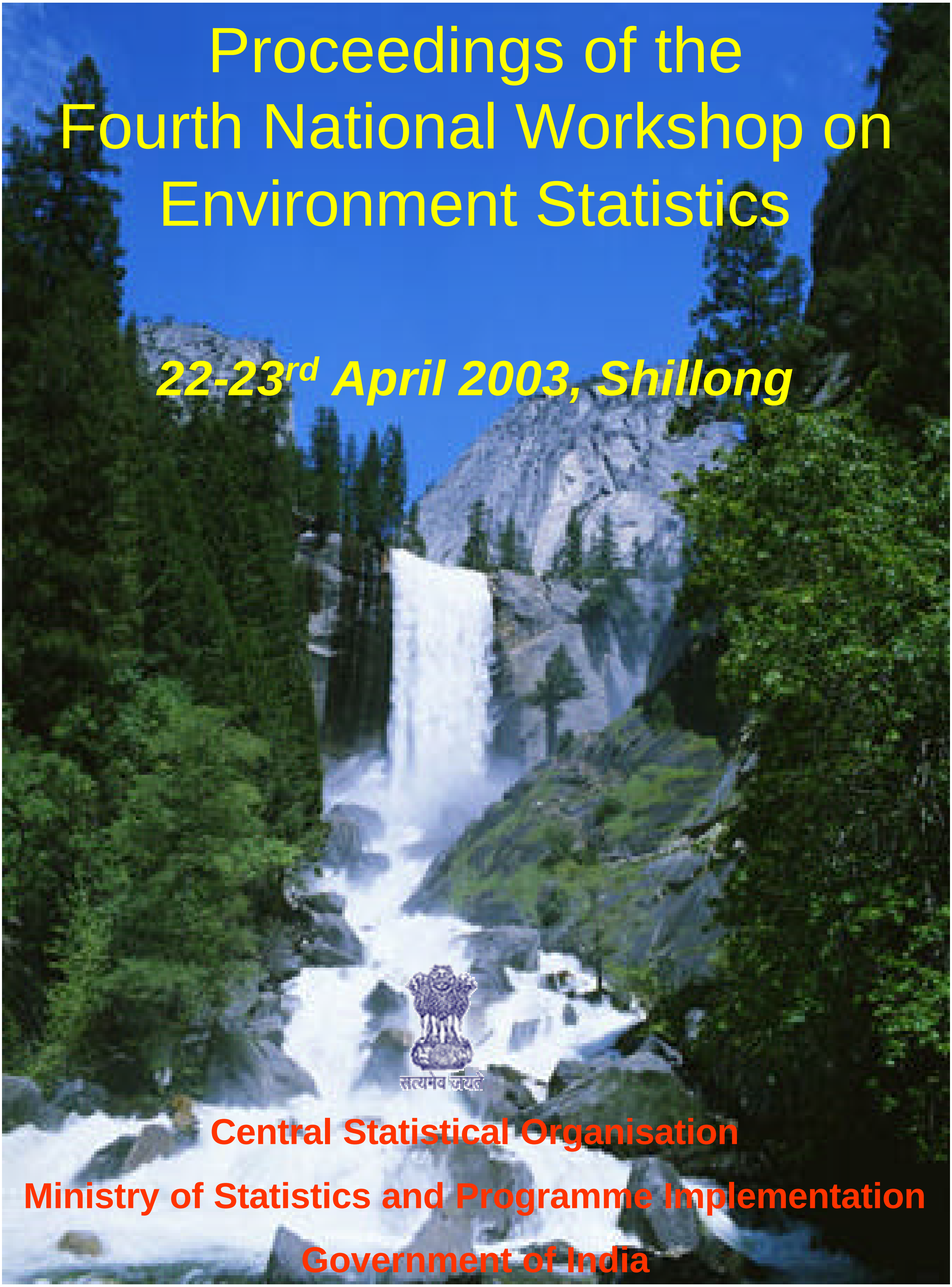

Proceedings of the Fourth National Workshop on Environment Statistics

22-23rd April 2003, Shillong

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Central Statistical Organisation

Ministry of Statistics and Programme Implementation

Government of India

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Preface

Environmental Statistics has come to occupy a very important place in most national statistical systems, next only to economic and socio-demographic statistics. The new branch has quickly become a sprawling field of loosely related topics. Rapid industrialisation and accelerated economic growth have been accompanied by the phenomena environmental degradation and depletion of natural resources. These developments have had an adverse impact on the quality of life and are beginning to circumscribe a wide range of economic activities. To respond to this problem, various national and international organisations concerned with environmental planning and management have been striving to develop an appropriate system for environment statistics.

In 1995, the Asian Development Bank (ADB) initiated the programme of Regional Technical Assistance for Institutional Strengthening and Collection of Environment Statistics in eleven developing countries, including India. In the process of implementation of this project, the then Department of Statistics created an Environmental Statistics Unit within the Central Statistical Organisation (CSO) in 1996. The unit has been organizing workshops to bring environmental scientists and statisticians closer to one another for a better understanding of multi-dimensional environmental issues.

In parallel, the Ministry of Statistics and Programme Implementation commissioned a project on Natural Resource Accounting in Goa through TERI in 1999. The project was based on secondary data. In its report, which was submitted in the first quarter of 2002, TERI highlighted the issues relating to valuation of physical stock and critical data gaps for environmental accounting. Against this backdrop it was decided to organise the fourth national workshop to enable environment statisticians and experts in environmental accounting and environmental management to deliberate on the issues. The workshop focused on harmonization of the framework for environmental accounting in India based on the System of Integrated Environment and Economic Accounting (SEEA) and identification of data requirement for environmental management. This volume is the outcome of the deliberations in the workshop.

A great deal of effort went into the organization of the workshop at Shillong with its attendant logistic difficulties. Thanks to the unstinted cooperation and support of the Government of Meghalaya and the State Directorate of Economics and Statistics under the able leadership of Shri W. L. Lyngdoh, the workshop proved to be an outstanding success.

I should also acknowledge the arduous work put in by all the officers and staff of the Environment Statistics Unit of the CSO. I wish to record, in particular, my appreciation for the contribution made by Shri S. K. Nath, Deputy Director General under the guidance of Dr. Vaskar Saha, Additional Director General. He was assisted in this venture by S/Shri M. C. Sharma, Rajesh Bhatia, Assistant Directors and Vijay Kumar, Computor.

New Delhi
July 1, 2003

Kamal Kant Jaswal
Secretary

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REPORT OF THE INAUGURAL SESSION

The Fourth National Workshop on Environment Statistics was organised by the Central Statistical Organisation (CSO), Ministry of Statistics and Programme Implementation, New Delhi in collaboration with the Directorate of Economics and Statistics, Government of Meghalaya on 22nd and 23rd April 2003 at Shillong.

The dais was honoured by Shri D.D. Lapang, Hon'ble Chief Minister of Megalaya, Shri J. Tayeng, Chief Secretary to the Government of Meghalaya and Shri K.K. Jaswal, Secretary to the Ministry of Statistics and Programme implementation, Government of India. The other dignitaries who were present on the dais were Dr. Vaskar Saha, Additional Director General, CSO, Shri S.K.Nath, Deputy Director General, CSO and Shri W.L.Lyngdoh, Director of Economics and Statistics, Government of Meghalaya.

In his address, Shri W. L. Lyngdoh welcomed the Hon'ble Chief Minister of Meghalaya - Shri Lapang, Secretary to the Government of India, Ministry of Statistics & Programme Implementation - Shri Jaswal, Chief Secretary to the Government of Meghalaya -Shri Tayeng and other Officers of the Government of India, delegates from different States and Institutions of the country to the Workshop.

After the welcome address, the staff of the Directorate of Economics and Statistics presented an invocation song entitled as "Green Green World". All the dignitaries on the dais were felicitated after the invocation song.

Dr. Vaskar Saha, Additional Director General, Central Statistical Organisation, Government of India in his speech mentioned that environmental issue was not a new one, it was first discussed in the historic Stockholm Conference in 1972 after which India took steps to accord priority on the issues relating to environmental protection and conservation of natural resources at the national level. Between the Stockholm Conference in 1972 and the Rio-Summit in June 1992, India took steps to build up suitable organisation structure for bringing out environment statistics for the Country. The Central Statistical Organisation under the direction of the Steering Committee had brought out the 1st Compendium on Environment Statistics in 1997, which has now become an annual publication. While preparing the manuscript of this publication, guidelines provided by the United Nations in the field of environment are kept in view. He also mentioned that the existing system of national accounts did not take into consideration the degradation of environmental quality. Dr. Saha was also of the view that the Seminar would deliberate on the need for suggesting steps to be taken to tackle the problems arising due to unplanned use of natural resources.

The Chief Secretary to the Government of Meghalaya, Shri J. Tayeng in his speech stressed the importance of Environment Statistics, which seek to present human activities relating to environment such as air, soil, land, water, forest and other available resources in the nature. There is a growing and burning issue on the deterioration of environment and the threat posed by pollution, deforestation and degradation of the surroundings. This issue has gained the attention of the Government, Non-Government Organisation and Social Scientists to conduct studies to measure the extent of environmental damages. Here lies the importance of environment statistics, which should provide factual information for use of the policy makers for taking preventive and corrective measures to safeguard the destruction of the environment.

The Chief Secretary further desired that the Central Statistical Organisation being the nodal agency for the improvement of statistical system in India and also the organisation responsible for the development of environment statistics for the country, would provide necessary guidance to the State of Meghalaya, which is still at the initial stage as far as environment statistics is concerned. He also hoped that this workshop has a great potential and we will be able to derive the full benefits from this workshop. He was also of the view that the workshop would provide important inputs for doing further work in the field of environment statistics in the State.

While delivering the keynote address, Shri K.K. Jaswal, Secretary to the Government of India, Ministry of Statistics & Programme Implementation mentioned that the very name of Meghalaya, the Abode of Clouds expresses its tranquil atmosphere. But the rapid demographic expansion and ruthless exploitation of its mineral resources have made the State to face the challenge of preserving its environment. This sensitivity and concern for the environment will change the situation not only in Meghalaya but also the rest of the Country. Regardless of exploitation in the quality of the environment, depletion of the stock of natural resources, the damage done to the environment has been varied and extensive and thus there is an urgent need for statistical analysis to know the present situation.

He further stressed that maintenance of the environment and conservation of its natural resources are crucial to sustain human development. The new emphasis of sustainable development has recognised the need to broaden the assessment of growth and welfare through a modified National Accounting System. Sustainable development is the best approach towards integrating environmental concern into national and international socio-economic development.

The Secretary also stressed about Natural Resource Accounting. He mentioned that various International Organisations have been exploring the feasibility of integrating physical and monetary accounting in the area of natural resources and environment in order to develop macro indicators of environmentally adjusted and sustainable National Income. In India, the first phase of the pilot study on Natural Resource Accounting has been conducted in Goa and the Government have decided to undertake more such studies as per recommendations of the National Statistical Commission. He was confident that the deliberations in this workshop would identify the data gaps and throw valuable suggestions for development of a framework for Natural Resource Accounting in the country.

The Hon'ble Chief Minister of the Government of Meghalaya - Shri D.D. Lapang, then inaugurated the workshop with the lighting of the lamp. In his inaugural address, the Chief Minister thanked the Government of India for having selected Shillong as the venue of this present workshop to create more awareness in the minds of the people of the environment protection although Shillong is perhaps free from industrial pollution but not cent per cent free from other environmental contamination. He mentioned about environmental degradation in the recent past, which the State of Meghalaya has been facing especially due to illegal felling of trees and illegal mining of coal particularly in Jayantia Hills. He stressed that environmental protection is an important issue the world over which has been compounded by the growth of population, development of industries to create employment avenues for the people, lack of sanitation facilities, improper disposal of waste materials, etc. He also hoped that through the interaction between statisticians, social scientists, non-governmental organisations and the government would provide a common approach to pave the way for building up a strong database for environment statistics to serve as information guide for protection of the environment.

At the close of the Inaugural Function, Shri S.K Nath, Deputy Director General, Central Statistical Organisation, Government of India offered a vote of thanks on behalf of the Ministry of Statistics & Programme Implementation.

WELCOME ADDRESS BY SHRI W.L. LYNGDOH, DIRECTOR, DES, SHILLONG

Honb'le Chief Minister of Meghalaya - Shri. D.D. Lapang, Respected Secretary to Government of India, Ministry of Statistics and Programmme Implementation -Shri. K.K. Jaswal, Respected Chief Secretary of Meghalaya - Shri. J. Tayeng, Respected Dr. Vaskar Saha - Additional Director General, Central Statistical Organisation and Shri. S.K.Nath , Deputy Director General, Central Statistical Organisation, Respected delegates from the different States, Organisations and Institutes of the Country, my Officers, Press and Electronics Media. On behalf of the Ministry of Statistics & Programme Implementation, Government of India and the Directorate of Economics & Statistics, Meghalaya, I express my sincere thanks to the Honourable Chief Minister, Shri. D.D.Lapang who is here in our midst, inspite of his tight schedule and Sir, your experience as the Head of the State and your long years in the service to the people will undoubtedly a message of your concern for the Environmental needs of the Country and the whole Universe. I welcome you, Sir to this Fourth National Workshop for building up a sound database on land degradation, deforestation, air and water pollution for effective planning and policy matters to protect the environmental degradation which is a matter of serious concern for all of us as well.

My gratitude goes to the Secretary, Government of India, Shri. K. K. Jaswal for sparing his valuable time to be in our midst particularly in Meghalaya which is perhaps for the first time as Secretary in the present Ministry. Your presence indicates your interest and concern for environmental protection and to conserve the natural resources of our country. I welcome you, Sir.

I cordially welcome the Chief Secretary of Meghalaya - Shri. J. Tayeng. Sir, your presence in this august session with your rich and wide experience in the field of environmental degradation will be an inspiration to have a meaningful interaction in the workshop.

Clean and green is the main theme and has greater relevance to this workshop. The presence of Dr. Vaskar Saha, Additional Director General, Central Statistical Organisation. Shri. S. K. Nath - Deputy Director General, Central Statistical Organisation, Professors of the different Universities , Institutes of. the country, the Director of Economics & Statistics of the different States, Officers of the Ministry of Statistics and Programme Implementation, Government of India and Officers of the Directorate of Economics and Statistics, Meghalaya and other delegates will be a source to develop a good understanding of our environment for appropriate protective and timely corrective steps. I welcome you all to this workshop. Your presence for deliberation in the 2 - day National Workshop will be an instrument to measure the status and strength on environment conditions and to provide environmental indicators to the users and policy makers.

I also extend my warm welcome to the Press, Electronics Media and I request a wider coverage of this Workshop as every citizen of the Country and the World is concerned with environmental degradation.

Thank you

ADDRESS BY DR. VASKAR SAHA, ADG, CSO, MINISTRY OF STATISTICS & PROGRAMME IMPLEMENTATION

Hon'ble Chief Minister of Meghalaya, respected Chief Secretary, Government of Meghalaya, Secretary. Ministry of Statistics and Programme Implementation. Government of India, Shri W. L. Lyngdoh, Director, Directorate of Economics and Statistics, Mcghalaya, Shri S. K. Nath, Deputy Director General, Central Statistical Organisation, experts from academic and research institutions and universities, Senior officers from Government of Meghalaya, distinguished participants and delegates from Central Ministries and Departments and State Governments from different parts of the country, and, Ladies and Gentlemen,

I consider it as my proud privilege to address this august gathering on the occasion of inauguration of the Fourth National Workshop on Environment I Statistics in Shillong. From this Workshop it is quite clear that the Ministry of ! Statistics and Programme Implementation had organized the National Workshop on Environment Statistics three times earlier also. The first National Workshop on this subject was organized in January 1998 in Goa. Subsequently, two more Workshops were organized in April 2000 and February 2001 in Hyderabad and Thiruvananthapuram. I am happy that the present Workshop is being organized in this beautiful hill city Shillong. This Workshop will not only give a respite for at I least two days from the rising mercury to those who have come from plane but also, I am sure, will provide an excellent opportunity to the experts, academicians and planners to make an assessment on the work done so far in this very important area and suggest concrete plan of action to be taken for achieving the goal of the , preparation of Green Gross Domestic Products which is also popularly known as ! Green GDP. The policy makers and planners have now accepted the need for a more integrated view of economic, social and environmental dimensions of the development for any country. What is more important now is to formulate and implement the policy to enhance sustainable development. This is however, not an easy task. But I have the strong conviction that this Workshop would provide the direction in this regard.

As we all know. at present the economic development in any counting is . usually measured in terms of the growth depicted by the income generated at the national level. This aggregate national income is primarily based on the value of unduplicated goods and services produced in the economy during a particular period of time after making adjustment, however, for the net inflow of compensation of employees, and property and entrepreneurial income from the rest of the world. The System of National Accounts (SNA) on which the compilation of national accounts 1is based, takes into consideration only the economic activities that are taking place within the specified production boundary. With this accounting procedure. man made assets are properly recorded, but the natural assets, like biodiversity, atmosphere, land and soil, mineral reserves, water, etc., are not properly recorded, though these natural resources are much more important than the man made resources in the sense that if the natural resources are used up, these will not be available for further production to the future generations. Further, the existing system of national accounts does not take into consideration the degradation of environmental quality. The environmentalists are, therefore concerned about the depletion and degradation of natural resources. Thus, if appropriate measures are not taken immediately to control environmental degradation, human health and welfare will be affected severely in the near future. In order to avoid this situation, a number of groups have been constituted both at national and international levels. The main task of these groups is to go through the problems arising due to unplanned use of natural resources and suggests steps to deal with the situation.

The Environmental issue is not a new one. It was first discussed in the historic Stockholm Conference on Environment held in 1972. After the Stockholm Conference, India took steps to accord priority on the issues of Environmental " Protection, and Conservation of Natural Resources at the national level. Between the Sto ckholm Conference in 1972 and the Rio Summit, which was held in June 1992, India took steps to build up a suitable organizational structure for bringing out Environment Statistics for the country. We feel happy to note that the issue on Environment Statistics was first discussed in the Fifth Conference of the Central and State Statistical Organisations_as early as in 1981. At that time, the importance of Environment Statistics as the emerging area was recognized in that Conference. Thereafter the subject was again discussed in detail in the Seventh Conference of the\Central and State Statistical Organizations held in 1985 and it was recommended to constitute a multi-disciplinary group to suggest measures to be taken to capture information in this emerging area. As a follow up of this important recommendation, a multi-disciplinary Working Group comprising various Central and State Ministries and Departments and research institutions concerned with environmental management was constituted in the Central Statistical Organization in 1986 under the chairmanship of the Director General, CSO. After detailed deliberations, the Working Group identified major areas of environmental concerns on which data are required. The specific parameters pertaining to the identified areas are also recommended by the Working Group. These are based on the United

Nations Framework for Development of Environment Statistics and consists of six internationally recognized broad groups, namely, Flora. Fauna. Atmosphere, Water, Land and Soil and Human Settlements. The overall framework identified by the Working Group is still being followed in the publication on Environment Statistics by the CSO. This Working Group also recommended that a cell should be set up in the CSO for bringing out Environment Statistics. This recommendation of the Working Group was also implemented in 1996. During this time Asian Development Bank came forward with a project on Institutional Strengthening and Collection of Environmental Statistics. India participated in this project along with other countries. For implementing the ADB project, an inter disciplinary Steering Committee under the Chairmanship of the Director General, Central Statistical Organization was constituted with members from the Ministry of. Environme nt and Forest, Central Pollution Control Board, a few Directors from State Directorates of Economics and Statistics and experts in the field of environment. The first Compendium of Environment Statistics was brought out under the direction of the Steering Committee and presently this has become an annual publication of the CSO. The requirement of the ADB project on Institutional Strengthening and Collection of Environment Statistics was also to organize National Workshop on Environment Statistics. The first National Workshop on Environment Statistics, as mentioned earlier, was organized in Goa in 1998 to fulfill this requirement. Subsequently, it was decided to continue the National Workshop and we are meeting here in the fourth endeavor of the CSO in this direction.

Since its inception in 1996, the Environment Statistics Unit, which is now under Social Statistics Division of the CSO has enlarged its activities by manifold. : The major activities of this Unit are to bring out the publication on Environment ! Statistics, to organize Workshops for the development of framework for Natural Resource Accounting and identification of data needs, to organize Training for capacity building for Central and State statistical personnel, and to promote research proposals in official statistics, especially to those leading to the development of framework for Natural Resource Accounting.

