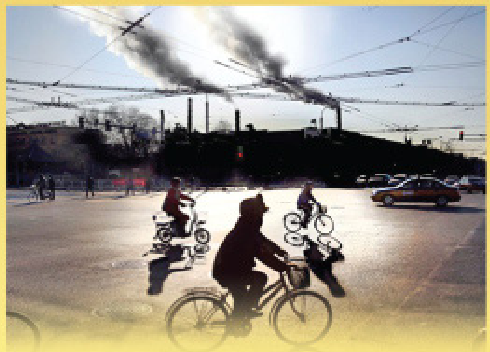
PROCEEDINGS OF THE 4th
NATIONAL SEMINAR ON

POLLUTION IN URBAN INDUSTRIAL ENVIRONMENT



Editors
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(NSPUIE-2014)

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CONTENTS

PREFACE

The book contains a compilation of selected papers presented at the 4th National Seminar on Pollution in Urban Industrial Environment (NSPUIE-2014), held in Kolkata during December 2014. Like the other three former meetings began in 2003, The Institute of Ecotoxicology and Environmental Sciences based in Kolkata organized the NSPUIE-2014 National event. After taking a great care in the compilation process, the Institute is proud to present this edited volume to our readership containing fourteen peers reviewed articles from over twenty three plus papers received at the NSPUIE-2014 National Seminar.

Environmental Ecotoxicology is a multidisciplinary field of science concerned with the study of the harmful effects of various biological and physical agents on living organisms at the population and ecosystem levels. In ecosystems, all living (animals, plants and microbes) and nonliving (air, water and soils) things are mutually interconnected and live together as a system in that environment. The sources of environmental contaminants are diverse and they are largely generated by human activities such as waste product discharge in the form of liquid, gas and fluid into the atmosphere from industrial factories, agricultural products, incinerators, sewage plants, etc. Many of these contaminants are known to devastate the ecosystems and adversely impact human health, and a substantial numbers of these pollutants are known mutagenic, teratogenic or carcinogenic substances. Furthermore, the damaging effects may not only be temporary but may also have long term effects.

In this volume, the authors address a variety of issues concerning the adverse impacts of atmospheric contaminants on ecosystems and human health. Identification, management, reduction of contaminants discharge from the sources as well as pollutants effects on environment and health are covered in certain chapters, while remediation, reutilization of waste products as well as regulations and monitoring the release of waste materials into the environment are included in other chapters.

The editors express their appreciation to the contributors for their quality work and cooperation. Gratitude is extended to The Institute of Ecotoxicology and Environmental Sciences for organizing the National Seminar at Kolkata and to Ms. Shreyasee Roy of St. Xavier's College for her help during the preparation of this volume.

Dr. Debabrata Mukherjee   Dr. Sarmila Pal   Prof. Badal Bhattacharya

30th March, 2015

Current Trends in Microextraction as a Clean up Process in Trace Analysis

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Abstract

Determination of analyte at trace levels particularly in complex matrices is a challenging task. The overall precision of the determination depends on analyte recovery in each of the multisteps during analysis. Direct measurement of trace components even through sophisticated instruments is rare and often requires a preliminary step for sample clean up, analyte isolation and enrichment. Extraction of solute to either solid or liquid phase offers a suitable option.

Extraction of analyte from the bulk is quite popular as it encompasses almost all kinds of samples. Microextraction as an improved version requires small volume of extractant/reagent compared to the sample volume. The extraction efficiency is governed by the partitioning of analyte between the sample matrix and the extractant. The more the affinity of the analyte for the extractant relative to the sample matrix, the greater is the amount of analyte extracted. Thus, quantitative extraction via equilibrium partitioning of the analyte can be achieved through microextraction.

Partitioning is controlled by physicochemical properties of the analyte, the nature of sample matrix and the extractant phase. Microextraction techniques represent an important contribution to the improvement of sample preparation performance, which especially addresses the issues of miniaturization, automation, onsite analysis, and time efficiency. In recent years solid phase microextraction (SPME) and liquid phase microextraction (LPME) are becoming much popular due to their wide applications. Several alternative approaches, such as in-tube SPME designed primarily for high-performance liquid chromatography (HPLC) have been introduced. In parallel to the development of SPME, attention has also been directed to the utility of small volumes of solvents for analytical extractions, namely liquid phase micro extraction (LPME).

Different types of microextraction techniques although available the success of any extraction always correlated with limit of determination (LOD) of the instrument used. In

order to improve LOD attention has been given to HPLC-MS, GC-MS hybrid techniques. Microextraction following green pathways always has some additional merit. Analytical protocol, efficiency and applications of green microextraction will be discussed.

1. Introduction

Design and protocol for solute estimation proceed via several steps viz. sampling, sample preparation, analysis, data treatment and finally the evaluation of the result. However, accuracy, precision and sensitivity of the method can be linked with each step. Sample preparation, is the most challenging with two main objectives; sample clean-up and enrichment/ preconcentration [1-8]. The aim of Sample Clean-up is to isolate the target analytes from matrix components which may interfere solute determination while preconcentration becomes evident for enrichment of the analytes in sample considering the LOD and sensitivity of the analytical instrument.

An ideal sample preparation technique must have the following characteristics:

1) quantitative analyte recovery with minimum sample loss
2) interfering component removal
3) simple, fast and cheap operation
4) response matching with analytical instruments
5) possibility for automation and
6) green pathway

The conventional procedure for extraction following equilibrium distribution of analyte [9] is from liquid phase to either liquid (LLE) or solid phase (SPE).

1.1 Liquid-Liquid Extraction (LLE)

Liquid-Liquid Extraction (LLE) is a versatile technique that utilizes distribution equilibrium of the analyte between two immiscible phases, generally an aqueous and an organic phase. Depending on the distribution ratio analyte can be transferred from aqueous to organic solvent. LLE commonly is used for extraction of both organic and inorganic compounds following either single or multisteps.

Ease of operation and simplicity of the method are advantages of LLE. However, consumption of large volumes of expensive and toxic solvents, emulsion formation at the interface of the two phases, difficulty in phase separations and low enrichment factor lead the analytical chemists to introduce alternative methods.

1.2 Solid Phase Extraction (SPE)

Solid phase extraction (SPE), the other popular technique is based on equilibrium distribution of analyte (both of the organic and inorganic) between solid sorbent and liquid sample. Adsorption, partitioning or ion exchange may be guiding mechanism. Versatility of SPE lies with the choice of a variety of sorbents such as silica with or without bonded organic phase, organic polymers and ion exchangers.

However, SPE has some limitations such as:

1) poisoning of the sorbent pores or surface leading diminished performance
2) proper optimization of the process leading to sufficiently large time
3) lack of proper elution behavior

It is therefore essential to improve the classical extraction techniques in terms of lower volume of solvents, fast operation and reproducible performance without compromising the analyte recovery. Development of microextraction or miniaturization of extraction techniques is the only option. The most popular among the microextraction techniques are Solid PhaseMicroextraction (SPME) and Liquid Phase Microextraction (LPME). Design and development of microextraction techniques are needed for applications to a large variety of samples.

2.1 Solid Phase Microextraction (SPME)

Solid phase microextraction requires only a small volume of extraction phase coated on some support that is mounted in a small syringe. It may be treated as a solvent free alternative method for conventional extraction techniques [10-13].

Extraction phase could be a high molecular weight polymeric liquid or a solid porous sorbent with high surface area. SPME process is used for recovery of both volatile and nonvolatile analytes, and suitable for biological or even dirty samples.

2.1.1. Influencing parameters determining SPME efficiency

A number of factors such as nature of fiber coating, time and temperature of extraction, time and temperature of desorption, salt addition, sample agitation and solution pH may influence SPME. Optimization of such factors is the key step for the success of a SPME. SPME coupled with GC, HPLC, CE and AAS yields excellent results.

2.2 Single Drop Microextraction (SDME)

In order to improve the performance of LLE, Single Drop Microextraction (SDME) was developed as a miniaturized technique of LLE under LPME. In SDME only a single drop of extraction solvent is required [14]. The limit of determination (LOD) and efficiency improves when SDME couples with GC & HPLC, AAS and ICP.

Although SDME may be treated as one of the QuEChERS ("catchers") i.e. **Qu**ick, **E**asy, **Ch**eap, **E**ffective, **R**ugged, and **S**afe method, it suffers from slow kinetics, instability and small surface area of the drop.

2.2.1 Influencing parameters determining SDME efficiency

The important factors affecting SDME are the nature of organic solvent, surface area of single drop, extraction time, agitation rate and temperature. In addition presence and nature of salt have some influence.

2.3 Dispersive liquid-liquid microextraction (DLLME)

Dispersive liquid-liquid microextraction (DLLME), an extension of LPME [15] involves a ternary solvent system consisting of aqueous sample solution, extraction solvent and disperser solvent. Extraction solvent must be immisible with aqueous sample solution and disperser solvent must soluble in both of the extraction solvent and aqueous sample solution.

Similar to SDME, again DLLME is a QuEChERS technique.

2.3.1 Influencing parameters determining DLLME efficiency

The efficiency of DLLME depends on several experimental parameters such as, nature and volume of both extraction and disperser solvent, extraction temperature, solution pH and ionic strength.

2.4 Cloud point extraction (CPE)

Cloud point extraction (CPE), is a micelle mediated operation. It utilizes phase behavior of non-ionic surfactants in aqueous solution. At a definite temperature (cloud point temperature) as phase separation occurs solute is transferred from aqueous to the micellar phase.

Trace metals can be extracted to the surfactant-rich phase usually via formation of a hydrophobic complex using an appropriate chelating agent [17-19]. CPE is considered as a QuEChERS technique with wide applicability.

2.4.1 Influencing parameters determining CPE efficiency

In CPE, factors affectingefficiency of extraction solution pH, the nature and concentration of surfactant, ionic strength (additive), equilibration temperature, incubation time and complexing agent.

2.5 Hollow fibre based liquid phase microextraction

Use of hollow fiber polypropylene membranes in liquid extraction constitutes a new kind of LPME [20]. This technique is based on the use of hollow fibers, typically made of polypropylene. This form of LPME consists of a donor phase (the sample), an acceptor phase (in the lumen of the hollow fiber) and the hollow fiber between them. Pores of the hollow fiber membrane impregnated with organic solvent served as supporting liquid membrane. The mechanism is based on solute transfer between a donor phase (the sample) and an acceptor phase (in the lumen of the hollow fiber) separated by the hollow fiber.

2.5.1 Influencing parameters determining LPME efficiency

The most important parameter is the nature and geometry of hollow fiber. Similar to other extraction system nature of organic phase, volume of donor, acceptor and organic phases, pH of donor and acceptor phases, salt addition and sample agitation time are also important.

2.6 Liquid phase microextraction with solidification of floating organic drop (LPME-SFO)

In LPME-SFO [21, 22] solvent used must be of lower density than water, low toxicity and melting point near room temperature. The sample separation is effected on solidification of organic solvent containing the sample.

The main disadvantage of LPME-SFO is in its applicability for only lipophilic solutes though it is very effective due to QuEChERS characteristics.

2.6.1 Influencing parameters determining LPME-SFO efficiency

The success of LPME-SFO requires optimization of type and volume of the organic solvent, aqueous sample volumes, the extraction time, the stirring rate, and salt addition.

3. Applications of microextraction (ME)

The use of ME for solute enrichment is an alternative to more traditional sample clean up technique [23]. The systematic performance is influenced by the experimental parameters. Thus optimization of such parameters constitutes the first step. ME techniques has been successfully employed for the preconcentration of micro amounts of several substances in different matrices, as prior step before their determinations by instrumental methods [24]. Application of ME includes both inorganic and inorganic substances. Metals, organometals, drugs, dyes, pesticides, PAHs etc. are some of the examples that can be determined via enrichment through ME as sample clean up technique. The advantages are simple, cheap, quick, efficient, and environmentally benign.

4. Conclusion

Trace level analytical determination in environmental, biological and food materials is challenging due to complex nature of sample matrix. Thus design of efficient sample preparation and clean up techniques in agreement with green chemistry is one of the most demanding fields of chemical research. Some QuEChERS microextraction as emerging techniques is discussed. The principle and efficiency determining factors are discussed. Each one has some advantages and limitations. The justice to any one lies with its selection based on the nature of sample and its matrix, concentration of analyte in the sample and obviously the goal of analysis.

5. Acknowledgment

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An Efficient and Reliable Method for Pesticide Residue Analysis in Food

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Abstract

Pesticides play a very major role in controlling the pest in the agriculture field and contributed much towards green revolution to meet the food demand in the world. However such chemicals are not green as they affect the quality of soil and water due to their long term persistence in the environment. Moreover pesticide residue retained in the crop and vegetable is a point of entry in the food chain. It is therefore highly needed to find out the amount or load of pesticide residue in water, soil and food items.

The present report describes the determination of some pesticides in water-soil-crop system using a ternary solvent system. The equilibrium partitioning of the pesticide from water to extraction-dispersive solvent mixture provides the guideline for the operation. The dispersive solvent assists transfer of pesticide from aqueous solution to the extraction solvent and sedimented at the bottom giving two distinct phases. The pesticide in the extraction solvent is then determined through coupled HPLC-spectral measurement. The efficiency, recovery and detection limit were evaluated. The method is successfully applied for pesticide residue analysis in soil, water and some vegetable.

Keywords: DLLME, HPLC-UV-Vis spectrophotometry, pesticides, vegetable.

Introduction:

In ecosystem different types of residual pesticides are usually occurring simultaneously. It is therefore of great importance to develop sensitive and efficient analytical methods to detect two or more pesticides from multi-media [1-3]. Unfortunately, most of the methods that have ever been established are only applicable to a single or a certain group of pesticide with different chemical properties. It is well known that extraction and pre-concentration of trace analytes from different samples are critical steps for the chromatographic or quantitative analyses.

Most analytical methods for pesticides analysis are based on gas chromatography (GC) with flame photometric detector,[4-7] nitrogen phosphorus detector,[8-9] or mass spectrometric detector (MS)[10-12] and high-performance liquid chromatography (HPLC) with UV detector,[13] MS detector [14,15] or diode array detector (DAD).[16-17] Capillary electrophoresis (CE) combines the advantages of GC resolution and the capability of LC for theseparation of compounds.

In comparison to the classical methods including liquid–liquid extraction (LLE),[18,19] cloud point extraction (CPE),[20] membrane filtration [21] and solid phase extraction (SPE),[22] dispersive liquid–liquid micro extraction (DLLME),[23,24] which was first reported by Rezaee and co-workers in 2006 [25] can overcome some of the above-mentioned methods limitations with the advantages of simplicity of operation, rapidity, low cost and high enrichment factor. DLLME is based on a mixture of a high-density extraction solvent, a water-miscible and polar disperser solvent. In this technique, fine droplets of the extraction solvent are dispersed into the aqueous phase when an appropriate mixture of both solvents is rapidly injected into aqueous samples. The mixture is then gently shaken, and a cloudy solution (water/dispersive solvent/ extraction solvent) is formed in the tube. After centrifugation, the fine drop of extraction solvent containing the target analytes is separated from the aqueous phase and finally determined by various analytical techniques.

In this work, we propose to develop a new method for the determination of the three pesticides in ladyfinger using DLLME as pre concentration techniques.

Experimental:

A Shimadzu UV-Vis recording spectrophotometer(model UV-2401 PC) with matched quartz cells was used for recording absorption spectra. All spectral measurements were performed using blank solution as a reference. A centrifuge (Rotofix) was used to accelerate the phase separation process. Adjustment of pH of solution was done by digital pH meter (Systronics, India: model no 335) with a combined glass electrode. A Cecil (CE 4201) HPLC coupled with UV-Vis detector was used for analysis of the solutes.

● Reagents and Materials:

Pesticides such as the insecticide [S1; 1-(6-chloro-3-pyridylmethyl)-N-nitroimidazolidin-2-ylideneamine]: CAS no 138261-41-3, fungicide [S2; bis(4-fluorophenyl)(methyl)(1H-1,2,4-triazol-1-ylmethyl) silane]:CAS no 85509-19-9 and herbicide [S3; 2-chloro-4-ethylamino-6-isopropylamine-striazine]:CAS no 1912-24-9 were obtained from Sigma Aldrich (USA). Solvents used viz. carbon tetrachloride (CCl_4), dichloromethane (CH_2Cl_2), chloroform ($CHCl_3$), acetonitrile (CH_3CN), methanol (CH_3OH) and acetones (CH_3COCH_3) were of HPLC grade (Merck, India). Other reagents used in the experiment were of the highest grade commercially available. The pH was monitored with 0.01(N) HCl or NaOH. Water was purified by using a Milli-Q system (Millipore, Bedford, MA, USA).All the solvents were filteredthrough 0.45 ìm membrane filter.

● Sample preparation:

A quantity of 20.0 g of chopped ladyfinger samples collected from the local market was accurately weighed, then homogenised by a food homogeniser, and subsequently centrifuged at 4000 rpm for 15 min. The supernatant was filtered through a 0.45 ìm membrane and diluted with equal volume of ultra-pure water for DLLME procedure with the minimum time delay.

● Extraction procedure:

In the present extraction operation 5.0 ml of aqueous sample was taken in a 10 ml screw cap glass test tube with conical bottom. A definite volume of suitable dispersive solvent (DS) was homogenised with a definite volume of extraction solvent (ES) and the mixture was quickly injected into the sample solution using a syringe. On gentle shaking a cloudy solution appeared first form fine droplets. The mixture was centrifuged for 5 min at 4000 rpm. The dispersed fine droplets of ES/$CHCl_3$ were sediment at the bottom of the conical test tube. The upper phase was withdrawn by a micropipette. The sediment phase was diluted with MeOH and run through HPLC for solute characterization and subsequent spectrophotometric determination. The enrichment factor, defined as the ratio of the analyte concentration in the sediment phase over the initial concentration, and recovery factor, defined as the fraction of solute transferred to the sediment phase [26] were determined.

Principle of DLLME:

Dispersive liquid–liquid micro extraction is a miniaturized LLE using micro liter volumes of extraction solvent, which isbased on the equilibrium distribution process of the target analytes between sample solution and extraction solvent. Distribution coefficient (*K*) is defined as the ratio between theanalyte concentration in extraction solvent and sample solution. Dispersive liquid-liquid micro extraction is only applicable for the analytes with high or moderate lipophilic property ($K > 500$) and not fit to those neutral analytes with high hydrophilic property. As for the acidic or alkaline analytes, distribution coefficient could be increased by controlling the pH value of sample solution, making the analytes existing in nonionic state. The enrichment factor and extraction recovery are calculated as follows:

The enrichment factor (EF) may be defined as the ratio of analyte concentration in the sediment phase (C_{sed}) to the initial concentration of the analyte (C_o) as,

$$EF = C_{sed} / C_o \qquad (1)$$

The recovery factor (RF) is defined as the fraction of solute transferred to the sediment phase, and is expressed in percentage as,

$$RF = (W_{sed} / W_O) \times 100 = (C_{sed} V_{sed} / C_O V_O) \times 100 \qquad (2)$$

Where, V_{sed} and V_o are the volume of sediment phase and aqueous phase, respectively. W_{sed} and W_o are the amount of solute in sediment and aqueous phase respectively. On combining equation (1) and (2) EF and RF can be correlated as,

$$RF = EF\,(V_{sed} / V_O)\ 100 \qquad (3)$$

Parameters affecting extraction efficiencies of DLLME:

The extraction efficiency for the target analyte by DLLME is influenced by many factors, such as the kind of extraction and disperser solvent, and their volume, the extraction time,and salt addition.

● Selection of ES-DS combination:

The selection of an appropriate extraction solvent is amajor parameter for DLLME process. The extraction solvent should satisfy two conditions: one is the higher density of the extraction solvent than that of water, which makes it possible to separate extraction solvent from aqueous phase by centrifugation; the other is the extraction capability of extraction solvent for the compounds of interest, good chromatographic behavior, and low solubility of extraction solvent in water. Halogenated hydrocarbon, such as carbon tetrachloride (ES_1), dichloromethane (ES_2) and chloroform (ES_3) are usually selected as extraction solvents because of their high density. The result shows that the best extraction efficiency for pesticide residue analysis was obtained when $CHCl_3$ was used as extraction solvent.

Disperser solvent is soluble in extraction solvent and should be miscible in water, thus enabling the extraction solvent to be dispersed as fine particles in aqueous phase to form a cloudy solution (water/dispersive solvent/extraction solvent). In such a case, the surface area between extraction solvent and aqueous phase (sample) can be infinitely large, thus to increase the extraction efficiency. The commonly used disperser solvents include acetonitrile (DS_1),methanol (DS_2) and acetone (DS_3). At optimized condition a typical experiment gives new idea about this whole experiment. From figure 1 we conclude that in case of herbicide extraction, the ES_3-DS_2 combination gives better result than rest.

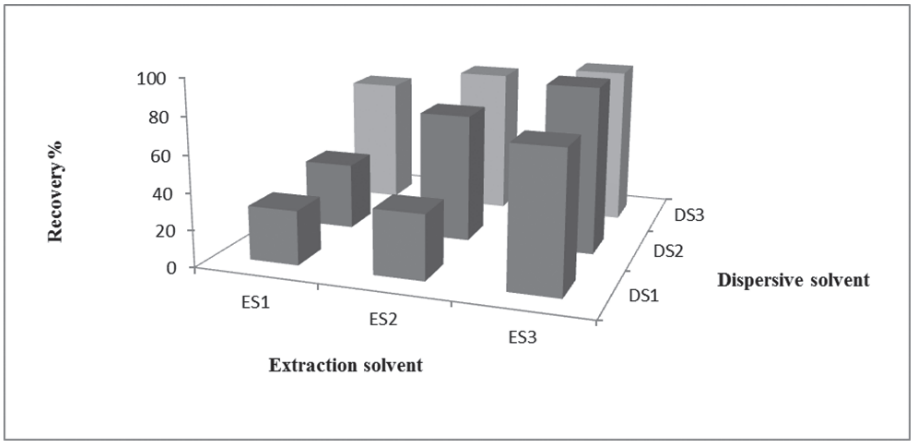

Fig 1. Effect of extraction solvent and dispersive solvent on the recovery of herbicide at optimum condition.

● Effect of extraction solvent volume:

The extraction solvent volume has great effect on the enrichment factor. With the increase of the extraction solvent volume, the final organic phase obtained by centrifugation is increased, resulting in a decrease of the concentration of the target analyte in organic phase. Although the extraction recovery remains almost constant, the enrichment factor will be decreased, leading to a decrease of the sensitivity of the determination for the target compounds. Therefore, the optimal extraction solvent volume should ensure both the high enrichment factor and the enough volume for the subsequent determination after centrifugation. In general, 0 1–0.9 ml of extraction solvent is selected. Figure 2 indicate that the extraction efficiency increased by increasing the volume of ES_3 then decreased further increasing of its volume. Thus the optimum extraction solvent volumes are 0.7 ml for insecticide, fungicide and 0.9 ml for herbicide extraction.

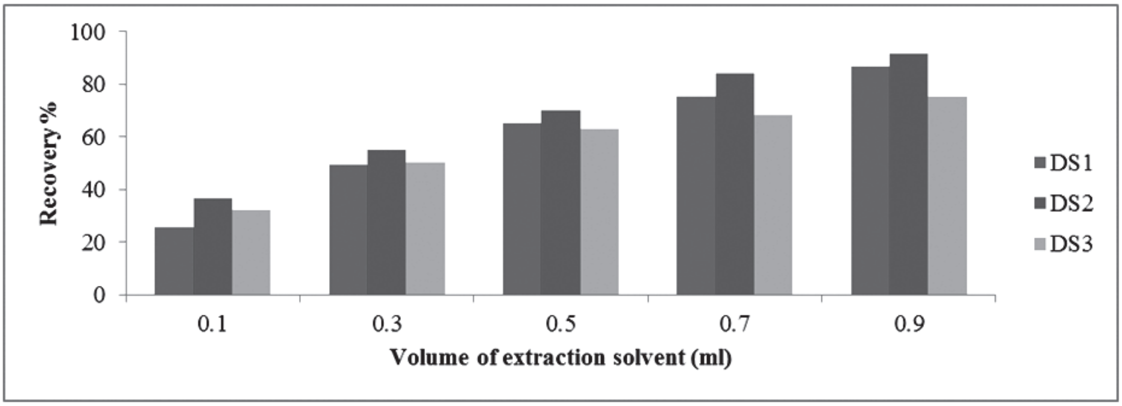

Fig 2.Optimization of volume of extraction solvent in herbicide extraction.

● Effect of dispersive solvent volume:

The disperser solvent volume directly affects the formation of the cloudy solution (water/dispersive solvent/extraction solvent), the degree of the dispersion of the extraction solvent tin aqueous phase, and subsequently, the extraction efficiency. Thus the optimum dispersive solvent (DS_2) volumes are 0.3 ml for insecticide, fungicide and 0.1 ml for herbicide extraction in this DLLME method. Here we show (Fig 3.) result of herbicide extraction with variation of different extraction solvent.

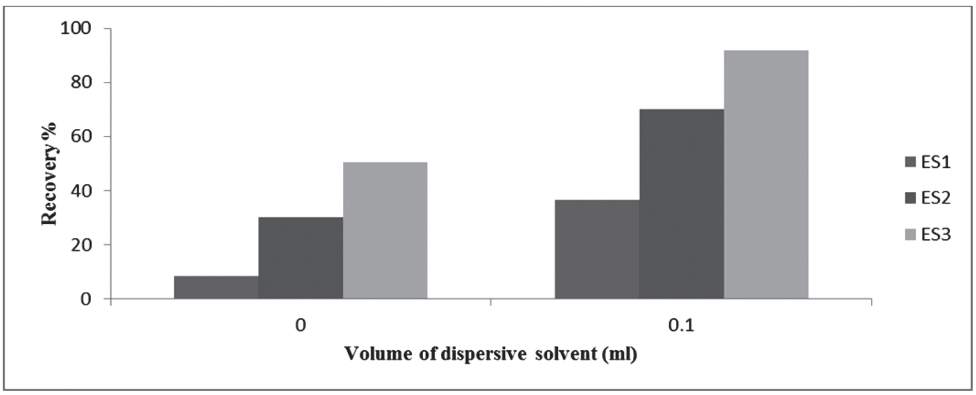

Fig 3. Optimization of volume of dispersive solvent in herbicide extraction.

● Effect of extraction time:

In DLLME, extraction time is defined as the interval between injecting the mixture of dispersive solvent and extraction solvent and centrifugation. It is revealed that extraction time (centrifugation time) may have some effect on the extraction efficiency of DLLME. The reason for this is that the extraction solvent can be evenly dispersed after the formation of the cloudy solution, the transition of the analyte from aqueous phase (sample) to extraction phase can be very fast, and the equilibrium state can be subsequently achieved very quickly, resulting in a very short extraction time needed for equilibrium. Short extraction time has a remarkable advantage of the DLLME technique. An unnecessarily long centrifugation should be avoided because the centrifugation motion generates heat, which can cause the phase separation to dissolve. Form this experiment we observed that with variation of extraction solvent at fixed dispersive solvent give different performance in case of all pesticide extraction. The optimum extraction time is 5min shown in (Fig 4.) when DS_2 is fixed.

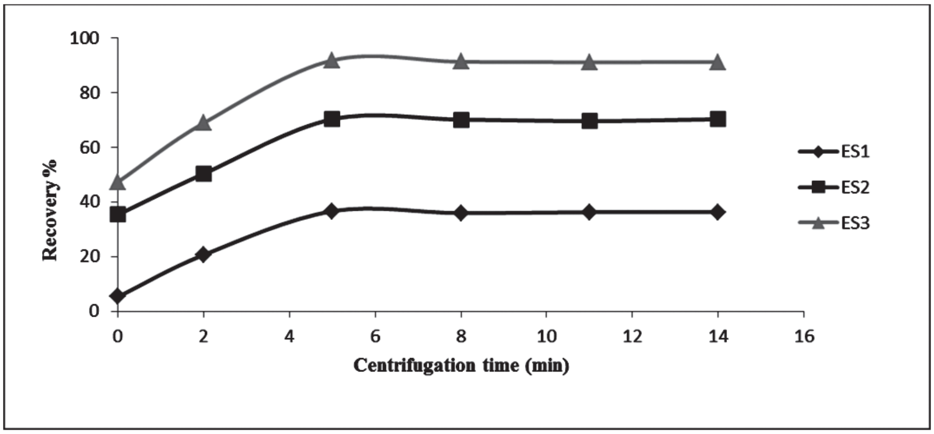

Fig 4. Effect of centrifugation time on the extraction recovery of herbicide with variation of extraction solvent at fixed dispersive solvent.

● Effect of pH:

pH is the key parameter for sample solution affecting both the extraction efficiency and DLLME selectivity. The sample must be adjusted to a desired pH where the analytes were uncharged, thus the uncharged molecular form analytes can be extracted into extraction solvent droplet effectively. The pH of the samples was adjusted with 0.01 (N) NaOH and HCl to ensure that the neutral molecular forms of the analytes are present prior performing the micro extraction step. The pH of the aqueous solution used in DLLME procedure was investigated in the rangeof 2.0-12.0. It demonstrates that the proposed DLLME method markedly improved the detection sensitivity compared with other techniques. The optimum pH was found to be 6,10and 5 respectively for insecticide, fungicide and herbicide respectively.

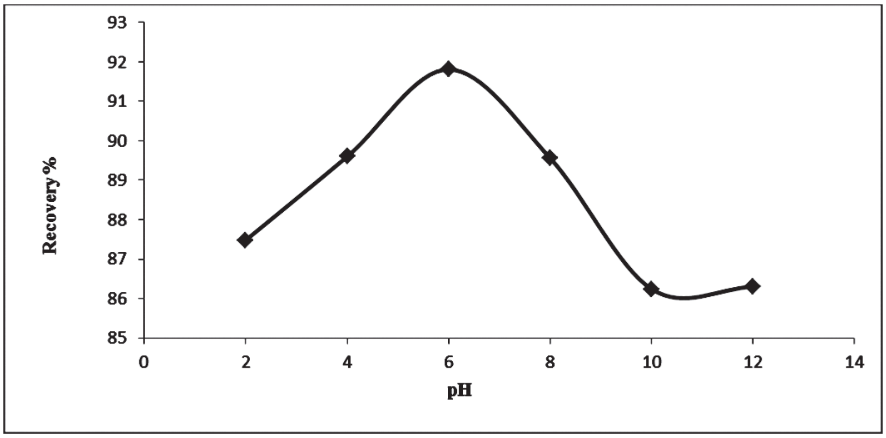

Fig 5. Effect of pH on the extraction recovery of herbicide extraction.

● Effect of salt addition:

The solubility of the target analyte and organic extraction solvent in aqueous phase are usually decreased with the increase of ionic strength, which is favorable for reaching high recovery. However, at the same time, the obtained volume of organic phase is increased, resulting in a decrease of both the target analyte concentration and the enrichment factor. The optimized NaCl %(w/v) are 5% for insecticide, fungicide and 2.5% for herbicide (Fig 6) respectively.

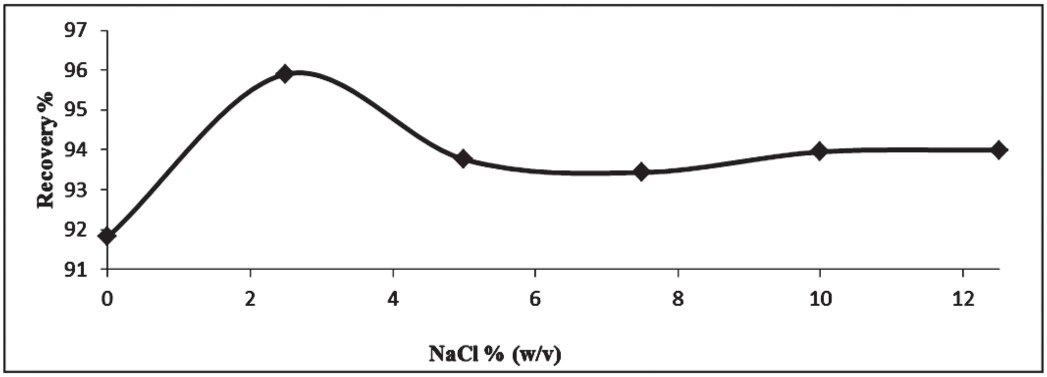

Fig 6. Influence of ionic strength on the performance of DLLME for herbicide extraction.

