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PRESIDENT'S COLUMN

The history of mineral extraction in India goes back to the days of Harappa Civilisation and the mining sectors form an important segment of country's economy. Having abundances of mineral resources in the country, mining professionals should strive hard to practise proper scientific and responsible mining and processing to optimise the growth potential of mineral resources. Since recent past, mining industries have been receiving step-motherly attitude from the concerned non-mining sectors and one of the reasons can be attributed to having non-cooperation between mining communities – a great loss to the country. Time has come to maintain harmony in the mining communities for which we have to practise “Karmayog” as indicated in GITA. GITA has preached three paths like Karmayog, Bhaktiyog and Gyanyog and all are divine, responsible and complimentary. One should respect all these divine virtues and should practise Karmayog and after both the Gyanyog and Bhaktiyog will manifest. There is no difference among three paths when “EGO” has removed from “ACTION” at Karmayog in true sense and you can achieve Gyanyog and Bhaktiyog.

Challenges in life come in three broad categories like easy, difficult and impossible. Those who take on easy have a safe and boring life, those who take on the difficult have a tuff and satisfactory life and those who take on impossible will be remembered. Think positive and no selfish, it will improve your health and mind.

Mining community shall keep all these things in mind and truly follow egoless and selfishless action to become true Karmayogi for the betterment of mining communities. One has to adopt and practise flexibility to prioritise innovation to promote quality deliverables.

In a view to create awareness and to bring harmony and unity among the Mining Communities, a proposal is mooted to observe **INDIAN MINING DAY (IMD)** on 1st of November of each year.

Your patronage and selfless cooperation are solicited.

Dr. S.K. Sarangi
(President, SGAT)

**PREVENTION AND CONTROL OF POLLUTION –
AN ANALYSIS OF VARIOUS APPROACHES**

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ABSTRACT

In this era of rapid urbanization and industrialization, there has been tremendous pressure on the natural resources. The industrial processes also generate a host of pollutants. There are various regulatory mechanisms to minimise the impact of pollution to the environment. In fact a striking balance between the environment and development has been necessary. This is being attempted not only by the regulating agencies but also by the judiciary, non-government and governmental institutions. Another dimension to tackle the issues of Environmental Management is in the shape of various economic instruments like Tradable Permits; Charges, Fees and Taxes, Subsidies, Eco-labelling etc. Besides the concepts of Extended Producer Responsibilities, Environment Management System and Greener & Ethical Financing have also their footprints in addressing the issues of environmental pollution.

1.0 INTRODUCTION

Rapid population growth is leading to urbanization and industrialization, resulting into generation of various types of pollutants that are adversely affecting the environment. With the present rate of economic growth, industrial development is bound to increase. Environmental protection is also equally important for sustainable development. In order to address the issue of environmental protection in this era of rapid industrialization many environmental regulations have been introduced. Environmental activism has also increased with the increase environmental awareness among common people. However, protection of environment throws up host of problems for a developing nation like India. Administrative and legislative strategies of harmonization of environmental values with environmental issues are a must and therefore need to be formulated in the crucible of prevalent socio-economic conditions. It is felt that a striking balance between the environment and development is highly essentials within the scope of the powers and functions of administrative agencies. Judicial intervention on environmental issues have reflected the concerns of judiciary for combating environmental assaults. The issue of environmental

governance at present has become an increasingly important concern both at the national and international levels. Environmental governance aims at addressing the decisions concerning the environment and also in determining who participate in the decision making, the mechanism of implementation to achieve the required environmental goal.

In India the control of environmental pollution is mostly regulated by enforcing various provisions of environmental regulations. In the post independent era particularly from second five year plan onwards high priority to economic growth was given as a result the environment receded to a less important place. Till 1970s, prior to the organisation of the 'Habitat Conference' at Stockholm, no specific steps were taken to protect and preserve the environmental quality in India. It is only in 1972 that steps were initiated to establish a separate department of Environment under the Ministry of Science & Technology and thereafter it reached the full-fledged stage of Ministry of Environment and Forests in 1985. The institutional framework took shape with the Central Pollution Control Board and State Pollution Control Boards.

Initially the Constitution of India did not contain any provision towards the

promotion/protection of environment. However, with the 42nd amendment to the constitution in 1977 some important clauses that entrusted the government the responsibility of providing a clean and well-protected environment were added in the Constitution. With the promulgation of the Water (Prevention and Control of Pollution) Act in 1974, a Plethora of legal arrangements came as watchdog against any injury to the environment. The umbrella Act i.e. Environment Protection Act (EPA) which was enacted in 1986 added strength to all preceding provisions.

Many instruments to address the environmental problems are globally implemented to achieve the required environmental quality. Some such instruments are also being used in India in piecemeal basis for this purpose. These instruments are discussed below:

2.0 COMMAND & CONTROL INSTRUMENT

This is the traditional approach for environmental protection. Under this instrument of command and control pattern of regulation set uniform target for how much the industry should be emitting often based on end of the pipe treatment approach. Two broad types of command and control regulations are practised which are technology based. The former specifies the method and equipment that the industries must use to meet the target or standard prescribed under the law. On the other hand performance based approach set an overall limit for each industry and allow the industry to meet such standards. This approach, however, ignore the possibility that some industries cannot be able to make reductions more readily than others and beyond the prescribed limit. This instrument mostly rely on the legal action including prohibition and closure. Environmental performance with respect to the prescribed limits / norms and their compliance verification is the major criteria.

The command and control instruments have some limitation which are described below:

- This approach does not give emphasis on pollution reduction by adopting systematic changes in production process or production design. The principle as such does not give any incentive to pursue such changes.
- There is no reward for getting a target or complying beyond standard.
- It is an "on & off" approach and does not have room for higher emissions due to equipment failure or process failure.
- This principle focuses on point sources and monitoring and measurement are largely a burden on regulators.
- Cumulative impact from cluster of industries are often ignored.
- The integration of pollution with the receiving environment is not considered.

3.0 ECONOMIC INSTRUMENTS

Economists have been advocating the use of economic instruments as an alternative, or supplement, to direct regulations. Most importantly it is argued that economic instruments can create a system that would offer pollution reduction at a lower cost. Economic instruments also allow for a more hands-off regulations and decentralized decision making, providing greater freedom to the industries about how to comply. However, in order to understand the logic of economic instrument, one must understand the reason of pollution. Economists perceive pollution as a "market failure" which arises because polluters and the people who use the goods do not face the consequence. For example a manufacturer releases effluent into a nearby river which adversely affects the fish population. In the downstream the fisherman face their livelihoods under threat because the use of the river as an effluent discharge is perceived as free, the manufacturer has no incentive to curb effluents in contrast in the permanent incentive such as reduction of labour, material, machinery, energy inputs etc., all of which have costs

attached to them. In economic terms the downstream impacts are "externalities" that lie outside the decision making framework of the manufacturer. The underlying premise for economic instruments is to correct the market failure by putting a cost on the release of pollutants. A technical definition for an economic instrument is a "tool that effect estimates of the costs and benefits of alternative action open to economic agents". In other words it is internalization of the externalities into the decision making process. Putting a charge or fee on every unit of effluent released into the river, influence the manufacturers decision regarding how much he will produce and how he will produce. The manufacturer by this instrument, will decide on production cost which not only consist of labour, material, machinery, energy etc., but also the effluent charges. Such an instrument in turn encourage the manufacturer to change the production process by installing new technology, better raw materials which result in less effluent (or emissions).

Several types of economic instruments exist and some of them are also practised in India to supplement the command and control principles. Such instruments are discussed below:

3.1 Tradable Permits

Instead of a pollution charge, a manufacturer would require to hold a permit to release a given quantity of pollutants. Since these permits are tradable, the manufacturer can pay to get hold off more permits or he can sell his existing permits if he can work out a way to reduce his current pollution levels. By controlling the aggregate number of permits, the regulator effectively control the total release of pollutants. This is widely practised in USA. Similar emission trading is practised for CO₂ emissions, more popularly known as carbon trading.

3.2 Charges, Fees and Taxes

These are prices paid for discharges and emissions of pollutants to the environment and based on the quantity and/or quality of

the pollutant (s). The charge is directly levied on the quantity of pollution (emission tax). Many a times it is difficult to measure or monitor the level of pollution therefore it may be necessary to levy a charge on a proxy for the emissions, typically on the resource that causes the pollution (product tax). Product charges can be levied at different user points, i.e. manufacturing level (e.g. fertilizers), consumption level (e.g. pesticides) or disposal level (e.g. lead acid batteries). In some cases the charge is part of a deposit – refund scheme which allow the user to redeem the initial payment, if the product is returned through appropriate waste channel. The effectiveness of product charges depends on the strength of the link between input or product with the eventual scheme of pollution.

3.3 Subsidies

Subsidies for achieving the environmental qualities is another effective instrument for prevention of pollution. In India, under Water (Pollution and Prevention) Cess Act, 1977, charges on water consumption are levied for the industry discharging wastewater beyond the prescribed norms. Subsidies are also provided for encouraging recycling of waste and implementation of improved pollution control equipments.

4.0 ECO-LABELLING (ECO-MARK)

This approach relies on cradle-to-grave principle i.e. from the raw material extraction, manufacturing and disposal. The environmentally sound products are encouraged and they are given eco-mark. This has helped the industries in better marketing as people are increasingly interested to buy environmentally friendly products. This concept is also manifestation of Life Cycle Assessment (LCA). Many of the products such as soap, detergent etc. now a days have eco-mark.

5.0 EXTENDED PRODUCER RESPONSIBILITY (EPR)

It has been seen that the manufacturers, once sell their products are not responsible

for environmental implications caused due to disposal of end of life products. This has also resulted in unorganised recycling and disposal causing more harmful effect on the environment. The most popular example is e-waste, plastic waste, lead acid batteries etc. Under EPR, the manufacturer have the responsibility to develop mechanism and network for collection of such end of life products and channelize them for environmental sound, recycling and disposal. Many of the countries including India have started implementing this concept through legislation.

6.0 ENVIRONMENTAL MANAGEMENT SYSTEM

Environmental management system is a safe certification process for reviewing the company's environmental goal. The process analyzes the environmental impact and the legal requirement and establish programme with objectives and targets to reduce environmental impacts. This exercise also identify the scope for environmental improvements and the same is assessed by third party auditors. Instruments such as Environmental Audit, Environmental Performance Evaluation, Environmental Aspects in Product Standards, ISO 14000 are common examples.

7.0 GREENER & ETHICAL FINANCING

Banks and financial institutions are now-a-days more concerned about the environmental performance of the developmental projects. Insurance companies and mutual bonds are insisting for greener industries as the risk of investment is reduced. There are specialised sustainability investors who carry out detailed analysis of environmental implications before finalizing the investment. They also need transparent reporting on environmental matters. Corporate sustainability reporting is one such document relied in Greener &

Ethical Financing, as these reports are reviewed by independent assessors.

8.0 CONCLUSION

It may be seen from the above discussions, that apart from statutory regulation there are many instruments used for prevention and control of pollution. In practice, with a well established regulatory system based on command and control principle can be made more effective, if it is supplemented with other appropriate instruments to address specific environmental issues. The use of various instruments depends on the type and source of pollution and also the receiving environment and management strategies. It is therefore necessary to integrate the conventional measures with other instruments to have an effective environmental management, which is multi-disciplinary, and by involving various stake holders.

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NATURE CONSERVATION

Bijoy Kumar Patnaik

ABSTRACT

Environmental processes provide a wealth of services to the living world – providing us with air to breathe, water to drink and food to eat as well as materials to use in our daily lives. Complex ecosystems with a wide variety of plants and animals tend to be more stable. A highly diverse ecosystem is a sign of healthy system. World population is forecast to reach a plateau of 9 billion during 21st century. It is self evident that the massive growth in human population through the 20th century has had more impact on biodiversity than any other single factor. Global warming caused by green house gases is also considered to be a major threat to global biodiversity. Over exploitation occurs when a resource is consumed at an unsustainable rate. This occurs on land in the form of overhunting, excessive logging, poor soil conservation in agriculture and the illegal wildlife trade. The natural environment is the source of all over resources for life. Conservation biology matured in the mod 20th century as ecologist, naturalists and other scientists began to research and address issues pertaining to global biodiversity declines. The conservation ethic advocates management of natural resources for the purpose of sustaining biodiversity in species, ecosystems, the evolutionary process, and human culture and society. Conservation of forests are extremely important for arresting global warming and climate change which are adverse to biodiversity. Focusing on limited areas of higher potential biodiversity promises greater immediate return on investment than spreading resources evenly or focusing on areas of little diversity but greater interest in biodiversity.

INTRODUCTION

“Nature” by dictionary, means “the phenomena of the physical world collectively, including plants, animals, the landscape, and other features and products of the earth, as opposed to humans or human creations”.

“Biodiversity” is the degree of variation of life forms within a given species, ecosystem, biome, or an entire planet. It refers to the sum of all the different species of animals, plants, fungi and microbial organisms living on Earth and variety of habitats in which they live. The Biodiversity includes:-

- species diversity
- ecosystem diversity
- genetic diversity

From afore said definitions it can be inferred that in biological sense **Nature Conservation**, in essence means **Biodiversity Conservation**. Therefore, to

understand nature and its conservation we have to know biodiversity and biodiversity conservation.

BIODIVERSITY DISTRIBUTION

Uneven Distribution: Distribution of Biodiversity across the globe is not even; rather it varies greatly across the globe as well as within regions. Biodiversity is a measure of the health of ecosystems. Biodiversity is in part a function of climate. Among other factors, the diversity of all living things (biota) depends on temperature, precipitation, altitude, soils, geography and the presence of other species. Generally, there is an increase in biodiversity from the poles to the tropics. Thus, localities at lower latitudes have more species than localities at higher latitudes. This is often referred to as the latitudinal gradient in species diversity. However the terrestrial biodiversity is up

to 25 times greater than ocean biodiversity.

The study of the spatial distribution of organisms, species, and ecosystems, is the **science of biogeography**.

Biodiversity Hotspots: A biodiversity hotspot is a biogeographic region with a significant reservoir of biodiversity that is under threat from humans. To qualify as a biodiversity hotspot on Myers 2000 edition of the hotspot-map, a region must meet two strict criteria:

1. it must contain at least 0.5% or 1,500 species of vascular plants as endemics, and
2. it has to have lost at least 70% of its primary vegetation

Thus a biodiversity hotspot is a region with a high level of endemic species. Many hotspots have large nearby human populations. While hotspots are spread all over the world, the majority is forest area and most are located in the tropics.

The biodiversity hotspots although hold very large numbers of endemic species, yet their combined area of habitat covers only 2.3 percent of the Earth's land surface. Each hotspot faces extreme threats and has already lost at least 70 percent of its original natural vegetation. The concept of Biodiversity Hotspots are important that over 50 percent of the world's plant species and 42 percent of all terrestrial vertebrate species are endemic to the 34 biodiversity hotspots in the globe. The distribution of 34 hot spots in different continents is Africa: 8; Asia_Pacific: 3; Europe_Central America: 4; North Central America: 4; South America: 5.

Bio Diversity Hot Spots in India : India contains 3 hotspots of Asia_Pacific Regions. They are:

- o Western Ghats and Srilanka Region: Western ghats in India harbours 6000 vascular plants belonging to over 2500 genera in this hotspot, of

which over 3000 are endemic. About 77% of the amphibians and 62% of the reptile species found here are found nowhere else

- o The Eastern Himalayas Region: The region encompasses Bhutan, northeastern India, and southern, central, and eastern Nepal. It harbours 163 globally threatened species including the One-horned Rhinoceros, the Wild Asian Water buffalo and in all 45 mammals, 50 birds, 17 reptiles, 12 amphibians, 3 invertebrate and 36 plant species. There are about 10,000 species of plants in the Himalayas, of which one-third are endemic and found nowhere else in the world.
- o Indo-Burma Region: North eastern India is part of it. Almost 13,500 plant species in this hotspot, with over half of them endemic with 6 large mammals and 1300 species of bird.

Mega Bio Diversity Countries: The mega diverse countries are a group of countries that harbor the majority of the Earth's species and are, therefore, considered extremely bio diverse. Conservation International identified 17 mega diverse countries in 1998. All are located in, or partially in, the tropics. India is one of it. Identification of such countries helps focusing efforts of conservation.

SPECIES DIVERSITY

Existing Species Diversity: The diversity of species on Earth is incredible. Right now, there are more than 1.7 million species that have been discovered and named while scientists think that there are millions more we don't know about. The different plants, animals and other forms of life interact with each other in so many ways that we are still figuring them out.

Number of Species in India and the World:

Group	Number of species in India (SI)	Number of species SI/SW in the world(%)	
Mammals	410	4,629	8.9
Birds	1224	9,702	12.6
Reptiles	408	6,550	6.2
Amphibians	197	4,522	4.4
Fishes	2546	21,730	11.7
Flowering Plant	15,000	270,000	6.0

Total Number of Species Discovered:

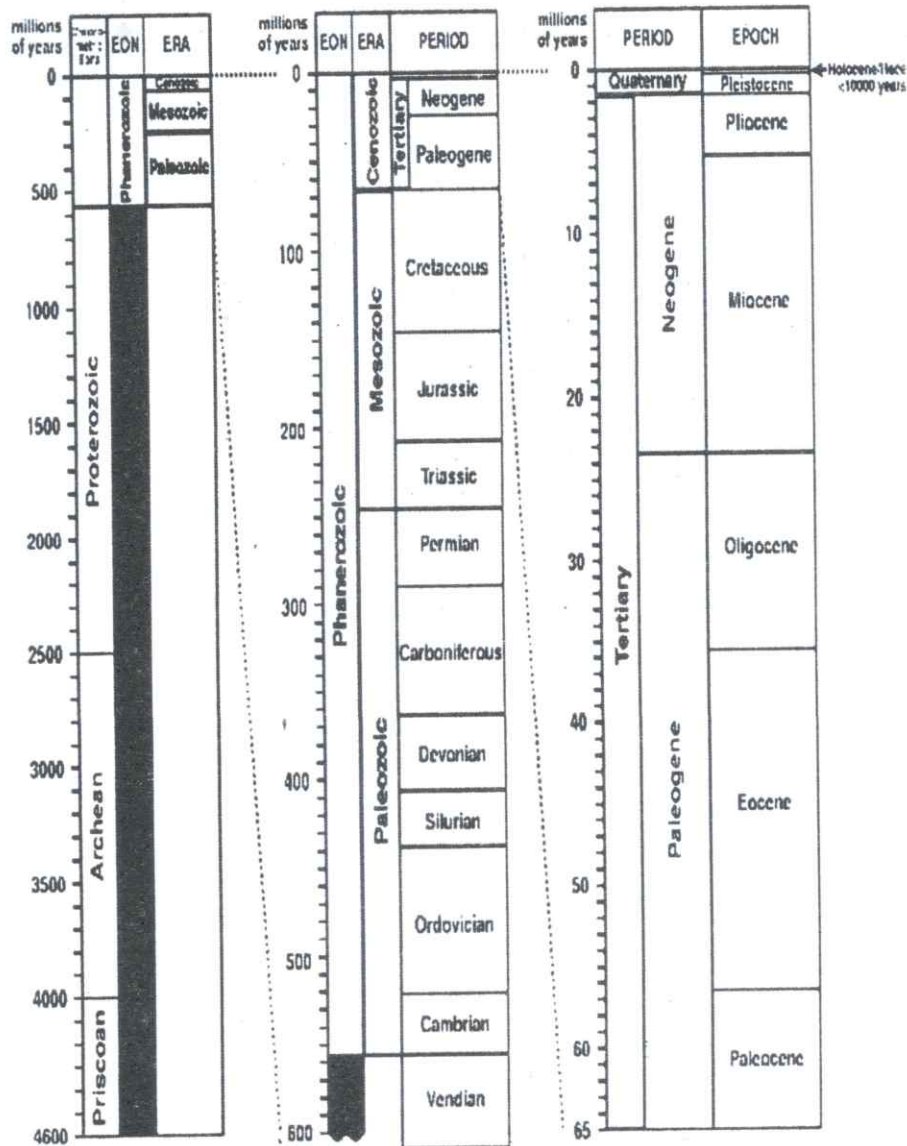
Flowering Plants	270,000
Fungi	72,000
Algae	40,000
Protozoa	30,000
Crustacea	75,000
Arachnida	75,000
Insects	950,000
Molluscs	80,000
Other Invertebrates	120,000
Vertebrates	56,000
Total:-	<u>1,768,000</u>

Total species estimated 10 to 12 millions

New species are regularly discovered (on average between 5,000–10,000 new species each year, most of them insects) and many, though discovered, are not yet classified (estimates are that nearly 90% of all arthropods are not yet classified).

Species Diversity Is Product of Evolution: Biodiversity is the result of 3.5 billion years of evolution. The origin of life has not been definitely established by science, however some evidence suggests that life may already have been well established only a few hundred million years after the formation of the Earth. Until approximately 600 million years ago, all life consisted of archaea, bacteria, protozoans and similar single-celled organisms.

GEOLOGICAL TIME SCALE



The history of biodiversity during the Phanerozoic (the last 540 million years), starts with rapid growth during the Cambrian explosion—a period during which nearly every phylum of multicellular organisms first appeared. Over the next 400 million years or so, invertebrate diversity showed little overall trend, and vertebrate diversity shows an overall exponential trend. This dramatic rise in diversity was marked by periodic, massive losses of diversity classified as mass extinction events. A significant loss occurred when rainforests collapsed in the carboniferous. The worst was the Permo-

Triassic extinction, 251 million years ago. Vertebrates took 30 million years to recover from this event.

Extinction of Species: Although Extinction and Evolution of new species are normal process of “Organic Evolution”, rapid environmental changes typically cause mass extinctions. One estimate is that less than 1% of the species that have existed on Earth are no more. There have been five mass extinction events throughout Earth's history:

1. The first great mass extinction event took place at the end of the Ordovician, 434 million years ago, when according to the fossil record, 60% of all genera of both terrestrial and marine life worldwide were exterminated.
2. 360 million years ago in the Late Devonian period, the environment that had clearly nurtured reefs for at least 13 million years turned hostile and the world plunged into the second mass extinction event.
3. The fossil record of the end Permian mass extinction 250 million years ago reveals a staggering loss of life: perhaps 80–95% of all marine species went extinct. Reefs didn't reappear for about 10 million years, the greatest hiatus in reef building in all of Earth history.
4. The end Triassic mass extinction 200 million years ago is estimated to have claimed about half of all marine invertebrates. Around 80% of all land quadrupeds also went extinct.
5. The end Cretaceous mass extinction 65 million years ago is famously associated with the demise of the dinosaurs. Virtually no large land animals survived. Plants were also greatly affected while tropical marine life was decimated. Global temperature was 6 to 14°C warmer than present with sea levels over 300 metres higher than current levels. At this time, the oceans flooded up to 40% of the continents.

Holocene Extinction: The period since the emergence of humans has displayed an ongoing biodiversity reduction and an accompanying loss of genetic diversity. Named the Holocene extinction, the reduction is caused primarily by human impacts, particularly habitat destruction. Conversely, biodiversity impacts human health in a number of ways.

About 40 percent of the 40,177 species assessed using the **IUCN Red List** criteria are now listed as threatened with extinction—a total of 16,119.

About one eighth of known plant species are threatened with extinction. Estimates reach as high as 140,000 species per year (based on Species-area theory). This figure indicates unsustainable ecological practices, because few species emerge each year.

The rate of species loss is greater now than at any time in human history, with extinctions occurring at rates hundreds of times higher than background extinction rates. As of 2012, some studies suggest that 25% of all mammal species could be extinct in 20 years.

ECOSYSTEM DIVERSITY

Ecosystem diversity refers to the variety of ecosystems in a given place. This is diversity of the place at the level of the ecosystems. Within any broader landscape there is a mosaic of interconnected ecosystems. All species depend on other species for survival. Ecosystems vary in size. A large stand of forest or a small pond can each be described as an ecosystem.

Ecosystems are the combination of communities of living things with the physical environment in which they live. There are many different kinds of ecosystems, from deserts to mountain slopes, the ocean floor to the Antarctic, with coral reefs and rainforests being amongst the richest of these systems.

Each ecosystem provides many different kinds of habitats or living places. The living things and the non-living environment (earth forms, soil, rocks and water) interact constantly and in complex ways that change over time, with no two ecosystems being the same.

