40.45	2001-02	66.65
1998-99	54.60	2002-03	56.65
Average (X) : 46.42			

All observations are well within the prescribed limit value for residential zones prescribed by Central Pollution Control Board (CPCB). The below detection level(BDL) concentration of gaseous pollutants can be attributed to the fact that gases (by fuel burning like coal and low sulfur oil) are being released through tall stack, which usually does not affect to the ground level concentration.

CONCLUSION

This kind of mathematical expression, approach and quantification signifies the extent of pollution load and degree of tolerance with respect to cumulative effect. This serves the purpose of assessing the overall quality of environment and reflects the degree of degradation. The study of API around the alumina plant concluded that locality is having API below 100 and can be considered under "Safer Zone".

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"GEOMORPHIC EVALUATOIN OF KURUNG WATERSHED USING REMOTE SENSING TECHNIQUES, ARPA VALLEY, C.G."

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ABSTRACT:

An integrated development of any area depends largely on total natural resources available within a watershed. In this paper, Geomorphic units of Kurung watershed, district Bilaspur, Mahanadi system have been evaluated using remote sensing techniques with limited field checks. Kurung stream watershed posses a variety of land forms including hills, ridges, buried pediplains and undulating plains etc. The sub tropical climate is prevailing in the region and watershed receives 1290 mm mean rainfall annually. The average density of water bodies (5.5 ponds / km^2) around Ratanpur indicates high surface water potentiality. The Kurung watershed consists of rocks ranging from Archean to Recent in age. It includes Granitoids, Chlorite Schists, Lameta beds, Deccan lavas, Gondwana Sandstone, Shale Chhattishgarh limestone and dolomite. The landforms of watershed are found useful in landuse practice. Geomorphic mapping indicate that 45% of the land area (buried pediplains) is suitable for cultivation in the watershed. Geomorphic features control the water conservation measures in the watershed. Erosional landforms are dominant in the area, largely influenced by fluvial processes and lithological variations of the terrain. Development of Gullies in upper reaches, deteriorating the fertile land, needs conservation measures. Pediments and undulating plains are favourable units for construction of check dams and underground dykes respectively.

Key Words: *Geomorphic Unit, Landuse, Remote Sensing, Water Conservation.*

INTRODUCTION

The Kurung watershed lies in Arpa Valley (District Bilaspur – Korba, C.G.) of Mahanadi drainage system (Fig.1). The study area is included in Survey of India toposheets Nos. 64 J / 3, 4, 7 & 8 (north latitude $22^0$3'30" to 22^0 30' 30" and east longitude 82^0 7' 20" to 82^0 26'). The sub tropical climate is prevailing in the region and watershed receives 1290 mm mean rainfall annually.

Kurung stream watershed posses a variety of land forms including Hills, ridges, buried pediplains and undulating plains etc. The purpose of present study is to identify different geomorphic units on remote sensing data and their utility in landuse potential for watershed development.

METHODOLOGY & DATA BASE

The geomorphological map has been prepared from visual interpretation of satellite imagery, False Colour Composite (FCC) paper print 1:250,000 scale data of MSS 124 with limited ground truth. Geomorphic units have been delineated and their spatial distribution computed and correlated with basin land use practice. Geological quadrangle map (GSI) has been also referred for geological information.

GEOLOGICAL SETTING

The Kurung watershed consists of rocks ranging from Archean to Recent in age. It includes Granitoids, Chlorite Schists, Lameta, beds, Deccan lavas, Gondwana Sandstone, Shale, Chattishgarh limestone and dolomite.

Three major physiographic zones are distinctive in the watershed (Fig.2, Table – 1) 1. Highland – between 360 to 988 metres from MSL. 2. Intervening Midland between 300 to 360 metres and 3. Undulating plains between 300 to 257 metres above MSL. Western highland is a part of Maikal Plateau (Eastern extension of Satpura Range) known as Pendra plateau. The highest surface of this tract is represented by Chittaurgarh (988 metres) which is capped by trap flow (Deccan) and forms a typical Mesa or Pat. In the northern side this highland merges imperceptibly with a group of gneissic hills (800 to 380 metres). The midland zone begins from foothills and continued up to the border of quartzite ridges (height 360 – 390 metres). The landscape then lowered down from south of this ridges to undulating plains (300 – 257 metres) which continued in the Mahanadi valley plains.

Table – 1: Kurung Watershed : Physiographic Divisions

Sl. No.	Physiographic Zone	Watershed Area Km^2	Height AMSL	% Area	Cumulative % Area
1.	High land	133.60	360 to 988	13.67	13.67
2.	Intermediate Mid Land	417.27	300 to 360	42.71	56.38
3.	Undulating Plains	426.13	300 to 257	43.62	100.00

Table – 2: Major Geomorphic Units and Their Distribution In Kurung Watershed

Sl. No.	Geomorphic Unit	Watershed Area Km^2	% Area	Cumulative % Area
1.	Hills	178.48	18.27	18.27
2.	Pediments	338.92	34.69	52.96
3.	Shallow weathered Pediments / buried Pediplain	127.80	13.08	66.04
4.	Deep buried pediplain	313.82	32.12	98.16
5.	Ridge	8.69	0.89	99.05
6.	Water bodies	9.27	0.95	100.00

GEOMORPHIC UNITS AND THEIR IMPACT ON LAND USE

On the basis of Landsat satellite imagery a geomorphological map has been prepared (Fig. 3). Different geomorphic units has been delineated and categorized using standard interpretation criteria (Lillesand and Kiefer, 1994) into hills, pediments, shallow weathered pediments, shallow buried & deep buried pediplain, ridges and water bodies. The significance of the geomorphic impact on land use and utilization of different land from is discussed below :-

HILLS: The hills comprise of Archean granite, gneisses, quartzite & phyllites. It occupies northern margin of the watershed. (Fig. 3, Table – 2). The structural hill rim express semicircular shape. The granite hills show the convex summits and concave basal slopes (Kuity and Diwan, 1997). They have many lineaments and escarpments in Upper watershed. The hills comprises metamorphic quartzite and phyllites, exists as residual hills and represented by Sonthi and Ghuska Pahar. They exhibits radial drainage pattern. The slope of hills vary from 15^0 to 33^0. Most of these units are covered with thick mixed forests. The forested part of these hills shows dark red colour on FCC. Coarse texture, high drainage lines and pattern are major recognition criteria of this unit.

RIDGES: Quartzite ridges are East-West trending landforms, exposed in the shape of hillocks and spread over less than 1 % area of the watershed. These units covered mainly with thin vegetation but also bared at some places. Slope varies from 15^0 to 20^0 which is easily recognized by medium texture reddish – brown colour bleb shaped linear arrangement and its occurrence at margin of sedimentary plains and metamorphic pediplains. Changes in drainage is also evidenced at margins of ridges.

PEDIMENTS: These are gently sloping rock cut surfaces (3^0 - 6^0) at the base of foot hills generally covered with thin veneer of soil mantle. It occupies nearly one third area of watershed. (Table – 2). These are generally open grazing lands and cultivation is possible only where presence of thin soil cover exists. Development of gullies and bank erosion are observed near Bhatapara and Shivpuri villages in Kurung main trunk. This unit shows sub parallel and dendritic drainage pattern. Pediments traversed by lineament features may have moderate to good potential ground water. Lineaments are subsurface expression of features and can be seen as linear or curvilinear feature on FCC (Fig. 3). This unit is recognized by mottled texture, whitish to light grey, brown colour association of drainage.

SHALLOW WEATHERED PEDIMENTS / BURIED PEDIPLAIN: The pediments / pediplains when covered with sediments and soils of varying thickness have been termed as shallow weathered in granite and shallow buried pediplain in Chattishgarh sedimentary terrain. These are mostly confined to the middle of the basin. This landform unit shows gentle slope (2^0 - 4^0) and spread over 13.08% of the watershed area. This unit is good for agricultural crops like Citrus, Mango etc. Light brown to whitish & dirty green colour and medium texture are recognition criteria on FCC.

DEEP BURIED PEDIPLAIN: In the watershed, the sedimentary rocks of Chhattishgarh is characterized mainly by deep buried pediplains. This unit is covered with thick soil and sediment mantle. The slope vary between 0^0 to 3^0. Few scattered uplands of laterite breaks the monotony of plains. This unit is mostly irrigated through canals. It consists single and double cropped land. Under Rabi, wheat and coriander are sown where as under Kharif paddy is cultivated. These are expressed on FCC by their yellow colour and association of canal. Laterites are recognized by their irregular shape, greenish grey colour and scattered patches.

WATER BODIES: On FCC, water bodies appears dark blue in colour. The drainage segments are recognized by their linearity and channelization. Tanks and ponds are identified by their shapes. Kurung originates from Chandala pahara (632 metres AMSL) west of Lapha forest. It flows NNW, where it attains foot hills (360 metres AMSL) near Kudar village. The river course follows the lineament and flows southwardly on pediment zones. Further down stream at Khutaghat the main trunk of Kurung river has been dammed. Here quartzitic ridges form favourable natural location for impounding water. It has 28.34 lakh cubic metre water storage capacity and irrigate 41,500 hectare agricultural land of the watershed. Tank and pond analyses reveal that within the 30 Km. peripheries of Ratanpur there are 167 ponds exist. Dulhara (167 hectare) and Ramtek ,temple ponds are bigger ponds (used for fisheries and irrigation). Most of the ponds store water permanently but 14.20 % dry out during summer season. Cluster of ponds in a group of 2.3 and 7 are common. The average density of pond is 5.5 per square kilometer. Metamorphic rocks are found suitable for impoundment of water.

GEOMORPHIC PROFILE AND CONTROL

The geomorphic units of Ratanpur – Khutaghat section is illustrated in Fig. 4. To the west of Ratanpur, structural hills cropped out and landscape gradually decline towards east. Pediments begin from foot hills where city Ratanpur is exhibited. Ramtek temple hill is an isolated hill emerges as residual hill, formed by differential erosion. The buried pediplain unit is present in the west of Kurung channel and is represented by cultivated land. At Khutaghat, ridges act as a natural barrier for water impoundment.

The watershed development management is influenced by geomorphic features. It controls the choice and type of water conservation structures. In Kurung watershed pediments are suitable for check dams location near to foot hills (Fig. 5). In this geomorphic unit the surface runoff is high and small streams carrying sediments of upper reaches are thereby protected. Small storage tanks on high order stream nearer to lineaments are significant. It will recharge the ground water in down stream. Quartzite ridges act natural barrier for big water storage structure. Buried pediments and weathered pediplains are suitable for small conservation structures like tanks and village ponds. The chlorite Schist and phyllitic rocks have very low primary porosity and permeability. Hence, surface runoff is high and water can be stored efficiently in this level or gently sloping unit. In down stream under buried pediplains of Chhattishgarh Supergroup

and river valley fills, the ground water recharge structures like percolation tank and underground dyke will be useful.

CONCLUSION

Various geomorphic units like structural hills, residual hills, ridges, buried pediplains are recognized with the aid of visual interpretation of FCC satellite imagery. Erosional landforms are dominant in the area, largely influenced by fluvial processes and lithological variations of the terrain. Geomorphic mapping reveals 45% of the land area is suitable for cultivation. Development of Gullies in upper reaches, deteriorating the fertile land, needs conservation measures. Water conservation structures are influenced by geomorphic controls.

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QUALITY OF GROUNDWATER IN RELATION TO AGRICULTURAL PRACTICES IN CHINNA HAGARI BASIN, KARNATAKA, INDIA

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ABSTRACT

Chinna Hagari basin, a sub-basin of river Vedavathi occupies a drainage area of 3461 sq.kms. It is a typical hard rock terrain and chronically drought prone region. The major part of the basin lies in Chitradurga, Bellary districts of Karnataka and a small portion in Anantapur district of Andhra pradesh. The evaluation of chemical quality of ground water is essential in order to utilize the available resources for agricultural purposes SAR, RSC, % Na, chloride, sulphate, permeability index and corrosivity ratio are used to evaluate the interpretations, based on the data of 204 water samples collected from bore wells from different aquifers in the study area. The study indicated that the quality of water is suitable for agricultural practices except for few pockets.

Key Words – Chinna Hagari basin; Ground water

INTRODUCTION

Water resources play a vital role in agricultural practices. But when the surface water is inadequate then groundwater plays an important role. A good quality of water has the potential to increase or decrease the yield under good soil and management practices.

Groundwater contains small amount of soluble salts dissolved in it. The kind and quality of these salts depend upon the sources of ,recharge of groundwater and strata through which it flows/percolates. The excess quantity of soluble salts may be harmful for many crops. Hence, a better understanding of the chemistry of groundwater is essential to evaluate the groundwater quality used for irrigation purposes.

The chemical characteristics of groundwater for irrigation given by Walton, (1971) are: (a) Concentration of total dissolved salt (TDS), (b) Electrical Conductivity (EC), (c) Sodium Concentration (Na), (d) Carbonate and Bicarbonate concentration (CO_3-HCO_3).

The TDS, expressed in terms of EC and relative proportion of sodium to calcium/magnesium expressed as SAR, forms the basis for classification of water for irrigation purposes. Sodium concentration is important in classifying irrigation water because sodium by the process of base exchange replaces calcium in the soil and there by reduces the permeability of soil, which has greater effect on the plant growth.

Location:

The Chinna Hagari basin is a sub-basin of river Vedavathi and occupies a drainage area of 3461 sq. kms. It lies between the Longitude 76^0 10' to 77^0 05' and Latitude 14^0 00' to 15^0 05', covering major parts of Chitradurga and Bellary districts of Karnataka and a small portion in Rayadurga taluk of Anantapur district in Andhra Pradesh, where the river confluence with Vedavathi river (Fig. 1).

Methodology:

In the present study the water quality criteria for agriculture has been evaluated by determining SAR, RSC, % Na, Chloride, Sulphates, Permeability Index and Corrosivity ratio in 204 water samples collected from bore wells (fig.2) in the study area by giving due emphasis for the lithology and spatial representation. The main aquifers are gneisses, granites and schists with intrusion of dolerite dykes, pegmatites and quartz reefs. The evaluation is based on the following criterias:

Sodium Adsorption Ratio (SAR): The relative activity of sodium ion in the exchange reaction with soil is expressed in terms of a ratio known as Sodium Adsorption Ratio (SAR), which is defined as

$$SAR = \frac{Na}{\sqrt{\frac{Ca+Mg}{2}}} \quad \text{(all values in epm)}$$

Higher concentrations of sodium reduces soil permeability and hardens by replacement of Ca and Mg. Because of its direct relation to the adsorption of sodium by the process of base exchange, calcium is replaced in the soil effecting the plant growth. The plotting of EC Vs SAR (Fig. 3) classifies the water as below:

SAR vs EC: salinity hazard.