At the Rio Summit there was an agreement among the participating nations that all the nations would make efforts to expand the existing system of national accounts for integrating environmental and social dimensions in the economic accounting framework. Some of the countries have already taken steps in this regard for the preparation of Green GDP. But the work done in this regard is primarily of experimental nature. The Green ODP in true sense could not be prepared yet mainly because of non-availability of required data in the various sectors for the compilation of the green GDP. As such present studies conducted by various countries are largely confined in evolving satellite accounts consistent with the main economic accounts. India is also not an exception in this regard. Here lies the importance of this National Seminar. For achieving the goal of the preparation of Green ODP the Ministry of Statistics and Programme Implementation has taken significant steps for improvement of Environment Statistics and also for the development of framework for the preparation of Natural Resource Accounting in India. We have been able to do a lot of work to meet our objectives. But still a lot more work is to be done in this challenging field. I am sure, the two day workshop organized here in Shillong will be able to provide guidelines through thought Provoking discussions for achieving the target of integrating economic, social and environmental dimensions of the development in our country.

Thank you all.

ADDRESS BY SHRI J. TAYENG, THE CHIEF SECRETARY OF MEGHALAYA

Hon'ble Chief Minister of Meghalaya, Secretary to Government of India, Ministry of Statistics and Programme Implementation and all distinguished participants.

Environment Statistics is no doubt an emerging subject in the Science of Statistics. With its unlimited scope, environment statistics seeks to present human activities in relation to environment which constitutes water, soil, forest and other resources that are available in nature. There is a growing concern on the deterioration of environment and need to improve the quality of environment. This has gained the attention not only of Government but also of Non-Government Organisations and other Non-Government Agencies of the threat posed by pollution, deforestation and degradation of the surroundings. As a result, the air become contaminated through pollution, water got impure due to defilements at various stages and climate change is the result.

According to available information, protection of environment and conservation of natural resources have emerged as key national priorities in India after the 1972 Stockholm Conference on Human Environment. It later emanates to develop suitable organizational structure for environment protection. In order to understand the impending problems, preventive measures and corrective steps may have to be resorted with at various levels to safeguard the destruction of environment. In this respect, Scientists who have conducted studies on environment could investigate and find the situation as it were. But such studies without statistics will not enable any Statistician to draw reference and suggest appropriate steps. It is, therefore, on this account that Scientists need environment statistics in order to make any concrete suggestions for improvement of environment.

The Central Statistical Organisation, Ministry of Statistics and Programme Implementation, Government of India, also a nodal agency which is responsible for the development of Statistical System in the country, has been an important organization to develop environment statistics. By virtue of constant contact with all Academicians and other Private and Government Organisations, they have the benefits to take the lead in the improvement of environment statistics. Perhaps the State of Meghalaya is still in the initial stage as far as environment statistics is concerned. As such, the Directorate of Economics arid Statistics will be guided by the concept and definition in relation to environment statistics. Disposal of waste materials is not uncommon in our day-to-day activities. But such waste materials require to be classified as they may be renewable resources. Nevertheless, statistical procedures need to be followed according to standardized ways so that presentation of environment data could make meaningful interpretation for comparison in different years. This will enable Statisticians to draw conclusion and accordingly assess the extend with effective recommendations.

The environment statistics would not be an end but will lead to other studies which will relate to other resources of the State. Exploitation of natural resources and their effects on environment, their value in economic term like contribution to the State Domestic Product vis-a.-vis depletion and degradation to environment may have to be studied and observed.

The present Workshop, I hope, would open up and throw some more light on new horizons of studies so that environment scenario, which has attracted much attention in different spheres of activities, could gain credibility at various levels. Impending threats on environment, over and above, needs wide publicity so that general public will not only be concerned of the danger, but become cautious of the unscrupulous habits and wanton destruction of forests, pollution of rivers and other polluting matters. Lastly, statistics on environment will, therefore, be the important information and these could be made only when we have sound database.

Thank-you.

INAUGURAL ADDRESS BY HON'BLE CHIEF MINISTER OF MEGHALAYA, SHRI D.D. LAPANG

It is indeed a great pleasure to be with all of you on this important occasion of holding the 4th National Workshop on Environment Statistics in Shillong which eventually is also the first of its kind in the North Eastern India. I could also understand that 3 (three) such Workshops were held in other places/cities of India with a view to disseminating information on the development of Environment Statistics. Such fora, I believe, could have purposely serve as an interaction between Statisticians and other Social Scientists. The Government of India, through the Ministry of Statistics and Programme Implementation has selected Shillong as the venue for the present Workshop. Shi1long is perhaps, comparatively less populated than other big cities of India. Well, I could recollect vividly on the remark made by the Honourable Prime Minister of India, Shri AB. Vajpayee, when he visited Shillong and described this City as the' Abode of gods', obviously after seeing the beautiful landscape with green vegetation hovering the environment. Yes, Shillong is perhaps free from pollution of the big industries, but I cannot say for sure that Shillong is 100 % free from other contamination.

Protection of environment has been very much felt globally and now it has become an important issue for development. Therefore, protection of environment is an essential gravity that could be drawn so that development of environment could be adequately taken care of and should not be undermined at any cost.

But protection of environment has been compounded by the growth of population with emerging new townships and new villages and also the setting up of industries. The future looks bleak if that social consciousness for environment protection were not seriously considered by the people at large and the Government in particular. It presents a challenge to social thinkers, Non-Government Organisations and Government how to match strategy for future generations. Therefore, special attention to the environment should be made so that damage to health and other problems could be safeguarded. In this context, statistics on environment is very much necessary so that database could be suitably established to serve as information guide for its protection.

Undoubtedly, different States and Regions have various problems at varied stages of development and such condition of development are likely to dictate terms on the policy for environment approach. One of the problems that is facing the various developing economies is water supply and sanitation. In this regard, the North Eastern Region is very much vulnerable to water-borne diseases in view of lack of sanitation facilities and the unconsciousness of the people in respect of health. Lack of sanitation consciousness had added to the people's woe and health hazards. Improper disposal of waste materials aggravated the situation, thus polluting rivers and environment. There are some Non-Government Organisations which are alive to the depredating situation of the environment and have made concerted efforts to enlighten the general public of the impending catastrophe. In the process, they appeal to make the environment clean and also to preserve the catchment area from degradation.

Environmental degradation is a very important subject in the present day. In 1970, under the able leadership of the former Prime Minister, Late Smt. Indira Gandhi, a National Committee on Environmental Planning was established and in 1980, the Department of Environment was set up which was subsequently followed by the establishment of the Ministry of Environment.

I earnestly hope that during the course of deliberation in this Workshop, a common approach could develop that may pave the way for building up strong database for environment statistics. The suggestions that could be arrived at would be important recommendations that could create impetus to be appropriately used by Planners at Government level in order to improve environment conditions.

Lastly, I wish this workshop a grand success.

KEY NOTE ADDRESS BY SHRI K.K. JASWAL SECRETARY TO THE GOVERNMENT OF INDIA, MINISTRY OF STATISTICS & PROGRAMME IMPLEMENTATION

Shri D. D. Lapang, Hon'ble Chief Minister of Meghalaya, Shri Jamin Tayeng, Chief Secretary, Meghalaya, Dr. Vaskar Saha, Additional Director General, Central Statistical Organisation, Shri W. L. Lyngdoh, Director, Directorate of Economics and Statistics, Government of Meghalaya, distinguished participants, ladies and gentlemen.

It is only appropriate that the National Workshop on Environment Statistics should be held in Shillong, the Queen of Hills and capital of the State of Meghalaya, the Abode of Clouds. The very name of the state conjures up images of dark clouds alternating with azure blue skies, verdant hills, sparkling streams and a tranquil atmosphere. But in recent years , a rapid demographic expansion, a ruthless exploitation of mineral resources and urbanisation have left their imprint and the state has to face up to the challenge of preservation of the environment. I fervently hope that the sensitivity and concern for the environment so beautifully expressed in the invocation song will lead to a turn around in the situation not only in Meghalaya, but also in the rest of the country. In this context, the presence of the Hon'ble Chief Minister of Meghalaya in this Workshop assumes a special significance.

Maintenance of the quality of the environment and conservation of natural resources are critical to sustained human development. These preconditions have, for the most part, not received due recognition in the development strategies that have been adopted since the Industrial Revolution. Only lately has the world begun to realise the dangers inherent in the pursuit of economic growth, regardless of deterioration in the quality of the environment and accelerated depletion of the stock of natural resources. The damage done to the environment during the long years of insouciance has been extensive and varied, but it is difficult to quantify it in the absence of the requisite statistical information. It follows that the estimation of the cost of environment protection measures required will be even more difficult.

For a long time now, the activities of policy advocacy and policy formulation in India have been supported by systematic data collection and statistical analysis. But this has not been the case in the area of Environment. The situation in other developing countries and many developed countries as well has been no different. Environment, until recently, was merely a peripheral issue. It is only since the early nineties that environmental concerns have begun to influence mainstream policies. And in consequence, the statistical community has started grappling with measurement issues.

The new emphasis on sustainable development heralded by the U. N. Conference on Environment and Development (UNCED) held at Rio in 1992 helped to secure recognition for the need to broaden the assessment of growth and welfare through a modified national accounting system. This conference, which is popularly known as the Earth Summit, greatly contributed to the realisation that sustainable development was the only viable strategy for long-term economic development. The main agreement to emerge from the UNCED was Agenda 21, which, to date, serves as the guiding document for pursuing the goal of sustainable development and bringing about the concomitant institutional changes. The World Summit on Sustainable Development held at Johannesburg last year could refocus attention on measurement issues, now that it is more readily accepted that "sustainable development is the best approach to integrating environmental concerns into national and international socio-economic development".

Initially, the National Accountants had their reservations about environmental accounting and its integration with economic accounting, but now they have come to realise that in many parts of the world, scarcities of natural resources are threatening the productivity of the economy and the degradation of environmental quality is telling upon human health and welfare. Against this backdrop, they have taken up the task of incorporating environmental considerations in the 1993 System of National Accounts. In the word of Mr. Hueting of the Central Bureau of Statistics, Netherlands, who has spent 25 years on the development of the methodologies for computation of sustainable National Income, "there was no conflict between recording environmental losses in physical terms and relating those to the monetary accounts". The United Nations Handbook of the System of integrated Environmental and Economic Accounting can be expected to have a standardizing influence on this emerging discipline.

Various UN and International Organisations have been exploring the feasibility of integrating physical and monetary accounting in the areas of natural resources and the environment and developing alternative macro-indicators of environmentally adjusted and sustainable national income. The first Pilot study on a system for environmental and natural resource accounting was conducted by the statistical offices in Finland, Norway and Sweden. Its results were published in 1993. Further Pilot studies on specific aspects of the system, such as resource accounts, nutrients and statistics on environmental protection expenditure, were carried out jointly by Denmark, Finland, Iceland, Norway and Sweden in 1994. In parallel, the System of integrated Environmental and Economic Accounting has been experimented with in Papua Guinea and Mexico.

In India, we have conducted the first Phase of the Pilot Study on NRA in Goa and have decided to undertake more studies on NRA in respect of selected sectors as per recommendations of the National Statistical Commission. These are exploratory in nature and are to be continued till the methodologies get standardised. We are also planning to kick start the second Phase of the Goa project in the current financial year.

Environment Statistics, which straddles a number of disciplines is an untrodden field in so far as India is concerned. Hence, there is a certain urgency for the creation of a proper Framework for the Development of Environment Statistics. The procedure prescribed by the United Nations for developing such a framework can be adopted by us. The steps involved are:

a) Review of environmental problems and concerns and determination of their quantifiable aspects.

b) Identification of variables for statistical description of the quantifiable aspects of environmental concerns

c) Assessment of data requirements, sources and availability

d) Structuring of database, information systems, statistical publications and methodological guidelines.

The Central Statistical Organisation, which is the nodal agency for the development of the statistical system in India, has been acting as the coordinating agency on Environment statistics in India since 1996. In order to assist in the creation of a database on Environment Statistics, the CSO has been bringing out a 'Compendium of Environment Statistics' containing data on various aspects of environment. This publication is being compiled as per the United Nations Framework for Development of Environment Statistics (FDES). The latest issue of the publication covering the year 2001 is under print and will be available shortly. It is heartening to note that some of the state governments have also taken similar initiatives. The Directorate of Economics and Statistics of the Government of Tamil Nadu has brought out a Compendium of Environment Statistics . Hopefully, other States will follow suit.

Given the importance of training in this emerging discipline, my Ministry has been organising training programmes on Environmental Statistics on a regular basis. Official statisticians from the Central and State Governments have been participating in these programmes. It is a happy augury that the number of nominations from State Governments has progressively been increasing. This signifies heightened concern among State Governments for capacity building in respect of Environment Statistics.

The CSO has been organising National Workshops on Environment Statistics since 1998, the present workshop being the fourth in the series. These workshops have been providing a platform for experts in the cognate fields to get together for sharing their individual experiences and knowledge and deliberating over practical strategies for the improvement of Environment Statistics of the country. In the near future, we may consider expanding the scope of this interaction by associating the international experts and organisations.

I am happy to note that the four technical sessions of the workshop are to be chaired by eminent resource persons . I am confident that the deliberations of the workshop will help identify the data gaps and throw up pragmatic suggestions for development of a framework for natural resource accounting in the country.

I wish the workshop every success

VOTE OF THANKS BY SHRI S.K. NATH, DDG, MINISTRY OF STATISTICS & PROGRAMME IMPLEMENTATION

It is my proud privilege to give vote of thanks on behalf of the Ministry of Statistics & Programme Implementation. I can well visualize that every body here is extremely happy to be in this beautiful and colourful city – the Scotland of East. It is in this romantic city Gurudev Tagore wrote his famous romantic novel "Sesher Kabita" – *the Last Poem* and the famous drama "Rakta Karabi"- the *Red Oleander* during the summer of 1924.

We are grateful to the dynamic Hon'ble Chief Minister Mr. D.D. Lapang for allowing us to hold this workshop here. Shri Jamin Tayeng, Chief Secretary helped us in providing with all types of logistic support without which it would have not been possible to make the workshop successful. We are also grateful to him.

We are also extremely grateful to Shri K.K. Jaswal, Secretary, Ministry of Statistics & Programme Implementation for his thought provoking speech. Your valuable suggestions will have lasting effect in improving the work of Environment Statistics in India. We are extremely thankful to you Sir, since it is because of your able leadership and constant encouragement we could take up this workshop far away in North – East of the country.

For organizing this workshop CSO had approached many states in early August 2002 but without any avail. But when I approached Shri W.L. Lyngdoh, Director of Economics and Statistics, he had readily agreed – we are all grateful to him. The entire burden of this work has been taken by Mr. Lyngdoh – the most capable and hard working Director of the DES, Shillong. For last three months he worked day and night. He showed his leadership capabilities most efficiently by organizing this workshop. Let us give a big hand to Shri Lyngdoh.

The entire staff of DES worked under the command of Shri Lyngdoh flawlessly and effectively. They should be congratulated for their sincere work. It would have been nice to mention the name of each of them but in this short time it is not possible to do so. However, I cannot help but to mention the name of the following:

The entire group who presented the nice invocation song.
Shri J.B. Momin, Joint Director,
Shri A. Marbaniang, Deputy Director,
Shri K.K. Raju, Deputy Director,
Shri C.M. Syiem, Deputy Director and
Shri Victor E. Iawphaniaw, Research Officer.

Let us give a big hand to all of them.

Bringing all delegated from Guwahati Airport, which is 100 Kms. away from Shillong, who had arrived by different flights on different dates & time, it is not an easy task. But the deligent drivers of the Govt. of Meghalaya did their task very efficiently. We are all proud of them. Let us give a big hand to them also.

Let me also thank the Shillong Club for allowing us to hold this seminar here. Thank are also due to the Press and Electronic media for covering the inaugural function.

Let me thank all the Resource Persons and Delegates from various Universities / Organisations / State Statistical Bureaus from West to East and North to South of the country. My personal thanks are to Prof. B.B. Bhattacharya and Prof. Amitab Kundu, who inspite of their preoccupations, agreed to work as chairpersons of the various technical sessions.

Lastly, I may mention that for every success of this workshop the credit must go to Shri Lyngdoh and for lapses, if any, it is none other than I, who is standing here before you, is responsible.

Thanking you all once again.

Chapter Two

The Work Undertaken by CSO

The Work Undertaken by CSO in the field of Environment Statistics
- Presented by Shri Rajesh Bhatia

Introduction

Natural resources are indispensable not only for sustaining life but also as an important input into economic growth. The global economy is expanding amidst a global deterioration in the environment. Due to poor availability of information on various environmental indicators, it is not possible to fully assess the damage being done to environment by the development. It is, therefore, necessary to develop a system of environment statistics, which should provide ample support to redesign the economic system, such that it is possible to attain economic growth without destroying environmental support systems.

The Environment Statistics Unit

2. Central Statistical Organisation, being the nodal agency for the development of the statistical system in India has paid increasing attention for the development of Environment statistics since 1996. As a consequence of deliberations in the Fifth and Seventh Conference of the Centre and State Statistical Organisations, a Working Group was set up in CSO in July, 1996. On the basis of recommendations of the Working Group, the Ministry of Statistics and Programme Implementation established the Environment Statistics Unit in CSO in the year 1996.

Compendium of Environment Statistics

3. The Central Statistical Organisation plays a vital role in the coordination and evolving of the statistical standards in environment statistics also. Environment being emerging area of importance there was an increased emphasis on making available relevant data required in the context of promoting environmentally acceptable production technology, conservation of resources, waste minimization, control of pollution of air, water and atmosphere, protecting of forests, flora and fauna etc. The various data source agencies are involved in the collection of data in their respective areas. CSO then undertook an ADB sponsored project on ‘Institutional Strengthening and Collection of Environment Statistics’. Under this project, a Steering Committee on Environment Statistics was constituted with an objective to give guidance for the preparation of framework for the development of environment statistics. As a consequence of the work done by this committee, in order to make available all the relevant statistics at one place, a publication entitled **'Compendium of Environment Statistics'** containing data on various aspects of environment was published in 1997. Since then, this publication is being brought out regularly and presently the issue related to 2001 is under printing.

4. The compendium has been prepared under the Broad Framework for Development of Environment Statistics provided by the United Nations Statistics Division and adopted by the Steering Committee on Environment Statistics for the 1997 issue. The same pattern has been followed in the subsequent issues. The five parameters of the framework namely bio-diversity, atmosphere, land / soil, water and human settlements have been used to divide the compendium in different chapters. The chapters are further subdivided into sections, based on different factors related to that parameter.

Natural Resource Accounting

5. Further, this Ministry has also organized a number of discussions / meetings to deliberate upon the issue of Natural Resource Accounting (NRA). It has been pointed at that since the data on national accounts released by the Ministry of Statistics and PI is treated as the official data and are quoted by other, the methodological framework and the data system for estimation of Green GDP need to be firmed up before releasing such data. It has been also suggested that the present system of national accounts should continue but at the same time a separate exercise for developing Green GDP should be made. The integration of them may be considered at a later stage, when the methodological framework for estimation of Green GDP is firmed up. In this connection, a three-pronged strategy has been suggested. Firstly, the statistics available in different sectors, relevant for the preparation of Green Accounts should be examined and the data gaps identified, with a view to fill in the gaps. Second, the methodology to be adopted should be firmed up. Thirdly, side-by-side some supplementary sectoral studies could also be taken up.

6. Accordingly, for the development of methodologies and estimating environmental cost on the basis of secondary data, a pilot project on Natural Resource Accounting in Goa was commissioned through Tata Energy Research Institute, New Delhi in 1999 with the following objectives :

- Development of physical accounts of natural resource depletion or enhancement and environmental degradation or improvement;
- Valuation in economic terms, natural resource depletion or enhancement and environmental degradation or improvement (to the extent possible);
- Adjustment of state domestic product to account for natural resource depletion or enhancement and environmental degradation or improvement.

As per the schedule, the Phase I was undertaken by TERI, which was based on the secondary data available from various sources. The Phase I of the project was completed by TERI and final report submitted in 2001. The report gives an overview of Goa- the demographic profile, main economic activities and environmental pressures in the state. The advances in the field of NRA with the objective of evolving a resource accounting framework for the state was also examined. The physical and economic accounts were also discussed in details to study the depletion or degradation of natural resources in the state, over the period 1991 to 1996. The following sectors were covered in the first phase of the project:

- Land use
- Forests
- Minerals (Iron ore)
- Energy and emissions accounts for the domestic sector
- Energy and emissions accounts for the transport sector

The results of this study highlighted the limitation of the non-availability of data on a number of relevant issues.

7. The first phase of this study has since been completed. On the basis of experiences now gained, it was decided to adopt a sectoral approach. It has been felt that a number of fragmented have been made by various experts/ expert-organisations in the country, but no work has been done in totality for the preparation of NRA. Moreover, there have been no efforts for integration of all these studies. As NRA is at an evolutionary stage, it is necessary to carry out more case studies on availability of data, development of methodologies and their integration, keeping in view the SEEA framework. Since the data-availability plays a major role in NRA study, case studies should be given to organizations that have expertise in the relevant field, as well as access to the data system. Emphasis needs to be given to sectoral studies, as most of the organizations have specialization in a few areas only.