Although ecosystems are ever-changing and complex, some universal principles apply. One of these is that matter

constantly cycles and recycles. Another principle is that energy moves through the cycle, being used, absorbed and stored.

For example, forests act as filters for air, absorbing carbon dioxide and releasing oxygen.

Seas are the great stabilisers of climates, with warm currents moderating temperatures on the land masses they pass. Mangroves and sea grass beds are the nurseries for marine creatures. While the sun is a constant source of Earth's energy, energy is also available from geothermal processes. So while each ecosystem generates its own relationships, the Earth's environments are interrelated — they all rely on the sun and the Earth's oxygen and water to survive.

Types of Eco System: There are many types of ecosystems on earth. Major classes of relatively contained ecosystems are called Biomes. There are essentially two kinds of ecosystems; **Terrestrial** and **Aquatic**. Any other sub-ecosystem falls under one of these two headings.

(1) **Terrestrial ecosystems:** Terrestrial ecosystems can be found anywhere apart from heavily saturated places. They are broadly classed into:

The Forest Ecosystems: They are the ecosystems in which an abundance of flora, or plants, is seen so they have a big number of organisms which live in relatively small space. Therefore, in forest ecosystems the density of living organisms is quite high. A small change in this ecosystem could affect the whole balance, effectively bringing down the whole ecosystem. One could see a fantastic diversity in the fauna of the ecosystems, too. They are further divided into:

- **Tropical evergreen forest**
- **Tropical deciduous forest**
- **Temperate evergreen forest**
- **Temperate deciduous forest**
- **Taiga** (Situated just before the arctic regions)

The Desert Ecosystem: Receive an annual rainfall less than 25cm. Occupy about 17 percent of all the land. The vegetation is mainly shrubs, bushes, few grasses and rare trees. The best known ones are the succulents such as the spiny leaved cacti. The animals include insects, birds, camels, reptiles all of which are adapted to the desert (xeric) conditions.

The Grassland Ecosystem: Savanna, Prairies and other grass lands.



The Mountain Ecosystem: Mountain and provides a scattered and diverse array of habitats where a large number of animals and plants can be found.



Tundra: Rainfall 25cm. Open, windswept, dry and ground always frozen.

(2) **Aquatic Ecosystems:** The aquatic ecosystem is the ecosystem found in a body of water. It encompasses aquatic flora, fauna and water properties, as well. There are two main types of aquatic ecosystem - Marine and Freshwater.

(A) The Marine Ecosystem: Marine ecosystems are the biggest ecosystems, which cover around 71% of Earth's surface and contain 97% of our planet's water. Water in Marine ecosystems features in high amounts minerals and salts dissolved in them. The different divisions of the marine ecosystem are:

- Oceanic: A relatively shallow part of oceans which lies on the continental shelf.
- Profundal: deep or Bottom water.
- Benthic Bottom substrates.
- Inter-tidal: The place between low and high tides.
- Estuaries
- Lagoons
- Coral reefs
- Salt marshes
- Hydrothermal vents where chemosynthetic bacteria make up the food base.

Many kinds of organisms live in marine ecosystems: the brown algae, corals, cephalopods, echinoderms, dinoflagellates and sharks.

(B) The Freshwater Ecosystem: Contrary to the Marine ecosystems, the freshwater ecosystem covers only 0.8% of Earth's surface and contains 0.009% of the total water. Three basic kinds of freshwater ecosystems exist:

- Lentic: Slow-moving or still water like pools, lakes or ponds.
- Lotic: Fast-moving water such as streams and rivers.



- Wetlands: Places in which the soil is inundated or saturated for some lengthy period of time.



These ecosystems are habitats to birds, reptiles, amphibians and around 41% of the world's fish species. The faster moving turbulent waters typically contain a greater concentration of dissolved oxygen, supporting greater biodiversity than slow moving waters in pools.

To conserve biodiversity, conservation at the landscape level is critical. This enables the protection of a representative array of interacting ecosystems and their associated species and genetic diversity.

GENETIC DIVERSITY

Genes contain the information necessary for all life on Earth. They are passed on from parents to offspring, and contain the information that builds and maintains cells and determines the essential physical and biochemical characteristics of each organism.

Genetic diversity refers to the variety of genes within a species. Each species is made up of individuals that have their own particular genetic composition. Within a species there may also be discrete populations with distinctive genes.

Genetic diversity serves as a way for populations to adapt to changing environments. With more variation, it is more likely that some individuals in a population will possess variations of alleles that are suited for the environment.

Those individuals are more likely to survive to produce offspring bearing that allele. The population will continue for more generations because of the success of these individuals.

To conserve the genetic diversity within a species, different populations must be conserved. This protects the genetic diversity that allows for adaptability to environmental changes and is therefore vital to species survival.

WHY BIO DIVERSITY IMPORTANT?

The natural environment is the source of all our resources for life. Environmental processes provide a wealth of services to the living world — providing us with air to breathe, water to drink and food to eat, as well as materials to use in our daily lives and natural beauty to enjoy.

Complex ecosystems with a wide variety of plants and animals tend to be more stable. A highly diverse ecosystem is a sign of a healthy system. Since all the living world relies on the natural environment, especially us, it is in our best interests and the interests of future generations to conserve biodiversity and our resources.

Some might argue that some species have become extinct, with no obvious effect on the environment. But the Earth's systems are so complex that we are still learning about environmental processes and resources and the roles they play. The careless loss of any part of the natural environment means that we may never know what use it was or could have been in terms of future technologies, or for medical science, or indeed for the health of the planet itself.

It's important to understand that environments are constantly changing. A healthy, robust environment evolves and adapts to naturally changing conditions. It is fascinating to observe the far-reaching effects even small changes can make and

the importance of genetic diversity for species to adapt, survive and evolve.

Preservation of biodiversity is not necessarily about preserving everything currently in existence. It's more a question of respecting the natural changes that occur and of protecting species and environments from wanton extinction and destruction. Life on Earth would not be the same if our planet's biodiversity were to be radically affected.

Human benefits: The economic value of 17 ecosystem services for Earth's biosphere (calculated in 1997) has an estimated value of US\$ 33 trillion (3.3x10¹³) per year.

Biodiversity supports ecosystem services including air quality, climate (e.g., CO₂ sequestration), water purification, pollination, and prevention of erosion.

Since the Stone Age, species loss has accelerated above the prior rate, driven by human activity. Estimates of species loss are at a rate 100-10,000 times as fast as is typical in the fossil record.

Non-material benefits include spiritual and aesthetic values, knowledge systems and the value of education.

Agriculture and Animal Husbandry: Crop diversity aids recovery when the dominant cultivar is attacked by a disease or predator:

- The Irish potato blight of 1846 was a major factor in the deaths of one million people and the emigration of another million. It was the result of planting only two potato varieties, both vulnerable to the blight.
- When rice grassy stunt virus struck rice fields from Indonesia to India in the 1970s, 6,273 varieties were tested for resistance. Only one was resistant, an Indian variety, and known to science only since 1966. This variety formed a hybrid with other varieties and is now widely grown.

- Coffee rust attacked coffee plantations in Sri Lanka, Brazil, and Central America in 1970. A resistant variety was found in Ethiopia. Although the diseases are themselves a form of biodiversity.

Monoculture was a contributing factor to several agricultural disasters, including the European wine industry collapse in the late 19th century, and the US Southern Corn Leaf Blight epidemic of 1970.

Although about 80 percent of humans' food supply comes from just 20 kinds of plants humans use at least 40,000 species. Many people depend on these species for food, shelter, and clothing. Earth's surviving biodiversity provides resources for increasing the range of food and other products suitable for human use, although the present extinction rate shrinks that potential.

The hybridization techniques using introduction of many wild genes has revolutionised animal breeding programmes that has shaped our present day poultry, dairy and fishery and wool industries. These activities need wide genetic base (Genetic Diversity) to overcome new pathogen attacks.

Human health: Biodiversity's relevance to human health is becoming an international political issue, as scientific evidence builds on the global health implications of biodiversity loss. This issue is closely linked with the issue of climate change, as many of the anticipated health risks of climate change are associated with changes in biodiversity (e.g. changes in populations and distribution of disease vectors, scarcity of fresh water, impacts on agricultural biodiversity and food resources etc.)

The growing demand and lack of drinkable water on the planet presents an additional challenge to the future of human health. According to *2008 World Population Data Sheet*, only 62% of least developed countries are able to access clean water.

Some of the health issues influenced by biodiversity include dietary health and nutrition security, infectious disease, medical science and medicinal resources, social and psychological health.

Biodiversity provides critical support for drug discovery and the availability of medicinal resources.

Business and industry: Many industrial materials derive directly from biological sources. These include building materials, fibers, dyes, rubber and oil. Biodiversity is also important to the security of resources such as water, timber, paper, fiber, and food.

Leisure, cultural and aesthetic value: Biodiversity enriches leisure activities such as hiking, bird watching or natural history study. Biodiversity inspires musicians, painters, sculptors, writers and other artists. Many cultures view themselves as an integral part of the natural world which requires them to respect other living organisms.

Ecological services: Biodiversity is directly involved in water purification, recycling nutrients and providing fertile soils. Biodiversity supports many ecosystem services that are often not readily visible. It plays a part in regulating the chemistry of our atmosphere and water supply. Experiments with controlled environments have shown that humans cannot easily build ecosystems to support human needs; for example insect pollination cannot be mimicked, and that activity alone represents tens of billions of dollars in ecosystem services per year to humankind.

THREATS TO BIO DIVERSITY

Habitat destruction: Habitat destruction has played a key role in extinctions, especially related to tropical forest destruction. Factors contributing to habitat loss are: **overpopulation, deforestation, pollution (air pollution, water pollution,**

soil contamination) and global warming or climate change.

A 2007 study conducted by the National Science Foundation found that biodiversity and genetic diversity are codependent—that diversity among species requires diversity within a species, and vice versa. "If any one type is removed from the system, the cycle can break down, and the community becomes dominated by a single species.

Co-extinctions are a form of habitat destruction. Co-extinction occurs when the extinction or decline in one accompanies the other, such as in plants and beetles.

At present, the most threatened ecosystems are found in fresh water, according to the Millennium Ecosystem Assessment 2005.

Introduced and invasive species: Isolation caused by Barriers such as large rivers, seas, oceans, mountains and deserts encourage diversity by enabling independent evolution on either side of the barrier, via the process of allopatric speciation. The term invasive species is applied to species that breach the natural barriers that would normally keep them constrained. Without barriers, such species occupy new territory, often suppressing native species by occupying their niches, or by using resources that would normally sustain native species. Such invasions can therefore substantially reduce diversity. Human activities have frequently been the cause of invasive species circumventing their barriers, by introducing them for food and other purposes. Human activities therefore allow species to migrate to new areas (and thus become invasive) occurred on time scales much shorter than historically have been required for a species to extend its range. The introduction of *Lantana*, *Eupatorium* and *Parthenium* in India has become serious menace invading large areas preventing regeneration of the native forest species.

Genetic pollution: Endemic species can be threatened with extinction through the process of genetic pollution, i.e. uncontrolled hybridization, introgression and genetic swamping. Genetic pollution leads to homogenization or replacement of local genomes as a result of either a numerical and/or fitness advantage of an introduced species.

Overexploitation: Overexploitation occurs when a resource is consumed at an unsustainable rate. This occurs on land in the form of overhunting, excessive logging, poor soil conservation in agriculture and the illegal wildlife trade. This is the "single largest threat" to biodiversity in Asia. The international trade of endangered species is second in size only to drug trafficking.

About 25% of world fisheries are now overfished to the point where their current biomass is less than the level that maximizes their sustainable yield.

Hybridization, genetic pollution/erosion and food security: In agriculture and animal husbandry, the Green Revolution popularized the use of conventional hybridization to increase yield. Often hybridized breeds originated in developed countries and were further hybridized with local varieties in the developing world to create high yield strains resistant to local climate and diseases. Local governments and industry have been pushing hybridization. Formerly huge gene pools of various wild and indigenous breeds have collapsed causing widespread genetic erosion and genetic pollution. This has resulted in loss of genetic diversity and biodiversity as a whole.

(GM organisms) have genetic material altered by genetic engineering procedures such as recombinant DNA technology. GM crops have become a common source for genetic pollution, not only of wild varieties but also of domesticated varieties derived from classical hybridization.

Climate change: Global warming caused by green house gases is also considered to be a major threat to global biodiversity. The burning of fossil fuels produce large amount of Green House Gases (GHG) which trap the heat in the air. This causes green house effect increasing the earth's surface temperature unnaturally and dramatically. As per IPCC Report, 2001 the GHGs, like Carbon dioxide, Methane and Nitrous oxide increased between 1750 to 2000 by 31%, 151%, and 17% respectively. This has resulted in increase of the earth's surface temperature by 0.6^o C over 20th Century. However the burning of fossil fuels and destruction of forests is very rapid. Without remedial measures, it is feared global temperature will rise by 2.9^oC to 4.2^o C during 2071 to 2100. The warmer temperature could melt polar ice caps which would cause the sea level to rise and land area to shrink. Many coastal towns including ports and villages will be submerged bringing innumerable loss to human beings. Large number of animals would be unable to survive the warmer temperature. Scientists have warned extinction is to be expected if temperature keeps rising in current rate.

Coral reefs -which are biodiversity hotspots - will be lost in 20 to 40 years if global warming continues at the current trend.

Human overpopulation: From 1950 to 2011, world population increased from 2.5 billion to 7 billion and is forecast to reach a plateau of more than 9 billion during the 21st century. It is self-evident that the massive growth in the human population through the 20th century has had more impact on biodiversity than any other single factor.

BIODIVERSITY CONSERVATION STRATEGY

Conservation biology matured in the mid-20th century as ecologists, naturalists, and other scientists began to research and address issues pertaining to global biodiversity declines.

The conservation ethic advocates management of natural resources for the purpose of sustaining biodiversity in species, ecosystems, the evolutionary process, and human culture and society.

Conservation of Wetlands: Wetlands are areas of land where the water level remains near or above the surface of the ground for most of the year. The association of man and wetlands is ancient, with the first signs of civilization originating in wetland habitats such as the flood plains of the Indus. Wetlands cover about 6% of the earth's land surface. There are several kinds of wetlands such as marshes, swamps, lagoons, bogs, fens and mangroves.

Forest as the Carbon Sink and their vulnerability: The carbon dioxide released to atmospheres is trapped by plants and forests, through trees. A significant amount of global carbon stock, about 638 gigga tone (gt) is in Forest Eco System. The Forest biomass contains 283gt, whereas the dead wood and forest soils contain 38gt and 317 gt of carbon.

Although forests are good carbon sink, they are extremely vulnerable to climate change. According to IPCC reports, even with a modest global warming of 1-2^o C, most forest ecosystems will be impacted through changes in forest species composition, biodiversity and plant productivity. Recent decades has already made impact on forest ecosystems, which is manifested as pole ward and an upward shift in ranges of plants, insect and fish species. The pattern of bird arrival and flowering is also changing. Therefore, conservation of forests are extremely important for arresting Global warming and Climate Change.

Protection and restoration techniques: The following measures are necessary for conserving bio diversity.

- **Biodiversity banking**, also known as biodiversity trading, places a monetary value on biodiversity. One example is the Australian Native Vegetation

Management Framework. The framework requires developers to source biodiversity credits, something similar to carbon credits through a market mechanism offset biodiversity loss.

- **Gene banks** are collections of specimens and genetic material. Some banks intend to reintroduce banked species to the ecosystem (e.g. via tree nurseries).
- **Reduction of and better targeting of pesticides** allows more species to survive in agricultural and urbanized areas.
- **Protection of forests, wet lands and wildlife protected areas** especially focusing on the ecological restoration of their degradation.
- Location-specific approaches may be less useful for protecting migratory species. One approach is to create **wildlife corridors** that facilitates to the animals' movements.

Resource allocation: Focusing on limited areas of higher potential biodiversity promises greater immediate return on investment than spreading resources evenly or focusing on areas of little diversity but greater interest in biodiversity.

A second strategy focuses on areas that retain most of their original diversity, which typically require little or no restoration. These are typically non-urbanized, non-agricultural areas. Tropical areas often fit both criteria, given their natively high diversity and relative lack of development.

Legal strategy: This includes bringing out International agreements, protocols and conventions between the countries as well as framing and promulgating appropriate policies and Legislations for conservation of biodiversity.

International Convention/ Protocols: The existing ones are as under:

- United Nations Convention on Biological Diversity (1992) and Cartagena Protocol on Bio safety;

- Convention on International Trade in Endangered Species (**CITES**);
- Ramsar Convention (Wetlands);
- Bonn Convention on Migratory Species;
- World Heritage Convention (indirectly by protecting biodiversity habitats)
- Regional Conventions such as the Apia Convention
- Bilateral agreements such as the Japan-Australia Migratory Bird Agreement.

National level laws: The concept of environmental protection is enshrined in the Indian constitution in articles 48a and 51a(g). Major central acts relevant to biodiversity include:

- ✓ Environment Protection Act, 1986
- ✓ Fisheries Act, 1897
- ✓ Indian Forest Act, 1927
- ✓ Forest (Conservation) Act, 1980
- ✓ Wildlife (Protection) Act 1972 and Wildlife (Protection) Amendment Act 1991
- ✓ Bio Diversity Act, 2005

In-situ Conservation: The animals and plants in their natural habitats is known as *in situ* conservation. The established natural habitats are:

- National parks and sanctuaries
- Biosphere reserves
- Nature reserves
- Reserved and protected forests
- Preservation plots
- Reserved forests

Ex-situ Conservation: Conservation of threatened species and their breeding in zoos and conservation breeding centres.

Community Participation in Biodiversity Conservation: The conservation strategy cannot be successful without getting support of the local community. Proper awareness building, education and incentive for the cost of conservation is the central theme for their involvement and participation.

‘EAT, SAVE – REDUCE YOUR FOOD PRINT’: FOOD SECURITY IS THE CALL OF THE TIME

Madhab Chandra Dash

Formerly, Chairman, SPCB, Odisha &
Vice Chancellor, Professor of Life Sciences, Sambalpur University

ABSTRACT

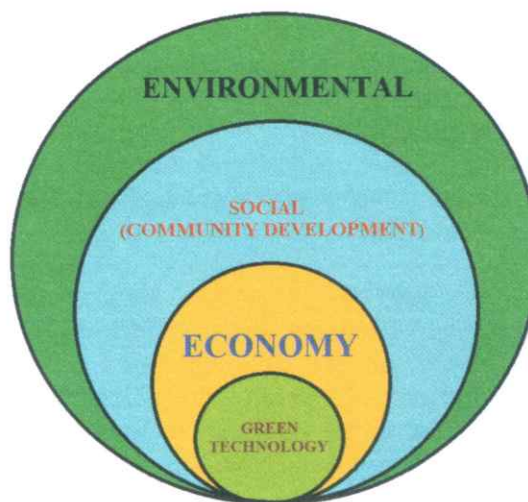
This year's message in the World Environment Day is 'Eat, Save-Reduce your Food print'. This slogan is linked to excessive consumerism, especially practiced by many industrially developed countries and by the rich people in all countries. Besides, there is wastage of food due to many reasons. The calories need per capita, on an average may not be more than 2000 per day. These calories should come from a balanced diet. But people abuse the food intake and do not care much for others in the world. World's population is more than 7000 million and India's population is more than 1210 million. To provide food and fresh water and other resources to this huge population is a daunting task. The population is growing on an average @1.3% in the world and @1.41% in India. This paper discusses the different aspects of increasing food production, especially grain production, animal protein production, water availability etc for achieving food security in India.

INTRODUCTION

Since the Rio-1992 summit, and adoption of Agenda-21 by the global community, most of the countries including India have set sustainability as a key goal for their development. It is generally accepted that the four pillars of sustainable development are the environmental, social, economic, and technological wellbeing, especially green technology (Figure 1). To achieve Sustainable Development (SD), different management systems are adopted.

The defining aspects of SD are: Population control, energy use, increasing productivity, food security, water resource conservation, and biodiversity conservation, development of Science & technology and technology transfer.

Figure 1. Four Pillars of Sustainable Development



This year's topic for the World Environment Day is 'Eat, Save – Reduce your Food Print'. There is huge wastage of food in urban life style. Massive awareness should be created among the people living in cities and towns to prevent food wastage, to adopt sustainable food habits etc. More incentives are to be given for opting birth control options so that population growth is brought down to less than 1% at the earliest.

Our modern way of living is based on unsustainable consumerism. The social repercussions of the unbalanced use of global resources are clear: social inequality, unemployment, emigration, poverty and harmful effects on our health. With our current patterns of production and consumption, we are rapidly approaching the natural and social absorption threshold limits. These developments should be counteracted by SD. The energy source from fossil fuels puts tremendous adverse pressure on environment, and our activity reduces biodiversity, which provides us food, shelter material, raw material for medicines, gases for survival, ecosystem services like recycling of water and other materials. The concept SD developed as the present model of unlimited growth in a limited environment is not the right answer to the complex of the problem that every country faces.

The Rio+20—2012 gave emphasis on Green Economy, which includes all aspects of SD but emphasizes on the adoption of Green Technology. The essence is use of green technologies in manufacturing and other sectors so that the GHG load to the environment will be substantially reduced to lessen the effect of climate change and to increase productivity by adopting green technology.

The world population is rising and predicted to reach 9 billion by 2050. Most of this growth will take place in developing countries. With huge population increase, there will be enormous pressure on the resources and to

provide food and water to people will become a daunting task for the governments. India accounts for the largest proportion of malnourished children in the world. The world will face several challenges in health care, food and energy security, and fresh water availability. India exhibits very high variability; on one hand we have high GDP growth rates, a big pool of scientific manpower, a large middle class, malls, global retail chains, expanding multi-millionaires, and on the other hand huge number of people under poverty, unemployment and debt, with limited access to health facility and education, and most of them live in rural areas and slum areas of urban centres. High level consumerism is seen especially among urban living people and they also put huge pressure on food, energy, water and many other resources.

Millennium Development Goals: In September 2000, world leaders came together at United Nations Headquarters in New York to adopt the United Nations Millennium Declaration, committing their respective nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets - with a deadline of 2015 - that have become known as the Millennium Development Goals. Eight issues were included. These are (i) to end poverty and hunger ;(ii) to provide Universal Education; (iii) to promote Gender Equality; (iv) to care for Child Health; and (v) Maternal health; (vi) to Combat HIV/AIDS; (vii) to promote Environmental Sustainability; and (viii) Global Partnership. This aspect of human development are also intrinsically linked to SD end poverty and hunger in India and in the world, is linked to individual and societal food print.