Class	Quality of water	No. of samples (%)
C_2S_1	Medium salinity – low sodium hazard	62 (30%)
C_3S_1	High salinity- low sodium hazard	96 (47%)
C_2S_2	Medium salinity-medium sodium hazard	2 (1%)
C_3S_2	High salinity – medium sodium hazard	42 (21%)
C_3S_3	High salinity – high sodium hazard	1 (0.5%)
C_3S_4	High salinity- Very high sodium hazard	1 (0.5%)

Majority of the samples in China Hagari basin fall under C_3S_1 (47 %) followed by C_2S_1 (30 %) and C_3S_2 (2' %). Most of the samples have low alkalinity, moderate to high salinity and are suitable for agricultural practices. C_3S_1 and C_2S_1 types of water can be used on soils with adequate drainage and moderate amount of leaching for most of the crop respectively.

SAR is also a measure of suitability of water for irrigation with respect to the sodium (alkali) hazard. There is a significant relationship between SAR values for irrigation water and the extent to which sodium is adsorbed by the soil. A higher concentration of SAR implies soil structure damage.

The water for irrigation is classified as follows:

SAR	Water Class	No. of samples
>10	Excellent	198
11-18	Good	6
19-26	Fair	-
<26	Poor	-
Total		204

Based on the above results it is clear that most of the samples fall under excellent to good category. Hence, the quality of water is suitable for agricultural practices.

Residual Sodium Carbonate

Bicarbonate concentration in water affects the suitability of water for irrigation purpose. If the water has high concentration of bicarbonate ion, there is a tendency for Ca and Mg ions to precipitate as carbonates. As a result, relative proportion of sodium increases and gets fixed in the soil. Thus, relative increase in the proportion of sodium which gets fixed in the soil decreases the permeability. The RSC is calculated using the following equation:

$RSC = (CO3^{-} + HCO_3^{-}) - (Ca^{++} + Mg^{++})$ (all values in epm)

Eaton (1950) has classified the water quality based on RSC as follows:

Range of RSC	Quality	No. of samples
< 1.25	Safe	51 (26 %)
1.25- 2.50	Marginal	56 (27 %)
> 2.50	Not suitable	97 (47 %)
	Total	**204**

It is clear from the study that the bicarbonate hazard is negligible in Chinna Hagari basin except in few localities. The RSC values of the study basin ranges from 0.32 to 79. Based on the classification 53 % of the samples of the basin fall in safe and marginal class and are good for agricultural practices.

Percent Sodium (Na %)

The relative proportion of sodium to other cations in water is usually expressed as percentage of sodium among the principle cations. Sodium percentage of groundwater in the basin is calculated by the formula

$$Na\% = \left| \frac{Na + K}{Ca+Mg+Na+K} \right| 100$$

Wilcox (1955) proposed a diagram in which percent sodium is plotted against electrical conductivity or total salt concentration (Fig. 4) for determining the suitability of water for irrigation. The classification for the study area is as follows:

Class	No. of samples
Excellent to good	38 (19 %)
Good to permissible	153 (75 %)
Permissible to doubtful	8 (4 %)
Doubtful to unsuitable	5 (2 %)
Unsuitable	---
Total	**204**

According to this classification most of the water can be classified as excellent to good (94%) for irrigation purposes. However, some water samples are classified under permissible to doubtful and doubtful to unsuitable classes. This is mainly due to the localized increase in the salinity of water in the area.

Chloride and Sulphates in Agricultural Water

Excess of chloride and sulphate in water affect the agricultural practices. Permissible range of both Cl and SO_4 for agricultural purpose (Eaton, 1942) is tabulated below. The results reveal that the overall water quality in the basin based on 'Cl' and 'SO_4' for agricultural practices is good with few exceptions.

Range in meq/ltr	Water Class	No. of samples	
		Cl	SO_4
< 4	Excellent	111	177
4-7	Good	59	24
7-12	Permissible	25	3
12-20	Doubtful	9	-
>20	Unsuitable	-	-

* 204 samples only

Doneen's Permeability Index (PI)

The soil permeability is affected by long-term use of irrigation water and it is influenced by various factors like sodium, calcium, magnesium and bicarbonate contents of water and soil. A criterion for assessing the suitability of water for irrigation based on Permeability Index (PI), is as follows:

$$PI = \frac{(Na + K) + \sqrt{HCO_3}}{Ca + Mg + Na + K} x100$$

Classification based on Doneen's Permeability Index:

Category of Irrigation water	No. of Samples
Class – I	14 (7 %)
Class- II	127 (62 %)
Class – III	63 (31 %)
Total	204

The permeability index of Chinna Hagari basin varies from 13 to 104 with an average of 70. The majority of the samples fall under class-I and II, which indicates that groundwater is good for agricultural practices. However, some samples show higher values of PI (Class-III) and that could be due to absorbing of less concentration of calcium and magnesium ions.

Thus it can be concluded that the quality of water in the study basin is suitable for agricultural practices, however some pockets of anomalies are due to unplanned agricultural practices.

Corrosivity Ratio (CR)

The Corrosivity ratio proposed by Ryzner (1944) is used to evaluate the corrosive tendencies of groundwater in an area. Corrosion is an electrolytic process that takes place on the surface of metals, which severely attacks and corrodes a metal surface. The corrosion and encrustation decreases the lifespan of iron or concrete pipes and may lead to the failure of water supply system (Sharma and Jayashree 1998). The rate at which corrosion proceeds depends upon the physical process, which is governed by the chemical reaction. Most of the corrosion and encrustation problems are associated with the problems of salinity and alkalinity of groundwater respectively. The corrosivity ratio is given by the formula:

$$CR = \frac{0.028\ (Cl) + 0.021\ (SO_4)}{0.02\ \{HCO3 + CO_3\}}$$

(all values in mg/ltr.)

The variation in CR (Fig. 5) shows anomalous zone at southern and eastern parts, which is due to the variation in lithology. This is due to the rock-water interaction during the process of percolation and infiltration of groundwater into the subsurface. The CR value ranges form 0.1 to 5.0 with a mean value of 1.80, indicating that groundwater of the basin is not intensively corrosive.

CONCLUSION:

The chemical quality of groundwater determined by various techniques reveals that the overall quality of water in the Chinna Hagari basin is suitable for agricultural practices. However, some pockets of anomalies noticed are due to unplanned agricultural practices.

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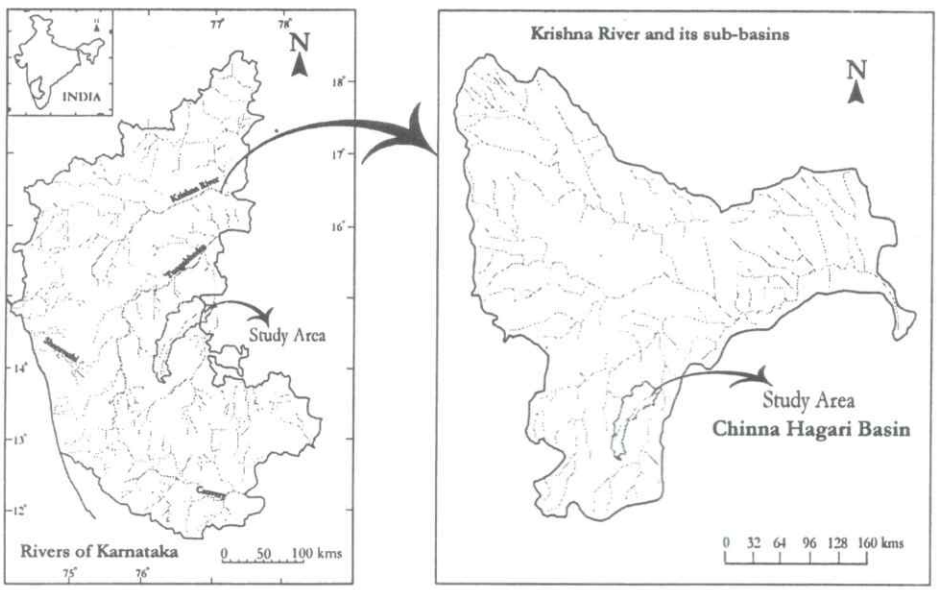
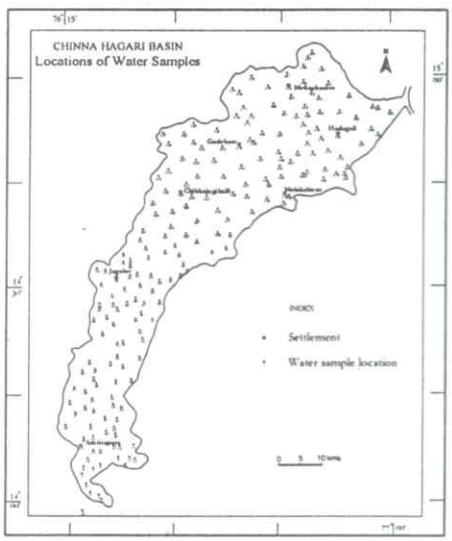


Map: 1 Location of the Study area



Map: 2

Map: 3

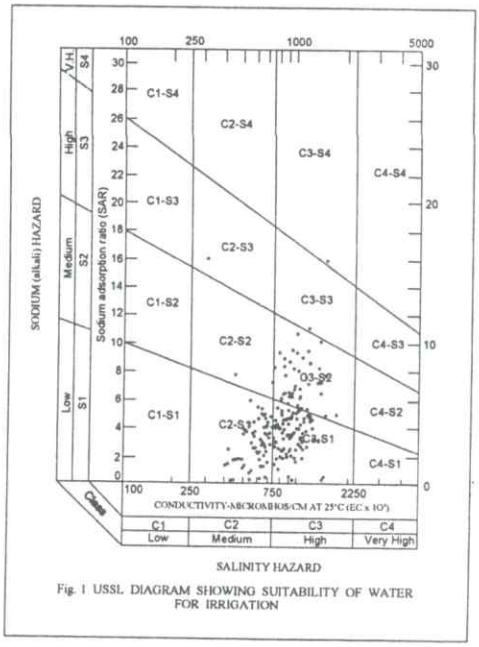


Fig. 1 USSL DIAGRAM SHOWING SUITABILITY OF WATER FOR IRRIGATION

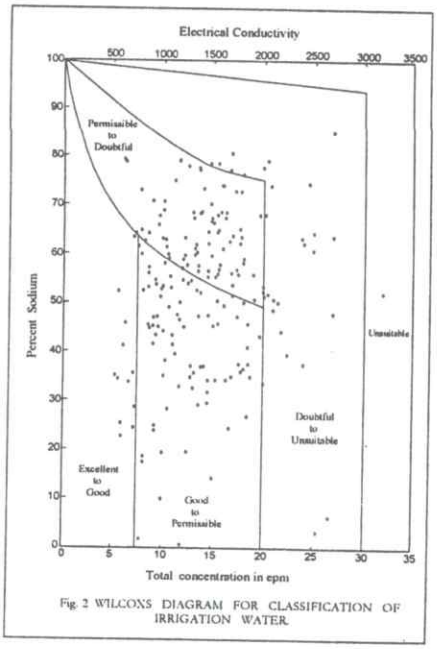


Fig. 2 WILCOXS DIAGRAM FOR CLASSIFICATION OF IRRIGATION WATER

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DISTRIBUTION OF HIGH FLUORIDE IN GROUND WATER OF ORISSA

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ABSTRACT

Occurrence of high Fluoride in ground waters of Orissa is needed to be highlighted, in order to make provisions for supply of safe drinking water to the people of the affected areas. Values of fluoride viz. more than 1.5 mg/L have been observed in both coastal and inland districts of Orissa. In specific areas like Harbhanga Block of Boudh district, Balasinghi area of Khurda district and in parts of Anugul & Puri districts, detailed studies have revealed high fluoride concentrations in ground water there. The adverse health effects, however, have been observed in Balasinghi-Singhipur area where such water is being used for drinking purposes. Conjunctive use of high fluoride waters by blending it with alternate source of safe water available in the area is one of the cheapest remedial measures suggested.

Key Words: Fluoride, Ground Water

INTRODUCTION

Orissa State has plenty of fresh water resources but availability of safe drinking water, especially in some of the rural areas, is a problem. High concentration of fluoride has been detected in some areas associated with health problem where such water is used for drinking purposes. To restrict the use of such waters, mass awareness programme of its ill effects, is necessary. Suggestion have been made to explore the possibility of low fluoride waters existence nearby, to blend it with high fluoride ground waters, so that it can be used for drinking purpose safely. This will enable to provide safe drinking water to the inhabitants of fluoride effected areas. This paper highlights the occurrence and distribution of fluoride in ground water of Orissa and its probable health effect on living beings. Some remedial measures of fluoride removal and its conjuctive use have also been discussed.

HYDROGEOLOGY OF ORISSA:

Hydrogeologically the state may be divided in three distinct units **(CGWB, 1995)**.

(i) Consolidated Formations:

Nearly 80% of the geographical area of the state is underlain by the consolidated crystalline formations consisting of granites, granite gneisses, quartzites, khandalites, charnockites and other meta sedimentries. Ground Water occurs under phreatic conditions in the weathered residuum of

these formations and circulates through underlying fractures and fissures. The weathered and fractured granites and granite gneisses are the dominant rock type and form potential aquifers.

(ii) Semi Consolidated Formations:

The semi-consolidated formations include Gondwana sandstones, shales, and coal as also loosely cemented Tertiary sandstones and shales.

Ground water in the Gondwana occurs under phreatic condition in the near surface shallow aquifers and under semi confined to confined condition in the deeper aquifers.

(iii) Unconsolidated Formations:

The unconsolidated formations include laterite and alluvium. The alluvial deposits occur mainly in the coastal tracts and the inland river basins. The sand and gravel layers comprise the most prolific aquifers. The ground water occurs under both phreatic as well as confined conditions. The depth to water level generally varies from 2 to 12 m bgl.

CLIMATE:

The Orissa State has a subtropical, monsoon climate. The average annual rainfall of the state is 1502.66 mm with average rainy days of 74. In summer the day temperature shoots upto 45° C. The mean monthly summer temperature is 37° C in western parts and 28° C in southern parts. The mean monthly winter temperature is 22° C in eastern parts and decrease to 18° C towards north western and southwestern parts of the state.

EFFECT OF FLUORIDE ON LIVING BEINGS

86 to 97 % of soluble fluorides contained in drinking water is absorbed by the human body (Irving, 1974). Fluorine is the component part of bones and teeth tissues. In every tissue it is accumulated during calcification. Its accumulation leads not only to high skeletal concentration but also the crippling affects. The water containing less than 1 mg/L of fluoride seldom causes mottling of teeth in the children, however its natural presence in drinking water should not exceed (on an average) more than 1 mg/L. Climatic conditions, volume of water consumed and intake from other sources is considered during setting of these limits. ICMR (1975) has recommended a limit of 1.0 mg/L of Fluoride whereas; Bureau of Indian Standards (1991) has recommended the limit of 1.5 mg/L for drinking water. The higher amounts of fluoride lead to physiological deformities in human beings (Table-1). In normal concentration it is not significant in irrigation waters, but higher concentration in plants prevents the accumulation of chlorophyll 'a' and 'b' and photo chlorophyll (Das et.al 2000).