National Workshops on Environment Statistics

8. The Central Statisical Organisation has also been organizing **National Workshops on Environment** from time to time to provide a common platform for interactions between data users and producers as well as policy makers. Three such workshops have already been organized. The first such workshop was organized at Goa during 12-13th January, 1998. The second such workshop was organized at Hyderabad during 6-7th April, 2000. The third National Workshop on Environment Statistics was held during 8-9th February, 2001 at Thiruvananthapuram. In all these workshops, detailed discussions and deliberations were made on a number of relevant issues during various technical sessions encompassing subjects like environmental issues and their impact on the population and human health, status of database on environmental issues e.g. bio-diversity, pollution, land and soil degradation, human settlements and Natural Resource Accounting or Green Accounting etc.

Training Programmes on Environment Statistics

9. In order to familiarize various statisticians working in the central as well as different state governments, to the relevant concepts, methodologies etc. involved in the development of environment statistics, the CSO has been organizing training programmes from time to time in collaboration with different expert organizations. To begin with, the CSO organized a two week International Training Programme of Environment Statistics with financial support from Asian Development Bank in 1998. Representatives from various South and South East Asian countries including India participated in this programme. The second such programme of training in Environment Statistics was organized at the Environment Protection Training and Research Institute, Hyderabad in the year 2000. Since then CSO has been organizing such training programmes on a fairly regular basis in association with different agencies which have expertise in the area of Environment Statistics.

Chapter Three

Technical Papers Presented

Data Need for Forest Resource Reporting : A Case Study

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Introduction

Environment protection and the conservation of natural resources emerge as the key national priorities in India in the wake of the 1972 Stockholm Conference on Human Environment. Between the Stockholm conference and the Rio summit India has been able to develop a stable organizational structure for environment protection in the country. Legislation, policies and programs also evolved during the same period. Despite achievements there has been for some time a need is felted to clearly establish our priorities in the environment and forest sectors and design a programme of action for sustainable management of the environment and in particular the forests in the country.

The government has enunciated its policy in the form of policy statement on forestry, on abatement of pollution and also through the comprehensive national conservation strategy and policy statement on conservation and development. The national forest policy 1988 emphasizes the need to restore the ecological balance and the conservation of the country's national heritage by preserving the remaining natural forests.

The word forest is derived from the Latin word 'Foris' meaning outside referring obviously to a village boundary or fence. Thus originally forest means all uncultivated or unused land. Today forest is any land managed for the diverse purpose of forest tree covered by trees or some other vegetation. Technically forest is defined as any area with vegetation set aside for any indirect benefits. Forests are a renewable resource and contribute substantially to economic development. They play a major role in enhancing the quality of environment. The universal standard is that one third of the geographical area should be under the forest cover. However the forest cover scenario is deteriorating fast. The world forest cover has reduced from 4289 million hectors in 19879 (32.8% of the geographical land) to 3454 million hectare in 199(26.6% of the geographical land). As per the satellite imagery, the Indian government has reported that the forest cover in India has slightly risen to 19.39% in 1999. But according to the State of World Forests, FAO 1999 the percentage of forest cover is shown as 15.7% only and per capita forest cover is as low as 0.06 hectare.

In view of this situation the need for proper forest management has gained utmost importance. In the planning aspect of the forest management so far as formulation of policy and regulation is concerned the picture is not so green in India. However the existence of good policy does not ensure good performance. In India the desired results have not been obtained so far and the control aspect of forest management should be given more importance for achieving the goal. The controlled function of forest management includes three major activities:

1. Measurement of forest inventory
2. Recording of forest inventory

3. Reporting of forest inventory

The first two activities are subsidiary to the third and final activity.

Control:

The entire gamut of forest activities is being given a new orientation in the light of the National Forest Policy of 1988. Under the provisions of the Forest (conservation) Act,1980, prior approval of the Central Government is required for diversion of forestlands for non-forest purposes. Since the enactment of the Act, the rate of diversion of forestlands has come down to around 25,000 Hectares per annum from1.43 lakh hectares per annum before 1980.

Joint Forest Management is another method of control. Joint Forest Management (JMM) is being practiced in 19 states of the country. About 4.06 million hectares of degraded forests of the country are being managed and protected through approximately 40,000 Village Forest Protection Committee. (Ref. Ministry of Information and Broadcasting, Govt. of India,1999).The pro-people land reform measures, initiatives of NGO's, involvement of people through three tire Panchayet Raj and planning process from the grass root level have helped West Bengal to have a unique position in the World. West Bengal has won **'J PAUL GETTY WILD LIFE PRIZE'** of World Wild Life Fund.

Present Recording System:

In order to have a proper management of the forests we must have proper records in the above three activities mentioned above. One may consider the records generated by the State Forest Department, West Bengal and records of the Forest Survey of India in this regard.

The following tables give the record of forest cover in different districts of West Bengal for different years:

District Year	Midnapur	Bankura	Purulia	24 Pgn	Jalpai	Darjee	Total	%
1988	2078	1696	1114	4045	1601	1609	12674	14.28
1991	2230	1815	1158	4123	1640	1670	13243	14.92
1994	2250	1823	1179	4122	1646	1678	13322	15.01
1997	2244	1871	1194	4122	1528	1681	13252	14.93
2000	2204	2193	1311	4040	1475	1681	13581	15.30

Notwithstanding adverse land man ratio, conservation strategies have started paying dividends. Apart from the above table Satellite image indicates the improvement of crop, increase in vegetation cover etc. with the initiation of protective measures there has been increase in quantity of N.T.F.P. per hectare of forests also.The following table gives the figures generated by the Forest Survey of India for more or less the same period reveals comparatively poor forest cover in West Bengal:

year	Total forest cover in sq. k.m.	Percentage
1987	8349	9.41
1989	8443	9.51
1991	8015	9.03
1993	8186	9.22
1995	8276	9.32
1997	8349	9.41
1999	8362	9.42

From the State of Forest Report 1997 and 1999 0f Forest Survey of India we get recorded forest area and actual forest cover of various states and union territory in square-kilometer and in percentage of geographical area:

	1997 Recorded Forest		1997 Forest Cover		1999 Forest Cover		Change in Forest Cover
State/UT	Area	%	Area	%	Area	%	Area
Andhra Pradesh	63814	23.20	43290	15.70	44229	16.08	+939
Arunachal Pradesh	51540	61.54	68602	81.90	68847	82.21	+245
Assam	30708	39.15	23824	30.40	23688	30.20	-136
Gujarat	19393	9.89	12578	6.40	12965	6.61	+387
Haryna	1673	3.78	604	1.40	964	2.18	+360
Himachal Pradesh	35407	63.60	125578	22.50	13082	23.50	+561
Bihar	6078	6.45	4832	5.13	4830	5.13	-2
Chattishgarh	59285	43.85	56435	41.74	56693	41.93	+258
Jammu& Kasmir	20182	9.08	20440	9.20	20441	9.20	+1
Jharkhand	23148	29.04	21629	27.21	21644	27.15	-48
Karnataka	38724	20.19	32403	16.90	32467	16.93	+64
Kerala	11221	28.87	10334	26.60	10323	26.56	-11
Madhya Pradesh	95212	30.89	74760	24.26	75137	24.38	+377
Maharastra	63842	20.75	46143	15.00	46672	15.17	+529
Manipur	15154	67.87	17418	78.00	17384	77.86	-34
Meghalaya	9496	42.34	15657	69.80	15633	69.70	-24
Mizoram	15935	75.59	18775	89.10	18338	86.99	-437
Nagaland	8629	52.04	14421	85.80	14164	85.43	-57
Orissa	57184	36.73	46941	30.10	47033	30.21	+92
Punjab	2901	5.76	1387	2.76	1412	2.80	+25
Rajasthan	31700	9.26	13353	3.90	13871	4.05	+518
Sikkim	2650	37.34	3129	44.10	3118	43.94	-11
Tripura	6293	60.01	5546	52.90	5745	54.79	+199
Tamilnadu	22628	17.40	17064	13.10	17078	13.13	+14
Uttaranchal	34662	64.81	23243	43.46	23260	43.49	+17
Uttar Pradesh	17001	7.06	10751	4.45	10756	4.96	+5
West Bengal	11879	13.38	8349	9.40	8362	9.42	+13
Andaman&Nicobar	7171	86.93	7613	92.30	7606	92.21	-7
India	765253	23.28	633397	19.27	637293	19.39	+3896

It is observed that both the Central Government and the State Government of West Bengal report the growth and decay of forest in terms of area of forest cover. It is interesting to note that the state of forest cover in West Bengal based on data generated by State Forest Department, West Bengal is far better than the state of forest covered measured by the Forest Survey of India, Central Government. It is observed that in West Bengal forest cover is rising.

If forests are considered as inventory of trees then from the recorded data of rising forest cover it may be understood that inventory of trees is also rising. But that would be a very remote approximation keeping in view the fact that remote sensing by satellite imagery has so far measured land with tree canopy density over 10 percent as forest cover and an increase in forest cover does not reveal much about the actual growth or decay of inventory of trees. The change in the area of forest cover with different crown density at different times are recorded but such change is not explained by the results of the plantation activities, felling activities, injuries to the forest and natural growth of forest. If forest is a resource, then these events are flows-inflows and outflows of resources must be integrated with the inventory of the forest at any point of time. The system of recording that ensures such integrity of flow with stock is called accounting. It is observed that the state of forest report does not pass this test of accounting since the change in forest inventory is not explained by the flows. This not only weakens the reliability of the reports but also impairs the controlled function of forest management,. The result of different forest policies and programmes and activities cannot be measured in terms of growth of forest inventory.

Natural Resorce Accounting

Prof. Nordhaus and Prof. Tobin in the United States initiated the treatment of environmental issues in accounting framework and the work on developing a natural resource accounting framework began in Norway in 1974. The second approach focused on developing a separate physical accounting system for national and environmental resources where as in first approach attempt was made to incorporate environment is national accounts. French accounts classification is on similar lines as the Norwegians. The construction of accounts in the case of French system is more comprehensive and includes some monetary valuation part also. World Resources Institute (WRI) developed a methodology for natural resource accounts and initiated a few countries studies using their methodology. Results for a few countries have been published by WRI, physical accounts are set up for natural resources and changes in stock are recorded for the accounting period. Procedure to determine stock for different natural products has been discussed and the valuation is done on the principle of economic rent. The National account of forest resources of France for the decade 1969 to 1979 has been presented below:

French Physical Account: Stock of commercial Forests (thousands of cubic meters)

Resource	Broad Leaf	Coniferous	Total	Use	Broad Leaf	Coniferous	Total
Volume of Growing stock in 1969	980.1	6526.5	7506.6	Natural reduction(mortality)	5.6	21.0	26.6
Natural Growth of Initial Stock	401.0	2583.5	2985.4	Accident reduction (breakage and wind fall)	9.7	481.2	490.9
Natural Growth by Reproduction	41.1	258.4	298.6	Resource extraction (commercial felling)	92.0	1474.0	1566.0

(recruitment)			Self Consumption Adjustment Volume of growing stock in 1979	13.6 -29.4 1330.7	395.0 +1239.2 5758.0	408.6 1209.8 7088.7
Total	1422.2	9368.4	10790.6	14222.2	9368.4	10790.6

In India statistical data on forest are generated at different entity levels by different authorities. However, if these statistical data are processed in an accounting model ensuring integrity of stock with flow and maintaining uniformity of unit of measurement at each entity level, this would enable summarization of records of individual mutually exclusive entities into a group report and summarization of different group reports into state report in a rational and systematic manner. Then the national account of forest resources can be prepared.

Accounting Model

The accounting model may be developed to ensure that:

i) Flow of forest resources can be determined by accounting of plantation, growth in yield, outrun and injuries to crops.
ii) Flow of forest resources can be integrated with inventory of forest resources.
iii) Accounted inventory can be compared with actual inventory taken.

Any recording system having the above mentioned features would be accepted as an accounting system since the quintessence of an accounting system lies in its integration of stock with flow at each entry level. The forest reports based on accounting system would certainly add reliability to the reports since accountability is inherent in the accounting system of the recording. The relevance of the reports to the evaluation of the existing policy and practice and to the decision making for future course of action would also rise because the in the forest inventory can be duly explained by the results of the planning activities, feeling activities and other activities separately. The design of the proposed model is presented below:

Opening Inventory		********
Add Natural Growth	********	
" Plantation	********	********
Less Certified felling	********	
" Illegal felling	********	
" Injuries to the forest	********	********
Closing Inventory		********

The unit of measurement

The unit of measurement of forest inventories so far as West Bengal is concerned in square kilometer. However the legal area or the forest covered measured in square kilometer or hectare does not revel the timber content of the forests. The timber measured in cubic meter (m^3) may be taken as unit of measurement of forest inventory. Such unit has been used by the Central Government Survey reports for sample areas and not for entire forests of the states. Again the Square kilometer or hectare as a unit of measurement of forest inventory is not appropriate for the accounting system because the flow, i.e., increase or decrease in forest resources during a period of time plantation, natural growth, felling of trees or pruning of branches can not be measured in square kilometer in hectare. Hence in this study the cubic meter is considered as the unit of measurement of forest resources. This would be suitable for measurement of both stock and flow. Certain sample survey of the Central Government used this unit of measurement of forest. Some other countries in the world also used this unit for their forest inventory accounting.

The Case study

The study attempted to examine how far the accounting system can be introduced in the recording system of forest accounting in West Bengal and in that direction the divisional level annual reports were examined along with the State Reports, Regional Statements, Central Government Survey Reports an Working Plans. As emphasis was given to prepare a forest inventory account at divisional level, the secondary data for Kharagpur Social Forestry Division and Second Working Plan for the Reserved, Protected and Unclassed Forests of West Midnapore Division were used for the development of the relevant statement of account.

As the recording in West Bengal only allows for measurement of forest inventory in units of square kilometer or hectare, for the Kharagpur Social Forestry Division we get the stock of forest for different years as follows:

A: Stock of Forest Inventory

Forest Area in hectares as on	01-04-1996	01-04-2001
1. Sal forest	4764	4764
2. Plantation forest	3571	3571
3. Blank & degraded	4776	4776
4. Coastal shelter belt (Jhaw) Plantation	1816	1816
5. Others	30	30
Total Area	14957	14957
Legal Status		
1. Reserved Forest	---------	--------
2. Protected Forest	10054	10054
3. Unclassed Forest	4903	4903
	14957	14957

B: Flow of Forest Inventory

Year	96-97	97-98	98-99	99-00	00-01	Total
1. Plantation raised in ha	497	495	243	265	900	2400
2. Felling of trees:						
- Timber (m^3)	---	56.93	93.92	100.47	241.01	492.33
- Firewood (m^3)	10154	3103	4798.27	6467	4045	28567.27
3. Timber sized (Illegal felling)						
- Timber (m^3)	3.53	42.84	4448.91	4.25	167.42	4666.95
- Firewood (m^3)	0.91	1.25	45.67	2	83.30	133.13
4. Natural Growth	---	---	---	---	---	---

It is to be noted that plantation raised in hectare does not increase the stock of forest inventory in hectare because total area remaining same only the number of stems and consequentially the volume of timber in cubic meter (m^3) increase. Again there is no scope of recording natural growth of trees when forest inventory is measured in hectare. In divisional reports no record of natural growth is maintained. The outflow in resources in form of commercial felling of trees and illegal felling trees is, however, recorded in cubic meter.

Now the otherwise available statistical data are fitted in the proposed accounting model as below:

The statement of stock and flow of forest inventory for Kharagpur Social Forestry Division for the five-year period from 1-4-1996 to 31-03-2001

			m^3	m^3
Opening Inventory on 1-4-96	Ha	m^3 / ha		
a. Sal Stratum	4764	17.84	84989.76	
b. Plantation Stratum	3517	6.20	22140.20	
				1,07,129.96
Add: Natural Growth				
c. Sal Stratum	4764	6.1	29064.40	
d. Plantation Stratum	3571	5.235	18694.19	47,758.59
Add: e. Plantation raised	2400	4.50		10,800.00
				1,65,688.55
Less: f. Commercial felling				
Timber -			492.33	
Firewood -			28567.27	(-) 29059.60
Less: g. Illegal felling:				
Timber-			4666.95	
Firewood -			133.13	(-) 4800.08
Less: h. Injuries to forest				------
Closing forest inventory on 31-03-01				1,31,828.87

Explanatory notes:

1. The stock of timber in (a) & (b) of the above statement is taken from the survey conducted by the Forest Survey of India in the district of Midnapore.
2. The average growth rate in the 5-year period in (c), (d) and (e) for the corresponding class is taken from Second Working Plan for West Midnapore, West Bengal.

3. The Accounted volume of timber at the end of 5-year period may be compared with the estimated volume based on actual survey of samples. Any difference may be accounted for as 'Adjustment of Forest Inventory' as observed in National forest account of France.

Conclusion:

The study attempted to introduce an accounting model in the recording and reporting system of forest resources in West Bengal. The statistical data generated by different authorities at different entity levels have been applied to produce the statement of forest account for the Kharagpur Social Forestry Division. The volume per hectare calculated for the entire district of Midnapore and the growth rate per hectare calculated for the West Midnapore division has been applied as the blanket rate for the Kharagpur S.F. Division such data are not available separately. Although this approximation reduces the quality of the reported result, the quality of the reporting system is not affected thereby. It is suggested that for attaining more precision in the measurement of volume and growth the data should be generated for each division separately. This system of recording forest inventory not only integrates flow with stock for each division but also summarizes the divisional forest inventories into the state forest inventory in a systematic manner. In this way it strengthens the control function of forest management.

Accounting for Ecosystem Diversity: Theory and Practice

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The quality aspects of an ecosystem are as much or even more vital than the quantity of the asset in determining its sustainability. An important quality parameter of ecosystems relates to the 'richness' in diversity of their species content. Ecological evidence on ecosystems' structure and functions suggests that for these natural assets the whole is more than the sum of parts. In other words, the Total Economic Value computed for any such asset would be an underestimate of its 'true value'. Specifically, the diversity-related services that arise because of complementarities, species substitutability and the infrastructure in the ecosystem are not taken into account in the TEV framework. Valuing these diversity-related benefits is difficult in practice, but conceptually possible. The valuation concepts corresponding to the ecological contributions of ecosystem diversity are the contributory value, insurance value and primary/infrastructure value. Methods attempting to account for these benefits are still in their infancy and need priority attention. However, it is important that the services are recognized (if not quantitatively, then at least qualitatively) and incorporated in the valuation framework. A key step to the accounting process is an understanding of the ecological, economic, recreational, scientific and cultural benefits that originate from diversity itself. Measuring the 'richness' of diversity is the next step, which requires a uniform set of indicators. The availability of remote sensing data makes it possible to construct 'diversity indices' of different ecosystems and even regions within a particular ecosystem. Based on the values of such index measures, ecosystems within a region can be distinguished, both across categories and within them. An illustration of the applicability of one such popular index measure is given for two different categories of agro-ecosystems in the state of Karnataka.

The widely accepted 'Total Economic Value' (TEV) approach to the economic valuation of natural assets is based on a categorization of the benefits generated by such assets under direct and indirect use values and a residual non-use or passive use value (Perrings, 1995). The typology of values itself is indicative of the "anthropocentric, instrumental and utilitarian point of view" (Fromm, 2000) that grants economic significance only to those segments and services of a natural asset that directly or indirectly influence human welfare. Further, the methodology used in the TEV approach assumes that the sum of the component values is equal to the aggregate value, which is very likely to be *not* true in the case of ecosystems (Turner and Pearce, 1993; Gren et al, 1994; Perrings, 1995). Ecological evidence on ecosystems' structure and functions suggests that for these natural assets *the whole is more than the sum of parts*. In other words, the TEV computed for any such asset would be an underestimate of its 'true value'.

The purpose of the present paper is to highlight the ecological significance of ecosystem diversity to the system itself. Section 1 of the paper touches upon three types of contributions of ecosystem diversity to the system itself that are not captured in the conventional TEV framework. Section 2 introduces the integrated concept of the *Total Economic & Ecological Value (TEEV)* of ecosystem diversity with illustrative examples of some recent attempts to value the non-instrumental services provided by diversity. Section 3 examines the practice of crop violations as a factor contributing to loss of crop diversity in the irrigated command areas of Karnataka and presents an application of the Shannon Diversity Index to the irrigated and rainfed agro-ecosystems of the dry zones in the state. Section 4 concludes.

