Proceedings of International Conference on Environment Governance & Green Technology

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Editorial:

It is a great pleasure to announce that Centre for Sustainable Development and Green Economics, Bhubaneswar is bringing out this volume on the eve of their international Conference on Environmental Governance and Green Technology (ICEGGT). I am honoured to be the Chief Editor of this volume.

Green Economics has emerged as the main thrust area for Sustainable Development and Green Technology will play a far greater role in the future in reducing Carbon Footprint. A lot of work needs to be done in making the national economies greener. Though a common agenda has emerged among the comity of nations regarding this, there still exist wide variations among nations in perception and implementation of a green economy. While developing countries like India have voluntarily adopted green economy as a mode of growth, a lot of investment in green technology and in poverty reduction is needed in order to make it happen.

Sustainability in all aspects of life from production to consumption should be the norm rather than a fad or exception. Reducing one’s ecological footprint either by reducing consumption or by compensating it with ecologically healthy practices will restore to the Earth its original sustainability. Climate Change has become a reality and if urgent steps are not taken, the carrying capacity of mother Earth may well exceed sustainable level.

In this context the CSDGE’s initiative in making the industry and professional practitioners aware about the issues involved is laudable. State Pollution Control Board, Odisha as the premier regulator of environmental issues is a worthy partner in the venture. We profusely thank the organization for furthering the cause of sustainability.

Lekhasri Samantsinghar

Chief Editor
Available empirical evidences exhibit worldwide enhancement of environmental degradation, depletion of natural resources and economic inequality. Mainstream science has developed a dehumanizing strategy towards animals, plants, natural resources, traditional knowledge and knowledge believes, cultural practices and more over the ethical values, and has harboured hate in the perspective of business and profit. Duality of approach in understanding and applying by separating the ecological and environmental paradigm creates enigma through mental blockage for undermining traditional belief of respecting the system against modern faith on consumerism. Quality of life could be managed through an integral approach among the society, economics, environment and institutions.

This is the recent approach of Environmental Governance for sustainable production with Green technology. Agroecosystems in tropical countries are facing serious problems of low production and high degradation. Some of the major concerns of Indian agriculture are extrinsic factors as it is gradually becoming demand driven. A Green Technology entitled ‘FBO’ (Fertilization Bio-organique Dans les Plantations de thé or “Bioorganic Fertilization for Plantations) has been developed by Indo-French collaborations.

The ‘FBO’ technology and is in application in 16 countries at different input levels. The result indicate system conservation and enhancement in production by both quality and quantity. Local resource use with innovative green technology linked to the farmer’s acceptance and market demand is need of the day.

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(A) Sustainable Production and Environmental Governance need integral approach:

Present globalization at the international level in both developing and developed countries has somehow managed to keep economic growth with active participation. But the available empirical evidences exhibit worldwide enhancement of environmental degradation, depletion of natural resources and economic inequality. There is lot of gap between systems managed to keep running (unpredictable) and to systems maintained with time and space (predictable). This is where sustainability attribute comes in to the picture. Environmental awareness will not yield satisfactory result without its linkage to the behavioural constituents. Quality of life could be managed through an integral approach among the society, economics, environment and institutions. This is the recent approach of Environmental Governance. The Brundland Report (WCED 1987) was best known for putting sustainability into the international policy agenda, but linked poverty to environmental
Sustainable Production in Agriculture Through Soil Care Management: an Enigma of Environmental and Ecological Paradigm

Degradation. Dasgupta (1993) has since explored the connection between poverty, population growth and environmental change. There is enough example of habitat conservation by traditional systems maintained through low input practices. Environmental degradation is induced by development but not by poverty (Barbier, 1977). It is important that both are responsible whether it is for poor quality material and rich ethical standard, or rich quality material and poor value system. Either way, the problem is coupled with both material status and mental understanding. That is perhaps the reason why article 11 of the convention on Biological Diversity calls on the contracting parties to ‘adopt economically and social sound measures that act as incentives for the conservation and sustainable use of components of biological diversity’. Environmental governance for sustainable production has to be linked to diversity of natural, scientific, socio-cultural and management knowledge resources with an objective of man (content) as a member of the container (the Earth Planet). Mainstream science has developed a dehumanising strategy towards animals, plants, natural resources, traditional knowledge and knowledge believes, cultural practices and more over the ethical values and has harboured hate in the perspective of business and profit.

Darwin’s work on ‘theories of Natural Selection and Origin of Species’ indicate the master plan of The Nature in the trajectory of evolution. James Lovelock first hypothesized the Gaia theory in 1969 that emphasizes the Earth and the life as contained in it and coevolved as a global integrated system. He defined Gaia as ‘Gaia is a complex entity involving the Earth’s biosphere, atmosphere, oceans, and soil; the totality constituting a feedback of cybernetic system which seeks an optimal physical and chemical environment for life on this planet’. The theory assumes this Earth to be a single interconnected, interrelated, interdependent and integrated Superorganism which maintains homeostatic regulations by positive and negative feedbacks with self-sustained life in the planet. The Earth planet also has its own self-regulating ability like that of an organism during its life time. Life is an open thermodynamic system maintained in a transient steady state with specific properties of genetic pool, biosynthesis and ability of self perpetuation through feedback mechanisms.

Recent presentation by Mae-Wan Ho and Robert Ulanowicz during ISIS presentation on 25th May 2005 proposed a new conceptual model for understanding sustainable systems as organisms A normal organism maintains its body, energy balance in a transient steady state between enthalpy and entropy. It keeps itself away from thermodynamic equilibrium (death) and simultaneously maintains all attributes of life including care for its future generation. In a true sense this is an ideal sustainable system. This supports the concept of Jones et al. (1994) who states that ‘Organisms are ecosystem engineers’. Synthetic view point of all these four theories may lead to the fact that: (i) organism engineers its surrounding for successful continuation, (ii) organism inherently understands sustainable maintenance or sustainability is an organism, (iii) diversity of life are intertwined to build up the Earth as a superorganism and (iv) in the trajectory of evolution, this superorganism undertakes selection and generation of new species and (v) modifies new conditions as per the demand of a sustainable situation.

Thus man has no option but to think about a sustainable Earth planet through Environmental Governance. Like evolutionary theory, the concept of Sustainable Earth Planet requires a major conceptual shift whose acceptance is slow to materialistic man and but painful to the biosphere. Failure of environmental management throughout the world is because of anthropocentric nature of Environmental Sciences approach without ecological base. Management is a lever for higher performance through multidisciplinary approach. Human understanding of the Nature has to be proportionately widened so as to link performance to quality and sustainability. This is the puzzle of the day.

(B) Enigma of environmental and ecological paradigm:

A paradigm is a vision of the world that corresponds to a certain set of values and principles. When dealing with the environment, two major paradigms exist: (i) the ecological paradigm, based on the science of nature, stresses the health and survival of ecosystems and (ii) the environmental paradigm that emphasizes maximizing the welfare of humans (table-I), even if this means harming the environment (Harris and Codur, 2004). Environmental science is clearly problem-oriented, and part of a policy process. A political scientist would say that the process starts only with identifying a problem. Major blockage in the marriage between these two paradigms is an utter enigma (puzzle) created through mental exercise for undermining traditional belief of respecting the system against modern faith on consumerism.

Most of the problems that have accumulated in the form of environmental crisis are the result of segmental/reduction approach to counteract his immediate demand that has changed face of the earth by manipulation. This is enigma of the day whether to remain adjusted to nature’s way of function which is near impossible or to continue with material affluence. Man is conscious of the Global Climate change impact and thus G-5 and G-8 countries have united to form G-13 world body recently. The field of ecological economics has emerged out of efforts to resolve the differences between these two paradigms. There may be bridges that can be built so that economics and ecology may have a
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The main thrust areas of ecological essence are: (i) the dynamics of hierarchical systems, (ii) carrying and assimilative capacity, (iii) resilience and stability attributes, (iv) biodiversity, and (v) the value of ecosystem functions (Perrings, 2005). Thermodynamically Energy balance is an essential criterion for any stable system.

Ecological and economic systems co-evolve (Norgaard, 1984) with time and space. Therefore, with priority of system sustainability, there cannot be any economic consideration without ecological analysis. The most obvious current example of this anthropogenic impact is climate change, a threat to both natural and man managed ecosystems. Hierarchical systems are nested structures existing at different spatial and temporal scales. Generally, small fast moving systems are constrained by large slow-moving systems, but there also occur junctures at which smaller systems are able to disrupt larger systems. The landscape is an interaction between biotic and abiotic processes at different scales Allen and Starr, 1982). Mutualism coexists between and among diversity of selection pressure, allometric relations and trophic functions.

Thus it is recognized that biodiversity is important for the functioning of all ecosystems. Reduction in the diversity of species in the ecosystem due to intensification may, in some cases, make agroecosystems more susceptible to exogenous shocks or changes in the environmental conditions that this effect is not captured in market prices (Perrings et al., 1995). Enigma of Environmental and Ecological paradigm has made its (table-1) reflection on India’s environmental management. Present problems of water shortage, weather disruption, decreased harvest leading to farmer’s suicide, people’s protest against mines and industries are some of the few examples. The inter-relationship between environmental degradation and many of India's serious problems is often overlooked.

Environmental Sciences is an anthropocentric applied science developed on the backdrop of Ecology which contains it. The contained to be content must understand the interrelation, interaction and interdependency of the components of the container.

(C) Status of Indian Agriculture: prospects and problems

Global climate change, depletion of the protective ozone layer, serious declines in species biodiversity, and degradation and loss of productive agricultural land are among the most pressing concerns associated with our technological search for a higher standard of living for an over growing human population (Doran and Safley, 1997).

Agroecosystems in tropical countries are facing serious problems (table-2) of low production and high degradation. Between 1950 and 1985, the dramatic yield enhancement at the international level was due to 6-9 times increase in commercial energy input resulting loss of product quality, human health, biodiversity and environmental health etc (Senapati et al., 1994). Simplified systems and monocropping harm soil fertility and the ecological balance to a much greater event than in temperate climate because of increased soil oxidation (decomposition & composition) and rapid pest population dynamics in the tropics. Heavy rainfall and high temperature accelerate mineralization of the nutrients and retard accumulation of soil organic matter (Kilcher, 2007). Some of the major concern for Indian agriculture is extrinsic factors (table-2) as it is gradually becoming demand driven. This is going to be more intense in future. Publication of Govt. of India, 2008, Eleventh Plan Vol.1,page 75 indicates Indian total population of about 1208 million people and it may exceed 1283 million by 2016. Economic growth is estimated to be between 6 to 8, and India is going to be third or fifth largest economy of the world.

More than 70% of Indian population remain in village areas and are small farmers. The large sector of subsidies that are pumped out in the name of the marginal farmers does not reach substantially and is mostly taken away by the middle men. Similar is the case of awareness about soil health, market compatibility of product, water and electricity power etc. Recent permission for FDI in retail market, pension and other sectors has created confusion about its impact on regional strategies of agricultural pattern. In the next two decades agricultural sector will be very rapidly diversified to meet market demand. The labour force that has been predicted by Alagh (2012) will be at much below the requirement level. Animal husbandry, fish and forestry section will attract larger attention because of several advantages. On the whole local resources and local demands have to be met with synchrony and sympathy. The effort should be to make it possible to move freely between ecological and social boxes, at all scalar dimensions of the problem, eventually leading to sustainability concerns (Ramakrishnan 2001). Sustainability and Environmental Governance will have a major role to play in years to come.

(D) Linking diversity of life and matter to local and global scenario of agriculture through Green Technology

The abundance of life, habitats, and the tremendous variety of soils as the Earth’s living skin, provide various opportunities for human occupation. Soil is a continuous natural body that has spatial and temporal dimensions (soil cover or pedosphere). Pedosphere strongly regulates and controls the present and future
functioning of the biosphere (Arnold et al., 1990). There is greater emphasis on the relationship between belowground and aboveground soil biodiversity for sustainable production and system stability (Hooper et al., 2000). Soil organisms contain microbes such as bacteria, fungi, actinomycetes and fauna (soil animals). While microflora activity is mostly responsible for nutrient supply through biocatalytic intervention of soil fauna, biophysical properties are sole contributions of mostly macrofauna (figure-1).

Ecosystem engineers (Jones et al., 1994) as described earlier are species that directly or indirectly modulate the availability of resources to other species (and sometimes to themselves) by causing physical changes to biotic or abiotic materials. By their activities, they alter, maintain, or create habitats. The ecosystem engineers largely regulate pedospheric activities in synergistic manner with the microbes.

Diverse soil biota facilitates soil formation and improves it for crop production (figure-1). Size, habitat and food preferences of principal soil animals are quite distinct. One square meter of soil frequently supports populations of approximately 200,000 arthropods and enchytraeids and billions of microbes. One hectare of high-quality soil contains an average of 1300 kg of earthworms, 1000 kg of arthropods, 3000 kg of bacteria, 4000 kg of fungi, and many other plants and animals (Pimentel et al., 1999). Earthworms bring between 10 and 500 t, ha⁻¹, yr⁻¹ of soil to the surface whereas insects often bring between 1 to 10 t ha⁻¹, yr⁻¹ of soil to the surface. Earthworms may ingest as much as 500 t ha⁻¹, yr⁻¹ of soil, thereby churning and mixing the soil.

About 3,800 species of earthworms have been documented around the globe and about 400 from India (Julka, 1993). This is only about half of the biodiversity as expected by taxonomist. Functional categorization of earthworm species has been made into three ecological groupings. Epigeic species live in organic horizons and ingest high calorific undecomposed litter, are good in vermicomposting. Endogeic species forage below the surface, ingest large quantities (figure-1) of soil (geophagous) and build horizontal tunnels. They are important in soil formation, aeration, water percolation, root passage formation, soil turn over etc. and are termed anecics. Bioenergetic demand of earthworms exhibit assimilates of about 25% of total organic input in comparison to about 90% assimilation by termites, an indication of soil conservation ability by the former (Senapati, 1990). An epigeic worm which is about 60 times smaller in dry weight than an endogeic one, the energy demand has been reported to be about 4 times higher in epigeic category (Sahu and Senapati, 1988; Senapati, 1990; Senapati and Sahu, 1993). Functional stratification is an indication of species potentiality for respective agricultural application.

**FBO** case study: an International Patented Green technology for the New Millennium

Plantsation crops need transplantation from the seedling beds. Rice, tea, coffee etc. are all included in this category. Economically tea is a cash crop that earns about 10% of total foreign exchange for India, and is an agroforestry system which is being practiced for about 100 years, mostly grown in south and north-eastern parts of India. Initial tea production was
## Table: 1

### Comparative account of ecological and environmental paradigms

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ecological paradigms</th>
<th>Environmental paradigms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System concept</strong></td>
<td>Ecosystems are natural and regeneration is attained through resilience. The ecological paradigm places value on the long-term sustainability of natural systems.</td>
<td>Systems could be oriented as and when required, and managed through scientific knowledge with short term objective.</td>
</tr>
<tr>
<td><strong>Central thrust position</strong></td>
<td>Nature centric with a message that ‘Nature is the best teacher.’ Man is a member of the community. Man is the content in the container of natural ecosystem.</td>
<td>Anthropocentric where man occupies the central position as the ‘Master blaster’ for the operator position.</td>
</tr>
<tr>
<td><strong>Size structure</strong></td>
<td>Infinite, interrelated, integrated and interdependent through parallel and series guilds.</td>
<td>Finite system of interrelation through mostly parallel guilds.</td>
</tr>
<tr>
<td><strong>Functional status concept</strong></td>
<td>Sink functional status of nature has ability to absorb and render harmless to the waste by-products of human activity within the biokinetic zone.</td>
<td>Source functional status of the environmental paradigm is its ability to make available for human uses the services and raw materials that we need.</td>
</tr>
<tr>
<td><strong>Utilitarian perspective</strong></td>
<td>Natural systems need to be protected for their own sake, independently of their use value to humans.</td>
<td>The environment is taken into consideration only to the extent that it is useful to humans.</td>
</tr>
<tr>
<td><strong>Externalities</strong></td>
<td>Positive as it benefits all the components because of interconnectedness.</td>
<td>Negative as it benefits only the associated target and linkage.</td>
</tr>
<tr>
<td><strong>Cost consideration</strong></td>
<td>Ecological cost or value is most important. There is no use and non-use value. Existence value is the centre of interconnectedness.</td>
<td>Market cost or economic cost is major determinant of cost. Depending on the market demand there is use and non-use value. Existence value is ignored.</td>
</tr>
<tr>
<td><strong>Management alternative</strong></td>
<td>Application of ecosystem principles of recycling to the industrial realm, replacing the straight-line process with a circular pattern, a recent development of Industrial Ecology.</td>
<td>Present path of straight-line process (shortest path from raw matter to finished product) is the cause for several pollution by by-products.</td>
</tr>
<tr>
<td><strong>Sustainable attribution</strong></td>
<td>Sustainability of the ecosystem that manage all natural resources such that natural capital remains constant over time.</td>
<td>Sustainability is attributed to availability of raw material, productivity and market stabilization.</td>
</tr>
</tbody>
</table>
### Table- 2

Relationship between agricultural intensification, inputs, outputs and biological management options:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Shifting cultivation</th>
<th>Fallow rotation</th>
<th>Agroforestry</th>
<th>Intercrop rotation</th>
<th>Monoculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainability components</td>
<td>****</td>
<td>****</td>
<td>***</td>
<td>**</td>
<td>nil</td>
</tr>
<tr>
<td>Crop biodiversity</td>
<td>******</td>
<td>****</td>
<td>****</td>
<td>***</td>
<td>monoculture</td>
</tr>
<tr>
<td>Organic input</td>
<td>******</td>
<td>****</td>
<td>****</td>
<td>***</td>
<td>nil</td>
</tr>
<tr>
<td>Humus status</td>
<td>****</td>
<td>****</td>
<td>***</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>External inputs</td>
<td>nil</td>
<td>nil</td>
<td>**</td>
<td>***</td>
<td>****</td>
</tr>
<tr>
<td>Human labour input</td>
<td>******</td>
<td>****</td>
<td>****</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td>Petrochemical inputs</td>
<td>nil</td>
<td>nil</td>
<td>**</td>
<td>***</td>
<td>****</td>
</tr>
<tr>
<td>Soil Biodiversity status</td>
<td>******</td>
<td>****</td>
<td>***</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Soil bio-physical status</td>
<td>****</td>
<td>****</td>
<td>***</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Exotic crop culture status</td>
<td>nil</td>
<td>nil</td>
<td>**</td>
<td>***</td>
<td>****</td>
</tr>
<tr>
<td>Overall soil degradation status</td>
<td>*</td>
<td>*</td>
<td>**</td>
<td>***</td>
<td>****</td>
</tr>
<tr>
<td>Optimal biological intervention</td>
<td>*</td>
<td>*</td>
<td>***</td>
<td>****</td>
<td>****</td>
</tr>
</tbody>
</table>
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About 1000 kg. ha\(^{-1}\), yr\(^{-1}\) during the early 1950s, the production gradually 1000 kg. ha\(^{-1}\), yr\(^{-1}\) during the early 1950s, the production gradually increased due to enhanced input of chemical fertilizers. In intensively managed tea estates like that of Parry Agro Industries Ltd. located in Annammalai and Nilgiris area of Tamil Nadu state, the annual production of tea ranged from 2500 to 3500 kg. ha\(^{-1}\), yr\(^{-1}\) and has been stabilized at this level. In average for south Indian estate, the yield has stabilized around 1800 ha\(^{-1}\), yr\(^{-1}\). This is in spite of increased input of chemical fertilizers even with spray of plant hormones. The work reported here largely relates to the work done at Carolyn tea estate in Nilgiris, in the Western Ghats, while the work done at other estates of Parry Agro Industries have been reported elsewhere (Senapati et al., 1994; Senapati, 1997 and Senapati et al, 1999).

An earthworm technology entitled ‘FBO’ (Fertilization Bio-organique Dans les Plantations de thé or “Bioorganic Fertilization for Plantations) has been developed by three inventors and associated parties. They are Prof. B.K.Senapati of Sambalpur University, Orissa, Prof. P.Lavelle of IRD (ex-ORSTOM) Univ. of Paris- VI (France) and M. Venkatachalam representing Parry Agro Industries Ltd. (India). This patent bears registration (Patent No. 11034 granted to IRD, France on 17th July, 1997, International Patent Classification (IPC): CO5F 11/08) through the Ministry of Agriculture, France and is protected in 24 different countries. This patent is applicable for various agroecosystems including plantation crops, floriculture, agroforestry, restoration of degraded systems, development of parks, lawns, home gardens etc. ‘FBO, technology was transferred to China in 2003. ‘FBO’ application has started in various countries. The result indicate system conservation and enhancement in production by both quality and quantity. Degradation status of the soil under tea was evaluated in the context of the adjacent native reserve forest soil. There was a significant depletion of soil fauna communities, especially litter feeding epigeics and vertical transporter anecics in comparison with the forest. The compaction, leaching and soil erosion had eliminated 60-70% of the non-target organism. Termites proliferated at the expense of earthworms. Earthworm diversity in Carolyn tea estate of Parry Agro Industries Ltd. Tamil Nadu (India) and adjacent native forest showed only 6 species of earthworms from the tea garden soil as compared to 13 species found in the native forest soil. A. minthas djeeringens, two Drieveida sp., one Megascolex sp., Moniligaster horstii and Pontoscolex corethrurus were found in the tea garden soil. Native species dominated the forest soil where as exotics were dominant in soil under tea. This study indicates that it is possible to assess degradation status of the soil linked with land use using soil macrofauna as indicators (Senapati, et al, 1994, 2002). There was 33.3% and 79.5% enhancement in plant production (processed tea) in the plot under indirect and direct ‘FBO’ technology applied blocks respectively, compared to that under conventional management practices. Cost benefit analyses indicated about 31.0 % and 80.0 % enhancement of profit with indirect and direct FBO’ technology respectively, when compared with conventional inorganic fertilizer input based management practices (Senapati, et al, 1999). Tea produced in eastern India is of a superior quality due to organic cultivation with less or no input of inorganic fertilizer, compared to the tea grown in southern India. The higher quality of eastern Indian tea is also due to plucking of a bud with a single leaf that partition more energy towards synthesis of taste associated with poly phenols, compared to plucking of increased number of leaves (2-3) in southern gardens. This suggests that maintenance of tea agroforestry closer to organic farming will produce better tea with more profit. Many problems arising from pest attack, soil erosion, drought, etc. associated with conventionally maintained agroforestry also will get reduced, by maintaining diversity of organic residues and soil organisms through ‘FBO’ technology. Indeed, the life span of the tea bush which has come down drastically under heavy inorganic fertilization, with serious economic implications for tea bush replacement, is another factor favouring ‘FBO’ technology. ‘FBO’ technology is distinct in its overall performance and linkages for: (i) synergy in the system development,(ii) enhancement of economic benefit,(iii) care for ecosystem conservation,(iv) international collaboration,(v) ecofriendly biotechnology package and (vi) for developing synergy between academic institutes and agroindustries. However, this scientific knowledge is often more effective when is draws upon the richness of existing traditional and popular know-how. Understanding, protecting, and using biosystems in a sustainable way requires an approach that incorporates both types of knowledge. Using this approach, social groups will be able to increase their pool of resources and, indirectly, quality of life. Through this type of “empowerment through knowledge” the issues of sustainable production, biodiversity, organic farming, home garden etc. can be addressed to produce the most profound and positive impact on human societies. But at the centre of all, it is the ecological understanding that matters much and will be the decisive factor to decide human destiny.

ACKNOWLEDGEMENTS

The author thanks all the collaborators and researchers scholars associated with different research projects which were in operation at School of Life Sciences, Sambalpur University before superannuation and to the Head, SoS Life Sciences,
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REFERENCES:


Abstract  Large area of uninhabited jungle and forest lands are cleared for extensive plantation of tea after necessary development. Tea is an intensive agricultural system presently where input is mainly inorganic fertilizers and pesticides to get maximum yield and tea being a cash crop and the continuous removal of green leaves, the system remains always under high input of agrochemicals, i.e. fertilizers and pesticides. Most of the tea garden areas are situated in hilly terrain exposed to constant leaching through heavy rainfall. Because of this the soil has gone considerable weathering with respect to physico-chemical and biological parameters.

With the concept of Tropical Soil Biology and Fertility (TSBF) a voluntary participatory international research programme that, “the fertility of the tropical soils is controlled by the biological processes and can be managed by the manipulation of these processes” an experiment was conducted at micro scale to increase the production level and subsequently not affecting the soil nutrient status and organism. Five themes of TSBF i.e. synchrony, soil organic matter, soil water, soil fauna and integration of all these resources while the ten specific objectives are : (i) to synchronize release of nutrients from organic inputs with plant demand for nutrient through the control of soil moisture, (ii) to synchronize release of nutrients from organic inputs with plant demand for nutrients by manipulating quality and quantity of litter (i.e. crop residues, manures and pruning) and the time of its application in relation to climatic factors (i.e. the onset of rains) and the planting of organic matter (SOM) pools, (iii) to determine the relative susceptibility to management of crops, (iv) to determine the best methods for quantifying the different soil, the SOM pools, (v) to manage SOM in relation to: nutrient release, cation exchange capacity and soil aggregation, (vi) to gain a predictive understanding of the influence of the surface organic inputs and soil organic matter on soil water balance, (vii) to quantify the effect of soil fauna in the formation and maintenance of soil structure, (viii) to quantify the effect of soil fauna in the regulation of decomposition, (ix) to develop techniques for managing soil fauna to improve soil fertility and (x) to develop an integrated approach to the maintenance of soil fertility (i.e. these theme interrelates the four process level themes with other aspects of sustainable agriculture and states that effective biological management of soil can be achieved by the integration of the contributory soil processes and the other factors regulating ecosystem function, including those of resource availability and access, and farmer’s decision making process).

Soil organic matter plays an important role of plant nutrient reservoir. The soil microbial community in association with other soil biota metabolize the organic substances to mineral forms, which are then incorporated to plant biomass. The major plant nutrients i.e. nitrogen, phosphorus, sulphur and other micro-nutrients are derived from common soil organic matter resource, partially decomposed plant, animal derbis, microbial biomass and humified organic matter. The soil organic matter increases the water content of the field, increases available water content in sandy soil and increases both air and water flow rate. The soil organic matter helps in increasing the soil pH, alteration of soil redox potential, direct oxidation or reduction of metallic cation and increase in the cation exchange capacity. The large available surfaces of humus have many cation exchange sites that adsorbs nutrients like calcium, magnesium, potassium and sodium etc. for eventual plant use and temporarily absorb heavy metal like lead, cadmium etc.. The humus reacts with clays in a manner conducive for formation of micro-aggregates which helps in reducing soil erosion. The low quality organic matter like mulch helps in reducing erosion, prevent rapid moisture loss and keeps the soil cooler in hot weather and warmer in winter. Organic matter acts as a chelate and helps in reduction of metal toxicity and enhancing the nutrient availability to the plant. Soil organic matter is a carbon supplier for many microbes that performs other beneficial functions (e.g. free nitrogen fixers, denitrifiers) and for other pedo-fauna. The organic matter combines with clay to form micro-aggregates and with the activity of macrofauna (like earthworm) immobilize the nutrients from leaching by formation of castings and form macro-aggregates. Management strategies like use of plant residues and manure leads to the change in the soil habitats, food web and change the soil quality.

Earthworm enhances plant growth through its contribution towards physical, chemical and biological factors. The mode of contribution towards plant growth are as follows: physically modifying breakdown of soil particles, turnover of soil, formation of aggregates, aeration, porosity and drainage. Chemically earthworm contributes to...
available nutrients in the form of polysaccharides, nitrogen from excretory materials, mucus, dead tissues, digestion process, decomposition and priming impact and bio-catalytic role with organisms, their impact on carbon:nitrogen ratio, role towards phosphate solubilization, role in enhancing cation exchange capacity and supply of plant growth promoters. Biologically earthworm contributes through their role in synergestic interaction in the rhizosphere, phyllosphere and drilosphere region, relationship with plant pathogen and pests for biological control, interaction with micro-organisms for production of plant growth promoters. These mechanisms involved are complex and dependent on the crop-soil-worm combinations. Earthworms modify soil properties at large and small spatio-temporal scales and the modification of soil in or near the rhizosphere is likely to lead to significant earthworm effects on plant growth. If nutrients or physical conditions are limitation to the plant growth to some extent, and earthworms helps to reduce these limiting factors as a result plants will respond positively. To obtain optimal earthworm benefits on plant production, they must be synchronized both spatially and temporally with root growth and nutrient uptake. These over all interaction contribute to the below and above ground plant production.

Looking to the beneficial role of earthworm and following the principle of TSBF a microcosm experiment was set to restore the soil quality and increase plant growth by manipulating different quality of organic matter and inoculating selected species of earthworms. The experiment was carried out in the tea nursery of Iyerpadi tea estate belonging to Parry Agro Industries Limited of Murugappa group in the Anamallai and Nilgiris hill range of Tamil Nadu state of South India. The tea nursery is about one hectare area and is being maintained by the company for supply of young tea plants for plantation in the field grown out of tea cuttings, grafting and seed germination. Eight (08) different input operational sets was prepared with and without different combination of high quality organic matter (a city composted waste named “Humigold”), low quality organic matter (tea prunings) and earthworm (Pontoscolex corethrurus) inoculation in which the tea cutting were planted. The tea cuttings were cultured on culture bed in single culture packet arranged closely in rows of 10 packets. The tea cutting culture is cared for moisture level, attack from pests, diseases and weeds. Initially a low height shade is provided for the culture which is gradually thinned as per the light requirement and finally removed at later stage.

Overall it was observed the percentage of contribution increased with indivisible input of low and high quality organic matter, combination of both high and low quality organic matter but the maximum was observed in the set with application of earthworm along with different quality of organic matter, individually or in combination. However some negative cases were was also observed. Present work indicates impact of organic matter and earthworms application on the growth of the tea cutting culture from wide spectrum of effects including shoot length, shoot biomass, root length and root biomass and inter linking with soil physico-chemical and biological characteristics. Through out the experiment the percentage increase in case of input operation experimental sets are significantly different to that of the control set (without high and low quality organic matter and earthworm). In this experiment there was an increase of 120.60% in the shoot biomass and 108.33% increase in the root biomass with the application of both earthworm and different quality of organic matter. With application of only organic matter the increase in shoot biomass was 68.57% and root biomass was 40.91%. This indicates the significant contribution of the earthworm on plant production. A maximum of 120.60% enhancement in the shoot biomass has been observed in case of tea cutting culture when earthworm along with low quality and high quality organic matter has been applied.

It was also tried to assess the growth of tea cuttings in terms of shoot and root morphometry and biomass. It was observed that there has been enhancement of shoot length, increase in number of lateral buds and number of leaves which has been proved statistically. There was also increase of root length, increase in the number of rooting points. It was observed that the length of the root was highest in the control set while in the input sets the length decreased and with the set both with different quality and earthworm the length further decreased. It may be concluded that due to less nutrient availability in the control set the root length increased for search of food while in the other sets i.e. with different quality of organic matter due to ready availability of nutrients the search of food decreased and hence decreased length of the root and number of rooting points. This shows that the shoot and root morphology changes with availability of nutrient and distance of the nutrient source.

With the objective to statistically prove the impact of both organic matter quality and earthworm inoculation on soil physico-chemical and biological parameters and its over all impact on plant growth, two types of statistics were used i.e. (i) One and Two way ANOVA and (ii) Principal Component Analysis (PCA). One and two way ANOVA are quantitative methods of analysis and the difference between the parameters are assessed by the quantitative values. Principal component analysis is a multivariate
Modulation Of Organic Matter Quality With Soil Organism In Biomass Production & Soil Restoration

A large scale field experiment was also conducted with the same objective at Lower Sheikalmudi tea estate in state of Tamil Nadu. Tea production was studied extensively over a 10 month harvest cycle. There was increase of yield from 135 to 351%. Under tea cropping in India, these species together with other four species resulted in an increase of 217% in green leaf production. These have been well classified and dealt in the book “Earthworm Management in Tropical Agroecosystems” edited by Lavelle et al. (1999).

With the rapid population growth, decrease of agricultural land, degradation of soil fertility and the increasing demand for food, the time has come for adopting management practices which will involve successful management of agricultural resources to satisfy human needs and at the same time also maintain the environmental quality and conserve natural resources for the next generations. Improvement of agricultural sustainability requires effective water and crop management, the optimal use and management of soil fertility and improvement of soil physical properties which rely on soil biological processes and soil biodiversity.

The experiment also proves concepts like integrated plant nutrient management and integrated soil management which will gain more importance and acceptance in the coming years. Soil biological management reduces input costs by enhancing the resource use efficiency (especially decomposition and nutrient cycling, nitrogen fixation, water storage and its movement). Less fertilizers is needed if nutrient cycling becomes more efficient and less leaching out of nutrients from the root zone. The conservation of soil organisms helps in preventing land degradation, especially by minimizing the use of agrochemicals, formation of the soil structure i.e. macro-aggregate and casts and increase of cation exchange capacity. Excessive decrease in soil biodiversity, especially the key stone species may have disastrous ecological effects leading to deterioration in the soil productivity capacity.

The observations made from the tea cutting culture experiment in nursery and field experiment can also be propagated to other commercial crops in a large scale. Most of the barren land rendered unproductive can be improved by use of this technology which is very cheap (cost-effective) and also have multiple beneficial effects on the soil subsystem and have long term effect. Farmers can actually manage and manipulate the different quality and quantity of organic matter and earthworm for enhancing crop production since this technology is not so costly and require less knowledge. They can also produce vermicompost and use the compost in the fields which are value added in terms of nutrients.
Modulation Of Organic Matter Quality With Soil Organism In Biomass Production & Soil Restoration

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Key Words: Soil Organic Matter, Tea Plant (Camellia assamica), Earthworm (Pontoscolex corethrurus), Above and below ground Biomass, Principal Component Analysis

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Abstract- Plastic as a component of MSW is difficult to dispose of. Because of its long breakdown period running into thousands of years, it poses a real problem in management. Depolymerisation through pyrolysis with catalytic breakdown is a cost effective and environmentally safe alternative of disposal. At 400°C to 500°C plastic depolymerises yielding carbonaceous compounds ranging from C1 to C24. The technology is available and a few plants are running on these principles. Worldwide, plastic waste constitutes 20% of the MSW. As against this MSW in Bhubaneswar yields around 7-9% of plastic. The daily production of plastic is around 25-30 tons out of which only 2.5-3 tons are collected by the unorganised sector. With a robust collection mechanism which will ensure 90% collection, four standard 7 ton plants using mixed plastic waste as feed stock can be established. A PPP model may work best in Bhubaneswar. The plant will earn positive cash flow from the fourth year of its operation onwards.