Table-1: Effects of Excess Fluoride on Human body.

Sl. No.	Physiological Effect	Amount of Fluoride in mg/L
1	Dental carries reduction	1.0
2	Mottled enamel	2.0
3	Osteoscleorosis	5.0 – 8.0
4	Crippling fluorosis and thyroid changes	20 – 80
5	Retardation	100
6	Kidney changes	125
7	Death	2500

METHODOLOGY:

The samples were collected from various dug wells (NHS) in the clean one lit. plastic bottles after rinsing it 2 to 3 times with the water sample. Various chemical constituents present in natural waters were analysed at Regional Chemical Laboratory, Central Ground Water Board, South Eastern Region, Bhubaneswar, by using standard methods (APHA 1985).

Chemical analysis results of the tubewells are also incorporated to evaluate chemical quality characteristic of the deeper aquifers, which are the exploratory wells drilled by Central Ground Water Board.

RESULTS & DISCUSSIONS:

The chemical analysis results indicate that ground water quality (shallow aquifers) of the coastal area is quite different as compared to the inland (away from the coast) area. The high values of fluoride have been observed in both coastal and inland areas of Orissa (Fig-1). The percentage frequency distribution of high fluoride in various districts has been given in Table-2. High fluoride concentration has been detected in Gop, Rengailinda, Khalikote, Kasinagar and Baliapal blocks of Puri, Ganjam, Gajapati and Balasore districts of coastal area. The deeper aquifers of coastal districts are relatively safe for drinking water supply. In districts away from the coast, 27 %, 10 %, 9.2 % and 6.8% dug wells of Anugul, Bolangir, Kalahandi and Boudh districts respectively, contain fluoride more than 1.5 mg/L (Table- 2). In deeper aquifers the fluoride has been found ranging between 0.1 and 5.6 mg/L (with max. 5.6 mg/l at Dadpur) in Kalahandi district and between 0.11 and 7.2 mg/L (with max.7.2 mg/l at Kanut) in Bolangir district.. High concentration of fluoride has also been observed in few pockets of Suvarnapur ,Bargarh Sundergarh, Keonjhar and Nuapada districts. The maximum, minimum and average values of fluoride in Shallow and Deeper aquifers are given in Fig. - 2 & 3.

Table- 2: Percentage Frequency distribution of Fluoride Concentration > 1.5 mg/L

District	Shallow		Deeper	
	n	% Freq.	n	% Freq.
Kalahandi	46	11	74	9.5
Bolangir	50	10	40	17.5
Suvarnapur	21	5	13	30.8
Rayagada	15	0	10	0.0
Nowrangpur	15	0	28	3.6
Malkangiri	17	0	9	11.1
Deogarh	4	0	3	0.0
Jharsuguda	6	0		
Bargarh	64	0	53	7.5
Sambalpur	52	2	12	0.0
Koraput	37	0	16	0.0
Cuttack	38	11	9	0.0
Jajpur	29	17		
Phulbani	32	0	14	7.1
Boudh	27	15	9	11.1
Keonjhar	42	5	53	7.5
Mayurbhanj	67	0	6	0.0
Nowapara	16	0	28	25.0
Sundergarh	37	0	67	4.5
Dhenkanal	38	0	3	0.0
Anugul	33	27	4	0.0
Khurda	23	13	8	0.0
Nayagarh	15	0	11	0.0
Puri	52	33	11	0.0
Ganjam	92	10	15	6.7
Kendrapara	12	25	13	0.0
Jagatsingpur	19	26	8	0.0
Gajapati	18	44	4	25.0
Balasore	26	8		
Bhadrak	14	7	17	0.0

Fig.- 2 Max. , Min. and Average Values of Fluoride in Different District in Shallow Aquifers

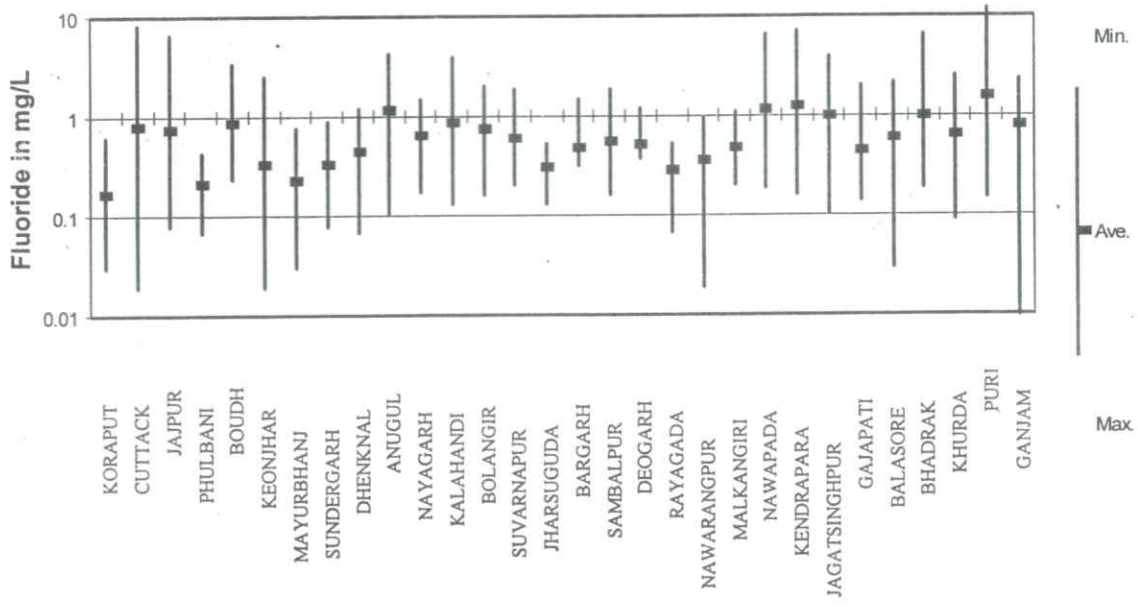
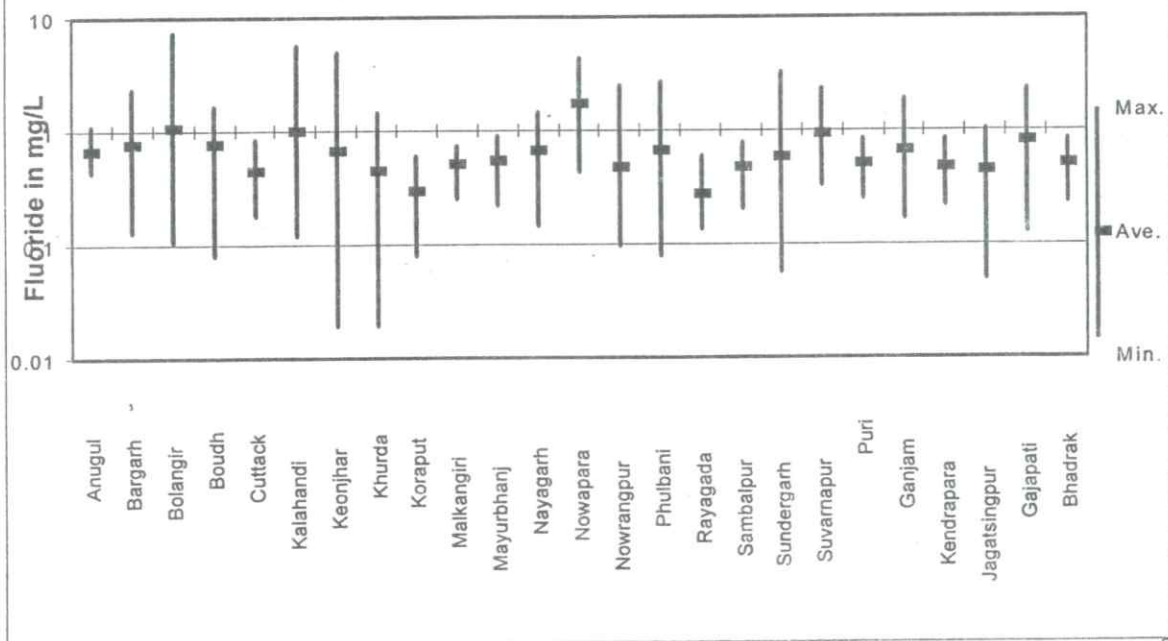


Fig.- 3 Max. , Min. and Average Values of Fluoride in Different District in Deeper Aquifers

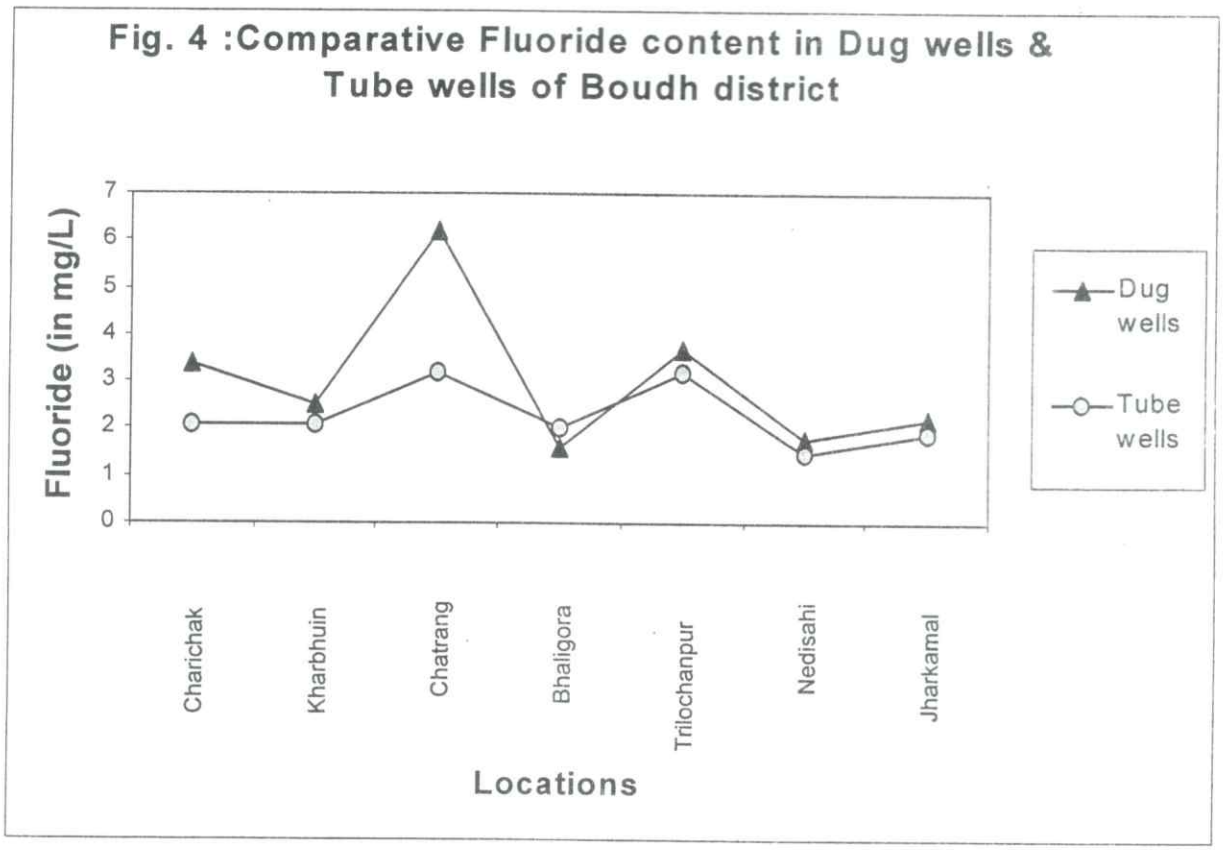


CASE STUDIES

The studies are mainly based on ground water monitoring in the state, carried out by Central Ground Water Board. These studies reflect sporadic occurrence of high fluoride in ground water of Orissa. In a few specific area utmost sincere efforts have been made to identify effects of high Fluoride on the health of the people, using such water for drinking purposes.

Boudh district (Harbhanga block)

Studies conducted (Bhargav et.al 2000) on the ground waters of Harbhanga block (Boudh district) reveal that high concentrations of fluoride occur mainly in $NaHCO_3$ types of water. This lead to the speculation of its probable source, being the fluoride bearing minerals of Amphibole group apart from Cryolite. Most of the shallow aquifers and aquifers tapped by hand pumps along Baisparha- Chatrang-Jharkamal tract and Chatrang - Baliagara-Harbhanga tract are contaminated with high fluoride. Comparative values of fluoride (Fig. - 4) content of dug wells and tube wells show, lower concentration of fluoride in tubewells through out the tract. The deeper aquifer is therefore forms a better alternative source for the domestic water supply.



Geochemical studies show a positive correlation between fluoride and other ions (Bicarbonate, Sodium, Calcium and Magnesium) in sodium bicarbonate type and calcium bicarbonate type of waters, but in case of mixed type of water the correlation has been found negative between fluoride and; bicarbonate, calcium and magnesium, indicating probable dilution of high fluoride waters of sodium bicarbonate type, with low fluoride water of calcium bicarbonate type.

Khurda district (Balasinghi - Singhipur)

In Bolagarh block of Khurda district, high fluoride concentration in ground water has been reported in and around Balasinghi and Singhipur areas. The area is underlain by porphyritic granite gneisses. The high concentration of fluoride ranging between 1.4 and 8.2 mg/L, has been observed upto a depth of 60 m below ground level, causing severe fluorosis accompanied by skeletal deformities (Das et.al 2000)among local inhabitants, consuming this water. Few villages like Jhariparah (2.9 mg / L), Sagaragan (3.4 mg/L), Singhpur (2.0 mg/l), Singhipur (8.2 mg/L) are reported to have high fluoride concentrations in ground water.

Anugul District

Occurrence of scattered pockets of high fluoride in a large area around Anugul, has also been reported ((Das et.al 1998, 2000). Fluoride levels ranging from, less than 1.0 mg/L to 3.5 mg/L have been recorded in shallow wells waters. Leptynites, granites, pegmatites, and amphibolites of basement crystallines and Gondwana sedimentries underlie the area. One carbonaceous sandstone - shale sample of a dug well, taken during its excavation, has shown 346 mg/L of fluoride content. The evidence point to Fluorapatite as a possible source of fluoride in ground water. In all thirty villages including Bonda (2.45 mg/L), Gobora (3.0 mg/L), Kukudang (3.04 mg/L), Barabehal (2.0 mg/L), Chandupal (2.72 mg/L), Jandhara (3.0 mg/L) etc. high fluoride in waters has been found in shallow wells.

Puri District

The occurrence of fluoride, more than 1.5 mg/L has been observed in dug wells of Puri district. Nearly 35 % wells (Srivastava et.al 2000) contain high fluoride concentrations ranging from 0.16 to 12.0 mg/L from Gop, Puri sadar, Bramhagiri, Sathyabadi and Pipili blocks are found to be effected with high fluoride. Fluoride content in deeper aquifers has been found less than one mg/L in most of the tube wells. Use of phosphatic rocks as fertilizers may be the probable source of high fluoride content in the ground water of Puri district.