● Analytical characteristics and method validation:

Important parameters such as linearity, LODs, and precision were determined to evaluate the method performance. A series of working solution containing each of the three pesticides at different concentration levels were prepared for the establishment of the calibration curve. Each concentration level was processed by the DLLME method and injected three times .A blank sample of ladyfinger extracts was also processed and no pesticide was detected. As shown in Table 1, the linear response was observed in the range of 0.1-100ìgL^{-1},with the correlation coefficient (r) ranging from 0.9924 to 0.9981. The LODs (S/N=3) of the three pesticides were ranged in 0.05-0.1ìgL^{-1}, and the enrichment factors ranged 613 -742.5, with the relative standard deviations (RSDs)varied from 2.1% to 4.2%.

Table 1. Linear range, precision and LOQ of proposed method.

Analyte	Linear range (ìgL^{-1})	Correlation coefficient (r)	Recovery (%)	Precision (RSD, %, n=3)	LOQ (ìgL^{-1})
S1	0.1-100	0.9924	98.6	2.1	0.30
S2	0.1-100	0.9981	80.59	2.9	0.24
S3	0.1-100	0.9944	91.81	2.7	0.15

Application:

The developed method was applied to the analysis of locally available ladyfinger samples. All samples were analyzed followed the procedure described above. The accuracy and applicability of the proposed method in real samples also demonstrated in spiked and standards.

The recoveries ranged from 80.5%to 98.6%. The proposed DLLME method is feasible and may be applied for quantitative analysis of the selected pesticides in real samples.

Conclusion:

Dispersive liquid-liquid micro extraction is a relatively new sample pretreatment method, combining sampling, extraction, and concentration all together. Compared with traditional extraction methods, DLLME has the advantages of simplicity of operation, rapidity, low-cost, high-recovery, high enrichment factor, and environmental benignity. It shows increased wide practical prospects in the field of trace analysis. It is predicted that DLLME has several scope viz. (1) to further develop applications in the analysis of samples with complex matrix. Since most of the target compounds detected by DLLME till now are relatively of simple matrix, it is important to make this method more applicable to samples with complex matrix;(2) to extend the selection range of extraction solvents for DLLME. At present, most of the reported extraction solvents are halogenated hydrocarbons. More extensive range of extraction solvents must lead to the more extensive range of applicable substrates pre concentrated by DLLME correspondingly, so as to make it have more practical prospects; and (3) to investigate new techniques by combining DLLME with other more different instruments.

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Industrial Waste: Resource & Co Product

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Abstract

Industrial growth accounts for generation of huge quantum of waste load including hazardous waste, which is a matter of sustainability concern. Improper management and disposal of such wastes lead to loss of natural resources and have its consequences in terms of environmental degradation and health hazard. Prevailing management approach primarily includes incineration or land filling, which unnecessarily leads to loss of potential resources. Generation of so called waste consumes energy and leave behind significant carbon foot print. High volume waste generated from industrial sectors like steel, aluminum, automobile, fertilizer and most importantly municipal waste, are primarily being disposed as land fill. Utilisation of such waste as supplement to fuel, filler materials and as raw material substitute have provided many industrial processes to reduce their cost as well as stress on natural resource requirement. Such practices have also provided alternate business and employment opportunity. Preprocessing for modulation and acceptability at receptor process in many cases are quintessential with limiting factor being mainly the logistic and sustainable supply chain availability. Utilization of these waste streams may be formulated based on intra or inter industrial approach whereby waste generated from one industrial operation find its way in other industrial process of same industry or may be transported to other industry. A number of achievements in this direction establish the potential of waste as valuable resource or co-product. Cost benefit analysis supports co-processing's potential edge over other management and disposal options, if streamlined and managed properly. Therefore, wastes should be termed as co-products till its potential is not realized as resource. Segregation and management practice demands modification accordingly. This paper attempts to provide synopsis of few success stories of sustainable utilization of selected waste both in inter/intra industrial scenario with prevailing challenges and future potential on their utilisation scenario.

Key Words: Industrial waste, Utilisation, Co-processing, Co-Products, Resource, Disposal

1. Introduction

Rapid industrialization has led to greater stress on natural resources. In absence of comprehensive approach towards utilization of extracted resources within the available technology and opportunities is causing adverse impact to local environment as well as accumulation of unutilized process co-products. Therefore, rational and sustainable utilization of natural resources with safeguard in place to ensure containment of any contaminant releases is vital for sustainable socio-economic development.

Wastes are categorized in reference to its source of generation. Source of generation includes impurities generated during raw material process, handling and transportation of raw material to process site, non-utilizable portion of materials at process and manufacturing facility, wastage during product handling and supply, and after utilization of the product - product life age. Many instances the product life age is extended by modification in the product or by exploiting the inherent potential of 3R – (Recycling, Reuse and Recovery). Truly assessed and exploited potential of 3Rs of any product reduces demand stress on natural resources thereby have positive impact on concerns associated with local pollution, product cost, health impacts, material handling and most importantly reinforce sustainable development.

Waste – the term itself neither encourages approach for re-utilization nor creates a sense for exploring its inherent potential. Basically, there is nothing as such called – WASTE. Waste is misplaced RESORCE - considering the amount of resources deployed or used during manufacturing of any product or generation of the so called wastes. As such WASTES also inherit similar value in form of energy, material, water, human effort and financial cost. Therefore, scientifically such unutilized products shall be termed as either CO-PRODUCT or treated as RESOURCE especially for their handling and management aspect.

CO-PRODUCTS can be defined as materials which possess values but may not have economically viable utilization potential in its present form or in prevailing economics or technological environment. Typically, the generation quantity influence utilization potential of such products. So, Co-products need special care for their storage and disposal in order to reap available benefits in future or when appropriate or suitable options is available. Steel Melting slags, part of municipal solid waste, dirt and grit collected from road sweeps and sewage treatment plants, waste generated from transport and commutation sectors, etc.

RESOURCES are unused materials having potential for its utilization in the same process facility, or at different facility either in similar form or by improvising its present physical or chemical characteristics to make it economically acceptable. Fly ash, Red Mud, Phospho-gypsum, and other high volume materials generated from one process with proved utilization potential at different product manufacturing facility either as raw material substitute and/or as fuel supplement.

Waste generated from a typical Industry process may be hazardous or non-hazardous in nature. Hazardous waste requires proper management and disposal system and pose a serious challenge to the scientific community, policy makers and regulators. It is presumed that about 10 to 15 percent of wastes produced by industry are hazardous and the generation of hazardous wastes is increasing at the rate of 2 to 5 percent per year.

Present Hazardous Waste Generation Scenario

The amount of hazardous waste generated in this country is quite small in comparison to thatof the developed countries. However, considering the fragile ecosystem that India has (The State of India's Environment, Part I, National Overview, The Citizens Fifth Report, Centre for Science & Environment, 1999), even this low quantum of hazardous wastes (around4.4 million MTA) can cause considerable damage to natural resources if untreated before releases or mismanaged.

About 6.2 Million tonnes of hazardous wastes is annually generated in India, out of which around 3.09 Million tonnes is recyclable, 0.41 Million tonnes is incinerable and 2.73 Million tonnes is land-fillable, while other estimates derived from correlating hazardous waste generation with economic activities predicts nearly five million tonof hazardous waste (Organization for Economic Cooperation and Development - OECD). Twelve States of the country (Maharashtra, Gujarat, Tamil Nadu, Orissa ,Madhya Pradesh, Assam, Uttar Pradesh, West Bengal, Kerala, Andhra Pradesh, Karnataka and Rajasthan) account for 97% of total hazardous waste generation. The top four waste generating states are Maharashtra ,Gujarat, Andhra Pradesh and Tamil Nadu . On the other hand, states such as Himachal Pradesh, Jammu &Kashmir, all North Eastern States excepting Assam generate less than 20,000 MT per annum. Given the wide variations in quantity and nature of waste generated across states and union territories (UTs) and also considering the wide variations in climatic as well as hydro-geological conditions in different regions of the country, the approach to waste management has to be essentially state specific.

Regulatory Frame Work

In order to manage hazardous waste (HW), mainly solids, semi-solid and other Industrial wastes which are not covered by the Water & Air Acts, and also to enable the authorities to control handling, treatment, transport and disposal of waste in an environmentally sound manner, Ministry of Environment & Forests (Mo EF). Government of India notified the Hazardous Waste (Management & Handling) Rules (HWM Rules) on July 28, 1989 under the provisions of the Environment (Protection) Act, 1986 and was further amended in the year 2000 & 2003. HW (Management, Handling & Tans boundary Movement) Rules, 2008 has comprehensively addressed many of the concerns, but most importantly encourages the utilisation aspect of HW under section 11 of the rules. Provision for recognising and approving an environmentally sound technology with adequate management practices has been made and responsibility has been entrusted with Central Pollution Control Board.

Present Management options for Hazardous Waste

Incineration

Incineration serves the dual purpose of reduction of both the toxicity and the volume of the waste, which is an important consideration when the disposal of wastes is finally destined for landfills. Most of the process wastes from chemical unit operations can very well be treated in properly designed incinerators. However, such option denies the exploitation of the inherent resource potential of the co-product, unless energy recovery is practices. The energy recovery option should be adopted only after carrying out due diligent assessment for other utilization options.

Hazardous wastes (secured) landfill

Hazardous waste landfill site is designed scientifically to have an impervious stratum at bottom to stop leachates percolation, and thus to avoid soil and water pollution/contamination in the vicinity of the landfill site. HDPE lining is used in making the landfill impervious. There are arrangements made for collection and treatment of leachates from the hazardous wastes. Such facilities together with proper segregation, preprocessing and environmentally sound management system are termed as TSDF. (Treatment, Storage & Disposal Facilities). More than 30 such facilities are operational in India.

A sustainable approach towards hazardous waste management

The hazardous wastes for co-processing need to be handled in an environmentally safe manner avoiding the possibilities of contaminating the nearby environment and eliminate the chances of accidents leading to environmental catastrophe.

Case Studies

A few selected case studies presented below in support of fact that waste co-processing may indeed provide a great opportunity to convert industrial waste into valuable resource or co-product. Moreover it provides ample scope to curb down greenhouse gas emission both in terms of reduction in fossil fuel burning as well as waste incineration.

Case Study I:

Utilization of Red mud from Aluminium Refineries in Cement Plant

Red mud is the waste product of the manufacture of alumina from bauxite by the Bayer process. The production rate of red mud depends on the origin of the bauxite. The chemical composition of red mud varies with the quality of bauxite and processing procedures. It is rich in Iron, Silica, Alumina, Tin etc and thereby can be utilized as alternative raw material for clinker production in cement plants. During process, at present bauxite residue (red mud) generated approx 1400 T per day dry mud pond (basis (@65% solids) and it is stored in RWDA (red mud pond). Storage of bauxite residue (red mud) is the main concern for alumina refineries across the world. According to various study by cement industries and CPCB, it is possible to use bauxite residue (red mud) in cement industries

Cement application:

Cement is the mixture of compounds, containing mainly of silicates and aluminates of calcium formed out of calcium oxide, silica, aluminium oxide and iron oxide. Cement is manufactured by burning of lime stone and clay at high temp in a kiln and then finally grinding the resulting clinker along with gypsum. The end product thus obtained is called ordinary Portland cement. Main raw materials are Lime stone, Clay / bauxite, Letrite / iron dust ,Gypsum. Red mud is used in the production of cement as a source of iron oxide or alumina or in the raw mix of special cements. The use of red mud must be limited to keep the clinker liquid and the module under control, a maximum of 8 – 10 % red mud can be incorporated in the raw mix when no clay is used.

Achievement

- 30505 MT of Red mud from alumina refinery has been utilised in cement manufacturing in last 18 months. The use potential will get enhanced to more than 36000 MTPA from one single generator to one single user, once adequate and environmentally sound logistic arrangements are in place. 3t.

Benefits

- Reducing the material, fuel and water footprints at generator as well as user level
- Reduce stress on land requirement for disposal
- Enhances the disposal area life span

Case Study II

Utilization of Hazardous waste from Automobile Industry in cement plants

Wastes with utilisation potential arePhosphate sludge, Paint sludge/ Paint mixed waste, Oil soaked waste, Packaging waste (Plastics and others)

Achievement

- Plastic waste in Cement Kiln as fuel substitute -67.32 MT utilised in 2012- 13
- Phosphate sludge (Incineration Ash) in Cement kiln - 46.43 MT in the FY 2011-12 as material substitute

Case Study III

Automobile / Engineering Industry

- Waste gets generated during manufacturing operation which is either recycled / disposed.

Waste scenario

Oil Soaked Cotton Waste: 12-15 tons,
ETP Sludge: 2.5 Tons
Grinding Sludge :16-20 Tons
Paint Sludge : 2-3 tons

Achievements

- Quantity Co-processed so far (2011 – 2013)

Grinding Sludge : 210 Tons , Cotton Waste : 126 Tons, ETP Sludge : 69 Tons
Paint Sludge : 25 Tons

Challenges

- Explaining Co-processing concept to the employees and stakeholders.
- Getting clearance of the waste for utilisation
- Since the generation is on continuous scale and the feasibility of daily transfers are not there. Following investment were required
- Preparation of specific rooms for storage of packed and tagged waste.
- Inventory monitoring and management system to track the retention.
- Manpower supply for packing of the material.

Case Study IV

Co-incineration of Spent Pot Lining in Boiler of Captive Power Plant

SPL has been classified as Hazardous Waste as per Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 under Schedule 1 (11.2); SPL waste is a rock hard material, consisting of anthracite (organic portion derived from coal and pitch), cyanide, alumina and complex fluoride compounds absorbed by the lining materials during the electrolytic cell operation; The Spent pot lining material is the cathode consists of carbon blocks with refractory material lining for insulation;

The spent pot lining after its use requires adequate and scientifically managed system for their final disposal, which at present is secured land fill. Utilising the option of calorific value/ fuel potential of SPL leads to safe disposal practice with added advantage of resource utilisation.

Observation on emission

The general observations of emission during the trial co-incineration study are:

- The particulate emissions were always less than 50 mg/Nm3
- Sulphur Dioxide emissions didn't reflect any particular trends;
- Oxides of Nitrogen emissions, which are much depended on the temperature, were found to be less than 750 mg/Nm3 (WB Standards);
- There is a slight increase in concentrations of HCL and HF emissions during co-incineration period. But all the emissions values are far below the emission standards.
- No volatile organics and PAH were generated during the entire trial period;
- Dioxins & Furans were observed to be Below Detectable Limit during the entire trial run period;
- Though Heavy metals and Mercury were found to be emitted from the stack, the concentrations were less than 0.02 mg/Nm3 for Cd+Tl, less than 0.003 mg/Nm3 for mercury and less than 0.025 mg/Nm3 for all other metals;
- Total Organic Carbon was also found far below the emission standards of 20 mg/ Nm3 for all trial periods;
- All the emissions values are far below the emission standards; and
- Ambient air quality didn't reflect any changes owing to co-incineration and was found to be normal representing the industrial activities.

Findings

- Insignificant variation trends observed in the concentration of Particulate matter, Carbon monoxide, Hydrocarbons
- The metal concentrations do not show any significant varying trends
- It can be concluded that the impacts of the Hazardous Solid Waste – SPL usage in the proportion of 1.0 %, as alternate fuel, are negligible
- The overall impact of the Hazardous waste on the environment is beneficiary in terms of the Disposal, Air Impacts and Conservation of fossil fuels.
- 0.1% is very very negligible and no impact to environment.

Conclusion

Industrial waste management is of utmost significance considering present industrial growth. Categorisation of waste as co-product / resource and accordingly development of their management and handling practices and system is required. TSDF / Common facilities to act as waste bank with facilities to pre-process and make waste usable to the extent possible and also provide the users a sustainable and regular resource supplier to adopt and modify the required infrastructural requirement for utilisation of such resources. Co-processing of waste provide one of the sustainable as well as economically beneficial options for waste management. Efforts are required to be put in for identification of more such waste and processes which promote utilisation. More over waste co-processing options has till date mainly focused on cement plants, but similar potential exist with high temperature furnaces in steel and thermal power plant. More research work and studies is required for such resource conservation / utilisation area.

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Metal Detoxification in Hypersaline Environments

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Abstract

Traditional salt farming has been practised in Goa, India for the past 1,500 years. The presence of mineral impurities in these salts is known to enhance the flavor, color and texture of foods. Organisms ranging from bacteria, fungi, algae, to archaea, are known to colonise salterns and influence the quality of salt produced. What is not known, however, is that these microorganisms also play an important role in detoxification of metal impurities in such hypersaline environments.

Goa's Mandovi estuary faces the threat of anthropogenic pollution, consequently the salterns fed by the estuary would obviously also get affected. In the salterns metals get concentrated along with the brine. Therefore, theoretically speaking, the salt from these salterns should also contain high concentrations of metals. The chronic exposure of humans to heavy metals has been linked to various diseases, including neurodegenerative conditions, dysfunction of vital organs like liver and kidney, and even cancer. However, this was not the case in the Ribandar salterns. Heterotrophic bacteria were found to play a pivotal role in the cycling of metals. In the salterns due to continuous exposure of these bacteria to heavy metals, there was an emergence of metal tolerant strains. It was seen that these tolerant bacteria employed various mechanisms for detoxification of metals. Multiple mechanisms employed for metal tolerance were - secretion of EPS, biosorption, bio precipitation, regulation of protein expression, presence of mnxG, metallothionein and groEL genes. The metals were therefore removed from the overlying water of the salterns and were found to accumulate in the sediment, thereby keeping the salt prepared from the overlying water free from metal contamination and safe for human consumption. Therefore, protecting the environment is dependent on our understanding of the detoxification mechanisms employed by organisms for remediating metal-polluted environments.

Key words: Metal, pollution, bacteria, remediation

Introduction:

Goa lies between 14°542 to 15°482 North and 73°412 to 74°262 East, with a coastline of about 110 km and an area of 3,702 sq. km. The coastline of Goa comprises of estuaries, river outlets, mangroves, saltpans and creeks. Being blessed with a vast coastline and a tropical climate with high intensity sunlight and strong winds, the traditional salterns of Goa are ideal for salt extraction, as being adjacent to the coast they get inundated by tidal waters from riverine and marine sources. Sea salt, bay salt or solar salt obtained from the evaporation of sea water has 85.62% sodium chloride and 14.38% other trace minerals: sulphate, magnesium, calcium, potassium, bicarbonate, bromide, borate, strontium, and fluoride. Unrefined sea salt is usually not processed, or undergoes minimal processing, and therefore retains trace levels of minerals like magnesium, potassium, calcium and other nutrients, as well as some microorganisms (http://sodiumbreakup.heart.org/). For centuries, salt produced in the four talukas of Pernem, Bardez, Tiswadi and Salcete had been adequate for the needs of the local populace, whether for consumption or commercial use. However, this salt production received a set back after liberation due to breaching of bunds, land reclamation and water pollution caused due to industries and tourism (Prabhudesai, 1997). The mining activities in this region have had a considerable influence on the biological and geochemical conditions of the estuarine waters and consequently on the adjacent salterns. The Ribandar solar salterns along the Mandovi estuary in Goa are exposed to an influx of metal effluents from the ferromanganese ore mining activities, barge traffic and sewage disposal activities, since they are fed by this estuary. The quality of water and sediment affects all the living organisms in this diverse and complex region. Therefore these salterns are a good example of a site where human pressures and ecological values collide with each other.

It is surmised that as a consequence of metal pollution of the waters from the estuary feeding the salterns, the metals probably would concentrate with the brine during evaporation. Since the salt from these salterns is consumed as well as used for various commercial purposes by the local Goan population, a study of the distribution of trace metals in the sediments and waters of the saltern becomes pertinent, in order to assess the probable influence of mining on the salt produced.

It is well known that solar salterns act as a niche for extremophilic organisms which thrive over a range of salinities, temperatures, pH, nutrient concentrations, oxygen availability, water activity and solar radiation (Sequiera, 1992). What needs to be determined is if these extremophilic heterotrophic bacteria play any role in regulating the concentrations of metals in these salterns. This paper attempts to determine if this hypothesis really holds true and if so to study the mechanisms employed.

Materials and Methods:

Study area and sampling site:

The study site was the Ribandar saltern (15° 30.166 N and 73° 51.245 E) Goa, India, situated along the Mandovi estuary. The climate on an average is generally warm and humid, fluctuating from a minimum of 20 °C in the month of December to 42 °C in May, hence highly conducive to salt-making. Sediment cores (0-10 cm) from the Ribandar saltern were collected during the pre-monsoon season (January–May), the monsoon season (August) and post monsoon season (November) in triplicates using 1.5-inch diameter graduated PVC hand-held corers. The corers were sealed at both ends with sterile core caps to prevent direct contact with air and transported to the laboratory in an icebox for further physico-chemical analysis.

Metal concentrations:

Sub-samples for metal analysis were dried at 60(±2)°C for 48 h and disaggregated in an agate mortar before chemical treatment for the measurement of Fe, Mn, Ni, Co, Pb, Zn, Cd and Hg following sediment digestion methods as described by Balaram et al. (1995). Briefly, a known quantity (0.2 g) of sediment was digested in a Teflon vessel with a solution (10 ml) of concentrated HF (48 % GR; Merck), HNO3 (69 % GR; Merck) and HClO4 (35 % GR; Merck) in the ratio 7:3:1. The mixture was digested on a hot plate in a fume hood chamber at 70 °C for 4–6 h. The procedure was repeated with 5 ml of acid mixture. A further 2 ml of concentrated HCl (35 % GR; Merck) was added followed by 10 ml of HNO3 (69 % GR; Merck). The residue was warmed and transferred to a clean, dry standard flask to make a final volume of 50 ml with double distilled water. The concentration of the metals was analysed on an atomic absorption spectrophotometer (AAS; GBC 932AA model) at wavelengths, ë: Fe = 372.0 nm; Mn = 279.5; Ni = 232.0 nm; Co = 240.7 nm; Pb = 217.0 nm; Zn = 213.9 nm; Cd=228.8 nm and Hg=253.7 nm using air acetylene flame. Blank corrections were applied wherever necessary and the accuracy was tested using standard reference material MAG-1 (United Geological Survey).

Heterotrophic metal tolerant bacterial counts:

The sediment and water samples from the Ribandar salterns were serially diluted in sterile saltern water and plated on modified salt agar (25% nutrient agar) amended with different metals and incubated at 38°C for 15 days (Rodriguez-Valera, 1981). The heterotrophic metal tolerant bacterial counts were enumerated as CFU/g and in water as CFU/ml respectively.

Studies on mechanisms of metal tolerance:

Cellular analysis was performed by light microscopy and SEM-EDS. Regulation of protein expression was studied using SDS-PAGE. Genetic basis of heavy metal tolerance was analyzed by screening for known genes related to heavy metal tolerance within the genome of isolated strains. The genes screened included mnx for Manganese tolerance (Dick et al. 2006) and ncc (Abdelatey et al. 2011), nik and cnr operons (van Vliet et al. 2002) for nickel and Cobalt tolerance, as also metallothionein genes (Naz et al. 2005).

Results and discussion:

Metal concentrations:

Coastal areas are sites of discharge and accumulation of a range of environmental contaminants. Anthropogenic activities like urbanization and industrialization, including mining, agriculture, and waste disposal are the main contributors of metal pollution in estuaries and rivers (Tabak et al. 2005; Ross, 1994). Econiches like estuaries (Kumar et al. 2010) and solar crystallizer ponds (Pereira et al. 2013) therefore may contain high concentrations of metals, since they serve as ecological sinks for metals and as effective traps for river borne metals (Chapman and Wang, 2010). In the present study, the average metal concentrations recorded in the Ribandar saltern sediment were 17.2±2.8 to 26.3±6.7 % Fe; 0.60±0.2 to 0.9±0.2 % Mn; 27.6±7.3 to 51±8.3 ppm Ni; 28.4±8.9 to 35.2± 10.6 ppm Co; 44.0±21.6 to 62.8±23.6 ppm Zn; 0.06± 0.01 ppm Cd; 1.7±1.0 to 2.6±0.7 ppm Pb and below detection limit Hg; whereas the average values recorded in the overlying saltern water were 4.6±3.2 ppm Fe; 0.5±0.1 ppm Mn; 0.5±0.5 ppm Ni; 1.1±1.0 ppm Co; 1.2±0.84 ppm Zn; 0.01±0.01 ppm Cd and 0.26±0.08 ppm Pb. The concentrations of toxic metals such as Cd, Zn and Pb were well within the permissible limits of 0.03-0.3ppm, 50-300ppm and 2-20ppm respectively in the sediment and 0.001-0.05ppm, 0.005-5ppm and 2-20ppm in water respectively (RSMENR, 2002). The higher concentrations of metals measured in sediment than in water indicate that lower pH (6.5 to 7.5) encountered in the saltern favoured metal accumulation and is in agreement with the report that sediments are the major depository of metals holding more than 99% of total amount of a metal present in the aquatic system (Campbell, 1995).The manifold increase in metal concentrations in the sediment could also be due to the absorptive nature of clayey soil. According to Martincic et al. (1990) and Biksham et al. (1991), this phenomenon is common as it is generally recorded that metals are associated with smaller grain size particles. An assessment of the concentration of metals in the Ribandar saltern sediment for all seasons revealed that the metal concentrations were higher in the salt-making season by 52 % for Fe, 42 % for Mn, 85 % for Ni, 23 % for Co, 42 % for Zn and 47 % for Pb, compared to the non salt-making season. The Ribandar saltern with salinity varying between 5 to 300 is therefore a classic example of several solubilised elements getting magnified with increasing gradients of salinity. Interestingly, the metal concentrations obtained in the Mandovi estuary which feeds the Ribandar saltern were lesser than the metal concentrations recorded in present study in the Ribandar saltern sediment during the salt-making season except in the case of Zn. According to Attri and Kerkar (2011), the concentration of metals in the Mandovi estuary were 18.3±1.9 % Fe, 0.19±0.002 % Mn 36.2±4.2 ppm Co and 102.3±9.8 ppm Zn.

In order to estimate the possible environmental consequences of metal pollution, our results were compared with Sediments Quality Values (SQV) using National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRTs) (Buchman, 1999).

According to NOAA SQuiRT (Table 1), Fe was below the AET during the monsoon and post monsoon season, but above AET during pre monsoon. Mn and Co concentration were above the AET for all seasons, while Ni, Zn , Cd and Pb were below AET for all seasons. Hg was below detectable levels. High Mn, Co and Fe indicate their possible toxicity which may impart an adverse effect on the biota (Buchman, 1999).

However, the metal concentrations from salt obtained from the same saltern were upto 2.58 ppm Fe; 0.24 ppm Mn; 0.065 ppm Ni; 0.012 ppm Cu and 0.032 ppm Zn (Kerkar and Fernandes, 2013). Surprisingly these concentrations were found to be well within the safe levels for human consumption (Table 2).

Table1: Screening quick reference table (SQuiRT) for metals in marine sediments (Buchman, 1999).

Elements	Background	Threshold effect level (TEL)	Effect range low (ERL)	Probable effect level (PEL)	Effect range medium (ERM)	Apparent effect threshold (AET)
Fe		-	-	-	-	22 (Neanthes)
Mn		-	-	-	-	0.026 (Neanthes)
Ni		15.9	20.9	42.8	51.6	110(Echinoderm larvae)
Co		-	-	-	-	10 (Neanthes)
Pb	4-17	30.2	46.7	112	218	400 (Bivalve)
Zn	7-38	124	150	271	410	410 (Infaunal community)
Cd		0.68	1.2	4.2	9.6	3.0 (Neanthes)

Table 2: Health based guideline values of heavy metals (http://www.who.int/water_sanitation_health)

Heavy metals	ppm
Hg	0.001
Cu	0.05-2
Zn	5
Ni	0.02-0.1
Pb	0.1
Cd	0.01
Fe	1-3
Mn	5

Though some of the metals like Cu, Fe, Mn, Ni and Zn are essential as micronutrients for life processes, they are proved detrimental beyond a certain limit (Marschner, 1995; Bruins et al., 2000), which is low for some elements like Cd (0.01 mg/L), Pb (0.10 mg/L) and Cu (0.050 mg/L). Some of the serious toxic effects of metals (mercury, lead, copper, cadmium, arsenic, chromium, nickel and manganese) are mental retardation in children, dementia in adults, CNS disorders, renal diseases, hepatic diseases, insomnia, personality changes, emotional instability, depression, panic attacks, memory loss, headaches, vision disturbances, excessive salivation, excess sweating, lack of co-ordination. Death due to encephalopathy or cardiovascular diseases may occur. Heavy metal toxicity causes toxicity of blood, causing extraction of calcium from bones to buffer the acidity. This calcium accumulates in soft tissue of arteries causing hardening of arteries (Hu, 2002). In the

Ribandar saltern microbial processes could be important and even dominating factors in the mitigation and fate of specific metals.

Role of heterotrophic metal tolerant bacteria in mitigation of metals:

Organisms inhabiting metal polluted environments develop resistance mechanisms that enable efficient detoxification and transformation of toxic forms to nontoxic forms. Heterotrophic metal-tolerant bacteria were abundant in the Ribandar saltern both during the salt-making as well as the non salt-making season. The count of Fe, Mn, Ni, Co, Pb, Cd and Zn-tolerant bacteria is given in Table 3.

Table 3: Count of heterotrophic metal tolerant bacteria in Ribandar saltern sediment

	Depth	Nov	Jan	Feb	Mar	Apr	May	Aug
Fe	0-5cms	5.00E+06	5.50E+05	3.00E+05	1.56E+07	1.35E+06	3.50E+05	5.09E+07
	5-10cms	3.00E+06	0.00E+00	1.40E+06	7.00E+05	3.65E+06	3.00E+05	6.00E+05
Mn	0-5cms	1.50E+06	1.15E+06	0.00E+00	1.33E+07	1.55E+06	3.00E+05	7.00E+05
	5-10cms	5.00E+05	0.00E+00	2.50E+05	1.00E+05	2.60E+06	2.00E+05	5.00E+04
Ni	0-5cms	4.60E+07	4.00E+05	0.00E+00	1.20E+06	2.55E+06	3.00E+05	1.30E+06
	5-10cms	1.30E+07	0.00E+00	4.00E+05	6.60E+06	2.60E+06	4.00E+08	0.00E+00
Co	0-5cms	4.00E+06	4.50E+05	4.00E+05	1.00E+06	1.90E+06	2.50E+05	6.50E+04
	5-10cms	7.50E+06	5.00E+04	1.25E+06	2.50E+05	2.90E+06	3.00E+05	0.00E+00
Pb	0-5cms	6.50E+06	5.00E+05	0.00E+00	7.00E+05	5.00E+04	2.00E+05	1.85E+06
	5-10cms	3.50E+06	5.00E+04	1.00E+06	2.75E+07	0.00E+00	2.00E+05	2.00E+05
Zn	0-5cms	0.00E+00	0.00E+00	0.00E+00	1.00E+05	0.00E+00	0.00E+00	1.00E+05
	5-10cms	0.00E+00	0.00E+00	0.00E+00	9.00E+05	0.00E+00	0.00E+00	0.00E+00
Cd	0-5cms	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E+04	0.00E+00	0.00E+00
	5-10cms	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+05	0.00E+00	0.00E+00
Hg	0-5cms	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5-10cms	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Highest counts of Fe tolerant bacteria (10^7 CFU $g^{”1}$ sediment) were seen at 0–5 cm depth during non salt-making season while at 5-10 cm depth the counts were less by one order. In the salt making season the retrievable count of Fe tolerant bacteria was one order lower than that during the non salt-making season. At 0–5 and 5–10 cm, irrespective of the season, the counts of Mn-tolerant bacteria were mostly in the order of 10^7 and 10^5 CFU $g^{”1}$ sediment. The counts of Co-tolerant bacteria during both non salt-making season and salt-making season were in the order of 10^{4-6} CFU $g^{”1}$ sediment. At 0-5 cm depth interval, the counts of Ni-tolerant bacteria in non salt-making season were lower by an order (~10^7 CFU $g^{”1}$ sediment) compared to the salt-making season. However, the counts were higher by three orders in the depth interval of 5–10 cm in the non- salt making season. In general, the counts of Zn- and Cd tolerant bacteria ranged from $10^{4"5}$ CFU $g^{”1}$ sediment. During non salt-making season, the counts of Pb-tolerant bacteria were in the order of 10^6 CFU $g^{”1}$ sediment; however, in the salt-making season, it ranged from $10^{4“7}$ CFU $g^{”1}$ sediment, with higher counts observed at 5–10 cm. The bacteria were found to exhibit a high degree of variation in the concentration of metals that they can tolerate. Similar observations were also made by Kaur, 2006; Sehgal and Gibbons, 1960; Nieto et al. 1987; Popescu and Dumitru 2009. At low concentrations, certain metal ions like Mn(II), Fe(II), Co(II), Ni(II), and Zn(II) were found to enhance growth of metal tolerant bacteria, though interestingly, at high concentrations, metals must be quickly and efficiently eliminated. Thus in order to avoid toxicity, bacteria activate metal resistance mechanisms to overcome metal stress (Kaur, 2006; Sehgal and Gibbons 1960). These microbiological processes can regulate the solubility of metals thereby governing bioavailability and potential toxicity. We have attempted to understand this aspect by identifying the genes responsible for tolerance to metals. It was seen that the bacteria employed multiple mechanisms for metal tolerance such as secretion of EPS, biosorption, bioprecipitation, regulation of protein expression, presence of mnxG, metallothionein and groEL genes (Pereira, 2013). In addition to these biological factors,an interplay of a large number of physico-chemical factors that enhances the settling and mitigation of locally introduced pollutants was also evident, thereby enabling the deposition of pollutants in the sediment rather than being available in the overlying waters. This proves beneficial especially in the saltern, since the metals are removed from the water and accumulated in the sediment and the salt obtained from this overlying water therefore remains safe for consumption. Interactions between bacteria and heavy metal ions are therefore of great interest not only as a fundamental process but also as a potential bio remedial technology.