Key Words: Waste plastics, polypropylene, low density polyethylene, polystyrene, pyrolysis, liquid fuel, plastic to fuel

INTRODUCTION

Plastic is a versatile material. It finds wide range of use in automotive, rail, transport, defense and aerospace, medical and health care, electrical and electronics, telecom, building and infrastructure etc. Worldwide consumption of plastic is expected to touch 297 million tons by 2015 (GIA, 2012). The per capita consumption is highest in Europe, as high as 27 Kg/year compared to 6.2 Kg in India. Plastic is not readily degradable and it takes millions of years to degrade. It contributes to global emissions (GHGs) and is harmful to health and environment. The disposal of plastics is a problem as it causes land pollution, prevents ground water recharging, clogs water channels and drainage systems. When burnt, it releases toxic gases like chlorine, aromatic hydrocarbon, dioxin, etc. Plastics contribute 28% of all cadmium in municipal solid wastes and approximately 2% of lead. Hence it is desirable to dispose it off in an environment friendly way.

ALTERNATIVE DISPOSAL OPTIONS

There are various options for plastic disposal. Most commonly practiced ones are given below.

LANDFILL

Landfill is the conventional approach to waste management, but space for landfills is becoming scarce in some countries. A well-managed landfill site results in limited immediate environmental harm beyond the impacts of collection and transport, although there are long-term risks of contamination of soils and groundwater by some additives and breakdown by-products in plastics, which can become persistent organic pollutants (Oehlmann et al 2009, Teuten et al 2009). A major drawback to landfills from a sustainability aspect is that none of the material resources used to produce the plastic is recovered—the material flow is linear rather than cyclic.

INCINERATION AND ENERGY RECOVERY

Incineration reduces the need for landfill of plastics waste; however, there are concerns that hazardous substances may be released into the atmosphere in the process. For example, PVC and halogenated additives are typically present in mixed plastic waste leading to the risk of dioxins, other polychlorinated biphenyls and furans being released into the environment (Gilpin et al 2003). As a consequence primarily of this perceived pollution risk, incineration of plastic is less prevalent than landfill and mechanical recycling as a waste-management strategy.

DOWNGAUGING

Reducing the amount of packaging used per item will reduce waste volumes. Economics dictate that most manufacturers will already use close to the minimum required material necessary for a given application. This principle is, however, offset against aesthetics, convenience and marketing benefits that can lead to over-use of packaging, as well as the effect of existing investment in tooling and production process, which can also result in excessive packaging of some products.

REUSE OF PLASTIC PACKAGING

Not long ago re-use of post-consumer packaging in the form of glass bottles and jars was common. Limitations to the broader application of rigid
container re-use are at least partially logistical, where distribution and collection points are distant from centralized product-filling factories and would result in considerable back-haul distances. In addition, the wide range of containers and packs for branding and marketing purposes makes direct take-back and refilling less feasible.

PLASTIC RECYCLING

Terminology for plastics recycling is complex and sometimes confusing because of the wide range of recycling and recovery activities. These include four categories: primary (mechanical reprocessing into a product with equivalent properties), secondary (mechanical reprocessing into products requiring lower properties), tertiary (recovery of chemical constituents) and quaternary (recovery of energy). Primary recycling is often referred to as closed-loop recycling, and secondary recycling as downgrading. Tertiary recycling is either described as chemical or feedstock recycling and applies when the polymer is de-polymerized to its chemical constituents (Fisher 2003). Quaternary recycling is energy recovery, energy from waste or valorization.

The effective disposal of waste polymers (Plastics) is now recognized to be a major environmental problem worldwide. Plastics are troublesome components for landfilling inasmuch as they are not presently biodegradable. Their destruction by incineration poses serious air pollution problems due to the release of airborne particles and carbon dioxide into the atmosphere.

India is not self sufficient in petroleum and crude oil. The national production capacity is capable of fulfilling not even 30% of the total fuel demand. The remaining whopping 70% is fulfilled by importing crude. Hence, there is a great opportunity of depolymerization of plastic waste to manufacture fuel.

TECHNICAL PROCESSES

The process of turning plastic into liquid fuel, called feedstock recycling, (or thermal depolymerization) breaks down plastic products that cannot easily be broken down into their pure generic resin types, or have some level of contamination. A typical feedstock recycling process operates in an oxygen-free environment to prevent the plastics from burning, and results in the recovery of liquid feed stocks. These can then be used in place of virgin oil for the production of new plastic resins, fibres, and other valuable petroleum derivatives (Mod. Plast., 1995).

However, polyethylene and polypropylene do not depolymerise thermally to ethylene or propylene with sufficient selectivity. On the other hand, waste plastics can be regarded as a potentially cheap and abundant source for fuels. Thermodegradation of polyolefins has been investigated extensively since World War II (Jellinek et al, 1949).

Solid household waste is made up of a mixture of largely polyolefin-based resins, such as HDPE, LDPE, PP, PET, etc., i.e. resins that have melt temperatures ranging between 110°C and 160°C. These can be categorised based on their suitability for depolymerisation.

Plastics suitable for depolymerisation process

Some plastics that are suitable for the depolymerisation process are listed below:

- low-density polyethylene (LDPE) used in plastic bags, cling film, flexible containers.
- high-density polyethylene (HDPE) used in piping, shampoo and detergent bottles, oil bottles, milk crates.
- polypropylene (PP) used in food containers, battery cases, bottle crates, automotive parts and fibres.
- polystyrene (PS) used in dairy product containers, tape cassettes, cups and plates
- pallet wrapping film (pallet wrap)
- shrink and stretch film
- shopping bags
- silage and mulch films
- commercial plastic packaging film
- shredded PP Scrap
- plastic packaging scrap
- oil bottles and plastic oil containers

MULTILAYER PACKAGING

Certain examples of multilayer packaging are listed below.

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Multilayer packaging</th>
<th>Examples in common use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Polyester + Polyethylene</td>
<td>Britannia Marie Gold Reynolds</td>
</tr>
<tr>
<td>2</td>
<td>Pearlized BOPP + BOPP</td>
<td>Reynolds</td>
</tr>
<tr>
<td>3</td>
<td>Polyester + Polyethylene</td>
<td>Surf Powder</td>
</tr>
<tr>
<td>4</td>
<td>LDPE</td>
<td>AAVIN</td>
</tr>
<tr>
<td>5</td>
<td>Polyester + Polyethylene + Metalized Polyester</td>
<td>Ajantha Supari</td>
</tr>
<tr>
<td>6</td>
<td>Polyester + Polyethylene + Metalized Polyester</td>
<td>Good Biscuit</td>
</tr>
<tr>
<td>7</td>
<td>Polyester + Polyethylene</td>
<td>Lays Chips</td>
</tr>
</tbody>
</table>
TECHNOLOGY OPTIONS CONVERSION OF PLASTIC TO FUEL

Various technologies are now commercially available for conversion of Plastic waste into fuel. Most use some form of catalytic conversion in order to optimize the yield. The catalysts are patented and are not available in the open market. Barring laboratory scale reactors, most of the catalytic converters are installed and maintained by the patent holders. Based on an extended field study it was found that M/s Polymer Energy a USA Company based in Beach Wood has been in the forefront of plastic to fuel conversion. There are 10 operating commercial sites at Poland, Europe based on this technology and 1 operating unit in India, Alathur, Chennai. There are two operating units in Thailand - Rayong & Hua-Hin Municipalities. Theirs is a patented technology for converting synthetic plastics and rubber wastes into hydrocarbons / fuel oil, using Transverse Flow Catalytic Conversion methodology. It is free of emission and effluents.

The present study focuses on the use of this technology and other plant parameters in order to explore the feasibility of establishing similar plants in Bhubaneswar.

**Thermal Process**

The thermal processes along with a flow diagram is given below.

**EXPERIMENTAL PROCESS DESCRIPTION**

A typical pyrolysis process uses thermal cracking to heat the waste plastic to form a liquid slurry, at a temperature ranging from 370 °C–420 °C, then the liquid slurry turns into vapour; that vapour is then condensed/distilled (Figure above) to produce the liquid hydrocarbon fuels.

As per Lee (2006) in the double condensation process, two different types of fuel can be collected at two different temperature ranges. The double condensed fuels are classified as NSR-1, NSR-2. NSR-1 (gasoline) will be collected at 200–240 °C and NSR-2 (diesel) in the range of 240–360 °C. Also during the fuel production process, some very light gas is produced (C1–C4). The gases include methane, ethane, propane and butane. These gases can be utilized as a heat source to carry out the fuel production process. A very minimum amount of solid carbon residue is leftover from the production step. The residues contents are similar to contents which are used for road and roof carpeting.

The properties of the mixed fuel compared well with that of gasoline as under

<table>
<thead>
<tr>
<th>Properties</th>
<th>Regular gasoline</th>
<th>Plastic waste fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour, visual</td>
<td>Orange</td>
<td>Pale yellow</td>
</tr>
<tr>
<td>Specific gravity at 28 °C</td>
<td>0.7423</td>
<td>0.7254</td>
</tr>
<tr>
<td>Specific gravity at 15 °C</td>
<td>0.7528</td>
<td>0.7365</td>
</tr>
<tr>
<td>Gross calorific value</td>
<td>11210</td>
<td>11262</td>
</tr>
<tr>
<td>Net calorific value</td>
<td>10460</td>
<td>10498</td>
</tr>
<tr>
<td>API gravity</td>
<td>56.46</td>
<td>60.65</td>
</tr>
<tr>
<td>Sulphur content(by mass)</td>
<td>0.1</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td>Flash point (Abel)</td>
<td>23 °C23</td>
<td>22</td>
</tr>
</tbody>
</table>

**Table 2: Comparision of gasoline with plastic waste fuel (Lee, 2000).**
Feasibility of a continuous system of waste plastic processing in Bhubaneswar

Worldwide, the percentage of plastic in MSW is between 15-20%. Similarly in India, of the total MSW, plastic waste increased from 0.7% in 1971 to 4% in 1995 and 9% in 2003 (Muthaa et al., 2006). Bhubaneswar city with a population of well over 8 lac is growing very fast and is the fastest growing city in the East. Along with growth, the problem of waste generation and disposal has presented itself in an urgent manner. It would be worthwhile to study the feasibility of a continuous plastic processing plant.

Plastic Waste Generation in Bhubaneswar

Bhubaneswar generates about 350-380 tonnes per day of municipal solid waste which contains about 7-9% of plastic material. Therefore about 28 tonnes/day of plastic is generated. (State Pollution Control Board, Odisha, 2010). Out of more than 100 types of plastic, only six are commonly found in MSW in Bhubaneswar - all of which are thermoplastics:

- Polyethylene Terephthalate (PET) – e.g. soft drinks bottles, video tapes, X-ray film
- High Density Polyethylene (HDPE) – e.g. detergent bottles, pipes
- Low Density Polyethylene (LDPE) – e.g. clingfilm, playground slides
- Polyvinyl Chloride (PVC) – e.g. insulation on electric wires
- Polypropylene (PP) – e.g. hinges, lids of confectionery packets.
- Polystyrene (PS) – e.g. yoghurt pots, CD cases, foam protection for packaging

The quantities of such plastic generated per month in Bhubaneswar is as under:

<table>
<thead>
<tr>
<th>Type of plastic</th>
<th>Quantity per day(in tons)</th>
<th>% w.r.t total plastic waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene Terephthalate (PET)</td>
<td>0.504</td>
<td>18</td>
</tr>
<tr>
<td>High Density Polyethylene (HDPE)</td>
<td>0.588</td>
<td>21</td>
</tr>
<tr>
<td>Low Density Polyethylene (LDPE)</td>
<td>1.092</td>
<td>39</td>
</tr>
<tr>
<td>Polystyrene (PS)</td>
<td>0.084</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>2.800</td>
<td>100</td>
</tr>
</tbody>
</table>

A sample survey revealed that presently rag pickers and other sources are collecting about 10% of the total plastics generated which comes to around 2.8 tonnes/day.

The present system of collection is depicted below.

However, there is a scope for segregation of the plastic waste at the source and up to 90% of plastic can be collected. Hence there is a scope of operating a continuous processing plant if other factors as narrated below are taken care of.

PROPOSED PLANT CAPACITY

As mentioned above, after extensive field study, it was considered that the technology patented by M/s Polymer Energy is suitable for Bhubaneswar. However, the technology works on at least a 7 ton supply of plastic daily. Bhubaneswar can successfully collect and feed around 28 tons of feedstock is the collection mechanism is tweaked to suit the requirement. A detailed suggestion is given elsewhere.

A 28 ton supply means 4 plants can run in Bhubaneswar. In order to cover the entire city geographically as well as to minimise transportation cost, four plants at strategic locations in Bhubaneswar can be set up. The suggested locations are at existing municipality dumpsite near Chandaka at Bhuasuni, Industrial estate Mancheswar, Ganeswar Industrial estate near Khandagiri and Uttara. These sites are chosen as there are pre-existing dumpsites and these will cover all areas of Bhubaneswar.

It is proposed to install a 7 tpd unit in first phase since the standard design is available off the self. The output from this plant will be a mixture of 20% Gasoline, 50% Diesel and 30% Heavy fraction. 1 kg of plastic waste yields approximately 0.78 kg of final products. (Polymer Technology, USA)
Man Power
The man power requirement based on three shifts working will be as under.

<table>
<thead>
<tr>
<th>Position</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance Engineer</td>
<td>01</td>
</tr>
<tr>
<td>Chemical Engineer</td>
<td>01</td>
</tr>
<tr>
<td>Electrical &amp; Electronics Engineering</td>
<td>01</td>
</tr>
<tr>
<td>Operators</td>
<td>06</td>
</tr>
<tr>
<td>Helpers</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

Table 4: Man power requirement Infrastructure

<table>
<thead>
<tr>
<th>Land/Building</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) 50 m x 20 m</td>
<td>(2) 10 m x 10 m</td>
</tr>
<tr>
<td>=2600 m² land needed</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electricity (2 supplies)</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) To PLC control panel : 3 phase 415 V AC, 50 Hz though 250A MCCB (Moulded case circuit breaker) &amp;</td>
<td></td>
</tr>
<tr>
<td>ii) To cooling tower panel : 3 phase 415 V AC, 50 Hz through 160A MCCB (Moulded case circuit breaker)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water connection</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water connection from DM water plant. 5 KL of DM water + daily top up</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Foundation</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace / reactor / product storage tanks / chilling units</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material handling equipments</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory spares and tools</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supply of LDO &amp; H&amp;D</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A storage tank capacity 900 liters</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Documentation</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete documentation in relation to approvals from competent authorities such as Pollution control Board, Controller of Explosives, Ministry of Environment and Forests etc</td>
<td></td>
</tr>
</tbody>
</table>

Minimum infrastructure required is given as under. Besides, all the statutory approvals must also be obtained. Business Model There could be four different models for working the plant. These are Private enterprise + municipality management, Municipality unit + municipality operation, Municipality unit + outsourced operation and outright private operations.

In view of the paucity of funds with the BMC, it will be better if the plant is established with a PPP model where the basic infrastructure will be provided by BMC. The company or the private party will be allowed to invest on plant and operate it as well. BMC need to provide land and ensure supply of plastic wastes. Some seed money in the shape of initial equity investment may be made by BMC to make it feasible. A suitable royalty/revenue sharing model may be devised between the two entities.

Economic Feasibility

<table>
<thead>
<tr>
<th>Projected Profitability statement (Rs. in Lakhs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTON</td>
</tr>
<tr>
<td>Rs.</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Total sales</td>
</tr>
<tr>
<td>Total variable cost</td>
</tr>
<tr>
<td>Contribution</td>
</tr>
<tr>
<td>Total fixed cost</td>
</tr>
<tr>
<td>Profit after tax</td>
</tr>
</tbody>
</table>

Table 6: Economic Feasibility
RECOMMENDATIONS:

The vital aspect of the project is to ensure a steady collection mechanism. A collection mechanism is proposed below which would ensure continuous flow.

![Proposed Collection Mechanism](image)

The dedicated collection mechanism can be run with the help of an NGO or by a private commercial operator. To start with, municipality may subsidise this service until it turns profitable. Alternatively, an NGO can coordinate the activities of the unorganised rag pickers who in turn will supply to the plants.

To ensure a continuous supply in case of sporadic supply by the Municipality or the agency, adequate feedstock (at least for a month) must be stored in the factory premises. If necessary, plastics can be bought from the Kawadiwalls from outside the city. It would be highly desirable also to develop a strong network of Kawadiwalls who will ensure steady supply. If recognised by the Municipality and given basic infrastructure like place to store their waste they can be a valuable partner in this venture.

CONCLUSION:

Plastic fuel technology has established itself as a cost effective method of generation of liquid fuel while solving the problem of plastic disposal to a great extent. It has been established that the plastic waste from the MSW stream of Bhubaneswar can yield liquid fuel with calorific value close to petrol. It is seen that if the present collection system is strengthened with introduction of third party organised door to door collection, 28 tons mixed plastic can be collected daily. This will be sufficient to establish 4 PPP model plant for Plastic to fuel which will earn profit from the 4th year onwards with a positive cash flow.

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[1]. European patent number EP 0720898 A2, 1996
ASSESSMENT OF FUGITIVE EMISSIONS FROM ALUMINUM SMELTER POT ROOMS

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Abstract: Fugitive emissions from aluminium smelter pot rooms contribute to air pollution and exposure of pollutants to personnel. This work focused on assessment of particulate and gaseous emissions from the pot rooms. PM₁₀, PM₂.₅ and particle mass size distributions were assessed. Fluoride emissions were estimated in gaseous and particulate phases. Contributions from fugitive emissions to ambient atmosphere were found to be above 90% of the total emissions. A corrective action attempted in the practice of opening and closing of pot doors and their maintenance, improved fluoride recovery in fume treatment plant from 0.95 to 1.53% indicating resource conservation and lowered environmental threats to flora and fauna.

Keywords: Aluminium smelter, Fugitive emissions, Hooding efficiency, Fluoride recovery, PM₁₀, PM₂.₅.

INTRODUCTION

Fluoride emissions into air atmosphere are a major concern in all aluminium industries of the world (USEPA, 1998, Buonicore and Davis, 1992). Apart from particulate fluorides, gaseous fluorides like HF, CF₄ and C₂F₆ are emitted from the pot rooms. These emissions to the atmosphere cause contamination of soil and water bodies in addition to air pollution. The combined effect of all causes significant damage to vegetation and habitats in terms of leaf necrosis and dental and skeletal fluorosis (Vike and Habjorg, 1995). CF₄ and C₂F₆ are perfluorinated carbons (PFCs) which contribute heavily towards climate change. It has been reported that one ton of CF₄ and C₂F₆ emissions are equivalent to approximately 6500 and 9200 tons of CO₂ emissions respectively, when warming effect is considered over a 100 year period. It was estimated that 2700 tons of such PFCs were emitted from aluminium smelters in USA in the year 1990 (Leber et al, 1998).

Dry scrubbing system involving adsorption of fluorides on alumina has been adopted for treatment of these pollutants in almost all the modern aluminium smelters in the world and the treated gases are emitted as stack emissions. However, a small fraction of the pollutants do not get captured in the pot off-gas system and escape out into the pot room as fugitive emissions and finally are emitted through the pot room roof under the influence of ventilation.

Figure 1  Schematic representation of pot room with fume treatment system. Points A, B, C, D and E represent several points of sampling (Modified from Whiteley, 1998)
Quantity of fugitive emissions increase during some operational activities like anode changing, metal tapping, pot tending. (Whiteley, 1998 and USEPA, 1998). A schematic representation showing of the pot off-gas treatment and fugitive emissions is shown in Figure 1, where the stack emission is marked as ‘C’ and Roof emission is marked as ‘D’.

Several studies have been done for emissions which are captured, treated and emitted through stack and the management practices are well in place. On the other hand, limited studies have been made on fugitive emissions and the area has still remained grey. Though, Central Pollution Control Board (CPCB), India has prescribed standard for total fugitive fluoride emissions, most of the Indian smelters lack with the measurement facilities. CREP guidelines formulated by Ministry of Environment & Forests, Government of India for taking pollution control beyond the prescribed standards have also recommended measurement of fugitive emissions from aluminum smelters.

OBJECTIVES OF THE STUDY

The objective set for the study was to assess concentration of pollutants emitted through various pathways in a pot room, and to study the significance of contribution of fugitive emissions to ambient atmosphere.

METHODOLOGY

Selection of Pollutants

Particulate matter and fluoride were considered to be the two focus pollutants for the study. For particulate matter, PM$_{10}$ and PM$_{2.5}$ were considered, and for fluorides both gaseous and particulate fluorides were considered. Further, for size distribution analysis of particulate matter, 10 stages (0.056 to 18 µm) were used.

Selection of Study Area and Sampling Locations

An aluminium smelter was selected for the present study based on its location and existing facilities for fugitive emission sampling. One pot room was considered for the emission measurements. The sampling locations selected have been marked in Figure 1 as A, B, C, D & E.

As the fugitive emission generated inside the pot room escapes through the pot room roof, USEPA has recommended for sampling of pollutants at the roof vent level. However, in the smelter under study, there was no approach to the roof vent level (14.5 m from ground) except that permanent arrangement for fluoride sampling was available at that point. Therefore, a sampling point inside the pot room (marked as ‘A’ in Figure 1 at the roof truss level (9.8 m) was approximated to the roof vent level for PM sampling. The approximation was done based on trial simulations of flow fields inside the pot room by using CFD software FLUENT. As outside air enters into the pot room for ventilation, the measured concentration of pollutants inside the pot room needed to be corrected using the background concentrations. Therefore, the location just outside the pot room (marked as ‘B’ in Figure 1 was selected as pot room intake for measurement of background concentrations. For measurement of stack emissions location ‘C’ in Figure 1 was considered at a height of 35 m from ground. The existing facilities for measurement of fluorides in fugitive emissions Location ‘D’ in Figure 1 at a height of 14.5 m was considered. For estimating ambient concentration in upwind and downwind of the smelter location ‘E’ in Figure 1 was considered. The upwind and downwind locations were selected at a distance of 1.4 km and 0.55 km respectively from the pot room in study.

Selection of Sampling Instruments and Sampling Procedures

Mini-vol samplers (5.0, AIR Metrics, USA) were used for sampling of PM$_{10}$ and PM$_{2.5}$. These samplers work on the principle of impaction and operate at a sampling rate of 5 litres per minute. For sampling of PM$_{10}$ and PM$_{2.5}$, one and two impactors were used respectively. MOUDI (MSP Corporation, USA) was used for sampling of particulate matter for studying mass size distributions in the size range of 0.056 to 18.0 µm. High volume samplers (Envirotech, India) were used for sampling of suspended and respirable particulate matter and gaseous fluoride from ambient air.

For all the samplings the procedures prescribed by the instruments suppliers were followed. Details of the sampling procedures have been described in Goyal (2009) and Dash (2010). For sampling of fluoride at the roof vent, the facilities provided by the industry were used. The arrangements were as per Method 14A of USEPA (with a deviation in terms of number of sampling points). Method 14A prescribes about providing 8 sampling cassettes within a distance of 8% of pot room length to get a representative sample of emissions. However, in the present case one sampling cassette was provided. Gravimetric and chemical analysis of samples was carried out. For analysis of fluoride procedure laid down in Method 13A of USEPA was used.

RESULTS AND DISCUSSION

PM$_{10}$ and PM$_{2.5}$ emitted inside Pot room and from FTP Stack

The results of PM$_{10}$ and PM$_{2.5}$ measurements inside the pot room and from FTP stack are presented as statistical box plots in Figure 2 and Figure 3 respectively.
In absence of any prescribed standards for emissions inside the pot room (fugitive emissions), the results were compared with concentration corresponding to the emission factor for TPM prescribed in AP 42, USEPA. The emission factor expressed in kg per ton of aluminium produced and was calculated to be 280 \( \mu g/m^3 \) for the pot room in study. Comparison of results of this study with the above indicates that PM\(_{10}\) and PM\(_{2.5}\) emissions from the pot room are much higher.

As there is no prescribed standard for PM\(_{10}\) and PM\(_{2.5}\) from stack emissions, the results of emission measurements from FTP stack were compared with the TPM standard of 150 mg/Nm\(^3\) (150000 \( \mu g/Nm^3 \)) prescribed by CPCB in India. The results show that PM\(_{10}\) is below 1000 \( \mu g/Nm^3 \), which indicates that PM in all forms is much lower in terms of concentrations. It is also observed that the concentrations are lower than the emissions inside the pot room, which should be close to ambient conditions. This reflects the effectiveness of the existing fume treatment system for the stack emissions.

It is also observed that the variations in concentrations of both PM\(_{10}\) and PM\(_{2.5}\) are much higher inside the pot room than those in FTP stack. This conforms to the high temporal variability of fugitive emissions inside the pot room, as reported in literature. Further, the ratio of PM\(_{2.5}\) to PM\(_{10}\) in emissions from FTP stack and inside pot room were found to be 0.83 and 0.64 respectively, indicating that the PM\(_{10}\) fraction in fugitive emissions is more than that in FTP stack emissions and that most of the PM\(_{10}\) in the stack emissions are removed by the existing treatment system in FTP.

Gaseous and Particulate Fluoride emitted inside Pot room and from FTP Stack

The six samples collected from the pot room roof vent were analyzed for gaseous and particulate fluoride and the result are presented in Figure 4.

As there is no prescribed standard for PM\(_{10}\) and PM\(_{2.5}\) from stack emissions, the results of emission measurements from FTP stack were compared with the TPM standard of 150 mg/Nm\(^3\) (150000 \( \mu g/Nm^3 \)) prescribed by CPCB in India. The results show that PM\(_{10}\) is below 1000 \( \mu g/Nm^3 \), which indicates that PM in all forms is much lower in terms of concentrations. It is also observed that the concentrations are lower than the emissions inside the pot room, which should be close to ambient conditions. This reflects the
Assessment Of Fugitive Emissions From Aluminum Smelter Pot Rooms


Table 1 Comparison of Emission Rates from FTP Stack and Pot room Roof Vent

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>FTP Stack emissions</th>
<th>Fugitive Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg. Conc. g/Nm³</td>
<td>Discharge in 1000s Nm³/day</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>785.01</td>
<td>17.8h</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>554.32</td>
<td>11.25</td>
</tr>
<tr>
<td>Fg</td>
<td>7.24</td>
<td>0.13</td>
</tr>
<tr>
<td>Fp</td>
<td>965.31</td>
<td>15.4</td>
</tr>
</tbody>
</table>

It was observed that the contribution of roof emissions to the atmosphere was much higher than the treated stack emissions. Fugitive factor calculated as the ratio of roof emissions to the total emissions for each pollutant showed that the contribution from roof vent emissions is above 90%.

Improvement of Hooding Efficiency

Poor pot door closure was identified as the single most vital reason for high fugitive emissions. Corrective measures were initiated to improve the same and percent pot door closure was estimated. As the performance of the pot door closure directly affects the fluoride recovery in the FTP, fluoride in alumina was also measured. The process was continued for 5 months and it was found that fluoride in alumina increased from 0.95 to 1.53% indicating improved hooding efficiency. However, the hooding efficiency calculated corresponding to 1.53% fluoride in alumina was 79.21% against more than 97% as reported in literature. This indicated about high scope for further improving hooding efficiency, thereby reducing fugitive emissions and conserving fluoride resources.

CONCLUSIONS

The relative contribution of PM₁₀, PM₂.₅, gaseous, and particulate fluorides from stack and fugitive emissions to the ambient atmosphere were estimated. It was found that the contribution of fugitive emissions to the total is greater than 90% for all the four pollutants. An attempt was made to improve work practices on pot door opening and closing by proper operation and maintenance and percentage door closure improved from 34.57% to 61.81% in 5 months time resulting in increased fluoride recovery from 0.95 to 1.53% during the period. Using the study results, hooding efficiency was estimated to be 79.21% as against more than 97% reported in literature. Thus, there is high scope for improving hooding efficiency thereby minimizing fugitive emissions and increasing fluoride recovery.
REFERENCES


0.28 0.56
RECLAMATORY AND CARBON SEQUESTRATION POTENTIAL OF PLANTATION FOREST: A CASE STUDY ON FLY ASH MOUND FROM HINDALCO.

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Abstract: - Coal-based thermal power plants produce huge quantity of fly ash during power generation. Usually power plants go for land disposal of fly ash and deposit fly ash in form of mounds up to a required height. As a preventive measure of fly ash erosion from the mound, power plant authorities go for plantation by selectively choosing suitable species that can grow on fly ash mound. Besides, plantations established on degraded / derelict land are reported to act as succession catalyst facilitating the process of reclamation, through their influence on under storey microclimate and soil fertility. There have been numerous scientific evidences on the ameliorative property of the vegetation, through which the vegetation component plays an important role in the pollution management of an area and can neutralize GHG emission, specifically acting as a potential sink for atmospheric carbon dioxide.

Coal-based captive power plant of HINDALCO, located in the industrial township of Hirakud of Sambalpur, Odisha, in average produces 2000 tones of fly ash per day and is transported to the ash mound through dumpers where disposal takes place adopting dry disposal method. After attaining the desired height, plantations (with the species like Acacia moniliformis, Cassia angustifolia & Delonix regia) are taken up over the ash mound in order to prevent erosion and also to stabilize the ash mound. Generally fly ash contains higher concentration of all essential plant nutrients like sodium, potassium, calcium, magnesium, boron, sulphates and other nutrients except nitrogen in comparison to soil. Hence we hypothesize that the ash mound under plantation can promote other vegetational succession and initiate the process of reclamation. Keeping these concepts in view, in the present study we attempted to make a detailed ecological enumeration of the vegetation on fly ash mound of Hirakud power plant industrial complex and their reclamation and carbon sequestration potential.

Ash mound is located at a distance of 5 KM from Hindalco Industries of Hirakud and it covers an area of around 103 acres. Dumping of ash in the ash mound was started from November 1993 adopting dry ash disposal method and has taken place phase-wise followed by plantation. Area of ash holding site is 6.0 acres with capacity of 47500 cubic meters.

Hindalco Industries have undertaken a massive plantation in the ash mound site in order to reclaim the site. Three sampling sites were selected which includes 5year & 10year old plantation on ash mound & a natural site for comparison. Standard methods were followed to study the vegetation, top soil quality, Litter disappearance, Air Pollution Tolerance Index and Dynamics of metal and fluoride in ash mound site as well as the natural forest site. Survey of different plantations and natural site revealed that vegetations for these sites could be categorized into three strata i.e. (a) Ground floor herbaceous stratum (b) Woody shrub stratum and (c) Emerging tree stratum. A comparative analysis of the herbaceous stratum of natural forest, 5 yr and 10 yr plantation site indicated that two plantation sites exhibited relatively better species richness, diversity and species density than the natural forest. Since herbaceous vegetation showing annual turnover contributes significantly to the nutrient cycling, it can be concluded that both the plantation sites on the ash mound have evolved an effective mechanism of nutrient cycling for the support of soil fertility and overlying vegetational productivity. However, overall analysis of shrub vegetation in different sites presented a different picture. In both the plantation sites, shrub richness and diversity were comparatively less than the natural site. This can be due to the absence of the germplasm of the shrub species on the ash mound sites. But the reverse trend was observed with respect to shrub species density. The density was substantially found to be higher in plantation sites in comparison to the natural forest. Gregarious growth of the existing shrub species explains such high density value on the ash mound plantation sites.

Analysis of tree component in three different sites revealed greater species richness and diversity in the natural forest site than the two plantation sites. This was obviously due to the plantation of only three plant species in the ash mound site. Total Basal Area (TBA) and Diameter at Breast Height (DBH) data for the tree component were also substantially higher in natural forest. It was observed that in the natural forest, trees are distributed in six DBH classes and the % of distribution of tree showed an increasing trend with increase in the DBH. In fact maximum trees in the natural forest were distributed in the highest DBH class (>100cm). This explains the
climax nature of the natural forest site. Contrary to this, maximum number of trees were distributed under the DBH class >20-40cm in the 5 yr plantation site. Similarly in the 10 yr plantation site maximum number of trees were recorded in the DBH class (>40-60cm). Further, in both the plantation sites no tree could be recorded with >80 cm DBH class. This explains the seral nature of the plantation sites in comparison to the climax nature of natural forest site. The growth performance of the three planted species (*Acacia moniliformis*, *Delonix regia* & *Cassia angustifolia*) on the ash mound was assessed through a comparison of the average data of DBH. The difference in value of average DBH of three different species with respect to the two plantation sites were used to calculate the CBH (circumference at breast height) increments (cm/yr). It was found that among the three planted species *Acacia moniliformis* exhibited the least CBH increment (0.7 cm/yr). The corresponding value for *Cassia angustifolia* and *Delonix regia* were 0.8 and 1 cm/yr respectively. The study therefore clearly indicates that among the three species the best growth performance was exhibited by *Delonix regia*. However the other two species, though exhibited relatively less increment, the growth performance was still observed to be satisfactory estimates for tropical seasonal/dry forests. From the differential biomass stock values of 5yr & 10 yr plantation, the annual increment of biomass stock was calculated on plantation sites, 6.2 t/ha of above biomass stock per year was added. The data of such biomass stock in the 10 yr plantation site was further extrapolated for calculation of carbon pool, carbon flow and carbon sequestration. Assuming 45% above ground biomass as carbon, the above ground biomass was converted to above ground carbon pool in 10 yr plantation site and this amounted to 162 t/ha. Usually the below ground carbon stock in form of underground root stock amounts to 20% of the above ground carbon. On the basis of such conversion the below ground carbon stock was calculated to be 32 t/ha. Annual increment in biomass carbon (45% of annual biomass increment 6.2 t/ha) amounted to 2.33 t/ha. Assuming that the annual foliage (litter production) is 20% of annual biomass increment, the annual foliage (litter) production was found to be 0.47 t/ha and this was subjected to decomposition on the floor of the plantation site on the ash mound. Assuming average decomposition constant (k) of 0.75 for the litter, it was further calculated that litter component contributed 235 kg C/ha to the soil, beside release of rhizoeoxudates which was calculated as 0.001% of the below ground carbon amounting to 32 kg C/ha in the site. Such rhizoeoxudates are usually utilized to support microbial biomass and productivity. Assuming 70% utilization of rhizoeoxudates for microbial biomass conversion, it was estimated that in the plantation site, 22 kg of microbial biomass carbon is annually added to the soil. Such microbial carbon pool, besides supporting the other soil organism in pedological food chain can also be involved in the immobilization and retention of valuable soil nutrients, essential for the restoration of soil fertility status on the ash mound. As already mentioned, the plantation site on the ash mound exhibits an annual net biomass carbon increment of 2.33 t C/ha. Assuming this annual increment, as the net carbon fixation through the photosynthetic process, the amount of CO$_2$ sequestered from the atmosphere by the plantation was calculated (by multiplying net biomass carbon increment × 3.67). The amount of CO$_2$ sequestered by the plantation site on the ash mound was calculated to be 8.54 t CO$_2$/ha/yr. This reflects the role of plantation in mitigating the problem of increasing level of CO$_2$ in the context of the present scenario of global warming. The biological properties of soil have been assessed in the present study through estimation of microbial flora (bacteria and fungal count) and quantification of the microbial function through soil metabolic activities (soil respiration and enzyme activities). Both the approaches are desirable to reveal their importance in ecosystem functioning. In all the sites fungal count was found to be high during rainy season (in the range of 5.27x10$^6$ to 9.64x10$^6$ per gm of soil) and low during summer season (in the range of 3.92x10$^6$ to 6.15x10$^6$ per gm of soil). Further natural site showed relatively higher fungal richness followed by 10 yr and 5yr plantation site (the average fungal count in the 5 yr old plantation, 10yr old plantation and natural site was 4.55x10$^6$, 5.08x10$^6$ and 7.38x10$^6$ per gm of soil respectively). The bacterial count in all the sites, also showed a similar trend like that of fungal count and bacteriologically natural site is rich followed by 10 yr and 5yr old ash mound plantation sites (the average bacterial count in the 5 yr old plantation, 10yr old plantation and natural site was 24.04 X10$^6$, 27.25 X10$^6$ and 45.06X10$^6$ per gm of soil respectively). Besides a good growth of ground vegetation during monsoon and microbial activities and metabolism in soil, the ash mound sites also recorded other fauna like four earthworm species, varieties of butterfly, spider, ant, frog, snakes and few types of birds the indicators of reclamation of ash mound which is in the direction of restoration.
IMPACT OF INDUSTRIAL EFFLUENT ON THE CHANGES IN DIFFERENT ION CONTENT IN BRAIN, LIVER, MUSCLES AND GILL TISSUES OF A FRESH WATER FISH, OREOCHROMIS MOSSAMBICUS, PETERS.