Hiradeipur area, Nayagarh District

High Flouride (more than 1.5 mg/ l) has been observed in some of the Tube wells/Dugwells located at Hiradeipur area, Nayagarh District. The rocks containing appreciable amount of biotite, hornblende, orthopyroxene and apatite are the main source of Fluoride. The concentration of fluoride in biotite ranges from 1.4 to 2.3% and in Hornblende from 0.8 to 0.9% as reported by Kundu et.al.(2001).

REMEDIAL MEASURES:

High fluoride Toxicity of water can be considerably reduced by the chemical treatment. Reverse osmosis, Electro-dialysis, activated alumina adsorption, activated carbon, magnesia, serpentine, tricalcium phosphate, bone char, carbion, defluoron-1 and defluoron-2 are few costly techniques available for the removal of Fluoride from drinking water (Apparao et.al 1990; Bhakuni, 1964; Bulusu et.al 1985; Kulkarni et.al 1974; Thergaonkar et.al 1969). The most easiest and economical way is the blending of high fluoride water with low fluoride water (Provided it is easily available nearby) including use of Rain Water harvesting techniques. Nalgonda Technique, developed by NEERI, using alum coagulation comprising of addition in sequence of (I) bleaching powder (ii) lime and (iii) alluminium sulphate or alluminium chloride or combination of both. The bleaching powder is used as disinfectant.

CONCLUSION

High fluoride in ground water is responsible for health hazards and areas where high fluoride concentrations are detected, need detailed studies by increasing sample density, and correlating the results obtained with the statistical data of health hazards. Preventive measures which include judicious and scientific ways of application of fertilizers, pesticides and insecticides, and curative measures that involve the installation of economically viable and user friendly Nalgonda technique are require to be introduced for the removal of fluoride. Conjuctive use of high fluoride waters by blending it with alternative source of safe water available in the area is one of the cheap remedial measures, suggested to be utilized in such problematic areas. The following areas are recommended for further detailed studies on fluoride concentration in ground water -

- Boudh district (Harbhanga block)
- Khurda district (Balasinghi - Singhipur)
- Nayagarh district
- Anugul District
- Puri District

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DISASTER MANAGEMENT IN ORISSA COAST – AN INFORMATION TECHNOLOGY VISION

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ABSTRACT

Disasters are unforeseen and unpredictable phenomena that can be mitigated by proper management taking the advantages of information technology. Management focuses on certain principles, practices and techniques. The principle incorporates Pre-disaster preparedness including DPS, DWS, PCS; Post-disaster settlement and environmental restructuring. Satellite points, remote sensing and radars are the significant sources for data acquisition. GIS, AI (fuzzy logic) programming, online transaction processes (OLTP) and online analytic process (OLAP) are the useful software in appraisal of data processing and interpretation. Communication techniques are facilitated through advanced electronic media.

Keywords: Management, OLAP, OLTP, GIS

INTRODUCTION

Orissa state is situated in the eastern flank of India and lying within $17^0 49'$- $22^0 34'$ latitude and $81^0 27'$ - $87^0 29'$ longitude. The state has a coastline of 482 km adjoining to the Bay of Bengal. Out of 30 districts nine districts constitute the coastal zone, which is considered as the most disaster prone segment in the eastern India. The lithology of the coastal belt comprises of mostly alluvium. Major rivers namely the Mahanadi, the Baitarani, the Subarnarekha and the Rushikulya are traversing in the coastal belt forming network of drainage system, peneplane, natural levees and compound delta.

The coastal Orissa being thickly populated, natural calamities like floods, droughts, tsunami and cyclones are becoming catastrophic. The past records of flood and cyclone were of its highest magnitude in the coastal zone disaster history. The coastal biozone witness the repetition of extreme human suffering along with the flora-fauna assemblages by frequent visits of the disasters.

Disaster management focuses on the various aspects of precautionary measures to mitigate the extremity of the natural calamities upon human being by certain principles, practices and techniques. Disaster

management is broadly operated on the principles of pre-disaster preparedness, post-disaster settlement and on the overall environmental restructuring of the affected zone. Thorough study of the destructive parameters and conceptualization of the suppressant methodologies are the primary tools of disaster management.

The present context of implementation of disaster management is yet to be upgraded as sought during the tough time and output observation of the three consecutive disasters in Orissa i.e. the super cyclone in 1999, the severe drought in 2000 and the catastrophic flood in 2001. Considering the vulnerability of the disasters in the coastal Orissa and the degree of human distress, it is high time to accelerate the disaster management horizon taking the advantages of information technology along with the parameters of earth science. Introduction of e-geo-technological consideration in the streamline of disaster management proceedings would have, no doubt, brought a dimensional change in credibility of tackling disasters.

The act of collecting and processing of data by means of computer and sending out results through telecommunication is termed as Information Technology. IT plays a vital role in Disaster Management as it deals with acquisition of data from different sources, processing of data, analysis and forecasting the result. Data is the basic element in disaster management though it travels through different communication media and format. In raw sense, there are two types of data format i.e. analog and digital. In communication, , data are converted frequently by moving from analog source to digital or from digital source to analog. Most external data source devices generate data in the form of analog signal or radio waves.

The disaster management has its scope from early warning system to rehabilitation through rescue and relief operations. All the activities falling under the scope of disaster management are in need of fast and accurate information. Application of information technology in pre- and post- disaster events can render immense access in managing the distress. Also implementation of e-techno-environmental measure has a long-term scope for disaster management.

PRE DISASTER MANAGEMENT

Natural disasters are unforeseen, severe and uncalculated. But despite of that, (Except Tsunami) they are predictable. It includes the pre disaster preparedness initiatives, which plays vital role in decelerating the disastrous impact.
Early warning system is the first and foremost activity followed in the pre disaster management. The basic thing is that public should be awakened regarding the forthcoming disaster. The next step is to evacuate the would be affected people to safer place. The pre disaster management is equipped with the following systems.

a. Disaster Prediction System (DPS)
b. Disaster Warning System (DWS)
c. Public Communication System (PCS)

Disaster Prediction System

The Disaster prediction system (DPS) includes monitoring the data related to severe weather phenomena. DPS should be concrete, unambiguous and believable otherwise it'll create pseudo-panic to public.

The DPS involves the process of receipt and regeneration of flood-climatic data from various primary and secondary sources respectively and proper compilation, critical study and analysis on indebt scientific ground to get synchronous information. Parameters responsible for flood can be studied accurately under the domain of Disaster Prediction Information System (DPIS) and then analyzed by the AI (fuzzy logic) software to produce the contents of forecasting. DPIS is a subset of Decision Support in which current and historical data are comprehensively analyzed and explored, creating summaries of the data, in order to support high-level decision-making.

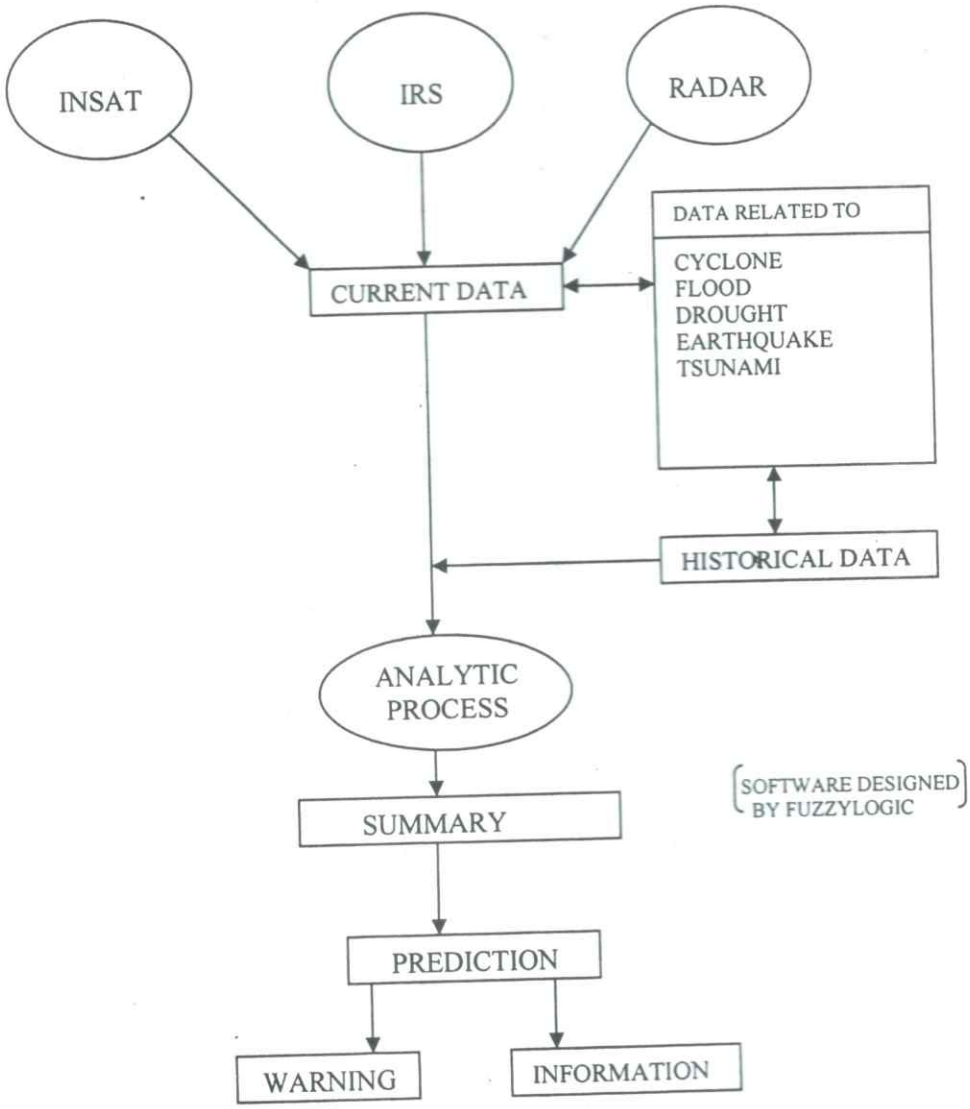
The forecasting data, being an important tool for DPS, should be spontaneous and error free. Utilization of different softwares in converting the remote sensing and satellite imageries to ready to understand at different centers is an added advantage. The data capture process should be at satellite points and the instantaneous database so created should be auto-modeled by computers for accurate and complete understanding of the phenomena.

At present a number of data capturing sources are being used for data reception at different centers of the meteorological department to predict the forthcoming disasters. Data from IRS is used for demarcation of flood risk zones. The meteorological data relayed by INSAT, world's largest domestic communication satellite system, comprising of INSAT-2B, INSAT-2C, INSAT-2DT, INSAT-2E and INSAT-3B is efficiently used not only to track the disaster formation but also to issue warning to the affected people. Landsat Multispectral Scanner (MSS) imagery can be used to know the regional geomorphological setting and the slope condition. IRS-P3 in association of other remote sensing satellites has enhanced the data availability. The WIFS (Wide Field Sensor) and Short-Wave Infrared (SWIR) band of IRS-P3 have the advantage in giving early warnings of disasters and also assessment of damage.

Irrespective of the satellite data, most important and basic information required for prediction and forecasting are the temperature-pressure variation data, rainfall data on the catchment areas of the major rivers, generation of low pressure zones and data on annual rainfall in coastal zones. Even today, estimation of such data is practiced manually. High powered S-band radars with DVIP facility for estimating data related to different disasters up to 200 km around the radar site can be introduced in the process of their management.

Data so obtained can be accumulated to create a database. IT has been so much wide spread due to the Database system. Database system is also very important for Disaster Prediction System because it manipulates very large amount of data.

Data in a database is stored on storage devices such as disks and tapes. Data are recorded on magnetic disk. When a record is needed for processing, it must be fetched from disk to main memory. There are different sizes of disk and tape drives for storage of very large amount of data. Speed is also important for disk access. Thus size (amount of data) and disk access speed play major role in data storage.



Schematic diagram of DPIS

Data warehouses contain consolidated data from many sources, augmented with summary information and covering a long time period. Warehouses are much larger than other kinds of database; sizes ranging from several gigabytes to terabytes are common. Typical workloads involving ad hoc, fairly complex queries and fast response times are important.

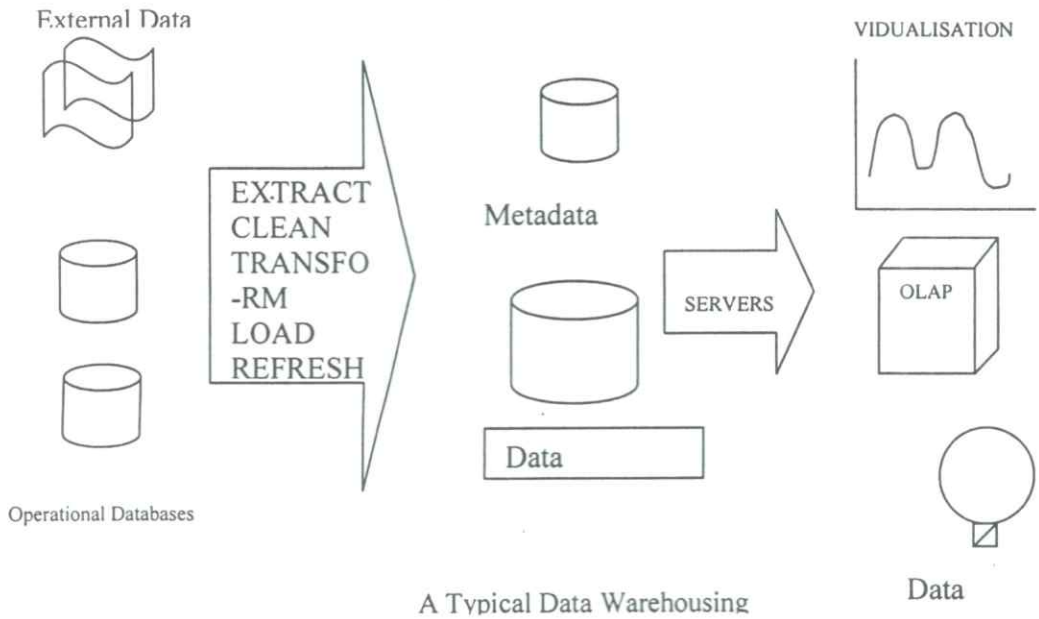
Disks are potential bottlenecks for system performance and storage system reliability. Since disks contain mechanical elements, they have much higher failure rates than other electronic parts of a computer system. If a disk fails, all the data stored on it is lost. A disk array is an arrangement of several disks, organized so as to increase performance and improve reliability of the resulting storage system. Performance is increased through data striping. Disk arrays that implement a combination of data striping and redundancy are called redundant arrays of independent disks or in short RAID.

Data are logically organized into files. Data files are organized in such a way that sorting, indexing and searching are very easy.