Conclusion:

Heavy metals entering into the Ribandar saltern are most likely scavenged by heterotrophic metal tolerant bacteria employing various resistance mechanisms, and by suspended particles leading to their removal from the surface waters and their accumulation in sediments. These sediments, however, could become a reservoir of metals and a source to the overlying water column long after their input to the ecosystem has ceased, potentially leading to adverse ecologic effects. Since the extent of the risks is difficult to assess accurately because of the complexity of biologic and chemical interactions that alter the bioavailability of metals, a continuous monitoring is recommended so as to ascertain that the heavy metals incorporated in the salt crystals are not at a level that could cause potential toxicity to human beings.

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Bio Fuels

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Abstract

High oil prices and growing concerns over climate change are driving investment and innovation in the bio-fuels sector as the energy demand per capita has been increasing due to improvement in living standard. Biofuels are fuels that are derived from biomass, including recently living organisms like plants or their metabolic by-products like cow manure. To be a viable alternative, a biofuel should provide a net energy gain, have environmental benefits, be economically competitive, and be producible in large quantities without reducing food supplies.

Biofuels are of two types: ‘First-generation’ or conventional biofuels are made from sugar, starch, or vegetable oil. Such as Ethanol, Biodiesel, Biogas, Vegetable oil. Second generation biofuels, also known as advanced biofuels, are fuels that can be manufactured from various types of biomass.

Since biofuels are mostly produced from agricultural sources, their effects are largely felt in agricultural markets with major land use and environmental consequences. Currently, most biofuel is in the form of ethanol generated from starch or sugar, but this can meet only a limited fraction of global fuel requirements. But increase in mobility and development in transportation system creating challenge not to reduce petroleum use but instead how to meet a growing demand for transportation fuels.

Introduction

A **biofuel** is a fuel that contains energy from geologically recent carbon fixation, such as plants. These fuels are produced from living organisms. Examples of this carbon fixation occur in plants and microalgae. These fuels are made by a biomass conversion (biomass refers to recently living organisms, most often referring to plants or plant-derived materials). This biomass can be converted to convenient energy containing substances in three different ways: thermal conversion, chemical conversion, and biochemical conversion. This biomass conversion can result in fuel in solid, liquid, or gas form. This new biomass can be used for biofuels. Biofuels have increased in popularity because of rising oil prices and the need for energy security.

Bioethanol is an alcohol made by fermentation, mostly from carbohydrates produced in sugar or starch crops such as corn, sugarcane, or sweet sorghum. Cellulosic biomass, derived from non-food sources, such as trees and grasses, is also being developed as a feedstock for ethanol production. Ethanol can be used as a fuel for vehicles in its pure form, but it is usually used as a gasoline additive to increase octane and improve vehicle emissions. Bioethanol is widely used in the USA and in Brazil. Current plant design does not provide for converting the lignin portion of plant raw materials to fuel components by fermentation.

Biodiesel can be used as a fuel for vehicles in its pure form, but it is usually used as a diesel additive to reduce levels of particulates, carbon monoxide, and hydrocarbons from diesel-powered vehicles.

Bio diesel

Biodiesel is the most common biofuel in Europe. It is produced from oils or fats using trans esterification and is a liquid similar in composition to fossil/mineral diesel. Chemically, it consists mostly of fatty acid methyl (or ethyl) esters (FAMEs). Feed stocks for biodiesel include animal fats, vegetable oils, soy, rapeseed, jatropha, mahua, mustard, flax, sunflower, palm oil, hemp, field pennycress, *Pongamia pinnata* and algae. Pure biodiesel (B100) currently reduces emissions with up to 60% compared to diesel.

Biodiesel can be used in any diesel engine when mixed with mineral diesel. In some countries, manufacturers cover their diesel engines under warranty for B100 use, although Volkswagen of Germany, for example, asks drivers to check by telephone with the VW environmental services department before switching to B100. B100 may become more viscous at lower temperatures, depending on the feedstock used. In most cases, biodiesel is compatible with diesel engines from 1994 onwards, which use 'Viton' (by DuPont) synthetic rubber in their mechanical fuel injection systems. Note however, that no vehicles are certified for using neat biodiesel before 2014, as there was no emission control protocol available for biodiesel before this date.

Green diesel

Green diesel is produced through hydrocracking biological oil feedstocks, such as vegetable oils and animal fats. Hydrocracking is a refinery method that uses elevated temperatures and pressure in the presence of a catalyst to break down larger molecules, such as those found in vegetable oils, into shorter hydrocarbon chains used in diesel engines. It may also be called renewable diesel, hydro treated vegetable oil or hydrogen-derived renewable diesel. Green diesel has the same chemical properties as petroleum-based diesel. It does not require new engines, pipelines or infrastructure to distribute and use, but has not been produced at a cost that is competitive with petroleum. Gasoline versions are also being developed. Green diesel is being developed in Louisiana and Singapore by ConocoPhillips, Neste Oil, Valero, Dynamic Fuels, and Honeywell UOP. And also by Preem in Gothenburg, Sweden Evolution.

Production and use of bio fuel

There are various social, economic, environmental and technical issues with biofuel production and use, which have been discussed in the popular media and scientific journals. These include: the effect of moderating oil prices, the "food vs. fuel" debate, poverty reduction potential, carbon emissions levels, sustainable biofuel production, deforestation and soil erosion, loss of biodiversity,[54] impact on water resources, the possible modifications necessary to run the engine on biofuel, as well as energy balance and efficiency. The International Resource Panel, which provides independent scientific assessments and expert advice on a variety of resource-related themes, assessed the issues relating to biofuel use in its first report towards sustainable production and use of resources: Assessing Biofuels."Assessing Biofuels" outlined the wider and interrelated factors that need to be considered when deciding on the relative merits of pursuing one biofuel over another. It concluded that not all biofuels perform equally in terms of their impact on climate, energy security and ecosystems, and suggested that environmental and social impacts need to be assessed throughout the entire life-cycle.

Another issue with biofuel use and production is the US has changed mandates many times because the production has been taking longer than expected. The Renewable Fuel Standard (RFS) set by congress for 2010 was pushed back to at best 2012 to produce 100 million gallons of pure ethanol (not blended with a fossil fuel).

Algae bio fuels

From 1978 to 1996, the US NREL experimented with using algae as a biofuels source in the "Aquatic Species Program". A self-published article by Michael Briggs, at the UNH Biofuels Group, offers estimates for the realistic replacement of all vehicular fuel with biofuels by using algae that have a natural oil content greater than 50%, which Briggs suggests can be grown on algae ponds at wastewater treatment plants. These oil-rich algae can then be extracted from the system and processed into biofuels, with the dried remainder further reprocessed to create ethanol. The production of algae to harvest oil for biofuels has not yet been undertaken on a commercial scale, but feasibility studies have been conducted to arrive at the above yield estimate. In addition to its projected high yield, alga culture — unlike crop-based biofuels — does not entail a decrease in food production, since it requires neither farmland nor fresh water. Many companies are pursuing algae bioreactors for various purposes, including scaling up biofuels production to commercial levels.

Jatropha

Several groups in various sectors are conducting research on *Jatropha curcas*, a poisonous shrub-like tree that produces seeds considered by many to be a viable source of biofuels feedstock oil. Much of this research focuses on improving the overall per acre oil yield of Jatropha through advancements in genetics, soil science, and horticultural practices.

SG Biofuels, a San Diego-based *Jatropha* developer, has used molecular breeding and biotechnology to produce elite hybrid seeds that show significant yield improvements over first-generation varieties. SG Biofuels also claims additional benefits have arisen from such strains, including improved flowering synchronicity, higher resistance to pests and diseases, and increased cold-weather tolerance. Plant Research International, a department of the Wageningen University and Research Centre in the Netherlands, maintains an ongoing Jatropha Evaluation Project that examines the feasibility of large-scale Jatropha cultivation through field and laboratory experiments. The Center for Sustainable Energy Farming (CfSEF) is a Los Angeles-based nonprofit research organization dedicated to jatropha research in the areas of plant science, agronomy, and horticulture. Successful exploration of these disciplines is projected to increase *Jatropha* farm production yields by 200-300% in the next 10 years.

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Industrial Waste Management

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Abstract

Industrial waste (SAIL-ISP, BURNPUR, WEST BENGAL) is the waste produced by industrial activity which includes any material that is rendered useless during a manufacturing process such as that of factories, mills and mining operations or excavation. It has existed since the outset of the industrial revolution. Some examples of industrial waste are chemical solvents, paints, sand paper, paper products, industrial by-products, metals, and radioactive wastes.

Toxic waste, chemical waste, industrial solid waste and municipal solid waste are designations of industrial waste. Sewage plants can treat some industrial wastes, i.e. those consisting of conventional pollutants such as biochemical oxygen demand (BOD). Industrial wastes containing toxic pollutants require specialized treatment systems.

There is a wide array of issues relating to waste management and those areas include:

- Generation of waste
- Waste minimization
- Waste removal
- Waste transportation
- Waste treatment
- Recycling and reuse
- Storage, collection, transport, and transfer
- Treatment
- Landfill disposal
- Environmental considerations
- Financial and marketing aspects
- Policy and regulations
- Education and training
- Planning and implementation.
- Throughout most of history, the amount of waste generated by humans was insignificant due to low population density and low societal levels of the exploitation of natural

resources. Common waste produced during pre-modern times was mainly ashes and human biodegradable waste, and these were released back into the ground locally, with minimum environmental. Tools made out of wood or metal were generally reused or passed down through the generations.

- However, some civilizations do seem to have been more profligate in their waste output than others.

Introduction

Waste management is the "generation, prevention, characterization, monitoring, treatment, handling, reuse and residual disposition of solid wastes" There are various types of solid waste including municipal (residential, institutional, commercial), agricultural, and special (health care, household hazardous wastes, sewage sludge). The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment or aesthetics.

Waste management practices are not uniform among: countries (developed and developing nations); regions (urban and rural area), and sectors (residential and industrial).

Recycling

Recycling is a resource recovery practice that refers to the collection and reuse of waste materials such as empty beverage containers. The materials from which the items are made can be reprocessed into new products. Material for recycling may be collected separately from general waste using dedicated bins and collection vehicles, a procedure called kerbside collection. In some communities, the owner of the waste is required to separate the materials into various different bins (e.g. for paper, plastics, metals) prior to its collection. In other communities, all recyclable materials are placed in a single bin for collection, and the sorting is handled later at a central facility. The latter method is known as "single-stream recycling.

The most common consumer products recycled include aluminium such as beverage cans, copper such as wire, steel from food and aerosol cans, old steel furnishings or equipment, polyethylene and PET bottles, glass bottles and jars, paper board cartons, newspapers, magazines and light paper, and corrugated fiberboard boxes.

PVC, LDPE, PP, and PS (see resin identification code) are also recyclable. These items are usually composed of a single type of material, making them relatively easy to recycle into new products. The recycling of complex products (such as computers and electronic equipment) is more difficult, due to the additional dismantling and separation required.

The type of material accepted for recycling varies by city and country. Each city and country has different recycling programs in place that can handle the various types of recyclable materials. However, certain variation in acceptance is reflected in the resale value of the material once it is reprocessed.

Waste handling system

- Vacuum collection in which waste is transported from the home or commercial premises by vacuum along small bore tubes. Systems are in use in Europe and North America.

- Curbside collection is the most common method of disposal in most European countries, Canada, New Zealand and many other parts of the developed world in which waste is collected at regular intervals by specialised trucks. This is often associated with curb-side waste segregation. In rural areas waste may need to be taken to a transfer station. Waste collected is then transported to a regional landfill.
- In many areas, pyrolysis is used to dispose of some wastes including tires, a process that can produce recovered fuels, steel and heat. In some cases tires can provide the feedstock for cement manufacture. Such systems are used in USA, California, Australia, Greece, Mexico, the United Kingdom and in Israel. The RESEM pyrolysis plant that has been operational at Texas USA since December 2011, and processes up to 60 tons per day.[19]
- In some areas such as Taipei, the city government charges its households and industries for the volume of rubbish they produce. Waste will only be collected by the city council if waste is disposed in government issued rubbish bags. This policy has successfully reduced the amount of waste the city produces and increased the recycling rate. A similar system operates in New Zealand where waste must be packed in specially identified bags.
- In some jurisdictions unsegregated waste is collected at the curb-side or from waste transfer stations and then sorted into recyclables and unusable waste. Such systems are capable of sorting large volumes of solid waste, salvaging recyclables, and turning the rest into bio-gas and soil conditioner.
- In San Francisco, the local government established its Mandatory Recycling and Composting Ordinance in support of its goal of zero waste by 2020, requiring everyone in the city to keep recyclables and compostables out of the landfill. The three streams are collected with the curbside "Fantastic 3" bin system - blue for recyclables, green for compostables, and black for landfill-bound materials - provided to residents and businesses and serviced by San Francisco's sole refuse hauler, Recology. The City's "Pay-As-You-Throw" system charges customers by the volume of landfill-bound materials, which provides a financial incentive to separate recyclables and compostables from other discards. The City's Department of the Environment's Zero Waste Program has led the City to achieve 80 % diversion, the highest diversion rate in North America.[20]

There are a number of concepts about waste management which vary in their usage between countries or regions. Some of the most general, widely used concepts include:

1. Waste hierarchy - The waste hierarchy refers to the reduce, reuse and recycle, which classify waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy remains the cornerstone of most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste recovery. The waste hierarchy is represented as a pyramid because the basic premise is for policy to take action first and prevent the generation of waste. The next step or preferred action is to reduce the generation of waste i.e. by re-use. The next is recycling which would include

composting. Following this step is material recovery and waste-to-energy. Energy can be recovered from processes i.e. landfill and combustion, at this level of the hierarchy. The final action is disposal, in landfills or through incineration without energy recovery. This last step is the final resort for waste which has not been prevented, diverted or recovered. The waste hierarchy represents the progression of a product or material through the sequential stages of the pyramid of waste management. The hierarchy represents the latter parts of the life-cycle for each product.

2. Life-cycle of a Product - The life-cycle begins with design, then proceeds through manufacture, distribution, use and then follows through the waste hierarchy's stages of reuse, recovery, recycling and disposal. Each of the above stages of the life-cycle offers opportunities for policy intervention, to rethink the need for the product, to redesign to minimize waste potential, to extend its use. The key behind the life-cycle of a product is to optimize the use of the world's limited resources by avoiding the unnecessary generation of waste.
3. Resource efficiency - the current, global, economic growth and development cannot be sustained with the current production and consumption patterns. Globally, we are extracting more resources to produce goods than the planet can replenish. Resource efficiency is the reduction of the environmental impact from the production and consumption of these goods, from final raw material extraction to last use and disposal. This process of resource efficiency can address sustainability.
   - Polluter pays principle - the Polluter Pays Principle is a principle where the polluting party pays for the impact caused to the environment. With respect to waste management, this generally refers to the requirement for a waste generator to pay for appropriate disposal of the unrecoverable material.

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Role of mangroves in phytoremediation of heavy metals

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Abstract

Heavy metals, like Cu, Pb, Mn, Hg, Cd, As and Zn, are highly poisonous and can cause even death of living organisms. These metals can only be remediated or cleaned up from the soil and water since they cannot be destroyed or converted to another. Plants play a major role in bioremediation as a few heavy metals, in a low amount, are essential for metabolism of plants. As mangroves are exposed to heavy metal pollution they are immune to heavy metal toxicity. *Avicennia marina*, the grey mangroves, absorbs Cu, Cd, Pb and Zn by roots, stems and leaves and shows the presence of these metals in its cellular distribution. The leaves shows highest accumulation of Cd compared to other heavy metals. The presence of Cd is not determined in *A. officinalis* although this species efficiently accumulate some heavy metals in the order of Zn>Cu>Pb>Cr. *Bruguiera sexangula* accumulate heavy metals like Hg, Pb and Cd more effectively by their roots than the stems and leaves and the accumulation rate is Cd>Pb>Hg. All these mangrove species can also be used as significant bio-markers or bio-monitors. *Avicennia* and *Bruguiera* along with other species are very common in Indian Sunderban and play a vital role in remediation and monitoring of environmental pollution, especially heavy metal pollution. Mainly the *Avicennia* species are very important in these aspects in the Sunderban estuarine system.

Key words: Heavy metals, phytoremediation, mangroves,

1. Introduction:

The term “environment” means collectively our surroundings or in other words the combination of the external physical conditions of the genome (Mumthas et. al., 2010). Since last two decades, the menace of the modern society is the environmental pollution, in which pollution caused by heavy metals is the greatest concern.The metals with an atomic number of 22-92 and at least five times more density are regarded as heavy metals (Mumthas et. al., 2010). According to Royal Commission of Environmental Pollution, UK, "pollution is the deposition of substances in excess amount causing various harmful effects and this occurs due to anthropogenic i.e. man induced activities". Heavy metal toxicity is one of the major affects of increasing industrialization. The toxic heavy metal contaminated wastewater is the result of different industrial, agricultural and municipal effluents (Kirupalakshmi, 2004).Heavy metals, like Cu, Pb, Mn, Hg, Cd, As and Zn, are highly poisonous and can cause even death of living organisms. These metals are required in a little amount for plant growth and metabolism; however, they result in heavy metal stress when present in excess amount. These metals cannot be destroyed nor transformed to another one and therefore the total amount of a metal remains same once it is activated in the environment (Sankar Ganesh, 2008). Heavy metals are therefore considered as the most menace pollutants that can only be remediated or cleaned up from the soil and water (Chakraborty et. al., 2013). Phytoremediation is the process where plants are used to solve the environmental problem without excavation of the contaminant material and disposing it elsewhere.

Mangroves grow in heavy metal rich coastal environment and shows highly specialized features to remove or immobilize metals. The heavy metals from the tidal waters and fresh water rivers are trapped in the sediment. The heavy metals are primarily accumulated in the root tissues of *Avicennia* spp., *Rhizophora* spp. and *Bruguiera sexangula* and found lower in bark with lowest concentration in the leaves. The bio-concentration factors or BCF (i.e., ratio of root metal to the corresponding sediment metal concentration) is of<1 (Peters et al., 1997). The mangrove root systems control the essential metal uptake by rejecting the non-essential metals. Thus, the mangroves reduce the heavy metal transport to the adjacent estuarine and marine ecosystem.

This study was conducted on the Sunderban Estuarine System (SES) of West Bengal which is also India's largest monsoonal, macro-tidal delta-front estuarine system. At mohona, the River Hooghly splits into several channels named as Saptamukhi, Thakuran, Matla, Bidya, Gomdi, Harinbhanga, Raimangaletc. The total area of SES is formed by the sediments deposited by these rivers. The urban municipal, industrial and agricultural wastes and garbage come into the River Hooghly through the sewages and then they are carried over up to the mohona. All these wastes are rich source of heavy metals that are deposited on the sediments of the SES and thus heavy metals are found in an alarming percentage in the soil samples collected from different sites of Sunderban.

2. Materials and Methods:

2.1. Site selection

The lower Ganga delta of the Sunderban was formed by the step by step deposition of the fine clay, silt and sand particles accelerated by the tidal thrust of the sea. At the mouth of the river systems the "Swatch of No Ground" causes continuous silt sedimentation upon the river banks. Thus, the Sunderban belt was developed. The total geographical area of the Indian part of Sunderban is 9630 km^2, within the latitude of 21°31'N to 22°30'N and the longitude of 88°10'E to 89°51'E with an estimated average annual rainfall of 1500-2000mm, average humidity of 60-90% and temperature variations within 12°C-35°C (Naskar and Mandal,1999).

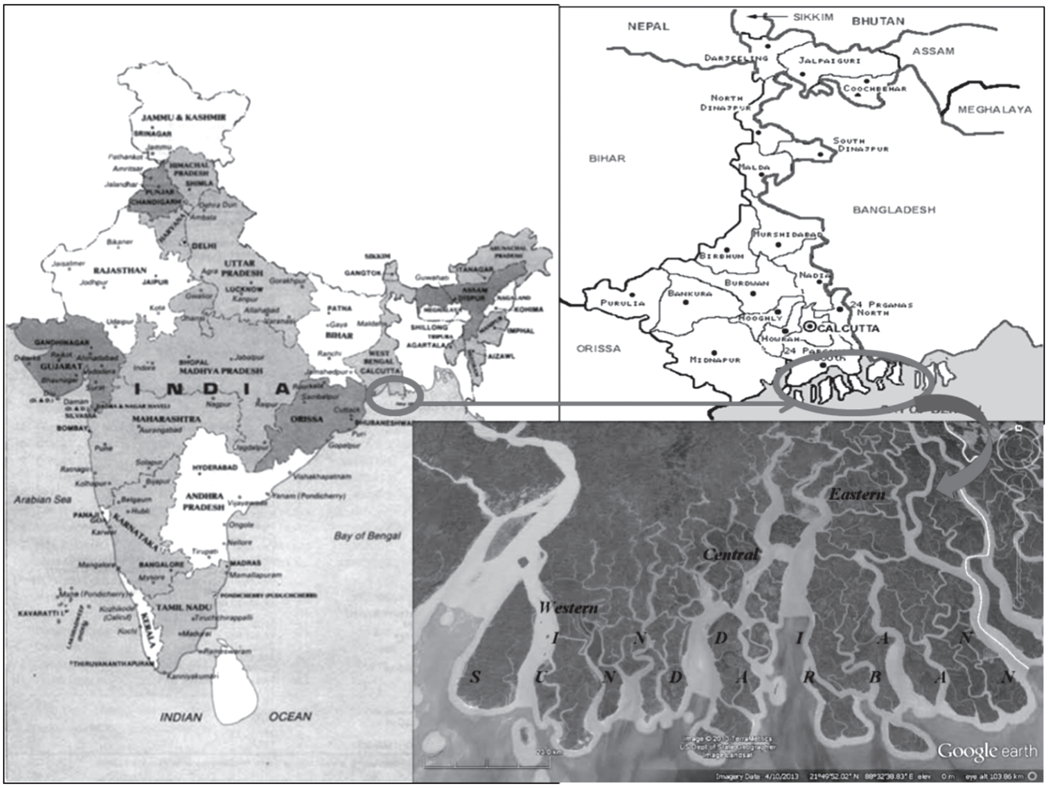


Fig.1: Study site

The study was carried out at four sites-(a)Kakdwip (21°8833'N and 88°1833'E), (b)Frezergange (21°34.528'N and 88°14.368'E), (c)Bakkhali (21°33.604'N and 88°15.706'E)and (d) Jharkhali (22°57'N and 88°36'E).

2.2. Sampling

The samples were collected from all the sites during the three seasons i.e. pre-monsoon, monsoon and post-monsoon of 2003 to 2008.The soil samples were collected during early June, just before monsoon; during September in monsoon when rivers are flooded and in December in winter or post-monsoon.

2.3. Sample analysis

For analysis of soil samples, the metals are determined by treating a 10 gram scoop of soil with 20 milliliters of DTPA extracting solution (0.005 molar DTPA, 0.1 molar TAE, and 0.01 molar $CaCl_2$, adjusted to pH 7.3). After shaking for two hours, the soil is filtered and the extract analysed for metals with an inductively coupled plasma atomic emission spectrophotometer.

Water sample was collected from the surface water of the estuarine rivers. To measure the DO separate DO bottles were used on the spots and other samples were carried to the laboratory and tested roughly within 24 hrs. To test the pH of water pH meter was used. Salinity, BOD, Nitrate and Turbidity were measured as per IS3025 [Method for sampling and Test (physical and chemical) for water used in industry].

2.4. Statistical analysis

The graphs for the comparative study of heavy metal concentrations in soil have been done by Microsoft Excel 2007 and the statistical analysis of the water parameters to calculate the water quality index has been done by Statistica 7.

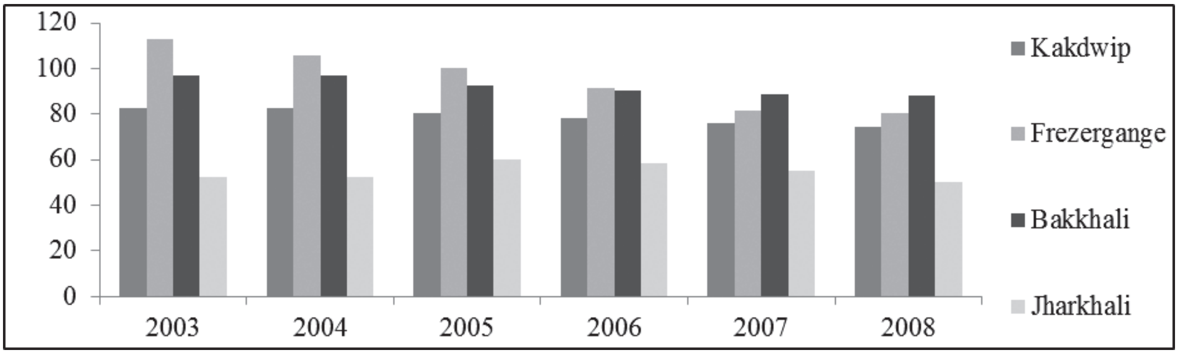
3. Results and Discussions:

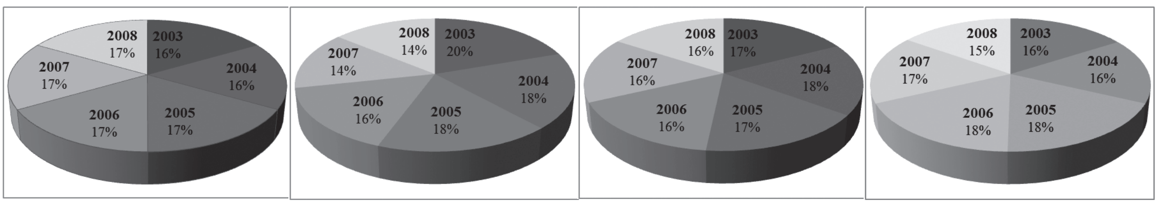
The results of the present studies are given below.

3.1 <u>Annual Heavy metal content of soil at the studied spots of Sunderban</u>:-

As the heavy metals, (i.e. Zn, Cu and Cd) have been found in remarkable concentrations in all the studied spots; only these three metals are considered for the present study.

Table 1: Comparative study of Concentration of Zn (mg/kg) in Soil from all studied spots of Sunderban.

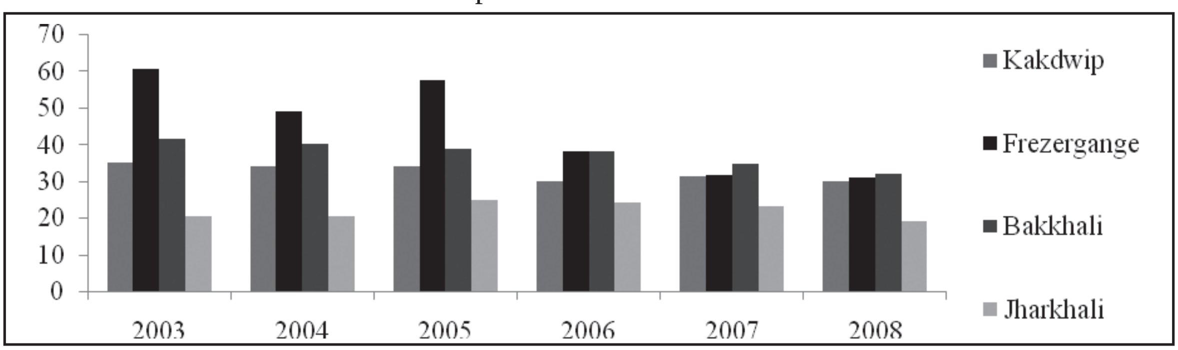


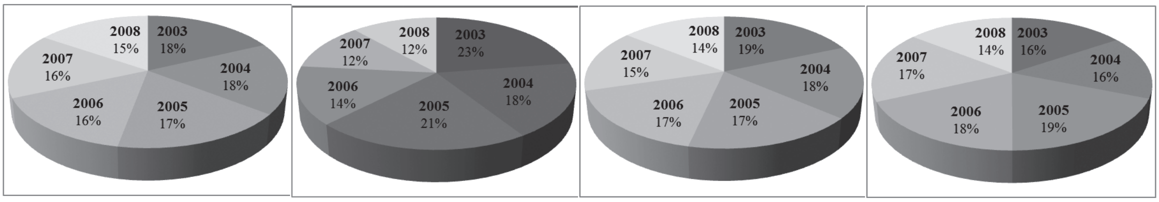


(A) **(B)** **(C)** **(D)**

Fig.2: Annual Concentration of Zn (%) in four studied spots of Sunderban during 2003-2008. (A) Kakdwip, (B) Frezergange, (C) Bakkhali and (D) Jharkhali

Table 2: Comparative study of Concentration of Cu (mg/kg) in Soil from all studied spots of Sunderban.



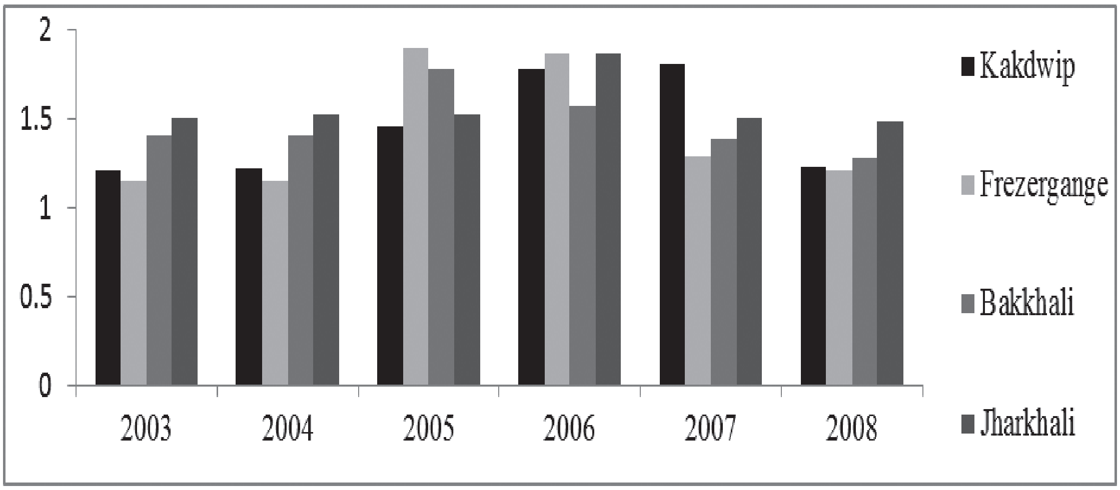


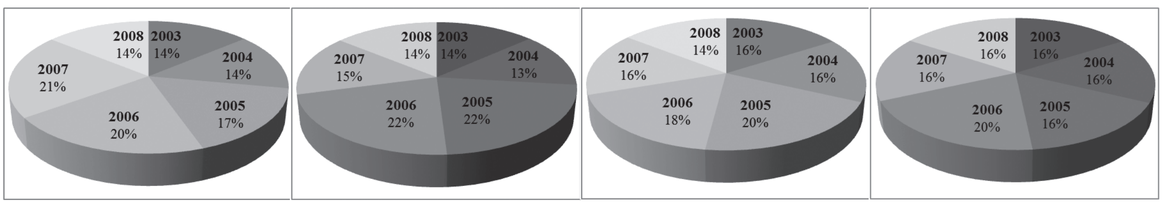
(A) **(B)** **(C)** **(D)**

Fig.3: Annual Concentration of Cu (%) in four studied spots of Sunderban during 2003-2008.