1. Complementarities, Substitutability and Infrastructure in Ecosystems

The TEV of ecosystems misses out in capturing the 'true value' on at least three counts. One, there is still only a limited scientific understanding of the full complexity of the biotic and abiotic interactions that determine an ecosystem's structure and functioning under given environmental conditions. Two, since the services of an ecosystem are contingent on the current state of nature, there is no way of gauging the full range of functions that the system may be capable of under different environmental conditions. Three, the structure of the system itself may be possessing a 'primary value' that is related to the system's ability to 'hold everything together'. On all these counts, an important characteristic of ecosystems that has been hypothesized to play a critical role is *ecosystem diversity.*

Complementarities

It is now established that the structure and overall behaviour of an ecosystem is determined by only a small set of biotic and abiotic processes, each operating over different scale ranges (Holling, 1992; Holling et al, 1995; Perrings, 1995). These critical structuring processes are supported by complementary relationships that exist between as well as within the biotic and abiotic elements of all ecosystems. In computing the TEV of an ecosystem, the 'complementarities' are ignored in favour of a segmented approach to identifying and valuing ecosystem output. Specifically, the non-anthropocentric interactions (biotic-biotic, biotic-abiotic, abiotic-abiotic) within an ecosystem are yet to find a place in the TEV schema, though it may well be hypothesized that there exists some sort of a 'scale effect' on ecosystem output, which is linked to the complexity and coverage of the complementarities within the system.

Complementary relationships between species and habitats within an ecosystem, and even between different ecosystems, have given rise to the notion of 'contributory value' (Norton, 1986). Ecologically speaking, the critical structuring processes of an ecosystem are characterised by a web of interactive relationships between the elements (biotic and abiotic) of the system. Each element has a very specific role to play in these ecological complementarities. In certain cases relating to the biotic species, "cascading effects" (Norton, 1986) would lead to the loss of a number of dependant species in reaction to the extinction of a single species. Alternatively, it is possible that increases in species diversity induce further increases in ecosystem diversity.

From the economic point of view also, the contributory value concept is important. An identification of the specific role that a species/element (abiotic) plays in the production of an ecosystem service, which can be economically valued, is the key to placing a monetary value on the contribution of the element itself. It is this possibility that probably holds the promise for ecological economists to go beyond the present species/system based focus on use and non-use values to valuing the ecologically significant contributions also. One can think of at least a couple of valuation methods that can be applied to derive the contributory value. The shadow price approach can be used to derive the marginal value of a particular contribution to an ecosystem output. Alternatively, the replacement cost of substituting the element/process by a technological intervention would yield an estimate of the contributory value of the substituted element/process. However, the prerequisite to application of any valuation method is that there exists a complete understanding of the complexity and coverage of the ecological complementarities, which at present is highly lacking (Perrings et al, 1992).

Substitutability

In the dynamic context, when environmental conditions are changing and thereby subjecting an ecosystem to stress and shocks of different degrees and variety, the 'resilience' of the system to such perturbations becomes an important parameter for evaluating 'ecosystem health'. Resilience of an ecosystem is a stability property that is defined in the traditional sense as the rate (per unit time) at which the system recovers its equilibrium after being disturbed (Pimm, 1984; Schlapfer et al, 2002). An alternative to this concept of 'equilibrium resilience' is that of 'structural resilience', which is a measure of the system's capacity to absorb shocks while keeping intact its structure (Holling, 1973; Perrings, 1995). Thus, in the latter sense, a loss of resilience carries the implications of greater vulnerability and reduced predictability for ecosystem structure and functions. From a policy perspective, and therefore for valuation purpose, the 'structural resilience' concept would be of greater relevance (Perrings, 1995).

Resilience of ecosystems has been linked to the idea of substitutability between species/processes in which ecosystem diversity plays a defining role. Notionally, the total picture of ecosystem diversity encompasses both biotic and abiotic diversity. However, in the applied literature one finds ecosystem diversity to be largely equated with biotic diversity or biodiversity. The supreme importance given to biotic diversity is attributed to the dominant role played by biotic elements in the structuring processes of ecosystems.

Species diversity among the biotic elements of an ecosystem contributes to a reserve pool of species that may be functionally redundant over a given range of environmental conditions. Beyond this range, however, substitutes from the reserve pool are likely to emerge with a capacity to 'take over' the structuring functions of the 'keystone species' that are threatened by the altered conditions. Greater the biodiversity of an ecosystem, more is the possibility of a larger reserve of latent keystone species, and greater would be the degree of the system's resilience. This link between species diversity and the structural resilience of the ecosystem has been sought to be captured in valuation studies as the "insurance value of biodiversity" (Perrings, 1995).

Infrastructure

The third ecological function of ecosystems is linked to their structure as such and its capacity to keep everything glued together. This function of an ecosystem is supposed to give rise to its "primary value" (Turner and Pearce, 1993) or, alternatively, its "infrastructure value" (Constanza et al, 1997). The difference between these two concepts is that while the former is based on the idea of an all-encompassing system characteristic, which leads to the generation of certain ecological services that are prior to and necessary for the economically relevant use and non-use values of the system, the latter concept of infrastructure value is linked to the hypothesized existence of a minimum level of ecosystem infrastructure necessary for the health and continued functioning of the system.

2. The TEEV of Ecosystem Diversity

The conventional formulation of TEV in the case of ecosystem functions does not take into account the ecological services critical to ecosystem health and its continued functioning. These services arise because of complementarities, species substitutability and the infrastructure in the system. Ecosystem diversity acts as a significant determinant of the complexity and coverage of the structuring processes that are supported by the above three properties. The valuation concepts corresponding to the ecological contributions of ecosystem diversity are the contributory value, insurance value and primary/infrastructure value. Though the methodology for deriving these values is at a very nascent stage, it is important that the services are recognized (if not quantitatively, then at least qualitatively) and incorporated in the valuation framework. Assuming that all services linked to ecosystem diversity gets valued, then the sum would be a close approximation to the *Total Economic & Ecological Value (TEEV)* of ecosystem diversity. Table-1 presents the valuation framework in this context.

Advances achieved in the field of valuation methodology relating to the contributory, insurance and primary/infrastructure values are fairly recent and still evolving. Much of the attention has been on estimating the insurance value of biodiversity in different habitats. For example, Schlapfer et al (2002) apply an option pricing model from financial economics to estimate the potential insurance value of plant diversity on the stability of hay yields from fertilized low-diversity grassland as compared to that from unfertilized high-diversity grassland. The annual insurance value of species diversity is defined as the premium (based on prices of ‘put options’) difference between the two categories of grasslands and is found to range from $3.50 to $6.00 per acre for rates return varying from 0% to 50%, respectively.

The study by Flaaten and Stollery (1996) is one example of the very few attempts to place an economic value on the contribution of a specific species (in this case it is the Northeast Atlantic Minke Whale) to ecological complementarities involving other species. In the absence of complete knowledge on ecological interactions involving different species, the study utilizes a single-species bio-economic model to analyze the economic costs associated with predator-prey relationships involving the particular whale species. The average predation cost per whale in the year 1991-92 is estimated to be in the range US $ 1780 to 2370. A 10% increase in the stock of the whale species is found to cause a loss of almost 19 million US$ to the fishers of the prey species.

The *shadow price approach* has been used quite extensively in the case of fisheries to estimate the marginal contribution of biodiversity to fish harvest. Kadekodi (2001) illustrates this approach using a modification of the classical bio-economic model of fishery stock dynamics in which the biodiversity variable is entered as a determinant of both the fishery growth and harvest. A distance value of biodiversity richness can be constructed first by defining a set of characteristics of a benchmark species and then adding up the distances of characteristics of all individual species in the ecosystem. Growth of the fishery stock is given by the model:

$$x' = g\,(X, B) - H\,(E, B)$$

where X is the fishery stock, g is the growth function for fishery stock, H is the fishery production function, E represents the usual fishery inputs and B is the distance measure of biodiversity richness. The optimization problem in this case involves the constrained maximization of the profit function P (X, H) discounted over a period of time. With r as the given rate of time preference, the optimization problem can be stated as:

$$\text{Max P (X, H)} = \int_0^\infty P(X,H)e^{-rt}dt \; ,$$

subject to $x' = g(X, B) - H(E, B)$ and the other usual constraints. From the optimality conditions of the above problem, it is possible to derive a numerical value of the marginal contribution (change in the shadow price) of the biodiversity variable to fish stock. Similarly, one can find the marginal contribution of the biodiversity variable in the case of other commercial products generated from the marine ecosystem and then compute the total value of biodiversity.

There is still a long way to go in building up a menu of techniques for valuing the ecological services of ecosystem diversity. Two things are basic to the development of such techniques: a complete understanding of the ecological dynamics and availability of data in appropriate form. Till such information is available, however, it is vital that the existing knowledge is used to go beyond the non-anthropocentric perspective and give recognition to the non-instrumental services provided by ecosystem diversity.

Table-1: Total Economic & Ecological Value (TEEV) of Ecosystem Diversity

	Services	Types of Value	Valuation Method
Economic	Use of genetic diversity (e.g.: producing improved varieties of crops from wild stocks; drug manufacture from plants and animals)	**Direct use values** (both actual and prospective)	Market-based valuation (for actual uses) and option pricing (for prospective uses)
	Aesthetic* Recreational* Inventory of scientific knowledge*	**Non-use or Passive use values** Bequest value Option value Quasi-option value Existence value	Contingent valuation
Ecological	Climate regulation Pest control Retention, removal and transformation of nutrients	**Indirect use values**	Productivity approach, Replacement cost, etc.
	Contribution to the complexity and coverage of ecological 'complementarities'	**Contributory value**	Bio-economic models, Shadow price or the marginal value of diversity, Replacement costs ???
	'Structural resilience' of the ecosystem	**Insurance value**	Option pricing ???
	'Minimum level' required for the health and continued functioning of the ecosystem	**Infrastructure value**	???

*These services are included under the economic category because, as in the case of the direct economic benefits, they too contain the potential to be economically exploited (e.g., through tourism for aesthetic and recreational services; R & D activities based on the knowledge inventory; etc.).

3. Accounting for Crop Diversity Loss in Agro-ecosystems of Karnataka

Compared to the accounting of diversity associated with natural ecosystems, determining the diversity within cultivated landscapes is relatively simpler. One particular aspect of the latter type of diversity, which has received considerable attention because of its ecological implications, is the loss of *crop diversity* in irrigated agro-ecosystems.

Agro-ecosystems are artificial ecosystems shaped by human intervention and consisting of an area of agricultural land where there are common features in crop selection, and where broadly shared agricultural practices are employed. There are a whole range of possible and actual agro-ecosystems depending on the local environmental conditions and the degree to which these have been altered by human design. In many cases, the greater the degree of human intervention, the greater the requirement for external sources of energy, water and nutrients in order to maintain the altered state. The artificial maintenance of such input-dependant systems imposes a continuous stress on them, which has the inevitable environmental consequences in the form of loss of productivity and erosion of resilience. Usually, the processes through which these environmental consequences take shape involve a loss of species diversity.

In the case of irrigated agro-ecosystems, the incentive for farmers from an economic point of view is to concentrate on the cultivation of high-yielding water-intensive crops, with high conjunctive use of fertilizers and pesticides. This practice ultimately leads to extensive violation of the cropping pattern recommended by irrigation authorities. The specific environmental problems linked to violation of cropping pattern are *waterlogging of the land*, *soil salinity* and *soil alkalinity*. Further, the loss of crop diversity that entails from the overwhelming emphasis on the cultivation of high-yielding water-intensive crops increases the vulnerability of the system to *pest attacks*, *crop failures* and *nutrient loss of the soil*. Table-2 presents a list of the important changes in land use due to irrigation and their environmental and economic consequences.

Table-2: Impacts on land use due to irrigation and their environmental and economic consequences

Impacts on land use	Environmental and Economic consequences
1. Submersion of land including: - *forests* - *habitations* - *agricultural land* - *mineral reserves*	Loss of forest area Destruction of forest flora and fauna Forced displacement (people as well as wildlife) Depletion of cultivable land Depletion of mineral stock
2. Utilization of land for construction of irrigation infrastructure	Depletion of cultivable land Depletion and degradation of forest area and resources
3. Crop violations	Waterlogging and its Health hazards

		Soil salinity and alkalinity
4.	Loss of crop diversity	Loss of pest resistance, Crop failures Nutrient loss of soil

The attempt in the present section would be to bring out the links between, on the one hand, the violation of planned cropping patterns and ecological damage to the cultivated landscape and, on the other, the impact of irrigated agriculture on crop diversity. The relevance of an examination of the first issue in the context of the second is that the general practice of violating the set norms of cropping pattern is symptomatic of the process that culminates in loss of crop diversity. Data relating to crop violations and the ecological damage to land has been obtained for the areas served by nine major irrigation projects located in the Krishna and Cauvery river basins of the state of Karnataka. For the second issue, standard *diversity indices* are computed using the data on fractional area cultivated for 15 crops in the rainfed and irrigated areas of five sub-zones of the dry agro-climatic zone of Karnataka.

Crop Violations

Violations of the recommended cropping pattern for the command areas of the nine major irrigation projects in Karnataka are the common practice rather than the exception. Table-3 presents the cropping pattern as planned and the actual for the command areas of the nine major irrigation projects of the state for the years 1998-99 and 1999-2000.

Table-3: Cropping pattern as planned and actual during 1998-99 and 1999-2000

(Area in hectares)

River basin	Project	Planned (P)/ Actual (A)	Cropping pattern (1998-99 and 1999-2000)				
			Kharif semi-dry	Rabi semi-dry	Biseasonal	Rice	Perennial
Cauvery basin	Krishnaraja Sagara	P	-	-	-	136000	60000
		A	*39492*	-	-	*103432*	*40388*
	Kabini	P	60000	102000	-	53000	-
		A	*14922*	-	-	*72606*	*4579*
	Harangi	P	117829	35129	-	14466	-
		A	*40144*	-	-	*37242*	*53*
	Hemavathy	P	390500	261500	-	13000	-
		A	*74800*	-	-	*126543*	*5713*
Krishna basin	Bhadra, Tunga and Gondi	P	118737	104822	-	35634	2123
		A	*65139*	*90187*	*19921*	*38305*	*10730*

	Tungabhadra	P	170288	112489	29975	29032	21011
		A	*61633*	*73302*	*36752*	*218105*	*4213*
	Malaprabha	P	42886	42886	21442	-	-
		A	*33552*	*56655*	*16677*	-	-
	Ghataprabha	P	68994	68994	34498	-	-
		A	*89077*	*74209*	*9200*	-	-
	Upper	P	73224	-	45807	-	-
	Krishna	*A*	*121406*	*204917*	*16825*	-	-

Source: Karnataka State Land Use Board (2001)

It is clear from the data presented in Table-3 that in all the project areas there is extreme violation of the planned cropping pattern. In case of rice, which is a highly water-intensive crop, the extent of violation is by a nearly 10 times deviation (on the higher side) from the planned figure in the Hemavathy project area and by a nearly 7 times deviation (again on the higher side) in the Tungabhadra project area. Similarly, in the Harangi project area though the recommended cropping pattern provided for 1,17,829 ha of kharif semi-dry and 35,129 ha of rabi semi-dry crops, in the actual case, the respective area for these two crops during 1998-99 and 1999-2000 were 40,144 ha and nil, respectively. In the Kabini, Harangi and Hemavathy project areas, there was cultivation of perennial crops like sugarcane though it was not planned.

The above instances of crop violations are only illustrative of a general tendency and are possibly party to a long-run trend. It would be highly pertinent to collect information on the cropping patterns in the irrigated areas of the state to identify the long-run trends in crop violations. Such information can be used along with time series data on crop diversity to model and test for the hypothesized link between crop violations and loss of crop diversity.

Table-4 gives the total area affected by crop violations as percentage of the total irrigated area for each of the projects as well as the details of soil problems in the respective command areas.

Table-4: Details of crop violations and soil problems in irrigated command areas

River basin	Project	Crop violations* *(Area in % of total irrigated area)*		Details of soil problems in 1999** *(Area in % of total irrigated area)*			
		1996-97	2000-01	Water logging	Soil salinity	Soil alkalinity	Total problematic area
Cauvery basin	Krishnaraja Sagara	9.32	18.39	2.19	0.97	-	3.20

	Kabini	27.38	32.45	7.10	7.24	-	14.30
	Harangi	21.83	32.06	0.78	0.98	-	1.80
	Hemavathy	45.69	42.01	2.09	-	-	2.10
Krishna basin	Tunga	0.0	0.26	-	-	-	-
	Bhadra	49.0	47.47	6.29	3.94	4.05	14.30
	Tungabhadra	36.38	52.03	5.84	7.17	1.71	14.70
	Malaprabha	4.40	1.40	2.84	1.12	0.41	4.40
	Ghataprabha	14.25	18.96	2.55	2.03	0.34	5.00
	Upper Krishna	45.91	8.44	1.99	3.26	11.02	16.30

*Source: Office of Chief Engineer, Monitoring & Evaluation, Dept. of Irrigation, Govt. of Karnataka

**Source: Puttaswamy (1999)

Out of the ten major irrigation projects for which data is given in Table-4, six projects are associated with an increase in crop violations in the year 2000-01 as compared to the situation in 1996-97. In case of the Tungabhadra project area, the extent of crop violation is as high as 52% of the total irrigated area, and this represents a 16% increase over the comparable figure given for the project area in 1996-97. Among the project areas for which crop violations have declined in 2000-01 as compared to that in 1996-97, the area served by the Upper Krishna project records the most dramatic decline from 45.9% in 1996-97 to 8.4% in 2000-01.

Soil problems are a consequence of both the type of cropping pattern and the soil type. Violations of the recommended cropping pattern can damage soil status because of the stress to the agro-ecosystem arising from overuse of irrigated water, chemical fertilizers and pesticides as shown in Table-4, soil problems are particularly severe in those project areas where there is a record of large-scale crop violations. Thus, for the command areas of Kabini, Bhadra and Tungabhadra projects, which have crop violations over one-third or more of their total irrigated areas, the total problematic area with regard to soil status in each of these three project areas is near to 15% of their respective total irrigated areas. In the case of the Upper Krishna project area, the decline in crop violation is yet to have an effect on the damage done to soil status and the total problematic area is highest at 16.3% of total irrigated area. Exception to the observed relationship between crop violation and ecological damage to land/soil is obsrved for the command areas belonging to Harangi and Hemavathy projects. Despite the extent of crop violations observed for these two project areas, the total problematic areas are at relatively lower levels (1.8% and 2.1% of total irrigated area, respectively, for Harangi and Hemavathy projects).

Diversity Indices

A number of standard indices are available for placing a quantitative value on the crop diversity within an agro-ecosystem. These indices can be estimated using crop data obtained in field or remote sensing studies. Some of these indices are as follows:

Richness N

Proportional Abundance $S = -\sum A_I \ln A_I$
(Shannon diversity index)

Evenness $E = S / \ln N$
(Shannon evenness index)

Relative dominance $D = A_{MAX} / A_{TOTAL}$
(Berger-Parker diversity index)

Similarity index $J = N_c / (N_a + N_b - N_c)$
(Jaccard's index)

where	N	=	number of different crops grown
	N_a	=	number of species in an area, a
	N_b	=	number of species in an area, b
	N_c	=	number of species common to a and b
	A_I	=	fractional area occupied by an individual crop, i
	A_{MAX}	=	fractional area occupied by the most abundant crop
	A_{TOTAL}	=	fractional area occupied by all crops

Information on the area cultivated for 15 major and minor crops under rainfed and irrigated conditions have been collected for the dry agro-climatic zone of Karnataka, which happens to be the major agro-climatic zone for the state. To smoothen the data, the average of three years (1995-96 to 1997-98) data has been computed. Table-5 presents this information in a modified form after the conversion of the averages into fractions of the respective net sown areas for rainfed and irrigated categories in each of the 5 sub-zones. This data has been used to compute the popular Shannon Diversity Index for crops cultivated under rainfed and irrigated conditions in the 5 sub-zones (Zone 2: North-eastern; Zone 3: Northern; Zone 4: Central; Zone 5: Eastern; Zone 6: Southern) coming under the dry agro-climatic zone of Karnataka. Table-6 gives the estimated figures. It can be seen that for Zone 6, which has more than half of its net sown area under irrigated conditions, the crop diversity index for irrigated areas is considerably lower (0.64) as compared to the measure for rainfed areas (1.60).