Maps of physically dynamic areas as rivers, coastal pressure zones, and periodic rates and kind of changes of river course can be determined by computerized processing of predictable data so received. Sedimentary process can be monitored and integrated by sequential mapping especially by aerial photographic and other remote sensing techniques. Newer high resolution data like IKONOS that provide resolution of panchromatic and multispectral are viable alternatives to aerial photographs.

Disaster Warning System

Disaster Warning System (DWS) acts as a source of transfer of disaster information and bulletin from the apex centre of meteorological department to the various nodal centers. The nature of hazards pertaining to physical, meteorological and moreover the mitigation are being communicated to various centers by DWS. The traditional methods used in DWS are no more in use. The DWS should act as an uninterrupted information circulating media. The DWS is encapsulated with On-Line-Analytic Process (OLAP). The DWS at different centers can be operated automatically by installation of voice based software and web based system. Both data capturing source and warning delivering source can act in coordination with processing device to make the system effective.



A Typical Data Warehousing

Public Communication System

Public Communication System (PCS) facilitates the disaster forecasting and warning to reach the community and individual level. PCS plays a vital role for communicating the disaster and mitigation of devastation during and after the havoc. PCS should be made available at every corner undisrupted. This system should be inter-communicable and everybody can access to the time-to-time information. For that WAP (Wireless Application Protocol) enable phones can be used to empower the PCS when the print and electronic media get paralyzed.

Proper and accurate prediction of the disaster leads to 'the process of evacuation, the remedial measure of pre disaster management. During this short period of emergency course of action, information technology plays an important role in quick assessment of dense and probable affected zone. Global Positioning System (GPS) can be utilized successfully to detect such segments. Evacuation is a partial but effective attempt to check the human suffering against nature.

POST DISASTER MANAGEMENT

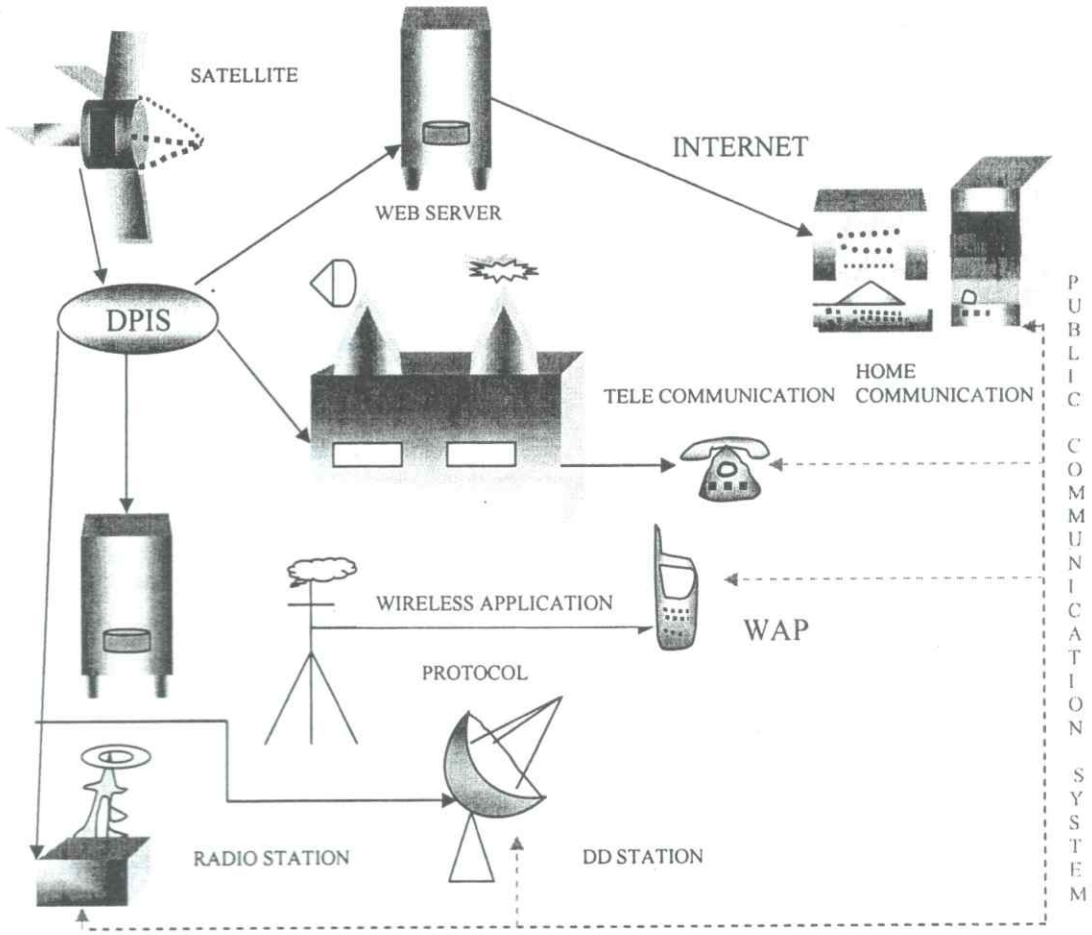
Post disaster management attempts to retrieve affected people and biosphere from multifaceted calamitous sufferings. Different types of tasks related to varieties of aftermath need are to be performed estimating and observing the loss and potential requirement respectively to regain the normalcy. Post disaster management stretches its scope to revive the affected belt through

(i) rescue operation
(ii) relief operation and
(iii) rehabilitation.

Rescue operation demands an instant and prompt action package supported by strong infrastructural readiness. Before sending rescue teams, status of the flood victims at different geographical segment are to be monitored. Geographical Information System (GIS) can provide the devastation picture in terms of location of affected zone, type of losses, amount of losses in terms of property and lives. The accumulated data is put into decision support to handle a precise and perfect rescue operation.

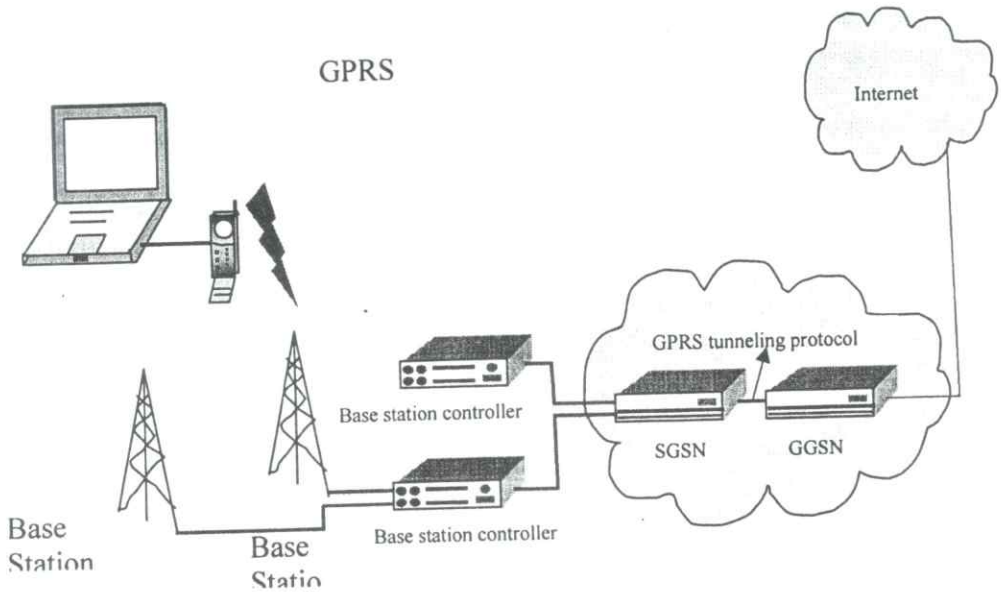
Relief operation, the challenging part of disaster management can better be materialized by e-technological processing. Clear picture of geographical location, selection of mode of transport, distribution status upgradation and transparency should be administered regularly during the relief operation. Online transaction process (OLTP) takes the vital role in the relief operation to smoothen the actions regarding the multifaceted requirements.

Rehabilitation is a major action plan aftermath. This aspect is related to physical, psychological, socio-economical, educational, occupational and environmental condition of the victims. Resettlement of victims requires food, clothing, shelter, healthcare, sanitation and moreover the moral support which is the test of the time. The Geographical Information system (GIS) can widely be used for obtaining post disaster status, instant action plan for which can be made accordingly. it is very quick and accurate to monitor the crop loss estimates, spreading of diseases and forecasting of epidemic outbreak by the use of Geographical Positioning System (GPS) in association with electronic sensors and remote sensing. Psychologically affected victims of the disasters are in need of computer aided counseling.

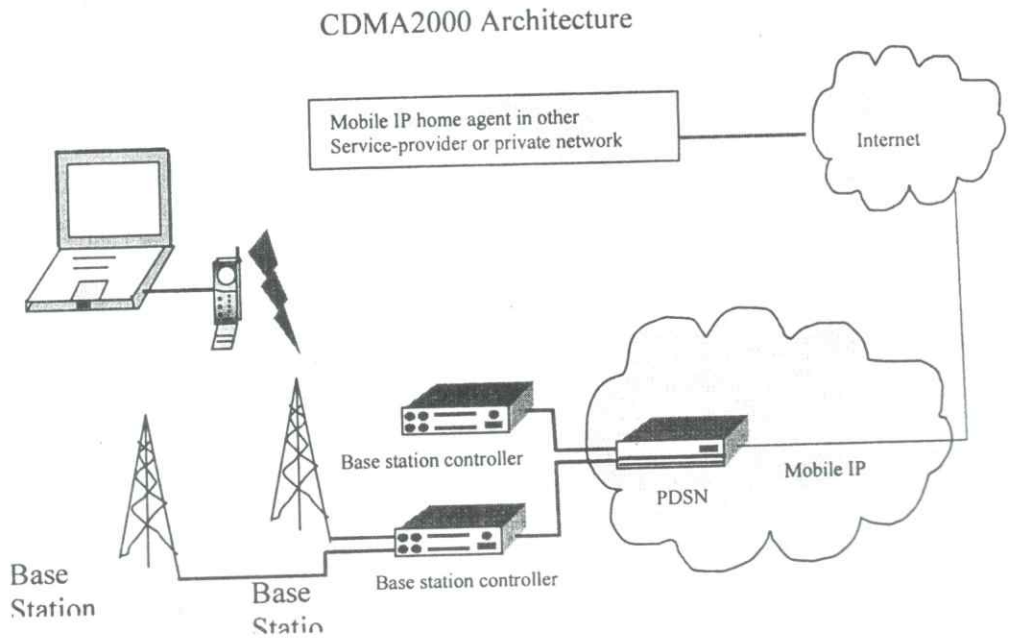


WAP (Wireless Application Protocol)

This software has been developed for wireless digital communication. There are different transmission technologies such as transmission by electromagnetic wave propagation, radio transmission, microwave transmission, Infrared, light wave transmission. Out of these transmission methods, radio transmission has been used for long distance communication. Present WAP technology is based on this radio transmission. Because of its popularity, WAP is being frequently upgraded time to time.



GPRS (General Packet Radio Service) is an IP based packet database system. Users like it because packet technology enables sustain virtual connections to services, eliminates long dialup delays and allows information such as e-mail to be pushed to users.



CDMA (Code Division Multiple Access), a newer US digital technology, uses spread spectrum technology, in which many users share the same radio channel simultaneously but are distinguished by pseudo random codes.

It is imperative that geo-scientific assessment can be made available through IT. This will benefit future sustainable development and disaster mitigation. Application of IT in pre- and post-disaster events can assist in managing the disasters. The present day information system has become such an endeavor where computer compatible database will help in storage and retrieval as and when need.

Identification of disasters, mitigation and post-disaster relief and rehabilitation are useful tool for decision making. The information and integration on disaster assessment can play important role for a sustainable environment management.

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INDIAN SPONGE IRON PRODUCTION – PROBLEMS AND SOLUTIONS

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INTRODUCTION

Sponge iron is produced form high grade lumpy / massive iron ore by reduction where iron content increases to 83 – 92%. It has low sulphur content and is obtained by use of low grade fuels unacceptable for conventional iron making. It is a substitute of steel scrap for steel making through the secondary route i.e. Direct Reduction / Electric Arc Furnace. This also replaces ferrous scrap as a coolant in LD converter.

For better melting results, the criteria for selection of sponge iron are –

- High iron content
- High degree of metallization
- Low gangue, sulphur and phosphorus content
- Suitable size, range and shape

The sponge iron specification is shown in Table – 1.

Table – 1: Specification of sponge iron

Particulars	Sponge Iron Lumps	Sponge Iron Fines
Total iron	91.5% minimum	92% minimum
Metallic Iron	80% minimum	82% minimum
Degree of metallization	88% minimum	90% minimum
Carbon	0.2% minimum	0.25% minimum
Sulphur	< 0.04% minimum	< 0.04% minimum
Phosphorus	<0.05% minimum	<0.05% minimum
Gangue	< 5%	< 5%
Non magnetic	<0.5%	<1.5%
size	3 – 20 mm	0 – 5 mm

The advantages of using sponge iron in Electric Arc / Induction Furnace in the charge mix are as follows.

- DRI permits automatic continuous batch charging.
- It helps create a foamy slag – provides lower electricity consumption, faster melting time, decreased electrode consumption, longer refractory life, and enhanced steel quality.

- The chemical composition of DRI is known exactly and is uniform.
- It contains very low level of undesirable metallic impurities.
- Use of DRI permits dilution with low cost scrap.
- Less noise occurs during melt down with DRI than scrap.
- It does not require desulphurising and dephosphorising process in Electric Arc / Induction Furnace.

REVIEW OF DIRECT REDUCTION PROCESSES

Essence of DR Process

Any DR process features 4 distinct steps.

- The availability of reducing agents, e.g. solid carbon, carbon monoxide, hydrogen.
- Heating of the burden to reaction temperature, and supply of reductant for the reduction process.
- Ore reduction by providing adequate time of contact between the iron ores and other reductant.
- Cooling and discharging of the directly reduced ores, evaluation of the waste gases following completion of reduction.

Classification of DR Processes

A DR process may be classified by the type of reductant it uses – solid or gaseous. It may be identified according to the furnace it utilizes – Rotary kiln, shaft furnace, Retort Reactor or Fluidized bed Reactor. Generally DR processes are classified into the following four types.

- Rotary Kiln process on the basis of solid carbon.
- Shaft furnace processes on the basis of reduction gases produced from solid carbon, or produced by cracking natural gas or fuel oil.
- Retort process on the basis of reduction gas produced by cracking natural gas or on the basis of solid carbon.
- Fluidized bed process on the of reduction gas produced by cracking natural gas or fuel oil.

Table – 2 summarizes the distribution of world reduction capacity and energy consumption for gas. Table – 3 summarizes the characteristics of Direct Reduction process and electric Furnace consumption. The three major processes adopted i.e. HYL, Midrex and SL/RN are described below.