HUMAN POPULATION GROWTH

The world population (Figure 2, & Table 1), predicted to reach 9 billion by 2050 and there will be enormous pressure on the resources. The world will face several challenges in health care, food and energy availability etc (Dash, 2012). The demographics of India indicate that it is

the second most populous country in the world, with over 1.21 billion people (Census2011), more than a sixth of the world's population. Already containing 17.5% of the world's population, India is projected to be the world's most populous country by 2025, surpassing China, its population exceeding 1.6 billion people by 2050. Its population growth rate is 1.41%, ranking 93rd in the world. India has more than 50% of its population below the age of 25 years and more than 65% are below the age of 35 years. It is expected that, in 2020, the average age of an Indian will be 29 years, compared to 37 for China and 48 for Japan; by 2030 (Census, 2011). The situation has started creating huge socio-ecological problem, which is to be

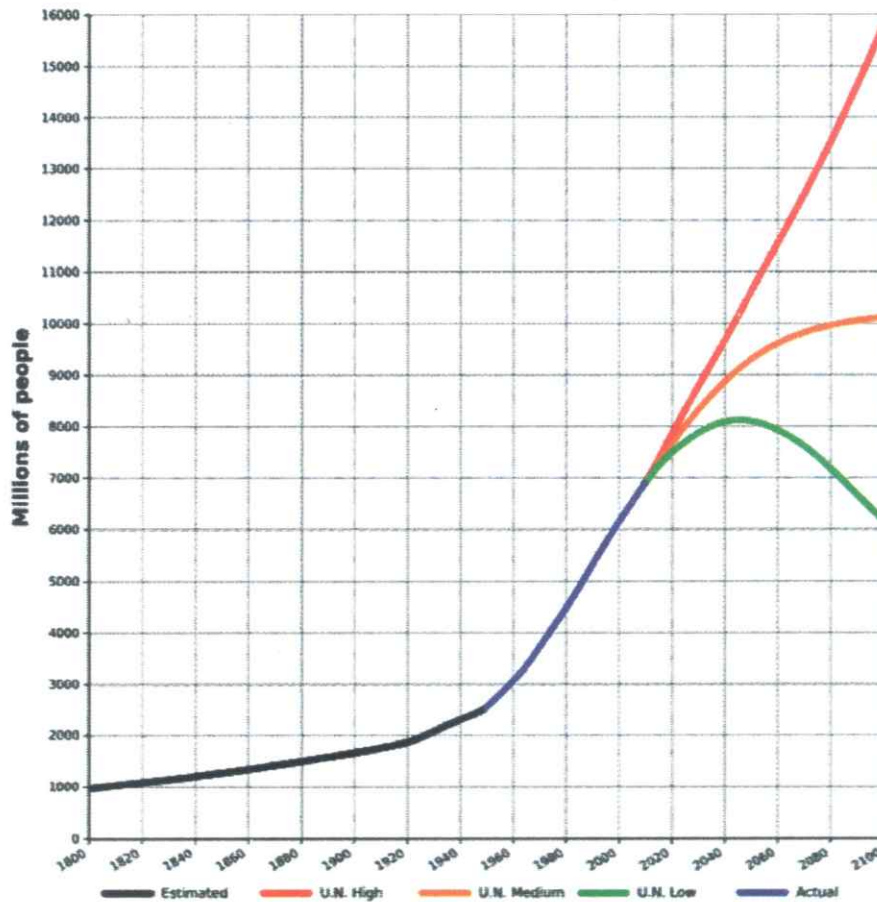
addressed properly if we like to survive as a nation with dignity. Food security is important.

India accounts for the largest proportion of malnourished children in the world because of poverty and no availability of food, especially balanced food. India exhibits very high variability; on one hand we have high GDP growth rates, a big pool of scientific manpower, a large middle class, malls, global retail chains, expanding multi-millionaires, and on the other hand huge number of people under poverty,(some people also search public dust bins for left-over food), unemployment and debt, with limited access to health facility and education.

Table 1. World Human Population Growth since 10,000 B.C. (based on Bhende, 2005, www.google.com/population/en.wikipedia.org)

B.C / A.D.	Population (estimated & census data)	Growth in %	Doubling Time(Years)
10,000 B.C.	5 million	negligible	
5000 B.C.	10 million	negligible	
1 AD	250 million	<0.1	many centuries
1000 AD	350 million	<0.1	
1500 AD	450 million	0.1	
1600 AD	500 million	0.1	1600
1700 AD	600 million	0.2	
1800 AD	1000 million	0.3	200
1900 AD	1500 million	0.5	
1930 AD	2000 million	1.0	130
1960 AD	3000 million	2.0	
1975 AD	4000 million	1.8	45
1987 AD	5000 million	1.7	
1999 AD	6000 million	1.5	
2011AD	7000 million (7 billion) (India: >1210 million, Census 2011)	1.3 (India 1.41)	
2030AD	8000 million (8 billion)		55 (estimated)
2050	9000 million (Estimated) (>1600 million-Estimated for India)		

Figure 2. Human population Growth in the World



To make provision for food, water, energy, houses etc is a daunting task for any government or society unless every aspect is planned and executed properly. Population control and increasing food production using green technology, changing mind set for the consumption pattern, reducing waste, and following a sustainable way are the call of the time.

The prospects of Green Economy can be summarized as follows:

1. Protecting and conserving ecosystems and biodiversity,
2. Strengthening the three pillars such as (i) Economic development, (ii) Social development & (iii) Promoting environmental protection,
3. Discouraging unsustainable consumption & practicing sustainable consumption. Green economy, productivity &

sustainable consumption are mutually supportive and may require macro and micro interventions that may require change in policy and regulatory framework, investments and business operations. This may induce behavioral change in the society,

4. Eradication of poverty- About 70% of India's population live in villages and about 50% of them depends upon biodiversity such as agriculture, forest products, animal husbandry, fishing and biodiversity based cottage industry for their livelihood. In view of this, biodiversity conservation and management to get value added products for poverty eradication is important. Economic wealth measured in terms of High Gross Domestic Product (GDP) is often linked to overexploitation of

resources and causing environmental pollution. Green economy aims to increase to basic services and infrastructure for alleviation of poverty and helping in the overall improvement of quality of life.

5. Green economy & Green Technology should generate employment. New avenues such as renewable energy, new building retrofits for energy efficiency, public transportation, organic agriculture and vermi-technology, reclamation of degraded lands and forests, recycling and reuse of waste materials etc. These practices are expected to provide economic benefit, employment benefit and environmental benefits.
6. Financial Incentive: The green economy policies may involve public-private partnerships as an economic instrument. This may involve public finance and fiscal measures, utilization of public expenditure on productive research and development, inclusion of environmental costs on goods and services, promoting purchase of green products and services, putting levies on pollution, and providing incentives on tax amount to industries for adopting green technology, strengthening legal framework. Governments can adopt appropriate policies depending upon the capability of the country to promote green investment
7. Benefits of Green Economy: It will generate clean environment by minimizing waste generation, reuse, recycling etc, provide security for getting clean water, renewable energy (energy security), change manufacturing philosophy, quality of

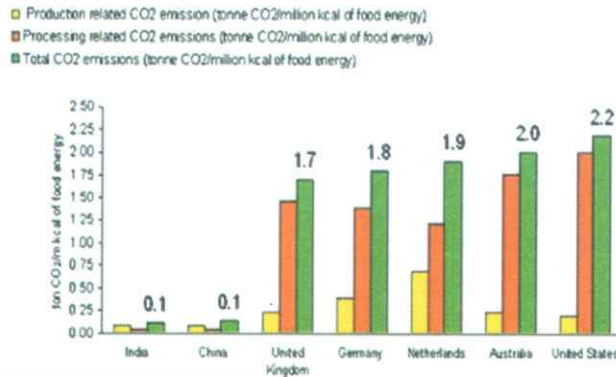
transportation, and food security etc. For example about 70,000 tons per year of plastic products are recycled in USA generating about 69 million dollars. In USA recycling of about 6.1 million tons of urban waste in five years has generated more than 1.6 billion dollars. Recycling of wastes instead of land filling or incinerating reduced about 412,000 tons of carbon dioxide emission (source: Paribesh Samachar, 2012).

With the background of Rio-1992 to Rio+20-2012, I wish to discuss mainly two issues such as (i) Energy use, energy security and climate change and where do we stand?; (ii) Food and nutritional security in the context of Indian situation.

ENERGY SOURCE AND USE

Energy is the key for survival, continuance and for sustainable development. There is increased need of energy in the agriculture, industrial and service sectors. Modern way and standard of living demand huge energy from unsustainable consumerism, transport facilities and increased construction work and other aspects of human use. Excessive consumerism is a factor for global warming and resource depletion. Patterns of consumption, food habits and recycling processes have influenced growth in energy demand and green house gas (GHG) emissions. The specific GHG emissions from food production and processing are much lower in developing countries including India than in developed countries. Besides, the consumption pattern in many industrially developed countries is not sustainable and puts pressure on the society at large. (Figure 2). On priority basis industrially developed countries must take action to change the consumption pattern in their society.

CONSUMERISM



Source: TERI Analyses (various data sources)

Fig. 3: CO₂ Emissions from the Food Sector – from field (Production) to Table (processed food), excluding cooking

Solar energy is abundantly available but we have not been able to trap it as per our need because of many reasons. The recent thrust is to utilize the renewable to address the GHG load in the atmosphere and environmental degradation.

FOOD SECURITY

In 2011 the global population reached 7 billion. India's population reached 1.21 billion with annual growth of 1.41 per cent. The global population has been estimated to reach 9 billion by 2050 and India's population will reach 1.6 billion. It is obvious that there will be huge demand on food. The 'Green Revolution' of 1960s helped India to overcome chronic shortage of food and reduced hunger. Based on FAO report, a recent report of Government of India and Association of Biotechnologist led Enterprises (Dash, 2012) has revealed that the number In of people who do not have food security increased from 800 million in 1998 to 1 billion in 2009 in the world because of rise of food prices from 2006 to 2008.

In India about 25% people are classified as Below Poverty Line (Census, 2011). It

means about 360 million people do not have food security.

Dash (2012) report quoting FAO report mentions that in recent times the dietary preferences change in developing countries and because of population rise and changed lifestyle, there will be 50% rise in cereals and 85% rise in demand of meat products between 2000 and 2030 and the food demand will double by 2050 putting enormous pressure on land, water and energy requirements. Indian census (2011) finds that about 69% of India's population (about 800 million) lives in villages. About 40-50% of them depend upon biodiversity such as agriculture, forest products, animal husbandry, fishing and biodiversity based cottage industry for their sustained livelihood and providing them food. In view of this, biodiversity conservation and management to get value added products is important for poverty eradication (Dash, 2010).

The livelihood options and rural economy are largely bio-resource based, especially on agriculture & horticulture (crops & fruits) as farmers, marginal farmers, labourers etc, home garden raising vegetables, fruits, flower and selling in the

local market; keeping local breed cows and buffaloes for milk, dung, ploughing; catching fish, prawn, turtle, from local river, rivulets, common property ponds, own ponds, goatery for meat, milk, skin, small poultry for meat and egg, keeping pigs for meat, and skin, use local forests/ Gramya Jungle for firewood, fruits, honey, ayurved, plucking kendu leaf for making bidi, a type of cigarette; artisan work based on bamboo, cane, wood and other bio-resources. Traditional ecological knowledge and bio- resource management is important.

Food grain production in India increased from 95 million tons in 1967 and 108 million tonnes in 1970s to 234 million tonnes in 2008, and to about 250 million tons in 2011(Prasad, 2009, TOI, 2012). On the average 207 kg of food grain was available per capita in 2011 in India and this amounts to on the average 567 gram of food grains per capita per day. Total crop production and yield has increased considerably and has met food requirement of the people but considering the fact India's population is growing @1.41 %, crop production has to be doubled for future requirement. Another green technology based green revolution is needed.

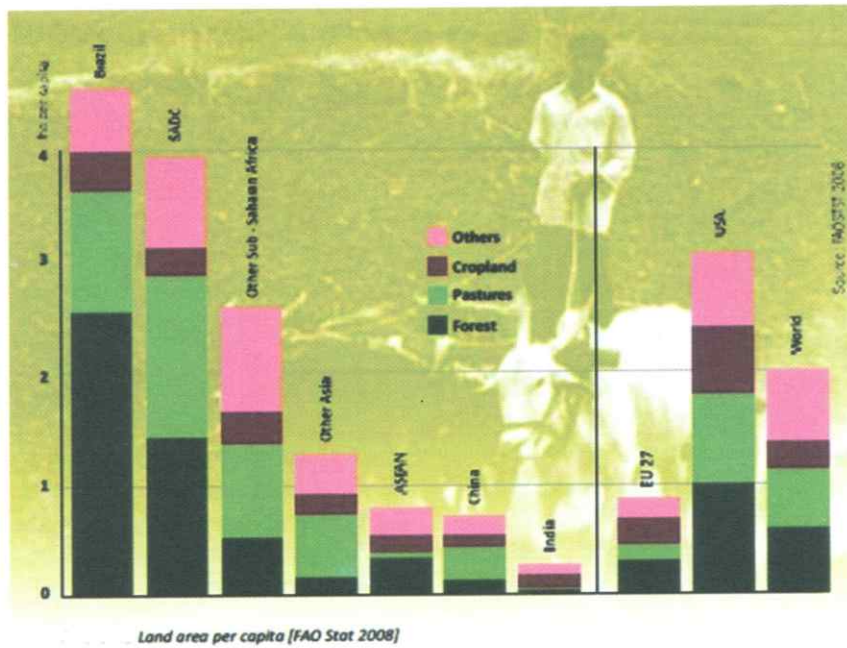
However the yield t/per ha varied from 1 in 1967 to 2.13 in 2011 for rice, 1.1 in 1967 to 2.9 in 2011 for wheat, 1.1 in 1967 to 1.9 in 2011 for maize, 0.5 to 0.6 for pulses(Prasad, 2009, en.wikipedia.org/wiki-Agriculture_in_India). The arable land area has increased from about 120-122 million ha to about 159.7 million ha and

the irrigated crop area is about 82.6 million ha. At present agriculture account for 16% of GDP and 10% of export earnings (Ayyapan, 2012 Orissa University of Agriculture and Technology convocation address).

Agriculture continues to be the largest sector in terms of employment, largely to the unskilled people as labourers. However the contribution of agriculture sector to India's GDP has fallen from 30% in 1990-1991 to 14.5% in 2011-2012(Dash, 2012) indicating that the economy is changing from agrarian to other sectors. Agriculture remains for sustenance and livelihood largely for the rural people. The income from these occupations is subsistence level and does not meet the family requirements fully. To meet the challenge, agricultural productivity has to be increased and food should be available at affordable prices in India.

The option of converting more forest area for agriculture is not available as there is serious constraint of forest land area (Figure 4). Further conversion of forest area to agricultural land will create ecological backlash. Only solution is to increase the crop production through technology application and switch over to those Genetically Modified (GM) foods, which have stood the rigorous scientific testing and protocol and declared as safe for human consumption. Safety is the main concern of GM foods. Creating massive awareness among people to avoid wastage of food and storing of food should be done by the press and media and NGOs can play important role.

Figure 4. World Forest Cover as percentage of land area (source Dash, 2012, FAO 2008)



Considering India's forest cover and land area, it will not be sustainable to convert forest land to crop land. Only option is left to apply green technology and adopt population control measures. Biotechnology enabled the global increase in corn and soybean production by 130 million and 83 million tonnes respectively (Inderscience publishers 2011). Dash (2012) points out that biotech can improve agricultural production by promoting the use of disease resistant crops, enhancing the flavour and nutritional value of food products and subsequently impact global health and economies, especially among developing countries.

Water Availability for Agriculture

Of the total water used in India, agriculture is the most dominant users of water resource. About 50 to 60% of water resource is used for irrigation (Patnaik, 2006). Both surface and ground water is used for agriculture. India receives about 1050 to 1170 mm of precipitation annually. This is a huge water resource but almost 90% of this precipitation falls between mid-June and mid-October. Fourteen major river systems account for

85% of surface flow and share 83% of the drainage basin. They serve 80% of the total population. There are about 100 medium and minor rivers. The storage capacity is only 3.65 million m³. Of the total annual precipitation, India utilizes only 10-15%, which may increase to about 26% by 2025. We need to apply improved technology to increase water harvesting and storage capacity and ground water utilization.

The Central Ground Water Board has estimated that the available ground water in India is 210 billion m³ and the annual utilization potential is about 42.3 million hectare, only one-fourth of which is used at present. However, the ground water availability is not adequate in provinces like Tamil Nadu and Andhra Pradesh and excessive ground water use (unsustainable use) for agriculture in Punjab, Haryana, Delhi and Rajasthan has depleted ground water resource. More than 26 cubic miles of ground water vanished from aquifers in these states due to excessive agriculture use and may bring collapse in agriculture production unless remedial measures taken on priority basis (NASA satellite data-Yahoo internet news dated 14 August 2009).

Adequate ground water recharge and shifting to non water intensive crops are important to address the problem. Due to large scale deforestation and monsoon failure, there is a regular occurrence of drought in Kalahandi district and some other districts of Orissa, in Jharkhand, Bihar, Karnataka, Rajasthan, and Maharashtra. The supply of drinking water in Indian villages is not adequate, especially in summer. There is no organized water supply in most of the villages and even in some small towns.

Although there is good precipitation in India, sufficient care is to be taken to manage this water efficiently. The climate change has brought irregularity in incidence of monsoon rains and amount of rain fall has also become erratic. In view of this water storage facility should be created to harvest more water. Diversification crops are also required. Crops requiring less water for production should be chosen.

Soil Metagenomics

Soil Metagenomics (Figure 4) involves the analysis of a mixture of microbial genomes isolated from a soil sample in a particular ecosystem/habitat. Soil Metagenomics and it's interlink with soil fauna and soil fertility can lead to the mapping of soil metagenome to crop productivity. In this process the crop productivity can be increased by scientifically manipulating the soil metagenome without extensive utilization

of pesticides and chemical fertilizers. Metagenomics studies can also improve the nutritional benefits of food crops; which will have a positive impact on public health (Figure 5, Dash 2012).

Soil faunal biodiversity has important role in many land uses and for crop productivity (Dash et al, 2009). Studies on Soil biodiversity carried out in a project funded by UNEP-TSBF, Nairobi in multiple centres in India coordinated by Jawaharlal Nehru University from 2002-2010 have provided insight to the role of soil biodiversity, especially earthworms and soil fauna in variety of land uses. ICAR National Fund for Basic, Strategic and Frontier Application Research in Agriculture had initiated to study the dynamics of soil Metagenomics with participation of IARI, GB Pant University of Agriculture and Technology, and Tamilnadu Agricultural University (Dash 2012). M S Swaminathan Research Foundation has developed a biodiversity conservation model called the '4C Model' that takes care of conservation, cultivation, consumption and commerce requirements for crop plants. This model involves Gene-Seed-Grain Banks that help scientific selection and preservation of good seeds from land races (Dash 2012).

Soil Metagenomics and soil faunal studies in situ and ex situ should be the thrust areas of research so that the findings can be applied for increasing crop productivity to meet the challenges of the future.

Figure 5. Implications of soil Metagenomics (source, Dash 2012)



Animal Protein

Fish, prawn, and turtle form part of the livelihood support in Indian villages. The total fish production (capture and culture) in India was about 8.29 million tons in 2010-2011, and out of this, fresh water aquaculture amounted to about 3.84 million tons, mariculture and coastal aquaculture 0.15 million tons and the capture fishery (both marine and fresh water) amounted to 4.30 million tons (Dilip Kumar, 2012). About 90% of fish production is consumed in the country. However the average per capita fish consumption is only 5.48kg compared to that of 12 kg internationally. However about 30-40 % people are vegetarian in India. In view of this the per capita fish consumption is estimated to be around 9kg among the non-vegetarian people.

There is good scope to increase capture fishery considering 8,118 km of coastline and 0.506 million sq.km of continental shelf and 2.03 million sq.km of Exclusive Economic Zone (upto 22m depth). The area under ponds, tanks, beels and fresh water lakes etc amounts to about 3.42 million hectare. The current average aquaculture production is 600 kg/ha/yr & this yield can be increased considerably with innovative technology & management input. There is need of renovating village ponds for water

harvesting and fish culture on priority. Rice-fish integration systems, cage culture etc are innovative systems, which should be widely practiced. The length of rivers and canals is 1, 71,334 km. The cleaning of rivers and canals for fish culture will boost the village economy. Serious efforts are to be made using modern technology to increase the production to maintain at least 10-12kg of per capita consumption even if the population grows to 1.6 billion by 2050.

The animals (Table 2) are important for providing protein rich meat, milk and organic manure for agriculture, dung-fuel for rural homes, and by-products like bone meal etc as manures etc. However with reduction in grazing land and monetary constrains for stall feeding by the small and marginal land owners, government subsidy helps the farmers and the rural economy. But this is not the permanent solution. India has >483 million livestock; about 187million cattle,97million buffaloes, 62million sheep, 120million goats,14million pigs, 1million horses & mule, 1million camels, and 1million other livestock (Table 2). These animals provide meat, milk and produce a huge quantity of dung, which is utilized for biogas production. Besides 440 million poultry chicken are also available.

Table 2. Animal Resource of India (GOI, 2005, and Khillare et al 2012)

Species No of Breeds	Population 1997 (million)	Population2003 (million)
Cattle 30	198.88	187.38
Buffalo 10	89.92	96.62
Sheep 40	57.49	61.79
Goat 20	122.72	120.10
Pig 3	13.29	14.14
Donkey	0.88	0.67
Horse 6	0.83	0.79
Mule	0.22	- 0.31
Camel 9	0.91	0.64
Yak	0.06	0.07
Mithun -	0.18	0.28
Rabbit	-	0.40
Poultry: Chicken 18	347.61	440.70
Duck 05		

Indian leather industry includes 125 medium and large scale units, 1200 small scale units and thousands of tiny tanneries in rural areas. Hides and skins are terminal markets. The states of Tamilnadu, Uttar Pradesh and West Bengal account for more than 80% of country's leather output.

Animal resource forms an important part in food security, especially for protein security and livelihood options for weaker section of the society. Fish and livestock yield can improve over all food security in India and income for rural people. Women are largely form the work force in animal farms and hence this sector helps in women empowerment through financial security. Marginal and small land owners are the owners of 71% of cattle, 83% of buffaloes, 88% of small ruminants, 70% of pigs and 74% of poultry (government of India-publication, 2005). In view of this the village livelihood sustainability is dependent on animal resources. The livestock contributes about 25% of the agro-sector of the country in terms of money. This is the important sector for scientific research to increase the milk, egg and meat production. There is good scope to enhance this production and other welfare measures are required. Genetic selection of animal breeds, feed and nutrition aspects, health and disease aspects and opening of veterinary dispensaries and hospitals in villages are the priority areas.

Environmental Impact Assessment (EIA):

Since 1994 EIA study has become mandatory for all new projects or expansion or modernization of existing projects which have substantial stake on environment. As per 14 September 2006 notification of Ministry of Environment and Forests of Government of India, and subsequent amendments, the generic structure of environmental impact assessment document and check list of environmental impacts have been stipulated. The purpose is to assess the expected impacts and to address them through an environmental management plan if the developmental project is

allowed to operate. The check list includes land environment, water environment, vegetation, fauna, air environment, aesthetics, and socio-economic aspects, building materials, energy conservation and environmental management plan. The check list is a reflection of livelihood options prevailing in rural India. However there is a big gap between the EIA stipulations and implementation. The sustainability concerns of Indian rural systems have not been adequately addressed. The interest of multinational companies and industrial houses of the country have received more attention than the natural resource management or furtherance of traditional livelihood options conserving the 'traditional ecological knowledge' available in village systems. Ramakrishna (2009) points out emphatically that 'very traditional societies living close to nature and natural resources around them may have to have traditional ecological knowledge being brought in to a much larger degree so as to avoid social disruptions setting in, compared to the more modern societies who may need traditional ecological knowledge only to be brought in so as to create buffering mechanisms within the socio-ecological system and thus cope up with the ill-effects arising from excessive use of energy-intensive technologies.'

My understanding is that sustainable development in Indian rural systems depends on creating facilities to enhance the existing livelihood options, adopting effective community participatory approaches, and sustainable management of bio-resources. However, this does not prevent opening of new avenues which will have minimum environmental impacts and can be addressed by application of green technology and will create livelihood options for youth. This is the time to strengthen the EIA protocol and its judicious implementation to address environmental uncertainties and to conserve bio-resources based traditional ecological knowledge and rural livelihood options of about 360 million people in the country.

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ONE WAY ANALYSIS OF VARIANCE TECHNIQUE TO STUDY THE VARIATION IN STRENGTH PARAMETERS

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ABSTRACT

A new approach is introduced for study of the behaviour of geotechnical strength parameter prior to slope analysis to ascertain whether strength parameters of slope materials are homogenous or heterogeneous at different mine depths. The strength parameters used for the study are uniaxial compressive strength, tensile strength and shear strength. The analysis is based on statistical analysis of variance technique for one-way classification. The application of the technique is given through a case study in an open pit mine.

INTRODUCTION

The geotechnical strength parameters significantly influence the stability analysis of surface mining, tailing dams, spoil piles etc. and study of their behaviour is very important. If the strength parameters of slope materials are homogenous, analysis of the slope stability is simple by the well-known limit equilibrium method. However, in case of complex rock conditions, average values of strength parameters may not give reliable results if this method was used. In such cases it is necessary to make use of other approaches, such as probabilistic (Nishimatsu and Okubo, 1983) and fuzzy set theory (Fernando, 1987), for slope analysis. Thus, before slope analysis can proceed it is important to study the variability of the geotechnical strength parameters of the slope materials in different parts of the pit. The slope angle in different sections of the pit will depend on the variation in the strength properties of the slope material (Hawley and Stewart 1986; Hustrulid et al 2000; Bye and Bell, 2001).