Table-5: Crop-wise fractional area under rainfed and irrigated categories for the dry zones of Karnataka (average of three years, 1995-96 to 1997-98)

Crop	Zone 2		Zone 3		Zone 4		Zone 5		Zone 6	
	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated
Rice	0.004	0.298	0.000	0.183	0.002	0.492	0.005	0.290	0.002	0.727
Jowar	0.358	0.063	0.384	0.117	0.071	0.047	0.001	0.000	0.093	0.007
Ragi	0.000		0.010	0.001	0.210	0.079	0.470	0.148	0.398	0.082
Maize	0.001	0.004	0.012	0.218	0.069	0.078	0.010	0.078	0.008	0.011
Bajra	0.058	0.115	0.094	0.025	0.009		0.000		0.001	0.001
Wheat	0.012	0.014	0.042	0.079	0.000	0.002		0.000	0.000	0.000
Tur	0.183	0.016	0.023	0.006	0.022	0.004	0.029	0.003	0.018	0.001
Bengal gram	0.081	0.010	0.044	0.030	0.008	0.000	0.000	0.001	0.005	0.000
Horse gram	0.008		0.028		0.062		0.046		0.154	
Groundnut	0.087	0.424	0.099	0.114	0.310	0.126	0.163	0.051	0.086	0.014
Sunflower	0.166	0.225	0.164	0.131	0.090	0.047	0.002	0.027	0.032	0.004
Safflower	0.056		0.028		0.002					
Sesamum	0.015		0.012		0.009		0.003		0.016	
Cotton	0.027	0.123	0.063	0.092	0.026	0.045	0.000	0.000	0.049	0.003
Tobacco	0.001		0.002		0.001				0.008	

Table-6: Estimates of the Shannon Diversity Index for crops grown in the rainfed and irrigated areas in 5 sub-zones of the dry agro-climatic zone of Karnataka

Area	Sub-zones of the dry agro-climatic zone of Karnataka				
	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Ratio of Irrigated to Rainfed area	0.184	0.370	0.196	0.243	0.548
Irrigated	1.94	2.06	1.48	1.12	0.64
Rainfed	2.01	2.01	1.78	1.00	1.60

4. Conclusion

The coming regime of Intellectual Property Rights promises to witness considerably greater commercial attention to the benefits flowing from ecosystem diversity. For developing countries, which are way behind their advanced counterparts in terms of data availability, it is imperative that priority attention is given to the building up of an inventory of diverse resources, their interdependencies, and the threats to their healthy existence. Recent advances made in analyzing remote sensing data carry considerable promise of tackling the data limitations relating to ecosystem diversity. Besides the data issue, valuing the ecological contributions of diversity to the ecosystem is also subject to a complete understanding of the ecological dynamics. It requires greater multi-disciplinary interaction to understand the processes through which diversity of an ecosystem contributes.

Accounting for the ecological benefits of high diversity ecosystems is complex and many of the techniques are still in the evolving phase. An immediate requirement for a country like India is that of a region-wide effort at building up the physical accounts of ecosystem diversity. An effort in this direction is the Committee constituted in 1998 by the Ministry of Environment and Forests, Government of India, for working out the methodology for quantifying intangible benefits of forests. The Committee has identified three main ecological attributes to analyze the structure of the forest ecosystem viz Importance Value Index, Population Dynamics and Species Diversity. Similar initiatives would contribute to the construction of a uniform set of diversity-related measures/indicators that would apply to different ecosystems at varying levels of accounting.

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Development and Harmonization of Framework for Natural Resource Accounting in India – An Experience from Forestry and Wetland Ecosystem

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Natural resources constitute wealth of nations. Degradation of various natural resources associated with economic development of population growth is visible in any places. This is mainly because not much attention is being paid towards heavy environmental costs that we pay for economic development. Though enough space has been created for depreciation of man made capital in our national income accounting system but no such depreciation account exist for natural capital which is a part of our national wealth or stock. Natural Resource Accounting is a revaluation of the National Income Accounts of a country, adjusting for the values of natural resources used in various economic activities during the past 'fiscal year'. Natural resources, as they appear in nature, get degraded in quality and depleted in stock due to economic and human activity. They also go through natural decay and regeneration. They may also have been enhanced due to plan interventions. There is need to understand the extent of such losses or gains and to work out their 'use values' and generate accounts of such resource deletions and additions. Therefore, being part of the wealth of the nation, there is a need to integrate the resource accounting along with the System of National Accounts (SNA). United Nations Statistical Division (UNSTAT) labeled this as System of Environmental and Economic Accounting (SEEA). In some sense it is often referred as Green GDP.

The main objectives of integrated environmental accounting are segregation and elaboration of all environmental and economic accounts, linkage of physical resource accounts with monetary environmental accounts and balance sheets, assessments of environmental costs, benefits and accounting for the maintenance of the tangible wealth. It is, thus, a complete accounting procedure for environmental assets. In India, though several individual studies have been undertaken for sector / resource to estimate economic value of benefits or cost of environmental degradation but there has been no attempt to integrate the various sector or resources at state and national level (except pilot project on NRA in Goa state by TERI where too independent sectorwise estimates based on secondary data have been worked out). The main reason being lack of availability of a standardized framework for NRA in India. Various approaches like input/output based SEEA or Satellite Accounting have been used to generate NRA. This paper is deals with two case studies done by the author on forest and wetland ecosystem accounting of various values and thus attempts develop and then harmonize framework for Natural Resource Accounting of these two ecosystems. It provides the framework following three basic steps of Physical accounting of various natural resources; use of various monetary valuation techniques to generate their market value; integration of environmental accounts with the conventional income accounts wherever possible.

1. Introduction

Natural resources constitute wealth of nations. They form an important type of capital for country's economic progress besides the physical, financial, human, social, intellectual and institutional capital. Thus to maintain all other capitals it is recommended to invest in natural capital so as to continuously provide for increasing needs of the population. Similarly, like recording and accounting of all other capitals, it is essential to account for natural capital to know the status of its availability, addition to and deletion from its stock. Natural Resource Accounting is a revaluation of the National Income Accounts of a country, adjusting for the values of natural resources used in various economic activities during the past 'fiscal year (Kadekodi, 2001). Natural resources, as they appear in nature, are degraded in quality and depleted in stock due to economic and human activity (e.g., hazardous chemicals polluting ground water or over-extracting of minerals or forest resources leading to depletion). They also go through natural decay (such as earth quakes or cyclones) and regeneration (e.g., in protected areas). They may also have been enhanced due to plan interventions such as plantations (e.g., social forestry). There is need to understand the extent of such losses or gains and to work out their 'use values' and generate accounts of such resource deletions and additions. Therefore, being part of the wealth of the nation, there is a need to integrate the resource accounting along with the System of National Accounts (SNA). United Nations Statistical Division (UNSTAT) labeled this as System of Environmental and Economic Accounting (SEEA). In some sense it is often referred to Green GDP.

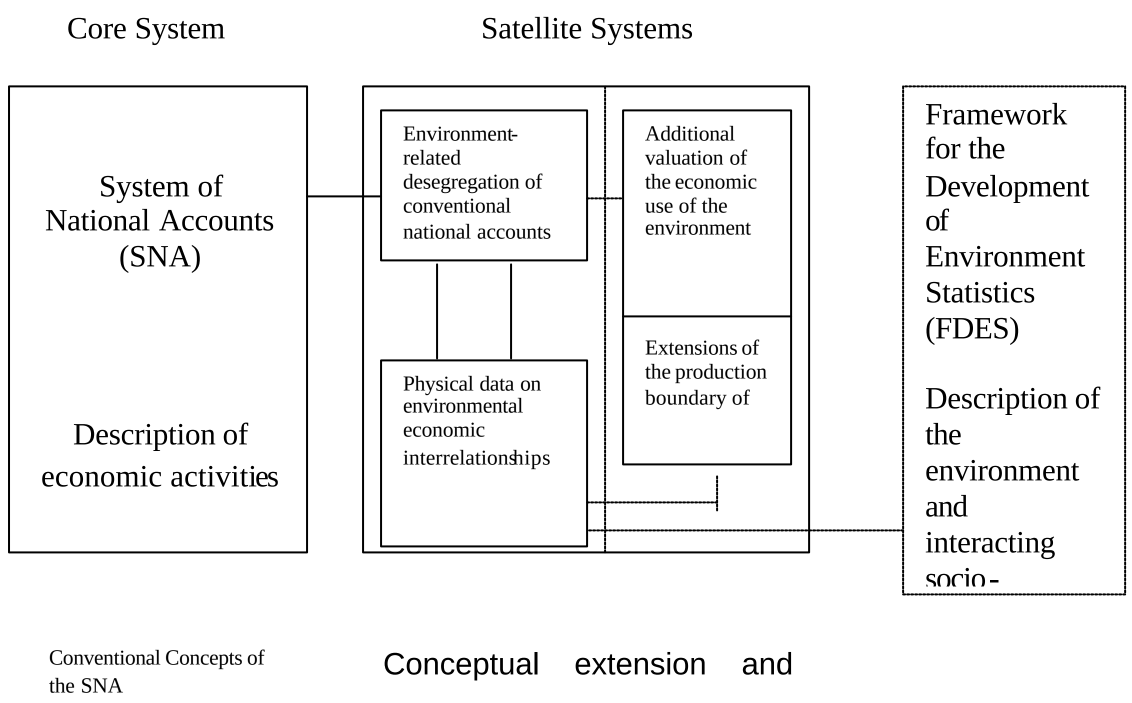
The main objectives of integrated environmental accounting are segregation and elaboration of all environmental and economic accounts, linkage of physical resource accounts with monetary environmental accounts and balance sheets, assessments of environmental costs, benefits and accounting for the maintenance of the tangible wealth. It is, thus, a complete accounting procedure for environmental assets. Natural resource accounting involves three steps:

- Physical accounting,
- Monetary valuation and
- Integration with national income accounts.

Physical accounting is very important to determine the state of the resource. However, physical accounting is only a part of the entire process of resource accounting. The step is followed by the valuation methods. Only after a monetary valuation has been done, it will be possible to integrate the net change in natural resource sectors to the gross domestic product of the nation/state/region. The net change in monetary terms, arising out of the change in state of the resource, is added or deducted from the GDP to arrive at the Adjusted Net Domestic Product or Green GDP. On practical terms this process is too complicated and the kind of data and information on these are not available for all the resources of the nation. Therefore, different alternative methods are also suggested for the for Natural Resource Accounting.

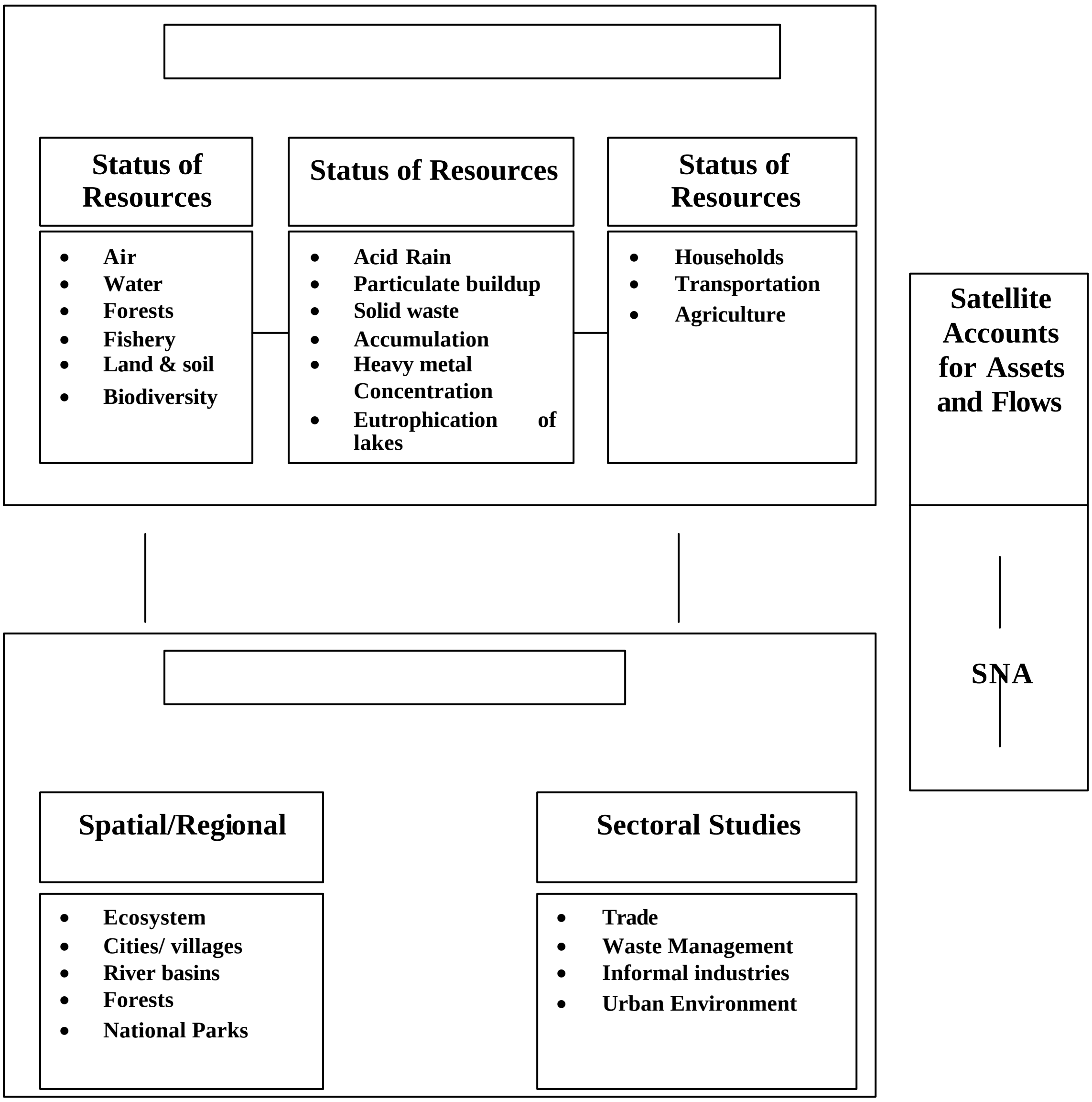
First, UNSTAT proposed the satellite system for environmental accounting that does not make any change in the core system of SNA, but proposes establishing linkages between the SNA and the integrated economic and environmental accounting. The values of the natural resources and their changes can be shown along with the usual national income accounts, as a satellite statement. It is essentially a modified income accounting system, showing environment related sectoral activities separately along with their physical accounts of flow changes, valuations and possible links to the main SNA. Figure 1 and 2 demonstrate the structure of satellite accounts.

Fig 1: U.N.'s Satellite System of Accounting



Source: UNSTAT, 1993

Fig 2: Linkages Between Environmental Assessment, Case Studies And Satellite Accounts.



Source: Parikh ,Parikh, Sharma & Paintuly (1997), NRA Framework for India

The second way is to treat natural resources as a separate set of activities (loosely to be termed as industries) in an Input-Output table (which is input for national income accounts, commonly used by the Central Statistical Organization). Then the outflows from such natural resource sectors will have been absorbed by other sectors of the economy. For instance, water production from Water Resource Sector would flow to many industrial sectors, household sector and or course to agriculture sector as irrigation. However, there are many more difficulties in completing the task of flows natural resource sectors.

The following framework provides integration of accounts requires to account all aspects of natural resource uses and abuses based on input output framework (Box 1)

Box 1: Input-Output Based SEEA

Net National Product = Value of consumption of normal goods and services
+ Value of production of nature collected (such as fuelwood, biomass)
+ Value of environmental amenities provided by environmental resource stocks (such as clean air, top soil)
+ Value of leisure enjoyed (say in enjoying aesthetic beauty of wildlife reserve)
+ Value of net additions to production capital
+ Value of net additions to natural capital stocks (such as plantations in forests, or depletion of exhaustible resource)
+ Value of additions to stock of defensive capital (such as water purifier).

The input output method calls for segregation of stock from flow, depreciation from depletion and natural and planned addition or deletion from the natural resource base.

The third way of generating NRA is to account for depletion of natural resources using cost based approaches like user cost method and depreciation or net price method as mentioned in the following section.

2. Methodology for Generating Values for NRA

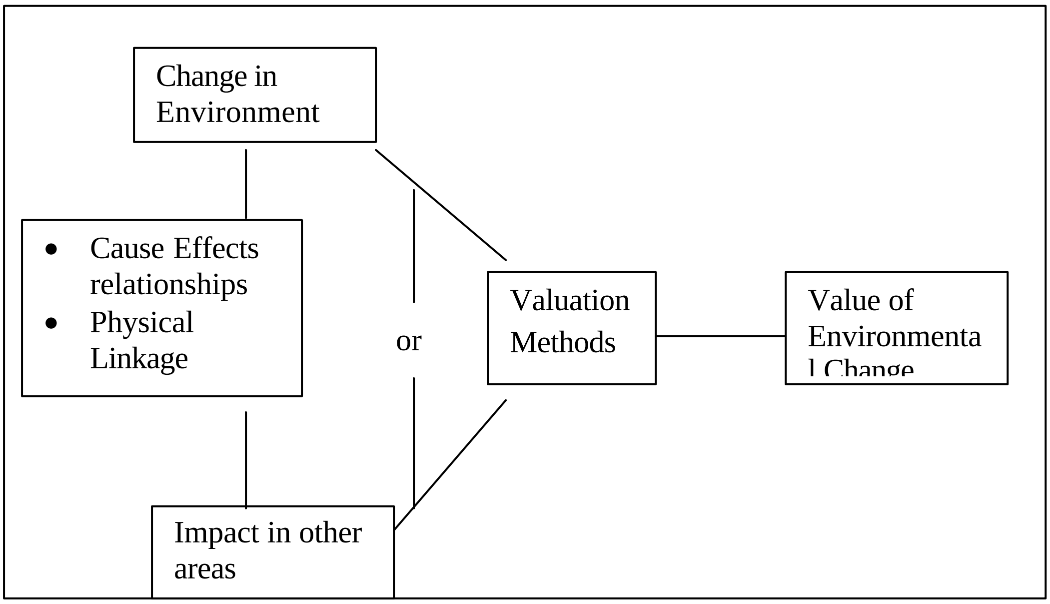
For generating the databases for eventual setting up of NRA various economic and ecological functions of environmental resources (Table 1) need to be considered and then appropriate methodology of valuation need to be used to (Figure 3 and Box 2) generate values for entering them in the accounting system.

Table 1 : Economic and Ecological Functions of Environmental Resources

Environmental Resource	Economic functions	Ecological functions
Water	Drinking Irrigation Fisheries Tourism	Life support Nutrient cycling Biodiversity
Land and soil	Food production Forestry Human habitation	Nutrient cycling Water retention Biodiversity
Forest	Sustainable timber Non timber forest products Recreation and Tourism Medicines Education	Watershed protection Nutrient cycling Habitat for flora and fauna

Source : Adapted from Parikh and Parikh, 2000.

Fig 3: Steps in Valuation



Source: Parikh and Parikh, ESCAP Vol.II

Box 2: Conceptual Representation of Total Economic Valuation Techniques

I. Market Based

- ***Conventional Market Approach:* productivity change, opportunity cost, replacement cost, shadow price etc.**
- ***Surrogate market approach :*** Property value or hedonic prices, travel cost method, etc.
- *Constructed market Approach*

1. **Market Valuation of Natural Resource Stocks and Changes**
   1.1. Depreciation Method
   1.2. User Cost Method
   1.3. Avoidance Cost Approach
   1.4. Market Price or Consumer Surplus Approach
   1.5. Opportunity cost or Substitution Approach
   1.6. Shadow Price Approach.