Table – 2 :Distribution of world reduction capacity

By Process		By Process type	
Midrex	38.4%	Shaft furnace	44.6%
HYL	38.1%	Static bed	38.9%
SL – RN	5.6%	Rotary kiln	12.6%
Purofer	4.2%	Fludised bed	3.9%
Others	13.6%		

By Reductant source		By country	
Natural gas	87.4%	Venezuela	24.8%
Coal	11.1%	Iran	14.2%
Gas / fuel oil	1.5%	Mexico	10.7%
		U.S.A.	8.7%
		Canada	6.1%
		Japan	6.1%
		Others	29.4%

Table – 3: Energy consumption in gas based direct reduction process and electric furnace consumption

Sl. No.	Midrex	HYL	HIB	Purofer	HOR - ESSO
Furnace	Kiln	Shaft	Retort	Fluid bed	Fluid bed
Reductant source	Coal	Natural gas	Natural gas	Natural gas	Natural gas / oil
Energy. 10^6 BTU / ton DRI	13.1	11.9	15.5	17.9 – 19.9	15.1
Feed, type	Coarse ore, pellets	Pellet	Coarse ore pellet	Ore fines	coarse ore pellet
Product metallization	90%	92 – 96%	85 – 90%	90%	95%
Electric furnace Consumption change					
Sponge	75%	70%	60%	50%	75%
Scrap	25%	30%	40%	50%	25%
Hot metal	0	0	0	0	0
Power kWh / ton	555	550	625	583	535
Yield	91%	93%	92.4%	-	-

PROCESS DESCRIPTION

HYL Process

The process has been developed to use economically reduction agent other than natural gas, such as reforming of naptha or ther light hydrocarbons, gasification of coal and oil and a completely new technique of use of coke oven gas without any reforming facilities.

Due to the static bed characteristics of the direct reduction process, fines generation is the lowest, allowing the direct charging of such fines and externally heated by the combustion of the process 'tail gas' used as fuel to recuperate its remaining heating value. The gas is passed through a desulphurising unit at the entry of the plant.

Apart from naptha reforming, the reducing gas can also be produced by coal gasification and partial oxidation of fuel oil.

The reducing section of an HYL plant consists of a set of four reactors, three of which are in line and the fourth in charging – discharging operating operation (Fig.1). The reduction of the re is performed in two stages and third stage for cooling and carburization, each stage last about 3 hours. The first one is a heating and initial reduction, for the materials just charged, where the first part of reduction take place. The second stage, where the main reduction occurs, and the third stage, where the final points of metallization are achieved ad also deposition of carbon. Carbon deposits during the cooling stage and mainly during the period when the temperature of the product passes through a certain 'carburization band' occurring in the neighbourhood of 550^0C. At such temperature, carbon deposits as Fe_3C, forming a 'cemenite shell' which among other advantage, protects the product against reoxidation. In the HYL sponge iron, over 95% is a cemenite carbon and mainly concentrate in the external shell. About 80% of the carbon deposition is concentrates in an external shell of about 2 mm. The reduced material can be directly charged in the electric furnace, so, no screening operation are required thus eliminating the cost of screening and briquetting.

In the HYL process, a reducing gas rich in hydrogen and carbon monoxide is used, obtained by several procedures one of which is the catalytic reforming of natural gas, which is mixed with water vapour before entering the reformer unit. Though most of the HYL plants operate with natural gas, other feed stock for steam reforming are propane, butane and naptha.

Steam reforming for these inputs may be represented by the following two chemical equations.

For natural gas

$$CH_4 + H_2O \rightarrow CO + 3H_2 \qquad (1)$$

For naptha

$$C_7H_{16} + 7H_2O \rightarrow 7\,CO + 15\,H_2 \qquad (2)$$

These reactions are endothermic and so, require heat and a nickel base catalyst.

Apart from naptha reforming, the reducing gas can also be produced by coal gasification and partial oxidation of fuel oil.

The metallization is a function of time of contact between gas and iron ore, the metallization level can be varied at will by controlling the cycle time. An HYL plant can operate satisfactorily within limits of 83 to 94%. The productivity of an HYL plant is directly related to the metallization.
A decrease in metallization is accomplished by a decrease in cycle time, which reflects in an increase in productivity. Such metallization decrease is beneficial if carbon deposition can be increased so as to produce a 'balanced' sponge iron, where the carbon content compensate for the additional FeO in the product.

The increase in productivity thus obtained represents a decrease in operating costs fixed and variable in the same percentage of the production increase, since the plant will remain operating at the same total gas composition same electricity, same man power, same financial costs, etc.

Some of the salient features of HYL technologists are as follows:

- Plant capacities 100,000 to 700,000 tpy in a single module or multimodules can be set up.
- Reducing gas an from reformation of natural gas or any light hydrocarbon by gasification of coal or oil by different use of coke oven gas.
- Metallization and carbon are acuraely controlled and can be combined to give a balanced product.
- Energy requirement are lower than 3 G Cal/ton.
- A wide range of iron ores can be used as feedstock, as pellets, lump ore or any combination thereof.
- Fines generation is kept to minimum. Such fines can be changed directly to the furnace without screening or briquetting.
- HYL product is stable, even if stored in open space. Any means of transportation is acceptable.
- Outstanding characteristics of steel making. The boiling action created by the formation of gases increases the thermal efficiency, which reflects in cost savings and increase in productivity.

Midrex Process

The Midrex technique produces 92% to 99% metalized material from cold industrial oxide pellets as they pass down a shaft furnace in counter flow of heated reformed gas. The reforming natural gas has a H_2 / CO ratio of 1.6 and the temperature is 900^0C, in furnace pressure of the counter current shaft furnace is 100 kilopascals and the energy necessary for reduction is 10.5 giga-jules / ton – DRI. Part of the exhaust is mixed with natural gas and reformed, and the remainder is used as the fuel for the reformer furnace. In the HYL –III process, the H_2 / CO of the reformed gas is 3, the temperature is 930^0C, the in furnace pressure of the counter current shaft furnace in 450 kilopascals and the energy necessary for reduction is basically the same in the Midrex process. In both processes, higher furnace temperature result in higher productivity because the metal is reduced by endothermic reaction.

However, an excessive furnace temperature will cause the pellets and lump ore to melt during reduction. The maximum reducing rate is about 95% and he carbon content is limited to about 2.5%.

The large specific area of the active surface of spongy DRI makes it sensitive to reoxidation and ignition when it comes into contact with air and water, specially sea water. Handling and transformation were, therefore, difficult and potentially hazardous. To overcome this difficulty, a hot briquetting facility to minimize the specific area by compaction was developed and has been installed in the lower part of the counter current shaft furnace. This had resulted in producing heat briquetted iron (HBI) has minimized he risk of ignition and substantially reduced reoxidation making handling and transportation of DRI much easier, and enabled DRI to be used as a substitute for scrap in steel making by the electric furnace. Figure– 2 shows the skeleton of Midrex process.

SL/RN Process

The original SL process was entered around a rotating refractory lined cylinder, slightly inclined to the horizontal so that ore and solid reductant feed in one end will travel by gravity, through several heating zones and exit from he other end. The modification in RN process added a system of burners positioned along the full length of the cylinder, the fuel inputs to these burners may be controlled and varied so that a desired temperature profile in side the kiln may be maintained longitudinally. Together, these systems make up the SL / RN process.

The flexibility in the use of wide range of carbonaceous material is one of the important advantages of this process. Supplementary fuels such as natural gas, fuel oil may also be used. Lime stone and dolomite may be included with the material as part of the charge to take case of the sulphur of the reductant.

The kiln temperature is maintained around 1050^0C with residence time from 2 to 5 hours. The residence time and productivity depends greatly on the desired degree of metallization and he characteristics of the ore and coal. The reducibility of ore and its degradation tendency are important factors but coal reactivity and ash fusion temperature are far more essential.

After the processed material are discharged from the kiln and cooled, the metallic product is separated from the coal char and flux screening. The char is recycled so that the kiln at all times has a large excess of reducing agent. Sponge iron, 92 to 94% metallization is produced by this process. The energy requirements has been claimed to below 14 million BTU / ton of iron produced.

The SL / RN process may be characterised by the two types of plant. Long rotary kiln, with iron ore charged in a cold condition, heating and reduction taking place in the kiln. Short rotary kiln with traveling grate place ahead of the kiln where the ore is preheated by the waste gas.

SPONGE IRON INDUSTRIES IN INDIA

India has emerged as the world's second largest producer of sponge after Venezuela. The growth of sponge iron units specifically during the last part of nineties is substantial in terms of capacity and production. Installed capacity of sponge iron units increased from 1.52 million tons in 1990-91 to 6.47 million tons in 1999-2000. After Brazil, India is the only country which has both gas based and coal based plants. Besides almost all sponge iron making processes like SL/RN. ACCAR, CODIR,

KRUPP, TDR, HYL, MIDREX are in operation in India. Presently there are 29 units out of which, 3 are gas based units covering a capacity of 3.5 million tones per annum and 26 are coal based units, covering a capacity of 2.7 million tones per annum.

Some of these units with the capacities etc. are given in Table – 4.

Table – 4 :Sponge iron units in India

Sl. No.	Units	Process	Capacity (000 MT)
Gas Based			
1.	Essar Steels, Gujarat	Midrex	1760
2.	Vikram Ispat, Maharashtra	HYL	750
3.	Ispat Industries, Maharashtra	Midrex	1000
Coal Based			
1.	Bihar Sponge Iron Ltd., Bihar	SL/RN	150
2.	IPITATA Sponge Iron Ltd., Orissa	TDR (SL/RN)	120
3.	Orissa Sponge Iron Ltd., Orissa	ACCAR-OSIL	100
4.	HEG Limited, MP	SL/RN-SIIL	60
5.	Tamil Nadu Sponge, T.N.	-do-	30
6.	Sponge Iron India Ltd., AP	SL/RN	60
7.	Bellary Steel and Alloys, Karnataka	SL/RN-SIIL	60
8.	Jindal Strips, MP	JINDAL	500
9.	Prakash Industries, MP	SL/RN	150
10.	Monet Ispat, MP	JINDAL	100
11.	Sunflag Iron & Steel, Maharashtra	CRVPP	150
12.	Raipur Alloys and Steel, MP	SL/RN-SIIL	30
13.	Goldstar, AP	KRUPP	220
14.	Llyid Metals, Maharashtra	OSIL	150
15.	Kumars Metallurgical, AP	SL/RN-SIIL	60
16.	Nova Iron & Steel, MP	SL/RN	150

There have been addition of a number of new sponge iron plant in Orissa, Chattishgarh, Jharkhand, Karnataka and other States during 2000-2005. Most of the plants have also gone for expansion of their capacities. These units have gone for eco-friendly operation by using hot gas for captive power generation and they also helps in steel making. Some of the new and old sponge iron units in Orissa excluding No. 2 & 3 of Table – 4 above are indicated in Table – 5. There are few more pipelines besides the expansion of the above. District wise sponge iron production in Orissa indicated in Table – 6. Sponge iron capacity in Orissa and other States with the use of imported coal and locally available gas is likely to increase further in the next decade.

Table – 5:

Sl. No.	New plants / proposed units & locations
1.	Bhusan Group, Lapanga
2.	SMC Power Generation Ltd, Hirma
3.	Visa Industries, Duburi
4.	Aarti Steels Ltd., Ghantikhal
5.	Neepaz Metalliks (P) Ltd., Rourkela
6.	Scaw Industries (P) Ltd., Dhenkanal
7.	Deo Mines & Minerals (P) Ltd., Bonai
8.	Shyam DRI Power Ltd.,. Sambalpur
9.	Sunflag Iron & Steel Co, Ltd., Rengali
10.	SPS Sponge Iron Ltd., Jharsuguda
11.	Orissa Cement Ltd., Rairangpur
12.	Monnet Ispat Ltd., Dhenkanal
13.	Maheswary Ispat (P) Ltd., Khuntuni
14.	Sree Metaliks, Barbil
15.	MSP Metalkcs (P) Ltd., Jharsuguda
16.	Aryan Ispat & Power (P) Ltd., Rengali
17.	Patnaik Steel & Alloys, Joda
18.	Viraj Steel and Energy, Sambalpur
19.	Konark Ispat Ltd., Jharsuguda
20.	Belkay Steel & Power Ltd., Barbil
21.	Deepak Steel & Power Ltd., Barbil
22.	Rathi Steel and Power, Sambalpur
23.	BRG Iron & Steel Co. (P) Ltd., Khuntuni

Table No. – 6:

Sl. No.	District	Capacity
1.	Sundergarh	1.54
2.	Keonjhar	1.78
3.	Dhenkanal	0.10
4.	Angul	0.20
5.	Jajpur	0.05
6.	Mayurbhanj	0.40
7.	Jharsuguda	0.50
8.	Cuttack	0.30
9.	Misc.	0.03
Total 75 Nos. of small & large scale sponge iron unit.		

MAJOR PROBLEMS WITH SPONGE IRON PLANTS

Following are the major problems generally encountered in sponge iron plants.

Raw Material: DRI technologies are very sensitive to the quality of raw materials like Iron ore and coal. For rotary kilns disintegration behaviour of Iron ore is very important in evaluating lump iron ores. Degradation during and after reduction should be low. If this is not low fines content of the product is high. DRI of less than 3 mm are not preferred. Sine no melting or refining occurs all other impurities in the oxide feed get concentrated in the final product necessitating the use of oe with high iron content preferably greater than 64%. Coal should be totally non-coking in nature, as the coking quality leads to agglomeration of charge, reducing reduction process and material flow in the kiln. With high ash content of coal a significant portion of kiln volume is occupied by inert material and thus affecting the productivity. Ideal ash content is 20-24% although coal with 35% ash is being used in commercial operation. Coal sizing becomes difficult during rainy seasons.

Ring formation in rotary kiln: Formation of ring or accretion is due to deposition of low melting complex compounds on the refractory wall of the kiln which increases in thickness with fine and ultimately takes the shape of a circular ring. The main reason is the formation of low melting complex compounds like wusite, fayalite in $FeO\text{-}SiO_2\text{-}Al_2O_3$ system or iron-magnesium silicate, spinels etc. in $CaO\text{-}MgO\text{-}FeO\text{-}SiO_2\text{-}Al_2O_3$ system. Agglomeration of fines nearer to charge end, sintering of sponge iron due to excessive temperature is also responsible for some accretions. Temperature difference between solid and gas should not exceed 100^0C in order to minimize concentration of heat on refractory wall or on the solid bed surface and thereby preventing materials fusing and sticking together or on the refractory wall. Use of higher reactivity coal can minimize this to large extent since kiln can be operated at relatively lower temperature.

Magnetic separation of finished product from non-magnetic generally does not perform well. About 2-3% char is mixed with the prime product.

In gas based sponge iron plants following problems are encountered:

i. Fluctuating compositions of natural gas.

ii. Channeling of the gas flowing through the packed bed in shaft furnace.

iii. Sticking together of the materials.

iv. Contamination of reformer catalyst especially with high sulphur containing feed.

v. Product is pyrophoric and needs briquetting.