In this paper a study of whether strength parameters of slope materials vary with increase in depth is carried out, i.e., whether the parameters are homogenous or heterogeneous. The strength parameters used for the study are uniaxial

compressive strength, tensile strength and shear strength.

The whole analysis is based on statistical analysis of variance technique for one-way classification (Box et al, 1978). In this technique, three or more samples are considered simultaneously in order to test the hypothesis that all the samples are drawn from the same population, i.e., that they all have the same mean.

Previously, this type of study was not felt necessary because the results of such a study would not have been particularly significant for the only one widely used limit equilibrium method of slope analysis. However, probabilistic and fuzzy set theory approaches have now been fully developed, and in these approaches the results of a study of variation in strength parameters can be used.

ANALYSIS OF VARIANCE FOR ONE-WAY CLASSIFICATION

The analysis of variance was developed by R. A. Fisher in 1921, but its power and versatility for use in the mining sciences has not been fully utilized. It is a powerful statistical tool for test of significance. In this section, the analysis of variance technique is introduced in the field of surface mining.

The test criterion

Let there be K samples of sizes n_1, \dots, n_k from K populations with unknown means μ_1, \dots, μ_k and with a common unknown variance σ^2 . The hypothesis which may be tested is:

$$\mu_1 = \mu_2 = \dots = \mu_k \quad [1]$$

The empirical equations, $n_1 + \dots + n_k = n$ in number, are given in Table I.

Table I: Empirical equations

First samples		K_{th} sample	
Variable	Expectation	Variable	Expectation
y_{11}	μ_1	y_{k1}	μ_k
y_{12}	μ_1	y_{k2}	μ_k
.	.	.	.
.	.	.	.
y_{1nk}	μ_1	y_{knk}	μ_k
T_1 Total		T_k Total	

The minimum value of $\sum \sum (y_{ij} - \mu)^2$ subject to condition of hypothesis [1], i.e., with common μ , is:

$$\min \sum \sum (y_{ij} - \mu)^2 = \sum \sum y_{ij}^2 - \frac{(\sum \sum y_{ij})^2}{n} = R_1^2 \quad [2]$$

which is the total corrected sum of squares of all the observations (Rao, 1974). The minimum value of $\sum \sum (y_{ij} - \mu_i)^2$ without any restriction is:

$$\sum_i \min_{\mu_i} \sum_j (y_{ij} - \mu_i)^2 = \sum_{i=1}^k (\sum_j y_{ij}^2 - T_i^2/n_i) = R_0^2 \quad [3]$$

The sum of the squares (SS) due to deviation from the hypothesis with $(K - 1)$ degrees of freedom (DF) is then:

$$R_1^2 - R_0^2 = \frac{T_1^2}{n_1} + \dots + \frac{T_k^2}{n_k} - \frac{T^2}{n} \quad [4]$$

$$T = T_1 + \dots + T_k$$

which depends on the totals of the samples only. In practice, it is more straight forward to calculate equations [2] and [4] and derive equation [3] for R_0^2 by subtraction. The computation scheme is set out in Table II. The quantities marked with the asterisks in the Table are obtained by subtraction. The F-statistic is constructed using the mean squares (MS) derived from Table II (Rao, 1974).

Table II: Analysis of variance, one-way classification

	DF	SS
Deviation from hypothesis or between samples	$K - 1$	$\sum T_i^2/n_i - T^2/n$
Residual or within samples	$* / n - 1$	$* / \sum \sum y_{ij}^2 - T^2/n$
Total		

* = obtained by subtraction. For abbreviations refer Table IV.

CASE STUDY

The practical application of the analysis of variance technique is given by means of a

case study in openpit limestone mine in the Karnataka state of India. The mine is in hilly area and the elevation ranges from 2056 m to ~1875 m. The present slope

angle of the mine is 45°. During mining at the pit cessation stage, for a short period the excavated slopes can stand at steeper angles than the natural slopes. The monthly production rate of the mine is planned for 40,000 tons/month. The important rock units in the mine are

limestone, grey marble, dolomitic limestone and basal dolomitic limestone.

In the present study, the uniaxial compressive strength, tensile strength and shear strength from different depths are used (Table III). The result of the relevant calculations are also shown in this table.

Table III: Test properties of different rock types

Depth of rock samples(m)	No. of samples	Rock type	Uniaxial compressive strength (MPa)		Tensile strength (MPa)		Shear strength (MPa)	
			Total	Mean	Total	Mean	Total	Mean
21	9	Dolomitic Limestone	540.368	60.041	54.503	6.056	112.238	12.471
41	9	Basal dolomitic limestone	409.135	45.460	59.046	6.561	94.176	10.464
71	8	Grey marble	586.635	73.329	55.716	6.965	81.825	10.228
156	10	Grey marble	807.467	80.747	93.125	9.313	107.396	10.740
226	9	Limestone	608.303	67.589	81.759	9.084	111.528	12.392
	45		2951.908	65.433	344.149	7.596	507.163	11.259

The test criterion

The equality of the means of the strength parameters is tested under the assumption given in equation [1]. The analysis of variance for uniaxial compressive strength

is shown in Table IV which shows that the sum of squares of uniaxial compressive strength for different rock types computed from equation [4] is 6736.695; the total sum of squares is found to be 16909.95 from equation [2].

Table IV: Analysis of variance for tensile strength

	DF	SS	MS	F - statistic
Between	4	6736.695	1684.174	6.62
Within	40	10173.255	254.33	
Total	44	16909.95		

DF = degrees of freedom; SS = sum of squares; MS = mean of squares

The variance ratio 6.62 on 4 and 40 DF is significant at the 5% level, indicating real differences in mean values of uniaxial compressive strength at different depths.

Similarly, the data on the tensile and shear strengths are computed and set up in the analysis of variance (Tables V and VI).

Table V: Analysis of variance for tensile strength

	DF	SS	MS	F – statistic
Between	4	83.465	20.866	9.40
Within	40	88.832	2.221	
Total	44	172.297		

Table VI: Analysis of variance for shear strength

	DF	SS	MS	F – statistic
Between	4	41.653	10.413	10.01
Within	40	41.563	1.04	
Total	44	83.216		

The variance ratios of 9.40 and 10.01 on 4 and 40 DF are significant at the 5% level, clearly indicating differences in mean values of tensile and shear strengths at different depths.

All three strength parameters vary with depth in mine. It is clear, therefore, that the slope material is of a heterogeneous nature.

CONCLUSIONS

In slope stability problems at present, the selection of the appropriate method for slope analysis is a significant problem. A new approach is proposed which enables the study of the behaviour of the strength parameters of slope materials at different depths prior to slope analysis.

The new approach has been successfully utilized in the case study presented. The strength parameters of the slope materials in the mine show a heterogeneous character. A probabilistic or fuzzy set theory approach can provide more reliable results to enable use of the limit equilibrium method.

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ESTIMATION OF CRITICAL PARAMETERS FOR SLOPE INSTABILITY IN AN IN-PIT MINE DUMP

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ABSTRACT

The increase in demand of coal for various industries like energy and steel sectors has put tremendous pressure on the Indian mining industries to minimize the existing demand-supply gap. To keep up with the pace the mining industries not only need to have an economically viable production, but also keep the mine workings stable and safe. The major surface mining methods produce 70 - 75% of the total coal production through a stripping ratio of 1:3 or more. An increase in the stripping ratio and depth poses grave difficulties to safely accommodate the excess overburden material. The external dumping is also not sustainable due to acute shortage of land, environmental and mining problems or other regulatory reasons. This limitation has compelled the mine management to take up the in-pit dumping, which are more efficient when there is a shortage of land. However, these in-pit-dumps are more prone to failure due to several factors. Although, gravity or the self-weight itself is enough to cause slope failure, but other parameters like shear strength, available shear stress along the slope angle and slope height also decides the stability of the slopes to great extent. An attempt has been made in this study to document the behavior of strength of the material in terms of stability of slopes by parametric study of shear strength parameters and slope height. This paper addresses a case study from Western Coalfields Ltd. (WCL) of an In-pit dump stability investigation using numerical studies. The actual mine dump profile is simulated using two dimensional tools to compare the behavior of the slope under varying conditions. The Numerical methods are time consuming and have various complexities. Therefore, Soft computing technique (ANFIS) has also been used to predict the factor of safety (FoS) using three most influencing input parameter i.e. cohesion, angle of internal friction and slope height.

Keywords: In-pit dump, Factor of Safety, Surface Mining, Shear Strength, ANFIS, Soft Computing

1. INTRODUCTION

India is the fifth largest energy producer in the world in terms of total installed electrical capacity which is around 223 GW. Out of this 54% of the total installed capacity comes from the coal powered thermal power plants (Ministry of Power, Govt. of India, 2013). Despite the fact that India is the world's fourth largest energy consumer, it suffers from major shortage of electricity in rural and urban population as well as industrial sector. To fulfill the continuously increasing demand of power, a lot of pressure is being put on various energy resources of India. Coal, a non-renewable entity, is the primary source which keeps the electricity production running. Coal in India is primarily

exploited from surface mining methods constituting about 70-75 % of the total production through a stripping ratio of 1:3 or more to ensure better recovery. The higher stripping ratio accompanied with the increase in dimension of the surface mining leads to the production of even larger volume of waste materials. The dumping of these wastes is quite challenging due the scarcity of land, environmental problems and mostly the economic and human losses caused due to their instability. This produces tremendous pressure on mine management to find a suitable method to dump the waste materials.

In the present scenario, the large overburden material is dumped in two

possible ways; 1) first is external dumping, where these materials are transported to a place away from the coal producing areas. This method is seldom practiced due to obvious reasons like paucity of land, extra transportation cost and further stability problems in the dump. 2) The other method is dumping the wastes internally, beside the space created due to extraction of coal. This method is widely practiced in Indian coal fields and around the world, known as In-pit dumping. It reduces the problems of utilizing extra land for dumping as well as lowering the extra transportation cost which greatly affect the mine's production and economics. But, several problems like instability caused by large precipitation, continuous ground vibration or even due to incapability of the dump material to stand against gravity may cause severe problems and hamper mine's production. Several studies have been conducted on the instability caused due to saturation of dump materials or failure simply due to gravity (Kainthola et al., 2011; Kainthola et al., 2011; Verma et al., 2011; Gupte et al., 2012).

Although, gravity remains the persistent important factor in dictating the slope failure, but other parameters like shear strength and available shear stress along the slope also govern the stability of the slopes to a great extent. The strength of the material comes from the mineralogical composition, internal bonding among the mineral grains, interface, contact between the particles and the ability of the material to respond to the stress conditions. Cohesion and angle of internal friction constitutes the most important material properties in defining the strength of any material.

The acronym ANFIS derives its name from adaptive neuro-fuzzy inference system, which is classified into four models (Singh et al 2012a). This advanced computing technique has become widely accepted and applied for the analysis of various complex geological problems (Finol et al., 2001; Gokceoglu, 2002; Singh et al, 2005, Singh et al, 2012a, b & c). Among those, the most commonly used

model in the field of engineering geology is Takagi–Sugeno–Kang (TSK) fuzzy models. A good discussion of ANFIS can be explored from the Jang (1992) and its application in rock mechanics is described by Singh et al. (2012 a,b &c).

A case study from WCL open pit mine has been selected to simulate the behavior of dump slopes under varying material characteristics and finally, an adaptive neuro-fuzzy inference system (ANFIS) was utilized to predict the factor of safety and compared with conventional slope analysis methods.

2. GEOMETRY AND MATERIAL

The excess overburden material is dumped by In-pit dumping method over a period of time which allows the dump height to increase with time. This causes the slope to become unstable and therefore, a standard slope design is very important for suitable management of the overburden material. The geometry (Fig 1) depicts one of the mine slope from WCL and has been constructed from the previous work carried out by Gupte et al. (2013). Various engineering geology parameters like elastic properties, shear strength parameters and unit weight have been estimated by earlier researchers (Gupte et al., 2013). Hence, the required material properties have been taken from the earlier study for the numerical simulation of slope behavior and estimation of the critical shear strength parameters for which the slope becomes unstable. The dump material is assumed to behave as Mohr-Coulomb material and therefore shear strength parameters becomes very important in the examination of slope behavior. Cohesion and internal friction is related to shear strength of the material through coulomb's law which states that

$$\tau = C + \sigma_n \tan \phi$$

Where, τ is the shear stress along the shear plane at failure, C is the cohesion, σ_n is the normal stress acting on the shear plane and ϕ is the angle of internal friction of the shear plane

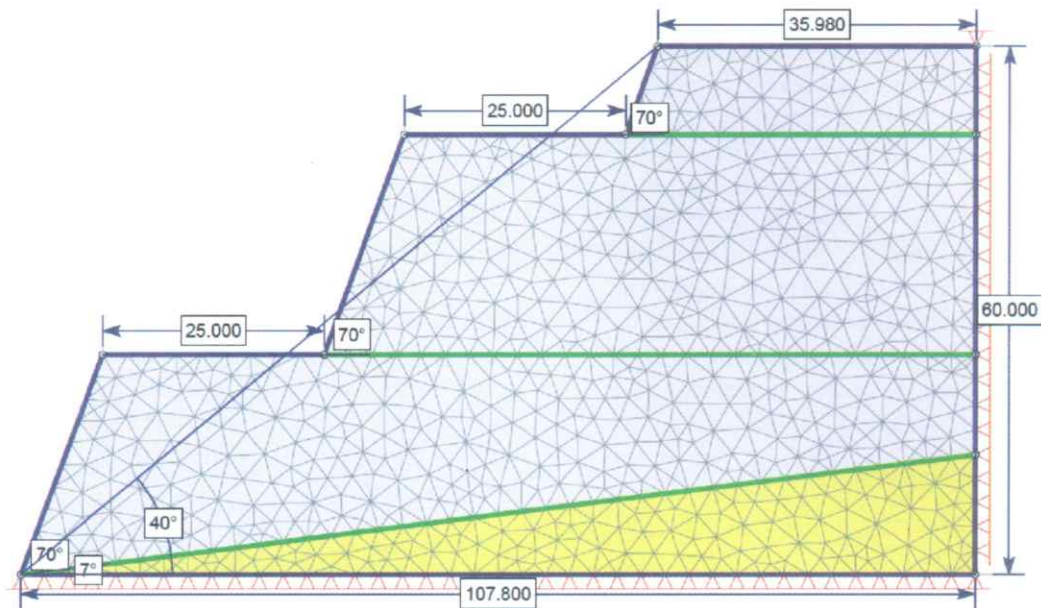


Figure 1 Dump slope geometry of a mine from WCL (after Gupte et al., 2013)

3. METHODOLOGY

Uncertainty in geotechnical engineering is inevitable. Most of the properties of soil and rock are essentially heterogeneous. Almost all minerals/ore deposits around the world are characterized by uneven layers of various materials with extensive range of material properties (Chowdhury, 2010). Ambiguity also exists in material testing where no single value can be representative of a particular sample. Since, most of the material properties considered for the simulation does not assume fixed value. So, an important way is to perform parametric analysis considering various material properties available for the simulation of slope behavior. This will also lead to estimation of the critical parameters responsible for the slope collapse, a method also known as back-analysis. This approach has been used extensively by various researchers to understand the mechanisms of the failed slope (Massanat, 2011; Priyanka et al., 2011; Chok, 2008; Singh et al., 2013). Besides the conventional methodology, i.e. FEM, soft computing analysis has also been performed which can be very effective for solving complex stability problems and saves analysis time.

4. NUMERICAL SIMULATION

Numerical methods such as the Finite Element Method (FEM) have now been successfully applied to slope stability analysis over the years. It is now assumed as the best alternative to traditional limit equilibrium methods; possibly because of less number of priori assumptions are required for the analysis. The FEM is the most widely sought numerical methods for rock and soil mechanics related problems in engineering geology because of its flexibility for treatment of material heterogeneity, complex boundary conditions, in situ stresses and gravity (Jing, 2003).

A general approach known as shear strength reduction (SSR) technique has been utilized to model slope behavior. SSR technique has been widely used for rock and soil slopes over a period of time by various researchers (Singh et al., 2013; Kainthola et al., 2012; Hammah et al. 2007; Dawson et al. 1999; Griffiths and Lane 1999; Matsui and San 1992). The factor of safety for a potentially sliding mass can be given as

$$\tau_f = C_f + \sigma_n \tan \phi_f$$

Where, τ_f is the reduced shear strength, C_f is the reduced cohesion, σ_n is the normal stress acting on the shear plane, and ϕ_f is the reduced friction angle of the shear plane.

5. RESULTS AND DISCUSSION

The dump slope with a total height of 60 m was analyzed in the present study to monitor the slope behavior. Since, the material is devoid of any discontinuities, the significant parameters which influence the slope are shear strength parameters viz. cohesion and angle of internal friction, height and the gradient of the bench slope. As indicated earlier, these material properties do not assume constant value throughout the slope and therefore there is always a degree of uncertainty. The stability analysis of dump slope is carried

out by varying cohesion, angle of internal friction and slope height keeping the stripping ratio of 1:3.

The different cases of the modeled dump slope shows that the contours of maximum shear strain generates a circular slip surface passing through the toe of the slope (Fig 2). Since, the dump slope material behaves almost like a soil, circular slip surface can be considered as the most probable mode of failure. Three cases have been examined in this study for the stability analysis of the dump slopes which are described below.

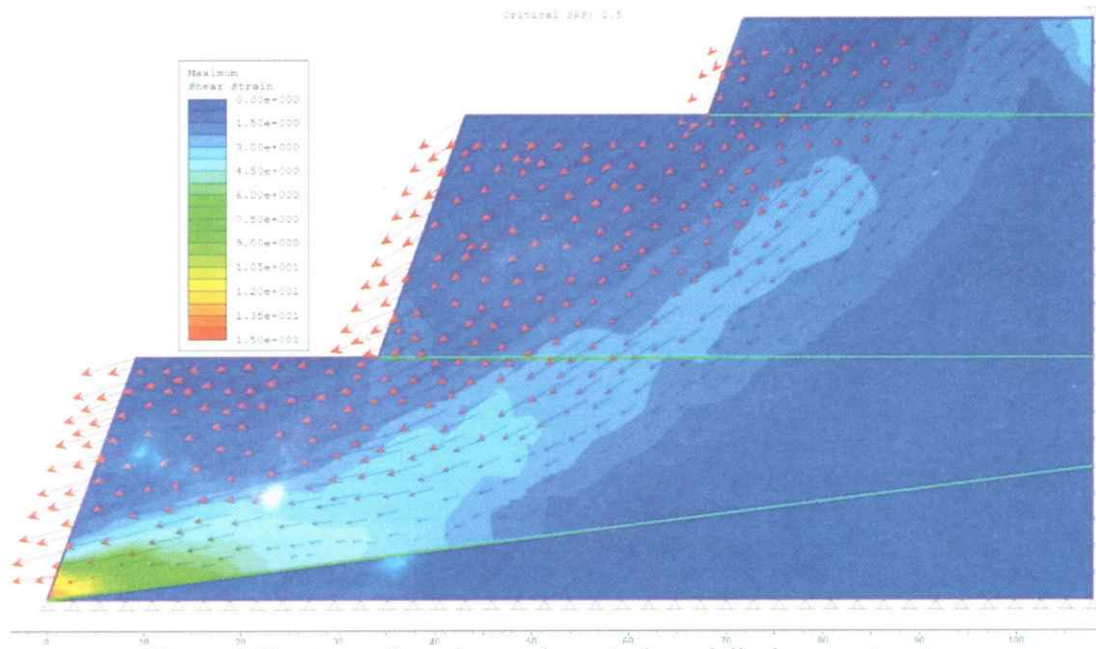


Figure 2 Contours of maximum shear strain and displacement vector

5.1. Variation of angle of Internal Friction

Internal friction is the intrinsic property of any material which is caused by the slippage along the contact between grains

constituting the material and is defined by the internal friction angle, ϕ . Better estimation of the geo-material's internal properties, can minimize the stability problems and reduce the risk of further damage

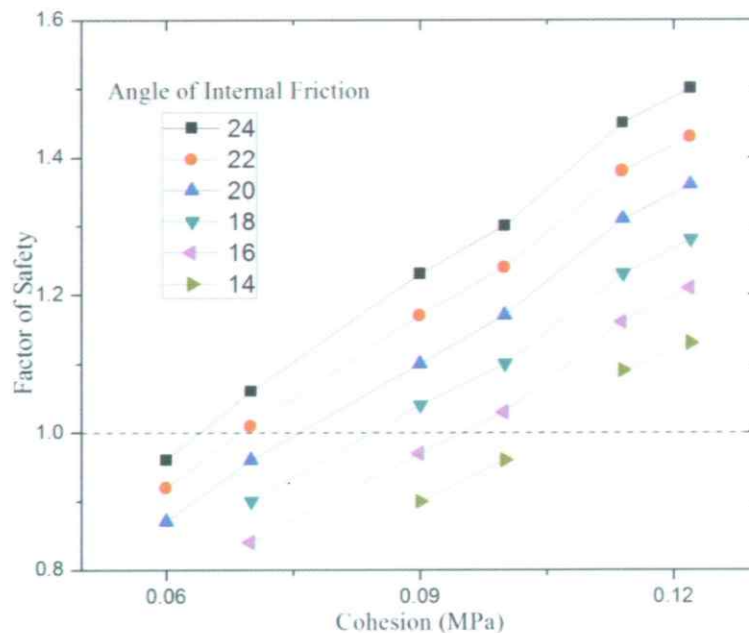


Figure 3 Variation in factor of safety with cohesion for a range of angle of internal friction

Stability analysis has been performed for a range of friction angle values that the dump material can assume. The lowest value corresponds to the dry material while the higher values correspond to saturated material. The dashed line shows the critical factor of safety for all the cases. Factor of safety (FoS) shows almost linear correlation with cohesion with high correlation coefficient. As cohesion and internal friction increases, there is a considerable increase in FoS (Fig 3). All those values which fall on FoS equaling "1 line", are the minimum threshold required to theoretically keep the slope critically

stable and below that the slope will fail preferably in circular mode.

5.2. Variation of cohesion

The strength of the material comes from the internal bonding between the mineral grains, contact between the particles and the ability of the material to respond to the stress conditions. Cohesion and angle of internal friction constitutes the most important material properties in defining the strength of any material. High fluctuation in the value of cohesion, like the previous case, is also a result of excessive precipitation.

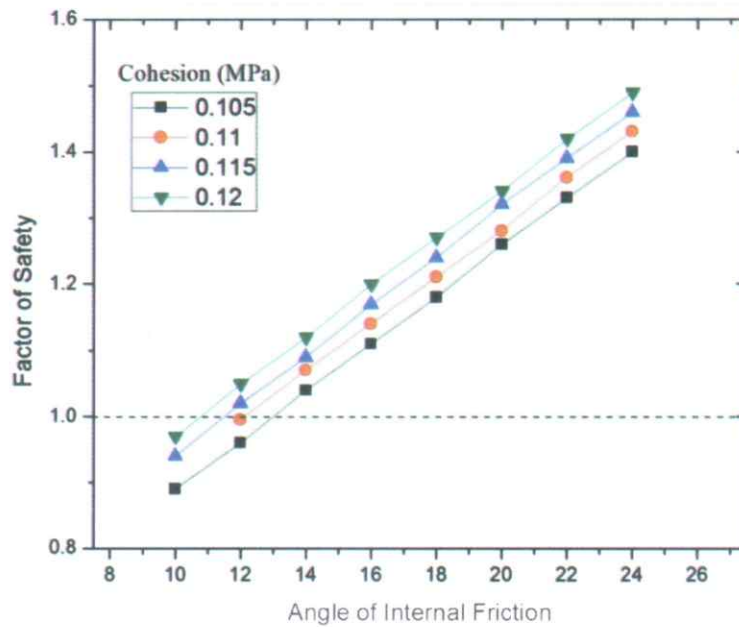


Figure 4 Variation in factor of safety with angle of internal friction for a range of cohesion values

This affects the material by weakening the internal bonding between the particles that reduces the overall shear strength of the material available along the slope. The result shows that an increase in cohesion and internal friction causes the factor of safety to be on the higher side (Fig 4). It can also be correlated from the two graphs that FoS increases in a linear fashion with increase in either of the shear strength parameters which further confirms that the material follows Mohr Coulomb criteria.