2. **Maintenance Costing**
   2.1 The Replacement / Relocation / Restoration Cost Approach
      2.1.1 The Replacement/Relocation/Restoration Cost Approach
      2.1.2 The change in Productivity Method
      2.1.3 The welfare Method

   2.2 Maintenance costing of natural asset : *Subjective Valuation Method*
      2.2.1 The Hedonic Price Method
      2.2.2 The travel cost approach
      2.2.3 The property value approach
      2.2.4 The production function approach

3. **Contingent Valuation Technique**

II. Non Market Based

Source: Modified from Kadekodi, 2000. Economic Valuation of Biodiversity (Forthcoming)

3. Framework of NRA - Experience from Forestry and Wetland Ecosystems

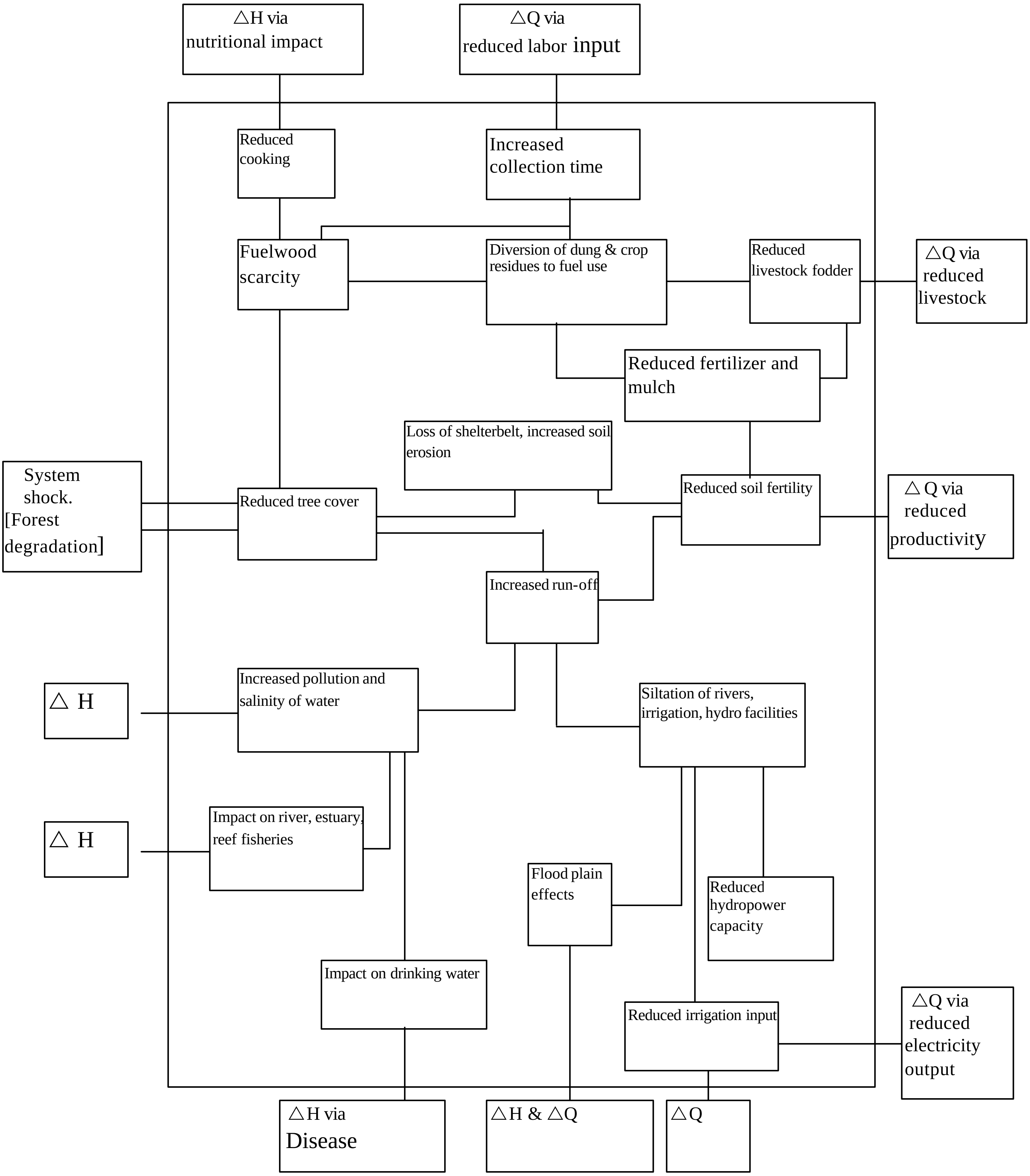
3.1 Sustainable Forest Management (SFM) & Need for Forest Valuation and Accounting

3.1.1 SFM & Forest Linkages

From the policy of point of view, sustainability is not in option, it is an imperative. Sustainable development, the central theme of UNCED Agenda 21,underlined the need to link rate of growth to environmental quality & conservation. Within this broad scheme, sustainable forest management (SFM) should ensure that values derived from the forest meet present day needs while at the same time ensuring that forest maintain a quantity & quality that contribute to long-term development needs (Chandrasekaran, 1996). Thus to conserve the sustainability of the forests, a rational and balanced combination of different functions of forests is needed. Resources for subsistence, shelter & employment as well as for development of other sectors are provided by the forests. They provide for immediate rural livelihoods, to adjoining & distant urban area & also generate many trans boundary benefits (Table 2).

Forests have very high resource inter connection & the dynamics of an economic system is heavily dependent existence or non-existence of forests. Such resource inter-connections in the form of initial system shock due to forest degradation & its impact there of are shown in Figure.4

Figure: 4 Resource Inter-connections of Forests



△H = Change in Health ; △Q = Change in Quantity

Source: *Environmental & Natural Resource Economics*, David Pearce

It is evident from the above diagram that forests have high co-efficient of forward linkages. The play an important role in the maintenance of both ecosystems & economic – social system through their various functions depicted in the following table.

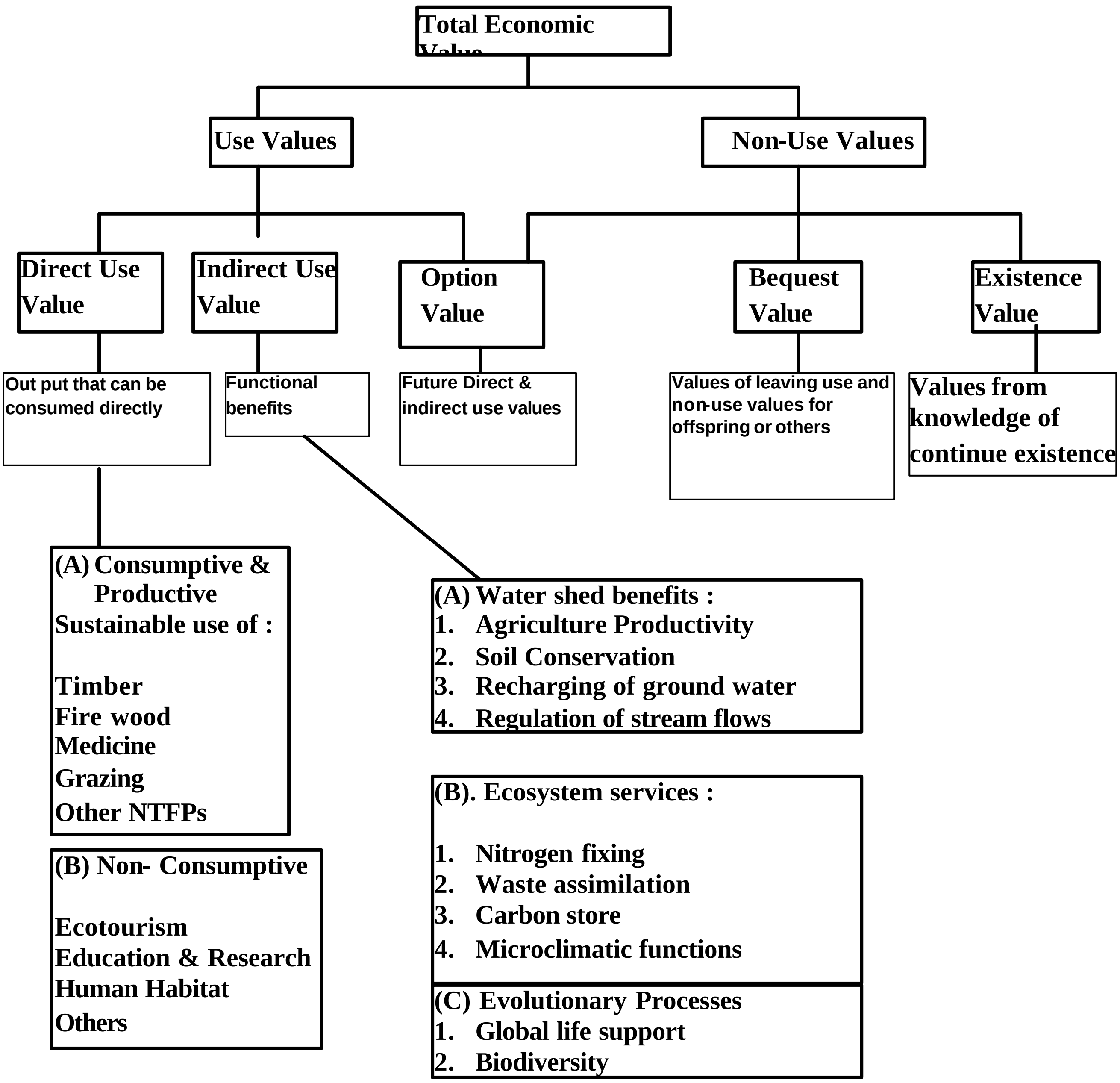
Table 2 : Functions of forests

For the Natural system	For the social system
Protective	
Soil protection by absorption and deflection, radiation, precipitation and wind conservation of humidity and carbon dioxide by decreasing wind velocity sheltering and providing required conditions for plants and animal species	sheltering agricultural crops against drought, wind, cold, radiation conserving soil and water shielding man against nuisances (noise, sights, smells, fumes)
Regulative	
absorption, storage and release of CO2, O2 and mineral elements absorption of aerosols and sound absorption, storage and release of water absorption and transformation of radiant and thermal energy	improvement of atmospheric conditions in residential and recreational areas improvement of temperature regimes in residential areas (roadside, trees, parks) improvement of biotype value and amenity of landscapes
Productive	
efficient storage of energy in utilizable form in phyto and zoomass self regulating and regenerative processes of wood bark, fruit and leaf production production of a wide array of chemical compounds, such as resins, alkaloids, essential oils, latex, pharmaceuticals etc.	supply of a wide array of raw materials to meet man's growing demands source of employment
In the case of tropical forests the first two functions – protective and regulative – are extremely important and not very well known while the third – productive – is largely underestimated and underused.	

Source : ICIHI (1989)

Thus various kinds of values that are mostly hitherto intangible values need to be considered for complete recording of forestry sector's contribution to the national economy such that as per contribution of the sector proper allocation of budget to the forestry sector could be made. The following table enlists such values which need to be considered in comprehensive recording of forestry sector's contribution to the region.

Figure 5: Total Economic Value of Forests

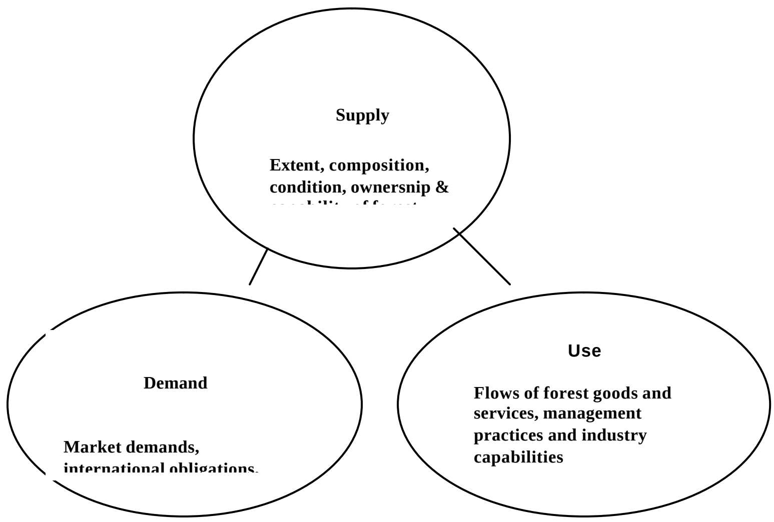


Thus it can be seen that the private costs of managing forests are higher (mostly borne by forest department), the social costs are minimal. Forests have very high positive externality in terms of various ecological, biological & aesthetic benefits provided by them but no price is paid in exchange. For the reason of managing forests on a sustainable manner, the key lies in communicating the "value" of forests both in economic & social terms of all stakeholders. Such a communication can begin by fully accounting the benefits from forests & assigning priority to the sustainable productivity to forest lands. The other sectors should be asked to compensate for capital transfers and support received from forestry & governments should provide increased allocation to forestry.

3.2 Importance of Forest Resource Accounting

3.2.1 Forest Resource Accounting (FRA) – helps to keep down the costs of information usage by focusing on what is essential only – i.e. the information which is required to set, achieve and review forest policy and management goals. As per the framework developed by IIED and WCMC for FRA (1996) the following are the key information areas of FRA:

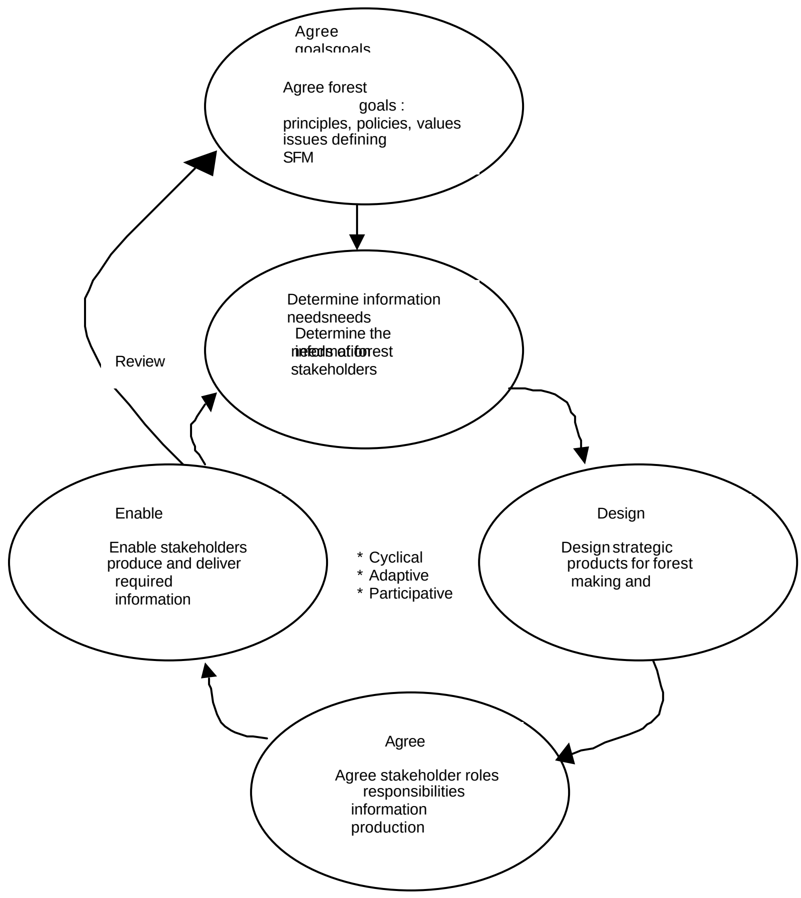
Figure 6 : Key information Areas for FRA



Source: IIED & WCMC, 1996

The next step would be to link the information usage with the refinement of policy and management objectives as illustrated in the FRA cycle (Figure 7)

Figure 7 : The FRA Cycle



Source : Same as Figure 6

The users of such FRA would be multiple as illustrated in the following Box .

Box 3 : Benefeciaries of FRA

FRA helps meet the increasing demand for information from different groups, including :

- national and state legislatures
- natural resource management agencies
- forest owners and concessionaires
- forest industry and trade groups
- local communities dependent on forest and supporting ngos
- international for, secretariats to conventions and donor agencies

Source : Same as Figure 6

By promoting step-by step, achievable objectives for the collection, analysis and interpretation of forest information, FRA helps to :

- Reduce the costs of information usage
- Guide managers towards improved forest policy and management effectiveness
- Enhance transparancy and accountability
- Lead to more productive use of forest assets.

The driving forces of FRA and typical FRA products are illustrated in the following Boxes.

Box 4 : Driving forces of FRA

To understand why stakeholders may be motivated to participate in FRA, it is necessary to examine its driving forces :

- Cost-effective information and monitoring: like other production factors, information is expensive and should be produced for specific policy and management objectives only.
- Participatory policy development: in almost all cases the participation of a broad range of stakeholders is central to the success of forest policy development. Participation facilitates trust, cooperation and information sharing, which are essential for the long term welfare of forests.
- Continuous improvement of information and monitoring (leading to continuous improvement of policy and management performance): small steps are advocated, resulting re-examination of infrastructure, human resources, and working practices is necessary to ensure the highest performance.

Source : Same as Figure 6

Box 5: Typical FRA products

Depending on need, the particular FRA 'products' selected for a given location may be drawn from the list below or entirely new. The FRA process will help to determine which products are achievable quickly, and which are longer term prospects requiring multiple inputs, perhaps from a series of agencies :

- State of the forests Report (baseline data and maps, selected criteria and indicators)
- Balance sheet of forest stocks and flows (including non-timber forest products).
- Concession monitoring and forest investment programme
- Forest valuation (notional or forest unit level)
- Audits of forest management (by different stakeholders) and administration.
- Forest sustainability assessment (according to notional standards / international principles).
- Country-level forest management certification.

FRA can also play a key role in cross-sectoral initiatives such as :

- Land capability information system
- National environmental management system
- National Biodiversity database
- Natural resource accounts (monetary or physical). \

Source : Same as Figure 6

Despite the availability of methodology for FRA, various difficulties in accounting in forestry sector are encountered as below:

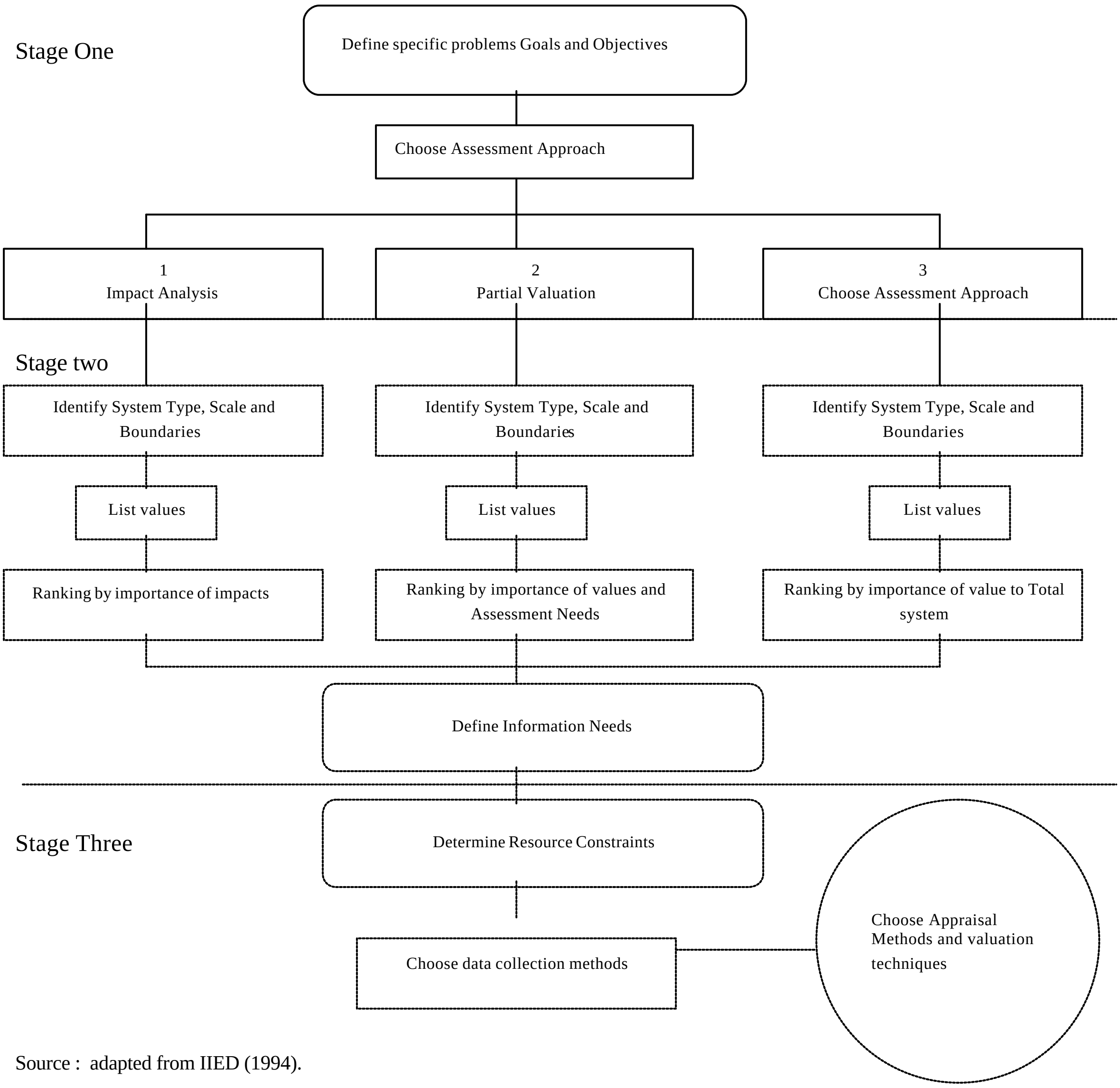
- Distinguishing between depreciation and depletion. In the case of depreciation, it can remain as a notional value judgment. The same cannot be said about natural resources when they actually degrade and deplete.
- Secondly, accounting for additions to forest stock is not easy. It takes place both through natural regeneration and plantation.
- Thirdly, the flow from forest stocks is only partially accounted as legal extractions: much of it is not. Then there are several natural phenomena such as forest fires, landslides, earthquakes, floods etc., because of which there are changes in this natural capital. In short, physical accounting of forest stock and flows is a complex task.