LINGARAJ PATRO

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Abstract:- Mushrooming of industries throughout the world to cater to the needs of the growing population and technology has resulted in the use and production of a large number of chemicals. These chemicals include extremely toxic substances which can affect man and other living bodies in the ecosystem severally. The most important thing is the introduction into the environment of chemical substances, which never before existed in nature. Emissions of effluent from various industries into water bodies are having detrimental effects on aquatic species like fish. High percentage of mortality of fish due to the action of the effluent might be due to the pathological changes. The present investigation was designed to study the effect of effluent of a chlor-alkali industry on changes in Na\(^{+}\), K\(^{+}\) and Ca\(^{++}\) ion contents in different tissues of a fresh water fish, Oreochromis mossambicus, Peters and its toxicological significance. The MAC value of the effluent was found to be 6.41 ml\(^{-1}\) for 30 days and to be on the safer side 6.0 ml\(^{-1}\) was considered for 28th days of the exposure for sub-lethal toxicological studies. The LC\(_{10}\), LC\(_{50}\), LC\(_{100}\) values after 28th days were recorded. It has been observed that all the exposed fishes appeared lethargic after exposure to the effluent. The major clinical symptoms such as inappetance and ataxia appeared immediately after exposure. At higher concentration, the exposed fish showed loss of equilibrium, gradual onset of inactivity, erratic swimming with irregular collision to the inner glass wall of the aquarium were observed. Infection of eyes, exophthalmia and involutions of test fish were observed, when compared to control fish. The percent changes in sodium ion content, potassium ion content and calcium ion content in effluent exposed fish, when compared to control fish. The gill showed the maximum percent decrease in sodium ion content when compared to liver, muscle and brain tissue. The brain tissue showed the lowest decrease in sodium ion content. The exposed brain showed 28.77 \% decrease, exposed liver showed 44.27 \% decrease, the exposed muscle showed 41.40 \% decrease and the exposed gill showed 64.02 \% decrease in sodium ion content, when compared to its respective control values. The brain showed the maximum percent decrease in potassium ion content when compared to liver, gill and muscle tissue. The muscle tissue showed the lowest decrease in potassium ion content. The exposed brain showed 57.96 \% decrease, exposed liver showed 44.87 \% decrease, the exposed muscle showed 42.28 \% decrease and the exposed gill showed 44.46 \% decrease in potassium ion content, when compared to its respective control values. The gill showed the maximum percent decrease in calcium ion content when compared to muscle, liver and brain tissue. The brain tissue showed the lowest decrease in calcium ion content. The exposed brain showed 03.89 \% decrease, exposed liver showed 17.32 \% decrease the exposed muscle showed 27.24 \% decrease and the exposed gill showed 32.61 \% decrease in calcium ion content, when compared to its respective control values.29.86 \% after 28th days of recovery, when the exposed fish was transferred to toxicant free medium.

Key Words: Fish, Chlor-alkali industry, Effluent, Toxic effect, Na\(^{+}\), K\(^{+}\) and Ca\(^{++}\) ion contents, Brain, liver, muscle and gill tissues.
PARTIAL REPLACEMENT OF FISHMEAL WITH LEMNA MINOR LEAF MEAL ON THE GROWTH PERFORMANCE OF CLARIAS BATRACHUS

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Abstract: A 60 day feeding trial was conducted to evaluate the effect of Lemna minor leaf meal at various levels of inclusion in the formulated diet of Clarias batrachus. Four test diets were prepared with 35% crude protein containing Lemna minor leaf meal at 0%, 10%, 20% and 30% inclusion level partially replacing fish meal, where 0% served as control. Clarias batrachus fingerlings were fed at 5% of their body weight twice daily. Growth was measured every two weeks interval and feeding rate was adjusted. Although the three inclusion levels supported growth, the feed conversion ratio and specific growth rate was more at low inclusion levels.

Keywords: Growth performance, Clarias batrachus, Lemna minor, partial replacement

INTRODUCTION:

Clarias batrachus is a delicious food fish of India. Its aquaculture potential is also very high since it can be cultured in swamps and marshes (Jhingran, 1997). The high cost of fish meal has motivated the search for local, cheap, alternative protein source that aim at reduced production cost without compromising fish quality. The use of leaf meal as a possible fish meal substitute to reduce the cost of fish feed is receiving attention of fish nutritionists. Several studies have been conducted on use of aquatic plants in fish feeds. Among these plants, duckweed is most promising because it has good protein content i.e. 20-45%, amino acid and mineral profile.

The present study is conducted to determine optimum inclusion level of duckweed, Lemna minor leaf meal in formulated feed of Clarias batrachus and examine the growth performance of Clarias batrachus in various levels of inclusion.

MATERIALS AND METHOD:

Experimental feed:

Leaves of Lemna minor were sundried and finely ground. Dried powdered leaves were passed through fine mesh to ensure homogeneity. Four isonitrous (35% crude protein) diets were prepared incorporating Lemna minor leaves in different inclusion levels i.e. 0%, 10%, 20% and 30% inclusion levels replacing fish meal. 0% served as control.

Experimental design:

The experiment was conducted in fiber glass tanks under laboratory conditions for 60 days. Fingerlings of Clarias batrachus were collected from natural sources and were acclimatised for a week to adjust with the experimental diets and laboratory conditions. During this period the fish were fed with a mixture of rice bran and mustard oil cake in ratio 1:1 at 5% of their body weight twice daily. Fingerlings mean weight (1.51±0.01) g were randomly distributed at 10 fish per tank with three replicates for each treatment. Each tank was supplied with unchlorinated water from borewell. Fish were fed twice daily at 5% of their body weight.

The weight gain was measured at every two week interval and quantity of feed was adjusted. Faecal matter and leftover feed was collected six hours after each feeding by pipetting. Water quality was monitored for temperature, pH, dissolved O₂ and total alkalinity at every two weeks interval following methods of APHA 1985. The ranges of water quality parameters were temperature 28-32°C, pH 6.5-7.3, D O₂ 4.8-7.2 and alkalinity 160-180 mg/l.

Data collection and analysis:

Proximate composition of diets and fish carcass before and after the experiment was done according to AOAC 2000. Moisture was determined by oven drying at 105°C at 24 hours. Crude protein (Nx 6.25) was determined by Kjeldahl method. Crude lipid was determined by extracting the residue at 40-60 °C with petroleum ether for 7-8 h in Soxhlet apparatus. Crude fibre was estimated as loss in ignition of dried lipid free residues after digestion with 1.25% H₂SO₄ and 1.25% NaOH. Ash was determined by ignition at 550 °C in a muffle furnace to constant weight. Growth performance in terms of growth increment, specific growth rate(SGR), feed conversion ratio(FCR), Protein efficiency ratio(PER) and survival% was calculated using the following formula:

Growth increment= final weight–initial weight
number of culture days

SGR(% day⁻¹)= 100× \frac{\log wt–\log wo}{r} where wt= final weight of fish
\log e= natural logarithm
Partial Replacement of Fishmeal With Lemna Minor Leaf Meal On The Growth Performance of Clarias Batrachus

Growth performance and feed utilization was affected by inclusion level of Lemna minor leaf meal in the diet of Clarias batrachus. It is evident from the present study that the aquatic weed, Lemna minor may be utilized as a feed ingredient in the diets for Clarias batrachus fingerlings due to its protein sparing action. Ahmad et al, 2003, reported that partial replacement of the costly sesame oil seed by cheaper unconventional duckweed in broiler diet resulted in increased nutrient utilization fish. This report is similar to the findings of present study. Inclusion of duckweed meal diet of other animals to replace fish meal and soybean has also been reported by Samrang, 1999, Hang, 1998, Becerra et al, 1995.

CONCLUSION:

This study showed that duckweed, Lemna minor meal which is in fact cheap, could be used to partially replace the highly expensive fish meal in the diet of Clarias batrachus fingerlings at regulated inclusion levels. This will definitely reduce cost of production and thereby further boost aquaculture development. Use of aquatic weeds, which actually are a menace in developing countries, will be put into good use if they are used to make fish feed.

RESULT AND DISCUSSION:

Percentage composition of experimental feed is presented in Table-1. Proximate composition of experimental feed is presented in Table-2. Data on growth performance and feed utilization of Clarias batrachus fingerlings in terms of growth increment and PER and percentage of FCR, SGR are presented in Table 3. Growth performance was significantly affected by inclusion level of Lemna minor leaf meal. Growth performance and feed utilization was favoured by low inclusion level of duckweed meal in the experimental feed. The similar result demonstrating the use of several species of duckweed as a partial replacement for fish meal in the diet of fish and other animals has been reported by few authors (Fasakin et al, 2001, Effiong et al, 2009). They opined that fish fed duckweed based diet had higher growth rates than fish fed diet containing water fern meal. The weight gain, food conversion and energy use were equal to a standard cat fish feed. It is evident from the present study that the aquatic weed, Lemna minor may be utilized as a feed ingredient in the diets for Clarias batrachus fingerlings due to its protein sparing action. Ahmad et al, 2003, reported that partial replacement of the costly sesame oil seed by cheaper unconventional duckweed in broiler diet resulted in increased profitability.

Bairagi et al, 2002, and Effiong et al, 2009, revealed that 30% fermented Lemna minor leaf meal incorporated in diet of Clarias batrachus gave the best performance in terms of growth response, food conversion ratio and protein efficiency. From this observation, 20% Lemna minor leaf meal diets had the best specific growth rate and food conversion ratio.

Guru and Patra, 2007, reported that protein content of Lemna minor was estimated to be the highest in comparison to Eichornia Crassipes and Pistia stratiotes. One important observation to be noted in this study was that Clarias batrachus fingerlings fed with formulated Lemna minor leaf meal grew more in width than in length, thus incorporating more flesh to the fingerlings. Apart from this survival rate was found to be 86-93% in this case. It was also observed by Liang et al, 1971 that the most favourable use of water hyacinth as a supplement to vitamin deficient diet at the rate of 5% to 10% increase growth and reduce mortality of the fingerlings of cat fishes.

Fasakin et al, 1999, reported that there was no significant difference in growth performance and nutrient utilization fish fed on diets containing up to 20% duckweed inclusion, they however stated that increasing dietary duckweed inclusion resulted in progressively reduced growth performance and nutrient utilization of fish. This report is similar to the findings of present study. Inclusion of duckweed meal diet of other animals to replace fish meal and soybean has also been reported by Samrang, 1999, Hang, 1998, Becerra et al, 1995.

Table 1: Composition (% of dry weight) of experimental feed.

<table>
<thead>
<tr>
<th>Ingredient</th>
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<td>3.5</td>
<td>7.0</td>
</tr>
<tr>
<td>Lemna minor leaf meal</td>
<td></td>
<td>20.0</td>
<td>16.5</td>
<td>13.0</td>
</tr>
<tr>
<td>Fish meal</td>
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<td>39.0</td>
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<tr>
<td>Groundnut oil cake</td>
<td></td>
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<td>39.0</td>
<td>39.0</td>
</tr>
<tr>
<td>Rice bran</td>
<td></td>
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<td>1.0</td>
<td>1.0</td>
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<tr>
<td>Vitamin mineral premix</td>
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<tr>
<td>Sunflower oil</td>
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<td>1.0</td>
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</table>

Table 2: Proximate composition of experimental feed.

<table>
<thead>
<tr>
<th>Experimental feed</th>
<th>Crude protein(%)</th>
<th>Crude lipid(%)</th>
<th>Ash(%)</th>
<th>Moisture(%)</th>
<th>Organic matter (%)</th>
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<tbody>
<tr>
<td>Control</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>T1</td>
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<td>16.5</td>
<td>13.0</td>
<td>9.5</td>
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</tr>
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<td>T2</td>
<td>39.0</td>
<td>39.0</td>
<td>39.0</td>
<td>39.0</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>39.0</td>
<td>39.0</td>
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<td>39.0</td>
<td></td>
</tr>
</tbody>
</table>
Control | 37.5 | 8.0 | 13.5 | 2.3 | 84.52  
T1 | 35.5 | 6.8 | 11.5 | 1.2 | 85.45  
T2 | 34.0 | 6.87 | 11.0 | 1.2 | 83.51  
T3 | 33.5 | 5.5 | 10.8 | 1.8 | 85.15

Table 3: Growth performance and feed utilisation of *Clarias batrachus* fingerlings fed *Lemna minor* leaf meal based diet for 60 days.

### REFERENCES:


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Partial Replacement of Fishmeal With *Lemna Minor* Leaf Meal On The Growth Performance of *Clarias Batrachus*
INDUSTRIAL POLLUTION AND HEALTH EFFECTS, A CASE STUDY IN A COMMERCIAL TOWNSHIP: RAJAHMUNDRY

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Abstract—This paper presents a report of a survey of the sources of water, the industrial scenario, the control methods and the medical history of the pollution in a typical commercial township located on the banks of the river Godavari. Rajahmundry: A Historic township earlier, now it is turned municipal corporation in Andhra Pradesh. It is a big commercial centre in neighboring districts in Andhra Pradesh. The primary sources of water supply for the city in the Godavari, which is a perennial and the longest river in South India. The major industries are in the city are paper mills, dyeing units, stone crushers and food industry. These industries cause pollution of the river Godavari into which the effluents are thrown out after treatment. The Stone Crushing units located nearby city cause air pollution due to minute particulates that get air borne diseases during crushing operations. The paper analyses the data collected on the status of pollutants and prevention, treatment and control of pollution from these industries. A survey of medical records have shown that dysentery, diarrhea, amebic colitis and other water borne diseases are on the increased due to pollution of water. Tuberculosis, bronchial asthma, chronic bronchitis is also found to be increasing due to increased pollution of ambient air. However a decrease in the number of cases of malaria and filarial reported during the last few years is indicative of reduction of water based disease due to better management of stagnant water. This paper describes the details of methods of water and waste water management techniques adopted by the industries and offers suggestions for improvements. The need to relocate air pollution industries like stone crushers from inhabited areas to a distance located is emphasized. Shifting the existing out fall sewer to a place downstream of the water in takes is suggested to prevent possible mixing of sewage with water.

Keywords: Pollution, Health, Industries, Treatment of effluents

1.0. INTRODUCTION

Many cities, towns in India and all over the globe are facing the problems of increased industrial pollution in various intensities and complexities. In this paper an attempt is made to study the intensity and complexity of increased industrial pollution in Rajahmundry, Andhra Pradesh, India. The primary source of water supply for city as well as water course for disposal of effluents is the river Godavari, which is a perennial river. The quality of river water is monitored for BOD, COD, suspended Solids and dissolved solids by the Pollution Control Board.

1.1. THE SCENARIO

The population of the city is 2001 census and the amount of water is purified to city only 33 million liters per day as against 60 million liters. It’s required for the city. The British’s built the intake well for taking water from Godavari in 1933, which lifts water at the height of 18 mts. This construction was so strong no repairs were under taken till date. Water is treated with Alum to remove turbidity 16% Ferric alum is used as a coagulant the dosage of which is determined based on turbidity of the raw water. The water is then passed through rapid sand filters of the and chlorinators. The variation of turbidity of raw water is as follows.

Table 1.  

<table>
<thead>
<tr>
<th>Months</th>
<th>Turbidity depend on Seasons</th>
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</thead>
<tbody>
<tr>
<td>July-August</td>
<td>3000 mg/liter</td>
</tr>
<tr>
<td>October-November</td>
<td>50 mg/liter</td>
</tr>
<tr>
<td>December to May</td>
<td>20 mg/liter</td>
</tr>
</tbody>
</table>

1.2. EFFLUENT TREATMENT & DISPOSAL

The city has various industries such as paper mills, small scale dyeing industries, stone crushing units, food industry and small scale aluminum industry, ceramic industries to discharge effluents and waste. The treatment of waste vary from industry to industry.

Paper Mills

A mill which produces 280-290 tones of paper per day, which has successfully adopted a unique system of effluent treatment and disposal. The system is based on the principle of natural evaporation and percolation. The effluent is pumped to the sand shoals on an island in the middle of the river Godavari at a distance of 5 Km away from the mills. On these sand shoals a number of lagoons are constructed covering...
an area of 600 acres taken on lease from the State Government. Since then the system was in operation and the Company is in the constant look out for further improving the system Primary and secondary treatment systems designed to handle an effluent volume of 20 MGD.

In the primary treatment system, effluent from different sections of the mill like Pulp Mill, Paper Machines, recovery and Bleaching etc. are first collected in a sump and combined effluent after passing through bar screens and stationary screen chambers pumped to two primary clarifiers of 150 ft. diameter each connected in parallel. The pump house is provided with four 6 MGD capacity pumps of 75 hp each.

The under flow from the clarifiers having a consistency of about 1.5 to 2.0% is further thickened in a thickener of 95% ft diameter to a consistency of about 6% and is finally dewatered in a specially imported Sludge Dewatering Machine. The Cake coming out of this machine is carted out and disposed off land fill.

The primary clarifier over flow, which is very clear, and a suspended solids concentration of less than 100 mg/l it is taken in to the secondary system.

The secondary treatment is a biological process, which involves an activated sludge plant is designed for an outlet B.O.D OF LESS THAN 60 PPM. The clarified effluent from the primary clarifier is taken into aeration tank where the organic matter in the effluent gets decomposed into sludge by bacterial action. The overflow from the aeration is having about 22,500 Cu. Mts. Volume with eleven mechanical surface aerators of 75 hp each goes into secondary clarifiers (2.Nos) of 160 ft diameter each. The sludge mass gets separated in these clarifiers. The secondary clarifier under flow sludge (about 60-70%) is recalculated back into the aeration tank in order to maintain the bacterial mass. The excess sludge is taken on to the dewatering machine and disposed of as land fill. Nutrients like Super Phosphate and Urea are added at the inlet of the aeration tank to activate the bacteriological action in the aeration tank.

The secondary clarifier overflow, which is very clear, is then pumped to lagoons on the sand shoals of islands. About six pumps of 150 hp each are provided for pumping the effluent to island sand shoals. From the pump house, effluent is covered through two pipelines of 36 inches and 48 inches in diameter which run all along the left river bank up to distance of 5 Kms and then crosses the river course under the river bed and drops the effluent into an open channel on the high level island. From the here effluent is flown by gravity up to a distance of about 1.2 Kms. And is distributed into a number lagoons constructed on the sand shoals. These lagoons are manually with sand. The width of the sand bunds at the bottom is maintained about 5-10 ft. And at the top 3-6 ft. The average depth of the lagoons varies between 1.5 – 2.0 mts. normally around 30 lagoons are constructed on the sand shoals having a holding capacity of about 25-30 days.

Utmest care is taken to see that sufficient distance of about 2000 ft. is always maintained between the last lagoon and the river course to avoid accidental effluent mixing into the river directly. Also empty buffer lagoons are provided at the end of the lagoons is all directions to take care of any seepage or accidental breaches from the lagoons. The company has employed forty permanent workers to regulate and distribute the effluent into the lagoons round the clock.

By implementing this unique scheme the company apart from storing the effluents in the sand shoals is providing indirect employment for 400-600 workmen from the nearby villages for a period of about four months.

It is ensured that the system functions really well by regular monitoring of river water quality of both by mills as well as State Pollution Control Board Authorities by collecting effluent and river water samples at various points every month. Also the Pollution Control Board Authorities have insisted to provide bore wells at a distance of 100 ft away from the river water edge in different directions, in line where the distance between farther most lagoon and the river water edge is 2000 ft. and prescribed a B.O.D value of 15 mg/l for these bore water samples. Regular monitoring has shown that the B.O.D value of these bore water samples have never exceeded 5 mg/l.

The total recurring cost per year for operation of this entire system works out to be about 310 lakhs, which includes construction and maintenance of lagoons, power costs and chemicals etc. It has been clearly established by operation of this treatment and disposal method that the river water quality is not at all affected. The quality of river water 1 Km up stream is equivalent to 1 Km downstream of the lagoons. This scheme is recognized by experts in the field as a novel, ingenious, unique and effective, not adopted anywhere else. In recognition of these unique effluent schemes, the Company has bagged the A.P. State Pollution Control Board award for most efficient effluent treatment plant for three successive years, 1983-84, 1984-85, and 1985-86.

Though the effluent meets the ISI specifications (IS: 2490) for inland surface water discharge (river Godavari) with 30 mg/l B.O.D. AND 100 mg/l of suspended solids after the secondary treatment, the effluents are still being pumped to lagoons for final discharge so that the colour of the effluent to be minimized to a great extent which is successfully being achieved by the natural evaporation and percolation process.

Apart from having a full-fledged effluent treatment and disposal system, the Company in the recent past has made special efforts towards conservation of water, keeping in view the stringent norms stipulated.
for the rate of water consumption and effluent discharge per ton of paper produced.
All possible measures for intensive recirculation of process water was taken up which resulted in bringing down the water consumption to lower levels. Besides this a project costing Rs. 25 lakhs was taken up for the natural clarification of the paper machine effluents, so as to make it fit for utilization in the process, particularly in the pulp mill section. This has made a land mark achievement, as the intake water consumption has been reduced around 2.5 MGD. This scheme has been kept in regular operation since April 1994. The effluent discharge level which was around 250-300 cu.m per tone of paper earlier has been brought down to less than 175 cu.m per ton of paper produced after the implementation of this scheme.

**1.3. DYING INDUSTRY**

The total number of textile units in Rajahmundry are 35, which are small scale industries. They work on manual labour. They do not use machinery for process. They are more than 2000 families benefited on this industry. It provides a livelihood for them. The process is two types dyeing and printing. The effluent is neutralized and let out into the municipal sewers.

**1.4. FOOD INDUSTRY**

Smithkline and Beecham Consumer Health Care Limited which manufacture Horlicks an ISO 14001 & ISO 9002 organization and is equipped the status of benchmarking ETP by the Andhra Pradesh Pollution Control Board officials and is well appreciated by the technical community. The technical community.

The structure of effluent is following

**FAT TRAP**

Wastewater from process passes through a fat trap, where fat is skimmed off from the surface and thus the water reaches to equalization tank.

**EQUALIZATION**

The wastewater from various streams viz. process, canteen and sewage gets mixed in equalization tank. The equalization tank has air compressor to keep the mixing uniform.

**UP FLOW ANAEROBIC SLUDGE BLANKET REACTOR (UASBR)**

The waste water is pumped to UASBR, where about 30-35% reduction in Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) takes place and overflow effluent from UASBR goes to two aeration tanks through effluent diversion tank. The methane generated in UASBR is let off now it is proposed to use for laboratory as fuel.

**AERATOR TANK**

Water flows to aerator from UASBR into two aeration tanks of 510 cubic meter & 1013 cubic meter. Aerators are fitted with 20 hp and 2x20 H.P. aeration tanks respectively. These decrease the Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) of the waste water.

**CLARIFIER**

The overflow water from both the aeration tanks comes to clarifier tank of 271 cubic metre from where suspended solid particles are allowed to settle down and the clear water goes to the last storage pond through ‘V’ notch. The stored water from last storage pond is used for internal irrigation. The final discharge water has following characteristics.

**SLUDGE FILTER BED**

The settled suspended solid particles are pumped out from clarifier to the sludge bed. Here the sludge is being dried after filtering water. The sludge is used as manure.

**CHARACTERISTICS OF WASTE WATER (INFLUENT) VS TREATED WATER (EFFLUENT)**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Waste Water (Influent)</th>
<th>Treated water (Effluent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.00-10.00</td>
<td>7.5-9.0</td>
</tr>
<tr>
<td>BOD</td>
<td>800-900 mg/lt</td>
<td>&lt; 30 mg/lt</td>
</tr>
<tr>
<td>COD</td>
<td>1200-1500 mg/lt</td>
<td>&lt; 70 mg/lt</td>
</tr>
<tr>
<td>TDS</td>
<td>1500-2000 mg/lt</td>
<td>&lt; 750 mg/lt</td>
</tr>
<tr>
<td>TSS</td>
<td>300-400 mg/lt</td>
<td>&lt; 75 mg/lt</td>
</tr>
</tbody>
</table>

The clarity and cleanliness of water in the last storage pond can be simply understood by a very practical way. i.e. 6 ducks are being living on water from last two years apart from 1000 fishes and many tortoise are living in the same water.

Few evidences are that this state of the art ETP has fetched the following awards.

1. Best Environmental and Ecological Implementation Gold Award for excellence in Indian Industries organized by A.P. Central Public sector employees Federation, Hyderabad.
2. A.P. Pollution Control Board Zonal Award For Outstanding Contribution Towards cleaner production technologies and waste minimization techniques.
3. FACPPI AWARD- 2001 in the category OF Best all round performance in industrial activity including promotion/expansion effort in the State.

**2.0. STONE CRUSHING**

There are 31 stone crushing units in the residential area of Rajahmundry. Nineteen of them were asked to close down by the Pollution Control Board. Fifteen
those for a grace time of 6 months for relocation. The fine dust generated during crushing operations was found to be spread over a radius of ½ km and create lung problems among the inhabitants.

3.0. SURVEY OF MEDICAL RECORDS

The medical reports collected the Superintendent of Government General Hospital, Rajahmundry and National Filarial Control Project, Rajahmundry were analyzed to find out the health status over the years. These analysis have shown are increase in water borne diseases like Acute, Diarrhea, Amoebiosis, soil borne disease Helminthiasis and air borne disease like acute respiratory (including influenza) pulmonary tuberculosis over the years. However a decrease with number of cases of malaria, filarial, typhoid and jaundice and Pneumonia was reported during the last few years. The reduction in water based diseases spread through mosquitoes is indicative of improved management of stagnant water bodies in the city.

FILARIA

National Filarial Control Project is a separate Department for Filalr in under the control of state Government. This unit is established in 1972. They National Filarial Control Official Project organize tests in two methods: 1. Clinical and Survey and at two stages. 1. Parasitological and Entomological. According to official reports, they tested 7, 401 blood smears in the year 2000 135 cases out of 7, 401 cases are found to be positive. These people have microfilarial in the blood. They were given 12 days treatment according to their age. The dosage of medicine of Diethyl carbogygine citrate is given 16 milligrams per body weight.

According to clinical tests in the years In 1972 the ratio of microfilaria was 15 % and disease rate was 12 %. The following tables show the survey data and clinical data of filaria.

In 2000 the rate of microfilaria was 1.82 and disease rate was 0.60%. The rate is decreased from 1972 to 2000. The government has taken preventive steps to control disease.

Table 3: Male

Survey of Medical Records Year 2000

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<th>June</th>
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<td>11</td>
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Table 4, Female

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<td>73</td>
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</tbody>
</table>

Tables 3 & 4 shows about the male and female patients attacked various diseases from January to December 2000. Diphtheria and polimycetitis are not recorded in the year 2000. The disease is completely eradicated due to best medical facilities are provided by the Government of India from the assistance of World Health Organization. Graphs 1 & 2 shows intensity of disease rate from January to December 2000. Helminthiasis and Amoebiosis are increased from January to December 2000 due to poor sanitary conditions.

According to Statistical Data

Table 5

<table>
<thead>
<tr>
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<tr>
<td>Blood Smear Collection Test Dose</td>
<td>1862</td>
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<td>1035</td>
<td>1039</td>
<td>891</td>
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<tr>
<td>Disease cases</td>
<td>1755</td>
<td>1514</td>
<td>992</td>
<td>964</td>
<td>794</td>
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<td>Positive for M.F</td>
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<td>19</td>
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<tr>
<td>M.F Rate</td>
<td>0.59%</td>
<td>0.35%</td>
<td>0.19%</td>
<td>--</td>
<td>2.13%</td>
</tr>
<tr>
<td>Disease rate</td>
<td>94.2%</td>
<td>90.44%</td>
<td>95.4%</td>
<td>92.7%</td>
<td>89.11%</td>
</tr>
</tbody>
</table>

Table 6
Survey Data

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</thead>
<tbody>
<tr>
<td>Infection rate</td>
<td>12.4%</td>
<td>1.1%</td>
<td>1.5%</td>
<td>1.5%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Infective rate</td>
<td>3.5%</td>
<td>0.4%</td>
<td>0.8%</td>
<td>0.5%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Mosquitos Infective L1</td>
<td>-</td>
<td>59%</td>
<td>62%</td>
<td>61%</td>
<td>61%</td>
</tr>
<tr>
<td>Microfilaria stage L2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>L3</td>
<td>-</td>
<td>27%</td>
<td>23%</td>
<td>25%</td>
<td>30%</td>
</tr>
<tr>
<td>Endomyelity rate</td>
<td>1.5%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 7 Clinical data

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Blood Smear Collection Cases</td>
<td>7218</td>
<td>7732</td>
<td>7373</td>
<td>7328</td>
<td>7401</td>
</tr>
<tr>
<td>Micro Filaria Positive</td>
<td>170</td>
<td>154</td>
<td>99</td>
<td>145</td>
<td>135</td>
</tr>
<tr>
<td>Micro filarial Rate</td>
<td>1.48%</td>
<td>2.0%</td>
<td>1.35%</td>
<td>1.97%</td>
<td>1.82%</td>
</tr>
<tr>
<td>Disease Rate</td>
<td>0.20%</td>
<td>0.46%</td>
<td>0.74%</td>
<td>0.64%</td>
<td>0.60%</td>
</tr>
<tr>
<td>Disease Cases</td>
<td>15</td>
<td>34</td>
<td>55</td>
<td>47</td>
<td>45</td>
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</tbody>
</table>

M.F. Micro Filaria
Entomological Test: In 2000 they collected 5, 653 culex mosquitoes. The female culex mosquitoes are 4007 out of 5,653 which cause disease.

Precautions
Conducting anti larval operations is continuous process by using Baytex and Abate.
1. Batex is used in drains, contaminated water sources, ditches.
2. Abate used in fresh water storage tanks. Baytex 5 ml /10 lts used for 500 liner meters.
3. Spraying DDT, Pyrethan, Malathine
4. Septic tanks are covered with nets
5. Oil Balls are thrown into stagnant water tanks & ditches. The oil spreads into ditches to control the development of larva.

4.0. CONCLUSIONS:
There is an immediate need to relocate air polluting industries like stone crushers from inhabited areas or residential area to distance location. Shifting the existing out fall server to a place downstream of water intake is suggested to prevent possible of mixing sewage with water, particularly during monsoon season. Existing stagnant to ensure decrease of water – based diseases. Participation of the public in the clean and green campaign of the State Government should be insured to regain in prestige of the historic city. Graph 3, 4, and 5 shows about the parasitological, clinical and survey data fileria.

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Tables 3 & 4

Smithkline & Beecham Consumer Health Care Limited Effluent Treatment Plant flow chart.
AN ANALYSIS ON ENVIRONMENTAL GOVERNANCE & ITS PERSPECTIVES

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“A margin of life is developed by Nature for all living things - including man. All life forms obey Nature’s demands - except man, who has found ways of ignoring them” - Eugene M. Poirot

INTRODUCTION

Globalization is undoubtedly altering the environment at a very rapid pace. The rapid acceleration in global economic activity and our dramatically increased demands for critical, finite natural resources undermine our pursuit of continued economic prosperity. The present world is different from the world of the agricultural and the industrial revolution and the pressure on the environment due to some human activities and some natural activities (flood, earthquake, eruptions) seem to be weighing much on the limited planet that mankind and other living organisms sharing the planet with us are adversely affected by, even the environment itself. The premise of this proposition is that a sound environment is essential to realizing the full potential of globalization. Conversely, the absence of a sound environment can significantly undermine the promise of economic prosperity through globalization and this is where merges the need of Environmental Governance for Environment Protection.

In India environmental law has seen considerable development in the last two decades. Good governance is the instrument to attain development in the most democratic way. It is believed that a country can develop meaningfully only when ecological sustainability and social equity are guaranteed, and a sense of respect for, and oneness with nature and fellow humans is achieved. The development of the laws in this area has seen a considerable share of initiative by the Indian judiciary, particularly the higher judiciary, consisting of the Supreme Court of India, and the High Courts of the States. The essence of the existing law relating to the environment has developed through legislative and judicial initiative there was a quantum leap with the amendment of our Constitution in 1976 and incorporation of Article 48-A in the Directive Principles of State Policy and Article 51- A (g) in the Fundamental Duties of every citizen of India. Both these Articles unequivocally provide for protection and improvement of the environment. Inevitably, Parliament enacted the Air (Prevention and Control of Pollution) Act, 1981 and Environment (Protection) Act, 1986.

Over the years, there has been an increasing awareness and consciousness among the people about their right to a healthy environment. Like any other social, economic and political problems, environmental problem has caught the attention of policy-makers, intellectuals, social movement activists and research scholars. No nation can afford to ignore the emerging environmental problems such as depletion of ozone layer, acid rain, green house effect, soil erosion, deforestation, water pollution, air pollution, noise pollution, etc. In this connection, the United Nations took the first initiative for the preservation of the environment. The status of the environment is closely tied to international economic growth and thus many economists believe that globalization is helping the environment through dissemination of better technology and more efficient economies of scale. Effective environmental governance is critical for the well being of a resource scarce society on a per capita basis like India. Among various levels of environmental governance, the most effective is the local level for efficient management and utilization of natural resources. Democratic decentralization in the country has been path-breaking. In India, our natural resources are getting depleted faster than the global average and part of the problem is ineffective environmental governance. Ineffective governance means the sub-optimum use of natural resources and leads to environmental degradation and is a major causal factor in enhancing and perpetuating poverty, particularly among the rural poor. The poor, largely depending on the natural resources for their livelihood, are the worst victims of resource degradation. Effective handling of environmental issues and management of natural resources are important for the very survival of all living beings.