(A) Kakdwip, (B) Frezergange, (C) Bakkhali and (D) Jharkhali

Table 3 Comparative study of Concentration of Cd (mg/kg) in Soil from all studied spots of Sunderban.





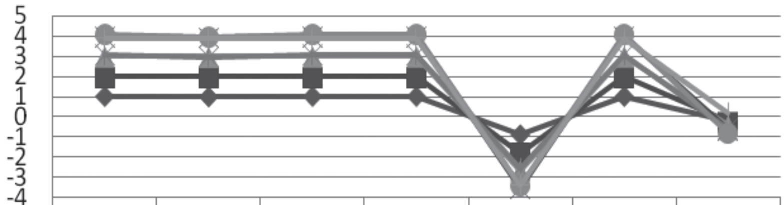
(A) **(B)** **(C)** **(D)**

Fig.7: Annual Concentration of Cd (%) in four studied spots of Sunderban during 2003-2008.

(A) Kakdwip, (B) Frezergange, (C) Bakkhali and (D) Jharkhali

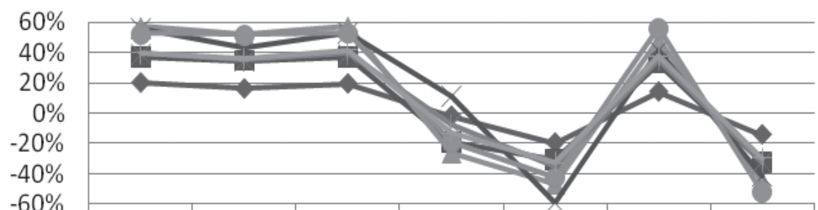
3.2 Correlation Matrix of heavy metals with water parameters:-

Table 4: At Bakkhali in Pre-monsoon [2004-2008]



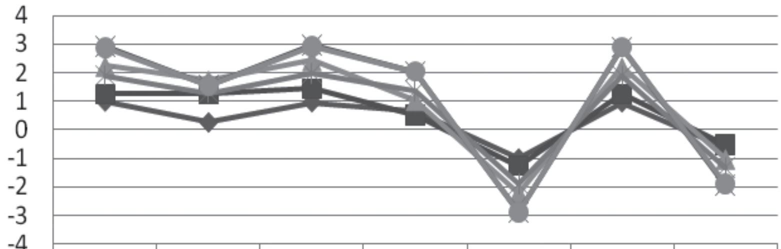
	Cd	Zn	Cu	Salinity	pH	BOD	DO
DO	-0.2	-0.05129	-0.2	-0.2	0.051299	-0.2	1
BOD	1	0.974679	1	1	-0.87208	1	-0.2
pH	-0.87208	-0.94736	-0.87208	-0.87208	1	-0.87208	0.051299
Salinity	1	0.974679	1	1	-0.87208	1	-0.2
Cu	1	0.974679	1	1	-0.87208	1	-0.2
Zn	0.974679	1	0.974679	0.974679	-0.94736	0.974679	-0.05129
Cd	1	0.974679	1	1	-0.87208	1	-0.2

Table 5: At Frezer gange Mohona in Pre-monsoon [2004-2008]



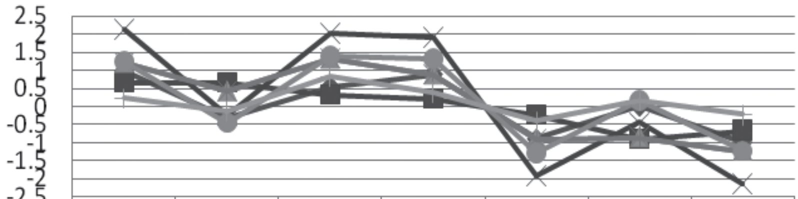
	Cd	Zn	Cu	Salinity	pH	BOD	DO
DO	-0.6315	-0.8029	-0.5642	0.15389	0.41039	-0.8720	1
BOD	0.66688	0.89442	0.7	-0.3	-0.3	1	-0.8720
pH	-0.8207	-0.4472	-0.7	-0.5	1	-0.3	0.41039
Salinity	-0.0513	-0.4472	-0.2	1	-0.5	-0.3	0.15389
Cu	0.97467	0.89442	1	-0.2	-0.7	0.7	-0.5642
Zn	0.86030	1	0.89442	-0.4472	-0.4472	0.89442	-0.8029
Cd	1	0.86030	0.97467	-0.0513	-0.8207	0.66688	-0.6315

Table.6: At Bakkhali in Monsoon [2004-2008]



	Cd	Zn	Cu	Salinity	pH	BOD	DO
BOD	0.974679	0.270369	0.947368	0.684211	-0.97467	1	-0.55263
pH	-1	-0.26352	-0.97468	-0.66689	1	-0.97468	0.61559
Salinity	0.666886	-0.16222	0.526316	1	-0.66688	0.684211	-0.92105
Cu	0.974679	0.459627	1	0.526316	-0.97467	0.947368	-0.5
Zn	0.263523	1	0.459627	-0.16222	-0.26352	0.270369	0.081111
Cd	1	0.26352	0.97468	0.66689	-1	0.97468	-0.61559

Table.7: At Frezergange in Monsoon [2004-2008]



	Cd	Zn	Cu	Salinity	pH	BOD	DO
DO	-1	0.33541	-0.5642	-0.9	0.9	0	1
BOD	0	-0.8944	0.05129	0.4	-0.4	1	0
pH	-0.9	0.67082	-0.6668	-1	1	-0.4	0.9
Salinity	0.9	-0.6708	0.66688	1	-1	0.4	-0.9
Cu	0.56429	-0.2294	1	0.66689	-0.6668	0.05129	-0.5642
Zn	-0.3354	1	-0.2294	-0.6708	0.67082	-0.8944	0.33541
Cd	1	-0.3354	0.56428	0.9	-0.9	0	-1

Spearman Rank Order Correlations. MD pair wise deleted Marked correlations are significant at $p < 0.05000$.

4. Conclusions:

The role of pH in determining the speciation of metal is very crucial in this estuarine system. In almost all the studied places pH shared a negative correlation with heavy metals like Zn, Cu and Cd and sometimes with significant negative correlation. In pre-monsoon at Bakkhali and Frezergange Mohona pH has a significant negative correlation at 0.05 levels with Zn, r = -0.947368 and r = -0.447214 respectively. In monsoon season during the study period at Bakkhali Cu had a strong significant negative correlation with pH and at Frezergange Mohona. Cd shared significant correlation with pH. It has been found that higher pH tends to precipitate the ionic species of heavy metals to the sediment compartment, thus limiting the availability of required metals to the biota and thereby reducing the magnitude of toxicity of some selective metals. Ghosh et al. (1997)(detail reference) found that Cu, Cd and Pb in their divalent state, form complexes with humic acids. At Namkhana in pre-monsoon during the study period pH shares a positive correlation with all these three metals. Due to the absence of dense mangrove vegetation the litter decomposition and humic acid formation is less in this site, this may be the reason for this phenomenon.

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Arsenic Remediation by Eco-Friendly Biomaterial

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Abstract

Groundwater contamination with arsenic, a geo environmental hazard, is reported throughout the globe. The scale and spread of the contamination has reached at an alarming level. The recommended maximum concentration limit for arsenic is 10 μg/L in drinking water. However, much higher concentration of arsenic in groundwater is reported in several countries including India. The arsenic source is geological, specifically through leaching of arsenic bearing minerals. The ground water with high arsenic content has high iron, manganese, bicarbonate and low fluoride, sulphate and chloride content. A continuous and long term exposure of arsenic contaminated water shows significant impact on living organisms, effecting human health ailment through food chain. Such health damage as is irreversible the only solution left is to avoid arsenic free water.

The adsorptive removal is the most popular technique considering the operational simplicity, applicability in wide range of solution condition and repetitive use of adsorbent via recycling. However, biopolymer, due to its degradable character and easy availability in nature, becomes a popular choice for preparation of new generation adsorbents. Cellulose being the most abundant biopolymer in nature, on modification with transition metal e.g. cerium, iron or aluminum is used for arsenic removal from laboratory samples. The adsorbent was characterized by FTIR, FESEM, EDS and EPR studies. The adsorption kinetics was established by Pseudo 1st order kinetic model. The process was applied for removal of arsenic from some real samples.

1. Introduction

Arsenic contamination in groundwater as a result of mineral leaching emerges as a serious issue of the present era.

In West Bengal and Bangladesh, more than 75 million people [1] are exposed to arsenic-laden water. Arsenic levels in public drinking water are regulated in the United States by the

Environmental Protection Agency (EPA). Since January 2006, the maximum level of arsenic allowed in US drinking water is 10 ìg/L (micrograms per liter), or 10 ppb (parts per billion)[2].

The acute effects of inorganic arsenic poisoning are well known from the incidence of suicidal, homicidal, and accidental poisonings. Early signs of arsenic exposure include garlic odor on the breath, excessive perspiration, muscle tenderness and weakness, and changes in skin pigmentation. Advanced symptoms include anemia, reduced sensation in the hand and feet from damage to the peripheral sensory system (stocking and glove syndrome), peripheral vascular disease, skin changes on palms and soles, and liver and kidney involvement. Arsenic causes both skin and lung cancer. Arsenic readily crosses the placenta, but there appears to be increased methylation of arsenic to its organic form, which reduces its toxicity to the fetus.

2. Occurrence

Source of arsenic in the environment includes natural and anthropogenic.

Anthropogenic (caused by human activities) sources:

There are several anthropogenic sources of arsenic, in addition to the natural sources. The arsenic may enter the environmental components from mining/smelting of copper, gold, lead and zinc ores, burning of fuels, wood preservative materials and plant protecting chemicals[3].

Natural sources

Arsenic is a natural constituent of the continental crust with an average content of 2 – 3 gt. Weathering of rocks and sediments, hydrothermal ore deposits, volcanic eruptions, geothermal activities, forest fire, wind-blown dust and sea salt spray can be identified as natural processes distributing arsenic into the environment. The arsenic concentration in minerals and in rock/sediment in presented in Table1 & 2.

Table. 1 Typical arsenic concentration in rocks, sediments, soils

Rock/sediment type	Arsenic (mg/kg)	Reference
Igneous rocks:		
Basic rocks (basalt)	0.18–113	[4, 5, 6]
Basic rocks (gabbro, dolerite)	0.06–28	
Intermediate (andesite, trachyte, latite)	0.5–5.8	
Intermediate (diorite, granodiorite, syenite)	0.09–13.4	
Acidic rocks (rhyolite)	3.2–5.4	
Acidic rocks (granite, aplite)	0.2–15	
Acidic rocks (pitchstone)	0.5–3.3	
Volcanic glasses	2.2–12.2	
Metamorphic rocks:		
Quartzite	2.2–7.6	[4, 7]
Slate/phyllite	0.5–143	
Schist/gneiss	0.0–18.5	

Sedimentary rocks:		
Marine Shale/claystone (nearshore)	4.0–25	[8, 5, 7]
Marine Shale/claystone (offshore)	3.0–490	
Carbonates	0.1–20.1	
Phosphorites	0.4–188	
Sandstone	0.6–9	
Non-marine shale/mudstone	3.0–12	
Iron formations and Fe-rich sediment	1–2900	
Evaporites (gypsum/anhydrite)	0.1–10	
Coals	0.3–35,000	
Soils		
Various	0.1–55	[7, 9].
Soils	>0.1–97	

Table. 2 Major arsenic minerals occurring in nature

Mineral	Composition	Occurrence
Native arsenic	As	Hydrothermal veins
Niccolite	NiAs	Vein deposits and norites
Proustite	Ag_3AsS_3	Generally one of the late Ag minerals in the sequence of primary deposition
Realgar	As_2S_2	Vein deposits, often associated with orpiment, clays and limestones, also deposits from hot springs
Rammelsbergite	$NiAs_2$	Commonly in mesothermal vein deposits
Orpiment	As_2S_3	Hydrothermal veins, hot springs, volcanic sublimation products
Cobaltite	CoAsS	High temperature deposits, metamorphic rocks
Safflorite	$(Co,Fe)As_2$	Generally in mesothermal vein deposits
Seligmannite	$PbCuAsS_3$	Occurs in hydrothermal veins
Arsenopyrite	FeAsS	The most abundant As mineral, dominantly in mineral veins
Tennantite	$(Cu,Fe)_{12}As_4S_{13}$	Hydrothermal veins
Arsenolite	As_2O_3	Secondary mineral formed by oxidation of arsenopyrite, native arsenic and other As minerals

Enargite	Cu_3AsS_4	Hydrothermal veins
Claudetite	As_2O_3	Secondary mineral formed by oxidation of realgar, arsenopyrite and other As minerals
Scorodite	$FeAsO_4.2H_2O$	Secondary mineral
Anabergite	$(Ni,Co)_3(AsO_4)2, 8H_2O$	Secondary mineral
Hoernesite	$Mg_3(AsO_4)2, 8H_2O$	Secondary mineral, smelter wastes
Haematolite	$(Mn,Mg)_4Al(AsO_4)(OH)_8$	Secondary mineral
Conichalcite	$CaCu(AsO_4)(OH)$	Secondary mineral
Adamite	$Zn_2(OH)(AsO_4)$	Secondary mineral
Domeykite	Cu_3As	Found in vein and replacement deposits formed at moderate temperatures
Loellingite	$FeAs_2$	Found in mesothermal vein deposits
Pharmacosiderite	$Fe_3(AsO_4)_2(OH)_3 \cdot 5H_2O$	Oxidation product of arsenopyrite and other As minerals

[Ref. 8, 10, 11]

3. Global Overview of Groundwater Arsenic Contamination

Arsenic in natural waters is a worldwide problem. As a rough estimate over 137 million people in more than 70 countries are probably affected by arsenic poisoning of drinking water. The countries affected are USA, China, Chile, Bangladesh, Taiwan, Mexico, Argentina, Poland, Canada, Hungary, New Zealand, Japan and India (Fig. 1) [12]. The largest population at risk among the 21 countries with known groundwater arsenic contamination is in Bangladesh, followed by West Bengal in India [13, 14].

Fig. 1 Worldwide known arsenic contamination area (Red mark) [12]

4. Human Health effect

Arsenic induced genotoxicity may involve an alteration of the integrity of the cellular genetic material by oxidants or free radical species. Many recent studies have provided experimental evidence that arsenic induced generation of free radicals and oxidative stress can cause cell damage and cell death through activation of oxidative sensitive signaling pathways Arsenic exposure has been linked with various types of cancer, cardiovascular diesase, diabetes, neurological disorders and dermal effects. Research on health effects is summarized and discussed by [15]. A compilation of their reviews is found in Table 3.

Table 3. Arsenic effect on human health

Disease	Health effects
Dermal Disease	Chronic exposure to arsenic leads to the development of lesions on the skin, including hyperkeratosis and hyperpigmentation,
Cancer	Arsenic is a pernicious environmental carcinogen, and leads mainly to cancers of the skin, albeit that there is epidemiological evidence for lung, bladder, liver and kidney cancers
Cardiovascular Effect	Heart attack, cardiac arrhythmias, thickening of blood vessels, loss of circulation leading to gangrene of extremities, hypertension
Gastrointestinal Disturbances	Clinical signs of gastrointestinal irritation, including nausea, vomiting, diarrhoea and abdominal pain.
Liver Diesease	Symptoms of hepatic injury after oral exposure of humans to inorganic arsenic. These effects were most frequently observed after repeated exposure to doses of 0.01–0.1 mg As kg^{-1} per day. Clinical examination confirmed liver damage and blood tests showed elevated levels of hepatic enzymes.
Renal Disease	Inorganic arsenicals do not cause any significant renal injury in humans. In some cases elevated levels of creatinine or bilirubin have been reported. Hematuria, proteinuria, shock, dehydration, cortical necrosis, cancer of kidneys and bladder.
Neurological Disorders	Brain malfunction, hallucinations, memory loss, seizures, coma, peripheral neuropathy.
Reproductive	Spontaneous abortions, still-births, congenital malformations of fetus, low birth weight
Pulmonary	Chronic cough, restrictive lung disease, cancer
Respiratory	Laryngitis, tracheal bronchitis, rhinitis, pharyngitis, shortness of breath, perforation of nasal septum.
Hematological	Anemia, low white-blood-cell count (leucopenia)

5. Technologies for removal

Considering the wide spread of the arsenic problem removal of arsenic becomes essential. There are several treatment methods available (Table 4). However, no universal method is recommended. The main criterion of selection of a method should be the efficiency. However, treatment cost, operational complexity of the technology, skills required to operate the technology and disposal of arsenic-bearing treatment residues need to be considered also.

Table 4. Main arsenic removal technologies

Technologies	Advantages	Disadvantages	Percentage removal
Precipitative/coagulation Processes			
Alum coagulation	Durable powder chemicals are available; relatively low capital cost and simple in operation; effective over a wider range of pH	Produces toxic sludges. Low removal of arsenic. Preoxidation may be required	90
Iron coagulation	Common chemicals are available; more efficient than alum coagulation on weigh basis	Medium removal of As(III); sedimentation and filtration needed	94.5
Lime softening	Most common, chemicals are available commercially	Readjustment of pH is required	91
Adsorptive Processes			
Activated alumina	Relatively well known and commercially available	Needs replacement after 4 to 5 regeneration	88
Iron-coated sand	Expected to be cheap No regeneration is required Remove both As (III) and As (V)	Yet to be standardized Produces toxic solid waste	93
Ion Exchange			
Anion exchange	Well-defined medium and capacity; pH independent; exclusive ion specific resin to remove arsenic.	High cost medium; high-tech operation and maintenance; regeneration creates a sludge disposal problem; As(III) is difficult to remove; life of resins.	87

Pre-Oxidation Processes			
Air oxidation	Relatively simple, low-cost but slow process. In situ arsenic removal Also oxidizes other inorganic and organic constituents in water	Mainly removes arsenic(V) and accelerate the oxidation process	80
Chemical oxidation	Oxidizes other impurities and kills microbes; relatively simple and rapid process; minimum residual mass	Efficient control of the pH and oxidation step is needed	90
Separation Processes			
Microfiltration	MF can remove particulate forms of arsenic	Microfiltration is a low-pressure membrane process which has only a marginal ability to remove arsenic. Highly cost due to its relatively large pore size in comparison to other membrane processes.	
Ultrafiltration	Electric repulsion of UF may play an important role in arsenic rejection and increase rejection beyond that achievable with only pore size-dependent sieving.	UF may be appropriate for surface waters with high colloidal and particulate arsenic concentrations.	52-70
Nanofiltration	Well-defined and high removal efficiency	Very high capital cost. Preconditioning. High water rejection.	95
Reverse Osmosis	No toxic solid waste is produced	High tech operation and maintenance	96
Electrodialysis Reversal	Capable of removing other contaminants	Toxic wastewater produced	95

Greensand Filtration	This technology could be effectively operated in larger system sizes. If high removals are needed the ratio needs to be at least 20:1 iron to arsenic.	Costly	
Alternative Technologies			
Iron Oxide Coated Sand			
Sulfur-Modified Iron			
Granular Ferric Hydroxide			
Iron Filings Photo-Oxidation			>95
Foam flotation			
Solvent extraction:			
Bioremediation:			

[Ref. 16, 17, 18]

6. Arsenic biosorption based on cellulose based sorbents

Cellulose constitutes the most abundant and renewable polymer resource available worldwide and it might be a suitable renewable substrate material for the synthesis of adsorbent through modification with metal such as iron, aluminum, titanium, lanthanum, cerium etc. for arsenic removal. Cellulose and its derivatives have been successfully used in the treatment of fluoride or arsenic solutions. Their main advantages are their unique hydrophilic and porous as well as high surface area which promotes high rates of adsorption and their compressibility into an extremely small volume to facilitate disposal once the capacity of the material has been exhausted. Beads made from cellulose and its derivative are commonly used as ion exchangers, packing materials for chromatography, adsorbents for toxic. In recent years more and more papers have been published on cellulose and its related composite, derivative used as adsorbent of arsenic and other contaminants in industrial wastewater.

In the present study cellulose nano composite bead modified with cerium (CCNB) is synthesized for selective adsorption of arsenic from ground water in batch system. Arsenic [As (V)] adsorption performance on cerium modified cellulose bead was evaluated. The synthesized adsorbent was characterized FTIR, FESEM, EDS, and EPR studies. The maximum adsorption of As (V) is near about 100 percent. The much higher adsorption extent and quick equilibrium time compared to the other reported adsorbents make the present adsorbent as efficient one. Single parameter such as initial concentration (mg/L), pH, dose (g/L), contact time (min.) and temperature (K) effect on removal percentage was evaluated. The adsorption kinetics was established by 1st order kinetic model.

7. Experimental and result discussion

Preparation of cerium loaded cellulose nanocomposite bead (CCNB)

Cerium loaded cellulose nano composite bead was synthesized by wet chemical process via sol–gel formation technique. Cellulose nano composite bead was prepared following the method described elsewhere (our previous work [19]).Alkaline cellulose was esterified by treatment with carbon disulfide, stirred and aged for 72 h at room temperature. The viscose solution thus obtained was purged drop by drop into de-aerated methanol through a needle. A faint red colored beads initially formed were filtered and immediately washed several times with double distilled water. The cellulose nanobead (CB) appeared as snow white, was stored under de-ionized water.

For incorporation of cerium, cerium ammonium nitrate solution (0.1M) at pH1.6 was added to CB and agitated at room temperature for 2 hr. A faint orange yellow colored cerium loaded cellulose nano composite bead, (CCNB) was formed, washed with distilled water and stored under de-ionized water.

Characterization of CCNB

The surface structure of CCNB was revealed from FESEM analysis [Fig. 2] which indicates spherical nature of the bead with an average size in the range 28 to 61 nm [19]. The EDS shows peaks corresponding to the presence of 'C', 'O' and 'Ce' in the CCNB (Fig. 3) [20]. The EPR study conducted at room temperature (303K) and lower temperature (77K) shows (Fig. 4) similar signals having characteristics g values attributed to $g_e = 2.03$, $g_{4\%} = 1.98$, $g_{ï} = 1.93$, ($g_e > g_{4\%} > g_{ï}$) [19] corresponding to Ce^{3+}. The FTIR spectral analysis of CCNB showing the characteristic bands of cellulose moiety with different linkages [20] is presented in Table 5.

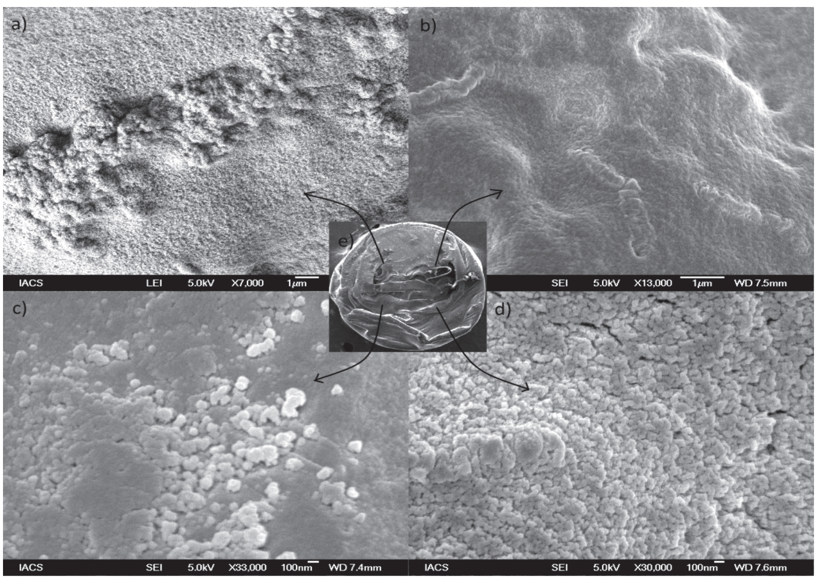
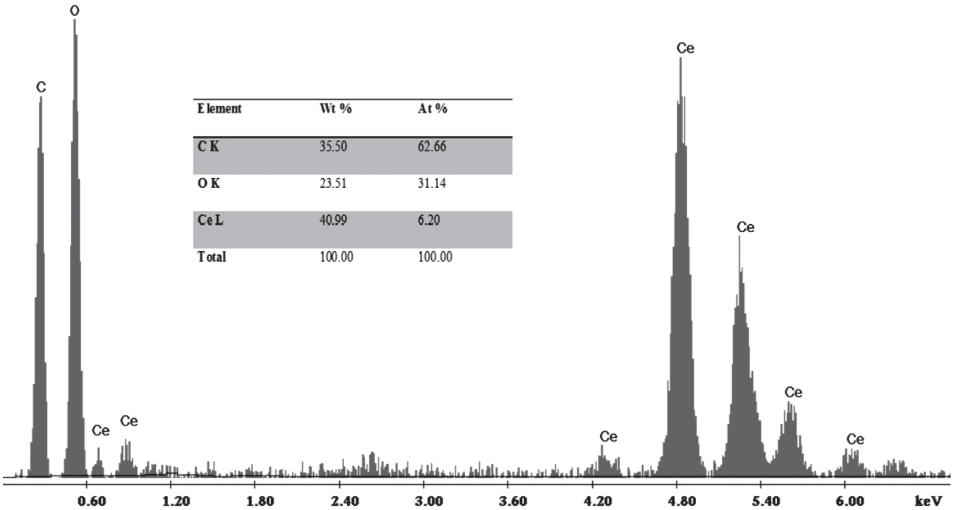


Fig.2. FESEM of CCNB (a)–(e) at four different magnifications and inset the overall look.



Element	Wt %	At %
C K	35.50	62.66
O K	23.51	31.14
Ce L	40.99	6.20
Total	100.00	100.00

Fig. 3 EDS with element percentage [20]

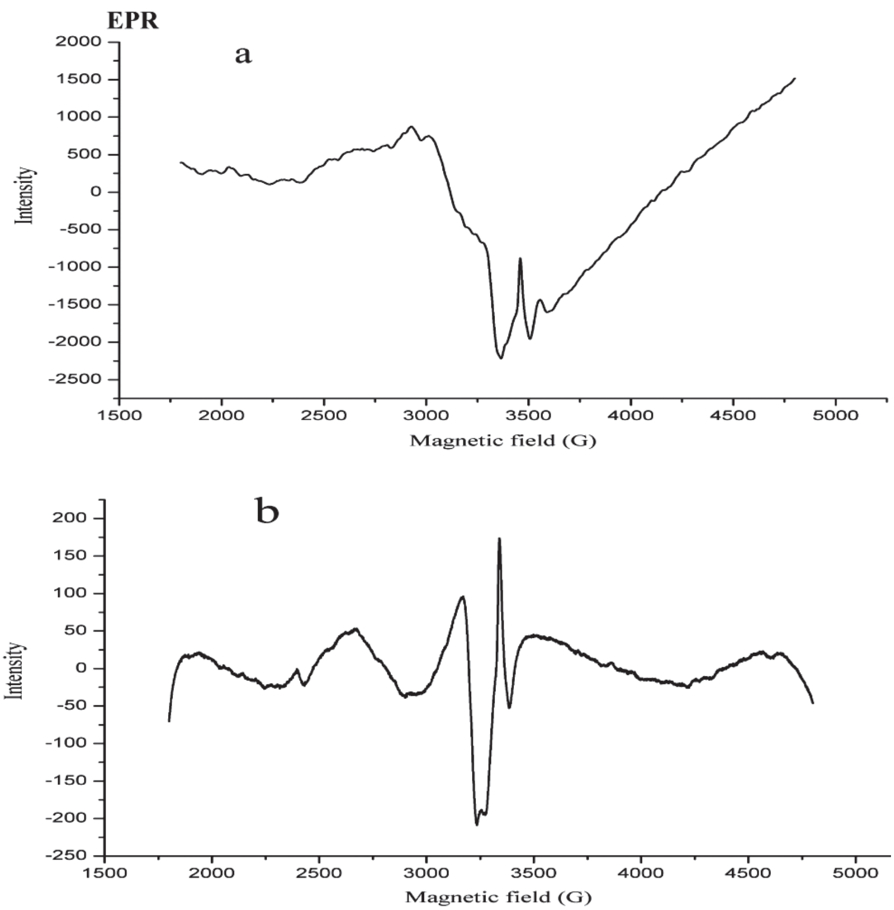


Fig. 4. EPR study at a) 303K b) 77K [19]

Table 5 FTIR spectral analysis of CCNB [20]

Position (cm^{-1})	Origin
3402	O–H stretching vibration
2918	C–H stretching vibration
1642	molecular water bending
1424	C–O–H and C–C–H deformations
1375–1317	C–H flexure vibration (symmetric)
1161, 1060	C–O stretching vibration
898	C-H bending vibration from the â-anomeric link of cellulose
769	C–C stretching vibration
535	Ce-O linkage

Analytical study

Biosorption experiments were conducted in 250 ml conical flasks containing 25 ml of various concentrations of As(V) solution using accurately weighed CCNB. The flasks were agitated in an orbit shaker at various temperatures (293K-313K). The effect of contact time on the adsorption capacity of adsorbent was studied in the range 1–5 h at an initial As(V) concentration of 6 mg/L. Effect of initial pH on the bio sorption capacity of bio sorbent for As(V) was studied by varying solution pH from 2 to 11 at the bio sorbent dosage of 1 g/L for 5h contact time using 6 mg/L initial As(V) concentration. The solution pH was adjusted with dilute HCl or NaOH solution. Adsorption kinetics were studied at initial As(V) concentrations of 6 mg/Lat various temperature. The concentration of As(V) concentration in solution/eluate was determined using an atomic absorption spectrophotometer (Varian AA240) at an wavelength; 193.7 nm, lamp current 10.0 mA, slit width; 0.5R nm, fuel; air acetylene. Bio sorption efficiency, expressed as percent bio sorption, was calculated using the following equation:

$$\text{Percent bio sorption (\%)} = (C_0 - C_e).100 / C_0 \qquad (1)$$

where, C_0 and C_e are the initial and equilibrium As(V) concentration (mg/L) respectively in solution.

Factors affecting bio sorption

Effect of initial As(V) concentration

Bio sorption and initial As (V) concentration correlation was exponential for CCNB as in Fig. 5. Thus the sorption is highly dependent on the initial concentration of As(V). The capacity of the sorbent material gets exhausted sharply with increase in As(V)concentration. This may be probably as a result of the fact that for a fixed sorbent dose, the total available sorption sites remain invariable for all the temperature checked. With increasing concentration the available sorption sites increases and hence the amount adsorbed of As(V) increases.