SCOPES FOR PROCESS IMPROVEMENTS

Coal based sponge iron process has the main drawback of higher energy consumption compared to gas based process where a major portion of waste energy is recycled in the process itself. Following measures can be taken for improving thermal efficiency and other process parameters.

i. By enriching secondary air with oxygen energy consumption can be reduced.

ii. Injection of submerged air reduces the length of preheating zone in rotary kiln.

iii. Use of alternative reductants like charcoal, lignite, middlings from coal washeries.

iv. Use of coal gasification and of gasified coal in shaft furnaces. By means of coal gasification virtually all types of non-coking coal can be utilized for direct reduction process.

v. Use of coal gasification and of gasified coal in shaft furnaces. By means of coal gasification virtually all types of non-coking coal can be utilized for DRI process.

vi. Utilization of waste heat for power generation. About 25 GCal of heat/hour is lost in a rotary kiln of 0.1 million TPA capacity.

vii. Proper utilization of iron re fines wasted during crushing and sizing by singing ore fines (3-6 mm) into the kiln from the discharge end.

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KUTURIA BOULDER BED AND PROVENANCE CHARACTERISTICS OF THE TALCHIR FORMATION AT THE EASTERN CLOSURE OF THE TALCHER GONDWANA BASIN

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ABSTRACT:

Recent geological investigation at the eastern closure of Talcher Gondwana basin has shown an important boulder horizon, forming the base of the Talchir Formation. The basal boulder bed is well developed south of Kuturia village and named as Kutria Boulder Bed. It forms hills and consists of large rounded boulders measuring maximum of one metre to smaller sizes. The boulders are of variable lithology such as specularite quartzite, very coarse granular quartzite and muscovite-bearing quartzite etc. The parent source rocks of these boulders are found forming hill ranges to the north (e.g. Petraparbat, Petraghati) within the Iron Ore Province and belong to BIF I Formation. The boulder bed is succeeded to the south by green shales and Talchir sandstones observed along the left bank irrigation canal which is under construction. From the similarity of boulders with source rocks to the north, it is believed that the paleoslope and sediment supply directions were from the Iron Ore craton on the north to the Gondwana basin on the south.

Keywords: Gondwana closure, Talchir Formation, Kuturia Boulder Bed, Talchir Boulder bed, Type area, Iron Ore provenance.

INTRODUCTION

The eastern closure of the Talchir Gondwana basin lying in Toposheets 73G/8 and 73H/5 (Fig. 1) were not properly mapped by earlier workers. The present authors examined the aera to bring out further details. The eastern closure of the Lower Gondwana lies to the east of Brahmani river and were deposited in a fault-bounded graben between the Easternghat Granulite Belt to the south and the Iron Ore Belt to the north (Mahalik, 1994, 1995, 1998). The faults, F1 and F2 as shown in Fig. 1, constitute the North Orissa Boundary Fault System (NOBF). Mahalik (2002, p.78) earlier reported a typical and excellent exposure of Boulder Bed south of Kuturia village (lat. 21°02′, long. 85°22′ in toposheet 73G/8). The construction of the left bank irrigation canal of the Rengali Dam Project (see Fig. 1) passing along the axis of the Gondwana closure gave an opportunity to study through an excellent profile of the members of the Talchir Formation such as the green shales and Talchir sandstones sitting at places directly on the Easternghat Group of rocks. The lithology and provenance characteristics of the Kuturia Boulder Bed are presented in this report.

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REGIONAL GEOLOGY

Figs. 1 gives the regional geological setting in which the Gondwanas of the closure zone is situated. The Gondwanas were deposited in a fault-bounded graben between two major crustal blocks, the Easternghat Belt to the south and the North Orissa Craton (Iron Ore craton) to the north, (Mahalik, 1994, 1995, 1998). The Iron Ore craton is underlain by granite-gneiss and amphibolites (Palkam Gneiss) succeeded by two sequences of iron ore formation e.g. the Malyagiri Assembalge representing earlier Banded Iron Formation (BIF I) and the Deogarh Assemblage representing the later Banded Iron Formation (BIF II, Table 1, Mahalik, 1994, 1995). The BIF I is represented by very coarse quartzite, kyanite quartzite, specularite quartzite and muscovite-bearing quartzite. These are well developed in hill ranges around Jhilli, Petraparbat, Petraghati, Bimala etc lying in toposheet 73G/8. The BIF I is succeeded by the typical banded hematite-jasper (BHJ) rocks of BIF II sequence well developed in Malyagiri hill south of Palalahara. The contact between BIF I and BIF II is an unconformity. The Easternghat Belt lies to the south of the Gondwana closure and is represented by typical khondalite, quartzite, gneisses etc. The regional geology is shown in Table 1.

GONDWANA ROCKS IN CLOSURE AREA

The Gondwana rocks lying within the closure zone (Fig. 1) starts with the typical boulder bed (Kuturia Bouder Bed) as described by Mahalik (2002) followed by green shales and fine-grained sandstone (Talchir sandstone). They together constitute the Talchir Formation. The end of Talchir Formation marks a hiatus in sedimentation followed by deposition of the Karharbari Formation. The stratigraphic sequence is presented in Table 2.

KUTURIA BOULDER BED

As has been mentioned earlier, it is a typical boulder bed and should form the type area for the Talchir Boulder Bed. It occurs in a hill range between Kamarda village (lat. 20°58′, long. 85°75′) on the south and Kuturia village (lat. 21°02′, long. 85°22′) on the north at the junction of Toposheet 73G/8 and 73H/5. There are two hill peaks located at heights of 280 m and 332 m (Bankua Pahar). The total outcrop could be more than 10 sq km in area. The hills are mostly made up of larger boulders. An excellent cave is made within this boulder bed on the Kuturia side, which exposes the boulders very well (Fig. 2).

The boulders are well rounded and range in size from smaller to as much as one meter. Larger boulders make up as much as 60 % of the total mass. The lithology of the boulders are variable, e.g. specularite quartzite, very coarse granular quartzite and mica-bearing coarse quartzite. The lithology of boulders matches well with rocks making hill ranges to the north around Petraghati area. They represent the older BIF I sequence of the Iron Ore terrain (Mahalik, 1994, 1995). The authors consider that it merits the type area status of the well-known stratigraphic unit, the Talchir Boulder Bed.

The boulder bed is succeeded by the well-known green shales (needle shales) at the bottom followed by fine-garined sandstone (Talchir sandstone) at the top. The green shales sit directly over the Easternghat basement on the south side of the closure. The canal section at Barjhara village shows an excellent sequence of the Easternghat rocks followed unconformably by green shale and sandstone-shale assemblage.

PROVENANCE CHARACTERISTICS

The lithology of boulders of the Kuturia Boulder Bed has been identified with parent source rocks lying in the northern hill ranges such as around Petraghati area (Fig. 1). From this evidence, it is established that during the Kuturia Boulder Bed period sediments were derived from north as shown in Fig. 1. Hence the paleo-slope was southerly. This paleo-slope direction shows high contrasts with dominantly northward sediment dispersal for the Talchir Formation in the Angul area on the southern margin of the basin (Das and Pandya, 1997; Maejima et al., 2004).

There is no occurrence of boulders identical to the Kutria Boulder Bed on the south side of Gondwana closure, which constitute the Easternghat terrain. In this part, massive green shales sit unconformably over the Easternghat rocks.

Remarks: The present work is in progress and more information is collected to show about the depositional characteristics of the green shales and sandstone sequence lying above the Kuturia Boulder Bed.

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Table – 1: Regional Geology around Gondwana Rocks with Eastern Closure of Talchir Basin.

LOWER GONDWANAS			
		Faulted contact	
IRON ORE SUPERGROUP	Deogarh Assemblage (-Dubri & Tikra Assemblage?) BIF II		BIF, Quartzites, Micaceous quartzites, Cherty quartzites
	Malyagiri Assemblage BIF I		Coarse amphibolites, Coarse quartzites, Kyanite schists, Specularite quartzites, Banded magnetite quartzites
	Palkam Gneiss		Granite gneiss of Pal Lahara, Khamar and Kamakhyanagar
		Faulted contact	
EASTERNGHAT GROUP	Angul Assemblage-khondalites and charnockites		

Table – 2 Stratigraphic sequence of the Gondwanas.

	Karharbari Formation	
	~~ Unconformity ~~~~~~~~~~~~~~~~~~~~	
	Talchir Formation	Talchir sandstone
		Green shales
		Kuturia Boulder Bed (= Talchir Boulder Bed)
	~~ Faulted contact ~~~~~~~~~~~~~~~~~~~~	
	Easternghat Group to the south and Iron Ore Group to the north	

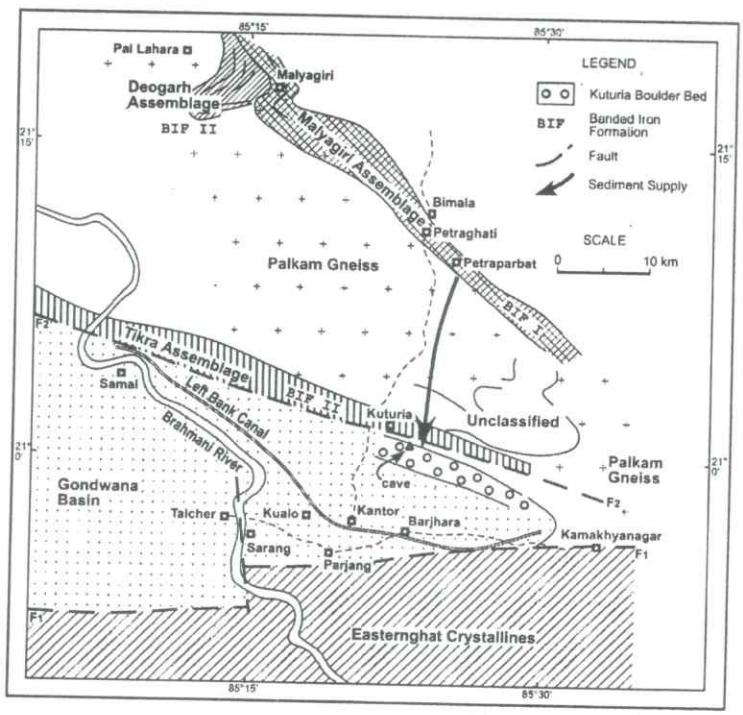


Fig. No.:1 : Geological Sketch Map Around Eastern Closure of Talchir Basin

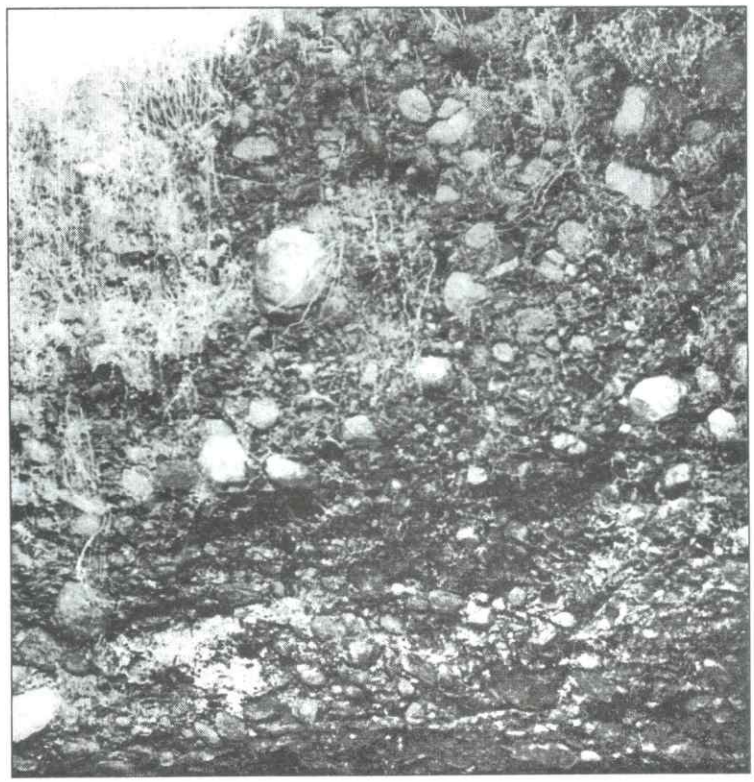
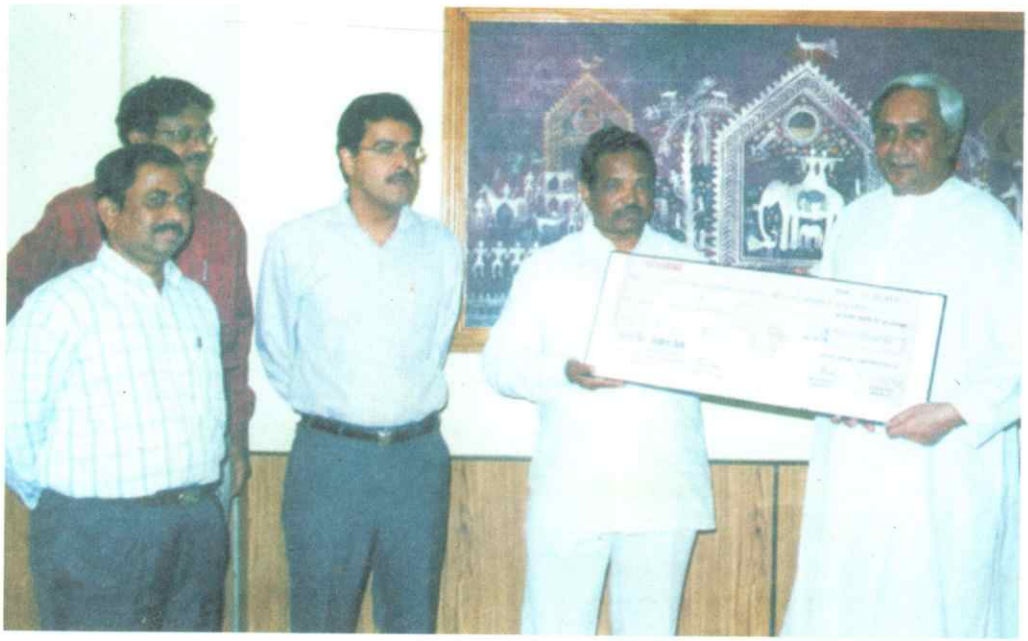


Fig. No.:2 Kuturia Boulder Bed

OMC: A SAGA OF SUCCESS

- Sanjeev Chopra, IAS

The chequered march of OMC for the last 50 years has been a memorable one for the Corporation. A number of new initiatives have been taken which have successfully laid the foundation for turning OMC into a world class mining company in the years to come. The Corporation is to-day basking in the glory of being the largest state PSU in the country's mining sector with a turn-over of more than Rs.700 crores.