As the country marches forward economically, the Indian Government is turning its attention to the environmental problems it faces and knows it must address. Many area of activity has been taken up which focus on strengthening environmental governance amidst of the Globalization and Urbanization leading to the development of the Country.

CONCEPT OF ENVIRONMENTAL GOVERNANCE

Environmental Governance is an over-arching principle that regulates public and private behavior
An Analysis On Environmental Governance & Its Perspectives


Environmental Governance encompasses the relationships and interactions among government and non-government structures, procedures and conventions, where power and responsibility are exercised in making environmental decisions. It concerns how the decisions are made, with a particular emphasis on the need for citizens, interest groups, and communities to participate and have their voices heard. It operates at every level ranging from the individual to the global and calls for a shared leadership and combined responsibility for maintaining environmental sustainability.

Environmental governance addresses how decisions concerning the environment are made and who participates in the decision making process. It seeks to address questions such as: Who makes and enforces the rules for using natural resources? What are the rules and penalties for breaking them? Who resolves disputes? How can the public influence or contest the rules over natural resources? Who represents those who use or depend on natural resources when decisions on those resources are made?

At what level—local, regional, national, and international—does the authority over resources reside? How do those who control and manage natural resources answer for their decisions, and to whom? How open to scrutiny is the decision making process? Who owns a natural resource or has the legal right to control it?

The series of questions which environmental governance seeks to address reveal that environmental governance does not exclusively involve decisions made by single entity rather it demonstrates a much more diffuse level of responsibility for environmental governance.

As an extension of the concept of environmental governance, good environmental governance is measured by the effectiveness of strategies and initiatives implemented to achieve environmental goals. These goals may be capacity building, increased access to environmental information, participation and justice. International environmental law instruments, such as The Earth Charter Initiative, Agenda 21, and the World Conservation Union’s (IUCN) Draft International Covenant on Environment and Development, set out the framework for achieving environmental goals such as these.

Environmental Governance comprises the rules, practices, policies and institutions that shape how humans interact with the environment. Good environmental governance takes into account the role of all actors that impact the environment. From governments to NGOs, the private sector and civil society, cooperation is critical to achieving effective governance that can help us move towards a more sustainable future. At last, Environmental Governance is the key to developments in today’s era of globalization and Urbanization. Only Good Governance of Environment can save our Planet earth and all the living being in it from the devastation & destruction.

ENVIRONMENTAL DEGRADATION AND INITIATIVES FOR GOVERNANCE

Globalization has considerably weakened traditional governance processes. Increasing global economic integration has reduced the power of national governments while granting other economic and political actors access to the world stage. In modern times, therefore, it needs more effective legal opinions to counter the problems. Accordingly Indian parliament passed The Environment Protection Act’1986 to safeguard the environmental degradation. The Indian Penal Code has few provisions on the subject, but they are ineffective when faced with the problems of an industrialized society. The first problem to attract the attention of certain state legislation in India was water pollution. But it was only in 1974 that a Central Act was enacted on the subject to be followed by The Water (Prevention and Control of Pollution) Cess Act’1977 and thereafter most drastic law had been enacted as Environment (Protection) Act’1986. India first got the taste of environmental disaster by two catastrophes that befell India – the Bhopal disaster in 1984 and Sri Ram Fertilizer Plant leak in 1985. With the realization that the exploitation of nature endangers the continued use of the bases of production itself, a need for political regulation was recognized so that it can continue with the growth of capital and its ruinous consequences. Enabling the constructive participation of civil society in global environmental governance is thus one of the most important tasks for policymakers concerned with the effectiveness of global governance. According to United Nations, good governance has 8 major characteristics. It is participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive and follows the rule of law. It assures that corruption is minimized, the views of minorities are taken into account and that the voices of the most vulnerable in society are heard in decision-making. Effective environmental governance at all levels is critical for finding solutions to these challenges. Though there are an extremely large number of environmental laws and regulations in India, the implementation and enforcement of these laws leave much to be desired. In light of the fast pace degradation and the affect it is having on already vulnerable communities there is an urgent need to encourage good environmental governance in the country. Among the various levels of environmental governance, the most effective is the local level for the efficient management and utilization of natural resources. Through the 73rd and 74th amendment to the Constitution, Panchayati Raj Institutions (PRIs) were set up and empowered to act.
as local governance bodies. They have a great deal of responsibility on them for managing environmental resources. PRIs, other community based institutions such as Van Panchayats and Pani Panchayats and informal community based organisations have been doing a lot of work at the grassroots level to protect the environmental resources, improve the condition of the people and provide alternate livelihoods. Also, many local communities are rich reservoirs of traditional knowledge on how to sustainably use natural resources, live in harmony with the environment and adapt to changing conditions. The PRIs and other community-based organisations have a very important role to play in preserving and furthering this traditional knowledge. Effective national environmental governance complements efforts to improve international mechanisms for environmental protection. For example, international treaty commitments cannot be implemented without corresponding national laws and institutions. Effective national environmental governance helps ensure that parties to international environmental agreements actually reap the benefits those agreements are designed to provide and also produces corresponding mechanisms for addressing national and sub-national problems that are not the subject of international attention to the same degree. Effective national environmental governance also helps advance environmental justice, because protection of vulnerable communities requires strong legal institutions and open forms of governance that foster public participation. Finally, it contributes to a level playing field for businesses operating globally and helps avoid the emergence of pollution havens in places lacking effective environmental governance.

An examination of the nature of global environmental problems, and the inherent shortcomings of the existing structure in responding to global pollution and natural resource management challenges, delivers a strong case for a restructuring of the environmental regime. The problem is not just environmental. It is closely linked to development, particularly for poor countries that rely heavily on the natural resource base for their livelihoods. From a plethora of judicial decisions and various other sources it is evident that that the authorities concerned ought to have laid more emphasis for the betterment of condition of life of the people and necessity for preservation of social and ecological balances. Proper Environmental Governance and Judicial activism in this sphere is need of the hour especially when legislatures lags behind in removing the lacunae in the present legal mechanism and administration is still ill-equipped to meet the challenges.

**NEED FOR ENVIRONMENTAL GOVERNANCE**

In today’s world the conservation, protection and improvement of human environment are major issues all over the world. The problem of environmental pollution has acquired international dimension and India is no exception to it. The protection of the environment and keeping ecological balance unaffected is a task which not only the government but also every individual, association and corporation must undertake. It is a social obligation and fundamental duty enshrined in of the Constitution of India and this is what perhaps Environmental Governance is. Imagine a world in which environmental change threatens people’s health, physical security, material needs and social cohesion. This is a world beset by increasingly intense and frequent storms, and by rising sea levels. Some people experience extensive flooding, while others endure intense droughts. Species extinction occurs at rates never before witnessed. Safe water is increasingly limited, hindering economic activity. Land degradation endangers the lives of millions of people. As a consequence of devastating environmental and economic crises, increases are being raised within mainstream politics and scholarship with respect to the sustainability of the existing world (economic) order. National, international as well as transnational initiatives are being set up that address the conditions for a sustainable economic order. Environmental protection and governance occupy a prominent role in these endeavors. It seems, thus, possible to detect a repoliticization of questions concerning a sustainable and just global order – questions which were partially withdrawn from political debate due to, on the one hand, a far-reaching juridification of international economic relations and, on the other hand, a scientification in form of the promotion of a certain economic order as a matter of scientific truth. Many problems have been recognized in the current system of international environmental governance: it is too large and too complex; it is chronically under-funded and yet also uses resources it has inefficiently; it has expanded in an ad hoc fashion; it lacks coordination and policy coherence; it is often duplicative and ignores interlink ages; and sometimes different organisations within the system work at cross-purposes to each other. Options do exist, however, that could effectively address these problems but they will require major reforms. The importance of governance in the organization of society is evident; furthermore, the nature of political conflicts surrounding environmental issues emphasizes the need to better comprehend different ways of governance. With knowledge comes the moral responsibility to act carefully in regards to the environment, on a global, domestic, and local scale. The concept of environmental governance incorporates this ethic. The Environmental Law expresses this sense of environmental responsibility by stating that the improvement of democratic practices, transparency and accountability of
government institutions, along with civil participation in decision making, are strongly related factors to the objectives of the protection of the environment and social and economic justice. Therefore, with such risks which is faced and which can be foreseen, it becomes utmost importance for us to take concrete steps for protection of Environment and a well planned Environment Governance System.

MAJOR PLAYERS FOR MAKING ENVIRONMENTAL GOVERNANCE A SUCCESS

(1) Central Governments
Central governments have played, and continue to play, a key role in environmental governance in Asian countries. Within the structure of central governments, however, environmental policy still tends to be separate or isolated from the mainstream policies of economic planning and industrial/agricultural development. In addition to the ministry of environment, many governmental ministries and agencies are responsible for environmental issues under their respective jurisdiction.

(2) Local Governments
Every environmental issue is a local environmental issue. Even when those issues also capture the attention of state and territory, regional or Commonwealth agencies, the local governments in which they are located always have a profound and enduring interest that is worthy of attention by all spheres and stakeholders. Local government is the sphere of government that is closest to the people and environment. Local governments set many strategic, long-term environmental policies, especially in the realm of land use planning. They also take small decisions and actions each day that cumulatively amount to shifts in regional environment and heritage values.

(3) Environmental NGO
Enabling the constructive participation of civil society especially NGO’s in global environmental governance is thus one of the most important tasks for policymakers concerned with the effectiveness of global governance. The definition of environmental NGOs and the relationship between the government and environmental NGOs are different in each country. Environmental NGOs themselves chiefly acted as a watchdog for government policies and institutions. Many actors such as the EU, UNECE and UNEP increasingly recognise the potential benefits of an enhanced involvement of civil society in international policy-making on sustainable development.

(4) Industries
Business & Industries Play an important role in Environmental Politics. Every sector effects the environment in some way or other. The Environmental impacts of their activities makes them play a central role in this. Most industrial enterprises in Asian countries have maintained passive attitudes towards environmental management. Large corporations that are well connected with various governmental sectors have planned and carried out many development projects and have maintained the decorum with regards to Environmental Concerns. There are many other small and big players in our society, rather the truth is every individual in his capacity has a role to play towards Environmental Governance for the improvement of our Environment and make this Planet a better place to live in for us and the future generations.

PRECEPTS OF EFFECTIVE NATIONAL ENVIRONMENTAL GOVERNANCE

As environmental laws and regulatory frameworks around the world continue to evolve and adapt in response to changing conditions, and though countries differ on the precise nature of the environmental challenges they face and on the best ways to address them, this global diversity in circumstances and the lessons derived therefrom point to a core of common governance precepts. Nevertheless, environmental challenges in different countries tend to share fundamental similarities, and thus it is not surprising to see a convergence of legal and institutional tools in response to these common challenges. These are some of the common precepts which have emerged till date:

• Environmental laws should be clear, even-handed, implementable and enforceable
• Environmental information should be shared with the public
• Affected stakeholders should be afforded opportunities to participate in environmental decision-making
• Environmental decision-makers, both public and private, should be accountable for their decisions
• Roles and lines of authority for environmental protection should be clear, coordinated, and designed to produce efficient and non-duplicative program delivery
• Affected stakeholders should have access to fair and responsive dispute resolution procedures.
• Graft and corruption in environmental program delivery can obstruct environmental protection and mask results and must be actively prevented

CONCLUSIONS AND SUGGESTIONS

• We have more than 200 Central and State legislations which deal with environmental issues. More legislation means more difficulties in enforcement. There is a need to have a comprehensive and an integrated law on
environmental protection for meaningful enforcement.

- To establish a network of regional and sub-regional institutions to monitor and review the status of environmental policy development and implementation in Asian countries and to widely disseminate the information and data obtained through various channels, including mass media and the Internet.

- The powers vested to the Pollution Control Boards are not enough to prevent pollution. The Boards do not have power to punish the violators but can launch prosecution against them in the Courts which ultimately defeat the purpose and object of the Environmental Laws due to long delays in deciding the cases. Thus, it is imperatively necessary to give more powers to the Boards.

- To undertake a comprehensive review of existing laws, policies and institutions related to environmental management in both public and private sectors, with a view to identifying and removing any gaps or inconsistencies among them, further integrating environmental considerations into economic and other sectoral development policies and processes, and thus consolidating the ground for an overall policy framework for building a sustainable society.

- To expand the membership and participation of environmental NGOs and other civil society organizations (CSOs) in national and local legislative or other policy-making bodies, and to involve representatives of affected local communities in the process of planning and implementation of regional/local development programmes and projects.

- To give special considerations to bringing small firms and factories into compliance with environmental regulations, without imposing severe costs to them.

- No law works out smoothly unless the interaction is voluntary. In order to educate people about the environmental issues, there should be exhibition of slides in the regional languages at cinema houses and television free of cost. Further, as directed by the Supreme Court of India, Environment studies shall be made a compulsory subject at school and college levels in graded system so that there should be general growth of awareness.

These are few steps which can pave way for better Environmental Governance at different levels. Environmental governance does not operate in a vacuum but is linked to and complementary with other aspects of good governance, including the need to ensure independence and prevent corruption within the various elements of the environmental governance system. Only if there is transparency, unity among each and every individual and a strong determination than only the goals of good Environment Governance can be achieved. Stringent Law and Effective governance is the key to success in addressing environmental challenges for that matter any important societal objective – is beyond reasonable dispute. Indeed, many governments and inter-governmental organizations have worked for years on building capacity to promote particular elements of effective environmental governance. The system which includes environmental laws, implementation mechanisms, accountability regimes, and institutional arrangements. Together, these elements provide the foundation for effective environmental protection and conservation of natural resources, and help chart a course towards an environmentally responsible future and in this scenario the only thing needed is a step forward by each of us to protect our Mother Earth as far as possible because we have not inherited it from our ancestors, rather borrowed it from them and our obligation and its our duty to keep it safe for the generations to come and this can only be done with a ‘l’il change in each of us.

Thus it was rightly quoted: “We have modified our environment so radically that we must now modify ourselves to exist in this new environment” – Norbert Wiene

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ENVIRONMENTAL IMPACT ASSESSMENT

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Abstract- Environmental Impact Assessment is one of the proven management tools for incorporating environmental concerns in development process and also in improved decision making. The purpose of the assessment is to ensure that decision makers consider the ensuing environmental impacts when deciding whether to proceed with a project. The process leads to the selection of the projects on the principle of sustainable development, so that the adverse effects of the new developments are mitigated through proactive and rational decisions making. Over the years, EIA has not been practiced holistically in the developing countries due to certain flaws in the implementation process. However in the last few years Governments, environmentalists, researchers, media and communities of these countries have formulated sufficient legislative and institutional frame work for the EIA. In this paper, an overview of the EIA has been mentioned. This paper proposes environmental impact assessment indices to evaluate various modes of public participation and decision making process and various international agreements that’s paves way for a better and smoother assessment.

In general the aim of this paper is to provide information on Environmental Impact Assessment. In particular emphasis is given to concepts, procedures and tools that are used currently or are potentially relevant in implementing an integrated approach to impact assessment of development policies, plans and programs. As far as possible, it tries to provide comprehensive coverage of generic elements of that are adopted for good practice and appears to be internationally accepted and widely applicable. It also attempts to indicate some of the internationally adopted policies and dimensions for integrated assessment based on current trends and initiatives.

Keywords – Environment Assessment, Decision-Making, Protection, Sustainable Development, Project, Policies, Tools, Public, Agreements

I. INTRODUCTION

By definition, an Environmental Impact Assessment (EIA) is a procedure that identifies, describes, evaluates and develops means of mitigating potential impacts of a proposed activity on the environment. EIAs can be carried out for single development projects (project EIAs) or for strategic plans, policies or management programs. EIA is a planning tool that is now generally accepted as an integral component of sound decision-making. The objective of EIA is to foresee and address potential environmental problems/concerns at an early stage of project planning and design. EIA should assist planners and government authorities in the decision making process by identifying the key impacts/issues and formulating mitigation measures.

It is an important management tool for ensuring optimal use of natural resources for sustainable development. A beginning in this direction was made in our country with the impact assessment of river valley projects in 1978-79 and the scope has subsequently been enhanced to cover other developmental sectors such as industries, thermal power projects, mining schemes etc. To facilitate collection of environmental data and preparation of management plans, guidelines have been evolved and circulated to the concerned Central and State Government Departments. EIA has now been made mandatory under the Environmental Protection Act, 1986 for 29 categories of developmental activities involving investments of Rs. 50 crores and above. Environmental Impact Assessment is one of the proven management tools for incorporating environmental concerns in development process and also in improved decision making. The growing awareness, over the years, on environmental protection and sustainable development has further given emphasis on sound environmental management practices through preparation of Environmental Management Plans (EMPs) for minimizing the impacts from developmental activities. The purpose of the assessment is to ensure that decision makers consider the ensuing environmental impacts when deciding whether to proceed with a project. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made.” EIAs are unique in that they do not require adherence to a predetermined environmental outcome, but rather they require decision -makers to account for environmental values in their decisions and to justify those decisions in light of detailed environmental studies and public comments on the potential environmental impacts of the proposal.

II. SCOPE AND METHODOLOGY OF THE EIA

The scope of an EIA study is typically defined by:

- The EIA legislation text, which usually contains general regulations;
• Standard guidelines, which may be specific to certain projects or activities;
• The Terms of Reference as established during scoping for a specific project.

To describe the scope of an EIA study, a reference to the applicable regulations or official documents should be given and their requirements briefly outlined, particularly: which environmental compartments, socioeconomic aspects and human health implications are being investigated in the EIA; which project components are included in the EIA in addition to the desalination unit (e.g. chemical storage facilities, intakes, outfalls, connecting infrastructure like water pipelines, power lines, access roads etc.).

National standards or guidelines may stipulate the EIA methodology to be followed for a certain type of project or activity. For a specific project, the EIA methodology may also have been a matter of debate during the scoping phase, when the Terms of Reference describing the content and extent of the EIA are established. In either case, a reference to the applicable regulations or official documents should be given and their requirements briefly outlined in the EIA report. If no conditions have been imposed on the methodology, EIA practitioners may adopt an individual approach, which should be briefly described in the EIA report.

The EIA methodology in general includes:

- Methodologies used for investigating the environmental baseline and the potential impacts, such as environmental sampling techniques, laboratory analysis, statistical data analysis, controlled field or laboratory experiments, computer models, etc.;
- Methodological approaches for evaluating the impacts, such as criteria for the identification of significance of impacts, for balancing the effects against each other, for evaluating the combined risk of all impacts, etc.

III. THE EIGHT GUIDING PRINCIPLES OF EIA

There are eight guiding principles that govern the entire process of EIA and they are as follows:
• Participation: An appropriate and timely access to the process for all interested parties.
• Transparency: All assessment decisions and their basis should be open and accessible.
• Certainty: The process and timing of the assessment should be agreed in advanced and followed by all participants.
• Accountability: The decision-makers are responsible to all parties for their action and decisions under the assessment process.
• Credibility: Assessment is undertaken with professionalism and objectivity.

• Cost-effectiveness: The assessment process and its outcomes will ensure environmental protection at the least cost to the society.
• Flexibility: The assessment process should be able to adapt to deal efficiently with any proposal and decision making situation.
• Practicality: The information and outputs provided by the assessment process are readily usable in decision making and planning.

IV. ENVIRONMENTAL ASSESSMENT

An Environmental Assessment (EA) is an environmental analysis prepared pursuant to the National Environmental Policy Act to determine whether a federal action would significantly affect the environment and thus require a more detailed Environmental Impact Statement (EIS). The certified release of an Environmental Assessment results in either a Finding of No Significant Impact (FONSI) or an Environmental Impact Statement (EIS). The Council on Environmental Quality (CEQ), which oversees the administration of NEPA, issued regulations for implementing the NEPA in 1979. Eccleston reports that the NEPA regulations barely mention preparation of EAs. This is because the EA was originally intended to be a simple document used in relatively rare instances where an agency was not sure if the potential significance of an action would be sufficient to trigger preparation of an EIS. But today, because EISs are so much longer and complicated to prepare, federal agencies are going to great effort to avoid preparing EISs by using EAs, even in cases where the use of EAs may be inappropriate. The ratio of EAs that are being issued compared to EISs is about 100 to 1.

Likewise, even the preparation of an accurate Environmental Assessment (EA) is viewed today as an onerous burden by many entities responsible for the environmental review of a proposal. Federal agencies have responded by streamlining their regulations that implement NEPA environmental review, by defining categories of projects that by their well understood nature may be safely exempted from review under NEPA, and by drawing up lists of project types that have negligible material impact upon the environment and can thus be exempted.

V. GUIDANCE ON EIA IMPLEMENTATION

Practical guidance for conducting EIA can help to promote better procedural compliance and effective process implementation. Normally, guidance will be issued by the responsible EIA administrative or expert body and should provide clear and authoritative interpretation of the actions to be taken and by whom. There are many different types of guidelines on how to undertake an EIA or particular steps and elements of the process. As used here, the term refers to official documents that are prepared or
Environmental Impact Assessment

VI. EIA IMPLICATIONS OF INTERNATIONAL ENVIRONMENTAL LAW AND POLICY

Principles and substantive aspects of international environmental laws and policies may be reflected in or applied by national EIA procedures, including those of developing countries. These aspects should be identified and appropriate action taken, where necessary with support from international agencies.

International environmental laws and policies have implications for the EIA systems of countries that sign or endorse them. The relevant instruments in this context fall into two main categories. First, there are non-binding instruments, such as the Rio Declaration on Environment and Development, which establish important principles and aspects that may need to be reflected in EIA arrangements and approaches. Second, there are legal conventions and treaties related to environmental protection at the global or regional level. These carry various obligations for signatory countries that may be implemented, inter alia, through EIA arrangements.

VII. SCOPING

Scoping is to determine what should be the coverage or scope of the EIA study for a project proposal as having potentially significant environmental impacts. It also helps in developing and selecting alternatives to the proposed action and in identifying the issues to be considered in an EIA.

VIII. AIM OF SCOPING

- identify concerns and issues for consideration in an EIA
- ensure a relevant EIA
- enable those responsible for an EIA study to properly brief the study team on the alternatives and on impacts to be considered at different levels of analysis
- determine the assessment methods to be used
- identify all affected interests
- provide an opportunity for public involvement in determining the factors to be assessed, and facilitate early agreement on contentious issues
- save time and money

IX. METHODS OF SCOPING

- Public involvement

Public involvement is a cornerstone of the EIA process. Appropriate provision should be made for affected and interested parties to comment on a proposal and its impacts. Public involvement is a key to achieving both other procedural principles and the substantive objectives of the EIA process. A requirement to make information available to the concerned public and seek their views and comments helps ensure that EIA procedures are implemented in an open, transparent and accountable manner. Public scrutiny also encourages the preparation of robust and defensible EIA studies and reports. In addition, information and inputs from the public have proven useful at various steps in the EIA process, including scoping, impact identification, examination of alternatives and planning of mitigation measures. Finally, the inclusion of public views and comments in the decision-making process promotes equitable and informed choice, leading toward better and more acceptable social and environmental outcomes.

Public involvement is an essential process in the planning, decision-making and implementation of development projects, and mandated by national and international organizations. The main goals, particularly for community water supply projects, are to involve the directly or indirectly affected population in decision-making and to establish trust and partnership. This requires that the public is informed and educated about the purpose and implementation plans of the proposed project. Benefits and drawbacks should be explained, including environmental, socio-economic and public health implications. Public involvement furthermore aims to gain all possible views and opinions to ensure that important aspects are not overlooked in decision-making. Invariably, this information from the public is in the form of subjective opinions, influenced by socio-economic, cultural and political factors. The information therefore needs to be scientifically analyzed in order to develop an objective picture of public priorities of the expected benefits and potential impacts of the desalination project.

- Identifying major Issues of public concern

All the concerns and issues raised by affected interests should be compiled into a comprehensive list. Each contribution should be categorized and no issue or concern should
be ignored or rejected in the compilation of the list.

- **Developing a strategy for addressing priority issues**

Issues to which immediate solutions can be provided -- such as suggesting feasible alternatives or mitigation measures that can be implemented at an early stage -- should be removed from the list. For those issues which need further information in order to be resolved, a term of reference (TOR) should be prepared in order to define guidelines for further study. The extent of information required for a detailed EIA depends upon the type, level, and magnitude of the project concerned.

X. **PUBLIC CONSULTATION AND PARTICIPATION**

The involvement of the "public", or often referred to as "stakeholders", is a vital component in successful EIA.

**Who Are The Stakeholder's?**

**Local people:**
- individuals
- communities/villages
- traditional authorities e.g. village leaders

**Project beneficiaries:** not necessarily have to be local

**NGOs:**
- those which are active in local area or have interest on natural resources/social welfare
- interested parties in the country of any external financing agency

**Voluntary organizations:**
- local community
- development or users groups
- kinship societies
- recreational groups
- neighborhood associations
- labor unions
- gender groups
- ethnic organizations
- cooperatives
- etc

**Private sector:**
- business interest groups
- trade associations
- professional societies

**National/local governments:** those with responsibilities for management of natural resources along with people welfare and those likely to be affected by the development project.

**Scientist/experts:** those who focus on technical aspects of the project, such as land use planning, natural resource management

XI. **ADVANTAGES AND DISADVANTAGES OF STAKEHOLDER INVOLVEMENT**

Experience has shown that there are benefits of stakeholder involvement in EIA process. However, there are difficulties and constraints while formulating plans for public involvement.

**Advantages**
- Improved understanding
- Identification of alternative and mitigation measures
- Clarification of trade-offs for each alternative
- Identification of forums to resolve issues
- Induces of transparent procedures
- Creation of accountability and sense of local ownership

**Disadvantages**
- Difficult to identify all affected parties
- Communication difficulty due to linguistic and cultural diversities
- Illiteracy
- Lack of local knowledge on the projects
- Unequal access to consultations (for example, women)
- Time/cost implications

XII. **METHODS FOR STAKEHOLDER INVOLVEMENT**

In participatory decision making, there is no single source of ultimate control or authority. The participating parties must discuss and reach a decision by means of an agreed process. There are numerous methods which can be utilized to involve stakeholders, especially the public, in EIA process.

- Public meetings - open with no restriction as to who may attend
- Advisory panels - group of individuals chosen to represent stakeholders meet periodically to assess work done/results obtained advise on future works.
- Public information centres- facility in an accessible location contains information on the project members of the public can visit, obtain information and express concerns
- Interviews- open-ended interviews with selected community representatives
- Questionnaires- a written, structured series of questions issued to local people assemble concerns/views/ideas
- Participatory Appraisal techniques- a systematic approach to appraisal based on group inquiry and analysis with multiple and varied inputs
XIII. TRANSBOUNDARY IMPACTS

Environmental threats do not respect national borders. International pollution can have detrimental effects on the atmosphere, oceans, rivers, aquifers, farmland, the weather and biodiversity. Global climate change is transnational. Specific pollution threats include acid rain, radioactive contamination, debris in outer space, stratospheric ozone depletion and toxic oil spills.

Environmental protection is inherently a cross-border issue and has led to the creation of transnational regulation via multilateral and bilateral treaties. The United Nations Conference on the Human Environment (UNCHE or Stockholm Conference) held in Stockholm in 1972 and the United Nations Conference on the Environment and Development (UNCED or Rio Summit, Rio Conference, or Earth Summit) held in Rio de Janeiro in 1992 were key in the creation of about 1,000 international instruments that include at least some provisions related to the environment and its protection.

The United Nations Economic Commission for Europe’s Convention on Environmental Impact Assessment in a Transboundary Context was negotiated to provide an international legal framework for transboundary EIA. However, as there is no universal legislature or administration with a comprehensive mandate, most international treaties exist parallel to one another and are further developed without the benefit of consideration being given to potential conflicts with other agreements.

Two UN Economic Commission for Europe (UNECE) Conventions apply respectively to the EIA procedures and to the provision for public involvement and consultation. These instruments have direct relevance to transitional countries and should be of interest to other developing countries for reference purposes and possibly future ratification.

International conventions with specific application to EIA and public involvement and consultation are a significant development, indicative of increasing acceptance of these processes and future directions in their regional harmonization.

The UNECE (Espoo) Convention on Environmental Impact Assessment in a Transboundary Context was adopted in 1991 and entered into force in 1997. It stipulates the responsibilities of signatory countries with regard to proposals that have transboundary impacts, describes the principles, provisions and procedures to be followed in this context, and lists the activities, content of documentation and criteria of significance that are to apply.

The UNECE (Arhus) Convention on Access to Information, Public Participation in Decision-making and Access to Justice in International Environmental Matters was adopted 1998 and entered into force in 2001. It establishes rules for informing and involving the public in environmental decision-making and backs these up with rights with regard to enforcement of the provisions of the Convention and environmental law in general.

The Espoo and Arhus Conventions are regional in scope and apply to member countries of the UNECE region, comprising Europe, North America and Central Asian republics of the former Soviet Union in Central Asia. However, the Conventions are of wider importance for a number of reasons. First, they set international legal precedents with regard to procedures for EIA and public involvement respectively. Secondly, the provisions and principles of the Conventions can be endorsed or adopted by developing countries.

The Espoo Convention primarily establishes a transboundary regime that can apply when a project in one country is likely to have a significant impact on the environment of another country. By doing so, the Convention also sets standards for national EIA systems of signatory countries and encourages good practice internationally.

The Arhus Convention is based on the three pillars of information, public involvement and consultation, participation and access to justice. It sets out rights of the public and obligations of authorities with respect to these elements and identifies minimum procedures for informing and involving the public in project and strategic level decision-making.

XIV. CONCLUSION

The focus has turned from EIA as a mainstream tool and emerging tool for integrating environmental considerations into decision-making, towards a broader perspective on integrated approaches. Ultimately, the focus is on integrated assessment of environmental, economic, and social effects of new proposals to inform decision-making in support of sustainable development. This approach is variously conceptualized, but can be characterized in general terms as proactive, participatory and trans-disciplinary. Some of the terms in use include sustainability appraisal, sustainability impact assessment and strategic impact analysis - for applications at the level of planning, programming and policy-making.

Integrated assessment is being strongly promoted by UNEP to assist decision makers in addressing the root causes of unsustainable development. This approach can have important benefits as outlined in the UNEP Initiative on Capacity Building for Integrated Assessment and Planning for Sustainable Development (UNEP, 2003), which has particular reference to developing and transitional countries. UNEP also considers an integrated assessment process can help to promote better governance and foster widespread public participation.
SPATIAL DISTRIBUTION AND SEASONAL ABUNDANCE OF PLANKTON POPULATION OF BAY OF BENGAL AT DIGHA SEA-SHORE IN WEST BENGAL

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P.G. Department of Zoology, Utkal university, Bhubaneswar-751004

Abstract Seasonal variations of Phytoplankton and Zooplankton dynamics were noted both quantitatively and qualitatively at Digha Sea Shore of Bay of Bengal in total of 72 special of Phytoplanktons known, 14 species of Chlorophyta(53.6%), 12 species of Bacillatiophyta(29.45) and 8 species of Cyanophyta (16.75%) were identified. Whereas in species variations of Zooplankton. Protozoa (37.7%), Nematoda (93.7%), Rotifera (92.5 .6%) and Anostroca (3.7%), Cladocera (12.7%), ostracod (5.5%), Copepod (7.4%) and Crustacean Larvae (3.7%), constitute 20,2, 14, 2, 7, 3, 4 and 2 species respectively. Chlorophyta amongst the Phytoplankton and Copepod amongst the Zooplankton imparted the highest numbers.

Key words : Plankton diversity, Bay of Bengal, Digha.

INTRODUCTION

Ocean reckoned as dynamic ecosystems with high productivity are no exception to the unwarranted trend of environmental degradation. Smith (1993) has claimed that the incessant demand for economic growth has tempted a small segment of individuals to make substantial profits from the non-sustainable exploitation of these resources without regard for the long term environmental consequences. Although, the fishes are considered as rich sources of food as they constitute 6% of the total proteins and 16% of the animal protein consumed by the people (Mc Ginn. 1999), but they are under fierce pressure and face the danger of severe depletion due to more frequent harvests. Furthermore, the technological advances along with impressive growth in the investment in fishery sector have resulted in the exploitation of the fisheries resources even in the most remote corner of the planet (Brown,1997). According to the estimates of the Food and Agricultural organization (1997B), eleven of the worlds fifteen most important fishing areas and 70% of the major fish species are either fully or overly exploited. Brown(1998) rightly opined that if the amount of fish harvested surpasses the sustainable yield of a fishery, the fish species would begin to shrink and its irrational continuance would land in collapse beyond any recovery.

Digha marine water offers one of the best lucrative fishing center in West Bengal fishery potentialities and thus serves as one of the most important economy. The composition of fish species is highly varies. The success of fishing operations depend upon the extent and efficiency of manpower(fishermen). Modern machanisation of the crafts and other ancillary facilities improve the fishing trade potential. The present study deals with the marine resources(i.e. plankton), its utilization and economic importance at Digha Sea-shore in West Bengal).

MATERIALS & METHODS

The planktons were collected by plankton net of standard bolting silk cloth no-25(mesh size.03-0.04mm) for different stations from 100 liter water sample b use of a plastic bucket of 10 liter capacity. Finally the planktons were preserved in 45 formaldehyde solution. The samples were thereafter taken to the laboratory for qualitative and quantitative analysis in Sedgwick rafter type counting cell(1 ml capacity) and then the planktons were identified as per standard methodology (Fritsch, 1965, Sahoo 1992 and Adhikari, 2000). After shaking the vials containing the concentrated plankton sample, a sub sample of 1 ml was quickly drawn with the help of a pipette and poured in the plankton counting cell. All organisms encountered were made and the data represented in the text were average value of counting. The planktons were identified as per species distribution and tabulated accordingly.

Digha is one of the coastal districts of West-Bengal, having a long stretch of coast-line.

The magnificence of Digha sea beach is embellished with unique scenic beauty and a popular tourist resort of West-Bengal. Its deep and clear blue waters instantly provoke many good swimmers to take a plunge and bathing temptation is irresistible. Data on metrological conditions of the study area were collected from metrological center of Digha from the period from January to December 2011.

Two observations of maximum and minimum monthly temperature were made. May was the hottest
month with average temperature reaching 37.5°C. December and January were the cooler months with minimum temperature scaling to 12.0°C.