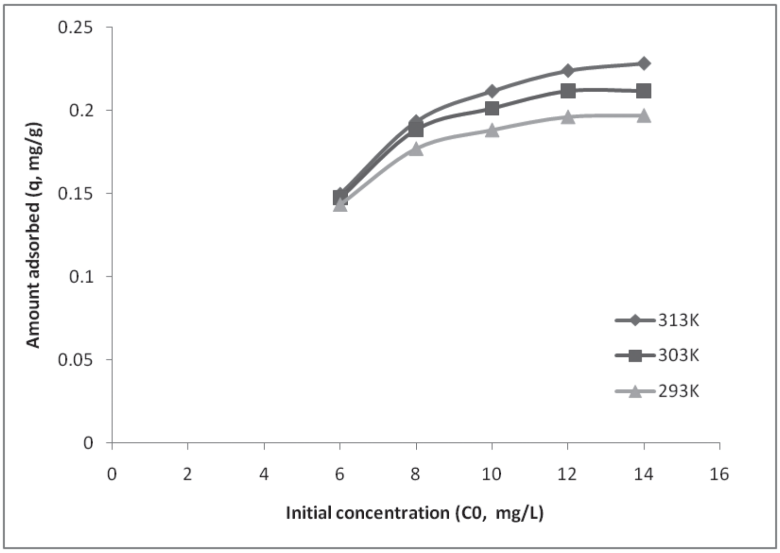


Fig. 5 Effect of initial As(V) concentration

Effect of adsorbent dose

The effect of adsorbent dose on the sorption process can be carried out by preparing adsorbent–adsorbate solution with different amount of sorbents added to fixed initial As(V) (6 mg/L) concentration and shaken together until equilibrium time. Generally, the percentage of As(V) sorption increases with increasing sorbent dose. It was observed that sorption of As(V) by CCNB first increases with increasing dose of sorbent in the range of 0.1 to 1.0 g/L, and thereafter remains almost constant. It may be due to availability of more number of adsorption sites at higher adsorbent dose with saturation of adsorption sites after a level. The saturation of the active sites could also be resulted due to the overlapping of active sites at higher dosages as well as the decrease in the effective surface area. Hence, 1.0 g/L is considered to be the optimum dose of CCNB for As(V) (Fig. 6)sorption from water.

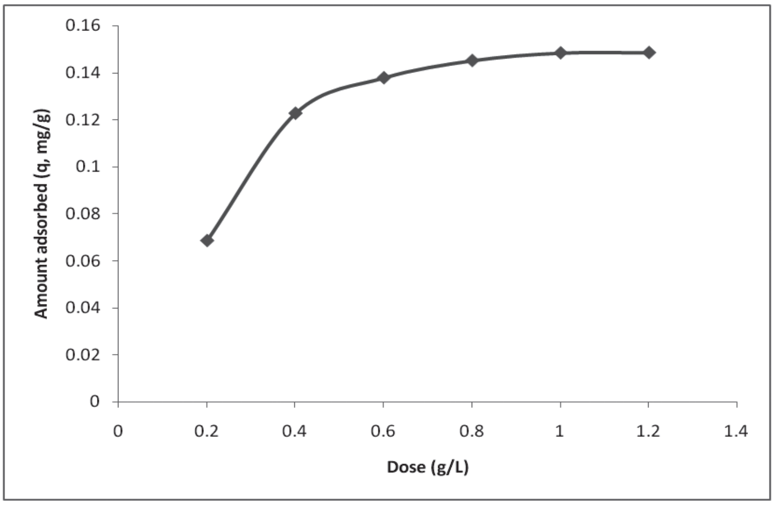


Fig. 6 Effect of dose

Effect of contact time

The effect of contact time on sorption of As(V) can be carried out by preparing adsorbent–adsorbate solution with fixed adsorbent dose (1 g/L) and initial As(V) concentration (6 mg/L) for different time intervals and shaken until equilibrium. It is found from Fig. 7 that the As(V) sorption is increase greatly as the contact time is increased from 0 to 300 min, and then tends to be saturated at about 99% when the contact time is longer than 300 min. The time required to attain this state of equilibrium is termed the equilibrium time, and the amount of As(V) adsorbed at the equilibrium time (300 min.) reflects the maximum sorption capacity of the adsorbent under those operating conditions.

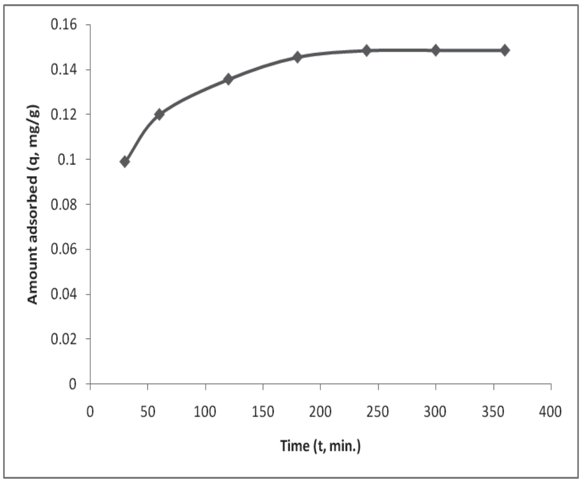


Fig. 7 Effect of time

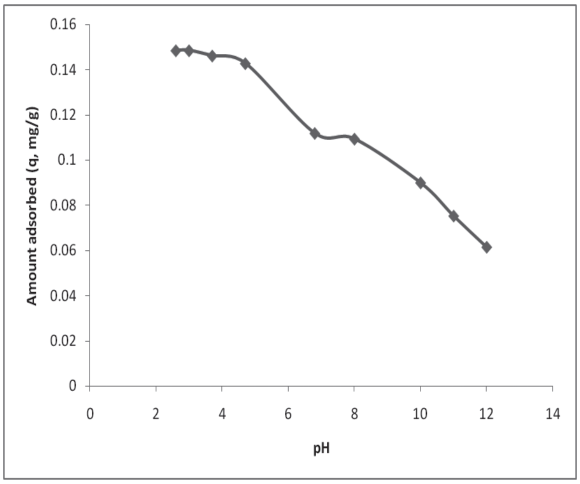


Fig. 8 Effect of pH

Effect of pH

The effect of pH on the As(V) adsorption by the CCNB is shown in Fig. 8 for the pH ranging between 2 and 12. It is observed that maximum adsorption of As(V) occurs at pH 3.0. pH dependent adsorption is significantly due to the speciation of arsenate and the adsorbent surface charge. Speciation study indicates that the dominant species of arsenate are H_3AsO_4 (pH < 2), $H_2AsO_4^{-}$ (pH = 2–6.1), $HAsO_4^{2-}$ (pH = 6.1–11.5) and AsO_4^{3-} (pH > 11.5). It is probable that $H_2AsO_4^{-}$ is the most species of arsenic for adsorption on CCNB.

Effect of temperature

A study of the temperature dependence of adsorption reactions gives valuable knowledge about the enthalpy and entropy changes during adsorption. Temperature is an indicator for the adsorption nature whether it is an exothermic or endothermic process. As shown in Fig. 9, sorption of As(V) is increased significantly when the temperature is increase from 293-313K. The marked temperature-enhancing effect indicates that the As(V) sorption process is an endothermic process. This may be due to increasing the mobility of the As(V) molecules and an increase in the number of active sites for the sorption with increasing temperature.

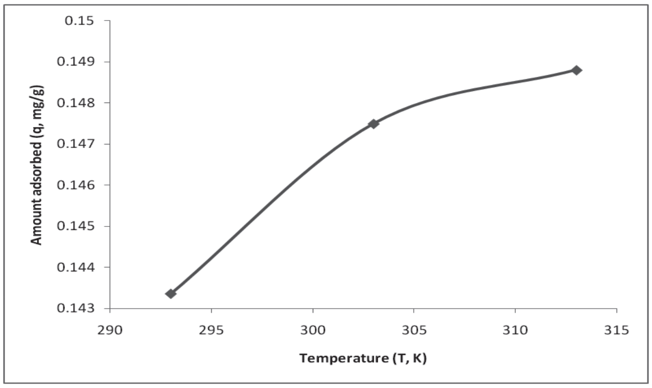


Fig. 9 Effect of temperature

Kinetics study

The effect of contact time on the sorption of As(V) by CCNB was studied at initial concentrations (6 mg/L) of As(V). The contact time varied from 30 min to 360 min (Fig. 7). It was observed that most of the adsorption occurred within 300 contact time. Thereafter the rate of sorption became constant. The adsorption capacity (qt) increased from 0.100 to 0.150 mg/g with increasing initial As(V) concentrations 6 mg/L. Pseudo-first-order kinetic models (Table 6) were used to test the experimental data for sorption of As(V) by CCNB. The sorption rate constant $k_1$was determined from the slope of the linear plots of ln(qe" qt) versus t. Fig. 10 presents the pseudo-first-order kinetic plot of experimental data of As(V) adsorption on CCNB in aqueous solution.

Table 6

Type	Equation	Plot	Parameters
Pseudo first-order	ln (qe -qt) = lnqe – k_1 t	ln (qe - qt) vs t	qe and K_1 can be determined from the intercept and slope of the curve

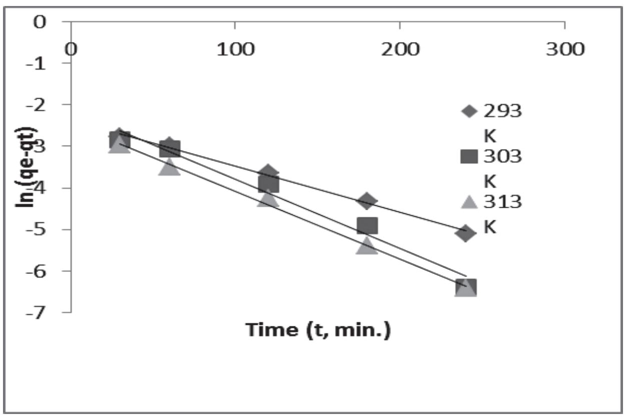


Fig. 10 pseudo-first-order kinetic plot

8. Conclusion

Cerium loaded cellulose nano composite bead is found to be effective for adsorptive removal of arsenic from water. The process is dependent significantly on the pH of the solution. At acidic pH range approx. 100 percent arsenic removed from aqueous sample. The process was tested by first order kinetic model; it was found high regression value. The process is effective for removing arsenic from real sample.

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Women In Biodiversity Conservation

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Abstract

Biodiversity is the term popularized by the sociobiology's Edward Wilson to describe the combined diversity at all the levels of biological organization in our biosphere. This ranges from genes to ecosystems. The first one is (i) Genetic diversity (Example- India has more than 50,000 genetically different strains of rice); The second one is (ii) Species diversity (Example- the Western Ghats have a greater number of amphibian species than the Eastern Ghats); and the last one is (iii) Ecosystem diversity (Example-India has a greater types of ecosystems than Norway).

This biological wealth provides communities with foods, medicines, raw-materials for housing and a wide range of goods and services, and genetic resources for agriculture, medicine and industry. But our globe is rapidly loosing these invaluable wealths or biological resources in our eco-systems, accumulated through millions of years of organic evolution. There are many reasons for this loss such as –[a] habitat alteration,[2] habitat destruction,[3] limitless pollution,[4] improper land husbandry, [5]erroneous agricultural practices, [6]erosion of traditional knowledge about managing biological resources due to lack of giving proper importance to the indigenous women , who led those preservation works from time immemorial,[7] lack of community initiatives and [8] lack of appropriate local legislations.

If the present rate of species-loss continues, we could loose all those wealth in less than two centuries only. So, Biodiversity and its conservation are now vital environmental issues of international concern, as more and more people around the world begin to realise the critical importance of biodiversity for our survival and well-being.

Women play a central role in the conservation, management and use of biodiversity, the Earth's rich animal and plant resources, on which life depends. Their contribution, however, is often overlooked. They are "invisible" partners from grass root-level to policy level. If biodiversity is to survive, women and men must play an equal part in its management. There is therefore an urgent need to consider gender in development efforts, to promote true

partnership and ensure the sustainable conservation and use of biodiversity now and in the future. This paper highlights the concerns of indigenous women, the challenges they face and the probable ways to overcome the challenges.

Keywords: biodiversity, conservation, indigenous women, ecosystem, traditional knowledge, legislation, etc.

1. Biodiversity Concept

Biodiversity may be defined as an indication of varied biological wealth, providing communities with medicines; food-stuffs; raw -materials for housing ; and resources for genetic research in agriculture, medicine and industry.''

Biodiversity ranges from genetic to ecosystem level. Thus it may be (1) genetic diversity (example- India has more than 50,000 genetically different strains of rice); (2) species diversity (example- the western ghats have a greater number of amphibian species than the Eastern ghats); and (3) ecosystem diversity (example-India has greater types of ecosystems than Norway)A number of Genetic diversities form a Species diversity .A number of Species diversities form an Ecosystem diversity.

Finally, all the Ecosystem diversities constitute the Biodiversity.

The Earth supports almost 100 different types of ecosystem, having about 4 million species, of which only 1.75 million have been described. These living organisms contribute to a wide variety of environmental services, such as i) regulation of the hydrological cycle and climate; ii) protection of coastal zones; iii) generation and conservation of fertile soils; iv) pollination; and v) breakdown of wastes. Species diversity buffers ecosystems against the effects of human change, with biodiversity ensuring local and global food security, providing the genetic basis for most food crops and increasing genetic resistance, obtained from wild varieties, to diseases (UNEP Global Environment Outlook). So Biodiversity is aptly called as the very core of our life.

Human health also depends directly on biodiversity, given that some 75% of the world's population relies for their health care on traditional medicines derived directly from natural resources. Traditional medicine systems, such as Ayurveda in India, are based on pure plant extracts.

Biodiversity is particularly crucial for people living in poverty, who directly depend on its services for their survival and livelihoods. Many people of indigenous communities, also draw cultural and spiritual values from it. Unfortunately, the loss of biodiversity is increasing at an exceptional rate. According to the World Conservation Union's 2002 Red List of Threatened Species, more than 11,167 plant and animal species are facing extinction. The most important reasons of biodiversity losses are:- a) unsustainable production and consumption; b) inequities in distribution of wealth and resources; c) demographic developments; d) international conflict; and e) international trade and agricultural policies.

The total effects of those causes are land conversion; climate change; pollution; atmospheric nitrogen deposition and unsustainable harvesting of natural resources.

The effects actually tend to destroy the ecosystems, thus, threats to food and water security, health care and economies grow faster.

To understand these problems and frame alternatives to overcome them, a global collaborative effort, the MEA (Millennium Ecosystem Assessment), is working on mapping the health of the planet. It seeks to provide an integrated assessment of the consequences of ecosystem change for human well-being and to analyze policy options.(UNEP, 2002; UNDP et al., 2000)

2. Womens' Role In Biodiversity Conservation

Relating to plant diversity conservation, the roles of women may be categorized as:

[A] housewives; [B] plant gatherers; [C] gardeners; [D] herbalists [E] plant breeders - cum-seed custodians, and [F] seed storage, preservation and exchange.

As housewives, their tasks are multifarious, such as I) Cooking (culinary traditions); ii) gathering of food, fuel and medicinal plants; iii) their processing and iv) their storage. Among those, cooking is the most important.

As plant gatherers they also take predominant roles (particularly in foraging societies), and according to BARRY & SCHLEGEL(1982), women collect about 79% of total vegetal food. Also, these vegetable foods increased their food security during bad situations, as famines, conflicts, epidemics, etc.

As gardeners, women dominate in Home- gardening and they hold much of knowledge & skills. Home gardens are the oldest and most widely used cultivation system. They are the single most important storehouse of cultivar diversity. In addition to plant diversities these gardens provide— 1) secondary source of food, 2) extra income for the family, 3) medicines, 4) spices 5) fodder 6) fuel, 7) minor building materials, and 8) spaces for aesthetic, social and recreational uses.

As herbalists, women play big roles. Among QUINCHUA tribe (EQUADOR), women herbalists can detail the effectiveness of herb-illness combinations, where about 350 plants are used. [KOTHARI (2003)] Moreover, it has been found that, there are 3 types of folk medicinal specialists—1.Shamans or Priestesses, who are medicine-men or women with magical powers, 2. Midwives, those who are only for female diseases and delivery cases, and 3. Herbalists- who are specialists to treat diseases. Among them, Priestesses and Midwives are only females whereas Herbalists are predominantly so.

As plant breeders and seed custodians, women are again predominant. For example—In RWANDA, they produced more than 600 varieties of Beans. (SPERLING & BERKOWITZ, 1994) and In PERU, they could produce more than 60 varieties of Manioc. (BOSTER, 1985)

Women are also very frequently responsible for seed storage; seed preservation; and seed exchange. Informal seed exchange systems are often female domains and include: bride price; gift giving; kinship obligations; market transactions; and barter transactions. The indigenous small farmers, especially women have long been saving seed varieties till today, sustaining our agriculture.

As main performer of religious activities women of different regions of the world are responsible for bio-reserve. A study on sacred groves in PANCHMARI BIOSPHERE RESERVE OF INDIA (PBRI), was done by C.P.KALA (2011) and found that these groves are very rich in genetic diversity and composed of *(*many ethnobotanically useful species.

Some of the plants preserved at PBRI (through sacred groves) are:- *1. Madhuca indica (mahul) 2. Ficus benghalensis (bot) 3. Ficus religiosa (ashwatha) 4. Bauhinia vahlii 5. Butea monosperma (palash) 6.Terminallia bellerica (baherra) 7. Aegle marmelos(bel) 8.Tamarindus indica (tetul) 9. Buchanania lanzen 10. Azadirecta indica 11. Phylanthus officinalis (aamloki) 12. Semecarpus anacardium bhela).* But, it is a matter of great regret that those 'illiterate scientists' are now totally been neglected . In stead, large multinational corporations are rapidly occupying the invaluable 'GENE BANKS' owned by them. So, global agriculture is now being more and more dependent on those corporations for seed. It is a matter of content that the National and International recognition to women preservers have been expressed in the Agenda 21 (UNCED, 1992*)*. Two main objectives are (i) To promote "the traditional methods and the knowledge of indigenous people and their communities, emphasizing the particular role of women, relevant to the conservation of biological diversity and the sustainable use of biological resources" and (ii) to ensure "participation of those groups in the economic and commercial benefits derived from the use of such traditional methods and knowledge". Convention on Biological Diversity (UNEP, 1993) and GPACSUPGRFA (FAO,1996)] acknowledge the role played by generations of men and women farmers, and by indigenous and local communities, in conserving and improving plant genetic resources. They affirm the need for women to participate fully the conservation programmes and at all levels of policy-making.

Beijing programme for action (1995) states that women must be included in the decision-making process on environmental issues, all policies and measures in the field of sustainable development must have a gender-perspective and take gender aspects into account.

Millenium Development Goals' Target No. 9 (2003) integrates the principles of sustainable development into country policies and programmes and reverses the loss of environmental resources.

For many women, biodiversity is the foundation stone of their work, their belief, and their basic survival. Besides the ecological services, biodiversity provides them to collect and use the natural resources. Direct links with the lands particularly for indigenous and local community women are fundamental, and so obligations to maintain those lands also form the core of their individual and group identities.

These relationships were also predominant in Stone Age about 15,000 to 9,000 B.C. Women's roles and tasks in hunter-gatherer communities were explicitly linked to biodiversity. OWEN (1998) describes that women used to collect and conserve edible plants which contributed 50 to 70% of dietary requirements.

Today, women continue to gather firewood and other bush products for food, medicine, paint and house-building. Wild food enhances food security in many communities during unfavourable situations such as famine, conflicts, and epidemics (KENYATTA and HENDERSON, 2001).

The older women frequently used to guide the children to collect grasshoppers, larvae, eggs and birds' nests, to prepare them for future (VAN EST, 1997). These relationships extend far back into human history, when division of responsibilities by gender began. Scientists have discovered that already in the early Stone Age (15,000-9,000 B.C.), women's roles and tasks in hunter-gatherer communities were explicitly linked to biodiversity, with the natural environment in essence determining their status and well being. For example, OWEN (1998) describes women collecting and conserving edible plants that contributed 50 to 70 per cent of dietary requirements.

Women also take charge of many agricultural activities. After men have cleared the land, women sow, weed, hoe and bind the stalks. On their own plots, they manage home gardens, growing a wide variety of vegetables, fruits and spices. Research on 60 home gardens in

Thailand, revealed 230 different species, many of which had been rescued from a neighboring forest before it was cleared. In many regions, up to 90% of the plant material of the poorest farming communities may be derived from the seeds and germplasm that the communities produce.

In 1993, the FAO (United Nations Food and Agriculture Organization) carried out a study in 31 municipalities across the Department, discovering that women are key to the conservation of the maize crop's genetic resources.

Women determine the seed-selection process, separate what is to be sown and what to be eaten. They are also in charge of selling the grain from the cobs, selected for seed in the next crop cycle. This manual harvest technique serves as a form of artificial selection which allows them to maintain the characteristics of local varieties as well as giving them the opportunity to recognize and propagate attractive mutations or new hybrids.

Today, however, a combination of social, cultural and environmental factors, is now neglecting the central role of women as resource decision makers. The result could be an erosion of genetic diversity, and a threat to food security. (Source: FAO and IPGRI, 2002)

Another women's task tied closely to biodiversity is the collection of medicinal plants, which may be used for curing ailments and also serving as fodder and fuel or even as manure and pesticides. Women often gather medicinal plants along road sides and fences because most of them do not have own lands. Yet their knowledge is immense, because community health depends on this knowledge, and preservation of it is crucial for maintaining biodiversity. Moreover, it has been found that, there are 3 types of folk medicinal specialists—1) Shamans or Priestesses-medicine men or women with magical powers; 2) Midwives-for female diseases and delivery cases; 3) Herbalists-specialists to treat diseases. Among them, priestesses and midwives are only women, whereas herbalists are predominantly so. On study walks in the Kanak valley of the province of Baluchistan in Pakistan, village women identified 35 medicinal plants that they commonly use. In an interview, Rehmat Khatoon, an older village woman, referred to wild medicinal plants in the following terms: "They grow up with no masters" .All her friends laughed because what she was really saying was that wild medicinal plants have no husbands to boss them around or to control them (FAO, 1997).

In various parts of India, traditional practices specifically emphasize the close ties between biodiversity conservation and spirituality. Some promising days are chosen to start preparing the fields, sowing the seeds or harvesting. When heads of grain arrive at the threshing yard, women welcome the first cartload with a worship. As the seeds are brought for storage, women appeal the deity for a good crop in the next growing season. And before the seeds are sown, the women take them to the local deity and worship them. They make seed offerings to the village goddesses, which are later collected by the poor. Women also worship the animals needed for cultivation and the farming implements that will be used for sowing. Interestingly, these procedures are followed only for traditional seeds, not for new high-yielding varieties (RAMPRASAD, 1999; SHIVA, 1993).

As is clear that, women's understanding of local biodiversity tends to be broad, containing many unique insights into local species and ecosystems gained from centuries of practical experience. For example, SHIVA and DANKELMAN (1992) reported that in a sample participatory study, women hill farmers in Dehra Dun, (India) provided the research-scholars with more than 145 species of forest plants that they knew and used .Similarly, DOMOTO (1994) observed in a study at *Siera Leone* that women could name 31 uses of trees on fallow land and in forests while men could name only 08.

Still, researchers often fail to study their knowledge, so, they remain unrecognized years after years. Moreover, some recent official development-approaches and intellectual property regimes actually threaten to turn women's local knowledge against them. There is a real danger that indigenous knowledge will be extracted, patented and sold for the benefit of industry and research institutions, undermining women's autonomy and their access to and control over vital resources. Many groups, such as Diverse Women for Diversity, warn against such biopiracy, a danger made even more acute by the fact that current patent systems are effectively inaccessible to indigenous peoples. As plant breeders and seed custodians women are again predominant.

For example—In Rwanda, they produced more than 600 varieties of beans. (SPERLING & BERKOWITZ, 1994), and in Peru, they could produce more than 60 varieties of manioc (BOSTER,1985)

The then indigenous societies also accepted women's role, honored them and gave them rights to protect plant genetic resources. Examples are:

a] Among the IGBOS (Nigeria),an indigenous vegetable *Telfairia occidentalis* (fluted pumpkin) is grown in women's home gardens and is known as "women's crop". [AKORODA, 1990] .

b] Among Californian Indians , 'Gathered Acorns' were the most important staple food and the rights to gather plants from a specific area were inherited matrilineal. [DICK-BISSONNETTE, 2003]

3. Wome's' Voices

- The modern Chipko movement started in the early 1970s in the Garhwal Himalayas of Uttarakhand, then in Uttar Pradesh with growing awareness towards rapid deforestation. (the CHIPKO MOVEMENT or Chipko Andolan is a movement that practiced the Gandhian methods of satyagraha and non-violent resistance, through the act of hugging trees to protect them from being felled.) The landmark event in this struggle took place on March 26, 1974, when a group of peasant women in Reni village, Hemwalghati, in Chamoli district, UTTARAKHAND, India, acted to prevent the cutting of trees and reclaim their traditional forest rights that were threatened by the contractor system of the state Forest Department. Their actions inspired hundreds of such actions at the grassroots level throughout the region. By the 1980s , Sunderlal Bahugana led the movement which had spread throughout India leading to the formulation of people-sensitive forest policies, the last one being the BAN of open felling of trees in regions as far reaching as Vindhyas and the Western Ghats. Today, Chipko movement of Garhwal is regarded as an inspiration for all other environment relating movements.

- Subsequently, both men and women of Garhwal (Uttaranchal) launched the 'BEEEJ-BACHAO ANDOLON' to preserve traditional seed varieties.
- THE MAHILA SAMIKHYA' an umbrella- organization of India also works on various developmental issues through women's welfare groups in about 250 villages
- In 1998, the global network 'DIVERSE WOMEN FOR DIVERSITY' was launched which strives to mobilize a global campaign of women on biodiversity preservation. To strengthen community initiatives for environmental enrichment:—MAHILA PARIYAVARAN SAMMITTEES (women environment councils) have been formed in the villages. These SAMMITTEES capacitate their PARIYAVARAN SEVIKAS (environment animators) through an intensive 3-year training programme on biodiversity conservation .
- VANDANA SHIVA is an Indian environmental activist and anti-globalizations author she has authored more than 20 books. She is one of the leaders and board members of the international forum on globalization and a figure of the global solidarity movement known as the ALTER-GLOBALIZATION MOVEMENT. She has argued for the wisdom of many traditional practices, as is evident from her interview in the book *VEDIC ECOLOGY* (by RANCHOR PRIME) that draws upon India's Vedic Heritage. She received the Right Livelihood Award in 1993, and numerous other prizes.
- ME ING of China worked diligently to promote environmental awareness throughout China. Her message of sustainability and eco-friendliness has reached nearly 860,000 people in 15 provinces. ME ING is an advocate of responsible consumption, renewable energy utilization, and sustainable development through the women and youth of China. She previously held the position of Director for Friends of the Earth.

4. Conclusion

Whatever those indigenous village and tribal people did were only for securing their livelihoods and reducing poverty, which immensely helped in biodiversity conservation. Really they have done the work of scientists But, it is a great regret that those 'Illiterate Scientists' are now totally been neglected. Instead, large multinational corporations are rapidly occupying the invaluable 'GENE BANKS' owned by the indigenous people.So, global agriculture is now being more and more dependent on those corporations for seeds.

Among the village people, particularly women have an intense interaction with natural resources, affording their heavy involvements in collecting and producing food, fuel, medicinal remedies and necessary raw materials. With knowledge passed down through many generations, women frequently acquire a profound understanding of their environment and of biodiversity in particular, yet their contributions to conservation go unrecognized. The' Loss of Biodiversity' as well as the 'Biopiracy' now endanger their knowledge and resources through the erosion of their diverse resource bases. The major causes are [1] Lack of ownerships; [2] Lack of control over land and resources; and [3] Limited access to education and services.

Although the Convention on Biological Diversity mentions women's roles, its implementation requires a greater focus on gender. Fortunately, there are already many inspiring examples of integrating a gender perspective into biodiversity conservation, and research is starting to gain steam. More needs to be combated to achieve the full and active participation of women in decision-making, assuring their access to services (including education) and opening the doors to equal sharing of benefits. The first essential two steps are (a) better collection of gender-specific information and data and (b) awareness on the potential wealth of women's contributions to be raised in all forums and institutions dealing with biodiversity. Above all, conservation efforts need to draw from the principles of social justice, equity and equality.So, to save our biodiversity *in situ* as well as to give proper status to its saviors, we shall have to —

(i) give priorities to the plant-conservation, important to women curators and doing opposites leading to there erosions;

(ii) recognize, promote & give importance to the intergovernmental transmission of women's traditional knowledge and practices;

(iii) recognize indigenous rights, mainly women's rights to plant & land resource-uses for their sustentation;

(iv) ensure women's full participation in decision- giving as well as policy-making,affecting their total welfare; and

(v) promote and spread research that enhances our knowledge of the same.

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Assessing Petroleum Hydrocarbons through GIS in the Coastal Waters of Northern Tamil Nadu, India

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Abstract

Coastal waters were collected at 15 coastal stations (opposite to the river mouths, fish landing centres and nuclear power station) on a onboard research vessel (Sagar Purvi) at a depth of 15m from the shore in northern Tamil nadu (from Chennai to Nagapattinam) in August, 2010 and analysed for pH, Dissolved Oxygen, Temperature, Salinity and Petroleum Hydrocarbons to find the impact of anthropogenic activities on the coastal water. The pH of the coastal water varied between 9.5 and 10.2. The dissolved oxygen content in the coastal waters ranged from 1 to 5.2mg/l which shows a decreasing trend from north to south of coastal Tamilnadu. The minimum and maximum coastal water temperature was 27.3°C and 28.8°C respectively. A low salinity of 34psu and a high salinity of 37psu were noted. The highest concentration of petroleum hydrocarbon was found in Kaliveli coastal water (1.78mg/l) followed by Ponnaiyar river region (0.1mg/l), Cooum river region (0.1mg/l) and Puducherry (0.01mg/l) coastal area. The data were integrated in ARCGIS/Inverse Distance Weighted (IDW) platform for spatial analysis. Kaliveli is an important wetland area for winter migrants like Storks (*Ciconia ciconia*) and Crested Pochards. The wind direction was found to be mostly towards Southwest and West. There is a lack of awareness about ecological importance and protection of such wetlands among local people. The present study necessitates continuous monitoring and modeling of petroleum hydrocarbons along with prevailing hydrodynamic conditions in the coastal water which will be useful in improving the health status of marine environment, nearby wetland and associated biota.

Keywords: Petroleum Hydrocarbons, Geographic Information Systems (GIS), Anthropogenic Activities, Coastal Waters of Tamil Nadu

1. Introduction

Oil was the first of the recognized “marine pollutants” which is to be controlled and regulated

(GESAMP, 2007). The Oil- petroleum hydrocarbons i.e. Polycyclic Aromatic Hydrocarbons (PAHs) are organic pollutants and have a widespread distribution in the environment. Concentrations of about 16 PAHs, classified as priority pollutants by the US Environmental Protection Agency (USEPA) and the European Union are being investigated in sediments, soils, air particulates and organisms due to their mutagenic and carcinogenic properties (Norena-Barroso, *et al*., 1999). The pollutant may get dispersed; diluted or deposited owing to the dynamicity of coastal water and the level of pollution may vary from very low to very highly polluted nature.

Petroleum compounds have an adverse impact on the environment. Marine pollution occurs mainly through marine operations (ship movements, fishing operations, boating activities, ship breaking activities, dredging etc) besides land based discharges from urban runoff and industrial activities etc. (GESAMP, 1993). The basic requirement in controlling the pollution is the generation of data on pollutant levels in the environment. Hence it is imperative to have systematic monitoring program in the concerned area to have a clear insight into the pollution level; to find out the impact of human activities on the environment and the ways and means to combat the pollution. The present study is aimed at to find out spatial distribution of petroleum hydrocarbons using GIS approach in the coastal water, sampled from northern Tamilnadu (Chennai to Nagapattinam), India, at a depth of 15m from the shore.

2. Materials and Methods

Coastal surface water samples at 15 coastal stations (opposite to the river mouths, fish landing centres and nuclear power station) from Chennai to Nagapattinam were collected onboard in Ocean Research Vessel (Sagar Purvi, National Institute of Ocean Technology [NIOT], Govt. of India) at a depth of 15m in August, 2010 (Fig.1 and Table 1). They were analyzed for water quality parameters like pH, temperature and dissolved oxygen as per APHA (1995) and petroleum hydrocarbons to find out the impact of anthropogenic activities/sea based activities on the coastal water. The atmospheric temperature ranges from 27ºC to 30ºC and the rainfall is 900mm/year.