5.3. Variation of dump slope height

Proper optimization of space requires the dump slope to be steeper with greater height at the same time. This will obviously question the management and stability of slopes. But, if a good correlation can be made between shear strength parameters, slope angle and slope height than the risk of instability can be reduced upto a considerable extent.

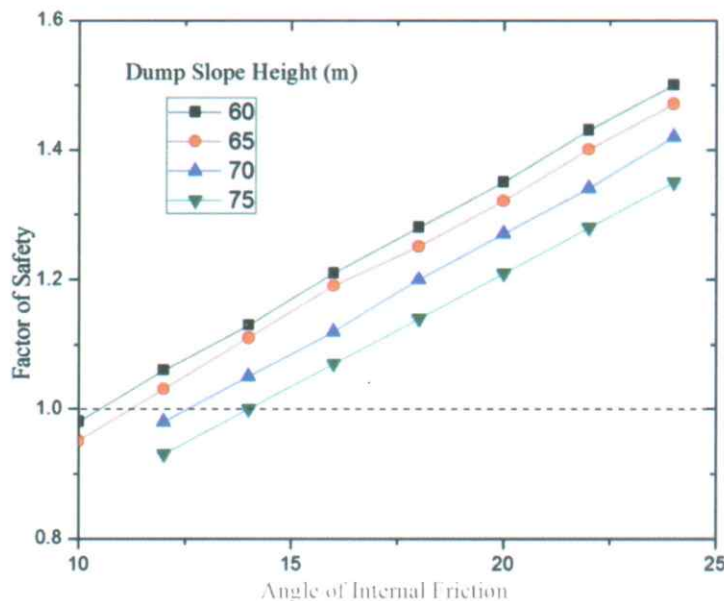


Figure 5 Variation in the factor of safety with angle of internal friction for increasing dump slope height

Slope angle in this analysis was kept at 70° for all the cases and only slope height was varied until the slope became unstable by

varying angle of internal friction (Fig 5) and cohesion (Fig 6).

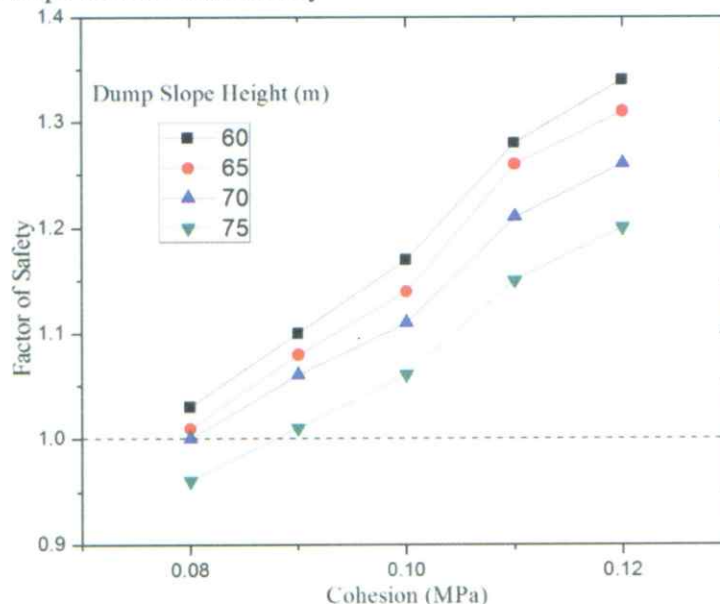


Figure 6 Variation in the factor of safety with cohesion for increasing dump slope height

The result of the analysis shows that the lower values of both the parameters causes the slope to fail. This indicates to the situation when the dump material is influenced by any external destabilizing agents like heavy precipitation, seismic activity or even sometimes due to blast induced ground vibration which aids in reducing these parameters. The graph clearly connotes to the fact that the slope can still remain stable until a certain threshold value is maintained. The possibility of local failures cannot be denied, possibly due to material inhomogeneities and local site geo-mining condition.

5.4. Soft Computing: Results of ANFIS approach

Takagi–Sugeno-type fuzzy inference system was used to compute FoS from three important parameters viz. cohesion (C), angle of internal friction (Phi) and the slope height. A total of 107 data-set have been used to train the ANFIS system using Gaussian's bell shaped function (Fig 7) with hybrid learning techniques. The hybrid learning algorithm increases the efficiency of the system (Singh et al., 2005; Singh et al., 2012 a & b).

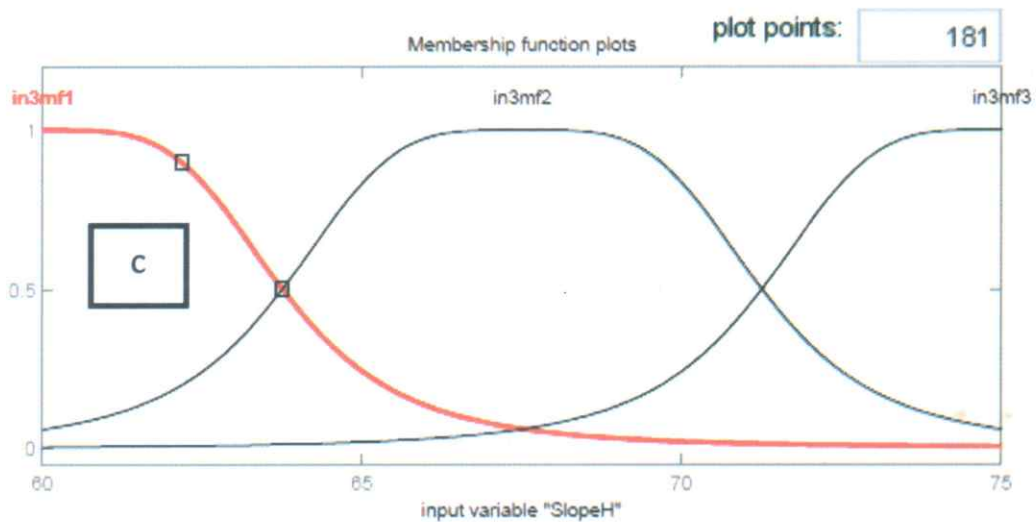
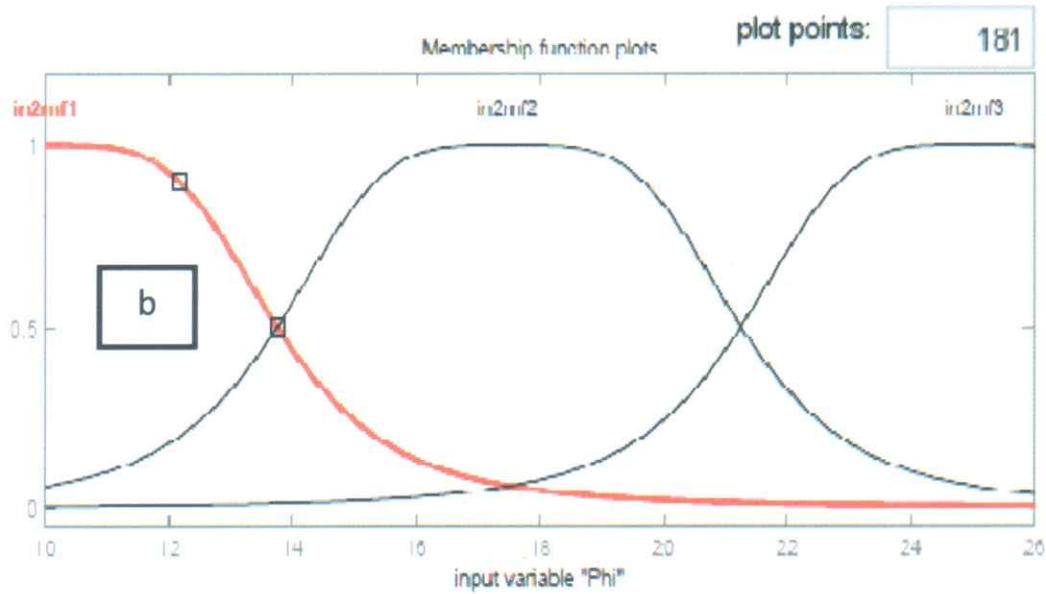
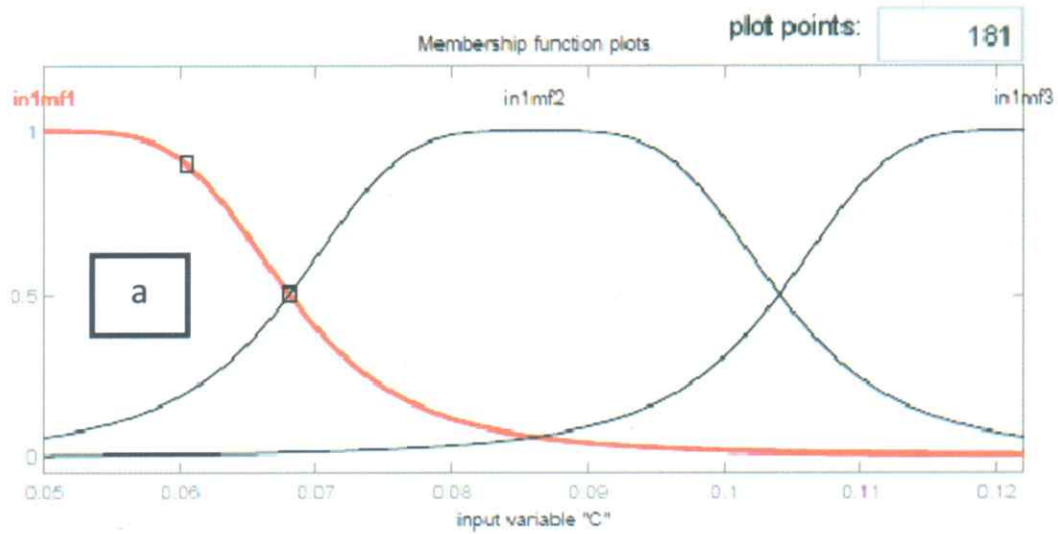


Figure 7 Membership Function used in AANFIS model for inputs (a) Cohesion (b) Internal angle of friction and (c) Vertical height of the Slope

Eleven data-set have been used to test and validate the ANFIS predictive efficiency (Table 1). A good correlation ($R^2= 0.9876$) was established between FoS computed using FEM and that predicted from ANFIS (Fig 8). It is observed that the prediction of

FoS using ANFIS is excellent and also less time consuming in comparison to the conventional method. Once, system is trained with sufficient data set, highly accurate value of FoS can be obtained within the limits of training data set.

Table 1 FoS values computed using FEM and predicted using ANFIS

Cohesion (MPa)	Phi (deg)	Height (m)	FEM FoS	ANFIS FoS
0.105	18	60	1.18	1.170
0.110	26	60	1.50	1.500
0.115	24	60	1.46	1.460
0.060	24	60	0.96	0.933
0.050	25	60	0.88	0.918
0.070	22	60	1.01	1.070
0.100	18	60	1.10	1.130
0.122	22	60	1.43	1.430
0.122	24	70	1.42	1.400
0.110	20	65	1.26	1.260
0.110	20	75	1.15	1.160

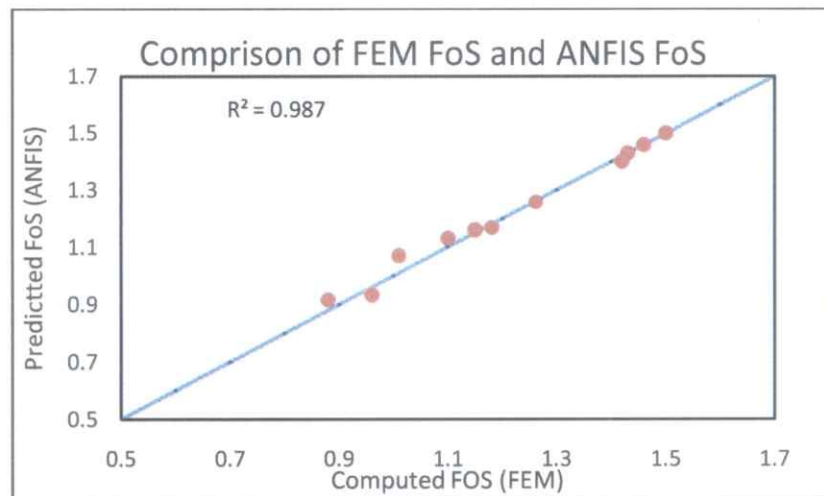


Figure 8 Correlation between the FoS evaluated using FEM and derived using ANFIS

CONCLUSION

Stability analysis of the in-pit mine dump slope from WCL is analyzed in the current study. Due to external disturbing agents like heavy rainfall and seismic activities, the shear strength parameters of the materials viz. cohesion and internal friction loses its coherence and decreases the strength of the material along the slope. Also, due to uncertainty in the representation of values of these input strength parameters, accurate estimation of

factor of safety is not possible. So, to model this complex behavior, parametric study was conducted for different possible ranges of the shear strength parameters and slope height. Also, for proper representation of shear strength values, samples should be collected from different parts of the dump slope and carefully tested in laboratory. FEM approach was adopted in this study to reach a reliable correlation between shear strength parameters and slope height. Numerical simulation of the dump material generates

a circular mode of failure and the most critical slip surface passes through the toe of the slope. The results of this analysis shows that an increase in either of the shear strength parameters causes the FoS to increase in a linear fashion with a very good correlation coefficient but for a certain value of these parameters, the slope becomes critically stable which demarcates the boundary between stable and unstable zones. If further degradation takes place due to external disturbing agents, then the slope may fail. Factor of safety also decreases with an increase in dump slope height for any shear strength parameter. Several critical threshold values were estimated from this study which may help to reduce the risk of slope failure, if proper mine planning is done. Soft computing technique using ANFIS has also been carried out to correlate the results with the conventional method. The results of the analysis are in agreement with FEM, albeit with slightly better confidence and also consumed less time.

ACKNOWLEDGEMENT

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MULTIVARIATE STATISTICAL METHODS FOR MINERAL EXPLORATION USING GEOCHEMICAL DATA

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ABSTRACT

Our mineralization exists in the crust and in a 3D static phenomena which can be modeled as a multivariate normal system through Gaussianisation of log (odds) of constituent fractions present in rock/ore/soil samples. Mineralisation processes are extremely complex, non-homogeneous, non-linear to be analysed directly. Therefore, these must be partitioned into homogeneous subsystems having strong dependence within but very weak interactions among the populations. Constituents of rocks/ores/soils are constrained to 1.0 or 100% which form a mathematically included dependence structure (not geologically interpretable or meaningful) but having a Binomial/Poisson distribution with heteroskedastic variances. Gaussianisation of marginal distribution are often performed but this does not guarantee that the joint distribution of random vector belong to multivariate normal distribution. However, for exploration we deal with a static system which is temporarily linear but spatially non-linear. Suitable pre-transformation is needed to linearise the system so that linear statistical methods such as multivariate normal distribution becomes applicable for analyses and inferences to discover concealed mineral deposits. In exploration stage, following multivariate methods would be useful. Multiple/partial correlation and factor analyses and also canonical correlation for finding path finders and delineating anomaly and multi group linear discriminants to delineate ore, low grade ore and waste zones. In development and production stages, it would be prudent to delineate ore zones such as i) marketable grades, ii) marketable grades after beneficiation, iii) low grade as future resource and, iv) waste material by using Multigroup Discriminate Function approach. Then optional mining, beneficiation and marketing operations would maximize economic benefits, social aspirations and environmental protection/remediation.

I. INTRODUCTION

Elemental concentrations in multi-component ($p > 1$) rocks/mineralisations are in different proportions (major $> 10\%$; minor 1-10%, trace levels $< 1\%$) which have either Binomial distributions for major/minor proportions and reduces to Poisson distribution for trace constituents. These concentrations are, spatially/temporally as well as within each sample, dependent and hence statistical methods dealing with independent data are not strictly applicable. Independence of various constituents within any sample can be achieved through $\log(\text{odds})$ transformation for each constituent which simultaneously achieves Gaussian probability distribution; so that univariate normal (UN) and multivariate normal distribution (MND) theory (using LINEAR theory) become applicable. Multivariate ($p > 1$ or vectors) theory

reduces to univariate theory when number of random variables become one ($p=1$, or scalar), so univariate model is included under multivariate model. Population parameters like, mean vector (μ) and covariance matrix (D) are then estimated for each population and appropriate statistical tests performed to take suitable statistical and geological decisions.

Ore mineralization exists in the crust and is a 3D static (not time-varying) phenomena which can be modeled as a multivariate normal system through Gaussianisation of $\log(\text{odds})$ of constituent fractions present in rock/ore/soil samples. Mineralisation processes are extremely complex, non-homogeneous, nonlinear to be analysed directly. Therefore, these must be partitioned into homogeneous subsystems having strong dependence within but very weak interactions among the populations

(groups). Two types of univariate hypotheses include (i) sample mean belongs a given population (Null or H_0) which tested against alternative hypotheses (H_1), (ii) variances are homogeneous (equal, H_0) or not (H_1). Two kinds of errors made for any decision are (i) Type I or α of rejection of H_0 when true and (ii) Type II or β of acceptance of H_1 when false. It is prudent to the test more powerful, i.e. $1 - \beta$ error is maximized for given Type I error; these procedures are extendable for MND models.

Multiple and polynomial regressions (correlations) are strictly univariate model having only one random error but generally included under multivariate model because Matrix Methods are essential to solve them as is necessary in MND analyses. However, F tests cannot be reliable for polynomial regressions, since powers of variable cannot be Gaussian when the variable is Gaussian. Power relation of dependent variable (Y) with predictor variable (X) can be linearised using $\ln(Y)$ transformation for statistical analyses.

II. MULTIVARIATE STATISTICAL ANALYSIS

This is appropriate for analyzing multiply correlated measurements (random vectors) made on one or more samples and on one or more (homogeneous) populations/groups. If a p-variate ($p \geq 1$) Gaussian random vector (X) is measured on N independent samples of a population, then the mathematical model has multivariate normal distribution (MND) which is characterized as all linear compounds of the variables are also MND as the rank of vector X may/may not be equal to its order (p). MND methods are classified on basis of number of Populations (one or more); number of sets of random vectors (one or more). Four classes thus form: (I) one Population & one set of variables: MND methods are Principal Component (PCA), Factor (FA); Cluster (CA); (ii) One Population but more than one set of variables: MND methods are Multiple Regressions (correlations); Polynomial Regressions; Canonical Correlation; (iii)

One set variable but more than one Population: MND methods include MANOVA, Discriminant functions (DF: linear, quadratic); Classification function (CF); and (iv). More than one Sets of variables and Populations: MANCOVA.

Constituents of rocks/ores/soils are constrained to 1.0 or 100% which form a mathematically induced dependence structure (not geologically interpretable or meaningful) but having a Binomial/Poisson distribution with heteroskedastic variances. Gaussianisation of marginal distributions are often performed but this does not guarantee that the joint distribution of random vector belong to MND. So, MND theory must be tested through all linear combinations (esp. Principal Components, Conditional regression components) of the random measurements are MND. However, MND theory is very robust and if N is fairly large then the random vector may be accepted to have MND and this is practical also. The parameters of a multivariate r.v. can be estimated for any homogeneous population by its mean vector (μ) and dispersion (correlation) matrix (D/R) using MLE. Null hypothesis of Homogeneity of population mean vectors (H_2) conditional on homogeneity of dispersion matrices is given by T^2 test:

$$T^2 = N (m - \mu)^T D^{-1} (m - \mu), \text{ with } (N-p)T^2/(N-1) \text{ is } F, p_{(N-p)} \text{ distributed and } m \text{ being sample mean.}$$

Homogeneity test for Covariance matrices (H_1) of different populations is more involved (Box test).

Matrix operations are essential for multivariate analysis. Matrix A is a rectangular array of numbers with p rows and q columns, where $a_{(I,j)}$ is its ijth element. Addition and scalar multiplication are straightforward but matrix multiplication requires that the number of columns of the pre-matrix must be equal to the number of rows of the post-matrix, otherwise multiplication is not defined. If $AB=C$ exists, the elements $c_{(I,j)} = \text{Sum over } r (a_{(I,r)} \times b_{(r,j)})$. But in general multiplication is not commutative,

AB not equal to BA, so pre- or post-multiplication of the matrix must be specified. However, multiplication is associative: $A(BC) = (AB)C = ABC$. Transposed matrix A^T has the rows and columns interchanged in A; so $(AB)^T = B^T A^T$. If X and Y are two conformable column vectors then their inner product is given by $X^T Y$. If A is (m x n) matrix, the Ax is a column vector. A^* is conjugate transpose of complex matrix A, then $(AB)^* = B^* A^*$ and so on. Rank of matrix is the number of independent columns (or rows) in the matrix. A square matrix of order m is nonsingular, if its rank (m) is less than its order (p). A unique inverse matrix A^{-1} exists if A is nonsingular, then $AA^{-1} = A^{-1}A = I$ (identity matrix). If unique inverses of A and B exist, then $(AB)^{-1} = B^{-1}A^{-1}$; also $(A^{-1})^T = A^T$ and $(A^*)^{-1} = (A^{-1})^*$. For an unitary, matrix A^* ; we have $A^*A = I = AA^*$ and so, $A^* = A^{-1}$. If A is a real non-singular square matrix is said to be orthogonal if $A^T A = A A^T = I$, so $A^{-1} = A^T$ and hermitian if $A^{-1} = A^*$. Elementary operations on columns (rows) of a matrix can give simpler form to interpret and compute but its rank is preserved.

Determinant of a square matrix A ($= a_{ij}$) can be obtained by expanding the element ($a_{(i,j)}$) of a row(column) by multiplying by its cofactor and summing over all elements of the row(column) or by multiplying the eigenvalues of A. Generalised inverse of a singular matrix (rank less than its order) is denoted as A^- ; then $A A^- A = A A^-$ is not necessarily unique. $A^- A = H$ with $H^2 = H$ (idempotent). If $A^- = A$, we get $\det A = r(A) = r(H) = \text{trace}(H)$. If A^- exists then $r(A^-) \geq r(A)$.

Quadratic form (Q) of matrix plays an important role in MND analysis and is given by $Q = X^T A X$ with $A = [(a_{(ij)} + a_{(ji)})/2]$ is symmetric matrix. If $X^T A X > 0$ it is positive definite(pd), 0 it is negative definite(nd) and semi-definite is 0 is included in the product. For any nonsingular linear transformation Q remain definite and invariant. Every positive definite matrix A can be decomposed into CC^T where C^T is inverse of the linear transform matrix. A necessary

and sufficient condition for A to be pd is that its determinant is positive. This summary on Multivariate Analysis is based on Sahu(2005) where more details are available.

III. PRINCIPAL COMPONENT AND FACTOR ANALYSIS

This method is for single population and one set of random variables, Original vectors in p dimensional space are linearly transformed to a smaller m dimensional subspace of principal components which are orthogonal. Mathematically, a real symmetric covariance(correlation) matrix is diagonalised(all correlations now zero) s.t. the principal diagonal yields the eigenvalues (variances) along the orthogonal eigenvectors(directions). In Factor Analysis, some of the smaller non-significant eigenvalues are deleted as negligible error components without losing information. The retained eigenvectors are rotated orthogonally in the lower common factor space ($m \ll p$), so the new correlations (loadings) become easily interpretable (either near 1 highly loaded or near zero uncorrelated) as Factors. Rotation of orthogonal factors in the lower space is made by standard VARIMAX program(Kaiser, 1958). Cluster analysis can be made to obtain homogeneous groups by using similarity or distance matrices but this process is rather empirical and needs great care for accuracy.

Eigenstructure of correlation(Dispersion) matrix (R or D) is achieved through powering the matrix to a very high index(say 64 or 128) so that the largest eigenvalue dominates over the rest and corresponding eigenvector is obtained by a few iteration. The effect of the first eigenvalue is subtracted from the matrix to obtain the Residual Matrix which is again powered to high index to get next eigenvalue and eigenvector. This sequence is continued till all information of R(or D) are extracted and residual matrix becomes zero matrix. However, before running the eigenstructure analysis, null hypothesis $R=I$ must be tested for statistical significance by a chisquare test with p(p-

1)/2 d.f. at 0.05 level. The test quantity is given by $-\left[(N-1) - \frac{1}{6}(2p + 5) \right] \ln(|R|)$.