The study area experienced both seasonal and monsoon rains. South-Western monsoons start from first week or mid-June and continued till the last week of October. Maximum of annual was between June to September.

RESULTS

Phytoplankton

Seasonal variations of phytoplankton were noted quantitatively and qualitatively (Tables 1-4).

Three groups of algae were identified viz. (i) Chlorophyta, (ii) Bacillariophyta (iii) Cyanophyta. In total 72 species known 14 species of Chlorophyta, 12 species of Bacillariophyta and 8 species of Vynphyta were identified of the total algal species 53.6%, 29.45% and 16.75% belonged to Chlorophyta, Bacillariophyta and Cyanophyta respective.

Bimodal nature of population peaks from whole phytoplankton was observed during early winter (December and January) and early summer (March and April) in terms of percentage of distribution and standing stock.

At station I out of species identified, 11 species belonged to Chlorophyta (47.82%), 5 species belonged to Cyanophyta (21.73%) and 7 species belonged to Bacillariophyta (30.43%).

At station 2 out of 27 species, 9 species were of Chlorophyta (3.35%), 7 species were of Cyanophyta (25.92%) and 11 species were of Bacillariophyta (40.74%).

Phytoplankton showed their peak growth during winter 279.96 n/l at S1, 178.34 n/l at S2.

TABLE-1: Number of total phytoplankton species identified and their percentage belonging to various taxonomic groups in S1 and S2 during 2009.

<table>
<thead>
<tr>
<th>Species Group</th>
<th>S1</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Species</td>
<td>%</td>
</tr>
<tr>
<td>Chlorophyta</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Cyanophyta</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Bacillariophyta</td>
<td>8</td>
<td>12</td>
</tr>
</tbody>
</table>

TABLE-2: List of available species of phytoplankton identified from different stations (S1, S2) during 2009.

<table>
<thead>
<tr>
<th>CHLOROPHYTA</th>
<th>S1</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euglena acns Ehrenb</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Euglena acns Ehrenb</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Euglena spirogyra Ehrenb</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Euglena eleganas Ehrenb</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Volvox globater (L) Ehrenb</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Volvox aureas Klein</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Pandorina morum Mull</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Chlorococcum humicolum (Naeg) Rabenh</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hydrodictyon idium lyenger</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cladophora profunda Brand</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Cladophora glomerate (L) Kutz</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Cladophora ephiophila magnus and Wille</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Cladophora callicoma Ag.</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Oedogonium coreatematum wittr</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Desmidium cylindricum Grev.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zygnema pelisoporum Wittr</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zygnema varians Kutz</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### Spatial Distribution and Seasonal Abundance of Plankton Population of BAY of Bengal At DIGHA Sea-Shore In West Bengal

<table>
<thead>
<tr>
<th>Species</th>
<th>S1</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zygnema pectinatum Vauch</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Spirogyra fluviatilis holes Var Africana</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Spirogyra varians Kutz</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Spirogyra sciriformis(Reth) Kutz</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Spirogyra longata Vauch</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Spirogyra webri Kutz</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Spirogyra majuscule hilse</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Cosmarium Sp.</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Cosmerium reniforme(Ralfs) Arch</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Cosmarium botrylis menegh(after Dobard)</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Closterium lannaceolatum kuz</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Colpeterium parvulam naeg</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Colsterium venus kutz</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Closterium parvulam Naeg</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Closterium venus Kutz</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Closterium Cambicum Arch</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Closterium ehrenbergii Menegh(after Lutman)</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Closterium leibleinii Kutz(after Steinecke)</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Closterium striolatum Ehrenb(after west)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Estella botryoides W/West</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Scenedesmus quadricauda Lurb</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Ankistrodesmus spinulosam Naeg.</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Sphaerozosma rotate Grev</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Ulothrix rodia Kutz</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Ulothrix variabilis Kutz</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Ulothrix oscillatoria Kutz</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td><strong>BACILLARIOPHYTA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amphora ovallis kutz.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylotella comta(her) Kuz var. affairs gum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baillaria paradoxa Gnel</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Cymbella cistuba(hempa)Grun.</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Navicula mutica kutz.</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Gomphonema Llanceolatum ehrenb</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Pinnularia gibbaft. Subandulata Mayr.</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Kelosira ganulata(e hr) Raif.</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Cyclotella Comate(Her) Kutz.</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Navicula laterostrate hust</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Gyrosignma. Attenuatum kutz</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Gomphonema ventricosum Gerg.</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Pleurosigma spenceri karston</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Pennularia major Kutz.</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Pinnularia viridis kutz.</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Navicula cuspidate Kutz.</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Pleurosigma gigantum Gran.</td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>


49
Spatial Distribution and Seasonal Abundance of Plankton Population of BAY of Bengal At DIGHA Sea-Shore In West Bengal

**CYANOPHYTA**

<table>
<thead>
<tr>
<th>Species Group</th>
<th>S1</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phormidium favosum(Bory) Gom</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Anabaena Crinalis Rabenh</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Anabaena Biasolatiana</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Synechocystis salansis Skuja</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Oscillatoria borneti Zukal</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Oscillatoria amphigranulata Van Goor</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Oscillatoria lenuis Ag.</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Microcystis aeruginosa kutz</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Nostoc linckia(Rolth) Born Flah</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Nostoc Commune Vauch</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Rivularia munulula(kutz.) Born Flah</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rivularia biasoletiana monegh</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Zooplankton**

Variations in quality and quantity composition of zooplankton were reported seasonally with the individual population peaks which were shown in Table- 3 & 4.

Eight groups of zooplankton were identified viz. protozoa, Nematoda, Riffiera, Anostraco, ostracoda, Cladocera, Copepoda and Crustacian larvae, at two different stations.

In total 29 known species protozoa, 8 species of Riffiera, 6 species of Cladocera and 4 species of Copepod were identified. Among all these zooplankton groups occupied the highest number.

At S.1, out of 23 species 33.33% protozoa, 33.33% Riffiera, 19.04% Cladocera, 4.76 and Copepoda and at S.2 out of 28 species 5=36.33% Protozoa, 27.57% Riffiera, 18.18% Cladocera and 6.6% Copepoda were reported. Nematode, Anostraco ostracoda and crustacean larval were absent at S1 Cladocera and Copepods were found to be present in large numbers among all the groups of Zooplankton, Zooplankton showed their peak growth during winter(196.6 n/l at S1, 745.6 n/l at S2).

**TABLE-3:** Number of total Zooplankton species identified and their percentage belonging to various taxonomic groups in S1, S2 during 2009.

<table>
<thead>
<tr>
<th>Species Group</th>
<th>S1</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protozoa</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Nematoda</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Riffiera</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Anostraca</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cladocera</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Ostracoda</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Copepod</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Crustacean Larvae</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**TABLE-4:** List of available species of Zooplankton identified for different station(S1, S2) during 2009.

**PROTOZOA**

<table>
<thead>
<tr>
<th>Species Group</th>
<th>S1</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoeba protues Muller</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Amoeba discoide Schaeffer</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Amoeba radosa Ehrenb</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Arcella Gibbosa pennard</td>
<td>-+</td>
<td>+</td>
</tr>
<tr>
<td>Arcella Vulgaris Ehrenb</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Arcella Discordes Ehrenb</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
DISCUSSION

Phytoplankton plays a great role for the water quality and productivity of the aquatic environment.


Further Phytoplankton is the breathing house of all aquatic animals through their power of photosynthesis which liberates huge amount of dissolved oxygen and taking in expired free CO$_2$. Thus these autotrophies in one way helps all living beings for their environment and in other way consuming green house gases i.e. CO$_2$ to keep the aquatic environment clean and pollution free. Above all phytoplanktons become day today food of Zooplankton which are important food items of all aquatic animals. Thus both phytoplankton and Zooplankton play a vital role to keep up the aquatic environment safe and healthy. Therefore, food chain and food web mechanism works in balanced condition due to harmonious relationship between autotrophies i.e. Phytoplanktons and heterotrophes i.e. Zooplanktons.

(b) Seasonal fluctuations of Planktons:- The seasonal fluctuations of bacilariophyceae follow those of the total phytoplankton closely. Dinophyceae show a peak during the South-West monsoon period (June 7 July) and one or more peaks during the North-East monsoon season. Cyanophyceae exhibit a peak during the North-East monsoon in the warmer months. The total quantity of phytoplankton per unit volume of water shows variations from year to year depending on the nature of floral elements present (Ewusie, 1980).

In the present investigation definite seasonal variations were observed in the compositions (n/l) or phytoplankton, with the maximum and minimum of...
Spatial Distribution and Seasonal Abundance of Plankton Population of BAY of Bengal At DIGHA Sea-Shore In West Bengal

Chlorophyta, Cyanophyta and bacillariophyta. The maximum number of the phytoplanktons during winter (November to January) and during spring (March and April) indicates favorable physicochemical condition in relation to the phytoplankton population.

The above findings are supported by (Munawar, 1974b, Munawar and Munawar, 1976, Kant, 1981, Kulkarni and Nimbalkar, 1981).

Zooplankton like phytoplankton, shows a higher standing crop in the sea of the west coast of India than that of the east coast. International Indian Ocean Expedition Plankton Atlas (Prasad and Saxena, 1980, Prasad and Singh, 1980) contains maps of the total zooplankton biomass in the Arabian Sea and the total zooplankton biomass in the Indian ocean. Average of zooplankton volume collected during the South-West monsoon period in the Arabian Sea for the entire annual period, showed its maximum concentration in the Western half of the Sea with high production areas lying off the Somali and Arabian coasts and to a certain extent, of the South-Western coast of India, the low productions zones being the central part of the Arabian sea and the precinct of the Gujarat coast (Prasad 1969). These observations lend support to the distributional pattern of plankton biomass as determined during the study of R.V. Vityaz(Bogorov and Rass, 1961). They also found that the areas of high productivity in the Arabian Sea are associated with upwelling along the Somali and Arabian coasts, an association which imparts a certain degree of predictability.

Among zooplanktons under present study, the commonly encountered organisms during South-West monsoon are foraminifers, radiolarians, polychaete larvae, Cladocerans, Small Copepods,nauplii, amphipods, lamellibranch larvae, Salps, tunicates with prawn larvae dominating towards the end of the period.

The present findings of the effect that zooplankton community is influenced by the physic-chemical regime of the water and thus the seasonal changes are brought about in their life-process and population dynamics find support in the studies of (George, 1968), (Ganapati, 1943), (Michael, 1970), (Sharma and Sksena,1981), and 9Smith, 1979). Further, the water systems support fewer species although the number of individuals in each of them may be large, (Dincen, 1952) and (Mitra and Mikherjee,1972).

ACKNOWLEDGEMENT

Authors are thankful to the Head of the Department of Zoology, Utkal university for providing necessary laboratory facilities.
CARBON FOOTPRINTS A CASE STUDY OF DURGAMANWADI BAUXITE MINES (HINDALCO INDUSTRIES), RADHANAGARI, KOLHAPUR.

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¹B.E (ENV), KIT’s College of Engineering, Kolhapur.  
²T.E (ENV), KIT’s College of Engineering, Kolhapur.

Abstract-In today’s world everyone is concerned about environment. Environment protection and climate change are most priority of many countries, companies and individual. Reducing carbon foot prints is top concern of every individual and company. People are becoming concerned about the environment in which they live. Each day one or the other development in the field is taking place to save the ecosystem, reduce the pollution and thereby save the health of human beings and the animals. Among this one of the major sources that can harm the environment is the greenhouse gases releasing from the industry, vehicles and any such burning process. These gases particularly try to heat up the environment thus increasing the temperature from normal level which all off are facing these days. It is increasingly clear that climate change presents a serious global risk and demands an urgent response. So it is very important to identify all the sources of these gases and provide remedies. As mining sector is also one of the major contributors of GHG’s.

Thus paper discusses carbon footprints generated in a bauxite mine because of various mining activities.

Keywords: GREENHOUSE GASES, CARBON CONVERSION FACTORS, EMISSION REDUCTIONS, BAUXITE MINES.

INTRODUCTION

Carbon footprint:-
It can be defined as the total carbon dioxide (CO₂) and other greenhouse gases emitted over the full life cycle of that product or service. It is the total set of greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event or product.

Greenhouse gases are gases in an atmosphere that absorb and emit radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. As greenhouse gases produced by human activities accumulate and their concentration increases in the atmosphere, it causes global warming. The main contributor to global warming is carbon dioxide, which accounts for nearly 80% of emissions from the industrialised countries. As these gases accumulate, they absorb infrared radiation in the atmosphere, thus changing the dynamic balance between the energy received from the sun and the energy escaping.

Common greenhouse gases in the Earth's atmosphere include CO₂, CH₄, and O₃. Water vapor, Nitrous oxide and Chlorofluorocarbons, Greenhouse gases, mainly water vapor, are essential to helping determine the temperature of the Earth; without them this planet would likely be so cold as to be uninhabitable. Although many factors such as the sun and the water cycle are responsible for the Earth's weather and energy balance, if all else was held equal and stable, the planet's average temperature should be considerably lower without greenhouse gases.

The net result of these changes is a rise in temperature. Climate models predict a global temperature rise in the range of 1.4 - 5.80 deg C by 2100, if current warming trends continue unchecked. Human activities have an impact upon the levels of greenhouse gases in the atmosphere, which has other effects upon the system, with their own possible repercussions.

The 2007 assessment report compiled by the IPCC observed that "changes in atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation alter the energy balance of the climate system", and concluded that "increases in anthropogenic greenhouse gas concentrations is very likely to have caused most of the increases in global average temperatures since the mid-20th century".

GREENHOUSE GASES IN MINES.

The air of the atmosphere that we breathe is a mixture of gases and its composition is practically constant over the whole surface of the earth from the sea level up to an altitude of at least 25 km. typical analysis of atmosphere air which also represents the intake of air of any mine is given below.

<table>
<thead>
<tr>
<th>Constituents</th>
<th>By weights %</th>
<th>By volume %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>23.15</td>
<td>20.93</td>
</tr>
<tr>
<td>Nitrogen (including Argon and other rare gases)</td>
<td>76.81</td>
<td>79.04</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>0.04</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Carbon dioxide and methane are the two most important greenhouse gases present in the mines which are major contributors to global warming and further to climate change.

The Aluminium industry is one of the most significant contributors to greenhouse gas (GHG) emissions to the atmosphere. Melting of aluminium is a major source of carbon dioxide (CO$_2$) being emitted worldwide.

**We are mainly concerned with CO$_2$ as we are dealing with bauxite mines.**

### Carbon dioxide

This gas is colourless, tasteless, and bitter in taste, with specific gravity of 1.52. It is very soluble in water. It does not sustain life. The gas is a product of respiration by human beings, animals, oxidation and combustion. It is present in the return of mines in very small percentages and is found in the dip areas of mines due to it’s heavier than air. It is product in mines by breathing by men, burning of lamps, decay of timber, electricity consumption, equipments in the mines, LPG cylinders used in canteens, and by working and transportation of internal combustion engine such as diesel locomotive as well as transportation of employees.

### WHAT IS A CARBON FOOTPRINT?

The term 'carbon footprint' has emerged the latest environment terminology to be used frequently in the media. The concept and name of the carbon footprint originates from the ecological footprint. The carbon footprint is a subset of the ecological foot print. The mitigation of carbon footprints through the development of alternative projects, such as solar or wind energy or reforestation, represents one way of reducing a carbon footprint and is often known as Carbon offsetting.

A **carbon footprint** is a measure of the impact our activities have on the environment, and in particular climate change. It relates to the amount of greenhouse gases produced in our day-to-day lives through burning fossil fuels for electricity, heating and transportation etc. The carbon footprint is a measurement of all greenhouse gases we individually produce and has units of tonnes (or kg) of carbon dioxide equivalent.

Every individual in your day-to-day affairs will contribute to carbon footprints. For instance your action in using an air conditioner (2.5 tonne) emits 3 kg of carbon dioxide (CO$_2$), a microwave oven generates 1.3 kg of CO$_2$ and a geyser emits 3.3 kg of carbon, an hour. A car that gives a mileage of 10 km per litre of petrol leaves 232 g of CO$_2$ per km.

### Constituents

<table>
<thead>
<tr>
<th>Constituent</th>
<th>% by volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>20.28</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>78.90</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>0.36</td>
</tr>
<tr>
<td>Methane</td>
<td>0.46</td>
</tr>
</tbody>
</table>

---

Defra’s greenhouse gas (GHG) conversion factors

The purpose of the greenhouse gas (GHG) conversion factors is to help businesses convert existing data sources (e.g. utility bills, car mileage, refrigeration and fuel consumption) into CO$_2$ equivalent emissions by applying relevant conversion factors (e.g. calorific values, emission factors, oxidation factors).

These greenhouse gas conversion factors should be used alongside guidance on how to measure and report your greenhouse gas emissions to help you measure and report on the greenhouse emissions that your organization is responsible for.
Carbon Footprints a Case Study of Durgamanwadi Bauxite Mines (Hindalco Industries), Radhanagari, Kolhapur.

**CO₂ CALCULATORS**

CO₂ calculation by conversion factors:

- Conversion factors are used to calculate the amount of CO₂ emissions resulting from burning fuel for electricity, heating or transport. To calculate the emissions caused by a certain activity, just multiply the amount of it (in the units shown) by the appropriate conversion factor. These factors all provide emissions in units of kg CO₂ eq (carbon dioxide equivalent, used to account for greenhouse gases apart from CO₂).

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Units</th>
<th>Kg CO₂ per unit (conversion factors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid electricity</td>
<td>KWh</td>
<td>0.537</td>
</tr>
<tr>
<td>Natural gas</td>
<td>KWh</td>
<td>0.185</td>
</tr>
<tr>
<td>LPG</td>
<td>KWh</td>
<td>0.124 1.495</td>
</tr>
<tr>
<td>Gas oil</td>
<td>KWh</td>
<td>0.252 2.674</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>KWh</td>
<td>0.268 3.179</td>
</tr>
<tr>
<td>Burning oil</td>
<td>KWh</td>
<td>0.245 2.518</td>
</tr>
<tr>
<td>Diesel</td>
<td>KWh</td>
<td>0.250 2.630</td>
</tr>
<tr>
<td>Petrol</td>
<td>KWh</td>
<td>0.240 2.315</td>
</tr>
<tr>
<td>Transportation</td>
<td>Km</td>
<td>0.1809</td>
</tr>
<tr>
<td>Industrial coal</td>
<td>Tonnes</td>
<td>2457</td>
</tr>
</tbody>
</table>

**Note:** “Carbon emissions are usually quoted in kg CO₂/kWh”

- For example, the conversion factor for natural gas is 0.185 kg CO₂/kWh, so the use of 1,000 kWh of gas is responsible for the production of 0.185 x 1000 = 185 kg CO₂.

**Durgamanwadi Bauxite Mines, (Hindalco industries), Radhanagari, Kolhapur.**

The key Operational and Environmental Management features of the mines has revolutionized the age-old concept of excavation through drilling and blasting causing shattering noise and throwing up earthful of dust. Instead, Durgamanwadi has introduced Ripper Dozers that gently cut through the earth’s surface with the minimum of noise and dust, totally eliminating the need of drilling and blasting.

Durgamanwadi mines is first bauxite mines in India to use tailor made mine planning software to guide its operations. Introduction of mobile crusher in place of stationery crusher eliminates deployment of dumpers for haulage of bauxite and saving non-renewable energy like diesel. Add to this the process of simultaneous backfilling into the voids created due to bauxite mining, thus restricting the mining activity to mineralized zone only.

**Carbon footprints for Mines:**

- **Electricity** – The electricity consumed in mines in a month is as follows (this includes electricity consumed in all the processes as well as lighting).
  
  Electricity consumed (kWh) / month - 10,000 kWh
  
  CO₂ emission in tones of CO₂ = 1,000 * 0.537 Kg CO₂/kWh (0.537 is Defra’s conversion factor)
  
  = 64,440 Kg CO₂ / kWh
  
  = 64.44 T CO₂/kWh

- **Canteen** – canteen is provided for the employees.
  
  Monthly 10 LPG Cylinders are used, each of capacity 14.2 L
  
  Cylinders used / year = 10 cylinders / month
  
  = 120 cylinders / year
  
  = 120* 14.2 = 1,704 L/yr
  
  CO₂ emission in tones = 1,704 * 1.495 = 2.547 T CO₂/year

- **Employee transportation** - Daily employees are taken to mines as per there shift timings from quarters.
  
  1 bus from Kolhapur to mines (60 Km up and down = 120 Km / day = 43,800 km/yr)
  
  = 43800 * 0.1809 = 7.924 T CO₂ /yr

  1 bus from Radhanagari to mines (20 Km up and down = 40 Km / day = 14,600 km/yr)
  
  = 14600 * 0.1809 = 2.641 T CO₂ /yr

  2 jeeps
  
  A) 30 Km/day = 30 * 30 * 12 = 10,800 Km/yr


55
Carbon Footprints a Case Study of Durgamanwadi Bauxite Mines (Hindalco Industries), Radhanagari, Kolhapur.

\[ \text{CO}_2 \text{ emission in tonnes} = 10,800 \times 0.1809 = 1.953 \text{ T CO}_2/\text{yr} \]
\[ \text{B) 14 Km/day} = 14 \times 30 \times 12 = 5040 \text{ Km/yr} \]
\[ \text{CO}_2 \text{ emission in tonnes} = 5040 \times 0.1809 = 0.911 \text{ T CO}_2/\text{yr} \]

**Equipment Handling –**

- **3 Ripper dozer of 770 HP** for excavation
  - consumes 85 L diesel/hr works for 5 hr / day.
  - \( = 3 \times 85 \text{ L diesel/hr} \times 5 \text{ hr/day} \times 30 \text{ days} \times 12 \text{ months} \)
  - \( = 4, 59, 000 \text{ L diesel / year} \)
  - \( \text{CO}_2 \text{ emission in tonnes} = 4, 59, 000 \times 2.63 \)
  - \( = 1207.17 \text{ T CO}_2/\text{yr} \)

- **2 shovel for loading consumes 42 L diesel/hr**
  - works for 6 hr/day
  - \( = 2 \times 42 \times 6 \times 30 \times 12 \)
  - \( = 18, 14, 440 \text{ L / year} \)
  - \( \text{CO}_2 \text{ emission in tonnes} = 18, 14, 440 \times 2.63 \)
  - \( = 4771.8 \text{ T CO}_2/\text{yr} \)

- **1 wheel loader consumes 22 L diesel/hr**
  - works for 7 hr/day
  - \( = 1 \times 22 \times 7 \times 30 \times 12 \)
  - \( = 55, 440 \text{ L / yr} \)
  - \( \text{CO}_2 \text{ emission in tonnes} = 55, 440 \times 2.63 \)
  - \( = 145.8 \text{ T CO}_2/\text{yr} \)

- **Mobile crusher of 9800 kWh**
  - \( = 9800 \times 0.537 = 5.262 \text{ T CO}_2/\text{yr} \)

**Total co2 emitted from mines = 6210.44 T CO}_2/\text{yr}**

**REDUCTION OF CARBON DIOXIDE**

Huge amount of carbon dioxide is being released from various processes in mines as well as in plants and these needs to be reduced in some way or else it will result in increase in the amount of GHG in atmosphere thereby resulting in warming of the atmosphere and will also have effect of the health of the employees.

There are various technological designs which can be incorporated to reduce the emission but all of them are too costly to implement. The cheapest and the simplest way to reduce the emissions are by plantation.

**PLANTATION**

By and large trees act as a carbon storehouse, they remove carbon dioxide from the atmosphere through the process of photosynthesis and store carbon within their cellulose fibres, about 70% of the mass of an average tree is carbon. The right tree planted in the right place can lead to a net reduction in atmospheric CO\(_2\) even if it is subsequently allowed to degrade. With the right planting, a tree during its peak growing phase, will remove up to 650 kg CO\(_2\)/ year.

**Calculation of net reduction of CO\(_2\) in mines and power plant by the plantation carried out.**

Around 2, 10, 000 fully grown trees exist presently in mines.

So, total CO\(_2\) that can be absorbed by trees / year = 210000 \times 650

\( = 1, 36, 500 \text{ tonnes / year} \)

Total CO\(_2\) generated in mines = 6210.44 T CO\(_2\)/yr

**CONCLUSION:**

From the data given above we can see that huge amount of carbon dioxide is released from various processes in mines which needs to be reduced. The best and cheapest method to do so is by plantation. As we can see from the above calculations huge amount of CO\(_2\) is generated from the mines but since Durgamanwadi mines have carried out plantation activity in the areas surrounding the mines for creation of green belt and rehabilitation of mined out areas which further leads to the absorption of CO\(_2\) emitted from the mines. As well as adoption of Ripping and Dozing instead of drilling and blasting has reduced the fugitive emissions thus doing a bit in saving the environment.

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http://answers.yahoo.com/question/index?qid=20071115111825AAKpoq2
PULP AND PAPER MILL WASTEWATER TREATMENT: USING A COST EFFECTIVE AND AFFORDABLE METHOD

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Abstract-This paper attempts to describe a method that uses a common, inexpensive and safe chemical, the alum [K₂SO₄·Al₂(SO₄)₃·24H₂O] for treatment of wastewater from a river receiving pulp and paper mill effluents. Alum in powdered form was weighed on electronic balance in 0.25, 0.5, 1.0, 2.5, 5.0 and 10 g fractions and poured into six different flasks. The flask containing 0.25g in 500ml sample was left for about 10 hours to allow complete precipitation. Colour of each treated sample was noted down and the samples were analysed for pH, BOD and COD. Application of just 0.50g alum per litre (or 0.05% alum w/v) of wastewater turned the sample completely clear by decolouration. The pH value of the treated water decreased with increased concentration of the alum. The pH of the control was 7.94 but that of the treated water with 2% alum (20g per litre of wastewater) was as low as 3.64. The pH of the water treated with 0.05 and 0.1% alum (w/v) was nearly neutral. Increase in alum concentration brought down the pH value up to unacceptable limit. There was 50% decline in the value of BOD on dissolving just 1.0g alum per litre of water. COD, however, did not decrease as the alum is an inorganic compound and contributes to increase COD on increasing its amount in the solution. It could be inferred that treatment of wastewater with 0.1% alum solution (w/v) is the most appropriate measure for the mitigation of pollution of the stream water due to pulp and paper mill.

Keywords- wastewater; alum; pH, BOD, COD

INTRODUCTION

The Ministry of Environment and Forest, Government of India, has categorized the pulp and paper industry as one of the most polluting industries [1]. Himalayan rivers and streams are especially of great ecological, social, cultural and economic importance. One of very specific roles of the fragile mountains of the Himalayas is reflected in the fact that they provide origin to a very large number of rivulets, rivers and streams, both glacier-fed and rain-fed. One of the largest river systems of the world – the Ganga River System – also finds its existence owing to the Himalayan mountains. These rivers are not only of critical importance for the Himalayan mountains, but also for the forelands in the plains. Healthy, clean and unceasingly flowing rivers are the best indicators of the ecological well-being of the mountains as well as of the plains.

Our rivers, unfortunately, are getting increasingly polluted. This is a matter of great environmental concern. Polluted rivers are slowly poisoning the land, livestock and human populations. Ill-health of rivers amounts to ill-health of people. Continuous disposal of human excreta and industrial effluents directly into rivers and streams is the major cause of water pollution of today.

Impact of cities on the environment is increasingly dominating the debate on sustainability. It is now evident that most global and regional environmental problems originate in cities. Cities accommodate and concentrate increasing number of people and human activities. Thus, they import increasing amounts of natural resources and export vast quantities of emissions and waste. Urbanization also entails major changes in the way people use natural resources, while it accelerates the transition from traditional to modern fuels. It also intensifies the use of energy and its environmental impacts. Economic development, increased industrialization, rapidly growing population and rising consumption of natural resources across the world are all impacting the environment significantly.

Pollution of environment is an undesirable change in the physical, chemical and biological characteristics of air, water and soil due to addition to the environment of material or energy (heat, noise and radioactivity etc.) in quantities and at a rate which is harmful to the living organisms including human beings. Pollution from pulp and paper industry further escalates this problem. When the pollution load flows through a stream, it is bound to affect whole socio-economic order for the inhabitants on the embankments due to pollution of underground water, wiping out of aquatic species especially fish, and also because of water’s becoming unfit for consumption by humans and livestock and for irrigation of crops.

There are several methods of water pollution mitigation. Most of the methods, however, are expensive enough and not affordable by common people. This paper attempts to describe a method that uses a common, inexpensive and safe chemical, the alum.

MATERIALS AND METHODS

Water pollution mitigation measure was carried out by using the alum [K₂SO₄·Al₂(SO₄)₃·24H₂O]. Water sample was taken from a stream that receives effluents from the Century Pulp and Paper Mill.
located in Lalkuan of Nainital district in Uttarakhand. After receiving the polluting effluents, the stream passes through dozens of villages and after about 18 kilometer long journey it is drained into Gola river near Kichha township in Udham Singh Nagar district. The water samples were taken from near Shantipuri, about 5 km away from the source of pollution, in the first week of June. Immediately after being brought to lab, the pH of the samples was measured using pH meter. Samples were also analysed for BOD and COD, which are regarded as pertinent indicators of the quality of water. Water samples with pulp and paper mill effluent in it were divided into six flasks. Each flask contained 500 ml sample. A lump of alum purchased from local market was powderised before dissolving in samples. Alum weighed on electronic balance in 0.25, 0.5, 1.0, 2.5, 5.0 and 10 g fractions was poured into six different flasks. Each flask was vigorously shaken for two minutes for ensuring thorough mixing of alum and was left for four hours until the precipitation was clearly observed. The flask containing 0.25g in 500ml sample was left for about 10 hours to allow complete precipitation. Colour of each treated sample was noted down and the samples were analysed for pH, BOD and COD. The pH of water sample was measured by an electronic pH meter. BOD was measured by Azide Modification of Iodometric method as described in APHA (1995). COD was measured according to the method described in Standard Methods for the Examination of Water and Wastewater [2].

RESULTS AND DISCUSSION

The pulping process in a pulp and paper mill generates a considerable amount of wastewater which is highly polluting [3]. Each pulping process utilizes large amount of water, which reappears in the form of an effluent. The most significant sources of pollution among various process stages are wood preparation, pulping, pulp washing, screening, washing, bleaching and paper machine and coating operation. Wastewater, which is coming from these processes, contains wood debris and soluble wood material. Wood consists of various compounds (lignin, carbohydrates and extractives) which are hard to biodegrade and these derivatives are washed away from the fibers during the washing, dewatering and screening processes [4].

The wood pulping and production of the paper products generate a considerable amount of pollutants characterized by BOD, COD, TSS, toxicity and colour when untreated or poorly treated effluents are discharged to receiving water [4]. Since the effluents cause a number of environmental problems, like slime growth, thermal impact, scum formation, etc., they also increase amount of toxic substances in the water causing death to the aquatic plants and animals, severely affecting the terrestrial ecosystem. Therefore, effluents must be treated before discharging them into the environment.

Mitigation of the polluted water taken during the month of June from the Lalkuan-based pulp and paper mill drainage channel in Shantipuri about 5 km away from the location of the factory was carried out using different amount of alum. This chemical method was opted for the wastewater pollution mitigation because of the following reasons, viz.: low cost and easy availability of the chemical; a natural germicide and coagulant or flocculent; requirement of lower amount of the chemical; and a reliable chemical frequently used in average families as preservative and water purifier. Alum is a salt that in chemistry is a combination of an alkali metal, such as sodium, potassium, or ammonium and a trivalent metal, such as aluminium, iron, or chromium. The most common form, potassium aluminium sulfate, or potash alum, is one form that has been used in food processing. Another, sodium aluminum sulfate, is an ingredient in commercially produced baking powder. The potassium-based alum has been used to produce crisp cucumber and watermelon-rind pickles as well as maraschino cherries, where the aluminum ions strengthen the fruits' cell-wall pectin. Alum is approved by the U.S. Food and Drug Administration as a food additive, but in large quantities – well, an ounce or more – it is toxic to humans [5].

Flocculants are used in water treatment. The addition of flocculants to raw water causes colloids and other suspended particles to stick together and form heavier particles (floc) which will be removed by the sedimentation or filtration. This flocculation (or coagulation) process is to aid the removal of contaminants like fine solid pollutants or microscopic molecules which are difficult or impossible to be removed by filtration alone. Generally flocculants are multivalent cations such as aluminium, iron, calcium or magnesium. Many of the suspended water particles have a negative electrical charge which repels each other. Positively charged flocculants attract and stick to many of the suspended water particles. Many of flocculant cations, under appropriate pH and other conditions, react with water to form insoluble hydroxides which join together to form larger settleable particles or physically trap small particles into the larger floc. There are organic flocculants also. Members of flocculants include alum, aluminium sulphate, calcium oxide, iron chloride, iron sulphate, polyacrylamide, Polyaluminum chloride, Polyaluminum hydroxidechloride silicate sulfate, Polyaluminum hydroxidechloride silicate, Sodium aluminate, Sodium silicate [5].

Alum, one of the most common flocculants, was used to remove the pollutants from the wastewater coming out of the pulp and paper mill. Four indicators, namely, colour, pH, BOD and COD were used to see the level of pollutants in the samples. Values of these indicators in the wastewater and treated wastewater are presented in Table 1.
The colour of the wastewater coming out of factory was dark brown. This colour is unacceptable in the water bodies and is the first conspicuous indicator of water pollution. Treatment with varying amounts of alum led to almost complete decolouration of the wastewater.

Application of just 0.50g alum per litre (or 0.05% alum w/v) of wastewater turned the sample clear by decolouration. Treatment by dissolving 1.0g alum per litre (or 0.1% w/v) of the wastewater turned the solution crystal clear. The supernatant in appearance looked like drinking water. Again, increased amount of alum beyond 0.2% w/v, imparts light yellow and pale yellow colour to the treated wastewater. The colour of the wastewater coming out of factory was dark brown. This colour is unacceptable in the water bodies and is the first conspicuous indicator of water pollution. Treatment with varying amounts of alum led to almost complete decolouration of the wastewater. Application of just 0.50g alum per litre (or 0.05% alum w/v) of wastewater turned the sample completely clear by decolouration. The pH value of the treated water decreased with increased concentration of the alum. The pH of the control was 7.94 but that of the treated water with 2% alum (20g per litre of water) was as low as 3.64. pH of the water treated with 0.05 and 0.1% alum (w/v) was nearly neutral. Increase in alum concentration brought down the pH value up to unacceptable limit. Alum is acidic in nature and forms acidic solution with water (Table 1).

Considerable decline in the BOD of water treated with increased amount of water was recorded. There was 50% decline in the value of BOD with dissolving just 1.0g alum per litre of water (Table 1; Fig.2.0). Alum acts as an anti-microbial chemical. It would suppress the growth of microbes in water. Demand of oxygen by microorganisms to decompose the organic matter would therefore be decreased leading to the lowering of BOD.