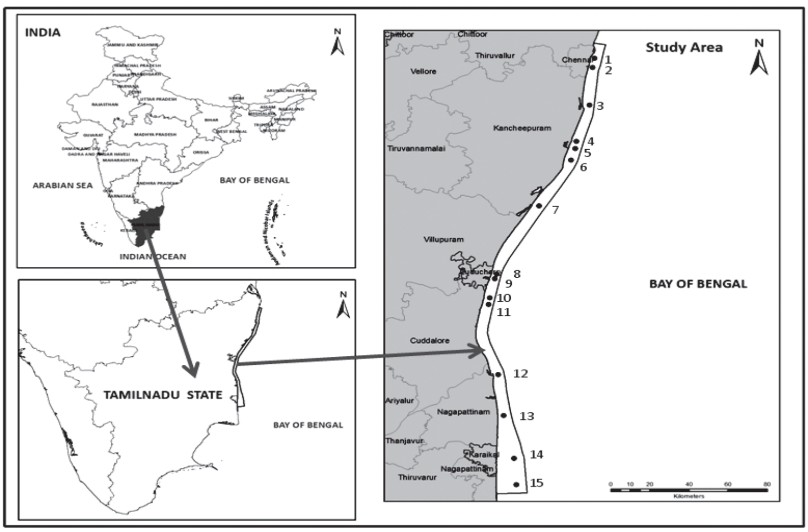

Fig. 1. Sampling stations (15) from Chennai to Nagapattinam

Table 1: Details of sampling stations

No.	Station in the sea (opposite to)	Latitude	Longitude	Depth (m)	Time (hrs)	Wind speed (m/hr)	Wind Direction
1.	Cooum river	13’03"45	80’18"18	15	07.45	6.8	SW
2.	Adyar river	13’00"50	80’17"65	15	08.45	6.0	W
3.	Muttukadu	12’48"38	80’16"76	15	10.55	16.5	W
4.	Mahabalipuram	12’36"76	80’13"23	15	13.15	Rain	SW
5.	Kalpakkam port	12’34"33	80’12"91	15	13.55	Rain	SW
6.	Kalpakkam town	12’30"65	80’11"75	15	14.50	Rain	SW
7.	Kaliveli	12’15"86	80’02"86	15	18.30	8.2	SW
8.	Puducherry	11’53"89	79’51"25	15	06.30	13.1	NW
9.	Varahanadi river	11’52"37	79’50"67	15	07.20	6.7	W
10.	Ponnaiyar river	11’46"25	79’49"25	15	08.30	Rain	W
11.	Gadilam river	11’44"11	79’48"95	15	09.05	17.5	SW
12.	Coleroon river	11’21"50	79’51"62	15	13.30	10.4	SW
13.	Cauvery river	11’08"35	79’53"07	15	16.30	13.9	W
14.	Nagapattinam	10’46"03	79’56"60	15	07.35	23.6	NW
15.	Karaikkal	10’54"56	79’55"97	15	10.10	Rain	SW

The petroleum hydrocarbon was extracted from the coastal water by n-hexane. The fluorescence of the samples was measured in Fluorescence Spectrophotometer (F-2000 HITACHI) at 360nm as emission wavelength with 310nm as excitation wavelength (IOC, UNESCO, 1984). The Chrysene (Merck) was used as the standard reference. The data were integrated in ARCGIS spatial analyst/Inverse Distance Weighted (IDW) platform and the outputs are shown in the Figures 2-4.

3. Results and Discussions

The results of the present study are shown in the Table 2 and in Figures 2-4.

Table. 2: Surface coastal water quality analysis (Chennai to Nagapattinam, August,2010)

No.	Station Name	pH	Temp (ºC)	Salinity (psu)	DO (mg/l)	PAH (mg/l)
1.	Cooum	9.6	28.3	36	1.0	0.10
2.	Adyar	10.1	28.8	34	3.4	BDL
3.	Muttukadu	9.8	28.7	35	4.9	BDL
4.	Mahabalipuram	9.7	28.7	35	4.4	BDL
5.	Kalpakkam port	9.9	28.2	36	5.2	BDL
6.	Kalpakkam town	9.5	27.7	36	4.7	BDL

7.	Kaliveli	9.5	28.2	37	4.3	1.78
8.	Puducherry	9.6	27.3	37	3.4	0.01
9.	Varahanadi	9.7	27.8	36	3.4	BDL
10.	Ponnaiyar	9.6	27.8	36	3.4	0.10
11.	Gadilam	9.7	27.9	36	3.2	BDL
12.	Coleroon	9.7	28.2	34	2.3	BDL
13.	Cauvery	9.9	28.5	34	2.5	BDL
14.	Nagapattinam	10.2	27.8	35	2.3	BDL
15.	Karaikkal	10.2	27.8	36	2.2	BDL
	Minimum	9.5	27.3	34	1.0	0.01
	Maximum	10.2	28.8	37	5.2	1.78

BDL – Below Detectable Limit

The present study reveals that the pH of the surface coastal water varied from 9.5 to 10.2. The minimum and maximum coastal water temperature was found to be 27.3ºC and 28.8ºC respectively which may be due to the different times of sampling during the day. The lowest salinity value of 34psu was noted against the river regions (Adyar, Coleroon and Cauvery) and the highest salinity value of 37psu was at Kaliveli and Puducherry regions. The dissolved oxygen (DO) content in the coastal water ranged from 1mg/l to 5.2mg/l. The lowest DO (1.0mg/l) was in the Cooum river region showing the anthropogenic impacts on the coastal water and the highest concentration of DO (5.2mg/l) was at Kalpakkam port region. Still down to the south, the DO concentration showed a decreasing trend and varied between 3.4 to 3.2mg/l (from Puducherry up to Gadilam river region). Still down south, the region between Coleroon, Cauvery and Nagapattinam, the DO concentration fluctuated from 2.2 to 2.5mg/l showing the anthropogenic impact through the rivers on the coastal water.

The available coastal water quality standards for pH, Dissolved Oxygen and PAH (CPCB,1993) compared with the results of the present study are shown in the Table 3. The lowest level of dissolved oxygen level (1mg/l) was at Cooum river region. The highest concentration of Petroleum hydrocarbon (1.78mg/l), as against 0.1mg/l for ecologically sensitive areas, was noted at Kaliveli region.

Table 3: General coastal water quality standards

Usages of sea water	pH	DO (mg/l)	PAH (mg/l)
Salt pans, Shell fishing, Mariculture and Ecologically Sensitive Zone.	6.5-8.5	5	0.1
Bathing, Contact Water Sports and Commercial fishing.	6.5-8.5	4	—
Industrial cooling, Recreation (non contact) and Aesthetics.	6.5-8.5	3	—
Harbour.	6.5-9.0	3	10.0

Navigation and Controlled Waste Disposal.	6.5-9.0	3	None
Present study	9.5-10.2	1-5.2	0.01-1.78

Source : CPCB,1993

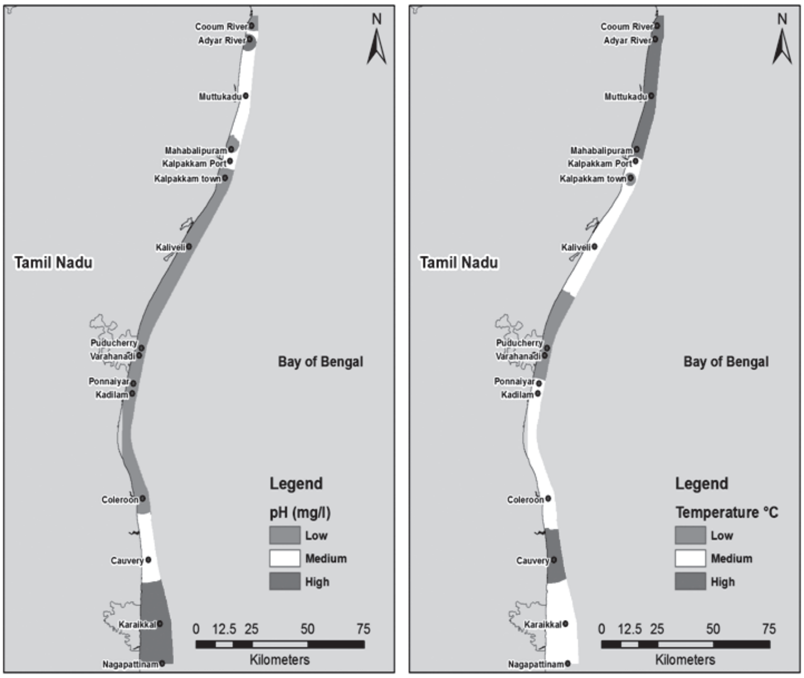

Figure 2 : pH and Temperature of coastal water, August, 2010

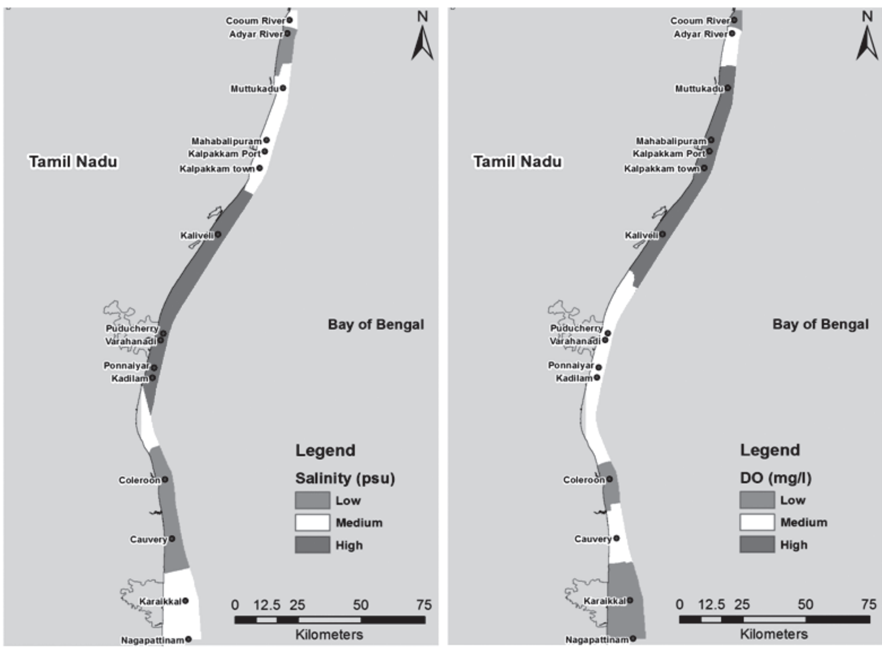

Figure 3 : Salinity and DO of coastal water, August,2010

The range of petroleum hydrocarbons in sediments of polluted coastal regions was found to be l00-12000ug/g while in unpolluted coastal basins was around 70ug/g (NAS, 1975). Nair *et.al* (1995) noted a concentration of petroleum hydrocarbons in Cochin estuarine sediments that varied from 249ug/g to 570ug/g. A concentration of 39.2ug/l of petroleum hydrocarbon was recorded in the coastal waters off Bassein-Mumbai (Chouksey *et.al*, 2004). However, the concentration of petroleum hydrocarbons in the present study reveals a minimum of 0.01mg/l at Puducherry and a maximum of 1.78mg/l at Kaliveli in the coastal water. Out of the fifteen stations sampled, only these stations i.e. 1) the Cooum river region, 2) Kaliveli region, 3) Puducherry region, 4) Ponnaiyar river region showed positive result for petroleum hydrocarbons.

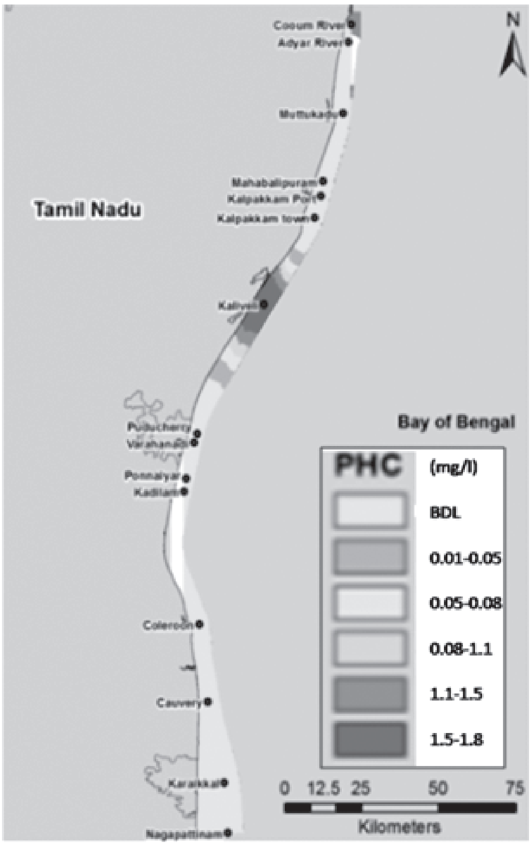

Fig.4. PHC of the coastal water, August, 2010

Wind:

The wind also plays an important role in dispersion of oil in the marine environment. In the present study, the wind speed varied between 6-23.6m/hr (light breeze to gentle, moderate and fresh breeze based on Beaufort's scale). The highest and lowest wind speed was noticed at Nagapattinam and Adyar river region respectively. The wind direction was mostly towards shore i.e. Southwest (SW) and West (W).

The petroleum hydrocarbons increase the risks to the surface and bottom dwellers through contamination (Nikolaou *et.al*, 2009, Veerasingam *et.al*, 2011a, Veerasingam *et.al*, 2011b). The hydrocarbon content of the Indian seafood ranges from 0.6 to 3.0 mg/kg of wet.wt. (Ramamurthy,1991) whereas, the petroleum hydrocarbon residues in the fish caught off Bassein-Mumbai showed a maximum concentration of 10.8ppm wet wt. (Chouksey *et.al*, 2004). In the present study, the higher PAH concentration in the waters at Kaliveli region gives a great concern, because the Kaliveli coastal lake which lies approximately 16 km north of Puducherry, is one of the largest wetlands in peninsular India, a wetland of both national and international importance by the IUCN. This has further been identified as one of the most seriously threatened wetland of substantial socio-economic and cultural value in India. Kaliveli is connected to the sea by Yedayanthittu estuary and has a good salinity gradient useful for a large array of water birds, amphibians, reptiles, mollusks and fishes. This area is classified as an important bird area, an important point for winter migrants like Storks (*Ciconia ciconia*). Besides the crested pochard, which is considered to be rare species in South India is found in thousands in Kaliveli Tank. These waterfowl arrive in late August and early September and depart in mid April after spending their winter in India.

4. Conclusion

The present study reveals the lowest level of dissolved oxygen level (1mg/l) at Cooum river region at 15m depth and a decreasing trend in the concentration of dissolved oxygen from Kalpakkam onwards (5.2mg/l) down upto Nagapattinam (2.3mg/l). The coastal water at Kaliveli is polluted with petroleum hydrocarbons (1.78mg/l) followed by Ponnaiyar river region (0.1mg/l), Cooum river region (0.1mg/l) and Puducherry region (0.01mg/l).Ecological sensitive area like bird sanctuary, historical sites and beaches are located adjacent to the sampling stations. The health of coastal environment and marine biota can be affected by low oxygen level and the petroleum hydrocarbons. The coastal area is undergoing a rapid development stage of having new harbour, expansion of harbours, industrialization (small scale and large scale industries, power plant, oil exploration, tourism related activities etc) and other commercial activities in the coastal zone which not only degrade the quality of coastal water but also pose a serious health hazard to marine biota. There is an urge to preserve, conserve and protect the coastal habitats and marine environment from all manmade activities. Assessment of petroleum hydrocarbons along with various hydrodynamic conditions prevailing in this region are to be modeled in detail and continuous pollution monitoring studies is useful for decision makers, coastal managers in improving the status of marine environment. There is also a lack of awareness among local people about ecological importance and protection status of Kaliveli wetlands which should be improved through socio-economic studies.

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Marine Biodiversity Conservation and Management in India

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Abstract

The coastal marine ecosystems play a vital role in India's economy by virtue of their natural resources, potential habitats and wide biodiversity. India has a long coastline of 8129 kms with Exclusive Economic Zone (EEZ) of 2.5 million sq.km which is an important area both for exploration and exploitation of natural resources. Marine biodiversity affords enormous economical, environmental and aesthetic value to human kind. Humans have long depended on marine aquatic resources for food, medicine and materials as well as for recreational and commercial purposes such as fishing and tourism. Marine organisms also rely upon the great biodiversity of habitats and resources for food, materials breeding and larval disposal environment. This interdependence is essential and maintaining a balance between them is cardinal. But the marine ecosystems are deteriorating at an alarming rate. The factors responsible for it are over exploitation of species, introduction of exotic species, pollution from urban, industrial, and agricultural areas as well as habitat loss and alteration of water diversion, excessive use of water resources etc. As a result, valuable marine aquatic resources are becoming increasingly susceptible to both natural and manmade environmental changes. The present paper deals with the strategies to protect and conserve marine biodiversity which are necessary to maintain the balance of nature and support the availability of natural resources for future generations in India.

1. Introduction

The coastal marine areas contain some of the world's most diverse and productive biological systems. They include areas of complex and sophisticated ecosystems, such as enclosed sea and tidal systems, estuaries, salt marshes, coral reefs, sea grass beds and mangroves that are sensitive to human activities, impact and interventions. Pressure on these systems is growing more intense. The coastal marine environment plays a vital role in India's economy by virtue of their resources, productive habitats and wide biodiversity.

The world oceans and seas are linked to many bodies of freshwater through coastal areas and the two forms and independent ecosystem that spawns much of the world's marine life. The Rio De Janeiro Earth Summit, (1992), the World Bank and other development practitioners are emphasizing an Integrated Coastal Zone Management (ICZM) approach. Integrated Coastal Zone Management (ICZM) provides unifying framework for protecting and managing the world oceans and coastal areas consistent with environmentally sustainable management (Turner and Bateman, 2001). Since, 1993, the World Bank has promoted the establishment of Integrated coastal Zone planning and management in client countries through (a) awareness creation and capacity building (b) investment and (c) partnerships. These efforts have parallel support for marine environmental protection, including pollution control and conservation of marine bio diversity (Stuart *et al.*, 2001).

The marine and coastal areas play an even more important role today, since they provide protein from fish and other sea foods. The current problems of environment destruction in tropical coastal seas, and the effects on the productivity of fish and other seafood from these areas are therefore are of primary importance. Continued destruction of estuaries and lagoons, mangrove forests, seagrass beds and coral reefs in the tropical third world countries will mean the difference between life and death for millions of poor people and for many others, the difference between a life in reasonable health and malnutrition, disease and starvation. There is now considerable evidence that for marine areas in the tropics, there is a clear correlation between the productivity of coastal ecosystems (particularly in mangrove forests, seagrass beds and coral reefs) and the productivity of fisheries. The use of Integrated Coastal Zone Management (ICZM) as a toolbox to develop coastal resources in a sustainable manner and to mitigate conflicts between users has proven to be a possible solution in many countries. The ICZM is a method that can lead to sustainable development because it has the advantage of securing government participation as well as stakeholder involvement.

The sustainability of coastal zone is a growing concern worldwide. There is rapid ongoing destruction of many of the marine and coastal resources essential to human beings throughout the Third world countries. Siltation and nutrition rich discharges from agriculture, waste discharges from industries and urbanisations are among the most important causes of coastal resources degradation. The major underlying factor is the rapid population growth that is taking place in most tropical countries. The courses are particularly venerable and often experience the highest growth rate of more than 5% per year. Coastal degradation cannot be solved within the traditional sectors like fisheries and shipping. What is required are integrated coastal zone management and projects, to address all the factors that have impacts on coastal zones. Major steps have been taken in several countries to halt negative trends which will be implemented ICZM programmes that will address the coastal resource user conflicts (Clark, 1996; Colin and David, 1997; Ramachandran, 2001).

In India, as rapid development and population continues in coastal areas, increasing demands are expected on natural resources and on the remaining natural habitats along the coast. Unless corrective measures are undertaken, environmental degradation and over exploitation will erode marine and coastal biodiversity, undermine productivity and intensify socio-economic conflicts over the increasingly scarce resources of the coastal areas. Current sectoral approaches to the management of coastal and marine resources have generally not proven, capable of conserving the marine and coastal biological diversity. This problem is more serious in Indian context that has a long coastline of 8129 kms with Exclusive Economic Zone (EEZ) of 2.5 million sq.kms. This zone suffers from the absence of an integrated attention to conservation and development. Since these regions form a vital link between the terrestrial and aquatic ecosystems their conservation is essential to maintain the ecological balance and biodiversity. A well-defined biodiversity lessons learnt in other regions of the world is proposed for implementation in several different types of regional scale coastal marine ecosystems. Various conservation and management strategies for sustainable use of coastal marine biodiversity are suggested for socio-economic development in India.

2. Maintenance of species diversity

A major need for biodiversity maintenance is protection of special or critical, littoral habitats including mangrove forest, coral reef, seagrass meadows, shallow water bodies like shallow water lagoons and beaches. While it is useful and practical to focus on individual habitat types or species, one must not forget that they exist only as components of wider coastal systems. The complexity of biotic systems and interrelatedness of their components require that each coastal water ecosystems be managed as a system. The need to preserve the biological systems and the method for doing so are terrestrially derived. Therefore, they require modification to fit to coastal habitats. Few oceanic species are in danger of extinction because of habitat damage. But along the coast and beaches many species of turtles jeopardized by habitat degradation and loss. Five aspects of marine biological diversity are paramount for consideration (Ray and McCormick Ray, 1992). 1.The diversity of marine fauna is much greater than for terrestrial fauna at higher taxonomic levels. 2. The marine fauna is also much well known.3. Most marine species are widely dispersed. 4. Most marine communities are highly patchy and variable in species composition. 5. The response type to environmental perturbations is relatively small. Major strategic objectives for ICZM is to preserve the habitats of the species that have been designated as especially valuable are in danger of extinction. Therefore, an important motivation for designating “Ecologically Critical Areas” (ECA’s) for special conservation is species protection; other purposes might be protection of specially productive or scenic natural resources. Threats to the productivity of unique biological systems of the coastal zone, species and their habitats arise from development activities and their side effects, including reef and beach mining, shoreline filling, lagoon pollution, sedimentation and marine construction activities that are quite distinct from those on land. The strategy plan must recognize that species and the habitats of coastal zones are so different from their terrestrial counterparts as to require different and special forms of conservation. For example, coral reefs, beaches, coastal lagoons, submerged sea grass meadows and intertidal mangrove forests have no counterparts in terrestrial systems. In addition to habitat management, there may be other appropriate actions to be taken under the ICZM programmes, for example, banning exploitation of endangered species.

Man made changes have the effect of reducing the number of species inhabiting the area. For example, eutrophication leading to lowered oxygen concentration in the water and the sediments limits the number species to those few to tolerate those conditions. In areas where large-scale aquaculture is practiced, the cultured species often occupy a disproportionately large amount of the habitat, forcing out many of the natural species. A case in point is in the mangrove forest of Southeast Asia where there has been great development of ponds for shrimp culture. Many of these operations rely on the natural spawning of shrimps to provide juveniles for introduction to the ponds, yet the mangrove ecosystems are so damaged in many areas that the natural shrimp populations are declining. In general, most adverse impacts on coastal ecosystems are characterized by decreasing species diversity. Monitoring of species diversity is therefore a useful technique for assessing damage to the system and maintenance of good species diversity is a positive management objective.

Among several plants and animals inhabiting the coastal ecosystems including the coral reefs, mangroves and estuaries only some species are exploited for human use. However, such species are often irrationally exploited with powerful harvesting techniques, sometimes leading to collapse of their respective habitats. It is, therefore, appropriate to deal with the question of biodiversity management from the point of view of "species – habitat" units in the case of the more sensitive and vulnerable ecosystems in the coastal zone.

2.1 Protected areas in India

Protection of species requires protection of their special habitats as well as preventing the hunting and harvesting them (fig.1). World concern regarding loss of biodiversity is neither felt equally in all nations nor all members of society equally share it. It stems from realization that humans have been transforming the oceans as dumping grounds for their wastes and modifying the natural composition of its environment. Preserving biodiversity is an important reason for protecting natural area. Endangered species are major beneficiary of coastal habitat protection, for example: Coastal birds, turtle and even marine mammals. Other protections for species are mostly regulatory that is providing legal protection against killing and disturbing endangered species whether inside or outside a designated area.

Some marine ecosystems- coral reefs for example have high species diversity but despite increasing marine pollution and degradation of coastal habitats, there is little evidence for an imminent major loss of marine biodiversity at the species level. This may be due to partly to lack of knowledge but an important factor is the typical marine life history. Marine species live in wide-open systems, the sea being continuous around the earth and have greater ranges and fecundity than the terrestrial species. This confers on them a greater resilience to exploitation and environmental change. Similarly endemism is rare. Many marine species particularly fish and invertebrates are so called strategists, producing large number of seeds, but having short lives. Recent species extinction is almost unknown among marine organisms with a planktonic larval stage and among the many species of migratory, highly mobile and wide spread fishes. Species that are large bodied, long lived, and slow breeding, producing few offspring with much parental investment. A few known cases of marine extinction in historic times include marine mammals.

The first Marine National Park in India came into existence in the Gulf of Kutch (Pirotan area) in 1980 followed by Gulf of Mannar and Wandoor Marine National Park in the South Andamans (Table.1&2). A marine park is a reserve and should be managed along several ecological principles and should serve many relevant purposes such as habitat and species preservation, scientific research, recreation and financial gains. Though these three marine habitats have been declared as protected areas, delineation of the core areas and the park limits and regulations on various human activities in the protected areas remain to be implemented. Proposals have been initiated to establish marine parks and preserves in Malvan-Vengrula (Coast of Maharashtra), Mincoy, Kavaratti, Chetlat, Kadamat and Kalpeni (in Lakshadweep).

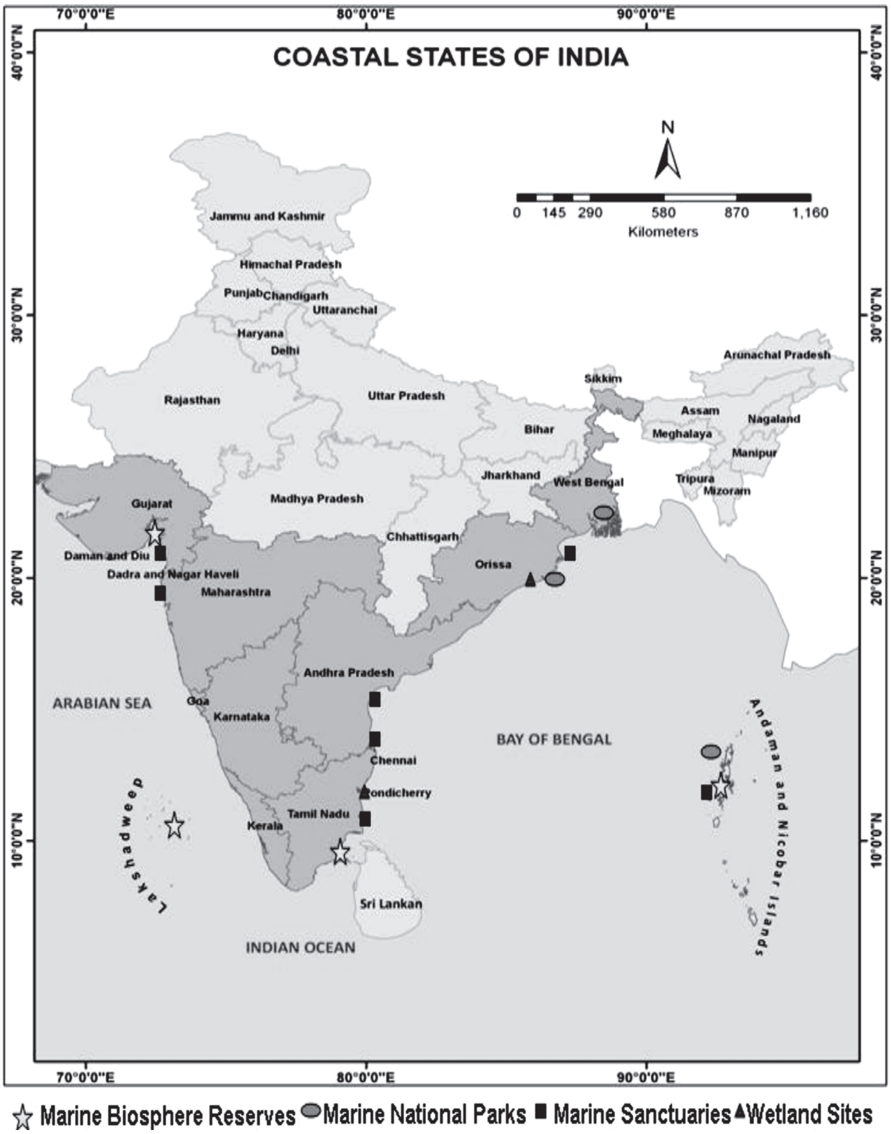

Fig. 1: Protected areas in India

Table.1: **Category-I Marine Protected Areas (National parks and Sanctuaries)**
(MAPs having entire areas in intertidal/subtidal or sea water-mangroves, coral reefs, lagoons, estuaries, beaches etc.,)

S.No	NAME OF THE MPA (District) State/UT	Year of Declaration	Area (sq km)	Ecosystem
1	Pulicat Lake (Bird) Sanctuary Tiruvellore, Tamil Nadu	1967	17.26	Lake of Brackish water of rain and seawater, mangrove and estuarine environment.
2	Point Calimere Sanctuary (Nagapattinam) Tamil Nadu	1967	17.26	Tidal swamp, mangroves, creek and evergreen forests.
3	Sunderbans National Park-Tiger Reserve (North& South 24 parganas) W. B.	1973	1,330.10	Mangroves, estuarine, creeks, swampy islands and mudflats
4	Bhitar Kanika Sanctuary (Kendrapara) Orissa	1975	672.00	Estuary, mangroves, terrestrial forest and ecotone with marine environment.
5	Halliday Sanctuary (South 24 Parganas) West Bengal	1976	5.95	Mangroves, estuaries, swampy islands and mudflats
6	Sajnakhali Sanctuary (South 24 Parganas) West Bengal	1976	362.4	Mangroves, estuaries, creeks, swampy islands and mudflats.
7	Pulicat Lake Bird Sanctuary, (Nellore) Andhra Pradesh	1976	500.00	Brackish water of rain and seawater, mangroves, estuarine and algal beds.
8	Coringa Wildlife sanctuary (East Godavary) Andhra Pradesh	1978	235.70	Mangroves, estuary, back water, creek and mud flats.
9	Gulf of Mannar NP (Ramanathapuram/ Tuticorin) Tamil Nadu.	1980	6.23	21 islands, coral reefs, mangroves, sea grass beds and beaches.
10	Marine Sanctuary Gulf of Kachchh (Jamnagar) Gujarat	1980	295.03	Mangroves, Intertidal area, marine water, coral patches and sandy beach.
11	Gulf of Kachchh Marine NP (Jamnagar) Gujarat	1982	162.89	Mangroves, Coral reefs, mudflats, Creeks, beaches and scrub forest.

12	Mahathma Gandhi Marine NP Wandoor (South Andaman) Andaman	1983	281.50	Tropical evergreen forest, mangroves, Coral reefs, creeks and seawater
13	Lahabarrack (Salt water crocodile) Sanctuary (South Andaman) Andaman	1987	100.00	Dense mangroves (tidal forest), littoral forest, creeks, marine water and tropical evergreen forest.
14	Chilka (Nalabund) WLS (Khundra, Puri, Ganjam) Orissa	1987	15.50	Island, Lagoon and Brackish water.
15	Bhitar Kanika NP (Cuttak) Orissa	1988	145.00	Estuary, delta and mangroves.
16	Rani Jhansi Marine NP (Ritchies Archipelago) Andaman.	1996	256.14	Evergreen forest, mangroves and Coral reefs.
17	Gahirmatha Marine sanctuary (Kendrapara) Orissa	1997	1,435.00	Sea water, sandy beach, estuary mangroves and ecotone with marine environment.
18	Lothian Island Sanctuary (South 24- Parganas) West Bengal	1998	38.00	Mangroves, Estuaries, creeks, swampy islands and mudflats
19	Krishna Wildlife Sanctuary Krishna/Guntur) Andhra Pradesh	1999	194.81	Mangroves, back water, creeks and mud flats.