Spectral decomposition of matrix gives :

$$R = \Lambda_1 v_1 (v_1^T) + \Lambda_2 v_2 (v_2^T) + \dots + \Lambda_p v_p (v_p^T) = \sum R_j \text{ over all } p_j.$$

If m components are found to be statistically significant then the rest $(p-m)$ components are noise and are deleted. So, total variance explained is sum $R(j)$ of first m components, and rank of R is now m ($\ll p$). Multiplication of all eigenvalues gives $|R|$ and sum of all eigenvalues gives trace of R .

Principal factors $(f(j); j=1 \text{ to } m)$ are computed dividing the retained eigenvectors by square root of their eigenvalues. Thus each factor becomes equally important as other with variance of one for all j . Factor Structure $S = V(\Lambda)^{-1/2}$ and predicted R by all factors is $S*S^T$; residual error is $R - S*S^T$.

The number of significant principal components (m) retained as factors is most important. A chi-square test of det of residual matrix; res (A) with $(p-m)(p-m-1)/2$ d.f. is given by:

$$-\left\{ (N-1) - \frac{1}{6}(2p + 5) - \frac{2}{3}(m) \right\} \ln \left[\frac{|R|}{\left\{ \prod_{i=1}^m \lambda_i \right\} / \left\{ \prod_{i=1}^{p-m} \lambda_i \right\}} \right]$$

Which is tested at 0.05 level. Another method is to plot j th eigenvalue vs j to get inflexion point giving m factors or to plot std. devn of cum. Eigenvalues computed on independent replicate samples of size N sampled from the same population vs. j to get a minimum at which cum. eigenvalue is 85% or more gives m . This second procedure is a second order criteria for deciding the common factor space(m) (see, Sahu,1973). Varimax rotation is absolutely necessary to eliminate non-interpretable intermediate loadings in the range of 0,2 to 0.5 in any unrotated eigenvector of principal component. Factor j is interpreted by the rotated loadings in the j th rotated eigenvector as follows: (i) absolute loadings close to unity are

statistically significant and identifies the factor in terms of the input variables and loadings near zero are nonsignificant and do not contribute to this factor (but may identify some other factor on which they are strongly loaded).

Correlation matrix can be computed over N samples to give R -mode R showing correlations among the random variables, or over the p variables to give Q -mode R showing correlations among N samples. However, both R or Q correlation matrices have the same information and hence give finally the same inferences/decisions. But the order of R in R -mode is $p \ll N$; hence computationally R -mode analyses are preferred/cheaper. The rotated eigenvalues are different from the variances from corresponding eigenvalues, although the total variance (= Cumulative Eigenvalue) of m retained factors is conserved by orthogonal rotations as can be easily demonstrated by matrix theory. (see,Sahu,1973).

IV. MULTIPLE REGRESSION (CORRELATION) AND CANONICAL CORRELATION

Multiple (including Polynomial) regression (correlation) yield linear prediction of dependent (criterion) variable (Y) from the knowledge of the predictors (X). The slope is given by $b = (\text{Var } x)^{-1} \text{Cov}(x,y)$ if X and Y are scalars (univariate analysis) which can be extended to vector random variables as $b = \text{Cov}(x)^{-1} \text{Cov}(x,y)$ if x is a vector random variable and Y is a scalar random variable. Multiple correlation exists if multiple correlation coefficient R is statistically significant, and R^2 indicates the sum of squares explained by predictors and $(1-R^2)$ indicates noise sum of squares. F test can be made with $(p-1)$ and $(N-p)$ as degrees of freedom. However, since elements of X are mutually correlated (not independent), the effect of each element of X on Y is highly confounded and not possible to correctly interpret. Partial correlations remove the effects for other elements mathematically to give correct interpretation for correlation of Y with any element (x_i) of X .

In Canonical correlation, two or more sets are variables are needed, one set is criterion, other set predictor and third set control which can be kept mathematically constant. In contrast to Principal Component Analyses, the eigenstructure is computed along the maximum covariances (not along maximum variances). The total correlation matrix R (with y as the p th r.v.) is partitioned into X of order $(p-1)$ and hence we get the real nonsymmetric matrix as $R_{22}^{-1} R_{21} R_{11}^{-1} R_{21}$ which is product of two real symmetric matrices: $B = R_{22}$ and $A = R_{21} R_{11}^{-1} R_{12}$. Mathematically we solve the eigenstructure of $(A - \Lambda B) = 0$ or of eigenstructure of $B^{-1} A$ $V = V(\Lambda)$. Eigenstructure of $B^{-1} A$ can be done through two stages : (i) eigenstructure of real symmetric matrix B to give Λ_1 an eigenvector U_1 to compute B^{-1} and obtain $B^{-(1/2)}$ and then(ii) eigenstructure of symmetric matrix $(B^{-1/2} A B^{-1/2})$ to give Λ_2 and eigenvector U_2 . Eigenvalues of $B^{-1}A$ is same as that of $(B^{-1/2} A B^{-1/2})$ but eigenvector V of $B^{-1} A$ is given by $B^{-1/2} U_2$. Statistical significance of diagonal elements of canonical eigenvalues (Λ_2) can be assessed as follows:(i). proportion explained by $\Lambda_j = \Lambda_j / (\text{trace } \Lambda_2)$ (ii) Bartlett Lamda statistic = Product ($j= 1$ to p_2) of $(1 - \Lambda_j)$, where p_2 is dimension of predictor vector. The null hypothesis that criterion and predictor sets are uncorrelated is assessed through chi-square with $p_{(1)} \times p_{(2)}$ d.f. as: $- [(N-1) - (1/2) (p_{(1)} + p_{(2)} + 1)] \ln (\Lambda)$. If null hypothesis of no correlation is rejected, then the effects of the first canonical root (Λ_1) is subtracted the rest $p_{(2)} - 1$ canonical roots tested as: Product($j = r+1$ to $p_{(2)}$) $(1 - \Lambda_j)$ as a chiequare with d.f. = $(p_{(1)} - 1) (p_{(2)} - 1)$

Chisquare = $- \{(N-1) + \frac{1}{2} (p_{(1)} + p_{(2)} + 1)\} \ln (\Lambda_1 \text{ residual})$. This test is continued as is necessary.

(iii) A thumbrule is any canonical correlation < 0.30 is statistically nonsignificant and hence dropped.

Multiple regression with standardized variables z can be written as $z(\text{hat}) = b_1 z_1 + b_2 z_2 + \dots + b_p z_p$ and multiple correlation coefficients R_p . $1, 2, \dots, (p-1) =$

R are similar to product-moment correlation coefficient (r) having range $[-1, +1]$ for linear regression of scalars but R has range 0 to 1. R^2 explains major part of the variance of criterion and $(1 - R^2)$ gives the error variance of regression. Therefore, F test with $(p-1)$ df in numerator and $(n-p)$ df as the denominator is applicable for the quantity $R^2 (N-p) / (1-R^2) (p-1)$. The $(p \times p)$ correlation matrix R can be partitioned into R_{11} with order $(p-1)$ and the last criterion (scalar) $z_{(p)}$ has variance 1.0. The multiple slope vector $b = R_{11}^{-1} R_{12}$. However, high values and high significance of any b_j does not imply true importance of z_j since other predictor z 's confound the multiple correlation slopes. Hence partial correlation of criterion with a z_j keeping all other predictors mathematically constant is absolutely necessary for any statistical/geological inference.

Polynomial regression is similar to multiple regression but powers of predictor random variables and the interaction terms are included. High degree of polynomial regressions is very difficult to interpret and also if X is Gaussian then its powers and interactions cannot be Gaussian, precluding use of F -test for the regression equations. So, unless theory dictates such polynomial regression, it should be avoided, and in any case the degree should as low as possible (say, second order).

Multiple partial correlation matrix $R_{2,1} = \{ r_{21, jk} \} = \text{residual } r_{22, jk} / (\text{res } r_{22, jj} \times r_{22, kk})^{1/2}$

For a trivariate-random variable, system $\text{res } r_{22} = 1 - r_{21}^2$ and $\text{res } r_{23, j} = \text{res } r_{23, j} / (1 - r_{21}^2)^{1/2}$. So, $r_{21, 3j} = \text{res } r_{23, j} / (1 - r_{21}^2)^{1/2}$, a well known result in statistical theory. The output of partial correlation analysis can be arranged as: $R = [(R_{21} / R_{32,1}) (R_{21,3} / R_{33})]$.

An Example of Partial Correlation would clarify many concepts involved. The following random variables were measured in 33 thin-sections from 33 sandstone samples. The variables were $X_1 = \text{phi long axis of grains}$, $X_2 = \text{matrix percent}$ and $X_3 = \text{porosity percent}$ as

reported in Griffiths (1967,p.468) and the multiple correlation matrix R with $r_{12} = .8813^{**}$, $r_{13} = -.7094^{**}$ and $r_{23} = -.66771^{**}$.

Here, ** means statistical significance at 0.01 level. We compute partial correlation $r_{13.2} = (r_{13} - r_{12} \times r_{23}) / (1 - r_{12}^2)^{1/2}$. Partial correlations between X_1 X_3 ; X_1 X_2 ; and $X_{2.1.3}$ are similarly computed and we get $r_{21.3} = .6439^{**}$, $r_{31.2} = -.3862^{**}$ but $r_{23.1} = .2222^{NS}$ instead of $-.6671^{**}$. Therefore, $r_{23.1}$ is nonsignificant indicating X_2 and X_3 are really not correlated and do not possess any negative correlation. This fallacy of multiple correlations must always be remembered and true inference sought through partial correlations.

Comments: Although X_1 has a Gaussian distribution, X_2 and X_3 possess closure constraints (range 0 to 100%, or 0 to 1 as fractions) and not Gaussian but Binomial. X_2 and X_3 can be Gaussianised by transformation $\log(x_j / (100 - x_j))$ for $j = 1, 2$. Multiple correlations should have been computed with X_1 and, the new transformed and Gaussianised X_2 and X_3 variables (not original non-Gaussian X_2 , X_3).

V. MANOVA, DISCRIMINATION AND CLASSIFICATION

MANOVA is similar to ANOVA for vector random variable X, In ANOVA (scalar r.v) two types of tests are necessary to test equality of Main Effects : (i) when interactions are nonsignificant the interaction variances are pooled with error variance and a pooled error variance is calculated to yield the F test, (ii) when interaction variance is significant then its variance is used to test main effects by F test. In MANOVA, treatment variance is divided by the pooled error variance to give F test since interaction variance is nonsignificant. But if interaction variance is significant then MANCOVA methods are used to test main effects (F test) by dividing treatment variance by interaction variance (not error variance). Populations (groups) are not necessarily homogeneous in mean vectors and covariance matrices. Two situations can arise (a) covariance

matrices homogeneous and testing done to find homogeneity of mean vectors (H2 test; LDFs and MDFs as hyperplanes) or otherwise. In second case (b) at least one covariance matrix is different we have to use nonlinear quadratic hyper- surfaces (QDF) to delineate regions of each population. If both the mean vectors and covariance matrices are utilized together, then the procedure is called classification.

We decompose a i^{th} vector of k^{th} group $X_{(ki)}$ from grand mean m as, $x_{(ki)} = X_{(ki)} - m = (m_{(k)} - m) + (X_{(ki)} - m_{(k)})$, where $m_{(k)}$ and m are the mean vectors for k^{th} population and all populations, respectively. So any data is the sum of main effects (Among Group) and Within Group deviations ($X_{(ki)} - m_{(k)}$). The SSCP are then $\sum X_{(ki)} X_{(ki)}^T = \text{Sum } (m_{(k)} - m) (m_{(k)} - m)^T + \text{Sum } (X_{(ki)} - m_{(k)})^T$, summed over $i = 1$ to $N_{(k)}$ and $k = 1$ to g groups. Symbolically, $T = A + W$, where only two matrices are independent because of closure constraint. We get $W^{-1}T = W^{-1}A + I$, having only one independent matrix, $W^{-1}A$, for further analysis as I (Identity matrix) is a constant. If covariance's (correlations) among the groups are equal (H_1 true), the dispersion among the groups $D(A) = A/(g-1)$ and dispersion within groups $D(W) = W/(N-g)$ where N is total data over g populations. The null hypothesis $H_2 : \mu_{(k)} = \mu$ for all $k = 1, \dots, g$, and $m = (\text{sum } X_{ki} \text{ over all } i \text{ and } k)/N$. Rao (1973) proposed F test as follows:

$$s = \{(p^2 (g-1)^2 - 4) / (p^2 + (g-1)^2 - 5)\}^{1/2}; n_{(1)} = p(g-1); n_{(2)} = s[(N-1) - (p*(s-1) + 1)/2] - (p(s-1) - 2)/2.$$

Let $y = (|W|/|T|)^s$. Then, $F(n_{(1)}, n_{(2)}) = ((1-y)/y) (n_{(2)}/n_{(1)})$ and tested for statistical significance. H_2 true, if F test is nonsignificant, means all mean vectors are equal.

Linear Discriminant Function (LDF)

For two groups, $g-1 = 1$; hence there can be only one LDF (Hyperplane). But for multigroups $g-1$ is more than one so we can have several LDFs some of which may not be significant (should be dropped) but we also need the angles between the

accepted (significant) LDFs (Hyperplanes). The retained LDFs form a subspace within the original p dimensional space and samples may be projected onto this subspace for visual studies. Optimal solution is to maximize the ratio $W^{-1}A$ (nonsymmetric real matrix) in the common discriminant subspace defined by vector v s.t. the ratio $(\Lambda) = (v^T A v / V^T W V)$ is maximized with the constraint $v^T v = 1$. The maximum values are the eigenvalues of $W^{-1} A$: that is we solve $(W^{-1}A) V = V \Lambda$. Since W is fullrank W^{-1} is unique and can be decomposed as $U \Lambda_1 U^T$, so $W^{-1/2} = U(\Lambda_1^{-1} U^T)$. Then, eigenvalues of $W^{-1} A$ is same as that of $W^{-1/2} A W^{-1/2} = B$ but having a different eigenvector U_2 . Since B is symmetric, its eigenstructure is $U_2 \Lambda_2 U_2^T$ and the eigenvector matrix V of $W^{-1}A$ is obtained as $V = W^{-1/2} U_2$ and eigenvalue Λ_2 . The number of LDFs to be retained are obtained by statistical significance tests for elements Λ_{2j} where $j = 1$ to $(g-1)$ or p whichever is minimum (= rank of $W^{-1}A$ matrix). The importance of j th discriminant function (if retained as significant) can also be judged by the ratio $\Lambda_{2j} / \text{trace } \Lambda_2$ where this ratio lies between 0 to 100 %. Also, each Λ_{2j} can be tested as a canonical correlation of discriminant vector v_j with any population (group) as the criterion (Y). The eigenvectors in V should be normalized (to vector with magnitude 1) and the angle between the i and j th linear discriminants $J_{(i)}$ and $J_{(k)}$ is given by: $(\theta_{(i,j)}) = \text{Cos}^{-1}(v_{(ik)} \cdot v_{(jk)})$. These angles are not necessarily orthogonal since $W^{-1}A$ is a nonsymmetric matrix. Discriminant scores can be computed as $v_{(i)}^T x_{(jk)}$ for each retained eigenvector j , and x_{jk} the k^{th} sample of j th group. These scores can be projected onto the common discriminant sub-space for visual perusal. A chi-square test of significance of discrimination amount for remaining $m-k$ discriminants after accepting the first k significant discriminants can be assessed and tested as $-(N - (p+g)/2) \ln \Lambda^*$ with $df = (p-k)(g-k-1)$ and Λ^* is product of $1/(1 + \Lambda_j)$ for $j=(k+1$ to $m)$. This test should be nonsignificant. Usually two discriminants are most useful for visual representation of projection of LDFs as straight lines in the discriminant space, but 3D projections can

be made if three discriminants are required.

Quadratic Discriminant Function (QDF)

If at least one covariance matrix is unequal among the groups, then pooling of covariance matrices to give a common covariance matrix is inadmissible. The discriminant is not linear but hypersurface (s) given by $\mu_{(1)} D_{(1)}^{-1} \mu_{(1)}^T - \mu_{(2)} D_{(2)}^{-1} \mu_{(2)}^T$ which reduces to LDF if $D_{(1)} = D_{(2)} = D$ as $(\mu_{(1)} - \mu_{(2)}) D^{-1} (\mu_{(1)} - \mu_{(2)})^T$ as was derived under LDF theory. If number of samples $N_{(1)}$ and $N_{(2)}$ are large, LDF is sufficiently robust for applications. Also, for QDF, F test is inapplicable to find its significance.

VI. GEOCHEMICAL EXPLORATION FOR URANIUM DEPOSITS

Exploration for U deposits has assumed great importance in the last 25 years because of (i) Energy crisis, (ii) Security and Defence (iii) medicinal use, (iv) social & economy, and (v) political factors. U does not enter into rock-forming minerals in the crust and is concentrated in residual fluids after acid-magmatic crystallization. So, U enters as ore minerals in pegmatites and hydrothermal veins. These ore minerals are weathered and deposited under reducing environments in Conglomerates, Sandstones, Black Shales, Unconformities etc. Geochemistry is important in all these hydrothermal and sedimentary ore deposits since deposition occurs through (i) oxidation-reduction reactions at different pH conditions, (ii) physico-chemical and biotic conditions and (iii) climate states in evolving earth. We know that Archean era was highly reducing with little free oxygen; Proterozoics became oxygenated but generally reducing, while Phanerozoics to Present became dominantly oxygen rich & aerobic (free oxygen in atmosphere and surface waters). U deposition is very complex, nonlinear and dynamic system with hysteresis loop (Sahu, 1995, 2001) of alternating deposition/nondeposition of U depending on its concentration and Eh and pH etc. However, for exploration we deal

with a static system which is temporally linear but spatially nonlinear. Suitable pre-transformation is needed to linearise the system so that linear statistical methods s.a. MND becomes applicable for analyses and inferences to discover concealed U deposits. Integration of all information on geology, geochemistry, geophysics, remote sensing, GPR, soil gas for He and Rn etc. is necessary for success besides proper statistical processing to delineate positive anomalies.

In exploration stage, following multivariate methods would be useful: Multiple/partial correlation and Factor analyses and also canonical correlation for finding pathfinders and delineating anomaly Twogroup and muligroup linear discriminants to delineate ore, lowgrade ore and waste zones.

In development and production stages, it would be prudent to identify ore zones s.a. (i) Marketable Grades, (ii) Marketable Grades after beneficiation, (iii) lowgrade as future resource and (iv) waste material by using Multigroup Discriminant Function approach. Then optimal mining, beneficiation and marketing operations would maximize economic benefits, social aspirations and environmental protection/remediation.

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EXPLORATION CONSTRAINTS AND COMPLEXITIES IN GRANT OF MINERAL CONCESSIONS

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ABSTRACT

India is endowed with vast resources of a range of minerals. Geological Survey of India and the geology department of state government have carried out exploration of these mineral deposits, but for the last three decades or more not much has happened in the area of exploration. Govt. of India came up with National Mineral Policy in 1993 and again in 2008 to boost mining industry. But even this did not deliver. Taking the support of liberalization, govt. of India decided to permit foreign direct investment in mining industry. Giants in mining industries came in the fray, but even this did not give any desired result. The MMDR 2011 is under consideration in the Parliament. In fact there are no complexities in the existing MMDR Act 1957 and MCR 1960. Many of the complexities are created by the state bureaucracy while processing applications or by the learned advocates and Judiciary in their wisdom. Every State Govt. should organize refresher courses for the personnel involved in Directorate of Mines, district level field officers. Lessees or applicants may be invited to interact with the regulatory authority and express their views on any complex issue. This sort of interaction may go a long way to resolve many issue and instill confidence to the personnel involved in processing applications and to the entrepreneurs.

1. INTRODUCTION

India is known for its natural wealth, specially the mineral wealth. For optimum extraction of mineral resources, proper understanding of mineral deposit like its extension, both lateral and vertical, its structural configuration, quality and quantity are very much essential. Such an understanding is possible through systematic exploration of mineral deposits in its entirety and is a must before starting mining. India is a vast country, and such systematic study is not possible through any one organization. Multiple approaches through private and public sectors together is only the solution. But for such a thing to happen, appropriate technologies, required funds and speedy disposal of applications for exploration is essential. But there are several constraints, which have come in the way of much needed exploration. Some of them are artificial or created, which needs to be tackled. Some of these issues which have become bottleneck have been discussed in this paper.

2. EXPLORATION ONSTRAINTS

2.1 India is a vast country. The geological set up of the country clearly indicates scope for occurrence of many valuable mineral deposits. To extract these mineral deposits optimally, proper understanding of mineral deposit likes its extension, both lateral and vertical, its structural configuration, quality and quantity are very much essential. Such an understanding is possible through systematic and scientific exploration. Geological Survey of India is the nodal agency responsible for systematic mapping and understanding of mineral deposits in the country. For more than a century, GSI has carried out regional mapping of many parts of the country and the organization has also discovered many valuable mineral deposits. In addition to this central agency, many States have their own geological organizations. Many of these organizations in the early 50's and 60's have done wonderful work in unearthing

several treasures from the mother earth. In spite of all these efforts, it is a fact that many parts of the country have not been covered with basic regional surveys. Today whatever the mining industry is extracting is the result of earlier explorations by the above agencies. There are no worthwhile exploration works carried out in the country in 70's and subsequent years. Why such a stagnation in exploration? Issues are many.

2.2 Main problem of the National and State agencies in carrying out exploration is resource crunch. In fact, at one point of time, the Government of India asked Geological Survey of India to generate its own source for sustenance. Story is same with the State organizations also. Added to this, many of these organizations have depleted human resources. Many of the sanctioned posts are vacant in many organizations, let alone creating new posts for new activities. This has created huge volume in trained manpower

2.3 Many of these organizations are also not having required equipment and state-of-the-art technology for carrying out exploration. In many organizations, even the available equipments are under utilized for want of trained manpower or resources to put them into use. With such a condition, one cannot expect huge exploration expenditure. Therefore, money spent on exploration in the country is nothing comparable or nearer to the expenditure by countries like Canada, Australia etc.

3. LIBERALIZATION POLICIES:

3.1. In order to come out of the above discussed problems, Government of India, brought in several policy initiatives. One such policy initiative was "National Mineral Policy 1993". The main objective of this policy was to bring in Foreign Direct Investment in

Mining sector, specially in exploration. Government of India wanted several foreign companies specialized in exploration to invest in India in exploration with latest technology. In order to attract them, the mineral sector was opened up to foreign companies. Minerals like Gold and Diamond which were hitherto reserved for exploration by National organizations were made available to foreign companies. Government of India has introduced a new concession called Reconnaissance Permit (RP) for regional exploration and aerial surveys. RP holders were given preference over others for further exploration through prospecting License.

3.2 In spite of all these policy initiatives, even after one and half decades, it did not give expected results. In order to overcome this, the Government of India further came out with 'National Mineral Policy 2008'. The main objectives of this policy initiative are zero waste mining, transparency in allocation of concessions, preference to value addition industry in grant of mineral concessions, seamless transfer of concession from exploration to mining.

They have also introducing one more mineral concession namely "Large Area Prospecting Licence" for exploration. It is in-between RP and PL. To give effect to these policy initiatives, Government of India is bringing MMDR Bill 2011 which is pending for consideration with Parliament. In the absence of this, for speedy disposal of applications for concessions, Ministry of Mines have issued several guidelines and circulars since 2009 and onwards. Ministry of Mines have created Central Empowered Co-ordination Committee and are meeting quarterly and deliberating on several issues. In spite of these

things, there were more than 50,000 applications for mineral concessions pending with several State agencies.