COD, however, is not brought down considerably. COD of the control and that of the waste water treated with 2.0% alum was almost equal. COD of the water treated with 0.1% solution (w/v) was recorded to be the lowest (Table 1; Fig.3.0). Since alum is an inorganic compound, it adds to the inorganic load of water. Therefore, COD increased with the increase of alum concentration in the water beyond a certain limit.

Based on the physical, chemical and biological indicators, it could be concluded that wastewater purified itself to certain extent as it flowed further in the stream, except for the colour of the wastewater, which did not improve at all. However, the purification process did not go on in a linear fashion. The process is affected by a mix of various factors. Mitigation of the polluted water was carried out using different amounts of alum. This chemical method was opted for the pollution mitigation because of low cost and easy availability of the chemical. Further, the alum is a natural germicide, an effective coagulant and flocculent and it is a reliable chemical frequently used in average rural Indian families as a preservative and water purifier.

The colour of the wastewater coming out of factory was dark brown. This colour is unacceptable in the water bodies and is the first conspicuous indicator of water pollution. Treatment with varying amounts of alum led to almost complete decolouration of the wastewater. Application of just 0.50g alum per litre (or 0.05% alum w/v) of wastewater turned the sample completely clear by decolouration. The pH value of the treated water decreased with increased concentration of the alum. The pH of the control was 7.94 but that of the treated water with 2% alum (20g per litre of wastewater) was as low as 3.64. The pH of the water treated with 0.05 and 0.1% alum (w/v) was nearly neutral. Increase in alum concentration brought down the pH value up to unacceptable limit. Alum is acidic in nature and forms acidic solution with water. Considerable decline in the BOD of water treated with increased amount of water was recorded. There was 50% decline in the value of BOD on dissolving just 1.0g alum per litre of water. Alum acts as an anti-microbial chemical. It would suppress the growth of microbes in water. Demand of oxygen by microorganisms to decompose the organic matter would therefore be decreased. COD, however, did not decrease as the alum is an inorganic compound and contributes to increase COD on increasing its amount in the solution. It could be inferred that treatment of wastewater with 0.1% alum solution (w/v) is the most appropriate measure for the mitigation of pollution of the stream water due to pulp and paper mill. It completely decolourises the wastewater, brings the pH to a desirable level. However, the BOD of the sample is above prescribed limits, which needs to be addressed. This low amount of alum would not act as a pollutant and is acceptable even for consumption (provided BOD is mitigated). Moreover, costs of this chemical available everywhere will be quite low and will hardly have bearing on the cost of paper and pulp production.

ACKNOWLEDGEMENTS
Authors gratefully acknowledge the facilities provided by Dean, College of Basic Sciences and Humanities, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India.

REFERENCES
Table 1: Physico-chemical properties of wastewater treated with alum

<table>
<thead>
<tr>
<th>Sample</th>
<th>Amount of alum (g/l)</th>
<th>Colour</th>
<th>pH</th>
<th>BOD (mg/l)</th>
<th>COD (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.00</td>
<td>Dark brown</td>
<td>7.9</td>
<td>120.0</td>
<td>300</td>
</tr>
<tr>
<td>1</td>
<td>0.50</td>
<td>Clear</td>
<td>7.6</td>
<td>90.00</td>
<td>298</td>
</tr>
<tr>
<td>2</td>
<td>1.00</td>
<td>Crystal clear</td>
<td>6.6</td>
<td>60.00</td>
<td>260</td>
</tr>
<tr>
<td>3</td>
<td>2.00</td>
<td>Clear</td>
<td>4.1</td>
<td>60.00</td>
<td>266</td>
</tr>
<tr>
<td>4</td>
<td>5.00</td>
<td>Light yellow, slightly translucent</td>
<td>3.8</td>
<td>56.00</td>
<td>269</td>
</tr>
<tr>
<td>5</td>
<td>10.00</td>
<td>Pale yellow, slightly translucent</td>
<td>3.7</td>
<td>54.00</td>
<td>276</td>
</tr>
<tr>
<td>6</td>
<td>20.00</td>
<td>Pale yellow, clear</td>
<td>3.6</td>
<td>54.00</td>
<td>302</td>
</tr>
</tbody>
</table>

Fig. 1. pH of Treated Waste Water with varying Alum concentration

Fig. 2. BOD of Treated Waste Water with varying Alum concentration

Fig. 3. COD of Treated Waste Water with varying Alum concentration
E-WASTE MANAGEMENT IN INDIA: A RIGHTS-DUTIES BASED APPROACH IN LIGHT OF ENVIRONMENTAL GOVERNANCE.

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Abstract—At the outset, it must be stated that the authors fully subscribe to the notion of multiple means of technology provided for in today’s era. But the resentment lies in the manner in which skeletal wastes of such technology are disposed off into the environment which is a sum total of public goods. The Indian legislature has devised a framework in the form of e-waste (Management & Handling) Rules, 2011 which came into effect recently, on May 1st, 2012. The impugned rules are a step in the right direction of India’s international commitments and in furtherance of a much-needed addition to the existing environmental governance framework. The e-waste rules seek to replicate the model of Extended Producer Responsibility which creates a duty in the producer to ensure that end-of-life products are disposed off in a safe manner. Following rights-duties based approach; the duty corresponds to a right of the people to safe, healthy and clean environment which is the cornerstone of India’s environmental jurisprudence. The rules also embody a well-designed procedure which includes entities such as collection centers, dismantlers, and recyclers. It further reaffirms duties of consumers of such electronic goods. The concern of the environmental policy-making can be seen in the further specifications made in the Schedules to the aforementioned rules in indicating certain industries and goods that are to be held responsible. But having so stated a system of rights and duties calls for a body that enforces the same. In this regard, the e-waste rules have been framed under the Environment Protection Act, 1986 and thus the sanctions that follow the feasance of the above duties may be derived from the same as the authorities are empowered to pass closure orders against the polluting industry. The authors, in this paper, dwell on the efficaciousness of the recently enacted rules and point out certain implementational difficulties through concrete legislative analysis. Further, the current status of e-waste management is statistically examined with proper reference to the pre-enactment period. The paper is concluded with a list of carefully drafted measures that derive inspiration from the European and American systems of waste management. Magnanimous references have been made to Indian judicial interpretation and scientific data and the effort being made encapsulates a rights-duties based approach in green economics.

INTRODUCTION

The Central Pollution Control Board (CPCB) has projected that the country will generate more than 8 lakh tonnes of e-waste this year. A CPCB report said 65 cities in India generate more than 60% of the total e-waste, 70% of which comes from 10 states. A recent finding by the Center for Science and Environment (CSE) said that 50,000 metric tonnes of electronic scrap is imported into the country every year. This, despite the blanket ban on hazardous waste imports by the Basel Convention treaty. The notion of environmental governance is fundamental to the affirmation of the Right to Life that our age-honored Constitution bestows upon us. The ambit of the same must be widened to include the impact of the ever-evolving technological paradigms. The aspect that is specifically dealt with in this paper is that of electronic waste or e-waste as it is popularly called. Illustratively speaking, an Apple I-Phone is upgraded even before one blinks today. What happens when you buy a new model? The obvious conclusion is that you possibly end up discarding the previously used model. Further, a very commonsensical definition of ‘waste’ demonstrates that the old model constitutes ‘waste’ or specifically e-waste. The commodity thus according to an economics-perspective loses sense of utility and thus is relegated to the junkyard. This ‘junk’ if not disposed off by collection, processing and recycling may and does indeed cause grave environmental repercussions. E-waste may contain hazardous chemical components such as sulphur and arsenic as a part of semi-conductors and the entry of such components into the food chain, the air or the water is detrimental to public health. As the premise of the author is based on a rights-duties approach, further elucidation involves imposition of a duty corresponding to the right of the public to a healthy and clean environment. A basic jurisprudential analysis indicates the efficaciousness of these rules.

A RIGHTS-DUTIES ANALYSIS

Rights and duties go hand in hand. A ‘wrong’ implies a ‘duty’. In the absence of a duty, which necessitates the logical existence of two parties, sanctions will not follow simply because the duty does not exist and hence cannot be enforced against any entity which is the repository of such duty. Such notions are beautifully interwoven with the conception of society. Transplanting the same concepts into the realm of environmental governance is seemingly an easy task. India is a signatory to multiple international conventions such as the Stockholm Declaration, UNFCCC, Basel Convention on Hazardous Wastes. The interplay and development of environmental law doctrines such as the Public Trust Doctrine clarifies the legal position of ‘environment’ as being a public good. The ‘ownership’ of such a ‘good’ is vested in all members of the public. The trusteeship is created with the government holding the same in trust for the public which is the beneficiary. Thus any ‘wrong’ committed against this ‘public good’ violates the rights of the public as it is the beneficiary of the same. This entails for a concrete black and white system of responsibilities that are compulsorily enforceable against the ‘wrongdoers’. The same involves considerations of various other notions such as the ‘polluter pays’ principle and the precautionary principle. The Bhopal Gas Disaster is a striking reminder of how extravagant claims ultimately boil down to an analysis of rights, duties, wrongs and liabilities. Thus an effort has been made to analyze the e-waste rules on the same basic jurisprudential lines.
The e-waste rules have been enacted under Sections 6, 8 and 25 of the Environment Protection Act. The above sections empower the Central Government to formulate rules to give effect to the object of the Act. These rules came into effect on May 1st, 2012. The model of e-waste management that the Government is trying to implement is based on the principle of Extended Producer Responsibility. The principle, in substance, creates a ‘duty’ of the Producer to ensure that any hazardous commodity at its end of life or at the raw material stage is disposed off in a safe manner.

I. GENERAL

II. RESPONSIBILITIES

Responsibilities of the producers:
Producer means any person who manufactures and offers to sale electrical and electronic equipment under his own brand or offers to sell in his own brand the electrical equipment produced by other manufacturers or imported electrical or electronic equipment.

As given in the E-waste (management and Handling) 2011the producers will be responsible for the collection of e-waste generated during the manufacture and the “end of life” for those electrical equipments and channelizing the same for recycling. The producers are also responsible for setting up collection centers for all electronic equipment at the end of life as well as setting up a financial system to meet the cost of an environmentally sound management of e-waste. Under such the producers have been given such responsibilities like to provide contact details of the distributors and the authorized collection centers to consumers so as to facilitate for the return of the used electrical equipment and also to create awareness through publications, advertisement, posters etc about and the handling of such e-waste.

Responsibilities of the distributors:
Any person who received electrical and electronic equipment of components thereof from the producer sells it to the consumers or bulk consumers or other retailers on behalf of the producers.

Every distributor will be responsible to collect the e-waste by providing proper box or bins for the deposits of such. It is the duty of every distributor to ensure that all waste which has been collected is safely transported back to the producers or authorized collection centre etc. Every distributor is also to make regular returns to the state pollution control board on or before the 30th day of June following the financial year to which that returns relates.

Responsibilities of dismantler:
Dismantler’s means a person who is engaged in dismantling used electrical and electronic equipment into their components.

It is the duty of every dismantler to ensure that there is no damage to the environment during storing and transport of e-waste and to ensure that the dismantling processes does not have any harmful effects on the health. To ensure that such dismantling processes are in accordance to the guidelines published in the Central pollution control board and finally to ensure that the non recyclable components are sent to the authorized treatment and disposal facilities. Every dismantler shall make an annual return to the state pollution control board on or before the 30th day of June following the financial year to which that returns relates.

Responsibilities of recycler:
Recycler means any person who is engaged in processing e-waste for the recovery of useful material or reuse.

Every recycler shall ensure that the recycling processes are in accordance to the standards laid down in the guidelines [published by the central pollution control board for time to time. It is the duty of every recycler to make available of all records to the Central or state pollution control board for inspection. It is their duty to ensure that the residue generated is disposed of in a proper disposal facility.

I. GENERAL RESPONSIBILITIES

The rules provides that very producer, distributor, collection centre, refurbisher, dismantler or recyclers may store e-waste for a period not exceeding one hundred and twenty days and shall maintain a record of collection, sale, transfer, storage and segregation of wastes and make these records available for inspection. The State Pollution Control Board may extend the given time as it deems fit.

Further it provides for the reduction in the use of hazardous materials in the manufacture of electrical and electronic equipment every producer of electrical and electronic equipment shall ensure that, such equipments does not contain Lead, Mercury, Cadmium, Hexavalent Chromium, or any other substances which may deteriorate the environment and health of individuals at large. And that in the event of such hazardous materials is used in such equipments, the detailed information shall be provided in the product information booklet.
With regards to the transportation of e-waste, when these are intact, shall be like any other electrical and electronic equipment. In case of transportation of e-waste for final disposal the transporter shall obtain ‘No Objection Certificate’ from the concerned State Pollution Control Board and shall intimate the State Pollution Control Board of State of transit. In case of transportation of e-waste for dismantling or for recycling in a State other than the State where the waste is generated/collected, the transporter shall intimate the concerned State Pollution Control Boards beforehand and the State Pollution Control Boards of the State of transit.

PROBLEMS WITH THE INFORMAL SECTOR: BALANCING OF INTERESTS & INCENTIVIZATION.

Informal waste collectors and dismantlers handle over 90% of India’s e-waste. Yet, their work is not clean. They work in the heat, the monsoon and in the icy cold winter, under appalling conditions. Experience tells us that even when they become formal, by forming associations or companies, their safety and health may still be compromised, unless producers themselves shift to clean production. For most informal sector actors, collection and selling e-waste to other dismantlers is still the best option. Dismantling requires more investment in training, skilled workers already familiar with dismantling, additional equipment and tools etc. This is difficult to procure even if you are organized. What is even harder is that many bigger cities are unwilling to give permits to set up more dismantling units, because they see dismantling electronics as a highly toxic enterprise because of what’s inside the old computers, phones, TVs and other electronics we trash. Delhi and its neighboring city, NOIDA, are two cases in point. This trend is likely to expand to other bigger cities. Unfortunately, they have a point-electronics do have toxics inside them. And while dismantling is not a toxic process, and does not burn or extract any metals, it can still lead to some toxic releases. If monitors break, for example. Or when they use blow torches, operating at high temperatures, to remove smaller components from mother boards.

This means that workers from the informal sector cannot value add and earn the most money from the e-waste they collect because the manufacturers have pumped them up with dangerous chemicals and this has the authorities very wary about dismantling except by very capital intensive plants. This is worrying for two reasons. First, that poor-and inconsiderate- design reduces the legal earning for such workers. Second that this acts as a disincentive for workers who are currently dismantling to actually formalize, because they will have to change their line of business to collection, where their core skills will be unused. They may even experience a reduction in incomes. Such a disincentive is bad for them and bad for the environment. If they continue to dismantle, they bear the brunt of the toxics in electronics. If they expand their business, as many of them hope to do, collection will only be a means of vertical integration and to secure their dismantling businesses. It will be peripheral. For most, real expansion means adding value and increasing incomes from opportunities in extraction— even if it is illegal. Again, they will end up exposing themselves and other workers to dioxins, lead and acid fumes.

The rule fails to provide safeguards to ensure the ban of import and export of electronic wastes. There is also a scope for further improvement by making every producer financially liable for the e-wastes generated by their products, based on its toxicity. To accelerate the introduction of greener products, Polyvinyl Chloride (PVC) and all form of Brominated Flame Retardants (BFR) should be included as banned substances.”

The authors submit that, the present e-waste rules do fill up a gaping blank in India’s environmental regime. But implementations of the same given the practical difficulties that will be faced questions its efficaciousness. E-waste processing in India is mostly managed by a very well networked informal sector, where the entire recycling chain, especially related to material recovery, are inappropriate and highly dangerous and are likely to impact both the environment and human health adversely. Also, the non recyclable materials are dumped, as the country does not have any landfills. The informal sectors engaged in recycling do not any have a tie up with the scientific disposal site thus, the materials are either dumped or drained. The other concern lies in International trade of second-hand products or dismantled parts/materials to the developing countries like India; China, Pakistan; because of cheap labor and sloppy environmental norms.

The enumeration of hazardous chemicals and wastes in the schedules could have been more exhaustive. The attempt made here is to replicate the European model into the Indian framework. Developed countries like Europe, have systems of tracing the source as well as disposal of waste; however, most Asian countries lack such systems. The distinction lies in the fact that India is a developing country and hence has very different traditions and legal and practical realities. Further, the only sanctions provided for in the Rules is that of cancellation or suspension of authorization. Such a sanction is only punitive in nature and does not clearly provide for specific compensatory regimes. Environmental Impact Assessment ought to have included as a mandatory requirement within the purview of the rules, not to ignore the fact that the Environment Protection Act, 1986 vide MoEF Notification in 1994 compulsorily includes impact assessment of any new activity.

THE EUROPEAN MODEL.

In 1998, the amount of electrical and electronic equipment arising (EEE) as waste was estimated for the EU15 at 6 million tons. The current amounts of WEEE in the EU are roughly between 25% for medium sized appliances to 40% for larger appliances. The two main legislations related to e-waste management in Europe are Waste Electrical and Electronic Equipment (WEEE) (Directive 2002/96/EC) along with the complementary Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) which seeks to reduce the environmental impacts of WEEE throughout all stages of the equipment’s lifecycle, particularly at the end of life stage, by encouraging the end-of-life management of the product, eco-design, life cycle thinking and extended producer responsibility.

The key aims of the WEEE Directive are to:

i) Reduce WEEE disposal to landfill;

ii) Provide for a free producer take-back scheme for consumers of end-of-life equipment from 13 August 2005;

iii) Improve product design with a view to both preventing WEEE and to increasing its recoverability, reusability and/or recyclability;
iv) Achieve targets for recovery, reuse and recycling of different classes of WEEE;
v) Provide for the establishment of collection facilities and separate collection systems of WEEE from private households;
vi) Provide for the establishment and financing of systems for the recovery and treatment of WEEE, by producers including provisions for placing financial guarantees on new products placed on the market.

Table 1: Timetable for Implementation of the Directive

<table>
<thead>
<tr>
<th>Publication of WEEE Directive</th>
<th>Member States</th>
<th>Transposition</th>
<th>Producer Responsibility</th>
<th>Substance Ban (RoHS)</th>
<th>Meeting Recycling Targets</th>
</tr>
</thead>
</table>

Source: ICSCG Circular, 2003

Table 2: December 31, 2006, Targets for Recovery and Reuse/Recycling, by weight

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Recovery Target</th>
<th>Recycling Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Household Appliances</td>
<td>80%</td>
<td>75%</td>
</tr>
<tr>
<td>Small Household Appliances</td>
<td>70%</td>
<td>50%</td>
</tr>
<tr>
<td>Information and Telecoms</td>
<td>75%</td>
<td>65%</td>
</tr>
<tr>
<td>Consumer Equipment</td>
<td>75%</td>
<td>65%</td>
</tr>
<tr>
<td>Lighting</td>
<td>70%</td>
<td>50%</td>
</tr>
<tr>
<td>Tools</td>
<td>70%</td>
<td>50%</td>
</tr>
<tr>
<td>Toys</td>
<td>70%</td>
<td>50%</td>
</tr>
<tr>
<td>Medical Equipment</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Monitoring Instruments</td>
<td>70%</td>
<td>50%</td>
</tr>
<tr>
<td>Dispensers</td>
<td>80%</td>
<td>75%</td>
</tr>
</tbody>
</table>

To elaborate on the model, the following illustrations of companies and compliances may be taken into regard;

FUJITSU SYSTEMS: E-WASTE IN GERMANY.

The remarketing, reuse and recycling of Fujitsu Siemens Computers products have taken place at the company’s Paderborn, Germany facility since 1988. At Paderborn approximately 20 percent of Fujitsu Siemens Computers-branded equipment is reused and, currently, only two percent is disposed. The processes employed by Paderborn far exceed the requirements set out in the WEEE Directive. Although recycled plastic is not used in their products, the products recycled, such as plastic casing, can be used to create new, high-quality products. Fujitsu Siemens Computers works very close together with Fujitsu, a leading provider of customer-focused IT and communications solutions for the global marketplace. Fujitsu already offers an environmentally sound recycle service in some countries were no take-back requirement was imposed.

II. AUSTRIA: A SOCIO-ECONOMIC MODEL

In Austria approximately 60 enterprises operating in this manner founded an association RePANET (Reparaturnetzwerk für die Zusammenarbeit für bessere Entsorgung und Recycling). They are lobbying on a Common base in the EU for social and ecological concern, developing and coordination social enterprises and projects. A main issue of the European network is the promotion of sustainable consumption. The corporate culture of social economy is based on civil corporate involvement combined with business initiative. Successful social economy enterprises follow specific financing mix of private economic returns in the market, returns from public funds for meeting public tasks and through the investment of work time or money from third parties.

LESSONS FOR INDIA

The authors have referred to the existing practices in the European countries to make an appraisal of the practicalities of a replication of the same model into the Indian laws. The e-Waste rules, as we know, clearly recognize the principle of Individual or Extended Producer Responsibility. The practices in Europe include not only elements of environmental protection at the foremost but also social economy. The fostering of such a culture needs backing from the rules which are silent on employment and market issues with regard to recycled e-waste. The rights-duties ideal might compel one to believe that every profit-minded producer will, even in circumstances of lax implementation and enforcement, follow the mandate of the new law. Incentivizing the performance of any duty as such is an anomalous proposition because the same flows from rule of existence of a right in an individual or the public. But, environmental issues, must not considered on the same platform as any other ordinary right-duty situation. Any environmental problem cannot be considered in vacuo with developmental motives. Both are to go hand in hand and hence a compromise must be struck. This balancing of interests involves rigorous social engineering and thus inclusion of certain incentives is necessary at the beginning of any reformatory or corrective initiative. It is suggested that, changes be brought about in the rules so as to incentivize the idea of e-waste management. Tax exemptions should be granted to dismantlers, recyclers, producers or even the transporters. Conceding to the fact that, the model that is sought to established in India


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requires flawless coordination between various entities to ensure safe e-waste disposal, each link in the chain should be given appropriate incentives. Further, we also suggest the creation of a specific body to deal with Statistical data regarding e-waste disposal procedures and management statuses.

CONCLUSION

To sum up, the authors reserve their praise for the wisdom of the legislature in meeting the need of the hour. Recognition of the principle of Extended Producer Responsibility introduces accountability into the present system. Further, the ‘step-wise’ mechanism that has been set up is financially sound in terms of its cost-demands. The spirit of ‘environmentally sound management of e-waste’ is followed throughout the rules as special provisions dealing with the handling of such hazardous waste and transportation of the same has been dealt with in comprehensive provisions. What remains to be seen is the integration of the informal sector with the formal sector. The social implications associated with the unorganized sector, like threat and harassment, child labor, unstable employment and unsafe working conditions are to be taken into consideration. However, this sector has had a historical role in waste management and is highly networked and skilled. There is a need to integrate the informal sector in the formal, as the network of the formalized informal sector will foster market cooperation. The Guidelines should be made comprehensive and should seek to go beyond the rules; addressing all the stakeholders' requirement. In India recycling is value driven and not environment or CSR driven and more of re-furbishing is carried out. But the aim is not to be ‘short term value creation’ rather it ought to be ‘long term environmental protection. A market mechanism to incentivize the initiative is most welcome. Furthermore, all pollution control boards must operate uniformly. Recyclers must include non-profitable products as a part of the scheme as well. This can be achieved by incentivization as has been stressed earlier. Preliminarily, awareness about the existence of such rules should be spread.

ACKNOWLEDGMENT

We would like to express our heartfelt gratitude firstly to our parents for their constant support and unfailing guidance without which we would not have been able to complete this paper. We also extend our sincere thanks to IIMT Bhubaneshwar for giving us the opportunity to present our views. Lastly we would also like to thank all the authors, writers, columnist and social thinkers whose ideas and works have been made us in the completing of this paper and all those who have contributed in their own small way but fail to receive mention.

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STUDY ON SOLID WASTE MANAGEMENT

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Abstract:- The topic of “Solid Waste Management” has attained a great signification as all our cities and Air, Water and Soil resources are highly polluted endangering humanity and the entire bio-system of plants, animals, marine life, flora and fauna. In spite of the seriousness of the problem of Solid waste in all areas of our activities from domestic, commercial, industrial, agricultural and so on, not much is done especially, our concern has been on the need for people’s participation in solving in a sustainable manner the domestic and commercial waste. Demand for consumer goods is increasing day by day at a very fast rate due to rapid industrialization and population explosion. This in turn results in production of solid waste with the use and throw concept, the generation of waste increased alarmingly both in quantity and complexity. Dumping is also not only gives ugly look, foul smell but also cause serious health hazard through pollution of land, air and water resources. Sometime outbreak of epidemic take place due to pollution of air, water and soil environments resulting from indiscriminate disposal of waste. The objective of this paper is to study comprehensive overview of all types of Solid Waste generated from Domestic, Commercial, Industrial, Mining, Agricultural and Tourism activities and dealt with the techniques available for management of all these Solid Waste and their limitations and benefits. This paper focus on effective handling of Domestic and Commercial Solid Waste known as Municipal Solid Waste (MSW).

INTRODUCTION:­

As urbanization continues to take place, the management of solid waste is becoming a major public health and environmental concern in urban areas of many developing countries. Solid or semi-solid, non-soluble material (including gases and liquids in containers) such as agricultural refuse, demolition waste, industrial waste, mining residues, municipal garbage, and sewage sludge. In the last 20 years, a number of solid waste management projects have been carried out in developing countries, some produced lasting impacts on the improvement of solid waste management in developing countries. However, many projects could not support themselves due to technical, financial, institutional, economic, and social factors contribute to the failure to sustain the projects. In order to remove this problem it is very important to identify the sources that contribute to solid waste and then to find a technology that can help to remove it or manage it.

SOURCES OF SOLID WASTE:

Tanneries:

As of estimates made in 2002, India had more than 3000 tanneries with a total capacity of 700000 tonnes of hides and skins per year. The annual income from leather trade in India was about Rs 20000 crores. More than 90% of the tanneries were small or medium with a processing capacity of less than 2 to 3 tonnes of hides/skins per day. The level of pollutants correspond to release of Chloride (1000 to 2000 mg/l), Sulphates (2000 to 4000 mg/l), BOD (1000 – 3000 mg/l) and COD (2500 to 7000 mg/l).

MINING WASTE

Mining wastes include waste generated during the extraction, beneficiation, and processing of minerals. Most extraction and beneficiation wastes from hard rock mining (the mining of metallic ores and phosphate rock) and 20 specific mineral processing wastes are categorized by EPA as "special wastes" and have been exempted by the Mining Waste Exclusion from federal hazardous waste regulations. Yet the amount of effluent released by these industries contribute to a major share in solid waste generation.

BIOMEDICAL WASTES:

These include blood-soaked bandages, culture dishes and other glassware, discarded surgical gloves, discarded surgical instruments discarded needles, used to give shots or draw blood cultures, stocks, swabs used to inoculate cultures, removed body organs (e.g., tonsils, appendices, limbs), discarded lancets. Improper management of discarded needles and other sharps can pose a health risk to the public and waste workers. For example, discarded needles may expose waste workers to potential needle stick injuries and potential infection when containers break open inside garbage trucks or needles are mistakenly sent to recycling facilities. Janitors and housekeepers also risk injury if loose sharps poke through plastic garbage bags. Used needles can transmit serious diseases, such as HIV and
hepatitis. In recent times biomedical waste has gained attention due to its priority and must be attended to immediately.

TEXTILE WASTE

Majority of textile waste comes from household sources. These are post-consumer waste that goes to jumble sales and charitable organizations. Most recovered household textiles coming to these organizations, are sold or donated. The remaining ones go to either a textile recovery facility or the landfill. Textile industry is accused of being one of the most polluting industry. Not only production but consumption of textiles also produce waste. To counter the problem, textile industry has taken many measures for reducing its negative contribution towards environment. One of such measures is textile recycling- the reuse as well as reproduction of fibers from textile waste.

MUNICIPAL SOLID WASTE:

Municipal solid waste (MSW), also called urban solid waste, is a waste type that includes predominantly household waste (domestic waste) with sometimes the addition of commercial wastecollected by a municipality within a given area. They are in either solid or semisolid form and generally exclude industrial hazardous wastes. The term residual waste relates to waste left from household sources containing materials that have not been separated out or sent for reprocessing. Biodegradable waste include food and kitchen waste, green waste, paper (can also be recycled). Recyclable material includes paper, glass, bottles, cans, metals, certain plastics, etc. Inert waste include construction and demolition waste, dirt, rocks, debris. Composite wastes include waste clothing, Tetra Packs, waste plastics such as toys. Domestic hazardous include waste (also called "household hazardous waste") & toxic waste include medication , e-waste, paints, chemicals, light, bulbs , fluorescent tubes, spray cans, fertilizer and pesticide containers, batteries, shoe.

SUSTAINABLE METHODS TO HANDLE SOLID WASTE:

In recent times the three “R”s- ‘Recycle’, ‘Reduce’ and ‘Reuse’ have gained a lot of momentum. In recent times this issue has been majorly addressed by treatment of solid through aerobic and anaerobic method.

AEROBIC TREATMENT:

Treatment of biodegradable wastes in presence of air/oxygen using aerobic bacteria to convert the wastes into biologically stable humus. Two methods that is being used for this purpose are Composting and Vermiculture.

COMPOSTING:

Biological decomposition of organic compounds of wastes under controlled aerobic conditions. Temp. of waste heats increases by in situ heating to the range of mesophilic (25-400C) & thermophilic microbes (50-700C). End product is the biologically stable humus referred to as compost, which can be used as a soil conditioner, fertilizer, biofilter or fuel. Organic wastes from industries, agriculture, horticulture, landscapes & forests can be treated by the same method. Degradation of organic compounds is done by diverse microbial communities: bacteria, actinomycetes & fungi. End products of metabolism consists of H2O, CO2, NH4+, NO3, NO4, heat and humus. Waste air containing H2O vapour, CO2, NH4+ & NO from aerobic metabolism are released to maintain microbial activity. The end products of microbial metabolism are O2, H2, H2 S, NH4+, N2O, N & H2O.

Mature compost consists of non-degradable components – lignin, lignocelluloses, minerals, humus, microbes & mineral N components. Dissolved oxygen from the gas phase in the compost heap helps in microbial activity. Higher the moisture content in the compost, higher the microbial activity.

VERMICOMPOSTING:

Vermicomposting is the degradation of organic wastes utilizing the high metabolic activity of earthworms to achieve the following objectives. In this process, the efficiency & adaptability of earthworms in inhabiting very high percentage of organic material, low incubation period of eggs & rapid multiplication rate is exploited commercially for biowaste treatment. Solid wastes is spread over soil surface for incorporation into the soil in situ . Earthworms help in decomposition & incorporation into the soil. Wastes are stacked in heaps or bins, treated like compost and earthworms are released into them. This method results in bulk production of worm casts rich in lignocelluloses, usable as manure. This can be mixed with cow dung, poultry waste or pig waste to increase degradation efficiency. Wastes are directly fed into specially
designed vermicomposting bins made of wood/plastic/brick masonry. Thus the treated waste can be used to obtain a finished value added product free of biological & chemical pollutants that can be used as manure.

**ANAEROBIC TREATMENT:**

Treatment of biodegradable wastes in the absence of air or oxygen using anaerobic bacteria through anaerobic fermentation, to convert the wastes into biogas is known as anaerobic treatment. In this closed process, temperature and moisture are controlled. It is suitable for wastes with high moisture content & higher biodegradable components. Naturally, this process occurs in marine sediments, marshlands, flooded rice fields & landfill sites where organic content is very high. This process is effected by specialized groups of bacteria.

This process is carried on by three simple steps:

**Hydrolysis:** Decomposition of water-insoluble biopolymers (carbohydrates, proteins & fats) to soluble monomers (monosaccharides, amino acids) accessible to further degradation.

**Acidification:** Hydrolysis intermediates are converted to acetic acid, H2, CO2, organic acids, amino acids & alcohols by bacteria. Some of them can be used directly by methanogenic bacteria, but the organic acids & alcohol are decomposed into acetic acid, H2 & CO2 during acidogenesis.

**Methanogenesis:** Acetic acid, H2, CO2, methanol, methylamine & formate are transformed into CH4 & CO2 (70 -30%-Biogas).

Anaerobic MSW digestion is a new technique in practice only during the last two decades. The product of anaerobic fermentation combined with an additional post-composting step can be used as a fertilizer, soil conditioner & peat substitute. Efficiency of this process is proportional to the water content & biodegradable organic matter.

**LANDFILLS:**

Disposing of waste in a landfill involves burying the waste, and this remains a common practice in most countries. Landfills were often established in abandoned or unused quarries, mining voids or borrow pits. A properly designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. Older, poorly designed or poorly managed landfills can create a number of adverse environmental impacts such as wind-blown litter, attraction of vermin, and generation of liquid leachate. Another common byproduct of landfills is gas (mostly composed of methane and carbon dioxide), which is produced as organic waste breaks down anaerobiocally. This gas can create odour problems, kill surface vegetation, and is a greenhouse gas.

Design characteristics of a modern landfill include methods to contain leachate such as clay or plastic lining material. Deposited waste is normally compacted to increase its density and stability, and covered to prevent attracting vermin (such as mice or rats). Many landfills also have landfill gas extraction systems installed to extract the landfill gas. Gas is pumped out of the landfill using perforated pipes and flared off or burnt in a gas engine to generate electricity.

**RECYCLE:**

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**Incineration**

Incineration is a disposal method that involves combustion of waste material. Incineration and other high temperature waste treatment systems are sometimes described as
"thermal treatment". Incinerators convert waste materials into heat, gas, steam and ash.

Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous waste. It is recognized as a practical method of disposing of certain hazardous waste materials (such as biological medical waste). Incineration is a controversial method of waste disposal, due to issues such as emission of gaseous pollutants.

Incineration is common in countries such as Japan where land is more scarce, as these facilities generally do not require as much area as landfills. Waste-to-energy (WtE) or energy-from-waste (EfW) are broad terms for facilities that burn waste in a furnace or boiler to generate heat, steam and/or electricity. Combustion in an incinerator is not always perfect and there have been concerns about micro-pollutants in gaseous emissions from incinerator stacks. Particular concern has focused on some very persistent organics such as dioxins, furans, PAHs,... which may be created within the incinerator and afterwards in the incinerator plume which may have serious environmental consequences in the area immediately around the incinerator. On the other hand this method or the more benign anaerobic digestion produces heat that can be used as energy.