OMC contributing dividend to Govt. Minister (S&M) presenting a cheque to CM, Orisssa in the presence of MD, OMC

Key Users & End Users of SAP during an ERP training in Head Office , BBSR

OMC has taken giant strides in implementing e-governance with the use of Information Technology in its business operations. Total Station equipments are extensively used for accurately capturing the excavation made by the raising contractors. The SURPAC software was made use of for the purpose of reserve estimation and mine planning. Above all, the implementation of Enterprise Resource Planning (ERP) has brought about a sea change in the functioning of the Corporation by integrating various functions and making available real time data for faster and more effective decision making. OMC holds the pride of being the first mining company in the country to map its business processes on SAP (Systems, Applications & Products-an ERP tool).

Site of a Screening & Crusher plant at Daitari

Besides, OMC is in the process of strengthening and intensifying the initiatives for obtaining statutory approvals viz., approvals for forest diversion, mining plans, NOC from OPCB and environment clearance. Once the requisite approvals are in place, we would be in a position to come close to a production level of 10 million tonnes of iron ore in the next 2-3 years.

The 1st MD of OMC Sri K.S Ramachandran during his visit to Head Office on the occasion of the Corporation's Golden Jubilee Celebrations in May's06.

The infrastructure development at the mines has been engaging urgent attention of the management and a number of steps have also been taken in that direction. We are committed to ensure that there is no problem of drinking water in any of our mines/camps in the ensuing summer season. Also necessary repairs would be carried out to check leakage of staff quarters during the rains. Pucca roads, boundary walls, illumination etc. are the other areas where there will be a marked improvement in the coming one year. The Corporate office at Bhubaneswar is undergoing renovation and is expected to provide comfortable working environment to all the employees with due regard to ergonomics. Security set up in the mines is all set to be overhauled with the induction of agencies sponsored by the Director General, Rehabilitation, Ministry of Defence which will deploy ex-servicemen. This will tone up the security and it is hoped that incidents of theft, pilferage etc. will become a thing of the past.

Regional Managers of Barbil & Gandhamardan presenting a cheque to the Collector , Keonjhar towards OMC's contribution for peripheral development in Keonjhar Dist.

While a paradigm shift has taken place in our various operations, we have also been equally conscious of our corporate Social responsibility. A sum of Rs. 14 crores and Rs. 1.25 crores has been contributed to the Peripheral Development Societies of Keonjhar and Sundergarh Districts respectively. We have also donated a sum of Rs. 5.00 crores to the Chief Minister's Relief Fund to help the poor, needy and those in distress. In order to directly undertake peripheral development works, especially in the non-scheduled areas and assist in tax planning, a Society called OMC MAITREE has been registered.

Chairman, OMC addressing the gathering during award of 3 - Star Export House status to OMC by DGFT, Govt of India .

We are also in discussion with CENDERET (Center for Development, Research and Training), the rural development centre of Xavier Institute of Management, Bhubaneswar to assist us in formulating projects for holistic development of the villages located in the periphery of our mines. The MAITREE will set new benchmarks of corporate social responsibility in the State within the next couple of years.

I am sure that the work tempo built up in the Corporation over the past couple of years will be sustained in the coming years. We are also taking initiative to diversify the business of the Corporation into coal and power sectors which is expected to propel the Corporation to reach dizzy heights in the days to come.

I am sure the Corporation will reach dizzy heights in the days to come.

• NEW MEMBERS

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3 **Shri Shrinivas D. Deshmukh**
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Pin – 491 001

4 **Dr. Barada R. Mishra**
Director
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Bhubanseswar

5 **Shri Sachikanta Mishra**
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10 **Dr. Desh B. Sikka**
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Canada, Deshs

• NEWS ABOUT THE MEMBERS

Smt. Smita Das, Member of the Society, is promotd to the post of Director of Geology, Govt. of Orissa since April 2006.

Shri Binod Chandra Patnaik, Joint Secretary of the Society, is promoted as Joint Director of Geology, Govt. of Orissa and is posted in Koraput.

Shri S.K. Das, Member of the Society, is promoted to the post of Joint Director of Geology, Govt. of Orissa and he has posted at Keonjhar since May 2006.

Smt. Maitreyi Patnaik is promoted to the post of Joint Director of Geology, Govt. of Orissa and she is posted to Bolangir since May 2006.

Dr. S.K. Sarangi, General Secretary of the Society, has attended the Seminar of Mining & Environment organised by MEAI at Udaipur, Rajasthan on 29th April 2006. He has also chaired one of the technical session.

Dr. R.C. Mohanty, President, (SGAT) has also attended the Seminar of Mining & Environment organised by MEAI held at Udaipur, Rajasthan on 27th April 2006.

Dr. Birendra Kumar Mohapatra, Member of the Society and Scientist in the Regional Research Laboratory, Bhubaneswar has received an award from IIM, Bhubaneswar Chapter on 26th May 2006.

• CHANGE OF ADDRESS

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Opp. Johar Office
Chaibasa – 833 201
Singhbhum (West), Jharkhand

Re: SGAT AWARD OF EXCELLENCE – 2006

Nominations are invited for SGAT Award of Excellence – 2006 in the Proforma enclosed. Persons awarded in the past should not be re-nominated. The proforma (7 sets) completed in all respects and duly signed by the proposer should reach the General Secretary, **Society of Geoscientists and Allied Technologists (SGAT)** at 267, Kharavela Nagar, Bhubaneswar – 751 001 on or before 30th September' 2006.

The Award will be in the form of a citation and a cash award.

Any person (member or non member) who has made outstanding contribution in the field of geosciences, mining, metallurgical and mineral process engineering, mineral beneficiation, environmental management in mines or whose work has helped in upgrading the quality of life in mining environment or whose work has led to significant development of mineral resources of a region, state or country shall be eligible for the award. Self nomination is possible.

1. Name of the persons proposed :
2. Date of birth :
3. Designation & address :
4. Educational qualifications :
5. Professional experience :
6. Membership of Professional bodies :
7. List of publications with names of journals : Vol. and Issues (if possible, send important reprints)
8. Details of outstanding work (Please attach a separate sheet)
9. Any other information

Signature

Place:

Date:

Full name and address of the Member/Institution proposing

(GENERAL SECRETARY)

Re: SITA RAM RUNGTA MEMORIAL AWARD

Nominations are invited for Sita Ram Rungta Memorial Award in the proforma given below. Any person (member or non-member) who would have made significant contribution in Mineral Exploration, Planning and/or Mineral Beneficiation involving utilisation of mine waste/sub-grade ores and minerals will be eligible for the Award. Persons awarded earlier should not be re-nominated. The Award will be in the form of a citation and cash. Self nomination is possible.

Proforma for Nomination

1.	Name of the persons (in Block letter) proposed	:
2.	Date of birth	:
3.	Designation & address	:
4.	Educational qualification	:
5.	Professional experience	:
6.	Membership of Professional Bodies	:
7.	List of Publications with names of Journals (Issues/volumes) if Possible, send important reprints	:
8.	Details of outstanding work (Please attach a separate sheet)	:
9.	Any other information	:

Signature

Place:

Date:

Full name and address of the
Member/Institution proposing

Note:

The work should be original, innovative and of applied nature in the areas of Mineral Exploration, Planning and/or Mineral Beneficiation involving utilisation of mine waste/sub-grade ores and minerals leading to its productive adoption in the field level.

The nomination (in 7 sets) in the prescribed proforma should reach the General Secretary, **Society of Geoscientists and Allied Technologists (SGAT)** at 267, Kharavela Nagar, Bhubaneswar – 751 001 on or before 30th September 2006.

(GENERAL SECRETARY)

BOOK REVIEW

ORISSA PRASANG

Author – Mr. Sahid Ummar

Since recent past Orissa has become a hub centre for many entrepreneurs for proper exploitation and utilization of its vast natural resources. Primarily priority has been given to obtain various informations and data on these natural resources to visualize the proper investment proposal. However, no single reference literature was available on the subject.

Sahid Ummar, a geologist in Geological Survey of India, has written an Oriya Book namely "ORISSA PRASANG". ORISSA PRASANG is a compendium of data / information on Orissa beginning with its geological location and history. He has vividly described on administration, population and demography, education, health, human resources, transportation, communication, commerce and banking facilities, climate, land use, river, lakes, geology, mineral resources, soil resources, water resources, plant resources, biological resources, fish resources, animal resources, forest and land use, agriculture, irrigation, power, industry, tourism, natural hazards, environmental plantation, developmental process and concluding remarks.

The author has attempted to bring all factual history of Orissa in one book in a very lucid and simple vernacular language. The book shall be useful for academicians, researchers and industrial entrepreneurs. This only book written in Oriya with all recent data on the State shall definitely be an important reference book for every schools and colleges of the State. This is the third book of the author. The book is priced only for Rs. 250.00. The author may be contacted in the following address.

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Bhubaneswar – 751 015

Dr. S.K. Sarangi
Editor

Society of Geoscientists and Allied Technologists (SGAT)

Announces
Rescheduling of Workshop

Industry and Mining –
Reclamation , Resettlement and Rehabilitation (R,R&R)

At Bhubaneswar on 16th December 2006

For further Details Contact: Dr. S.K. Sarangi, General Secretary, SGAT
267, Kharavelanagar, Bhubaneswar – 751 001
Tel: (0674) 23902080, 2390516 Fax: (0674) 2390687
Email: sgat@sgatindia.com

SUBMISSION OF PAPERS FOR SGAT BULLETIN

(Guidelines to Prospective Authors)

Research papers, review articles, short communications, announcements and letters to editors are invited on topics related to geosciences, viz, mineral exploration, mineral characterization and beneficiation, mining, materials science, metallurgy, mineral industry and trade, mineral economics, environment, education, research and development, legislation and infrastructure related to mining, mineral policy and mineral development planning.

Submission of manuscript implies that it is original, unpublished and is not being considered for publication elsewhere. Two copies, complete in all respects (with copies of figures and tables), are required to be submitted. Originals tracings of figures and tables should be enclosed separately. Each manuscript must be accompanied by a computer diskette (floppy) containing the electronic version of the text. Electronic files of figures, if available, should be submitted in a separate diskette. In each case, the details of software and type of equipment used should be clearly indicated.

Journal Format: **A-4 size**
Language: English

Manuscripts: Manuscripts should be typed in double spacing with wide margins on one either by electronic typewriter or computer (size 12 point Times New Roman font). The title page should include the title of the paper, name(s) of author(s) and affiliation(s). The title should be as brief as possible. An informative abstract of not more than 500 words to be included in the beginning. Not more than 5 key words are to be listed at the end of the abstract. Text of research papers and review articles should not exceed 4000 words. The short communication is for quick publication and should not exceed 1200 words.

Headings: Different headings should be in the following format.

(a) Title: Centrally aligned, bold, capital
(b) Author(s): Centrally aligned, short name, bold, first letter of all words capital followed by communication address (Not Bold)
(c) Abstract: Left aligned, bold
(d) Key words: Left aligned, bold
(e) Primary heading: Left aligned, bold, capital
(f) Secondary heading: Left aligned, first letter of each word capital
(g) Tertiary heading: Left aligned, first letter of first word capital
(h) Acknowledgements:Left aligned, bold, first letter capital
(i) References:Left aligned, bold, first letter capital
(j) Figure Caption: Left aligned, first letter of first word capital, below the figure
(k) Table Caption:Left aligned, first letter of first word capital, at the top of the table

Illustrations: All illustrations should be numbered consecutively and referred to in the text. They should confirm to A-4 size and carry short captions. Lettering inside figure should be large enough to accommodate upto 50% reduction. One set of hard copy of all figures (either tracing in ink or laser prints) should be provided in a separate envelope marked "Original Figures". Photographs should be of good quality with excellent contrast, printed on glossy paper. Colour photos are acceptable, provided the author(s) bear the cost of reproduction. Figure captions should be provided on separate sheet.

Tables: Each table must be provided with a brief caption and must be numbered in order in which they appear in the text. Table should be organised within A-4 size and should be neatly typeset for direct reproduction. Tables will not be typeset by the printer, so their clarity and appearance in print should be taken into account

while the author(s) prepare(s) them. Use of 10 points Time New Roman/Arial Font for table is recommended.

References :

(a) References in the text should be with the name of the author(s) followed by the year of publication in parenthesis, i.e. Patnaik (1996); Patnaik & Mishra (2002); Nayak et al. (2001)

(b) Reference list at the end of the manuscript should be in alphabetical order, in the following format: Sehgal, R.K. and Nanda, A.C.(2002) Paleoenvironment and paleoecology of the lower and middle Siwalik sub-groups of a part of North-western Himalayas. Jr. Geol. Soc. Ind, vol. 59, pp. 517-529

(c) Articles from the books should follow the format given below:Windley, B.F. and Razakamanana, T. (1996) The Madagascar – India connection in a Gondwana framework. In:Santosh, M. and Yoshida, M. Eds.) The Archaean and Proterozoic terrains of South India within East Gondwana. Gond. Res. Group Mem. No.3, Field Sci. Publ., OSAKA, pp. 25-37

(d) Books should be referred to as:Sengupta, S.M. (1994) Introduction to Sedimentology. Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi, 314 pp.

Submission of manuscript

Manuscripts strictly confirming to the above format should be mailed directly to Editor in his mailing address available in the bulletin. Manuscripts not conforming to the format of the journal will be returned.

All the manuscripts conforming to the standard format of the bulletin will be reviewed by specialist referees before publication.

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AN APPEAL

WE ARE PLEASED TO INFORM YOU THAT SGAT HAS ALREADY GOT ALLOTMENT OF LAND MEASURING 90' X 45' IN IRC VILLAGE, NAYAPALLI AREA OF BHUBANESWAR. SGAT HAS ALREADY TAKEN THE POSSESSION OF THE LAND ON PAYMENT OF THE COST.

SGAT DESIRES NOW TO CONSTRUCT ITS OWN AUDITORIUM WITH OTHER UTILITIES COMPONENTS IN THE SAME PLOT. THIS IS ESTIMATED THAT AN AMOUNT OF ABOUT RS. 50.00 LAKHS SHALL BE REQUIRED TO COMPLETE THE FIRST PHASE OF CONSTRUCTION. IN VIEW OF THIS IT IS PROPOSED TO MEET THESE EXPENSES THROUGH DONATIONS FROM MEMBERS AND VARIOUS INSTITUTIONS. SGAT HAS ALREADY APPLIED FOR OBTAINING INCOME TAX RELAXATION UNDER RULE 80 - G WHICH WOULD BE OBTAINED SHORTLY.

AN APPEAL IS, THEREFORE, MADE FOR A GENEROUS CONTRIBUTION TOWARDS BUILDING FUND OF THE SOCIETY. ALL PAYMENTS CAN BE SENT EITHER BY CHEQUE/DEMAND DRAFT PAYABLE AT BHUBANESWAR IN FAVOUR OF "SOCIETY OF GEOSCIENTISTS & ALLIED TECHNOLOGISTS" AND MAY BE SENT TO THE GENERAL SECRETARY, SOCIETY OF GEOSCIENTISTS & ALLIED TECHNOLOGISTS, 267, KHARAVELA NAGAR, BHUBANESWAR - 751 001, ORISSA.

YOUR GENEROSITY FOR THIS NOBLE CAUSE SHALL BE HIGHLY REMEMBERED.