3.3 Wetland Valuation for its Sustainable Management

3.3.1 Need for Wetland Valuation

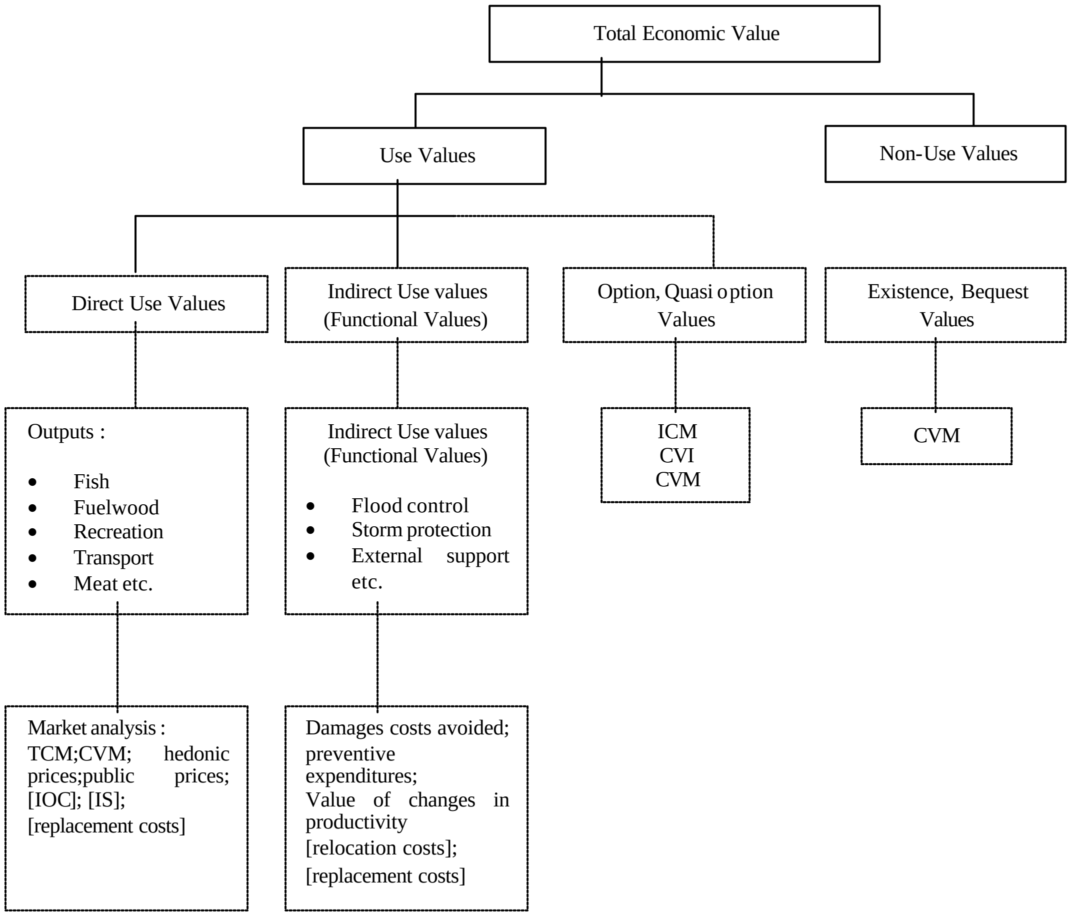
Wetlands are generally highly productive ecosystems, providing many important benefits. These benefits some times described as 'goods and services', may be wetland functions (e.g. ground water recharge, flood control), uses of wetland or its products (e.g. site for wood collection or research site) or attributes of the wetland (aesthetic component of the landscape, religious significance). In order to utilise the benefits provided by wetlands successfully it is important to identify and assess the benefits that a particular wetland provides. These multilateral ecosystems through their numerous functions provide substantial benefits to society. However despite their important role in maintaining the ecology and economy of the regions, almost all wetlands in India are endangered by lack of appreciation of their role. A few of the country's wetlands, which have a great deal of biological wealth are protected under the Wildlife Protection Act, 1972, whereas others which may not be as biologically rich do not share the same protection, and are easy target of developers. Considered wastelands, wetlands are the obvious choice when land is needed for development. However more often than not these benefits are recognized and undervalued, as they fall outside the ambit the market economy (Sustainable Wetlands, EG-2, Cap 21). *People have well understood the uses of wetlands but not their use values.* There has not been much effort in the past to assign the use value or a price tag to various extractives and non-extractive uses of the wetland such that it can be sustainably managed. People in the urban areas must learn to live in harmony with nature in their own habitat. The wetlands, the green belts, and the flora and fauna of these areas have to be preserved for urban areas to survive and remain healthy. But most of these wetlands are considered wastelands, and they become obvious choice when land is needed for development. For complete understanding of wetland values the assessment framework for economic valuation of wetlands (as per figure 8) need to be considered and then various valuation techniques as per the benefits extracted need to be used for understanding the status of the wetland (as per figure 9).

Figure 8 : The Assessment Framework for Economic Valuation of Wetlands



Source : adapted from IIED (1994).

Figure 9: Wetland Valuation Techniques.



Notes :

ICM	=	individual choice models
CVI	=	conditional value of information
CVM	=	contingent valuation method
TCM	=	travel cost method
IOC	=	indirect opportunity cost approach
IS	=	indirect substitute approach
[ ]	=	valuation methodology to be used with care

Source : adapted from Barbier (1989a)

3.4 Indian Experience of FRA and Wetland Valuation

3.4.1 An Overview

Few attempts have been made in India recently to estimate economic value of intangible benefits of forests like eco-tourism, recreation, water supply, watershed value, carbon store & biodiversity and conservation, recreation, property prices and secondary values for the wetland. An overview of such studies is given in table 3.

Table 3 : Economic Value of Goods and services of Forest & wetlands Ecosystem: Indian Case Studies.

Goods and services	Annual value	Location	Methodology applied	Source
Recreation/ Ecotourism	Rs. 16197 per ha (Rs. 427.04 per Indian Visitor Rs. 432.04 per foreign visitor)	Keoladeo National Park, Bharatpur	Travel Cost Method	Chopra (1998)
Recreation/ Ecotourism	Rs.20944 per ha (Rs.519 per Indian visitor and Rs. 495 per foreign visitor)	Keoladeo National Park, Bharatpur	Contingent Valuation Method	Murthy & Menkhuas (1994)
Recreation/ Ecotourism & other benefits	Rs. 23300 per ha (Rs. 519 per Indian visitor and Rs. 495 per foreign visitor)	Borivelli National Park, Mumbai	Contingent Valuation Method	Hadker, et.al (1995)
Ecotourism	Rs. 675 per ha (for locals); (Rs. 3.2 million total per year)	Periyar Tiger Reserve	Contingent Valuation Method, Travel Cost method	Manoharan (1996)
Ecotourism	Rs. 2.95 million toal; (Rs.34.68 per visitor)	Kalakadu Mundanthurai Tiger Reserve, Tamil Nadu	Contingent Valuation Method	Manoharan & Dutt (1999)
Ecotourism/ recreational/ pilgrimage/ sacred grove	WTP for maintenance and preservation of the lake by Local community-US$0.88 (Rs.36.08) Local pilgrims -US$2.2 (Rs.90.20) Resident Visitors-US$2.5 (Rs.102.5) Non-resident visitors-US$7.2 (Rs.295.2) (Aggregate WTP-US$46940 based on total visits per year (Rs.1.92 million) Per hectare value – Rs.1604	Recreational value of a sacred lake in Sikkim Himalaya (Khecheopalri lake)	TCM & CVM	Maharana et.al (2000)
Ecotourism	WTP for the management of the park : By foreign tourists: $8.84; by domestic tourists: $1.91; by local community:$6.20 per year. WTP total for annual maintenance works out to $87,777	Khangchendzng National park, Sikkim	CVM	Maharana et al 2000
Wetland	Additional value of property around the lake is Rs.186 per sq.ft	Bhoj Lake, Bhopal	Hedonic Pricing	Madhu Verma (2000)
Biomass / dung/watershed	Value of additional dung collected due to stall feeding is Rs. 34.40 per cattle per year	Sukhomajri village	Opportunity cost	Chopra, et.al. 1990

Ecological functions(use value) for local residents	Rs. 624 per hectare	Yamuna Basin	Contingent valuation method	Chopra and Kadekodi, 1997
Carbon store	Rs.1292 billion for total Indian forests) and Rs.20125 per hectare	Indian Forests	Specieswise forest inventory data	Haripriya (1999)
Carbon store	Rs. 1.2 lakh per hectare	All India Forests	Biomass estimation	Kadekodi & Ravindranath (1997)
Watershed values (soil conservation)	Rs. 2.0 lakh per hectare meter of soil	Yamuna Basin	Indirect method (Reduced cost of alternate technology)	Chopra & Kadekodi, 1997
Forests in Himachal Pradesh	• The total economic value of forests in HP is estimated as Rs. 106664 Crores, which is 2.61 times the value of the growing stock. • The contribution of forestry as a percentage of corrected GSDP is 92.40% instead of recorded 5.26%.	Himachal Pradesh State	TEC approach	Verma (2000)
Forests in Maharashtra	• Contribution of forests is estimated as Rs. 35245.65 millions as against Rs. 14080 millions shown in SNA (i.e. it is 3.56% of adjusted NSDP and not 1.46% recorded). • Value of depletion (difference between the value of opening stock, other volume changes and the closing stock in forest accounts) = Rs. 6989 millions (this is 19.8% of the estimated value added) • Estimated asset values of forests = 28.6% of net fixed capital stock	Maharashtra state	Physical accounting (tool employed: net price method, present value method, etc.)	Parikh and Haripriya (1998)
Forests in Yamuna Basin	• Use value of timber (Rs.8279 to Rs. 18540 per cubic meter of extracted timber) • Annual value of main non-timber forest products (NTFPs): Rs. 7509 per sq.km in Hills and Rs. 558 per sq.km in plains • Use value of ecological functions and unrecorded production; Rs. 176 per hectare in Himachal Pradesh, Rs. 3509 per hectare in Haryana, Average Rs. 624 per hectare. • Value of preservation as contributing to national output; Rs. 576 lakhs per			

	year • Household willingness to pay in rural areas for use value of forests: Rajasthan : Rs.1072 per ha UP : Rs. 360 per ha HP : Rs. 176 per ha Haryana : Rs.3509 per ha			

Source : Adapted from Kadekodi, 2001.

It can be seen from the above table that most of the studies are region and value specific and we have yet to have a comprehensive framework for working out total economic values of various ecosystem. Because of overlapping of various values, it becomes sometimes difficult to demarcate one value from another. Recently an attempt has been made to estimate the contribution of Forestry Sector to the Gross Domestic Product (GDP) in India by **Chopra, Bhattacharya & Kumar (2002**). The study takes into conideration values like timber, furlwood, NTFPs, Eco-tourism, carbon sequestration to estimate the total value of forestry sector of India. Because of time and data constraint many values relating to services from the forestry sector like watershed benefits, biodiversity values, microclimatic values could not be considered. Findings of this study are mentioned in the Tables 4,5 & 6.

Table 4 : Gross Value of Production and Value Added from Forestry Sector

(Rs. In Crores)

	Forest area correspon-ding in Mil hectare	Lower Estimates	Higher Estimates	Value Reported	Source / Assumptions
Industrial Wood	---	2441.75 (12.3)	2441.75	2441.75	From CSO with adjustments
Fuelwood	---	14272.96 (71.92)	14272.96 (29.83)	14272.96 (87.46)	
Non-timber Forest Product	25.00	2068.32 (10.42)	16884.1 (35.29)	4188.85 (15.91)	Own Estimates: Chapter 3 and assumption that NTFPs accrue from forest based CPRs
Eco-tourism	4.9	331.24 (1.67)	11417 (23.86)	3647.256 (13.85)	Own Estimates : Chapter 3
Carbon Sequestration	10.85	732.08 (3.69)	2825.88 (5.91)	1778.98 (6.76)	Own Estimates: Chapter 3
TOTAL VALUE (at market / international prices)		19846.35	47841.69	26329.8	
TOTAL COST 2404.83 (government costs) + 921.54 (private costs)		3326.37	3326.37	3326.37	Own Estimates: See chapter 4)
Contribution to GDP at market prices		16519.98	44515.32	23003.43	

Source : Chopra, Bhattacharya, Kumar. 2002

Table 5 : Range of Gross values of Forest products and services

(Rs. In Crores)

Products	Lower value	Higher Value	Value taken in this report	Remarks
NTFP	827.33 per ha	6753.64 per ha	1675.54 per ha	Area identified is 25 million hectares
Eco-tourism	676 per ha	23300 per ha	7443.38 per ha	Area identified is 4.9 million hectares out of the 15 million hectares of PA, which are actually managed
Carbon Sequestration	674.73	2604.45	1639.61	Area identified is 10.85 million hectares (Area under plantation with age more than 10 years)
Firewood	14272.96	14272.96	14272.96	Total value of output in Rs. Crores
Industrial wood	2441.750	2441.750	2441.750	Total value of output in Rs. Crores
Remarks	The low value is obtained from different studies and it is based on the availability of NTFP (which in turn depends upon the forest stratum in that area). Similarly for ecotourism the per hectare values differ markedly across states owing to the health of forest in them. The range of values for carbon sequestration depends upon the prices and the decay rates			

Source : Chopra, , Bhattacharya, Kumar & , 2002

Table 6: Range of contribution of forests as a percentage of GDP* in 1996-97 at 1993-94 prices.

Range	**Lower**	**Value reported**	**Higher**
Value (in Rs Crores)	16519.98	23003.43	44515.32
Percentage of GDP	1.7	2.37	4.58

(in 1996-97 India's GDP was Rs. 970083 Crores at 1993-94 prices).**Source : Chopra, , Bhattacharya, Kumar & , 2002**

Recent studies by the author on economic valuation of forests from Himachal Pradesh and Economic valuation of Bhoj Wetland considering multiple values and adjusting them to conventional accounts are discussed in details in the following section.

3.4.1 FRA of Himachal State

The values covered, methodology used and contribution of various uses have been worked out as per the following table.

Table : 5 Economic Value of Forests of Himachal Pradesh (On Annual Basis - for 2000)

Stock and Flows from Forests	Physical Value	Valuation method	Value (Rs.) per hectare of	
			Geographical Area of Forest	Area under tree and scrub forest only
Forest Stock Accounts				
1. The geographical forest area of HP	36,986 Km^2	NA		
2. Area under tree cover and scrub forest	14,346 Km^2	NA		
3.Total growing stock	10.25 Crore m3	1. User cost method 2. Present value method 3. Net Present value method	1.10 lakhs	2.85 lakhs
4. Area lost due to forest fire	571.43 Km2	As per records		
5. Forest area diverted	33.88 Km2	As per records		
6.Area afforested	38.90 Km2	As per records & cost estimates		
7.Annual Increment 8. Annual Productivity	1.28 m3/ha * 0.43m3/ha *	As per records and direct market price As per records and direct market price		
Forest Flow Accounts (annual Flows)				
(A) Direct Consumptive Uses :				
9. Salvage 10.Timber for right holders 11.Fuelwood	3.50 lakh m3 1.06 lakh m3 27.60 lakh tons	1.Direct market price techni-que 2.Indirect esti-mates	0.08 thousand 0.16 thousand 0.75 thousand	0.22 thousand 0.42 thousand 1.92 thousand

12.Fodder 13.Minor Forest produce	92 lakh tons 1,161.56 tons		1.86 thousand 0.067 thousand	4.81 thousand 0.17 thousand
Total Direct Consumptive Uses				
(B) Direct Non-Consumptive Uses :				
14. Ecotourism	66.56 lakh tourists	1.CVM 2.Travel cost method 3.Benefits Transfer method	18.0 thousand	46.0 thousand
Total Direct Benefits			21.0 thousand	53.0 thousand
(C) Indirect Uses :				
15.Watershed	6.77 crore m3 (growing stock of river basin forest circle) and 36986 km2 (entire forest area)	1. CVM 2. Change in producti-vity approach 3. Replacement cost approach 4. Benefits Transfer method	2.0 lakh	5.16 lakh
16.Microcli-matic functions	969018 households	1.CVM 2.Indirect esti-mates	0.39 thousand	1.0 thousand
17.Carbon sink	12521 Km2 (area under tree cover and scrub forest)	1.CVM 2.Indirect esti-mates 3.Benefits Transfer method	48 thousand	1.23 lakh
18.Biodiversity /Endangered species	8966 (total no. of species in Himachal Pradesh) and 125 (endangered species)	1.CVM 2.Option value 3.Bequest value 4.Benefits Transfer method	20 thousand	20 thousand
19.Employ-ment genera-tion	48.4 man days	1.Direct Costing	0.06 thousand	1.7 thousand
Total Indirect Benefits			2.68 lakhs	6.90 lakhs
TOTAL ECONOMIC VALUE			**2.89 lakhs**	**7.43 lakhs**

Note : (1) There could be many more economic values associated with forests. Instances of **Direct Use Values** are genetic material, human habitat, cultural and educational use; **Indirect Use Values** are air & noise pollution reduction, micro-climatic regulation, nutrient recycling, flood control & soil conservation, **Non Use values** are intrinsic worth.

CVM= Contingent Valuation Method, NA= Not Applicable, Indirect Estimates include opportunity cost, replacement cost, productivity change etc.

Table 6: Contribution of Himachal Forests in GSDP

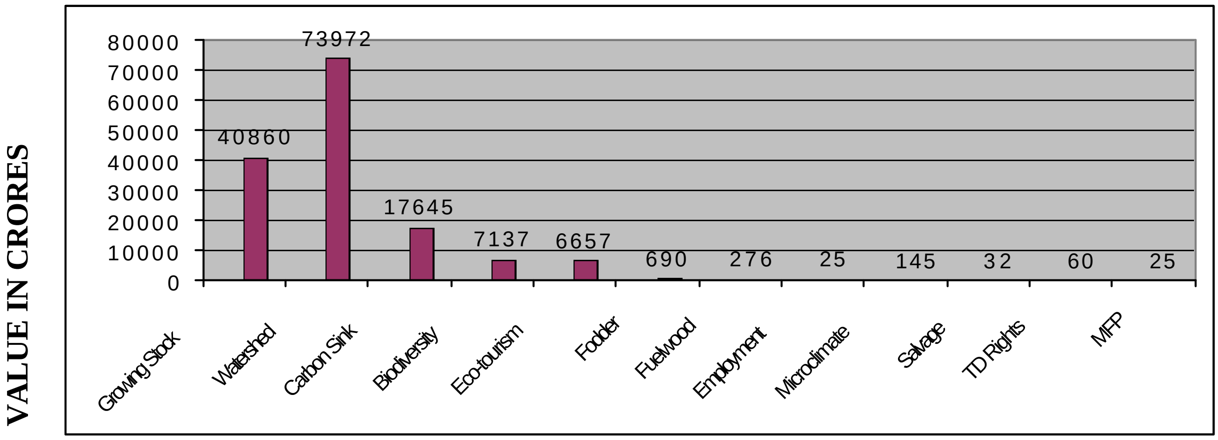
I. Forest Resource Contribution vs. Investment	
1. Value of Growing Stock	Rs. 40860 Crore
2. Total Economic Value of Forests	Rs. 106888Crore
3. Total Expenditure incurred in forest (Annual Budget)	Rs. 109 Crore
4. Revenue realised by forests	Rs. 41 Crore
II. Contribution of Forests to the GSDP	
1. Total GSDP	Rs.9258 Crores
2. Forestry & logging	Rs. 487 Crores
3. Forestry as % of GSDP	Rs. 5.26 %
4. TEV of forests of HP (as per current estimation)	Rs. 106888 Crores
5. Corrected GSDP	Rs.116146 Crores
6. Forestry as % of corrected GSDP	92.00 %

The above table finds that total economic value is 2.61 times the value of the growing stock, 980 times the total expenditure incurred in the forestry sector of Himachal Pradesh and 2607 times the revenue realized by the forests annually. This comparison proves gross underestimation of forestry sector's contribution in the economy of the state. Further when the GSDP of the state is corrected for Total Economic Value calculated through the current study the contribution of forestry sector increases from 5.26% of GSDP to 92.00 % of GSDP.

As mentioned earlier the benefits in the form of various values generated by the Himachal Pradesh forests are not only realised by the local communities but also by people in the state as a whole neighbouring states (watershed benefits, biodiversity, ecotourism & carbon sink) & by international communities (biodiversity, ecotourism & carbon sink). Table 9 presents the multiple forest values realised by primary, secondary and tertiary stakeholders and the ownership of costs & benefits by them (in the form of presence or absence of such costs & benefits), whether such values do not have any significance for them and whether activities of stakeholders pose a threat on forest values. It could be seen from table 9 that in most of the cases, the private costs associated mainly with the forest department, the social costs (to be borne by rest of the stakeholders) are low & social benefits in the form of positive externality are very high. There is no compensation paid to the forest department on account of its multistakeholders & multisectoral contribution.