4. EXPLORATION IN LEASE HOLD AREAS

- 4.1 Understanding of mineral deposit within the lease hold areas is not different. There are large areas with several public and some private agencies. Exploration within these lease hold areas is also not complete. Even within these areas, exploration is limited to annual production or at the most production for next 2 or 3 years. Not that these agencies have financial crunch. Many have expressed that if I explore the entire lease hold area with huge investment, what guarantee is there that the State will permit me to hold the entire area with me till exhausting explored mineral deposit. There is a fear that the State may take back part of the area at the time of renewal. It has become true in several cases. To overcome this, the State have to take a firm policy decision and decide on the area which will be permanently or till complete extraction of mineral deposit, with much lessee. Such decisions shall not be meddled with at any cost.
- 4.2 Instead of such an approach, Ministry of Mines have come out with guideline to introduce an additional condition under rule 27(3) of MCR, 1960 in the lease deed. As per this additional condition, exploration in the lease hold area shall be complete within a maximum of 5 years. The progress and information of this has to be sent to the Chief Controller of Mines, in addition to State Mining and Geology Departments. Almost 3 years are over for this guideline and I am doubtful about the progress made in introducing this additional condition in the existing lease document let alone

monitoring the progress of exploration.

5. SCHEME OF CONCESSION FOR EXPLORATION.

- 5.1 Let us examine what are the concessions available for exploration and problems in obtaining them. There are two concessions namely 'Reconnaissance Permit' (RP) and 'Prospecting License' (PL) for exploration purposes. As earlier discussed, RP is for regional exploration and PL is for detailed explorations.
- 5.2 There is a time frame for disposal of applications for RP and PL. As per Rule 63A of MCR, 1960, an application for an RP has to be disposed within 6 months and PL application has to be disposed of within a period of 9 months. But no State Government takes decision on RP and PL application within the time frame. Reasons for delay are many.

6. COMPLEXITIES IN GRANT OF MINERAL CONCESSIONS:

- 6.1 If you carefully study the provisions of MMDR Act, 1957, MCR, 1960 and several guidelines for speedy disposal of applications issued by the Ministry of Mines, there are no complexities. The MMDR Act, 1957 is crisp with 33 sections and clear, so also MCR, 1960 and guidelines. Many of the complexities are created either by the State while processing applications or by the learned Advocates and Judiciary in their wisdom. As a result, a project proponent for exploration has to pursue with the State for several years and fight legal battle from High Court to Supreme Court for several decades.
- 6.2 Now let us try to understand some of the complexities created by States and how to overcome these. In respect of grant of RP, the State,

based on their geological understanding, notify areas available for RP for a set of minerals or associated minerals. The experience indicates that several States have not notified area available for an RP for a mineral or associated minerals. Further, after grant of RP and relinquishment of RP area or within 6 months from completion of RP work, the area shall be made available for others for regrant by notifying such areas. But this also never happens for several years. What is the hindrance for notifying the areas. There are no practical difficulties in notifying areas.

- 6.3 Law is very clear, if an RP is granted over certain area for a certain mineral to an applicant, the application of others over the area for other mineral for an RP/PL/ML may be considered. But, the State will not consider and reject other applications for other mineral stating that the area overlaps with already granted RP.
- 6.4 Another hindrance to get an RP is that the project proponent has to get clearances from several organizations for aerial survey, including Ministry of Defence, which takes quite some time.
- 6.5 In respect of grant of PL, some of the complexities created are as follows. Along with a PL application, the applicant has to submit sketch of the area for which PL is requested. As per rules and also guidelines issued by MoM, if the application is for area less than 40 ha. or if two or more villages are covered within that area, then applicant has to furnish a sketch, preferably on village scale may (1"=660' scale) with khasara numbers. Otherwise a topo map on 1"=50,000 scale is enough. But, the agency processing the application writes to the applicant, even if the applied area is more than 40 ha. to furnish sketch on 1"=660' scale. If the applied area is, let us say 2000 ha, then it covers

several villages. Even, if all the village maps are joined and a sketch is prepared, it will be much bigger than a big table and it may not be possible to open and superimpose other applications. Added to this, lot of precious time and money is wasted in acquiring village maps and preparation of sketches which is uncalled for as per rules.

- 6.6 Another problem faced by PL applicant is the letter issued by the State agency to get clearance from Revenue Authorities like Deputy Commissioner of a district, from forest authorities and if the land is private, consent from individual pattadars. Are these consents really required? The law is very clear that it is the responsibility of the applicant to obtain the consent of the land owner at the time of entry into that particular piece of land. But inspite of it, the granting authority insists for these consents. For getting consent from Deputy Commissioner, the project proponent has to move from village accountant to the District Magistrate. Also, guidelines issued by Ministry of Environment & Forest is very clear that if no tree felling is involved, clearance under Forest Act, 1980 is not required and with the permission of the District Conservator of Forest, 25 boreholes of 4" dia can be drilled in an area of 10 sq.km. during prospecting. Also, no environmental clearance under environmental Notification is required for a prospecting licence. Also, during prospecting, if a bore hole or a pit or a trench is not covering in a particular piece of land, consent from such land holders are not needed. Therefore, insisting on consent from DC/Forest/Pattedars before grant of a PL is unnecessary and uncalled for, which leads to delay in grant of concession.
- 6.7 There are several instances where the granting authority has written to PL applicant stating that the area is

already explored by the State / Central agency and therefore, he should apply for Mining Lease instead of a PL. Let us presume that even if the area is explored by State / Central agency, whether the date / information is sufficient to prepare a mining plan as per the guidelines of IBM and also such date is how far reliable and authenticated. In such matters, the law is very clear. The State, in their opinion feels that a mining lease application is to be filed over an area, they cannot reject or refuse to grant PL over the area. But why the State does not understand this.

6.8 Another peculiar instance which has come to the notice of the author is issue of notices to applicants under Rule 5 (1) for RP applicant, under Rule 12(1) for PL applicant and under Rule 26(1) for ML applicant who is later in preference over others. Sec 11(2) of MMDR Act, 1957 is clear that if there are multiple applicant over an area and if the area is not notified, the application who is first in time has to be considered and granted lease if eligible as per Sec 11(3). If he is not eligible, a speaking order rejecting his application after giving him an opportunity to be passed and subsequent applicant may be considered. There is no need to issue notice to a later applicant stating that why your application should not be rejected as it overlaps with earlier applications. Such improper actions will result in multiple applications. Because, the affected applicant approaches the Revisional Authority, which reverts his application for consideration.

6.9 There are other peculiar instances of rejecting applications. One such instance is that the State has invited applications for grant of licence for a mineral by notifying certain area. There is no bar for consideration of application over the same area for other minerals. If the area is already granted to an applicant

from the notified area and application is received for other than the notified mineral, opportunity to be given to the holder of the licence and if he is not interested it can be granted to the applicant who has applied for other mineral. But the granting agency rejects the other applicant stating that the area is not notified and therefore his application cannot be considered.

6.10 Section 6 of MMDR Act, 1957 has stipulated maximum area for concession for a mineral in a State. It is 10,000 sq.km for RP, 25 sq.kms. for PLs and 10 sq.kms. for MLs. However, there is provision to relax this upper limit in certain cases with the prior approval of Central Government. There are no restrictions in area for filing applications. Any number of applications over any extent may be filed. It is the application whose consideration for grant or grant will become void. But there are instances where the State has issued notice or rejected applications, at the application stage itself, stating that the applied area exceeds the upper limit, without granting an inch of land to the applicant. Even Sec.11(1)(d) provides for relaxing the upper limit, but the State in that wisdom, rejects applications stating that the area applied exceeds the upper limit, without granting an inch of land.

6.11 Under rule 28 of MCR, 1960, if a concession after grant has not worked continuously for a period of 2 years or starts work but stops continuously for a period of 2 years, such licensee before 6 months of such 2 years period shall apply to the activities for revival of licence giving sufficient reasons. Then the authority can consider his application and revive his license. Such revival can happen only twice in the life span of a licence. If there are no application for revival, then the authority shall declare such leases as lapsed lease. Such areas

shall be made available for regrant to others be notifying. Unfortunately, the State is not using these provisions. In many cases State has transferred such lapsed lease to other entrepreneurs without notifying. There are many leases under lapsed category where the State has not used the provisions for declaring them as lapsed leases.

6.12 There are provisions to reduce the area by the lessee at the time of renewal. There are instances where the lessee has opted for a lesser area at the time of renewal for various reasons. However, while preparing a mining plan, he finds that such reduction will result in insufficient mining. Then he approaches the State Authority, before he passes an order on his earlier renewal application, requesting him to consider his new application for the full area for renewal. But, the State in its wisdom refuses to consider his 2nd request for full area, though it has not passed any orders on his earlier renewal application.

6.13 There are many such complexities created by the State which I would not like to dwell upon. Only I would like to say that most of these complexities are created by the persons involved in processing applications and not because of the provisions of the Act or Rules.

7. CONCLUSIONS

7.1 When we examine the complexities created in grant of mineral concessions, it is evident that there is no problem with the Act or Rules. The problems are because of the persons involved in processing applications who does not apply their mind in understanding the procedures laid out in the Act and Rules or guidelines issued by the Ministry of Mines, Government of India. If they only devote some time to understand the procedures laid

down, more than 50% of complexities can be avoided.

7.2 In this regard, every State Government should devote some time for organizing refresher courses periodically to the personnel involved in the Directorates, district level field officers and also to the personnel involved at Government level. In these courses with the help of experts in the field, different provisions and actions required to be taken at different levels have to be discussed. At the end of the course some time to be devoted to invite some prominent lessees or applicants and they should be asked to express their problems and solutions for such problems as per the provisions of the Act and Rules should be found out. This sort of interactions will help in resolving many issues and also gives confidence to the personnel involved in processing applications and to the entrepreneurs.

7.3 Most important thing required in resolving many issues is the change of mind set of the bureaucracy. Decision makers, many times does not devote time in understanding the issues. In many cases, they rely mostly on their trusted leftinants. If the trusted leftinant is in the right track, decisions will also go in that direction. Decision makers should come out of the mind-set that they are helping some applicants. If there is change in the mind-set, most of the complexities can be sorted out. In the process, litigations at many levels will get resolved. If the personnel involved at different level feel that they are meant for doing the work of the mining industry, as per rules, industry will flourish without problems.

➤ **SGAT NEWS**

- **Workshop on Allocation of Coal Blocks held on 12 April 2013 at Bhubaneswar**

Summary of Proceedings

Welcoming the delegates, guests of honour, special invitees, representatives of electronic & print media and Hon'ble Minister for Steel & Mines, Government of Odisha, Shri B K Mohanty, Advisor, SGAT informed that a background paper spelling out the objective of the Workshop and issues for deliberation has since been circulated for reference of the delegates.

The inaugural session contained addresses by Shri S B Mishra, IAS (Retd), former Chief Secretary to Govt. of Odisha, Dr. S K Sarangi, President, SGAT, Shri Vivek Patnaik, IAS (Retd), former Chairman, Odisha Public Service Commission. Shri Rajani Kant Singh, Hon'ble Minister for Steel & Mines, who graced the Workshop as Chief Guest delivered his inaugural address.

Shri. Sudhansu Mishra, IAS (Retd), former Chief Secretary to Govt. of Odisha

Shri. Mishra who graced the Workshop as Guest of Honour had met the following observations

1. SGAT has an excellent track record as a Think Tank on Mining Sector.
2. Mining sector is in complete disarray in Odisha and this leading player in the State's economic growth is in distress. Sponge iron plants have practically closed down. Steel plants are operating at a fraction of their capacity due to severe raw material shortage.
3. Coal scenario in the country is equally chaotic. Scams, scandals and litigations have taken precedence over the needs of critically starved power plants. With past allocation of blocks under legal scrutiny by Apex court, development of allocated blocks and further allocation of

blocks have become uncertain. All the while a severe power crisis grips the country.

4. Legally speaking, there seems to be serious doubts about the authority of Ministry of Coal (MoC) to allocate coal blocks earlier through screening committee procedure or now (from 2012) through auction, since MoC has no role under MMRD Act under which the States lease out coal areas. It is necessary to expedite final legal decision on the issue so that the current stalemate is resolved and coal allocation/lease/development can move ahead. Expeditious enactments of new MMRD Act and LA Act are in the national interest.

5. The practice of allocating large blocks to multiple companies located in different parts to the country should be done away with as joint effort for development of mineral bearing blocks can rarely succeed. NALCO has failed to show any tangible progress in years in respect of the new mines in Chhendipada as a joint partner. However, where such joint allocation becomes inevitable, a state PSU such as IIDCO or OMC must spearhead a SPV to implement the project as the principal facilitator.

6. The OMC should take on the responsibility to supply mineral ore and coal to starving industries. It should get allocation of coal blocks through auction or JV with Coal India/other lease holders and develop coal mines for local industries /consumers. The primary mandate of OMC is to facilitate mineral based industries in the State, not so much to work its mines for profit only.

7. Odisha has already earned a bad reputation for undue delay in implementation of projects. NTPC has shifted Gajamara project from Dhenkanal district to MP and would do so in case of Darlipali project in Sundergarh district due to abnormal delay and lack of State assistance to overcome impediments. Land acquisition, rehabilitation, allocation of water and power supply, forest/ environmental clearances take ages to

materialise, thanks to governmental apathy. Lawlessness is a chronic feature in many industrial clusters. Firm and proactive governance is the crying need. Likewise, there is also the need to discipline errant companies to ensure local employment, adherence to safety and environmental norms, and worthwhile CSR activities.

8. Many regions, specially Angul-Talcher and Sambalpur-Jharsuguda zones, have high levels of pollution. New thermal plants or polluting industries should not be permitted at places without further carrying capacity study.

Shri Vivek Pattanayak, IAS(Retd), former Chairman, Odisha Public Service Commission and MD, IPICOL.

Shri Pattanayak discussed about the powers of the State Government and Central Government in the Federal set up in the matter of grant of mineral concessions. He thought that in the absence of any specific legal provision, the executive power of these State is supreme. Coal blocks are being allocated by MoC on the basis of recommendation of a Screening Committee since 1993. 20 year have since passed. Now a question is raised whether the Central Govt. has the authority to do so. He felt that executive decisions can be made as long they do not conflict with the existing law and the constitution. The problem is there are too many legislations often at variance with each other. Whether it is allocation of coal blocks or grant of PL/ML for coal, there has to be clear cut statutory enactments. The natural resources are not evenly distributed in the country and no State can claim exclusive right over such resources even though these occur within its territorial jurisdiction. They have to be shared for inclusive growth of the Union.

Dr. S K Sarangi, President, SGAT

Dr. Sarangi, in his address presented an overview of the global and national scenario in energy sector, production and consumption of coal. He mentioned that out of 200 blocks allocated, 22 have been

re-allocated and in only 30 blocks mining have started. The total production from these blocks during 2010-11 was only 36.30 million tonnes as against the target of 104 million tonnes. He attributed the short fall to delay in land acquisition, statutory clearances, R & R package and grant of mining lease and lack of road connectivity. He mentioned that as many as 179 proposals of CIL were pending for forest clearance.

Dr. Sarangi mentioned that considering the increasing coal demand and reliance on coal for power generation collective efforts of the Govt. power producers, coal miners, service providers and called for in the areas of land acquisition, R & R package, R & D, infrastructure development, and up-gradation of technology to improve productivity and recovery. He suggested for creation of a single window system to expedite all statutory approvals, involvement of technocrats for over all mineral development.

Dr. Sarangi mentioned that keeping the overall mineral development of Odisha in view, SGAT had prepared a Vision Document for Mineral Development – 2020 but no follow up action has been taken till date. On the other hand, Govt. of Gujarat has evinced keen interest for preparation of such a document by SGAT.

Inaugurating the Workshop, Shri Rajani Kant Singh, Hon'ble Minister for Steel & Mines, Government of Odisha said that the issue of Allocation of Coal Block has attracted lot of attention and controversy in recent days and the competence of the Ministry of Coal, Govt. of India to allocate Coal Blocks has been questioned by the Hon'ble Supreme Court of India. The matter has been dealt extensively in the background paper prepared and circulated by SGAT for deliberation in the Workshop. He complemented SGAT for spelling out the issues in proper perspective and expressed that the distinguished delegates will express their considered views in the matter.

Coal is a fuel of supreme importance and it will continue to be so for quite some years. Apart from its conventional uses, efforts are on to utilize coal of Talcher Coalfield for production of oil. In spite of the fact that the resources of coal in the country are estimated at over 293 million tonnes, there is excellent potential to locate additional resources and this can be achieved by detailed proving. Besides, CMPDI, the State Directorate of Geology will have an important role to play in this regard during the 12th five year plan.

Odisha contributes about 25% of the total production of coal in the country. Additional production to be achieved during the 12th five year plan will be almost entirely contributed by open cast mines. This will result in increase in pollution load, degradation of land surface and displacement of persons. These adverse affects have to be mitigated by appropriate R & R measures and environment management.

On the topic of the Workshop, Hon'ble Minister emphasised the fact that the State is the owner of mineral resources in its territory and this includes coal. It is therefore, necessary that any decision regarding allocation of coal blocks and grant of leases for coal will have to be done with the approval of the State Government and keeping in the interest of the state in view.

The state earned revenue of approximately Rs. 5400 crores by way of royalty during 2012-13, an increase of about Rs. 800 crores over 2011-12. It is pertinent to note here that revision in royalty rates has become due since August, 2012 and the revised rates cannot be given retrospective affect. The State Government has been pursuing with Government of India for revision in the royalty rates. But this has not materialised yet. As a result, the State Government has been put to substantial loss in revenue.

The statements being issued by Coal Ministry and Ministry of Environment & Forests are often at variance. This should be reconciled so that the State

Government and the industry do not get wrong signals. Several industrial and infrastructure projects across the country have failed to take off due to delay in environment and forest clearances. This should merit urgent attention of the Central Government

The two coal mining areas of the State namely Talcher and Ib river valley are among the most polluted reasons of the country. It is incumbent on MCL, NTPC, NALCO, and other companies who are generating power and producing metallurgical products to ensure that the pollution level is kept at bay, massive afforestation is taken up, water bodies are kept clean and the villages around are provided with clean drinking water.

Continuing his address, Hon'ble Minister recalled his experience during the tenure with NALCO. He observed that record of MCL, NALCO, NTPC and other industrial houses consuming coal being mined in Talcher and Ib Valley Coalfields in the field carrying out CSR programmes and community development leaves much room for improvement. He emphasised the need for settlement of R & R issues and payment of compensation to project effected people before commencement of any project on the ground and the need for association of local community, MLAs, and M P in formulation and implementation of CSR programmes.

The inaugural session ended with a vote of thanks proposed by Shri B C Patnaik, General Secretary, SGAT.

This was followed by presentations by

Shri N C Mohanty, Advisor (Coal), OMC
Shri Sreejit Mohanty, Advocate and Consultant to Steel & Mines Department
Shri Ujjwal Chatterjee, C O O (Coal Project), Tata Sponge Iron Ltd.
Shri R N Sahu, Mining Law Consultant and Advisor, OPGC
Shri R S Malhotra, C O O, Bhubaneswari Coal Mining, Aditya Birla Group
Shri Soumya P. Patnaik, Executive Director, NALCO

Shri Bhola Singh, Dy. General Manager,
OPGC

Shri G S Khuntia, Director in the Board of
OMC & former E D, SAIL

Shri Prabhakar Rout, Mining Law
Consultant

**Shri N. C. Mohanty, Coal Advisor,
Department of Steel & Mines, Govt. of
Odisha**

Shri N C Mohanty had the following
views

(1) "Coal" is the prime source of
"energy" and "energy" is the first
essential requirement for economic
development of any State/Country.

(2) Although Odisha is the State having
two major coalfields with the largest
reserve of "thermal grade coal" in the
country (i.e. Talcher coalfield and Ib-
Valley coalfield), still the State is
facing acute shortage of thermal
grade coal for the upcoming power
plants and steel plants in the State.
PSUs of other developed States like
Maharashtra, Gujarat and U.P. etc
have been allocated substantially
large quantity of coal-reserves from
Odisha coalfields whereas the PSUs
of Odisha have been deprived of their
due share.

The State Govt. has been repeatedly
pointing out to the Central Govt.
about the discriminatory allocation of
coal-blocks.

(3) Shri Mohanty wondered why such a
situation has arisen? and what should
be done at this stage?

There was lack of long-term vision
for the coal-sector in the State. The
demand from this state for allocation
of coal-blocks to PSUs was
insignificant in comparison to the
demand from other developed states.
As a result, PSUs of other states like
Maharashtra, Gujarat, U. P. etc have
been able to grab the lion share of
prime coal-reserves from Odisha
State.

Now, Odisha Govt. has been demanding
before the Central Govt. that coal-reserves
from Odisha coalfields, to the extent of
7,000 million tonnes, should be allocated
to the State Mining PSU of this coal-
bearing state so that high-capacity coal-
projects can be planned for development
for production of 250 mtpa coal for the
upcoming coal-based industries in the
country, with due priority for the coal-
based industries in the State.

**Needed is sustained efforts on the part
of this State to achieve this goal.**

**Shri Sreejit Mohanty, Advocate &
Consultant to Steel & Mines
Department, Odisha**

Shri Sreejit Mohanty, in his presentation
dwelt extensively about constitutional and
statutory framework and current scenario.
Shri Mohanty observed that the increasing
industrial and domestic demand for
electricity coupled with delay in
development of new coal blocks in the
country and burgeoning dependence on
imported coal makes this workshop on
coal block allocation extremely
significant. The volatility in the
international coal market, the trend of
resource nationalism witnessed in the last
couple of years in the major coal-exporting
countries such as Indonesia, Australia and
South Africa and the proposal for coal
price pooling compel India to be self
sufficient in coal. Therefore, there is need
to augment production from the available
coal blocks.

India is widely considered by the layman
as a federal republic but the division of
legislative and consequently executive
powers under the Constitution of India,
1950 ("Constitution") implies a marked
inclination towards a strong centre. The
aforesaid is evident from Article 246 of
the Constitution pursuant to which the
Seventh schedule enumerates the list of
legislative entries under the heads, "Union
List", "State List" and "Concurrent List".
The fields of legislative entries in the
Seventh Schedule do not explicitly refer to
coal.

The control exercised by the Union in respect of regulation of mines and development of minerals is to the extent provided under MMRD Act [now the Mines and Minerals (Development and Regulation Act, 1957 (“MMDR Act”)] and not absolute. The measure of denudation of the legislative/executive powers of the States are the provisions of the MMDR Act, which set out the terms and conditions for grant and exploitation of mining leases, including that for coal.

Apparently, the Coking Coal Mines (Nationalisation) Act, 1972 and the Coal Mines (Nationalisation) Act, 1973 (together the “Nationalisation Act”) were also enacted pursuant to Article 246 read with Entry 54 of List – I. The Nationalisation Act enabled the Central Government to acquire and take over the right, interest and title in respect of coalmines. Consequently, ownership right and interest in all coalmines, including coking coal, across the country came to be vested in the Government or Government companies. However, subsequent amendments in 1976 and 1993 partially opened up the scope for mining of coal by companies owned by the State Governments as well as eligible companies in the private sector. Further, vide letter dated 12th December 2001, the Central Government allowed State Government companies or undertakings to do mining of coking and non-coking coal or lignite reserves subject to stipulated terms and conditions.

Thus, now companies engaged in the production of iron and steel, generation of power, washing of coal obtained from a mine and such other end use, as specified by the Central Government through notification, are allowed to mine coal only for captive consumption. The Government, any corporation or company that holds a lease for coalmine can grant a sub-lease in respect of isolated small pockets of coal reserves and in respect of areas where the reserve is not sufficient for scientific and economical development in a coordinated and integrated manner.

Beginning from 1993, coal blocks were allotted by a Screening Committee constituted by way of an executive order of the Central Government under the Nationalisation Act. The coal block allottees were required to obtain a mining lease from the concerned State Government.

Much of the confusion regarding the process of coal block allocation is attributed to the catena of enactments on coal and the dichotomy between the Nationalisation Act and the MMDR Act. Section 10 of the MMDR Act confers the State Governments with the power to grant mining leases for all minerals. The State Governments are required to apply their mind in making recommendation for grant of mining leases for major minerals in favour of eligible applicants to the Central Government. However, the process of allocation of coal mines on the basis of scrutiny of applications by the Screening Committee renders redundant some of the provisions of the MMDR Act like the aforementioned. Although the Legislative Entries envisage predominance of the Centre in the matter of regulation of mines and development of minerals is concerned, yet the Centre must enact a law with the requisite declaration as to expediency to denude the State Legislatures from making laws under Article 246 on matters enumerated in Entry 23. Once, such law is enacted with appropriate provisions on delegation, the Union Executive can make rules and issue orders. In this context, it would also be worthwhile to mention that the Central Government could exercise its executive powers pursuant to Article 246 read with Entry 54. This is because executive powers are co-extensive with legislative powers and the Constitution does not require the State to act through a law unless fundamental rights under Article 19 or 21 are abridged or a tax is being imposed on a citizen.