ENERGY RECOVERY
The energy content of waste products can be harnessed directly by using them as a direct combustion fuel, or indirectly by processing them into another type of fuel. Recycling through thermal treatment ranges from using waste as a fuel source for cooking or heating, to anaerobic digestion and the use of the gas fuel (see above), to fuel for boilers to generate steam and electricity in a turbine. Pyrolysis and gasification are two related forms of thermal treatment where waste materials are heated to high temperatures with limited oxygen availability. The process usually occurs in a sealed vessel under high pressure. Pyrolysis of solid waste converts the material into solid, liquid and gas products. The liquid and gas can be burnt to produce energy or refined into other chemical products (chemical refinery). The solid residue (char) can be further refined into products such as activated carbon. Gasification and advanced Plasma arc gasification are used to convert organic materials directly into a synthetic gas (syngas) composed of carbon monoxide and hydrogen. The gas is then burnt to produce electricity and steam. An alternative to pyrolysis is high temperature and pressure supercritical water decomposition (hydrothermal monophasic oxidation).

CONCLUSION:
Apart from alternative management methodologies there is requirement for education and awareness in the area of waste and waste management is increasingly important from a global perspective of resource management. The Talloires Declaration is a declaration for sustainability concerned about the unprecedented scale and speed of environmental pollution and degradation, and the depletion of natural resources. Local, regional, and global air pollution; accumulation and distribution of toxic wastes; destruction and depletion of forests, soil, and water; depletion of the ozone layer and emission of "green house" gases threaten the survival of humans and thousands of other living species, the integrity of the earth and its biodiversity, the security of nations, and the heritage of future generations. Thus it is a responsibility of producers from every angle be it from the household origin or industrial, to achieve sustainable treatment of solid waste to keep this Earth green and clean.

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SIKKIM MARCHING TOWARDS GREEN ECONOMY

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Abstract:-Environmental degradation have assumed alarming proportions, the ill effects are seen in the form global warming, erratic rainfall, devastating floods, glacier melting, acid rain, and a host of other environmental problem, threatening the human survival on long term basis. This is engaging the attention of the World leaders, policy makers, and general stakeholders. Recent international meetings convened by the United Nations have focused on the challenges of actualizing the promise of sustainable development, of recreating a world economy that is “greener” and more sustainable, and identifying institutional frameworks that could help achieve this vision. Sikkim, one of the youngest and smallest states in India has initiated a number of steps to realize its dream of green economy through environmental governance framework. The most notable among them are Green Mission, Organic Mission, 10 minutes to earth, etc. The unparalleled participation and enthusiasm with which all the stakeholders have come up, the dream to make Sikkim a Green economy state may not be a distant reality.

Key Words: Green Economy, Green Mission, Organic Mission, Environmental Governance.

INTRODUCTION

Governing our planet’s rich and diverse natural resources is an increasingly complex challenge. In our globalised world of interconnected nations, economies and people, managing environmental threats, particularly those that cross political borders such as air pollution and biodiversity loss, requires new global, regional, national and local responses involving a wide range of stakeholders. Effective environmental governance at all levels is critical for finding solutions to these challenges. Environmental Governance comprises the rules, practices, policies and institutions that shape humans interaction with the environment. Good environmental governance takes into account the role of all actors that impact the environment. From governments to NGOs, the private sector and civil society, cooperation is critical to achieving effective governance that can help us move towards a more sustainable future.

Sikkim, one of the youngest and the smallest states of India is poised to make green economy as its future to attain growth in an unprecedented pace with due regards to the sustainable development. It is important to introduce Sikkim to the readers before we dwell upon the green economy efforts initiated by Sikkim Government in a participatory mode. Sikkim is one of the youngest and smallest North eastern States of India, having a population of only 6 lakh, recording highest GSDP during last seven years (2007-12). The state is primarily mountainous and a land locked one which is surrounded by three international borders (Nepal, Bhutan and China (Tibet) and state of West Bengal in the southern side as shown in the map.

GREEN ECONOMY

Green economy is an economy or economic development model based on sustainable development and knowledge of ecological economics. A feature distinguishing it from prior economic regimes is the direct valuation of natural capital and ecological services as having economic value and a full cost accounting regime in which costs externalized onto society via ecosystems are reliably traced back to, and accounted for as liabilities of, the entity that does the harm or neglects an asset. Thus, the Green Economy is one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.

"Green economics" is loosely defined as any theory of economics by which an economy is considered to be component of the ecosystem in which it resides. A holistic approach to the subject is typical, such that economic ideas are commingled with any number of other subjects, depending on the particular theorist. Proponents of feminism, postmodernism, the ecology movement, peace...
movement, Green politics, green anarchism and anti-
globalization movement have used the term to
describe very different ideas, all external to some
equally ill-defined "mainstream" economics.

According to Karl Burkart, Green economy
is based on six main sectors, i.e., Renewable energy
(solar, wind, geothermal, marine including wave,
biogas, and fuel cell); Green buildings (green retrofits
for energy and water efficiency, residential and
commercial assessment; green products and
materials, and LEED construction); Clean
transportation (alternative fuels, public transit, hybrid
and electric vehicles, car sharing and carpooling
programs); Water management (Water reclamation,
grey and rainwater systems, low-water
landscaping, water purification, storm water
management); Waste management (recycling,
municipal solid waste salvage, brownfield land
remediation, Superfund clean up, sustainable
packaging); and Land management (organic
agriculture, habitat conservation and restoration;
urban forestry and parks, reforestation and
afforestation and soil stabilization).

**RELEVANCE OF GREEN ECONOMY IN GLOBAL CONTEXT**

Worldwide, risks to development are rising as the
current models of growth continue to erode the stocks
of natural assets and undermine services provided by
ecosystems. A lack of action to preserve natural
capital will result in increasing costs to substitute it.
Moreover, policy needs to take account of evidence
that changes in ecosystems, and their capacity to
support growth, do not necessarily follow a smooth,
foreseeable trajectory. New ways of production and
consumption, as well as new approaches for defining
growth and measuring human progress, are required
in order to avoid the degradation of current living
standards. Green growth strategies aim to foster
economic growth and social development while
ensuring that natural assets continue to provide the
material inputs and services on which our economies
and well-being rely. The green transformation can
bring many positive development outcomes, such as
enhanced productivity and innovation, creation of
new jobs and markets, and fiscal revenue generation.
Furthermore, by achieving climate change resilience,
water and energy security, and adequate functioning
of ecosystems, the likelihood of abrupt changes that
may trigger economic and social shocks is reduced.
To enable greener growth, market signals and policies
must catalyse investment and innovation into new
ways of sustainably managing natural capital and
extracting higher, long-term benefits from its use.

A genuine transition to a green economy needs to involve fundamental changes to both macro-
economic and micro-economic conditions and,
therefore, institutions. The most obvious case for a
shift towards a green economy is in macro-
economic policy instruments relating to structures and
principles for international trade and finance issues.
For example, the role of trade in resources especially
in energy-related resources and also including the
security implications of resource trade is central to a
green economy. Any shift in this area will require
carefully crafted incentives to align international
markets simultaneously towards environmental and
resource goals. At the micro-economic level, the
institutional challenge is to create individual
incentives (including negative ones) to realign
consumption and production decisions that can have
significant environmental and economic ramifications.

The period right before and after both the
1972 Stockholm conference and the 1992 Rio Earth
Summit saw a frenzy of new international treaty-
making and institution-building for the environment.
This gave a rich edifice of institutions and
instruments that will be central to creating and
managing a green economy. However, the system as
it has evolved, remains focused on negotiation rather
than on implementation. A functional green economy
will require that societies shift their attention much
more towards implementation. Rio+20 provided an
ideal opportunity to accelerate this transition. There
has been growing restlessness amongst industrialized
and developing countries alike, although for different
reasons, to make implementation a more central
focus.

A global green economy will therefore
necessitate an emphasis on implementation and on
implementation coordination. Such a focus involves
at least two important changes. First, it will require
better incorporating public, private, and civil society
actors who are closer to implementation, including at
the national and sub-national levels. A green
economy and any institutions devised for it must
make their core focus the well-being of people, of all
people, everywhere, across present and future
generations. It also brings to the fore the centrality of
consumption questions, not only among nations but
within societies. It would be a folly to forget that a
green economy demands not just “green consumers”
but “green citizens.” Therefore, a green economy is
one that takes us toward sustainable development.
Once a green economy is fully in place, we might say
that our form of development can be deemed
sustainable. A green economy recognizes that it is the
form of organization of humankind’s economic
activity that will, in the end, determine whether or not
we are successful in addressing the problems of social
marginalization and environmental destruction. In a
green economy, actions taken to reach economic ends
also advance social and environmental ones, just as
actions taken to meet social and environmental ends
strengthen and develop the economy.
GREEN ECONOMY AND SIKKIM

The Sikkim state has realized the importance of sustainable development and initiated effort towards environmental governance for attaining Green economy. For this, a number of statute, acts, laws and rules have been framed for compliance by all stakeholders. The Green Governance has always been in the forefront of the agenda in Sikkim. The conservation paradigm of Sikkim is always very imaginative. It is not based on growth versus green but growth with green. This unique innovative programme was conceived by the Chief Minister, Shri Pawan Chamling himself and formally launched by him on 27 February 2006. The programme started with avenue plantation for beautification and gradually went on to become mass movement. Now all vacant lands, ranging those from monastery lands to community lands in village are being covered under the programme and all walks of life ranging from government officers, to public to housewives to army enthusiastically participate every year in the programme voluntarily.

IMPORTANT AREAS OF GREEN GOVERNANCE EFFORTS PAVING WAY TO GREEN ECONOMY FOR SIKKIM ARE ITERATED BELOW:

4.1 The State Green Mission

Of all the forestry sector programmes, the State Green Mission launched on 27th February 2006 in Sikkim occupies a flagship position in as much as its outreach, content and substance of objective is concerned. The brainchild of the Chief Minister’s pragmatic policy – it aims at shifting the theatre of forestry activity from the Government and departmental level to that in the people’s arena. The participation by bureaucrats, peoples’ representative, the Panchayats, the students and the teaching community all in all is the hallmark of this Mission. Whereas at the State level, the Chief Minister himself heads as Chairman at the Constituency level it is headed by MLAs as the Chairmen of the Green Task Force, an implementation body of the State Green Mission at the District/Constituency level. The concerned District Collector is the Member Secretary of all the constituencies within his District. Similarly in the field level officials and members drawn from different Departments and society within the Constituencies have been constituted to be called as Sub Committees. This is headed by one Nodal Officer. It is such a comprehensive manpower manipulation that no member of the civil society not even the Non Government Organizations, Self Help Groups, Community Based Organizations, Eco-clubs, local Societies are excluded from the purview of its scope and zenith.

The articulation, formulation and preparation of such a broad based manpower tool with all Government Departments also as implementers of this mission is an act of profoundest maturity and far-sightedness. It brings under its fold all that can be comprehended by way of manpower input into the working, improving and strengthening the system of delivery in the forestry sector. Unless the peoples’ component of participation is infused in the developmental process it can safely be termed as half-successful as we all have been experiencing at one time or other. It is an act that reminds the people that resource belongs to them, they are the custodians and managers, they are the consumers and protectors as well. The planting, protecting and propagating responsibilities throughout the State is now vested in the people, in the entire Government machinery, the Forest Department not being a lone manager as has been the usual tradition and practice. This is a paradigm shift in policy, approach and execution. The response was not only overwhelming but spontaneous and warm. It is no surprise therefore that people throughout the State took religiously to planting saplings in every vacant land, road side and in their back yard. It was a green revolution, a people’s movement in greening the Sikkim hills. Towards this goal, the State Green Mission stands tall and towering.

4.2 The State Organic Mission

Organic farming is yet another environmental governance effort initiated by the State Government of Sikkim. Green revolution launched in India in the early seventies enhanced chemical use in agriculture leading to enhanced production and productivity of crops under irrigated agriculture. But mountainous state like Sikkim and other North Eastern states where basically agriculture in rain fed,
the chemical use did not have significant impact on production and productivity. Considering this, Government of Sikkim took a decision to adopt organic system of farming in the entire state and probably the first state in India to bring resolution in the State Assembly. Concern for the people of the state for a healthy and wealthy living in a sustainable way keeping due care of ecology and environment has been taken as the prime duty. Now Sikkim is taking a lead in the North East part of the country on Organic farming and has targeted to convert the entire state into Organic by 2015.

It was in 2003, the State Government advocated the idea of making Sikkim an organic state. It was part of a larger concept of making whole of North Eastern region as wholly organic zone of India. The decision of Government of Sikkim to go organic was based on the premise that farming in this hilly state was traditionally organic and it will be to the benefit of not only to the sixty two thousand farming families of the state who own an average of 1.9 hectares of farmland but also to maintain quality of environment of the state. Government saw comparative advantages in promoting organic because use of chemical fertilizers and pesticides was still minimal by farmers and therefore it was relatively easy for them to shift to organic or improve their already known organic ways of farming. Average fertilizer use on the one lakh hectares of farmland, that Sikkim has on record, was never more than 12 kg/ha, as compared to national average of 90kg/ha.

There is a growing thinking that hilly state is increasing its dependence for food commodities, especially vegetables and fruits, on outside state supplies. It is seen as money not going to its farmers as well as questions about safety of food to consumers. Government wants to reduce dependence of the consumers of the state for vegetables / fruits on outside state supplies to help its farmers benefit from the consumer boom and discourage Sikkim becoming a consuming society, particularly when rural population starts moving away from farming increasing dependence on Public Distribution System. In the face of increasing consumer demands, it would benefit farmers and the state of Sikkim if farmers could substantially diversify farming to meet much of the consumer demands of vegetables, within the state through organic farming. It will help improve rural economy as well as provide on farm employment to so many in rural areas.

4.3 Eco-tourism

Eco-tourism is another environmental governance effort in Sikkim. This is more so as state receives a lot of tourists and a sizeable number of local people earn their livelihood from tourism and allied activities. The environmental effort in the form of ban on plastics, non bio-degradable, green mission, etc. promoted eco-tourism in state. The Tourists’ information leaflet included dos’ and don’ts which essentially solicit cooperation and support from visiting tourist to promote eco-tourism in the state through green governance. This has given boost to eco-tourism in addition to increasing green cover.

4.4 Ten minutes to earth

It is a very unique programme conceived by Chief Minister of Sikkim, Shri Pawan Chamling where everybody commits him/herself to earth for ten minutes by planting a sapling. It was launched on 15th July 2009 when the thousands of hands in Sikkim lovingly lifted the seedlings for plantation on mother earth. This initiative also supported The United Nations Environment Program (UNEP) worldwide tree planting campaign. Plant for the Planet: Billion Tree Campaign. About 6,10,000 seedlings were planted throughout the Sikkim. The idea was to plant trees equivalent to the population of Sikkim in ten minutes; one tree for one person. This was also a record that within ten minutes the plants numbering population of the State were planted anywhere. This ten minutes activity would be able to sequester about 1400 tons of carbon dioxide annually. This is the Sikkim’s own unique way of contributing to climate change mitigation. The Greener Chief Minister of India has further emphasized on important native species like quercus (oak), rhododendron, magnolia and native wild fruits to have a well-balanced forest ecosystem and preserve local biodiversity. The people of Sikkim, communities, industries, government officials, civil society organizations and religious institutions participated on a massive scale. The objective was not only to make tree planting as a Sikkimese way of life but also to send the message to the world community at large that ‘we care for nature’. The year 2010 was equally illustrous. Cumulative seedlings planted under the programme have gone up to 9,24,600. This unique programme continues with innovative themes every year and the idea ‘Each one

Organic Mission Objectives

- Prepare a clear cut implementable road map of organic farming.
- To implement the programmes of organic farming with a systematic approach to achieve the target set by the Govt.
- To develop and explore markets of Organic commodities.
- To develop linkage between the organic farmers and the market with intervention of certification agencies so as to continue the policy permanently.
- To make farming profitable, sustainable and environmentally acceptable.
plant one’ have taken deep root. Ten Minutes to Earth has become annual ritual.

4.5 Environmental policies and practices

To attain the goals of green economy, a number of environmental regulations in the form of act, rules, notifications have been passed by the State Government which have far-reaching ramifications. Important ones are mentioned below:

**Hari Kranti diwas:** Government declared 1995-96 as “Harit Kranti” year for greening Sikkim through people’s participation and also adopted the ten-year period from 2000-2010 as “Harit Kranti Dashak”.

**Eco-friendly Industrial policy:** Incentives for eco-friendly, pollution-free and green industries under State Industrial Policy 1996.

**Participatory forest management policy introduced:** Participatory forest management involving active peoples’ participation through Joint Forest Management Committees (JFMCs) and Eco-Development Committees (EDCs) in each villages (1998).

**Eco Clubs and Green fund:** Eco Clubs and Green fund instituted for Schools and Colleges (2000).

**Environmental Education introduced in Schools:** Environmental Education introduced in Schools from Nursery to Class-VIII; implemented various action oriented schemes like National Green Corps Programme, National Environment Awareness Campaign, Green School Programme (2002).

**Sikkim Ecology Fund and Environment Cess Act:** Sikkim Ecology Fund and Environment Cess Act, 2005 framed; One of the very unique Act providing for levy of cess on industries, traders and consumers for using non-biodegradable materials.

CONCLUSION

The state of Sikkim, although, endowed with rich flora and fauna and also natural environment; realizing the importance of sustainable development, initiated a number of environmental governance effort towards attaining green economy. The idea is to grow with greenery which means development without damaging nature-a fine balance between growth and natural balance. Given the effort, initiatives and the people participation; Green economy for the state may not be a distant reality, provided the policies are practiced and pursued vigorously with right earnestness by all the stakeholders.

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CONSERVATION OF BIO-RESOURCES VIS A VIS SUSTENANCE OF LIVELIHOOD

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Abstract: Since the publication of “Our Common Future” much emphasis has been given for long term sustainability throughout the world. The sustainable development refers to the judicious management of the resources so that it can meet the needs and aspirations of the present generation without jeopardizing its potential to meet the needs and aspirations of the future generation. Even though the proposition seems to be simple, achieving sustainability in its real sense is a difficult task. The ever increasing population, changing life style and increase in the aspirations of the people are the major reasons behind resource over utilization and environmental pollution. In the days of globalization and open market, rise in the trends in consumerism and life style are always expected. At that situation maintaining the potentials of the resources for future generation and managing environmental problems for long term sustainability are difficult tasks. Therefore, much attention is now being given on different approaches for achieving sustainability. Some of them include: development and utilization of alternate sources of energy; giving much emphasis on renewable sources of energy; developing strategy for eco-friendly disposal of industrial wastes; recovering wealth out of waste; upgrading the technology for reduction in emission; approaches for effective dematerialization etc.

Among the different environmental problems, loss of biodiversity is an important one. A rich biodiversity is always essential for the sustenance of this biosphere. At many places there are certain bio-resources which are under tremendous pressure due to much dependence of the local people on it for their livelihood. The local people are very much dependent on these resources as a result these are over utilized and are on the verge of their extinction. For conservation of these species, if restriction will be imposed on the uses of these species then that would adversely affect the economic condition of the people and they will slip further deep into their poverty. Under such situation, it is now highly essential to identify these bio-resources on which the economic conditions of the local people are very much dependent. One such bio-resource is mud crab. The two known species of mud crab that are available at Odisha coast are Scylla serrata and Scylla tranquebarica. The mud crabs that are available in the markets of Odisha coast are coming from wild catch only. In a personal interview it was reported by many fishermen, those who very much depend on mud crab catching for their livelihood, that they are not getting adequate catch now a days as they were used to get 10-15 years back. This clearly indicates that there is a declining trend in mud crab population in the wild. This has also adversely affected the economic condition of the people. But there is always a great demand of mud crab in the market. Thus, the species is under tremendous pressure and if the present trend of catching from wild would continue for another 10-15 years then perhaps the existence of this species would be in danger. Therefore, for conservation of the mud crab, to sustain the livelihood of crab catchers and to cater the market popularization of mud crab aquaculture is highly essential. Even though in South mud crab aquaculture has already been popularized, no significant step has been taken so far in this regard, either from Government sector or from NGOs. There are many such bio-resources throughout the world which are under tremendous pressure because of the direct dependence of the people for their livelihood. Identification of such bio-resources and formulation of effective strategy for their conservation are highly essential so that the resources would maintain their potential to cater the future generation without affecting the livelihood of the people directly depending on the resource. A coordinated effort from Government sectors and NGOs is highly essential for this.
COLLABORATIVE ADAPTIVE MANAGEMENT FOR LOCAL RESILIENCE:

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Prescriptive Theories to Address the Empirical Insights of the IAD, Using Gangtok India as an example

INTRODUCTION

The need to engage local communities in the management of their own resource pools is increasingly recognized in various literatures, and in different contexts around the world. Local institutions can and do provide an important alternative to the traditionally considered duality of the market and governments. Despite increasing recognition of the important role of local institutions that encapsulate all stakeholders, the state of the prescriptive theory and practice around how such institutions can be fostered is relatively weak. The emphasis of this paper is on moving the theory building around institutions and resource management from the descriptive to the prescriptive, proposing a model of how local resource management institutions can be fostered. The aim is to advance the theory on how local communities can manage complex problems in practice, acknowledging that institutions are important and hypothesizing one way in which they can be fostered.

The model introduced focuses on collaborative and adaptive local governance systems involving a range of stakeholders - henceforth called collaborative adaptive management (CAM). CAM provides a set of tools for improving the robustness of local planning and decision-making processes, furthering sustainability objectives by creating strong local institutions. It helps communities to develop institutional arrangements that approximate Ostrom’s (1990) design principles.

This paper examines the role of institutions and possibilities for CAM as a driver of positive change using land degradation in the city of Gangtok, India, as a case study. Gangtok faces significant challenges as a growing city in a very mountainous and earthquake and landslide prone region. Frequent and gross violations of land use laws are compounding problems by degrading the slopes and preventing proper drainage. Land use is not a resource in the classic sense, but does share many of the same characteristics, including the presence of significant externalities and the possibilities for severe degradation or long-term sustainability. Much can be learned from this case, and this case could, arguably, benefit greatly from attention to the current state of its institutions and how they may be harnessed for sustainable management.

THE CALL FOR STAKEHOLDER ENGAGEMENT IN THE MANAGEMENT OF RESOURCES

The importance of deep and meaningful stakeholder engagement in decision making, including around the management of natural resources, is increasingly recognized across sectors, disciplines and geographic regions. Stiglitz (1998, 17) asserted in his Towards a new paradigm for development: strategies, policies and processes Prebisch Lecture that ownership and participation by the people for whom development is made is essential, stating that "institutions, incentives, participation and ownership can be viewed as complementary; none on its own is sufficient". North (1992) adds that cognitive models or belief systems have a significant role to play in institutional change. Brett (2000, 800) argues that "developmental successes or failures will depend on the extent to which important social groups and movements can be mobilized to fight for progressive social change". Simon (1997) asserts that there is a new thrust on localism, traditionalism with emphasis on local vitality and social cohesion. There is movement away from universalism or "one hat fits all" theories as espoused by Escobar. Pieterse (1998) asserts that "development is becoming more oriented towards local actors. Participation is increasingly a threshold condition for local development".

Stakeholder-driven processes are necessarily - and appropriately - tailored to the local context, taking stock of the broader institutional environments in which they operate. Rodrik (2008) notes that the 'best-practice' approach is grounded in a 'first-best' mindset, which presumes that the primary role of institutional arrangements is to minimize transaction costs in the immediately relevant domain without paying attention to potential interactions with institutional features elsewhere in the system and would, therefore, not work. He argues that the institutional landscape, particularly in developing economies, requires a 'second-best' mindset. There cannot be a normative standard or design of a generalized...
kind of institutional framework that would work in all situations for all countries and in all contexts. It would be expensive and may even backfire. Hence a generalized institutional reform agenda would not work. In a similar vein, Evans (2004) argues for a new approach of "participatory development", as seen in Kerala, India and Porto Alegre, Brazil, suggesting that the same old blueprint approach to institutional change in developing countries to promote growth will not work. Though institutions are important for growth, the kind or type of institution that would promote this growth would vary from context to context. Munir (2002), in a brilliant analysis of a case that is also in the Indian sub-continent, argues that although less obvious in their influence, normative and cognitive institutions are no less important than the relatively more visible regulatory institutions. Steenstra (2009) examined how indigenous knowledge, cultural and social relationships and social, cultural and economic wellbeing issues have to be taken into account in natural resource management. He advocates for a multi-cultural approach that evaluates projects against local preferences - sometimes it is privatization that works, whereas in other cases it is co-management.

STUDYING MANAGEMENT THROUGH THE INSTITUTIONAL ANALYSIS AND DEVELOPMENT FRAMEWORK

Work on institutions over the past 25 years has expanded our understanding of how and why community engagement is important. It has demonstrated that complex systems can be managed via institutional arrangements far beyond the classic market-state dichotomy. Ostrom's (1990; 1994; 2010) Institutional Analysis and Development (IAD) framework (figure 1 below) provides a lens through which empirical case studies can be conducted, examining how local communities around the world manage common-pool resources sustainably. Under the IAD framework, policy processes and outcomes are assumed to be influenced, to some degree, by four types of variables external to individuals: (1) Attributes of the physical world; (2) attributes of the community within which actors are embedded; (3) rules that create incentives and constraints for certain actions; and (4) interactions with other individuals (Ostrom, Gardner and Walker 1994).

![Figure 1 - The Institutional Analysis and Development (IAD) framework](image-url)

External variables: Source: Ostrom 2010, 646

The 'action arena' is the physical and social space in which "individuals interact, exchange goods and services, engage in appropriation and provision activities, solve problems, or fight" (Ostrom, Gardner and Walker 1994, 28). Individuals need to make decisions around which actions they will take based on the information they have about the positive and negative consequences of each option. An actor is the individual - or group functioning as a corporate actor - that takes action and is characterized by four features: "(1) the preference evaluations that actors assign to potential actions and outcomes; (2) the way actors acquire, process, retain, and use knowledge contingencies and information; (3) the selection criteria actors use for deciding upon a particular course of action; and (4) the resources that an actor brings to a situation" (Ostrom, Gardner and Walker 1994, 33).

Ostrom defines 'rules' as statements about what actions are "required, prohibited, or permitted and the sanctions authorized if the rules are not followed" (Ostrom, Gardner and Walker 1994, 38). Rules are created by humans and are often the target of attempts to solve problems - that is, the solution applied to a problem is often to change the rules with the hope that new outcomes will emerge. The physical world varies from setting to setting and context to context. Other elements include the size of the resource pool, the temporal and spatial variability of resource units, and the current condition of the resource pool (Ostrom 1990, 197).

Finally, the community is an important part of the context that influences individual actions, including things like "generally accepted norms of behavior, the level of common understanding about action arenas, the extent to which preferences are homogeneous, and distribution of resources among members" (Ostrom, Gardner and Walker 1994, 45). The IAD framework is multidimensional in that it describes three levels of action: operational, collective choice, and constitutional choice (Kiser and Ostrom 1982; Ostrom, Gardner and Walker 1994).
At the operational level, day-to-day activities that impact the world directly are considered. At the collective choice level, decision-makers create rules to impact and influence operational level activities. At the constitutional level, decision-makers determine how the selection of collective choice participants will be done and the relationship among members of the collective choice body (e.g., voting rules, agenda setting power). In essence, constitutional choice outcomes affect collective choice decision-making, which, in turn, affects operational level activities in the action space of the actors. Actors may move among the different levels, seeking their best outcomes within a given set of rules or attempting to change collective or constitutional choice rules to their advantage (Schlager and Blomquist 1996).

What are institutions?
Adding to Ostrom's IAD framework, it is crucial to consider the various informal and enforcement rules that exist in the action space or context, which influence the various actors and stakeholders. The informal institutional trust within society, and between a given society and their government, could be a very important factor as well. At a broad level, institutions have been categorized as formal and informal. Many of the institutions operating at the local level are of the informal variety, based on values, belief systems, traditions and religious and cultural frames and models. Douglas North (1991, 97) defines institutions as "the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights)". North's definition is based more on the game-theoretic model of incentives and disincentives lying behind the expression of human choice and preferences, but he does acknowledge the social construction of human instrumental rationality to some extent. Organizational theorists like Scott (1995, 48) have a slightly broader conception:

- Institutions are social structures that have attained a high degree of resilience.
- Institutions are composed of cultured-cognitive, normative, and regulative elements that, together with associated activities and resources, provide stability and meaning to social life.
- Institutions are transmitted by various types of carriers, including symbolic systems, relational systems, routines, and artifacts.
- Institutions operate at multiple levels of jurisdiction, from the world system to localized interpersonal relationships.
- Institutions by definition connote stability but are subject to change processes, both incremental and discontinuous.

Barley and Tolbert (1997) define institutions as "shared rules and typifications that identify categories of social actors and their appropriate activities or relationships. " By advancing such a definition of institutions, they made no assumption about the identity of the social actors. They may be individuals, groups, organizations, or even larger collectives. While the neo-institutional economists understand institutions as more of a regulative entity - hence 'rules of the game' as defined by North (1990) - the sociologists would like to look at institutions at the normative and cultural-cognitive level. The political scientists look at institutions more from a power and interest perspective, as have the organizational institutionalists (DiMaggio 1988; DiMaggio and Powell 1991).

For the purposes of this paper, we take all of the above conceptions of institutions into account, believing that they subsume the formal and informal, the economic and the non-economic, the regulatory and the normative, and the discernible and the cognitive understandings and variants. We assume that institutions are complex structures that play an important and multifaceted set of roles in individual and group decision making.

THE FRUIT OF IAD: OSTROM'S DESIGN PRINCIPLES

Empirical analysis using the IAD framework has yielded important insights into how local institutions successfully manage common pool resources. Despite concerted attempts to do so, this analysis has not generated a concrete set of rules that communities must follow in order to successfully manage resources (Ostrom 2010). The failure to do so reflects the complexity within and variety among the institutions that have emerged in different places around the world. A set of more general design principles — or 'best practices' - that are typically reflected in the local institutional frameworks that are successfully managing resource pools have, however, been identified.

Ostrom's (1990) design principles, as reformulated by Cox, Arnold and Villamayor Tomás (2009), are (Ostrom 2010, 653):

1. User Boundaries: Clear and locally understood boundaries between legitimate users and nonusers are present.

2. Resource Boundaries: Clear boundaries that separate a specific common-pool resource from a larger social-
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1. **Ecological system are present.**

2. **A. Congruence with Local Conditions:** Appropriation and provision rules are congruent with local social and environmental conditions.

3. **B. Appropriation and Provision:** Appropriation rules are congruent with provision rules; the distribution of costs is proportional to the distribution of benefits.

4. **Collective Choice Arrangements:** Most individuals affected by a resource regime are authorized to participate in making and modifying its rules.

5. **A. Monitoring users:** Individuals who are accountable to or are the users monitor the appropriation and provision levels of the users.

6. **B. Monitoring the Resource:** Individuals who are accountable to or are the users monitor the condition of the resource.

7. **Graduated sanctions:** Sanctions for rule violations start very low but become stronger if a user repeatedly violates a rule.

8. **Conflict Resolution Mechanisms:** Rapid, low cost, local arenas exist for resolving conflicts among users or with officials.

9. **Minimal Recognition of Rights:** The rights of local users to make their own rules are recognized by the government.

10. **Nested Enterprises:** When a common-pool resource is closely connected to a larger social-ecological system, governance activities are organized in multiple nested layers.

A meta-analysis of more than 100 empirical studies testing these design principles, conducted by Cox, Arnold and Villamayor Tomas (2009), found that they are present in most successful cases of community-level common pool resource management and absent in most unsuccessful cases.

**From empirical analysis to prescriptive institutional design**

The important work done on institutions by Ostrom (1990; 2010) and others is largely empirical in nature, exploring a wide range of cases to provide a rich appreciation of how communities can and do manage common pool resources. Important work has yet to be done in taking these insights and developing prescriptive theories around how successful institutional regimes can be fostered in practice. Ostrom calls for the advancement of this theory when she states that (2010, 665): "Extensive empirical research leads me to argue that [...] a core goal of public policy should be to facilitate the development of institutions that bring out the best in humans". As noted previously, Ostrom did not intend for her design principles to serve as concrete blueprints for managers and resource users, suggesting ranges of conditions that would satisfy the principle rather than specific rules (Cox, Arnold and Villamayor Tomas 2009). Still, they can serve as general goals or guideposts when interventions are being made to support the development or maturation of local institutions. Advancing the normative theory and state of practice around which interventions will help communities to approximate Ostrom's design principles is a logical next step for researchers and practitioners. This is the challenge that we - in an admittedly provisional and minor way - take on with this paper.

We forward collaborative and adaptive local governance systems involving a range of stakeholders - henceforth called **collaborative adaptive management (CAM)** - as a set of tools for improving the robustness of local planning and decision-making processes, furthering sustainability objectives by creating strong local institutions. It must be noted that fostering institutions is not an easy task. Gibson, McKean and Ostrom (2000) conclude that self-governing institutions are difficult and costly to create and maintain. They are complex phenomenon that cannot be simply created or altered by applying a standardized method. They are also stable by nature, making change difficult to foster. North (1990) cautions that institutional change is thus overwhelmingly incremental. Proactively intervening as an external agent is even more challenging, as it is impossible to acquire a complete understanding of the complexity of the institutional environment; those directly involved must actively engage in institution-building in order for the effort to succeed.

These challenges make CAM all the more appropriate. CAM addresses two key problems common to coupled human-environment systems (CHES) while respecting the nature of institutions. The first problem is that systems are dynamic in nature, constantly changing in seemingly unpredictable ways. This unpredictability is due to the sheer range and complexity of forces acting upon them. Institutions may tend towards stability in many situations, but the dynamic nature of most CHES requires that they be somewhat adaptive. CAM is an inherently iterative process, respecting the incremental nature of institutional change rather than attempting drastic shifts or allowing for systemic stagnation. That is, CAM can help institutions to maintain the stability necessary for their own survival while facilitating the responsiveness necessary in light of ongoing systemic change.

Second, on a related note, it is virtually impossible to gain a complete understanding of
most CHES. Properly structured, CAM regimes can provide long-term frameworks for institutional development and maintenance. CAM systems are appropriate because they do not produce one-off decisions, instead facilitating contingent and iterative streams of decisions interspersed with ongoing monitoring so that the management regime can respond as the system changes and new knowledge emerges (Holling 1978).

In general, we believe that CAM processes can foster institutional arrangements that approximate Ostrom's (1990) design principles. CAM particularly excels in the areas of stakeholder engagement, mediation and adaptive management.

STAKEHOLDER ENGAGEMENT

The successful management of resources by those directly using them is a central theme of Ostrom's work. At least two of Ostrom's (2010) design principles directly relate to stakeholder engagement in decision-making. The third principle - 'collective choice Arrangements' - suggests that, in successful regimes, those impacted have the opportunity to participate in the rule-making process. The seventh principle - 'minimal recognition of rights' - stipulates that governments must acknowledge the rights of stakeholders to make rules. CAM systems are responsive not only to new information, but also inclusive of the knowledge and interests of the various stakeholders in any given CHES. Stakeholders bring a wealth of local knowledge on the system.