Table.2: Category II: Marine Protected Areas
(Islands MPAs in Andaman and Nicobar and Lakshadweep Islands, which have major parts in marine ecosystem and some part in terrestrial ecosystem)

S.No	Name of the MPA (District) State/ UT	Year of Declaration	Area (sq km)	Ecosystem
1.	North Bhutan NP (Middle Andaman) Andaman	1987	0.44	Evergreen forest, littoral forest, mangroves, beach and coral reefs.
2	South Bhutan NP (Middle\ Andaman) Andaman	1987	0.03	Evergreen forest, littoral forest, mangroves and beach.
3.	North Reef Island Sanctuary (North Andaman) Andaman	1987	3.48	Evergreen forest, littoral forest, mangroves and beach.

4.	South Reef Island Sanctuary (Middle Andaman) Andaman	1987	1.17	Beach and Coral reefs.
5.	Cuthbert Bay Sanctuary (Middle Andaman)	1987	5.82	Splendid beach and creek.
6.	Cingue Sanctuary (South Andaman) Andaman	1987	9.51	Evergreen forest, coral reef and beach.
7.	Parkinson Island Sanctuary Middle Andaman	1987	0.34	Evergreen and littoral forest and mangroves.
8.	Mangrove Island Sanctuary	1987	0.39	Mangroves and marine life
9.	Blister Island Sanctuary North Andaman	1987	0.26	Mangroves and beach.
10.	Sandy Island Sanctuary South Andaman	1987	1.58	Sandy Islands.
11.	Galathea Bay sanctuary Great Nicobar	1997	11.44	Evergreen forest and mangroves.
12.	Pitti wildlife Sanctuary Lakshadweep	2000	0.01	A small sandy island surrounded by sea.

Table. 3: Biosphere Reserves in Marine Areas

S.No	Name	State	Year of Notification	Area (sq km)
1.	Sundarban	West Bengal	1989	9630
2.	Gulf of Mannar	Tamil Nadu	1989	10500
3	Great Nicobar	Andaman and Nicobar	1989	885

2.2 Areas rich in biodiversity

The priority towards the conservation of marine biodiversity is to identify / locate the areas, which are highly critical and rich in species distribution and their favourable habitats (Ray, 1991). Species diversity can be made as the criteria for ranking the areas for conservation (Grassle *et al*., 1991). An area that harbors smaller assemblage of species is to be given more importance, evolutionary significance, ecological importance and endangerment. An area with lower diversity might be better at providing ecological services important to people. Species diversity differs markedly on both ecological and biogeographic special scales. On an ecological scale, it is important to conserve coral reefs and mangrove forests, which are unusually species rich for its ecosystem type (Bakus, 1994). On a biogeographic scale, using species diversity/

richness as the sole criterion for priority conservation. Areas of high biodiversity may not be most critical to the sea as a whole, for various reasons (Sasikala, 2004). Coral reefs generally have high species diversity but tend to be low in other biological attribute such as endemism. The salt marshes, mangrove forests and seagrass beds can have special importance than coral reefs because they serve as significant nursery areas and their productivity supports important food webs (DeRoy and Thadani, 1992). Moreover, some areas are especially important seasonally because they are critical to key elements of marine biological diversity, even if their diversity is low. These include courtship, spawning areas, nursery grounds, and migration areas and stop over points. The areas rich in productivity, spawning grounds, nursery grounds, migrations are to be protected.

2.3 Marine Biodiversity in India

The marine ecosystem is a varying profile. The coastline encompasses almost all type of intertidal habitat from hyper saline and brackishwater lagoons, estuaries and coastal marsh and mudflats to sandy and rocky shore. The sub-tidal habitats are equally diverse among the coastal wetlands, estuaries, mangroves, coral reefs and coastal lagoons which are areas of rich biodiversity. Each local habitat reflex prevailing environmental factors and is further characterized by its biota. Thus the marine fauna itself demonstrate gradient of change throughout the Indian coast. Among the total 32 animal phyla 15 are represented by taxa in the marine eco system. They may constitutive either migratory or resident species. The former includes pelagic crustaceans, Coelenterate (Medusae), Cephalopods, fishes, reptiles, birds and mammals. The benthic macro fauna comprises residence species of polychaets, bivalves, gastropods, sipunculas and mud- borrowing fishes. Among invertebrates the sponges, phoronids and echinoderms generally do not prefer an estuarine ecosystem. In Indian estuaries, species diversity seems to be maximum in the molluscs. About 245 species belonging to 76 genera under 54 families have been catalogued. Other important taxa, polychaeta are represented by about 167 species belonging to 97 genera under 38 families. Maximum diversity has been reported in the much studied Hooghly- Matla estuary (West Bengal). Macro organisms and meiofauna of Indian estuaries are not properly investigated. Estuarine mud may contain rich variety of bacteria, flagellates, ciliates, nematodes, ostracods, harpacticoid copepods, rotifers, gastrotriches, arachnids, and tardigrades. Free swimmers or nekton are important components of marine biodiversity and constitute important fisheries of world. The dominant taxa in the nekton are fish, others being crustaceans, molluscs, reptiles and mammals. Out of the total 22,000 finfish species, about 4000 species occur in the Indian Ocean of which 1800 species are reported in the Indian seas. A majority of the nektonic species is found in coastal waters. It is estimated that 40 species of shark and 250 species of bony fishes represented the oceanic fishes (Table.3).

Among reptiles, sea snake and turtle are important and represented world wide by 50 and 7 species respectively. These are generally oceanic forms but a majority of them visit the shore at some part of life. About 26 species of sea snake belonging to one family hydrophiidae, and 5 species of sea turtle were reported in seas around India. Oceanic island seem to harbor more reptiles in their marine environment. All the sea snakes and 4 species of turtles in their marine environment are known from island of Andaman and Nicobar. Nesting sites of amphibious snake were reported from the south and north Andaman Island. Sea turtles visit the shore during breeding season to lay their eggs. The visit of these turtles to the shore especially Olive ridley is spectacular site on the sandy beach of Gahirmatha near Bitarkanika in Orissa. The Andaman and Nicobar islands have the nesting beaches for the leatherback the hawksbill and the green turtle in addition Olive ridley. The seashore offers the variable feeding and breeding grounds for a number of birds. It is difficult to define precisely the avian component of marine biodiversity and there are special species, exclusively dependent on the marine ecosystem, while a few are generalists without much dependents on it.

From the available data, it has been inferred that 12 family, 38 genera and 145 species occur in coastal eco system. Marine mammals belong to 3 orders ie., Sirenia, Cetacea and Carnivora. About 120 species are estimated to occur in world seas and of these 30 are reported from seas around India. But a majority of these is found in oceanic forms and occasionally a few individuals may get stranded on the shore. The sea cow occurs in near shore water.

Table.4: Marine Biodiversity in India (* in estuaries/ Mangroves)

S.NO	GROUP	No. of species
1	Algae	724
2	Protista	750
3	Mesozoa	12
4	Porifera	486
5	Cnidaria	842
6	Ctenophore	12
7	Gastrotricha	98
8	Kinorhyncha	10
9	Platyhelminthes	550
10	Annelida	440
11	Mollusca	3370
12	Bryozoa	200
13	Crustacean	2934
14	Merostomata	2
15	Pycnogonia	16
16	Sipuncula	35
17	Echiura	33
18	Tardigrada	10
19	Chaetognatha	30
20	Echinodermata	765

21	Hemichordate	12
22	Protochordata	119
23	Pisces	1800
24	Amphibia	3*
25	Reptiles	26
26	Aves	145
27	Mammalia	29

2.4 Strategies for Conservation and Management of Marine Biodiversity in India

The Indian coast is indented by a number of rivers, which forms estuaries at their confluence with the sea. The complex coastal ecosystems are comprised of estuaries, lagoons, mangroves, backwaters, salt marshes, mud flats, rocky shores and sandy stretches. Besides, there are three Gulfs, one on the east coast, the Gulf of Mannar, and two on the west coast, Gulf of Kutch and Gulf of Camby. The two island ecosystems i.e. Lakshadweep and Andaman and Nicobar Islands, add to the ecosystem diversity in India. The Gulf of Mannar, Gulf of Kutch and the two island ecosystems have rich coral reefs and mangroves harboring valuable marine biodiversity (Anon, 1998; Nammalwar and Edwin Joseph, 2002; Kannaiyan and Venkatraman 2008).

A well-defined set of biodiversity lessons learnt in other regions of the world is proposed for implementation in several different types of regional scale marine ecosystems (Venkataraman, 2003), which needs biodiversity information data bank (Madhav Gadgill and Seshagiri Rao, 1998). These information will permit meaningful comparisons across different habitats of the causes and consequences of changes in biodiversity due to human activities. This lesson requires significant improvement in taxanomic expertise for identifying marine organisms and documenting their distribution, knowledge of local and regional natural patterns of biodiversity and in understanding in the processes that create and maintain these patterns in space and time. (i) Need for rapid expansion in taxonomy in order to interpret, manage, conserve and use biodiversity sustainability and the need to pool together the existing data from all sources by forming an information network of all agencies in the country. (ii). Priority for the biodiversity conservation to understand what values are important, which genes/ species/ habitat and how much biodiversity should be conserved. (iii). Improve the methodologies for different programmes, evolve more effective policy and target with priority. (iv). Practice of the biodiversity conservation programme with precise definition and clear targets. (v). Recognition of priority of the communities. (vi). Application of anthropogenic objectives of maintaining biodiversity so that it is of possible value to the mankind. The conservation of coral and mangrove habitats has attained great significance in developing countries in the context of its functional role in ecological and socio-economic sustainable development and the Ministry of Environment and Forest, Govt. of India can formulate decisive policies for conservation and the management of coral and mangrove habitats along the Indian coast (Anon,2002; Kathiresan and Qasim, 2005 ; Nammalwar 2008).

The species (oyster, octopus, porpoises, whales, sea fishes, sea turtle, sea cow) at risk are quite different from terrestrial ones. The occurrence of endangered and threatened species is less in the sea because it is an open system with few boundaries to migration. While several of the sea mammals and sea turtles are endangered, the fishes and shellfishes are usually not. The species protection by designating protected natural reserves is relatively inexpensive and simple to administer. This strategy can be implemented on a site-specific basis, and commensurate with available information, staffing or expertise. It can be reinforced with regulatory measures that combine “wetside” (estuarine or marine area) protection with “dryside” (shorelines) management strategies offering the possibility of managing whole coastal ecosystems. But first, it is necessary for ICZM process to identify during strategy planning, the critical coastal habitats that merit high degree of protection, so they can be addressed specifically in the Master Plan (Gustavson *et al*., 2000).

a) East Coast of India

The development of coherent and directed multidisciplinary research program for the east coast is considered a priority. This region has a major but not well-understood influence on climate. It contains major recreational values, and potential for tourism which requires further investigation. The area supports the valuable finfish, a growing aquaculture industry and a high level of biodiversity that has not been studied intensively. This biodiversity includes, particularly in southeastern waters, a high degree of diversity of species unique to Indian marine ecosystems.

Although the east coast is highly productive, there are signs that this environment is under pressure. Several bays and estuary systems are under threat from degradation, for example PalkBay, Gulf of Mannar, PulicatLake, Chilka Lagoon and Krishna and Godavari Estuaries. Major seagrass losses have occurred in PalkBay and Gulf of Mannar. Major Fisheries are under threat or in decline. The prawn fishery suffered a major collapse some years ago, and some species show that its spawning population is reduced to dangerously low levels (Nammawar *et.al* 2007).

As a first step, collaborative linkages between research Institutes and Universities should be strengthened, for the purpose of better existing research activity, and developing new multidisciplinary programs in priority areas. The activity would include studies designed to improve understanding of biodiversity and biological processes, and the development of new long-term monitoring programs. Such targeted collaborative research programs are important to the development of the knowledge base as an under pinning to the effective operation of resource based marine industries in the area, and to protection against environment threats. Specific initiatives would include:

- Studies on the ecosystem dynamics of east coast of India;
- Establishing long-term monitoring programs and baseline data sets; and
- Establishing field research stations in Andaman and Nicobar Islands.

b) West Coast of India

There is a strong case for establishment of a multidisciplinary research facility in the west coast to develop an understanding of the region’s marine resources and ecosystems. The major demand for marine science is to build the basic knowledge needed:

- For the continuing sustainable use of marine resources, including traditional uses by Lakshadweep islanders;
- For the continuing success of growing commercial fishing, and aquaculture and pearl industries;
- To understand the marine environment that supports oil and gas industry; and
- Supportive research activity such as mapping of seabed topography, studies designed to improve understanding of biodiversity and biological processes, the designed and implementation of monitoring fisheries development, and development of an understanding of industry impact programs, and research supporting sustainable use of marine environment.

The shared borders with Pakistan, Bangladesh, Maldives and Sri Lanka, and large coastlines supporting similar tropical marine ecosystems in other areas, are further considerations in planning the management of resources in this region, and encourage the concept of joint research programs.

2.5 Strategies for Sustainable Development

The investigation of marine biodiversity possesses a considerable scientific and conservation challenge because of the great size and relative inaccessibility of marine ecosystems (UNESCO, 1992). The scale of marine systems and the mixing dispersion and transport that occur in the oceanic medium require different thinking and investigative processes. Marine pollution, eutrophication (inshore and offshore), sedimentation and silting from coastal run off may outweigh the direct impacts on species (e.g., fishing), or even the indirect effects of climate change. Entire watersheds are obviously involved. Habitat protection is the most serious need for coastal and marine biodiversity. However, this need is very often obscured by different view by the overlaying waters. A spectrum of measures from overall regulation to area specific protection and spectrum of scales from local to global must be involved (Salm and Clark, 1989). There is an urgent need therefore, to establish strictly, comparative data bases for various groups of marine organisms on both global and regional scales, to test the hypothesis relating to the evolutionary and ecological constrains on diversity, and to provide a proper scientific basis for the implementation of conservation measures. The International Association of Biological Oceanography (IABO) in co-operation with UNESCO has launched an international co-operative programme on biological diversity during 1990. The major objective of the programme is to understand biological diversity within the context of the structure and function of ecosystem. The IABO/ UNESCO International Marine Biodiversity programme is of particular importance to global change research given the forecasted climatic changes and their implication for the function of natural and man identified marine ecosystems, within the context of sustainable development. It is extremely important to select representative ecosystems for experimental studies that involve improving the outcome of this prediction, as well as for long-term monitoring of biodiversity, in estuaries, lagoons, coral reefs, mangroves and salt marshes believed to be vulnerable to pronounced climatic and environmental change. One of the most important problems is the necessity to tackle simultaneously global climatic changes, marine biodiversity and sustainable development (Lasserre, 1992). As part of that effort, much more attention and visibility needs to be given to the link between pollution regulation and the ecosystem function of biological diversity. An understanding of marine biodiversity is indispensable for advances in all fields of biology, including ecology, fisheries and aquaculture conservation and pollution. These areas of research are equally important for both developed and developing countries.

2.6 Conservation of Marine Biodiversity through Coastal Zone Management

Some coastal ecosystems are particularly at risk, including saltwater marshes, coastal wetlands, coral reefs, coral atolls and river deltas. Other critical resources, such as mangroves and seagrass beds, submerged systems and mud flats are at risk from climate change impacts, exacerbated by anthropogenic factors (Masan, 1999). Changes in these ecosystems could have major negative effects on tourism, freshwater supplies, fisheries and biodiversities that could make coastal impacts on important economic concern. Coastal zones comprise of aquatic systems including the network of rivers, the estuaries, the coastal fringes of sea and continental shelf and its slope. The functional value of diversity concept encourages analysis to take such a wider perspective and examine changes in large-scale ecological processes, together with the relevant environmental and socio-economic driving forces. At the global scale, while climate has fluctuated throughout time, a global warming scenario could lead to accelerated sea level rise, changes in rainfall patterns and storm frequency or intensity and increased siltation. The consequences may include shore-line erosion and associated loss of habitats, such as salt marshes, mangroves and mud flats. An economic multiplier effect would then be generated leading to, for example, loss in tourism income and fisheries productivity, together with the increased cost of water supply and biodiversity conservation. In principle, the core objective of coastal zone management is the production of a socially desirable mix of coastal environmental system states, products and services. A future, more integrated coastal zone management process should include:

- Integration of programmes and plans for economic development, environment quality management and ICZM
- Integration of ICZM with programmes for such sectors as, fisheries, energy, transportation, water resources management, disposal of waste, tourism and natural hazards management.
- Integration of responsibilities for various tasks of ICZM among the level of government-local state/ provincial, regional, national, international and between the public and private sectors.
- Integration of all elements of management, from planning and design to implementation, that is, construction and installation, operation and maintenance, monitoring and feedback and evaluation over time.
- Integration among the disciplines; for example, ecology, geomorphology, marine biology, economics, engineering, political science and law. Integration of management resources of the agencies and entities involved.

The Integrated Coastal Zone Management process should aim to unite government and the community science and management and sectoral and public interest. It should *interalia* improve the quality of life human communities who depend upon the coastal resources while maintaining the biological diversity and productivity of coastal ecosystems (Clark, 1992).

The rapid industrialization along the coast especially in the areas along the metropolitan cities has caused enormous damage to the coastal ecosystem. Hence, the laws governing the coastal land use should be framed with a view to promoting the economic development designed in tune with the coastal ecosystem.

Threats to marine biodiversity could be categorized which include; habitat loss, population, pollution, natural disasters and over exploitation. Destruction of thousands of mangrove forests and coastal wetlands for the construction aquaculture farms in certain

coastal states were reported. Besides these threats, the coral reefs are also subjected to man made pollution such as heavy metals, fertilizers and sewage and industrial wastes.

Together, the unintended consequences of over fishing, by-catches and habitat degradation can alter the very biodiversity, productivity and resilience of marine ecosystems on which economically valuable species and fisheries depend (Menon and Pillai, 1996).

3. Key Challenges

Conservation of marine biodiversity in India can be best managed by the following guidance;

i. Revitalizing the 200 year tradition of marine biodiversity inventorying in order to interpret, manage, censor and use bio-resources in sustainable manner.
ii. Reconstruction/restoration of lost habitats.
iii. Reduction of discards, by-catch being thrown overboard.
iv. Establishment and management of marine protected areas.
v. Ecosystem based fisheries management
vi. Formulation of effective policy measures
vii. Economic values of biological resources of coral reef ecosystem of India in the international market and impact due export revalidated.

4. Conclusions

The biodiversity/bio-resources of many habitats is under threat and although seas cover the major part of our earth, far less is known about the biodiversity/bio-resources of marine environment than that of terrestrial ecosystem. Unless we have firmer idea of the diversity of a wide range of marine habitats, we have little hope of conserving biodiversity or determining the impact of human activities such as mari-culture, fishing, dumping of waste and pollution. Therefore, recognition of scale of the problems and the nature of underling causes, will definitely lead to a best way of conserving the marine biological diversity of India.

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Coastal Zone Environment And Management In India

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Abstract

The coastal zone is the broad interface between land and sea is a dynamic area with many cyclic and exchange processes occur at high rates of intensity owing to a variety of resources and habitats. The coastal zone although occupies only a narrow stretch of marine biosphere, it offers tremendous opportunity for an array of economic activities. Ecologically, the coastal zone is an area of dynamic, biological, hydraulic, geological and chemical activities supporting various forms of human use. The coastal region is thus a place of hectic human activity, followed by intense urbanization, resulting in human interference because of human development. The coastal ecosystem is now highly distributed and very much threatened, encountering problem like pollution, siltation, erosion, accretion, subsidence occurring on shoreline of river deltas, flooding, salt water intrusion and ever expanding human settlements. Problems in coastal zone ecology is continuously increasing due to accelerated rise of sea level, extreme weather events like storm surges, cyclones, tsunami, pollution changes in bio geo-sphere leading to extinction of sensitive ecosystem and precious biodiversified species. This has thrown new challenges to scientists, engineers, planning managers, government agencies, and stakeholders, policy makers to device suitable methods to manage and protect the coastal zone in an integrated manner. As the only way to combat this problem and protect the coastal zone for future generation, the concept of coastal zone management has been developed by many countries around the world. The need for such an integrated management exercise has become formidable option to all maritime states in India. Suitable management strategies for responsible integrated coastal zone planning and management for protection and to prevent further deterioration of the coastal environment and above all for responsible utilization of our coastal resources are discussed in this paper.

Key words: Coastal zone environment; resources and habitats; urbanization; pollution; protection and management.

Introduction:

The coastal zone provides immense opportunities for ecologically oriented forestry, fisheries, tourism, harbour and port development activities and for expert oriented industrial and agricultural activity. In spite of such potential, the coastal communities are generally poor with uncertain and fluctuating income based on the quantity of fish caught and volume of tourist traffic. The already precarious livelihood security of coastal aquaculture farm and fishermen families living along the coast is being further threatened by activities such as coastal deforestation including cutting of mangroves, construction of buildings for the purpose of tourism very near the coast line, coastal erosion / accretion, pollution and unsustainable exploitation of living coastal marine resources.

Integrated Coastal Zone Management (ICZM) is a process meant for the management of coastal marine resources using an integrated approach covering all aspects of the coastal zone including geographical and political boundaries that will ensure sustainability. This concept was born only in 1992 during the historic earth summit of Reo de Janeiro although the various uses of coastal zone for the benefit of mankind are known since the dawn of civilization. This has aroused due to the conflicts over the use of the coastal resources by different **stakeholders** followed by intensification of man's interference that has demonstrated the loss of habitat and resources. The policy document regarding ICZM is set out in the proceedings of the earth summit has made it almost mandatory for all maritime nations to concentrate on Coastal Zone studies at local, regional, national and global scales. The Indian subcontinent laced by two arms of the northern Indian Ocean, the Arabian Sea forming the west coast and Bay of Bengal forming the east coast, **which has a coastline** length of about 7,500 km. The diversified coastal zone habitats such as extensive areas of estuaries and mangroves, coral belts and seaweed beds, beautiful and pristine beaches, lagoons and backwaters with their unique flora and fauna in the mainland and bay islands offer tremendous opportunity for economic development processes. The coastal zone habitats however have shown signs of deterioration coupled with loss of biodiversity as a consequence of mindless intervention of man and the destructive natural hazards. Thus, integrated management exercise has become a formidable option to all maritime states.

Coastal management may be subdivided into three broad areas – policy, planning and practice. Almost all the coastal issues can be discussed under these headings.

Policy related to the political and administrative **framework** through which coastal management is regulated, be it by legislation, education or a combination of both.

Planning is the process resource allocation, be it by environment, ecological, social or economic yardsticks. Planning may be negative in that it may discourage development or, positive in that it encourages it. Practice covers the techniques needed for the implementation of planning decisions or for undertaking restorative or remedial measures. Obviously, policy, planning and practice fall within a major feedback loop, as further planning/policy decisions are often taken in the light of performance.

The paramount objective of coastal management is to devise a framework within which man may live harmoniously with nature. Or, in current jargon, to provide "sustainable utilization" of coastal resources.

To summarise, there are six major spheres of human activity along the coast.

1. Residential and recreational
2. Industrial and commercial
3. Waste disposal
4. Agriculture, aquaculture and fisheries
5. Nature reserves, and heritage areas
6. Military strategic areas,

Some of which are complementary, while others conflict, since the shorelines always support multiple activities.

The coastal management issues are complex, involving political, economic and environmental arguments. Many issues have a clear spatial dimension, allowing rational decisions on siting, zoning and timing to facilitate management.

The coastal management can be examined under five main headings.

1. Organisational frameworks
2. Coastal water management
3. Coastal land management
4. Coastal ecosystem management
5. Coastal hazards management.

Coastal zone problems:

The areas in India face wide range of problems. A recent region survey conducted by international Ocean Institute, Operational Centre at Madras revealed several problems and the results obtained are shown in the Fig.1. The problems were rated according to their importance from 5 to 1.

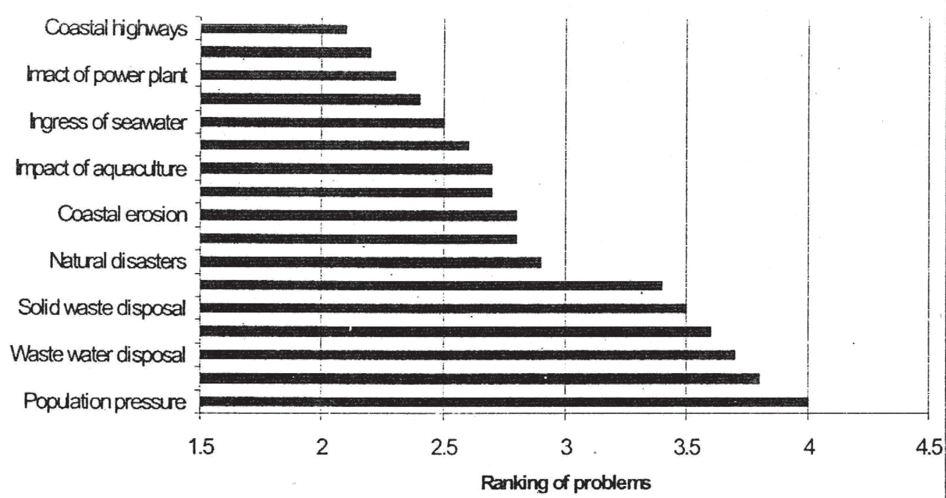


Fig-1 Coastal zone Problems in India

As per the survey, in India, population pressure has been considered as the most important problem. Environment such as destruction of mangroves along with pollution and urbanization are considered as the next serious problem. Surprisingly, the much talked about aquaculture received a low rating. Similarly, Sea level rise is also not considered as a major issue (Rajagopalan, 1996). Ranking of problems on the coastal zone have been described. Traditionally coastal areas are highly populated and developed because they are the places where trade, transport, communication and civilization are well developed. It is estimated that out of the total of 25 global mega cities, 15 would be on the coast. In India, out of the **3-mega** cities with population more than 10 million, Delhi (13.2M), Bombay (16M) and Calcutta (16.5M), two are coastal cities i.e., Bombay and Calcutta (Sinha, 1996). The population density is also much more in coastal areas than the national average. For example, in the state of Tamilnadu, the population density in coastal areas is 528per sq.km. The increased population pressure led to resource depletion and environment degradation.

Coastal issues:

Currently, almost all coastal issues raise conflict between coastal users and interest group-between developers and ecologists, engineers and geologists and land owners and economists. While some issues can be smoothed by education, others require legislation. In recent years, the shift in coastal management is from direct resolution of conflicts towards planned avoidance of them. Some of the most important coastal issues are:-

a. **Sea level variations**: the reasons for which are complex, but one factor seems to be an increase in atmospheric CO2, and trace gases, leading to increased heat absorption – the so called "Greenhouse effect". Planning to mange this is perhaps the most crucial environmental issue facing coastal scientists at present and in the near future.

b. **Storm hazards**: destructive coastal storms are common and massive increase activities along the coast have led to more deaths and damages. There is a need for integrated coastal planning to offset potential dangers, in addition to increasing our capacity to install early warning systems, to reduce risks.

c. **Shoreline erosion:** the traditional engineering methods for "holding the shoreline" are now justifiably questioned in the light of down coast repercussions. Devising and testing more flexible techniques and strategies for erosion control has paralleled a new wealth of knowledge into the root causes of coastal erosion.

d. **Coastal Protection:** Against tidal flooding needs more sensitive environmental designs and innovative low cost techniques as used recently in Netherlands.

e. **Recreational despoliation destabilization** of the coast had led not only to ugly disfigurement of many previously scenic coasts but also to economic disruption. Lack of foresight in recreation development leads to destruction of fragile ecosystems; ironically, often the attraction of these ecosystem only encouraged the initial development.

f. **Coastal wetlands,** including shallow inter – and sub – tidal areas, act as nurseries for fishes from adjacent coastal waters and therefore their loss will have a marked effect on biological productivity.

g. **Waste disposal –**Indiscriminate dumping often results in widespread phsysico- chemical changes; with radioactive waste, there is a direct threat to health. In addition, there is gradual environmental deterioration, leading to declining diversity or productivity. Only way to improve this situation is by imposition of new environmental standards by national and regional decrease.

h. **Coastal energy –**Both the harnessing of coastal energy from thermal, waves and tides and the siting of conventional or nuclear power plants along the coast give rise for concern. The potential impacts are considerable and call for thorough investigations.

i. **Sustained productivity and diversity in coastal ecosystems- u**ncontrolled enrichment or exploitation of many coastal ecosystems will cause changes in ecological structure, productivity and diversity. An ecosystem is always finely balanced, recycling only a particular quantity of nutrients to sustain production. Further, unsympathetic management will definitely lead only to deterioration in geomorphology and ecological diversity.

j. **Salt water intrusion and subsidence of coastal aquifers -**The abstraction of ground water form fresh water coastal aquifers will lead to both the landward encroachment of saline waters and the subsidence of coastal lands. Rational use is needed.

In the coastal context, increasing public awareness plus increasing scientific knowledge will only have a major influence on management. The need for assessment and evaluation in order to retain the quality of the environment must be considered in tandem with the economic need to invest and develop. The basic target should be to sustain environmental quality commensurate with growth. The need to integrate environment and engineering (as well as technology) is a persistent theme and in order to achieve this, we need to examine the physical and biological framework of coastal studies and the scales and tares of change.

A careful assessment of coastal changes must form the cornerstone of effective coastal management. The idea of changes not a new one in coastal study. For coastal scientists and engineers, many of the best clues for such changes come from geologists, meteorologists and biologists, all of which disciplines have undergone a revolution in approach in recent years, due to wide spread introduction of information technology and attendant data acquisition and handling method with profound effects. While defining and understanding the environmental issues facing coastlines are crucial, the need to provide an effective executive structure for management is equally important. The general aim of such agency is to preserve environmental quality in the phase of acceleration resource use, by fostering scientific and management co-operation and funding.

It is not easy to organize a coastal management **framework**. Lack of integration between various government departments with vested interests, difficulties in achieving consistency from place to place and lack of finance are all common complaints and constrains. There are two basic approaches to the national and / or regional organization of coastal management, first, the creation of specific authority and secondly, a nebulous association of interested agencies or departments perhaps with a designated lead agency. The grafting of coastal management onto existing administrative, judicial and legislative structures is not easy and often results in interagency conflicts. Resolution of such conflicts quite often requires compromise solutions, leaving the coast to suffer from less effective management. Invariably, compromise the major tactic in **an** economically biased democracy is not at all acceptable in environmental issues.

There is a growing awareness now in environmental issues and there is also a persistent need to preserve and conserve and sustain the quality of life afforded by our surrounding environment. The simple creation of more wealth is no answer to environmental degradation, since the external costs of economic activity will rise sharply if nothing is done to maintain environmental quality. A pragmatic approach is to ensure that everybody knows what everybody else is doing. Let our motto be environmental awareness and good coastal management.

COASTAL ENVIRONMENT:

The mainland coastline of India is remarkably unintended and generally emergent. The Indian coastal zone comprises of (i) the east and west coasts of mainland and (ii) three groups of islands, the Lakshadweep in the southern Arabian Sea and Andaman and Nicobar island groups in the eastern Bay of Bengal. The east and west coast are markedly different in their geo morphology. The west coast is generally exposed with heavy surf and rocky shores and headlands. The east coast is generally shelving with beaches, lagoons, deltas and marshes. It is also relatively low lying with extensive alluvial plains and deltas (Table. 1)

Table 1: Characteristics of east coast

State	Characteristic feature	Ecologically sensitive area
Tamilnadu	Coastal length -1026km Narrow belt of sand dunes, low – lying beach, plains mostly formed by rivers. Two major, two intermediate and two minor ports.	Tuticorin – Chank and pearl bedsCoral reefs at Gulf of MannarWildlife sanctuary at vedaranyam Mangrove at Pichavaram and Muthupet
Andhra Pradesh	Coastal length – 1014km. the coastline is smooth and long with inundations, deltaic coast– Krishna and Godavari, marshy, muddy coast. Port at Vishakapatnam.	Pulicatkake – Largest lagoon Mangroves at Krishna and Godavari delta Wild life sanctuary at Kolleru lake14 santuaries
Orrisa	Coastal length – 450km. Coast is depositrional , formed by Mahanadi, Brahmani and Baitarani delta. Port at paradip.	Wildlifesantuary at BhitarkanikaMangrove at Mahanadi deltaLargest lagoon – Chilka Lake
West Bengal	Coast langth – 200km. ganga and Brahmaputra river systems create large intertidal , deltaic mass. Hugli mouth is uneven formed by massive sedimentation, coast and roffed with innumerable tidal creeks and estuaries.	Sundarbans – Largest mangrove forests, Swamps and back waters.