Be it as it may, much of the confusion is put to rest with the amendment of the MMDR Act vide Act 24 of 2010 pursuant to which section 11A was incorporated in the MMDR Act. Now, the Central Government is empowered under the law

to select grantees of reconnaissance permits, prospecting licenses and mining leases through auction by competitive bidding. However, only companies engaged in,-

- (i) Production of iron and steel;
- (ii) Generation of power;
- (iii) Washing of coal obtained from a mine; or
- (iv) Such other end uses as may be prescribed in a notification issued by the Central Government are eligible to apply for grant of mineral concession in respect of coal and the concerned State Government is required to grant the mineral concession to the company selected in the auction by competitive bidding.

The Central Government has framed the Auction by Competitive Bidding of Coal Mines Rules, 2012 (“**Auction Rules**”) setting out the modalities for grant of coal blocks through the auction route. These rules were notified in February, 2012 and further amended in December, 2012. Whilst allocation of coal blocks to Government companies shall be by way of allocation, private applicants are required to go through the auction procedure. As on date, applications have been invited for allocation of coal blocks in favour of Government companies. However, the modalities for auction under rule 3 of the Auction Rules are yet to be notified and it is likely that the auction process may not begin in the next six months. The scenario on allocation in favour of eligible private applicants by way of auction will be clear only when the terms and conditions for such auction are notified.

Considering that allocation by auction is likely to take some further time, it is recommended that the Central Government through its coal companies like the Coal India Limited or a separate subsidiary created for the purpose commence ground work such as obtainment of forest clearance and land acquisition on the lines adopted for development of Ultra Mega Power Projects. This would expedite actual coal

production as and when the coal blocks are put for auction.

Further, while identifying the coal blocks and fixing the eligibility criteria for allocation by auction the following may be considered:

- (i) Equitable distribution of coal amongst the States and different classes of end users;
- (ii) Proximity of the end use plant from the coal block to avoid pollution, reduce costs and reduce the burden on the railways;
- (iii) Fixation of practical time limits for achievement of any milestones that may be prescribed with regard to allocation of coal blocks;
- (iv) Imposition of restrictions on change in shareholding or control of coal block allottee company within a prescribed lock-in period;
- (v) Giving preference to eligible users with operational plants but with inadequate coal supplies;
- (vi) Do away with joint allocation and instead allot coal blocks to mining companies, whether in the private sector or Government sector to mine coal for users with limited requirement. This will help avoid lack of initiative or complacency in development of coal block pending commencement of commercial production in the end-use plant and also reduce litigation between the joint allottees.

Shri Ujjwal Chatterjee, COO (Coal Project), Tata Sponge Iron Ltd.

Shri Chatterjee dwelt about the legal aspects, coal block allotment conditions, blocks allotted in Odisha and blocks under production.

1. Legal Aspect

Coal Allocation Letters issued by the MoC mentions that allocations are made pursuant to the provisions contained in Section-3(3)(a) of the Coal Mines (Nationalisation) Act, 1973. It appears that the MMDR Act

does not authorized the Union Govt. to allot coal blocks.

2. Coal block allotment conditions

Blocks allotted on Projected EUP i.e. with no Physical Assets.

The allotment letter does not say anything on change of ownership/manager etc.

Thus, 'fly by night' operators changed ownership

No physical verification of EUP prior to or after allocation.

Blocks allotted jointly were grouped/pooled by MoC

Three types of allotment (a) w/o B G (b) with BG and 100% forfeiture (c) with BG & 50% forfeiture.

Leaders under option II did not have option to choose associate companies.

This lead to unnecessary litigations.

Some of the allotment conditions are arbitrary, viz. Forest Diversion Time schedule.

Centre-State issues were non starters

MoC had no control over the State clearances

MoC pressurizes allottees to expedite on areas where it has no control

"Zero Date" in some cases were revised.

3. Coal block allotment in Odisha

Out of 34 blocks allotted, work has started in only one block (Talabira-1 by Hindalco Industries). The allotment was made in the year 1994. Years of allotment of other blocks ranged between 1998 to 2010.

4. Coal blocks : under production

Shri Chatterjee reported production in 30 blocks (5 in West Bengal, 7 in Chhattisgarh, 9 in Maharashtra, 3 in M P, 4 in Jharkhand, 1 in Arunachal Pradesh and 1 in Odisha). Time taken for starting production ranged from 1 year to 13 years 9 months.

Shri R.N. Sahu, Mining Law Consultant and Adviser, OPGC

Shri Sahu highlighted the various inconsistencies and incongruities in the laws dealing with grant of concessions for mining of Coal. The following are the gist of his presentation.

1. In view of the provisions existing in the MMDR Act, 1957 for the States to obtain prior approval of the GoI for grant of Mineral Concessions for specified minerals like Coal, allocation of Coal blocks by the GoI amounts to infringement of the right of the State Governments as the proprietary right over minerals vests with the States. He observed that leases for Coal are being virtually granted by the GoI, in the guise of allocation of Coal blocks.
2. Though as per the stated object of the Coal Bearing Areas (Acquisition and Development) Act, 1957, (CBA Act, 1957) the Coal bearing areas shall be acquired by the State, but the acquisition is being done by the Union not by the State. Further, the said Act is being used discriminately. While the Act provides that the Coal bearing areas could be acquired for Government companies, this is being done only for Central Government Companies not for State Government Companies.
3. Though it is said that Coal Blocks are being allocated by the GoI in accordance with the provisions of Sec 3(3) (a) of the Coal Mines (Nationalisation) Act, 1973, there is no explicit provisions to that effect in the referred Sec. The observation of the Hon'ble Supreme Court made on 24.01.2013 that allocation of Coal Blocks does not *prima facie* seem to get sanction from any law was cited in this context.
4. Insistence for obtaining previous approval from the GoI for grant of MCs by the State Governments even after allocation of Coal Blocks by the GoI, is avoidably delaying the process of Coal development.

5. Three different categories of Coal Mines exist in the country and there is no uniformity in their legal status. These are

- i. Coal Mines taken over by the Central Government under the provisions of the Coal Mines (Nationalisation) Act, 1973. It is not known if leases in respect of these Mines have subsequently been granted.
- ii. Mines developed in Coal bearing areas acquired under the CBA Act, 1957. There is no provision for execution of leases in respect of such areas except, that the Act provides that mining operation in the areas shall be undertaken as per provisions of the Mineral Concession Rules.
- iii. Coal Blocks allocated by the GoI and leases subsequently granted in respect of such Blocks by the State Governments.

Shri Sahu suggested that uniformity in legal status of all the Coal Mines in the country needs to be ensured

Shri R. S. Malhotra, Chief Operating Officer, Bhubaneswari Coal Mining Ltd., Aditya Birla Group.

During 1980s and 1990s, with the growing economy, it was evident that there would be increasing requirement of power in India. Govt. of India and Private sectors along with CIL would not be able to meet the demand. Amendments to legislation were difficult and as also investment through private sector and its involvement in Coal mining.

Against the above background, GoI, came up with the concept of allocating coal blocks for captive mining.

Only 30% of expected production has come from private sector. Capital investment in modern technology (latest equipment, etc.) has not come in a big way. Generally (except a few), the block

owners are sub-contracting the mining to petty contractors who are experienced in working with CIL. Underground mining has taken back seat with virtually no investment in latest mining technology.

The country is not going to benefit by looking back at what has been done. We need to accept and agree that whatever was done, was with good intent. A major impediment is lack of exposure to coal mining. Therefore, till such time the private sector acquires adequate expertise and make sizable investment, the blocks may be awarded to CIL with condition that after due clearances, the blocks may be operated through the MDO route. The advantages of this approach are

- (1) experience of CIL in handling mining project can be fully utilised.
- (2) investment in modern technology by serious private players through MDO will take place.
- (3) private Sector efficiency would be introduced in mining
- (4) linkage would be under the control of GoI.
- (5) the profits from sale of coal would be with CIL (GoI), thus there would be no controversy.

Shri Soumya P. Patnaik, Executive Director (CP & BD), NALCO

Shri Patnaik suggested that before allocating coal blocks, all statutory clearances should be in place including land acquisition. The State Government should take steps to provide the basic infrastructure facilities like access roads, railway corridor and water supply to facilitate working of the coal blocks to be allotted. After allocation of coal blocks, E-governance and availability of data in Web sites of Central Govt. (Ministry of Coal, Forest & Environment, Power) and various State Govt. Departments in order to facilitate various activities of project proponents. He suggested for development a proper mechanism to avoid procedural delays on account of R & R issues. Shri Patnaik emphasized for proper monitoring of the project by nodal persons nominated by the Central and State Government.

Shri Bhola Singh, Dy. General Manager (Mines), OPGC

Shri Singh observed that the State Government and Govt. of India are not working in tandem, as a result, there is long delay in obtaining statutory permits and clearances before the allottee could start working in the coal block. He suggested for single window clearance, so that the milestones prescribed by MoC can be achieved. He thought that every mining plan should be vetted by either CMPDI or any other institute of repute. Shri Singh was of the view that MDO approach would facilitate and accelerate development of the coal blocks.

Shri G.S. Khuntia, former ED, SAIL, Director, NMDC and currently Director, OMC

Shri Khuntia recounted the history of allocation of Coal blocks since 1993 and mentioned that allocation to private companies based on the recommendations of a inter- Ministerial screening committee has been the accepted procedure since. Subsequently it was claimed that allocations were made basing on merit and intensive consultation with involvement of some Chief Secretaries. CAG reported that the country has lost Rs 1.8 lakh crores by not having competitive bidding. But the estimated loss reported by CAG is not sacrosanct and is open to question. Shri Khuntia thought bidding of mineral bearing blocks is not the best approach for sustainable development of mineral deposits. Then there is question of legality. He expressed that de-allocation of coal blocks would not only be suicidal for economy of the country but it may end up in controversy and scam. Shri Khuntia advocated allocation of coal blocks to private sector will help in reducing import of thermal grade coal to large extent.

Shri Prabhakar Rout, Mining Law Consultant

Shri Rout elaborated the practice of allocation of coal blocks. The MoC calls for applications from the intending parties for allocation of Coal Blocks carved out

by CMPDI. The applications are scrutinised by Screening Committee of MoC. The representatives of the State Government are Members of the Committee. They take part in the allocation process concerning their respective States. On the basis of recommendation of the Screening Committee, the MoC allocates coal blocks. Thereafter, it is left to the State Government to process the PL/ML applications for grant over the blocks allocated. This has been the practice for last several years.

The Constitution of India provides federal structure of Governance in our Country. Due to varied political demography, the States some time differ from the Union on issues concerning their interest. Recently, many States as well as the opinion makers have challenged the authority of MoC regarding allocation of coal blocks. The matter is now subjudice in the Apex Court. Be that as it may, the rule of business in vogue has to be followed until it is altered by the competent authorities.

The coal blocks allocated since 2005 are pending with the State Government for grant of PL/ ML or issue of execution orders. On a reference from the State of Odisha, the Central Government have clarified that until any adverse comments are passed by any competent authorities, the process of converting coal block allocations into PL/ML should continue. Had this been done, there would have been considerable progress for mining in the coal blocks allotted. Presently, a number of applications have reached advanced stages of grant or issue of execution orders. But these are held up as the Steel & Mines Department has not issued any guidelines as to how to proceed with this survey, which has to be done by DGPS. As ORSAC has been nominated as the Nodal Agency to authenticate the DGPS survey, there is some amount of confusion as how the field operations would be coordinated. It has to be established if ORSAC alone is competent to authenticate the boundaries of leaseholds during the process of survey in the field. These issues need to be sorted out by issue of clear

guidelines by the Steel & Mines Department.

The organisations represented in the Workshop include IMFA, NALCO, OMC, OPGC, IBM, DoM (Odisha), Tata Sponge Iron Ltd., Tata Steel, Geomin, EMIL, MGM Group among others. Also present were Dr. S K Tamotia, former CMD, NALCO and Dr. H P Mishra, former CMD, IPICOL and IDCOL.

Summing up the proceedings, Shri B K Mohanty observed that the Workshop has been quite a success considering very useful and informative inputs provided by the distinguished presenters. He mentioned that a Working Group comprising Shri Vivek Patnaik, Shri Ujjwal Chatterjee, Shri Sreejit Mohanty and Shri R N Sahu would finalise the recommendations to be sent to the Attorney General of India, Ministries of Coal & Mines, Government of India, Planning Commission, State Steel & Mines Department and other concerned organisations.

- Prof. Dr. Omkar Mohanty addressed the members on "Heritage of Odisha" on 01.04.2013 evening on the eve of Utkal Dibasa at SGAT Hall.
- SGAT celebrated Earth Day on 22.04.2013 at SGAT Hall. Mr. B.K. Patnaik, IFS, former PCCF, Uttar Pradesh addressed the gathering.
- World Environment Day was celebrated in SGAT hall on 5th June 2013. The function was organized in association with Orissa Environment Society and Indian Science Congress Association, Bhubaneswar Chapter. The first part of the event was on the theme of Earth Day i.e. "Think, Eat and Save" where, Prof. S. Acharya, President, OES; Dr. S.K. Sarangi, President, SGAT; Dr. S.N. Patro,

Working President, OES; Dr. J.K. Panigrahi, Convenor, ISCA, Bhubaneswar Chapter have participated in the discussion. Dr. Manoranjan Kar, Vice Chancellor, OUAT, delivered his address as the Chief Guest. The second part of the event was discussed on the theme "Development in Harmony with Environment". Dr. B. Sengupta, member, QCI; Prof. M.C. Dash, Vice President, SGAT and Mr. B.K. Patnaik, former PCCF, Uttar Pradesh, addressed the gathering.

- SGAT conveyed the Press Meet to highlight the bauxite and alumina scenario of Odisha with special reference to operation of Niyamgiri Bauxite deposit granted to Odisha Mining Corporation on 20.06.2013 which has held at SGAT building. It was attended by number of media persons and the professionals from the society and discussed on various issues on bauxite mining in Odisha. A base paper on "Mining of Bauxite – issues and Apprehensions" was prepared and presented by SGAT. SGAT requested media to work as partners and bring the common people to realize advantages of bauxite mining in Odisha through print and electronic media.

FORTHCOMING EVENTS OF SGAT

- **National Seminar on Developments in Mineral Exploration Techniques - Strategy and Challenges** is going to be held on 14 & 15 December 2013 at Hotel Crown, Bhubaneswar.
- **33rd Annual General Body Meet** shall be held on 15.12.2013 at 6.00pm in SGAT Building.

AWARDS 2013

• SGAT AWARD OF EXCELLENCE – 2013

Nominations are invited for SGAT Award of Excellence – 2013 in the Proforma enclosed. Persons awarded in the past should not be re-nominated. The proforma (4 sets) completed in all respects and duly signed by the proposer should reach the General Secretary, Society of Geoscientists and Allied Technologists (SGAT), Plot No. ND/12 (Part), VIP Area, IRC Village, Bhubaneswar – 751015, Odisha, India on or before **31st October 2013**.

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 or whose work has led to significant development of mineral resources shall be eligible for the award. Self nomination is also accepted.

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

• **SITA RAM RUNGTA MEMORIAL AWARD – 2013**

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 also accepted. The work should be original, innovative and of applied nature.

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 :

The nomination (in 4 sets) in the prescribed proforma should reach the General Secretary, Society of Geoscientists and Allied Technologists (SGAT), Plot No. ND/12 (Part), VIP Area, IRC Village, Bhubaneswar – 751015, Odisha, India on or before **31st October 2013**.

Signature

Place:

Date:

Full name and address of the
Member/Institution proposing

• **H.H. READ MEMORIAL GOLD MEDAL AWARD – 2013**

SGAT awards a gold medal to the best worker on “**Granites and Magmatic Rocks**” on alternative years. The achievement on the works by the nominee shall be scrutinized by a committee. The documents to evaluate shall reach to the General Secretary, **Society of Geoscientists and Allied Technologists (SGAT)**, Plot No. ND/12 (Part), VIP Area, IRC Village, Bhubaneswar – 751015, Odisha, India in four sets on or before **31st October 2013**.

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

Signature

Place:

Date:

Full name and address of the
Member/Institution proposing

All the awards shall be conferred during A.G.M. to be held on 15.12.2013 at 6.00pm in SGAT Building.

➤ NEWS ABOUT MEMBERS

- Prof. Satyananda Acharya was conferred Life Time Achievement Award by the South Asian Association of Economic Geologists (SAAEG) during the Seminar held at Visakhapatnam on 08.03.2013 for his outstanding work in economic geology.
- Sri P.C. Vajani, Dy. Director of Geology, DoG, got retired on 31.01.2013 A.N. due to superannuation.
- Sri Trilochan Mahanta, Joint Director of Geology (L-I) retired from Govt. service on 28.02.2013 on attaining the age of superannuation.
- Sri S.N. Parida, Joint Director of Geology (L-II) was posted in the Directorate of Geology, Bhubaneswar after promotion to the post of Joint Director of Geology (L-I).
- Sri Mihir Dwivedi, Geological Assistant got promotion to the post of Assistant Store Officer on 26.03.2013 and retired from Govt. service on 31.03.2013 on attaining the age of superannuation.
- Sri R.N. Patra, Dy. Director General & HOD of Southern region, Geological Survey of India, Hyderabad retired from Govt. service on 30.04.2013 on attaining the age of superannuation.
- Dr. B.M. Faruque, former Director, GSI and member, National Working Group (NWG) for International Geo Science Programme "IGCP-588 preparing for Changing Coastline", participated in the 2nd NWG meeting convened by Director, GSI, Cochin, in the 9th April 2013.
- Shri Khitis Patnaik, Geologist was promoted to the post of Deputy Director of Geology and was posted in the south zone, Berhampur on 01.03.2013.

- Dr. R.N. Hota, Professor of Geology, Utkal University, Bhubaneswar joined as Head of the P.G. Department of Geology on 1st June 2013.
- Dr. S.K. Sarangi, President, SGAT has presided over Inaugural Session of the National Conference on "Challenges on 21st Century, Mining - Environmental and Allied Issues" organized by IBM at Nagpur on 19th - 21st Feb'13.

He has attended a Seminar on "Innovative Practices for Sustainable Mining" organized by OMQ Division of Tata Steel Ltd. as Chief Guest at Noamundi on 09.04.2013.

He has attended a National Seminar on "Mining Agenda for Future" on 21st -22nd April'13 at Hyderabad as Chief Guest.

He has attended a Seminar on "Sustainable Mining" organized by The Institution of Engineers (India), Andhra Pradesh State Centre on 22.06.2013. He was the Guest of Honour in the Inaugural Session and also presented a paper on Sustainable Mining Practices – A Futuristic Mineral Development Programme.

He has relinquished the charge of President, MEAI on 23.06.2013 at Hyderabad during the AGM of MEAI.

He has visited an industrial laterite mining of Maheswari Minerals near Annavaram East Godavari district of Andhra Pradesh. He has visited 3 mines and the socio-economic and environmental management programme at various areas developed by Maheswari Minerals. During his visit, he has inaugurated the field laboratory at Vanthada.

NEW MEMBERS

1. **Dr. Rosalin Das**
Lecturer in Geology, Banki (Auto.)
College Banki
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2. **Dr. Yamuna Singh**
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3. **Dr. Omkar Nath Mohanty**
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8. **Dr. Naba Kumar Shukla**
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➤ BOOK REVIEW

BOOK REVIEW on 'Paribesh O Man' in Odia Language ('Environment and Man') written by Professor Golak Bihari Mishra, an eminent Mining Engineer, and published in 2013 by PageMaker Publication, Bhubaneswar.

The apex court of India gave a direction to include environmental studies in the curricula of all disciplines of human knowledge some 15 years before and since the environmental studies is a compulsory subject in Arts, Commerce and Science streams in the undergraduate classes. Since late 1980s Departments of Environmental Sciences started opening in Indian Universities. Environmental Management courses have been introduced in Bachelor of Business Administration and Master's in Business Administration and in Environmental Science courses. In Odisha Environmental Science departments have been opened in Sambalpur University, Fakir Mohan University, & the courses are taught in all universities. Courses on environment are taught in schools also. Indian experts have written books on ecology, environmental science and environmental management and many of them have been published by International/National Book publishers. But books popularizing the discipline among school, & college students and people, especially in regional languages are very few. Any new book on the subject written by experts is welcome.

Professor Mishra with rich experience on mining environment has written this book for the school and college students and educated citizens for creating awareness about the urgent need of environmental protection and simultaneously narrating the scientific principles involved in understanding the functioning of the environment and man's role in it. The book contains nine chapters; five of them deal with different facets of the environment; three chapters on different aspects of environmental pollution, the causes, and effect of pollution on environment and man; and one chapter on energy which drives functions of the environment and activities of mankind.

The writing is very lucid, supported with illustrations by line diagrams and with

examples mostly from abroad and few from India and Odisha. The principles/laws involved in understanding the structure and functions of the environment are included in the first five chapters and these will be very much useful to the students and people at large to understand the effect of pollutants on the environment and on Human beings and on climate change aspects. He has dwelt upon the basic scientific principles involved in energy transfer and the need of using renewable energy; especially solar, wind, geothermal, biomass gasification etc. Since Man is dependent on the environment for his continuance in the planet, the environment must be protected with help from technology and changing human mindset on consumerism, energy use etc. The book is very much readable and will be an asset for students in general and especially to the school students, Arts and Commerce students in undergraduate classes.

However the data cited in the book on human population aspects refer to 2001 census, although the projections for the future is given. The book does not deal with adequately on acid rain formation, ozone depletion, vehicular pollution, conservation aspects separately and does not cover in detail United Nation's active involvement since 1972 on climate change, biodiversity conservation, and emphasis on using green technology to achieve sustainable development etc. In spite of these omissions, the book is a welcome addition to the discipline of environmental studies. The printing is good; printing errors are very few and the book is handy. The subject matter has been covered in about 200 pages very nicely and some of the subject-narration is excellent.

I wish to recommend this book for the +2 students, undergraduate students and people at large for reading and learning many aspects of the environment and how human activities are linked to environmental abuse. The book is definitely a vehicle to create awareness. Professor Mishra has ably succeeded in doing this.

Professor M.C. Dash
Vice President, SGAT

OBITUARY



Ashok Kumar Jain
(1954-2013)

SGAT deeply mourns on the sad demise of A.K. Jain who passed away at Bridge Kandi Hospital at Mumbai on 12.04.2013. He is survived by his wife, one sons and one daughter.

He was the Director of Saruabil Chromite Mines of Misrilall Mines (P) Ltd. and also Director of various companies like Misrilall Jain Group, Indian Seamless Metals Tube, Taneja Aerospace & Aviation Ltd. and other. His contribution to construct the SGAT building at Bhubaneswar is highly remembered.

SGAT conveys soulful condolence to the members of the bereaved family. May his soul rest in peace.

Members of SGAT Family

• **SUBMISSION OF PAPERS FOR SGAT BULLETIN**
(Instruction to Authors)

Research papers, review articles, short communications, announcements and letters to editors are invited on topics like geosciences, mineral exploration, 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 the same is original, unpublished and is not being considered for publication elsewhere. Two copies, complete in all respect (with copies of figures and tables) are required to be submitted. Originals of figures and tables should be enclosed separately. Each manuscript must accompany 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. The copies of manuscripts, strictly in accordance with the instructions to authors given below may be sent to the editor of the bulletin.

Journal Format: A-4 size

Language: English

Manuscripts: Manuscripts should be typed in double spacing with wide margins in one side of A-4 size paper 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 conform to A-4 size and carry short captions. Lettering inside figure should be large enough to be accommodate up to 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 the 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) Palioenvironment and palioecology 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 confirming to the format of the journal will be returned.

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

Page proofs: One set of page proofs will be sent to the corresponding author, to be checked for typesetting only. No major changes are allowed at the proof stage. Proof should be returned within three days.

Reprints: 10 free reprints of each published article will be supplied to the corresponding author. Additional reprints can be ordered through payment at the proof reading stage.