The important corollary question tackled in this paper is: How can meaningful stakeholder engagement that leads to implementable agreements be fostered? CAM fosters stakeholder engagement by methodically enumerating stakeholder groups and providing a powerful framework for their engagement in decision making.

MEDIATION

Any set of stakeholders assembled for decision making around the management of a local resource are almost certain to have conflicting interests, which need to be acknowledged and mediated. The sixth design principle - 'conflict resolution mechanisms' - suggests that effective and efficient methods for internally dealing with disagreements among stakeholders at the local level are necessary.

The corollary question is: How can what Ostrom (2010, 653) typifies as "rapid, low cost, local arenas [...] for resolving conflicts among users or with officials" be created and maintained? We believe that CAM provides for effective mediation by, among other things, promoting the use of neutral facilitators that help stakeholders work through their disagreements.

ADAPTIVE MANAGEMENT

The design principles suggest that a balance between order and flexibility is key. Stability is important to the maintenance of successful management systems, but they must also be responsive to change (Cox, Arnold and Villamayor Tomas 2009). Design principles 4A and 4B - monitoring users and monitoring the resource - imply an element of adaptivity in successful management regimes (Ostrom 2010). Rather than establishing a single set of norms and rules around usage, the condition of the resource is evaluated on an ongoing basis to ensure that long-term sustainability is maintained. The behavior of users is also monitored to ensure compliance and identify changing patterns of use.

In a similar vein, Turner et al. identify adaptive capacity - that is, "the flexibility of ecosystems, and the ability of social systems to learn in response to disturbances" (2003, 8075) - as a key variable in the resilience of CHES. Adaptive capacity is particularly important in the context of highly dynamic CHES, including those experiencing climate change-related perturbations. The important corollary question that this paper addresses is: How can ongoing, adaptive regimes best be maintained and supported? CAM is an inherently adaptive process, promoting ongoing learning and decision making rather than one-off decisions.

CAM FOR LOCAL INSTITUTION BUILDING

To those familiar with both CAM and IAD, the idea of associating the two may require a significant leap in logic. IAD is a framework for empirically exploring how communities around the world can and do play a central role in sustainably managing common pool resources (Ostrom 2010). The IAD framework leads Ostrom (2010) to forward a model of 'polycentric' systems of governance in which local institutions play an important role, rejecting the notion that governments and markets are the only ways in which resources can be managed. In apparent constrast, CAM is an approach to resource management that is typically implemented by federal agencies in the United States (Williams, Szaro and Shapiro 2009).

We counter that CAM can and should be about fostering local institutions for resource management. While many efforts have fallen short in practice, CAM claims to revolve around genuine stakeholder engagement in decision making (Lee 1999; Williams, Szaro and Shapiro 2009).
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2009; Susskind, Camancho and Schenk 2010). Much more can be done to move CAM far beyond the traditional model of simply consulting stakeholders to fostering institutional regimes in which the range of stakeholders are directly engaged in management. We provide some initial ideas on how this agenda may be advanced below.

It is also noteworthy that Ostrom's (1990; 2010) call for the recognition of the importance of local institutions is not in any way a rejection of the importance of government, as the term 'polycentric' indicates. In fact, her seventh design principle - "Minimal Recognition of Rights" - suggests that strong government agencies must exist at higher scales to recognize and protect local institutions (Ostrom 2010). Design principle eight - "Nested Enterprises" - also suggests that government can play the central role at other scales.

What is Collaborative Adaptive Management (CAM)?

CAM certainly cannot be considered a widely adopted approach to natural resource management, but has been implemented in a handful of cases across North America (see Collaborative Adaptive Management Network [CAMNet] 2010). These range from Everglades restoration in Florida to the Adaptive Harvest Management system for setting nation-wide duck hunting quotas each year (CAMNet 2010). Similar approaches have also been applied elsewhere in the world under other banners (see Pierce Golfer 2005 on 'adaptive collaborative management', for example). Exactly what qualifies as CAM is a somewhat contested concept. Some consider any adaptive management regime that involves cooperation across a traditional departmental boundary to be CAM, while others subscribe much more rigorous criteria for stakeholder engagement and are critical of existing efforts for falling short (Lee 1999; Susskind, Camancho and Schenk 2010). For this paper, we favor an interpretation that strongly emphasizes the collaborative element, focusing on deep stakeholder engagement in process design and implementation.

CAM is a synonym for adaptive management to some, while a subset to others. The addition of the word collaborative emphasizes the importance of stakeholder engagement. The concept of adaptive management (AM) emerged in the 1970's, drawing upon a range of different disciplines and theories (see Rolling 1978; Walters 1986). A National Research Council book on AM in the water resources sector defines the concept as (National Research Council (U.S.) Panel on Adaptive Management for Resource Stewardship [NRC] 2004, 1-2):

[A modus operandi that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.

The NRC (2004) report goes on to caution that there is no one size fits all approach to AM, but that common characteristics include: The ongoing review and revision of objectives; the use of models of the systems being managed; the identification and evaluation of various management options; monitoring and evaluation on an ongoing basis; the means to incorporate lessons learned; and the engagement of stakeholders.

U.S. Department of the Interior (DoI) agencies, including the Bureau of Reclamation and the Bureau of Land Management, are the most prominent users of AM in the United States. The DoI's Adaptive Management Technical Guide is subsequently a reflection of the state of practice, and of the ideal practitioners aspire to achieve (Williams, Szaro and Shapiro 2009). The DoI guide prescribes the process illustrated in figure 2 below.
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stakeholders that will be impacted by or have influence over the resource management decisions made; ensuring that those stakeholders are committed to the process and able and willing to devote the resources necessary to actively participate; ensuring that stakeholders are also wining and able to devote the resources necessary for ongoing monitoring and evaluation, not just decision making; fostering agreement among all stakeholders) on the overarching scope, objectives and management alternatives; and maintaining an open and transparent process throughout (Williams, Szaro and Shapiro 2009). The second step prescribed is the identification of specific, measurable, achievable, results-oriented and time-fixed objectives for the process (Williams, Szaro and Shapiro 2009). These objectives must recognize the various social, economic and ecological values that stakeholders hold, while allowing for ongoing learning and subsequent shifts in positions. Once the objectives have been set, the next step is to identify a range of potential management actions. That is, putting all of the options that may help to achieve the previously established objectives on the table (Williams, Szaro and Shapiro 2009). Options should come from stakeholders, and be clearly enumerated to allow for subsequent research, evaluation and decision making. The next step in the Dol's process is to construct models that represent estimates of how the system will respond to the various management actions on the table; some of the relationships within each model will be well understood and generally agreed upon, while others will be very uncertain hypotheses that are highly contested among those at the table (Williams, Szaro and Shapiro 2009). It is important to include these uncertain and/or contested variables in the model, as developing better understandings of them is a core goal for any group. The fifth step is to develop and implement monitoring plans for tracking changes in the resource being managed, and other important related variables (Williams, Szaro and Shapiro 2009). It is via effective monitoring that the hypotheses factored into the models created in step four can be tested. Monitoring should focus on acquiring the best data possible, given the resources available. The next step is to decide which management actions will be implemented in practice, based on the objectives the group has established, state of the resource, and predictions yielded from the models (Williams, Szaro and Shapiro 2009). It is important to note that the management actions chosen at any point in time are only provisional, contingent upon what is learned as the system responds and conditions change. In fact, the next step, which is central to AM, is the execution of followup monitoring (Williams, Szaro and Shapiro 2009). Data is collected on how the resource, and other variables, changes in response to the management action taken. The results of the followup monitoring conducted are compared to the predictions made in the modeling stage and underlying objectives in the assessment step (Williams, Szaro and Shapiro 2009). Assessment leads to improved understanding of the system, and the ability to comparatively evaluate the efficacy of management actions taken. The final step is ongoing iteration (Williams, Szaro and Shapiro 2009). The group can loop back to any point in the decision making process, but the logical point to return to is typically the decision making stage, choosing slightly altered or completely new management actions for provisional implementation. The following steps - monitoring then assessment - subsequently repeat from there in an ongoing cycle for as long as the need to manage the resource persists, which may be indefinitely. The focus in repeating this cycle is to learn more about the system over time and enhance management accordingly.

It is important to note that AM is not appropriate in all resource management contexts. It fits best in situations with high 'uncertainty' and high 'controllability', whereas other approaches - including scenario planning and hedging - may be more appropriate in other cases (Williams, Szaro and Shapiro 2009).

Overcoming the challenges of CAM in practice

As noted previously, implementing successful CAM regimes has proven challenging in practice (Lee 1999; Williams, Szaro and Shapiro 2009; Susskind, Camacho and Schenk 2010). Many of the most promising case studies in North America have had limited success, falling short of achieving their goals completely and facing significant hurdles along the way (Innes, Connick and Booher 2007; Lee 1999; Susskind, Camacho and Schenk 2010). This is not altogether surprising, given the complex nature of the problems involved and challenges associated with significantly changing established management regimes, but does underscore the fact that success is far from guaranteed. We assert that one of the problems with AM in practice is that the collaborative element is too weak, with regimes all too easily defaulting to traditional patterns of government management with weak consultative procedures added on. When done properly, CAM offers an opportunity to foster local institutions for resource management, with government agencies as stakeholders -and perhaps final decision makers when legally necessary - but not lone drivers. CAM can provide the means for fostering
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Successful local resource management institutions that approximate Ostrom's (1990) design principles. This requires much more robust mechanisms for stakeholder engagement. Focusing on the shortcomings in the area of collaboration in particular, Susskind, Camacho and Schenk (2010, 31) suggest six 'best practices' that CAM regimes should employ to increase their chances of success:

1. Identifying appropriate stakeholder representatives;
2. Setting clear goals and involving stakeholders in developing a collaborative process;
3. Using professional neutrals when appropriate and committing to building common ground;
4. Incorporating joint fact-finding to deal with scientific uncertainty;
5. Producing collectively supported written agreements; and

These best practices, which are expanded upon below, have emerged from a wealth of experience on the part of both scholars and practitioners in a wide range of resource management settings (See Susskind, McKearnan & Thomas-Larmer 1999; Susskind, Amundsen & Matsuura 1999; Innes & Booher 2003; Innes & Booher 2010; Straus 2002; Chrislip 2002).

Similarly to Ostrom's (1990) design principles, these practices are intentionally somewhat vague, recognizing that the actual implementation of each will vary by context. Incorporating these best practices into CAM regimes is certainly not a panacea solution, but the evidence suggests that doing so increases the probability of success in managing the resource over the long term and with minimal tension between stakeholders.

**Identifying appropriate stakeholder representatives**

In all but the smallest of communities it is not realistic for everyone to be engaged in the resource management process; it is logistically impossible and many are not able or willing to invest the time. Representatives are subsequently chosen for delineated stakeholder groups. Inattention to the selection of stakeholder representatives can, however, lead to frustration on the part of, and thus opposition from, those that feel they have an inadequate stake in the process. It is important that all constituencies are identified and represented, and that those not directly at the table maintain their support for those speaking on their behalf.

**Conflict or situation assessments** are promoted in the consensus-based decision making world as a means to systemically identify the stakeholder groups and their various interests and positions before the process formally starts (Ramirez 1999; Susskind and Thomas-Larmer 1999). A common approach is to interview an initial set of stakeholders recommended by the convening agency or group and ask them to recommend others for interviewing, and so on outwards in a 'snowball' technique until the assessment team is hearing the same responses in terms of who the stakeholder groups are, who among them might be good representatives, what issues are important to each, and what positions each group seems to hold on those issues. The resulting assessment report is shared with the community for feedback and modification, and then ultimately serves as a foundation for choosing stakeholder representatives to join the process.

**Setting clear goals and involving stakeholders in process development**

AM, as outlined by the Dol, calls for stakeholder engagement in the establishment of clear objectives (Williams, Szaro and Shapiro 2009). Proceeding with unclear or contended objectives can make decision making difficult, particularly when the objectives different groups are forwarding are mutually exclusive (Susskind, Camacho and Schenk 2010). Groups will not be able to reach consensus on objectives in all cases, but AM may not be the right approach unless it is probable that consensus can emerge during the process, or that ways of meeting seemingly competing objectives may be found.

In a contentious environment with competing interests, the process of debating and settling upon objectives can be one of the most difficult steps. Collaborative processes can help stakeholders to collectively explore their underlying interests and move towards innovative agreements that meet everyone's needs. The best processes engage stakeholders from the beginning in their design and implementation.

**Using professional neutrals and building common ground**

Professional neutral facilitators can offer process expertise in collaborative planning, increasing the chances of success. Facilitators focus on creating spaces conducive to collective learning and shared decision making, supporting stakeholders procedurally as needed while maintaining substantive neutrality (Poirier Elliott 1999; Emerson et al. 2003). Each neutral brings a preferred style - some see their role as simply enforcing the ground rules while others will engage more actively, meeting with parties individually away from the table to help them explore their options and interests.

The use of external neutrals may not be desirable, or feasible, in all community-based resource management processes. It is still valuable to...
devote attention to considering who will facilitate, choosing someone that all parties respect and that is able to help the group proceed in a creative and collaborative manner.

Incorporating joint fact-finding
Learning is fundamental to most CAM processes, as it is via new information that management decisions improve incrementally over time. Information can, however, be a major point of contention, with different stakeholders bringing different data to the table to justify their own positions, and challenging the veracity of the data others bring. Progress is restricted when the battle is over which data should be used for decision making, rather than focusing on the objectives or decisions themselves.

Joint fact-finding offers an alternative method of data collection in which the participants collectively identify their information needs, agree upon the ways in which research should be conducted, select third-party researchers, and receive and evaluate the results (Ehrmann and Stinson 1999; Susskind et al. 2007). Joint fact-finding will not resolve all disputes over data and how it is interpreted, but at least offers a framework in which the disputes can be minimized, and isolated and acknowledged for deliberation. Joint fact-finding is a procedure that any community engaging in resource management can employ; even if hiring external researchers is not realistic, it is helpful to collectively establish the research agenda, identifying who will collect data and how.

Producing collectively supported written agreements
The presence of cheap talk - that is, informal communication among stakeholders - is very important for communities managing common pool resources (Ostrom 2010). Ongoing, informal dialogue provides necessary opportunities for reinforcing norms, enforcing sanctions and so on. The consensus-based decision making literature suggests that more formal written agreements are no less important (Fisher, Ury and Patton 1981). Groups should maintain records of what is agreed to at each juncture, with parties explicitly confirming their support for those records. It is much easier to confirm consensus at the time it is made than it is to hold parties to it later when the rules are being challenged.

Building long-term adaptive management capabilities
CAM involves ongoing learning and incremental improvements in resource management. This learning and improvement should go beyond the substantive to include group capacity building and process improvement (Moore and Woodrow 1999).

By maintaining a self-critical stance and openness to procedural evolution, groups can evolve in response to changes in the resource and to the emergence of new best practices. Groups can maintain this procedural adaptiveness by examining their operations on an ongoing basis. Watching for opportunities to improve and bringing them to the group is a task that professional neutrals can carry out when present.

Case Study: Land use in Sikkim, India
Gangtok is the capital of the state of Sikkim, lying in the eastern Himalayan foothills at 5,500 feet above sea level. The city is located in a seismically active region, prone to earthquakes and associated landslides. According to the Bureau of Indian Standards (BIS), the town falls within seismic zone IV (on a scale of I to V, in order of increasing seismic activity). Surface water runoff from natural streams (jhora) and man-made drains contributes to the risk of landslides, as does building and deforestation on steep slopes.

Recognizing the importance of this issue, both the federal and state governments have enacted environmental protection legislation in various relevant sectors, including land use (i.e. restrictions on new construction in certain highly vulnerable areas and limiting the maximum height of new buildings in less vulnerable areas) and forest conservation.

In this section, we first examine the extent of land degradation in Gangtok and its relationship to deviations from the statutory norms prescribed, assessing the efficacy of existing policies and mechanisms for their enforcement. We then analyze the research findings within an explicitly institutional lens, using the Institutional Analysis and Development (IAD) framework of Ostrom (1994). Finally, we explore the possibilities for alleviating existing regulatory problems by fostering community-level institutional structures that engage in collaborative adaptive management (CAM) to address non-enforcement issues and encourage learning among the population. These structures need to address the complacent view among citizens that the environment will automatically adjust to the degrading process. There are also opportunities to draw on local knowledge to build an appreciation for the long-term dangers associated with the current practices and to devise strategies that are sensitive to local needs and context.

Our research is based on an evaluation conducted by an independent agency of the Government of India, which was directed by one of the co-authors (Patnaik). The findings are contained in a report that was presented to the legislative assembly of the state of Sikkim in 2008 (Government of India 2008). The study covers the five years from 2002-
Empirical findings

Incomplete techno-legal regime

The collapse of structures is the main cause of casualties during earthquakes. The National Disaster Management Framework of India subsequently envisages that construction in seismic zones III, IV and V will meet BIS and other national building codes, involving comprehensive reviews and compliance with Town and Country Planning Acts, Development Control Regulations and Planning and Building Regulations. The framework also envisages that appropriate techno-financial regimes and capacity enhancement of urban local bodies will be put in place to enforce compliance with techno-legal regimes. The Government of India report (2008) concludes, however, that the Building and Housing Department and the Urban Development and Housing Department of Sikkim had not initiated any action to incorporate and enforce BIS codes as of May 2007, leading to the construction of unsafe buildings and rampant violation of even the existing building laws.

Enforcement issues

The city of Gangtok had approximately 6,000 buildings as of March 31\(^{st}\), 2007. From the Government report (2008), it is clear that the Urban Development and Housing Department has not maintained year-wise and zone-wise data on blue print plans approved and the actual number of buildings constructed. As a result, the Department does not have records on the establishments that have been issued trade licenses for carrying out business, nor on new water and electricity connections from the Water Security & Public Health Engineering and Energy and Power Departments. An in-depth examination of 217 cases selected at random in the study indicates that some major deficiencies are present.

(i) Inconsistency in Acts/Rules

Since Sikkim is located in Zone IV of the seismic zoning map of India, corresponding to 5.52 on the Richter scale, only lighter structure buildings of two and a half storeys or less are to be constructed so as not to disturb the land profile and minimise the damage during earthquakes. The Government report (2008) indicates that, despite this, the Urban Development and Housing Department permitted floor height limits of six (vide notification in July 1995), three (vide notification in June 2000), and five and a half (vide notification in October 2001). Besides being inconsistent, there was no scientific reason for State Government to itself violate the prescribed norms, thereby creating favourable conditions and legal backing for private players to continue with their transgressions.

(ii) Failure to restrict construction within permissible height

Notwithstanding this defect in the stipulation of maximum height the enforcement machinery of the Urban Development and Housing Department also failed to restrict the house owners to the prescribed limits as mentioned in the report and reflected in the figure 3 below:

<table>
<thead>
<tr>
<th>Seismic zone</th>
<th>Permissible height</th>
<th>Cases checked</th>
<th>Violations exceeding norms</th>
<th>Construction within limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>82</td>
<td>11 (13.41%)</td>
<td>55</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>12</td>
<td>4 (33.33%)</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>8</td>
<td>3 (37.50%)</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>1</td>
<td>1 (100%)</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>1</td>
<td>1 (100%)</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>No limits</td>
<td>111</td>
<td>11 (10.36%)</td>
<td>95</td>
</tr>
<tr>
<td>Total</td>
<td>217</td>
<td>111</td>
<td>11 (5.09%)</td>
<td>95</td>
</tr>
</tbody>
</table>

Source: Government of India 2008, 82

17 per cent of the buildings test checked violated the norms with maximum violation occurring in Zone 3 (38 per cent). There was violation of norms in 16 per cent cases where stability report was made available. In 111 (51 per cent) of cases, the Department did not mention any zone while approving BPP. These cases indicate the casual approach of the Department in allowing construction freely in violation of norms, without considering the seismic zonation and the impact of such violation on the safety of lives and property (Government of India 2008, 83). It approved BPPs without even indicating the zone.

(iii) Failure to demolish unauthorized structures

Though the legal provisions and rules authorize the Urban Development and Housing Department to demolish any construction that contravenes the provisions of the Act or the Regulation, the Government report (2008) concludes that even the existing enforcement mechanisms are failing to monitor construction and enforce restrictions. The provision of the Act prescribing penal action, including simple imprisonment of six months, is not acting as a deterrent as actors are generally certain that the government will not enforce action.

The indifference of the Department appears appalling because it is the defaulters themselves who typically apply for the regularization of their unauthorized and illegal construction by payment.
of a nominal regularization fee. While forbidding construction beyond the maximum floor heights, simultaneously providing for the regularization of unauthorized construction beyond the prescribed limit on the payment of some fees obfuscates the restrictions. Instead of acting as a deterrent, the notifications are used as an easy tool by unauthorized structure owners to easily regularize their irregular and illegal constructions by payment of nominal fees. This is clear evidence of misalignment of sanctions, leading to government failure.

(iv) Construction activities in banned areas
The Government report (2008) found that 322 water connections to newly constructed houses were provided during 2002-03 to 2006-07 in certain areas that have been declared unsuitable and unsafe for human habitation and accordingly further construction of houses in those areas had been banned.

(v) Non-adherence to BIS norms relating to seismic design guidelines
The Report (2008) indicates that, although the Department prescribed compliance with BIS norms while according approval to the BPP, it is failing to monitor the actual implementation of the conditions laid down for earthquake resistance design to be incorporated during actual construction of the buildings.

(vi) Construction on valley side of the road
The Sikkim Building Rules stipulate that buildings constructed on the valley side of the road are to have a maximum of one storey only above the road level, depending on the stability of the location and structured foundation of the building, and the total number of floors of the building is not to exceed four stories or 40 feet. The government report (2008) conducted a test check of 127 buildings constructed on the valley side in different areas and found that 75 (60 per cent) of cases are in violation. Interestingly, most of these buildings are being utilized for commercial purposes such as lodges and shops.

(vii) Provision of gully A gully is a passage or strip of land set apart of the purpose of serving as a drain or affording access to privy urinal, cesspool or other receptacle for filthy or polluted matter for municipal employees and includes the air spaces above such passage or land between two plots/buildings. As per the SikMm Building Rules 1991, where two plots/sites are joined on one side, a minimum gully of 6 feet on the opposite free site of these plots/sites is to be provided for emergency exit, ventilation, proper drainage, for containing damage to adjacent buildings during earthquake and avoidance of congestion leading ultimately to a safer environment and avoidance of land degradation. In case of detached single plots/sites, a minimum gully of 6 feet each is to be provided between the plots/sites. However, the Report (2008) indicates that 50 buildings (60 per cent of the 83 buildings test checked) had no provision for gullies between two plots. Figure 4 below provides an illustrative example.

Monitoring and evaluation
The activities leading to land degradation are not monitored centrally by any department or agency at the state level. The Urban Development and Housing Department, which is assigned responsibility for urban planning, the allotment of house sites, the construction of buildings, solid waste management, and so on failed to oversee and monitor the enforcement of the Acts and Rules pertaining to these activities. Thus, land degradation leading to increased vulnerability and loss of resilience is being caused by unrestricted constructions in violation
of seismic zoning norms, soil quality and building laws. This is exacerbated by inadequate technologic frameworks as the building laws do not prescribe stringent penalties. There is also the serious issue of misalignment of incentives and sanctions in the sense that any violation could be regularized by payment of some token fines. The imprisonment clause has never been invoked by the enforcing authority and inconsistent rules abound. The awareness generation campaign was not robust enough to create awareness among citizens, as the throwing of waste into the drains and *jhoras* continues, leading to choking and landslides. These flagrant contraventions of rules are contributing to the deterioration of the resilience of the city's fragile socio-ecological systems.

**Institutional arrangements in Gangtok**

We previously noted that we conceive of institutions in a holistic way, assuming that they subsume both the formal and informal, the economic and the non-economic, the regulatory and the normative, and the discernible and the cognitive understandings and variants. We will now explore the complex network of grass-root level institutions in Gangtok, India, which may play a role in the sustainable local management of land (the resource of concern in our case study).

In the 'action arena' of the physical and social space of Gangtok city, there are mainly five actors who are the primary stakeholders in the land use of the city - the government represented by the Building Department and the Housing and Urban Development Department; the large majority of ordinary rule-abiding and largely poor or middle-class city-dwellers; the small minority of transgressors or violators, who are typically rich and powerful (both economically and politically); the strong socio-cultural institutional fabric of churches and temples that have a strong say in matters of governance in the small city; and the non-state actors - nongovernmental organizations and other civil society organizations, including some that work in the environment space. The interactions between these five actors are illustrated in figure 6 and expanded upon below.

The ordinary city-dwellers have played no part in the framing of rules and the changes brought about in these rules through separate notifications from time to time, and have no formal and official or informal channels for putting forth complaints when violators are actually carrying out transgressions. Although they can be in the best position to monitor and provide early warnings of potential violations, they have no such legal power. There is also a feeling among ordinary city-dwellers that their voices do not matter to the official bureaucratic circles, and thus that their complaints would have no impact on the illegal and unauthorized activities under way. The socio-cultural organizations (primarily religious organizations) have a strong moral and ethical influence on the Sikkimese, but take no interest in the city's land use and environmental concerns as they think that it is the concern of government. Both the ordinary city-dwellers and socio-cultural organizations - which together constitute the largest proportion of the population and are almost nested in their interactional space as most Sikkimese are quite religiously inclined - have very little or no knowledge of the formal government laws and rules in this regard. They have no idea about the building and zoning norms and maximum heights to which buildings can be constructed. At some level, they are also quite ignorant about the negative externalities associated with such constructions on the environment and its eco-system, though they do witness, and suffer the consequences of, the landslides occurring regularly in their neighborhoods or on the roads. They typically believe that either the environment will take care of itself and adjust to the human interventions, or that their environment is naturally fragile so nothing can be done, while the development processing the form of housing has to continue. Because they are poor, and overwhelming number of ordinary city-dwellers have a tendency to look at the immediate outcomes rather than the long-term impacts of such violations though, in terms of impact, they suffer the most in case of loss of environmental resilience and increase of vulnerability in the form of increased incidences of landslides.
The NGOs and other civil society organizations, including citizen's forums and associations and some environmental bodies, do not have a strong present in Gangtok so far for historical reasons. The area was part of a strong, centrally controlled, feudal and non-democratic kingdom. There has been little outside interest in the city's environmental woes. The small size (in terms of population) of the city makes large political associations, mobilizations and congregations rather difficult. The terrain is also challenging, with landslides regularly blocking roads, making access to the city difficult.

This asymmetry of information coupled with a certain degree of indifference of the other stakeholders allows the other two stakeholders - the government and violators - to enter into unholy alliances at the level of bureaucracy and even at the political level. Legislators nullify their own laws by providing loopholes - in the form of regularizing avowedly illegal actions with the payment of small fines - or simply not enforcing the laws. Bureaucracy, and associated rent and corruption, are major problems, but it is also true that government does not have the capacity (human resource and capital) to monitor and take prompt action. This situation is exploited by violators, which actually have more information about the negative impacts of their action than any other stakeholder, but are driven more by economic gains in the absence of any socio-cultural sanction or civil society/NGO pressure. Besides, they are the least affected by the impacts like landslides because they are already rich and can easily build another house or hotel or move to another place. That is, they can withstand financial losses much more easily than ordinary city-dwellers.

Indian bureaucracy has inherited paternalistic, top-down, know-all attitudes from its colonial British past. This is true in Sikkim and Gangtok, despite the area's small size and population. The absence of a local municipal administrative set-up further compounds matters. Similarly, using Hofstede's (1980; 2001) framework, the societal culture is characterized by high power distance. The ordinary city dwellers do not like to ask questions of their government or their political representatives and the violators who, by virtue of their wealth, have high power distance from ordinary citizens. Hence the community, which is an important part of the context that influences individual actions, generally remained silent over illegal and unauthorized constructions rather than coming together to exercise collective political and social action. The absence of any formal local governance structure in the form of a municipality or corporation further aggravated their woes and lulled them into indifference. They had no process or mechanism in place for their empowerment and ownership over their land as a collective or community.

Improving the process: Implementing CAM in Gangtok

The research (Government of India 2008) suggests that the citizens of Gangtok have continued to build large concrete structures on dangerously steep slopes, often in violation of seismic zone norms and building laws. This has resulted in the loss of vital resilience in the Himalayan ecosystem, and the socio-ecological system in and round the city. The practice continues unabated due to a general shortage of land on account of increased migration from rural areas into the city and economic development.
Collaborative adaptive management for local resilience:

The problem is, firstly, that citizens are not aware of the gravity of the associated dangers, making awareness raising and learning, followed by action and advocacy, necessary. Secondly, there is inadequate enforcement of top-down policies, rules and regulations imposed from above. These rules are unidirectional and hence there is no community buy-in at present. Thirdly, there is no mechanism for reporting violations and an absence of legal provisions for community monitoring. Fourthly, there is no community ownership over the rules and regulations and over the common property that is the natural environment. As a result, violations of laws and regulations are often overlooked or treated lightly. Some attributes of the society, which is largely feudal with large power imbalances, facilitate this process.

We, therefore, posit that the command and control, top-down and formal rule-based institutional mechanism for enforcing norms may not be adequate to address this problem of loss of resilience. Despite the presence of large populations on and below the heavily degraded slopes in an earthquake-prone region which represents a ticking time bomb, affirmative action by the private sector (including citizens) has been conspicuously absent leading to a market failure situation. The Government, on its part, has also failed to enforce the norms. Though the regulatory failure can partly be ascribed to misaligned penalty (negative incentive) structures, the capacity of government to enforce the norms is also in question. This apathy on the part of both the market and the government and the individual represents a general lack of appreciation of the danger and inadequate opportunity to learn; and a related lack of stakeholder engagement in norm-setting and enforcement mechanism. Ordinary citizens are completely absent in this silo-based decision-making process conducted by government agencies. The silo approach, lack of engagement and lack of information all reflect a general lack of ownership.

In Sikkim, it is also often seen that government policy is geared more towards the management of post-disaster response and relief rather than building institutions and mechanisms for pre-disaster prevention. The robustness of the latter would form a significant part of the environmental resilience of an eco-system in question. Policies for individual and institutional learning and social capacity building have to be aggressively pursued. Basically, there is a need for all the five primary stakeholders as identified in the paper to collaborate instead of either the government or the ordinary city-dweller doing everything.

Theories of local development that would prefer that local citizens do everything may not be realistic in light of capacity issues and the strong bureaucratic tradition. Local citizens are not prepared to assume full control, nor are bureaucrats likely to give it up. The CAM methodology offers an alternative approach that can bring the disparate stakeholders to the table for a transparent process. The violators need to recognize that, by adhering to restrictions, they increase the chances of their long-term economic benefit, as a degraded environment will eventually impact them economically too. Also, they can access outside experts - either from local NGOs or even professional ecologists and environmental managers from outside the community - to help them develop more sustainable development modus operandi. This expertise is largely absent now.

The most appropriate role for the large community of ordinary city-dwellers is monitoring against transgressions. The government can do its role by providing a techno-legal framework for this kind of structure and arrangement, and their could also be legally binding and enforceable written agreements (now the agreement is only between government and the violator and both choose to ignore it and continue the violations). Advocacy and awareness can be done by both the churches/temples and NGOs. This group can also work towards improving resilience by taking on precautionary preventive maintenance work on land, making more of it available for construction purposes. This could include reforestation on slopes, and stone packing on roadsides and in vulnerable areas. The lack of communication between the ordinary city dweller and the government and the violators - which do interact with each other, though often to conspire to violate the rules and regulations - has resulted in lack of trust. Trust is a key element for CAM to succeed, and is identified by Ostrom (1990) as essential for local governance structures to give positive outcomes rather than fall into disuse. While fostering this new institutional structure, it is important to follow the best practices for a successful CAM, which share similarities with Ostrom's design principles discussed in this paper.

It is important to identify appropriate stakeholder representatives, avoiding the politicization of the process that would take place if representatives were chosen from existing political groupings. Instead, they should come from the range of substantive stakeholder groups. An open and transparent democratic process should be followed within each group. It is necessary to set clear goals as part of the process - one goal may
Collaborative adaptive management for local resilience:

be, for example, to lay out the number of hotels new permitted in a five year period, taking the tourist traffic and availability of suitable land into account. Another may be to mandated that no asset - even in the government sector - should be created that is likely to remain idle and unoccupied for most of the year. This may be a luxury that this small city has to forego in view of its fragile eco-system.

Though government could play the role of convening the other actors and their interests and place it on the table, it may be appropriate for another external organization to play this role, given the lack of trust between the government and the local, ordinary, city dwellers who have historically mistrusted government and its bureaucracy because of its record of bias and insensitivity to their actual needs and aspirations.

The government is always perceived to be on the side of the violators. A neutral actor, like an NGO or a group of university professors from outside the state, could be drafted in to mediate and steer the collaborative decision-making process.

A joint fact-finding mechanism should be instituted to deal with scientific uncertainty, the lack of trust between stakeholder, and the information asymmetry between violators and regular citizens. This should be followed-up with mediated discussions that reflect on the goals and data collected, producing collectively supported written agreements that are legally recognized by government and hence, enforceable in the courts.

Process meetings should be open and transparent and the results made public as soon as they are completed. In order to foster long-term sustainability and adaptive capacity, the group should meet regularly and maintain an open and self-critical stance both on its outputs and own structure and modus operandi.

Any CAM regime implemented in Gangtok to manage land - a resource that is locally scare, common-pool in the sense that its use is rife with externalities and currently characterized as unsustainable - would need to be developed with difference to the local context, and in concert with the relevant stakeholders. Here we have simply illustrated that a CAM approach to decision making may be an appropriate alternative to depending wholly on either markets or the government. Both of these parties seem to be failing on their own at present. **Conclusion**

Local communities can and should play an important role in the management of their natural resource pools. This paper has focused on the possibilities for moving from the descriptive - that is, acknowledging and explaining the advantages of stakeholder engagement - to the prescriptive, providing one possible approach for institution-building. The approach introduced, collaborative adaptive management (CAM), is already being used in a limited set of cases, mostly in the United States, to manage resources. CAM has not, however, completely fulfilled its promise as a viable approach for putting management in the hands of stakeholders. Should they be analyzed using Ostrom's (1990) Institutional Analysis and Design (IAD) framework, they would be found to be lacking many of the 'design principles' that are found in successful cases of local community resource management.

We believe that a new generation of CAM that focuses more explicitly on fostering and supporting local institutions does, however, offer a great deal of promise. A set of process improvements that can strengthen CAM to foster stronger institutions empowered for genuine decision making have been introduced. The city of Gangtok, India, was used as a case study to illustrate why current institutional frameworks may be insufficient, and how CAM can help.

One of the next steps moving forward will be to test the next generation of CAM as a tool for fostering local institutions capable of local resource management. In general, more can and should be done to develop and test prescriptive theories around how institutions that approximate Ostrom's design principles can be fostered.

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