Characteristics of Island coast

State	Characteristic features	Ecologically sensitive areas
Andaman and Nicobar island	Coastal length – 1962km. 340 islands of volcanic origin, irregular coast, limited shelf area, mostly inundated by bays, inlets, estuaries and lagoons.	Mangroves and coral reefs, 16 national parks and 94 wildlife sanctuaries
Lakshadweep	Coastal length – 132 km. 36 archipelago islands consisting of 12 atolls, 3 reefs and 5 submerged banks	Coral reefs

Characteristics of west coast

State	Characteristic feature	Ecologically sensitive area
Kerala	Coastal length – 560km. chain of brakish water, lagoons and backwaters parallel to the coast, beautiful beaches, estuaries and lagoons, harbor at kochi	Asthamudi and Vembanad lakes, Cochin backwaters
Karnataka	Coastal length – 295 km. Straight coastline broken at numerous places by river by rivulets, creeks and bays. Northern part is rocky coast	Wildlife and mangroves at Gokaran
Maharashtra	Coastline – 720km. Rocky coast belt broken by small bays, creeks and fringed with islands. No major rivers. Major port at Mumbai.	Marine sanctuary at Malvan
Gujarat	Coastal length – 1663km. Gilf of Kuchchh and Gulf of cambay with extensive continental shelf area and shallow coast, sandy intertidal Zone with vast stretch of muddy or sand stone areas. Port at Kandla, Porbandar and Okha.	Mangrove, Coral reefs at gulf of Kuchchh.

The coastal environmental problems and issues in India are concerned with the following three main conditions: environmental degradation, resources reduction and user conflicts. The integrated coastal zone management plan has been recognized as a tool for addressing these issues and identified as a means to achieve the sustainable development options that ensure livelihood security and environmental stability in coastal zones.

COASTAL POLLUTION:

The major activities that are responsible for coastal pollution in India are discharge and disposable of untreated domestic and industrial wastes, discharges of coolant waters, harbour activities such as dredging, cargo handling, dumping of ship waste, spilling of cargo's chemical and metal ores, oil transport, fishing activities such as mechanized fishing vessel movement, draining of waste oil, painting of fishing vessels, scrapping of metal linings of fishing boards, dumping of waste and trash fishes, oil transport, oil exploration and oil refining activities, ship breaking, recreational and tourism activities, salt production etc.,(Ramachandran 2001).

The coastal areas of Tamilnadu are assuming greater importance owing to increasing human population, urbanization and accelerated industrial activities. There are about 12,000 industries in Tamilnadu, out of these 5500 industries are located in coastal districts and 2500 are situated near the coast. The major congregation of industries along Chennai coast where 1500 industries are located.

a. Disposal of domestic wastes:

Domestic are discharges mostly in untreated conditions due to lack of treatment facilities in most of the cities and towns (Ramachandran, *et al*, 1991). It has been estimated that approximately 18240 mld (Million Liters per Day) reach the coastal waters of the country.

A preliminary survey was conducted to assess the pollution load discharged directly into the coastal waters along the Chennai coast – Tamilnadu. The quantum of domestic sewage output in Chennai metropolitan area has been estimated to be about 51-million gallons/ day and out of that 1.8 million, 15.4 million and 0.9million gallons/ day is allowed to flow into Adyar, cooum and Ennore estuaries along the Chennai coast respectively. It has been estimated that about 7,75,000 litres/ day, 2,52,000 liters/ day, 4,49,000liters/day of industrial effluents carrying heavy metallic elements are discharged into these river estuarine ecosystems, respectively (Nammalwar, 1982, 1995)

b. Industrial wastes:

India is one of the largest industrialized nations in the world. Major industrial cities and towns in the country such as Surat, Bombay, Cochin, Madras, Vishakhapatnam and Calcutta are situated on or near the coastline. The estimated total quantity of waste discharged by these industries is estimated to be approximately 700 million cu.m. (Department of Ocean Development Report, 1996). The Central Pollution Control Board has recently compiled a report on the pollution potential of the industries in coastal areas of India.

COASTAL VULNERABILITY:

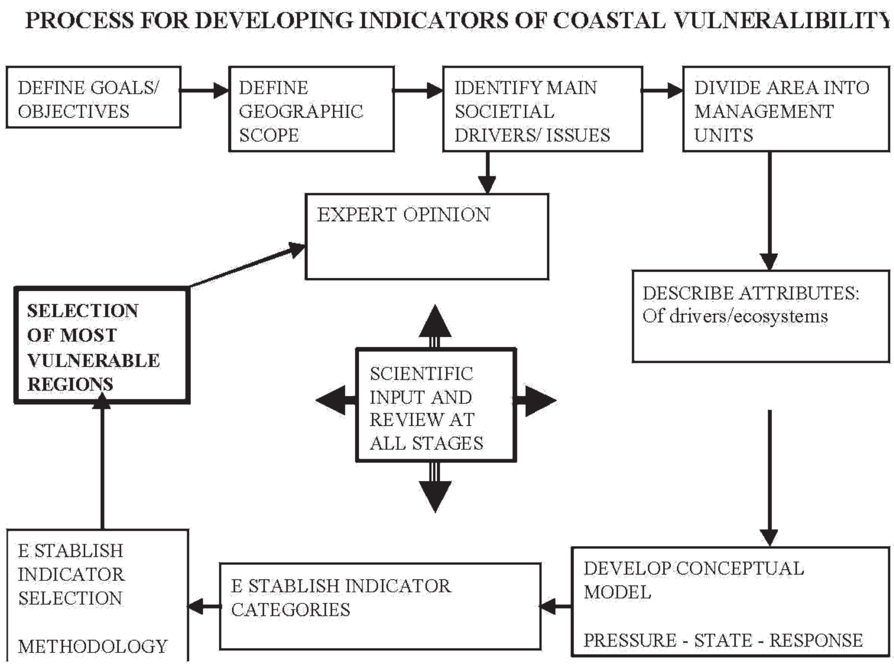
Many of the coastal fishing villages are vulnerable to sea level rise as they are located close to the **seashore**. The data on vulnerable fishing villages will be useful to sensitize the fishing communities on the perils of rising sea level and to take up appropriate disaster management. In this context, a survey has been conducted by the Central Marine Fisheries Research Institute (CMFRI, 2008) to find out the distance from high tide line (HTL) to each fishing village.

As India globalizes, the impacts of development are increasingly felt in the 13 coastal states through increased multilateral investment, new industry, increased rural urban migration, and other societal forces. This is already evident in increased levels of investment in the country, and especially in the 13 coastal states of India, and more policy decisions to gear up the economy to open up and out. The coast has come to assume a special significance, for its logistic advantages, more developed infrastructure, potential for accommodating global tourism, and also supporting export industries such as aquaculture. In this paper, we identify and examine the drivers of change on local coastal ecosystems as a first step towards contributing to more integrated thinking on coastal management issues.

A number of different frameworks have been proposed to measure links between development and the environment. Pressures have been defined more broadly through the inclusion of factors, human and non-human. Second, pressures have been divided into three sub-categories: underlying, indirect, and direct pressures. Underlying pressures include social and demographic forces, technological change, and policies that stimulate economic activities. Indirect pressures include human activities (mostly but not exclusively economic activities) intended to benefit human welfare, as well as some natural processes and forces, such as nutrient cycles, volcanic eruptions, earthquakes, and meteorological events and cycles.

Direct pressures include actual biophysical stresses on the environment, such as pollutant releases, resource extraction, and exotic species introductions. Ecosystem approaches which are based on assessing the performance of a sector according to ecological, economic, and social dimensions and use four criteria for sustainability: productivity, resilience, stability, and equity.

The process of developing the indicators of the coastal vulnerability is summarized in Figure 2.



framework (poster abstract presented at the 1999 International Conference on ecosystem health, Sacramento, California, August 1999).

The following are the main drivers of change in coastal India: Urbanization, Industrial activity, Intensive aquaculture/agriculture, Tourism and Port activity. The main pressures for the ecosystems from urbanization arise from the growth of population whether due to migration or natural growth and the consequent increase in demand for water, land, sewerage and other infrastructure. Coastal areas in India are particularly vulnerable to pressures from urbanization, as 25% of its one billion people live along the coast and the migration to coastal areas occurs all the time.

The ecosystems considered here are mangroves and dune vegetation, coastal aquifers and near shore coastal water. These are also typically the ecosystems that are stressed by anthropogenic activity in Indian coastal areas. Mangroves are generally found in the littoral zones of tropical and subtropical sheltered coastlines. Quite apart from their role as coastal stabilizers and buffer zones, these ecosystems are very highly productive, which enables them to support large artisanal and commercial fisheries. Very recent studies have estimated a mangrove cover of approximately 3,15,000 ha in the country of which almost 80% occurs long the northeastern (Orissa and West Bengal) coast and in the Andaman and Nicobar group of islands. Approximately over 80% (2,67,000 ha) of the total Indian mangrove cover, exists in the deltaic regions, of which 78% occurs in the Ganges (Sunderbans) delta alone. The Gulf of Kuchchh and Gulf of Khambat and Kerala coasts have most degraded mangroves.

Sand dune vegetation has been classified into the pioneer zone, mid shore zone and the backshore zone. The pioneer zone is closest to the sea and the backshore zone is the farthest. The three zones together form a vegetation slope, which acts as a block to the movement of wind and sand. Plants on dune systems flourish with the organic matter brought by high waves during storms or heavy winds. The berm swells due to the aeolian import of sand dune vegetation traps sands and thereby increases the amount of sand in the dunes. Sand dunes play a vital role in protecting the coast from erosion and flooding. One of the important factors in dune stability is the cover it provides. The number of dune vegetation species on India’s west coast is almost double that on the east coast.

The key characteristics for each of the ecosystems of our study are given in the chart below.

Characteristics of ecosystems

Ecosystem	Characteristic/attribute
Coastal water	Water quality
Groundwater	Water quality and quantity
Mangrove vegetation	Area covered, trends in composition and Abundance

The state indicators are based on the characteristics of the ecosystems or surrogates that provide information on the condition of the ecosystems. The following were used for this study:

- Coastal water: (physical, chemical, biological parameters)
- Coastal aquifers: (physical, chemical, biological parameters)
- Mangroves/dune vegetation: (basal area covered, number of species, canopy cover) To assess the state of ecosystems (groundwater, mangroves, coastal waters) in the coastal districts, the following indicators were used to grade coastal ecosystem health.

- Coastal water: levels of DO, BOD, pH, colour and odour, floating matter, turbidity, suspended solids, oil and grease, heavy metals (Hg, Pb, Cd), dissolved iron, manganese, faecal coliform and following the use classification suggested by the CPCB (SW1 to SW5).
- Ground water: levels of pH value, coliform count, TDS (ppm), nitrate (ppm), specific conductivity (micro seimen/cm), hardness (ppm), percentage of sodium, boron (ppm), depth to WT (m), total groundwater draft (%), rainfall recharge (%) and aquifer type.
- Mangrove vegetation: Area covered by forest, number of species, and luxuriance of the forest.
- Indicators of the health of coastal ecosystems within each district were placed in grades from 1-5. The grades/categories used to indicate the quality of each ecosystem are: Good - 1, moderately affected - 2, affected – 3, highly affected – 4, and severely affected - 5. Using the indicators described above, these grades were assigned to each ecosystem within each district based on the experts' (scientists working with the each of the relevant ecosystem) opinion. These five levels are taken as scores of each state indicator (from 1 - 5). The scores were summed for all three ecosystems and the district, with the highest score for state indicators, was assigned the highest rank indicating that the ecosystems here were the most affected.
- Figure 3 presented below summarize the hypothesized links between driver and ecosystem. Coastal districts most threatened or vulnerable to development activities were those ranked high for both drivers and for stressed ecosystems. The Venn diagram (Figure 4) below illustrates this

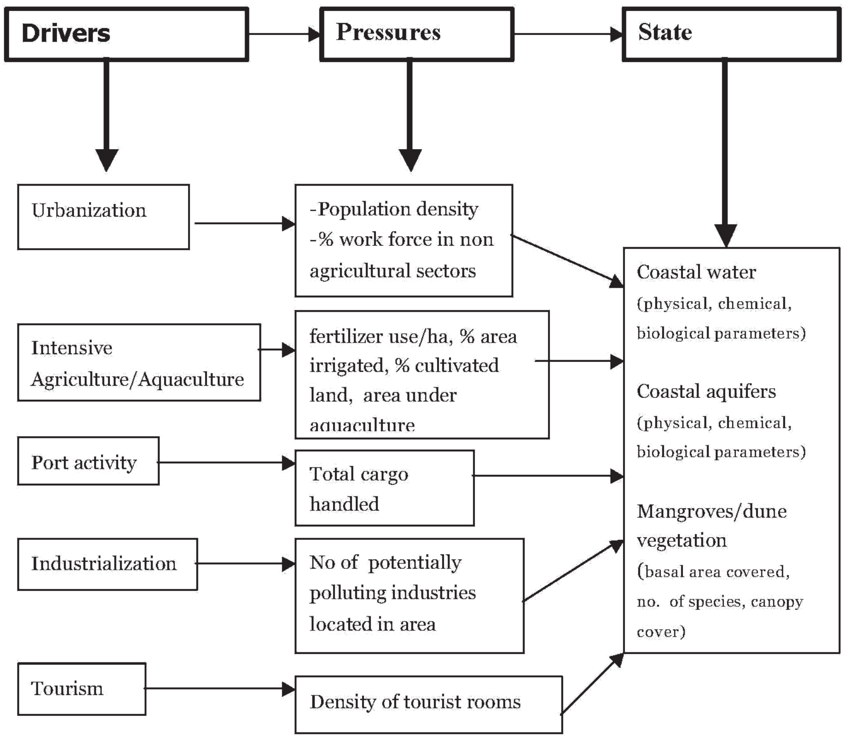


Fig.3: The Diver – pressure state indicator framework

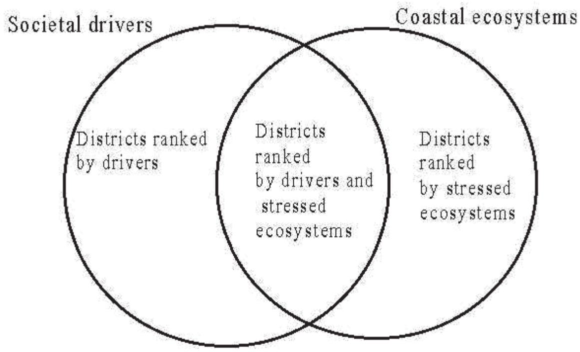


Fig.4: Potentially vulnerable coastal districts

If these districts are examined for (1) pressures from the various drivers, and (2) ecosystem stress, we get:

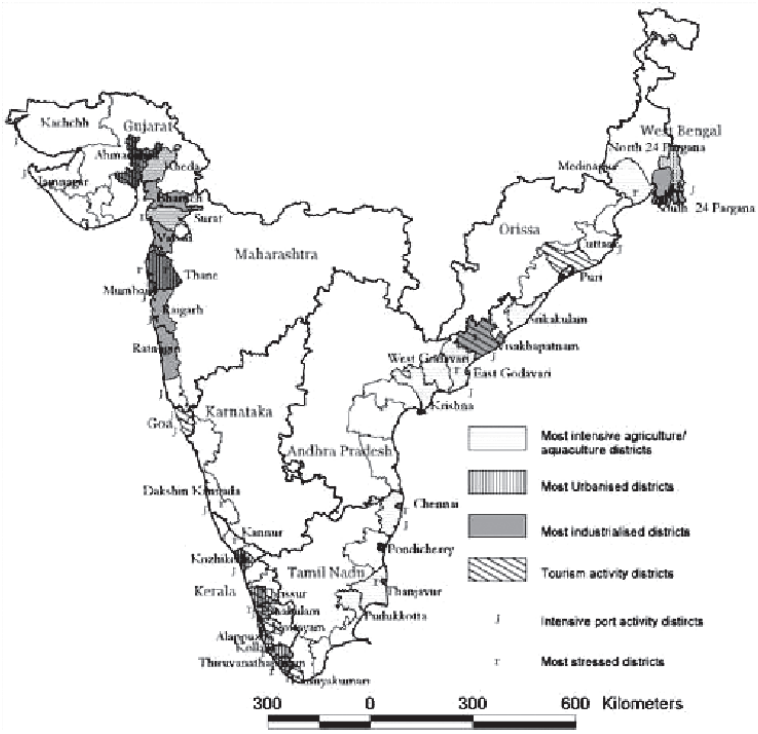
- Urbanization driver: Of the 15 districts potentially threatened by urbanization pressures, only six can be said to have affected ecosystems. These are Mumbai, Chennai, Ernakulam, Trivandrum, Quilon, and Thane.
- Industrial activity: Of the 15 districts potentially threatened by heavy industrial activity, only four districts can be termed affected: Mumbai, Chennai, Thane, and Visakapatnam.
- Intensive aquaculture/agriculture driver: Mednipur, Ernakulam and East Godavari emerge as districts most representative of intense agricultural activities. Among these, East Godavari has the highest aqua cultural activities. These also have affected ecosystems.
- Port activity: Of the 15 districts potentially threatened by port activity, only seven districts can be said to have affected ecosystems. Mumbai, Chennai, Vishakhapatanam, Dakshin Kannad, Ernakulam, Jamnagar, and East Godavari.
- Tourism activity: The districts of Mumbai, Chennai, North Goa, South Goa, Ernakulam, Trivendrum and Visakhapatnam emerge as potentially vulnerable districts.

Table-Coastal districts short-listed by heavy pressures from drivers and with affected Ecosystems

Districts/ Driver listed By ranks	Urbani-zation	Industriali-zation	Aquaculture/ Agriculture	Port Activities	Tourism	Stressed Ecosystem
1	Mumbai	Mumbai	Kheda	Mumbai	Chennai	Mumbai
2	Chennai	Thane	Tanjore	Chennai	Mumbai	Chennai
3	Mahe	Ahmedabad	West Godavari	Kachch	North Goa	Dakshin, Kannada
4	24 Paragnas North	Raigad	24Paragnas North	Visakha-patnam	South Goa	Visakha-patnam
5	Ernakulam	Chennai	Krishna	24Paragnas North	Ernakulam	Ernakulam

Map - Coastal districts defined by drivers and stressed ecosystems

The coastal districts whose ecosystems are vulnerable to development drivers are given in Map.



COASTAL NATURAL HAZARDS:

Natural hazards are intimately connected to the process of human development. Disasters triggered by natural hazards put development gains at risk. About 75% of the world's population living in areas affected at least once by earthquake, tropical cyclones, tsunami, storm surge, flood or drought. In India, nearly 150million people are prone to natural hazards in coastal areas. The Bay of Bengal is one of the five cyclone prone areas of the world. The coastal regions surrounding this Bay are frequently affected by flooding from the sea as well as from the rivers due to tropical cyclones and related storm surges and heavy rainfall. Early warning systems and coastal protection methods being a part of integrated coastal zone management are expected to minimize the laws and control the human interference that increases the degree of severity of these natural hazards.

COASTAL REGULATION ZONE:

Boundary: From the high line up to 500m in the land – ward side. Area between the low tide line and high tide line. In the case of rivers, creeks backwaters, the distance from the high tide level shall apply to both sides and this distance shall not be less than 100 meters or the width of the creek, river or backwater whichever is less, (Ministry of environment and forests Notification, Feb 1994). **Sentence structures are fragmented in this paragraph —consider revising!**

Category – É: (CRZ É). Areas that are ecological sensitive and important such as national parks; marine parks, sanctuaries, reserve forests, wildlife habitats, mangroves, corals/coral reefs, areas close to breeding and spawning grounds of fish and other maritime life, areas of outstanding natural beauty, historically important and heritage areas, areas rich in genetic diversity, areas likely to be inundated due to rise in sea level consequent upon global warming and such other areas as notified by government from time to time.

Category – ÉÉ: (CRZ ÉÉ). The areas that have already been developed upto or close to the shoreline. For this purpose, developed area is referred to as that area within the municipal limits or other legally designed urban areas which are already substantially built up and which have been provided with drainage and approach roads and other infrastructure facilities such as water supply and sewerage lines.

Category – ÉÉÉ: (CRZ ÉÉÉ). Areas that are relatively undisturbed and those**,** which do not belong to either category É or ÉÉ. These will include coastal zone in the rural areas within municipal limits or in other legally designated urban areas, which are not substantially built- up.

Category - ÉV: (CRZ ÉV). Coastal stretch in the Andaman and Nicobar Islands, Lakshadweep and other small islands except those designated as category É, ÉÉ and ÉÉÉ.

As per the CRZ notification, the coastal states must prepare a coastal zone management plan identifying and classifying the CRZ areas within 1 year from the date of CRZ notification i.e., February 1992, nut in reality, till 1998 most of the states did not do it, the CRZ notification also states that during the interim period till the coastal zone management plans are prepared and approved, all developments and activities within CRZ will not violate the provisions of the notification.

COASTAL PROTECTION:

a. Coastal Bio-Shields and their role in coastal protection:

Even eight years after the Indian Ocean tsunami, one of the most widely debated topics has been the role of coastal vegetation in mitigating impacts of the tsunami. Following the aftermath, several publications, both in scientific journals and popular media, staked claims on the positive and protective role coastal vegetation provided in the event of such large-scale natural disasters.

b. Disaster risk reduction measures for coastal protection:

There are many techniques of coastal protection including hard and soft construction and planning approaches. Hard construction is the more traditional response to erosion and involves the constructions of structures which stops wave energy reaching the shore or absorb and reflect the energy.

Hard construction techniques

Sea walls, Revetments, Artificial headlands, offshore breaks, detached breakwater, Groins.

Soft construction techniques

Coastal sand dunes, Cliff Stabilization and Mixed Coast/shore protection by structures and beach fill.

c. Management of coastal protection

Protection of the coast and the shore against the erosive forces of waves, currents and storm surge can be performed in many ways.

- The choice of the measure in given situation depends on three primary conditions:
- The problem (coast, erosion, beach degrading or flooding).
- The morphological conditions (the type coastal profile and type of coastline).
- The land use (infrastructure / habitation, recreation, agriculture etc.)

Protection of coastal marine and estuarine environments is an important component of coastal management and any successful management of coastline requires a detailed understanding of local coastal environment and the processes. Natural bioshields (Shelter beds) such as mangroves, coral reefs, planting trees (*Casuarina*) etc, close to the sea are the possible system to protect coastal areas from cyclone, storm surges and tsunamis.

The oceans and seas are linked to many bodies of fresh water through coastal areas and the two forms and independent ecosystem that spawns much of the world's marine life. A series of program areas aimed by World Bank at protecting the coastal marine environment, promoting sustainable use of marine living recourses and strengthening national and international co–operation. In the past, the World Bank activities are related to marine and coastal management focused on discrete areas, such as fisheries and aquaculture, water supply, sewage and waste disposal, ports development and coastal erosion protection. Since the Rio de Janeiro summit during 1992, however the World Bank and other development practitioners are emphasizing an integrated coastal zone management (ICZM) approach. Most recently the 1995 Jakarta Mandate under the convention of biological diversity, ICZM provides a unifying framework for protecting and managing the world's oceans and coastal areas consistent with environmentally sustainable development. Since 1993 the World Bank has promoted the establishment of integrated coastal zone planning and management through (a) awareness creation and capacity building (b) investment and (c) partnerships. These efforts have paralleled support for coastal marine environmental protection, including pollution control and conservation of marine biodiversity. The combination of awareness creation and capacity building has led to growing investment by many countries in coastal and marine resources management programs, with the support from the World Bank ICZM projects. These projects include strengthening institutions and developing technical skills; establishing environmental systems to identify problems and target interventions; reforming marine policy and regulatory frame works; and introducing innovative, sustainable production technologies. In addition, strategies are being explored of sustainable Mari culture, ecotourism, marine Bio-prospecting and micro-enterprises.

Integrated coastal zone management is essential for coastal zone regulation and planning, monitoring and evaluation for our country.

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Environmental Impact Assessment

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Abstract

1. Introduction

Environmental Impact Assessment (EIA) is a tool to assess and predict impact of a project on Physical, Biological and Human environment and also suggest/recommend mitigation measures. Internationally the process of environmental impact assessment study and formulation of the EIA Report is well defined. The assessment is generally quantified based on objective and subjective judgment of the agency/consultant carrying out the EIA study. This being experience oriented, EIA report prepared by experienced senior consultants are always expected to be of acceptable quality and purposeful. For all practical purpose the present deliberation shall be confined to Indian scenario only.

It should be noted that any new project needs Environmental Clearance (EC) barring a few small projects / developmental activities. The assessing / sanctioning authority scrutinize the project features, identify the probable impacts on air environment, water environment or land environment on the first phase and finally the social / human and ecological impacts are evaluated for decision making.

Governmental actions towards environmental protection in India started only after the famous Stockholm Conference in 1972 attended by India's the then Prime Minister Mrs. Indira Gandhi. If we follow the dates of different enactments towards environmental protection in India the above statement gets justified.

1.1 The background

The first Act towards environmental protection in India was "The Wildlife Protection Act, 1972" and next was "The Water (Prevention & Control of Pollution) Act, 1974" popularly termed 'Water Act'. Thereafter came the "Air (Prevention & Control of Pollution) Act, 1978" popularly termed "Air Act" and so forth. Finally, the Environment (Protection) Act and the Environment (Protection) Rules both dated 1986 paved way for all subsequent fields towards environmental protection in India.

The need of EIA study for Government projects was first introduced in 1982 while the same for private projects was introduced in 1987. In this respect the fist Environmental Guidelines for Siting of Industry was published by the Ministry of Environment & Forests (MOEF) in 1987. In the same year Environmental Guidelines for Thermal Power Plants was also published. Subsequently, several other environmental guidelines have been published and are in use.

Till 1994 EIA study used to be carried out by different consultants as per practice of the respective consultants. Dispersion modeling for gaseous emission to determine the increase in ground level concentration of a gaseous effluent emitted through the stack also used to be different from consultant to consultant. By the time the 1st EIA Notification was issued, a national consensus was arrived by the leadership of the Central Pollution Control Board (CPCB) so that every consultant uses the same formulae and dispersion coefficients. DCPL was a party to this effort by CPCB and contributed positively.

1.2 Generalized definition

An Environmental Impact Assessment (EIA) is an exercise to identify the possible impacts that a proposed project may have on the environment, consisting of the environmental, social and economic aspects. The purpose of the assessment is to ensure that decision makers consider the environmental impacts when deciding whether or not to proceed with a project.

1.3 The history

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."

In 1994, EIA Notification under the Environmental Pollution Act 1986 was introduced. Public Hearing was introduced in 1997.

On Sept. 14, 2006, the EIA Notification -1994 was replaced by a more comprehensive EIA Notification covering a larger variety of projects and activities. In the EIA notification 2006 a schedule is provided for list of Projects or Activities requiring prior Environmental Clearance. All new projects listed in the schedule including expansion, modernization of the existing projects or activities and change in product mix shall require prior Environmental Clearance.

No activity relating to any project covered under this notification including civil construction can be undertaken at site without obtaining prior EC except fencing of the site to protect it from encroachment and construction of temporary shed(s) for the guard(s).

2. Categorization of Projects and Activities

Categorization of the Projects or Activities is done based on the anticipated impact potential of the project activities on human health, natural and manmade resources.

- Category – A
- Category – B

- Category – A Projects : Requires prior EC from EAC / MOEF.
- Category – B Projects: Requires prior EC from State Environmental Impact Assessment Authority (SEIAA).

Stages in Environmental Clearance (EC) Procedure

1. Stage (1) Screening (Only for Category 'B' projects and activities)
2. Stage (2) Scoping
3. Stage (3) Public Consultation
4. Stage (4) Appraisal

Stage (1) : Screening

- Scrutiny of the application (Form – 1) seeking prior Environmental Clearance
- Only for Category 'B' Projects or Activities
- B1 Sub Category – Environmental Impact Assessment (EIA) report required
- B2 Sub Category – Environmental Impact Assessment (EIA) report not required

● **Application for prior Environmental Clearance (EC)**

Application to be submitted in prescribed Form 1 format (the form is available in the MOEF website). Supporting document for Form 1: Pre feasibility report, other documents as applicable like site map, land ownership documents.

The filled in application can be submitted to the concerned authority (EAC-MOEF Delhi or SEAC of concerned State, as the case may be). Some states charge fee and the same is also to be submitted in the requisite form.

Stage (2) : Scoping

Done by the concerned authority. It is the process to determine detailed Terms of Reference (TOR) addressing relevant environmental concerns for preparation of the EIA Report. The EIA will, however, be developed as per the generic structure laid down in the EIA Notification.

In the process of Scoping the authority normally invites the project proponent / its consultants to the present the project before the committee explaining the probable impacts and mitigation measures contemplated, the expected resultant impact etc. Based on clarifications the TOR is determined. From 01.04.2010 *(As per MOEF Memorandum, dated 22nd March 2010)* the prescribed TOR would be valid for a period of 2 years for submission of EIA / EMP Reports, after Public Consultation where so required. The period will be extended to 3rd year after proper justification and approval of EAC / SEAC as the case may be.

Stage (3) : Public Consultation

This is popularly termed as Public Hearing. All category 'A' and category 'B1' projects or activities shall undertake Public Consultation with exemption of followings:

- Modernization of irrigation projects
- Expansion of road or highways projects
- All projects concerning national defence and security etc.
- Any project, located in "Industrial Notified Area".

Public Consultation may be exempted by Expert Appraisal Committee (EAC) if project is not affecting the local people.

Stage (4) : Appraisal

Appraisal means detailed scrutiny of EIA report by Expert Appraisal Committee (EAC) of MoEF or State Level Expert Appraisal Committee (SEAC) of state level.

Outcome of public consultation including has to be submitted as enclosure to the EIA Report. In appraisal proceedings, applicant / authorized representative is invited for necessary clarification.

At this stage, recommendations are made to regulatory authority by EAC either for grant of prior Environmental Clearance (EC) with stipulated terms of conditions or rejection with reasons for the same. Normally ECs are issued with a number of specific conditions that has to be taken care of in the design / implementation.

The prior environmental clearance granted for a project or activity shall be valid for a period of **10 years** in the case of River Valley projects (item 1(c) of the Schedule), project life as estimated by Expert Appraisal Committee or State Level Expert Appraisal Committee subject to a maximum of thirty years for mining projects and **5 years** in the case of all other projects and activities. This period of validity may be extended by the regulatory authority concerned by a **maximum period of 5 years** provided an application is made to the regulatory authority by the applicant within the validity period, together with an updated Form 1, and Supplementary Form 1A, for Construction projects or activities (item 8 of the Schedule).

3. Inputs required for formulation of an EIA Report

As regards basic inputs for the EIA it should be noted that all FR / DPR must contain apart from conventional detail like land, water source, layout, mass balance etc., specific size calculation for waste disposal area like ash disposal area or ash pond.

- Clearly marked Green Belt that should be around 1/3rd of the total land.
- The FR/DPR should have fund provision for CSR reflected in the project cost. For return calculation 2% of profit should be reserved for CSR also.
- Confirmed fuel linkage and water availability has to be there. Without these two prime needs no EIA is even considered for EC.
- Similarly, for availability of power specific confirmation from concerned Distribution Company is essential.
- In case Ground water is used as source of water, clear clearance from Ground Water Board or other local competent authority is a must.
- State Govt. and Local body (like Panchayat) clearance often poses hindrance in proceeding with EC. This must also be included in the DPR.

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