Recently (August 2002) the total economic value of Himachal forests so estimated by the author has been used by the Himachal government to issue the notification for user agencies who are diverting forest lands for non forest use by imposing one time levy on them (Rs. 10 lakhs/hectare and Rs. 8 lakhs/hectare in dense and other forests respectively) besides the clause of compensatory afforestation, cost of catchments area treatment plan, rehabilitation of dumping sites etc. Thus H.P. has become the third state in India to impose an environmental value tax on agencies using forestlands where the major contribution comes from the watershed values of *forests. Though such a charge has been levied but no mechanism has been worked out to provide compensation for loss of various watershed and other direct benefits to the communities out of the collected levy.*

Figure : 8 Bar Diagram Depicting Comparative Picture Of Economic Value Of Forestry Goods & Services



3.4.2 Economic Valuation of Wetlands - Case from Bhoj Wetland, Bhopal

The Bhoj wetland located in the heart of the Bhopal city, India originated as manmade lake primarily to supply drinking water to the city's population and over the years it attained features of wetland and started providing multiple functions like commercial fishing, waste assimilation, microclimate regulation and recreation etc. to multiple users. It has so happened that multiple benefits have been extracted but little attention has been paid on the maintenance of this wetlands. In this context it becomes imperative to generate quantitative information on the economic benefits from the wetland, which could serve as a powerful tool to influence decision-making.

Bhoj wetland is a Lacustrine wetland which is the highly diminished remains of the vast lake created in the 11^{th} century by the then ruler of princely state of Bhopal The wetland has water spread area of 32 square kilometers and catchment area of 370 square kilometers. It is an important source of drinking water for the 40% of city's total population of 1.5 millions. Multiple stakeholders use it for multiple uses. 17 municipal wards (administrative division of the city) around the lake directly drain into it. Over the years because of indiscriminate and unsustainable use of lake, its water quality has degraded from 'A' quality to 'C' quality along with prolific growth of weeds on account of which benefits from the lake have reduced and all the stakeholders are paying heavy direct and indirect costs including the government agencies which are engaged in its restoration and management activities

The goal of the management is essentially to balance the use of lake with conservation measures to sustain ecosystem services overtime. The paper tries to analyze the factors causing Bhoj Wetland degradation; nature and extent of injury to the wetland; how does this degradation impact on the uses those citizens of Bhopal extract out of it? What cost is borne by the users on account of degradation in terms of productivity losses and health impacts? How feedback can be taken from these impacts to revise or develop management policies and to seek participation of stakeholders to check wetland degradation or losses? What type of benefits accrues to people from this wetland? What is the willingness of the people to pay to conserve this important water body?

Various values which generate incomes to stakeholders from activities like fish production, boating, *Trapa* cultivation , washing of clothes, secondary selling activities,.then the values in terms of cost borne by the population on account of treatment of water borne diseases, getting quality water, cost borne by various agencies to purify and distribute water. And eventually the recreational value for the entire population and property price differential for lake front property owners were estimated using various valuation techniques which are summarized in Table 9 .

Table 9 : Estimation of Economic Values of Bhoj Wetland (Annual for 1999-2000)

Uses / Impacts	Stakeholders	Valuation Techniques	Value (in Rs)
A. Drinking Water	Water supplying agencies	Supply Cost	9,54,13,962
B. Fish Production	Fishermen	Market Price of Existing Production	80,00,000
C. Boating	Boatmen	Income Estimation	24,37,880
D. *Trapa* cultivation	*Trapa* (water chest nut) Cultivators	Market Price of Existing Production	50,000
E Washing of clothes	Washer men	Income Estimation	36,00,000
F. Secondary Activities Maize cob selling Sugar cane juice selling Snacks &cold drink stalls Horse rides MPTDC a. Cafeteria b. Boating	Maize Cobb sellers Sugarcane juice sellers Individual owners Individual owners MPTDC	Income Estimation ii. Income Estimation iii. Income Estimation iv. Income Estimation v. a. Revenue Generation b. Revenue Generation	1,44,000 ii. 2,73,600 iii. 2,06,400 iv. 7,92,000 v. 18,00,000 b. 6,74,635
G. Water borne Diseases	Population using lake's water	Cost of Illness	12,00,254
H. Quality water	Population using lake's water	Purification Costs	1,24,35,876
I. Recreation	Entire population of the city	CVM (i) As Voluntary Payment (ii) As Compulsory tax	4,84,68,956 59,32,922
J. Increase in property prices	Lake front property owners	Hedonic pricing	50% difference in property prices

It is evident from the table that the drinking water, recreation, property attributes command high values from lake whereas other income based values are important to specific sections of the people. All the values so estimated have not been aggregated as some stakeholder use the lake for multiple values and such overlapping could not be avoided. Further other important values like biodiversity, microclimatic effects have not been estimated due too lack of availability of data. But the undertaken exercise does give a good insight of multiple values which have not been considered so the extent possible in the current management activities.

Further even if one is able to collect the revenue through what people were willing to pay in the from of voluntary payment to the society (Rs. 4,84,68,956 per annum) or in the from of tax to the government (Rs. 59,32,922/- per annum) the amount so collected would be much more than the existent estimated cost of maintenance of various subprojects of the BWL agency (Rs. 80,70,00/- per annum) if the collected revenue is from voluntary payment and reasonably collects 74% of the amount through taxes.

4. **Conclusion**

The above attempts tried to work out the multiple values of the forests and wetlands in two different regions of India representing specific subtype of two ecosystems. However due to lack of availability of specified format for data generation and data itself, for such valuation in Indian context, many problems were encountered and thus studies are subject to certain limitations. The major limitation is overlapping of values and thus need to correct such double counting. Secondly, a uniform format taking into consideration various subtypes of ecosystems need to be developed to fill such data gaps, would serve as a toolkit for future valuation studies and generation of NRA. Only after developing and harmonizing such accounts, we shall be able to truly represent hitherto unaccounted values of various ecosystems into the conventional calculus of national income accounting and would be able to bring environmental considerations into economic planning for sustainable management of our precious natural capital.

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Measuring Environmentally Corrected Net National Product: Case Studies of Industrial Water Pollution and Urban Air Pollution in India

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JEL Classification: Q 25

Key words: environmentally sustainable income, national accounts, maintenance cost, hedonic property prices

This paper first briefly discusses the concept of environmentally sustainable income and a method of measuring it starting with the conventional national accounts. Methods of developing physical and monetary accounts of environmental assets as satellite accounts to conventional national accounts as given in UN Methodology of `Integrated Environmental and Economic Accounting' are described. Physical and monetary accounts of industrial water pollution and urban air pollution in India are developed. Physical accounts of influent and effluent loads of BOD, COD, and SS are prepared for the Indian water polluting industry. The monetary accounts explaining the cost of reducing the water pollution from the current level to the safe MINAS standards in India are made. Similarly physical accounts of urban air pollution explaining the ambient concentration of SPM, NO_x, and SO_2 for 15 major cities in India are developed. The monetary accounts explaining the damages avoided to local households by reducing the urban air pollution from the current level to MINAS standards are prepared. Estimates of environmentally corrected NNP for India, corrected separately for industrial water pollution and urban air pollution, are obtained.

I Introduction

Assessment of environmentally sustainable development requires a system of national accounts integrating the environmental and economic problems. It is the environmentally sustainable income that becomes a measure of welfare if one takes in to account the relationship between the economy and the environment or wants to account for the effects of economic activities on the environment and the effects of environment on the economic activities. The environmentally sustainable income is the maximum currently producible income with the environmental and other services in the economy by guaranteeing the current levels of environmental services to the future generations. There are many definitions of environmentally sustainable income depending upon the assumptions one makes about the substitution between man made capital and the environmental or natural capital and the requirements for maintaining the quality of environmental resources at certain threshold level. The general view about sustainable income is that it is the maximum attainable income in one period with the guarantee that the same level of income will be available in future periods given the constraints on the resources: labor, man made capital and natural capital. Therefore, income is straightaway related to the availability of man made and natural capital. Alternatively, in the neo-classical approach to sustainability, sustainable income is defined as the maximum amount spent on consumption in one period without reducing the real consumption expenditures in future periods. In the face of changing prices and interest rates over time, this is the most appropriate definition of sustainable income. The sustainable income defined in this way represents the welfare of the nation and there is a lot of discussion in the literature about whether the net national product (NNP) would appropriately represent it. Samuelson (1961) has argued, the rigorous search for a meaningful welfare concept leads to a rejection of current income concepts like NNP and end up something closer to a wealth like magnitude such as the present discounted value of future consumption. However, Weitzman (1974) has shown that in theory, the NNP is a proxy for the present discounted value of future consumption[1].

It is long recognized that the conventional system of national accounts (SNA) to measure NNP has treated the environmental resources and their role in the economy inconsistently. Under SNA, NNP increases when natural resource stocks are depleted and the quality of environment is reduced by pollution. The correct approach to natural resources accounting is to account for the depletion of natural resources and the fall in the environmental quality in estimating the NNP.

There is now a lot of literature about the problem of estimating NNP and the sustainable use of natural resources[2]. Studies by Solow (1974) and Hartwick, (1977, 1978a,b) have tried to derive the conditions under which real consumption expenditure might be maintained despite declining stocks of exhaustible resources. The main result of these studies known as the Hartwick rule, states that consumption may be held constant in the face of exhaustible resources only if the rents deriving from the inter-temporally efficient use of those resources are reinvested in the reproducible capital. The relationship of the Hartwick rule with sustainable income hinges on the assumption of the substitutability between man made capital and natural capital. The main criticism about the Solow-Hartwick definition of sustainable income is that the man made capital could not be substituted to natural capital. Natural capital can be exploited by man, but could not be created by man. According to the thermodynamic school (Christensen, 1989), natural capital and man made capital are not substitutable. One can think of two subsets of inputs, one containing the natural capital stock `primary inputs' and another containing man made capital and labor the `agents of transformation'. The substitution possibilities with in each group can be high while they are limited between the groups. Increasing income means increasing the use of inputs from both groups. Given the limited substitutability between man made capital and natural capital, it is necessary to maintain some amount of the natural capital stock constant in order to maintain the real income constant at the current level over time (Pearce et al., 1990; Klaasen and Opschoor, 1991; Pearce and Turner, 1990). This can be a heavy restriction on development if the current levels of natural capital stocks are chosen as a constraint, since it requires a banning of all projects and policies impacting the natural capital stock. As a way out of this problem, Pearce et al. suggest the use of shadow projects. These are the projects and policies designed to produce environmental benefits in terms of additions to natural capital to exactly offset the reduction in natural capital resulting from the developmental projects and policies. Daly (1990) has suggested some operational principles for maintaining natural capital at a sustainable level. For example (1) in the case of renewable resources, set all harvest levels at less than or equal to the population growth rate for some predetermined population size, (2) for pollution, establish assimilative capacities for receiving ecosystems and maintain waste

[1] See Murty and Kumar (2002)
[2] See Murty and Kumar (2002).

discharges below these levels, and (3) for non-renewable resources, receipts from non-renewable extraction should be divided into an income stream and an investment stream. The investment stream should be invested in renewable substitutes (biomass for oil).

The more general concept of ecologically sustainable income requires the integrated economic and environmental accounting to consider possible ecologically sound balances between nature and man and account for actual imbalances. The objective here is to have an optimal balance between human and non-human claims. The less general concept of environmentally sustainable income considers the anthropocentric point of view, the natural environment exists for the benefit of human beings, especially in the context of various economic activities promoting human welfare. The recent literature in Environmental Economics has called for a synthesis of ecological and anthropocentric points of view. The exploitation of the environment has reached a stage where human beings are impairing their own living conditions. For instance, the waste disposal function of the environment may compete with the physiological need for its provision of clean air and water. Therefore, the integrated framework for economic and environmental accounting should help in identifying the strategies of sustainable development that balance the satisfaction of human needs with the long-term maintenance of environmental functio ns.

II Methodology

2.1. System of Integrated Economic and Environmental Accounting (SEEA)[3]

There are two important aspects in the development of integrated economic and environmental accounting. First the description of environment in physical terms by defining an asset boundary that is more extensive than that is given in the conventional national accounts. A distinction has to be made between natural and manmade assets. Natural assets consists of biological assets, land and water areas with their ecosystems, subsoil assets and air. The second is the valuation of natural assets. Natural assets provide both marketable and non-marketable services and therefore their valuation requires the use of market and non-market valuation techniques. Also it is not possible to value all ecosystem functions of natural assets that are described in the physical accounts that show the economy and environment inter-linkages.

The development of environmental accounts as a satellite system of core accounts of SNA starts with the review of those parts of the conventional SNA that form the conceptual basis for the development of SEEA. The relevant parts of SNA are the supply and use table of produced goods and services, and the non-financial asset accounts that include the opening and the closing balance sheets of produced and non-produced natural assets as well the changes therein as a result of capital formation and other changes in the assets. The supply and use tables show the supply of domestic and imported goods and services, their use for intermediate, final demand, and the value added connected with production in economic activities. The non-financial asset accounts comprise opening stocks at the beginning of the accounting period, price and volume changes during the period and the closing stocks at the end of the period.

[3] This section is mainly drawn from UN (1993b).

The SNA already has some information related to the environment. Part of this information is explicitly identified in various categories of its classification, notably those of asset accounts. Further environmental related information can be obtained by desegregation of SNA classifications without modifying the basic accounting structure. In the desegregation of SNA, environmental protection services are identified within intermediate consumption of industries, final consumption by government and households and investment. The separate identification of environmental protection expenses gives a comprehensive picture of the efforts made by the different sectors and institutions in the economy to protect environment. Using the input-output analysis one could assess the direct and indirect value added contributions to gross national product by the environmental protecting activities. Such accounting also helps one to know how capital-output ratios are affected by investment in environmental protection equipment. In the desegregation, first of all, non-financial asset accounts are divided in to produced assets of industries and non-produced natural assets. The produced assets are divided in to man made assets and natural assets. In the case of man made assets, they are further subdivided in to assets created for external environmental protection services and internal environmental protection.

The development of SEEA by showing environmental accounts as satellite accounts starts with the description of two proto types of environmental accounting in physical terms: material energy balances and natural resource accounting. Material/ energy accounts show raw materials as inputs, transformation process in the economy, and flows of residuals resulting from the economic uses of materials back to the environment. Transformation processes within the natural environment are excluded. They show material flows and transformations within the domestic economy and their connections with the domestic environment and the rest of the world. Material changes within the domestic economy refer to production and consumption processes as well as use of produced assets. Natural resource accounts describe the stocks and stock changes of natural assets, comprising biological assets (produced or wild), subsoil assets (proved reserves), water, air and land areas with their terrestrial and aquatic ecosystems. Biological natural assets consist of plants and animals of economic importance. Land areas include area as well as related biological ecosystems. Subsoil assets consist only of proved reserves. Water and air are accounted in so far as they are used or affected by the economic activities.

In SEEA the environmental accounts are developed as satellite accounts of SNA by combining the concepts of material/ energy and natural resource accounting. The physical accounts of the SEEA extend the SNA without modifying the monetary flow and asset accounts of the SNA. Monetary data in SNA are described in terms of their counterparts in physical terms. Physical data in the SEEA describe the parts that are not part of the conventional SNA. Linkage of the physical data with monetary accounts is obtained by bridging matrices that applied compatible concepts at the interface between SEEA and SNA.

The product flow accounts consist of the following four important groups that are linked together.

(a) Domestic output;
(b) + Import of products;
(c) – Exports of products;

(d) = Domestic use of available products (for intermediate consumption by different production
activities, final consumption and capital formation).

The non-produced natural raw materials are the primary material inputs of economic activities obtained by exploiting natural assets. SEEA provides a broad classification of these raw materials as follows:

(a) Wild biota
- Plants and products of plants (except forest products)
- Animals and animal products (except aquatic animals)
- Fish and other aquatic animals

(b) Subsoil resources
- Coal and lignite, peat
- Crude petroleum and natural gas
- Uranium and thorium ores
- Metal ores
- Stone, sand and clay
- Other minerals

(c) Water

(d) Air, wind, and natural heat
- Air
- Wind
- Natural heat

(e) Soil (erosion)

The residual flow accounts of SEEA different sources of residuals and their destinations that include treatment in environmental protection facilities, or disposal in natural environment. Residuals include solid, liquid, gaseous and vaporous materials. In SEEA, the flows of residuals are subdivided with regard to their destination: residuals discharged without or after treatment or storage in environmental protection facilities in to the natural environment (water, air or land) and the residuals that are treated or stored in environmental protection facilities.

In SEEA, the physical asset accounts comprise accounts for produced and non-produced assets. Physical accounts describe the stocks at the beginning of the accounting period (opening stocks), the changes within this period (increases and decreases due to economic decisions and natural causes) and the stocks at the end of the period (closing stocks). The accounts of produced assets comprise

(a) Opening stock;
(b) Increase by gross fixed capital formation and increase of inventory stocks;
(c) Increase in stocks of produced assets due to storage of residuals for environmental protection;
(d) Decrease in inventory stocks of products;
(e) Decrease in produced assets as a consequence of scrapping assets used in production;

(f) Capital consumption (depreciation) of fixed assets;
(g) Volume changes due to other causes, especially natural ones;
(h) Revaluation due to market price changes;
(i) Closing stocks.

Estimation of ENNP requires the monetary values of physical data on economic environmental relationships. Various concepts of values could be used to estimate the imputed environmental costs or monetary values of physical data. These are market values, cost of sustainable use of environmental resources or maintenance cost, and user and non-user values of households. The imputed environmental costs are given for three types of natural environment: quantitative depletion of natural assets, use of land, and use of disposal function of natural environment. The ENNP could be estimated as

ENNP = NNP – IEC
where
NNP = Gross Output of Industry and Agriculture – Use of Products of Industries – Use of Products of Fixed Assets
IEC = Imputed Environmental Costs or Use of Non-produced Natural assets

In SEEA the ENNP is called as eco-value added and the imputed environmental costs as eco-margin.

2.2 Valuation in SEEA

The methods of valuation of environmental services could be classified as three different valuation types: (a) market valuation according to the concept of the non-financial asset accounts in the conventional system of national accounts, (b) maintenance valuation, which estimates the cost necessary to sustain at least the present level of natural assets, and (c) household valuation: contingent valuation or hypothetical behavioral methods and the observed behavioral methods. The maintenance valuation method uses actual or hypothetical cost data. Expenditures required for maintaining the services of natural environment constitute the actual cost. The hypothetical cost of using environment is the cost that would have been incurred if the environment had been used in such a way that would not affect its future use. These are the costs for the mitigation of damage caused by the decreased environmental quality or for an increase in environmental protection activities that prevent degradation of natural assets. These costs will not capture the entire value of decrease in environmental quality and they can be interpreted as the minimum value of change in environmental quality. The rationale behind using this method of valuation is the concept of sustainable income discussed in the earlier sections. There is a lot of literature now about the use of behavioral methods for valuing environmental resources (Freeman, 1993; Mitchell and Carson, 1989; Murty and Kumar, 2003)[4]. The hypothetical behavioral methods comprising contingent valuation and other variants of this can be used to measure both user and non-user benefits from environmental resources. The observed behavioral methods indirectly use market information to estimate user benefits. They are hedonic prices, and household production functions for estimating the value of consumptive services of natural environment. The following sections provide case studies of valuation and accounting of industrial water pollution

[4] See Murty and Kumar (2003).

and urban air pollution in the measurement of ENNP of India. The maintenance cost approach is used in the case study of water pollution provided in Section III while the household valuation method of hedonic property prices are used in the case study of air pollution given in Section I

III Environmental Accounts for Industrial Water Pollution in India

3.1. Maintenance Cost or Cost of Environmentally Sustainable Industrial Development

It is now known that sustainable industrial development requires the preservation of the environment. Industries create a demand not only for waste receptive services from the environmental media: air, forests, land and water but also for some material inputs supplied by the environmental resources (for example, wood in the paper and pulp industry). Environmental resources can ensure a sustainable supply of these services, if they are preserved at their natural regenerative level or the demand for waste receptive services is equal to the waste assimilative capacity of the environmental resources. Given that the demand for environmental services from various economic activities can exceed the natural sustainable levels of supply at a given time, and if measures are not taken to reduce this excess demand to zero then it is likely that there can be a degradation of environmental resources. The cost of reducing the demand for environmental services to the natural sustainable level of supply is regarded as the cost of sustainable use of environmental resources and in the case of industrial demand for environmental services; it is the cost of sustainable industrial development.

As a part of environmental regulation, a firm faces a supply constraint on environmental services in the form of prescribed standards for the effluent quality. The effluent standards are normally fixed such that the demand for the services of environmental media does not exceed the natural sustainable level of supply. The firm has to spend some of its resources to reduce the pollution loads to meet the effluent quality standards. The firm with a resource constraint will have lesser resources left for the production of its main product after meeting the standards. Therefore, the opportunity cost of meeting these standards is in the form of a reduced output of the firm. If all the firms in the industry meet the standards, the value of the reduced output of firms is the cost of sustainable industrial development. How to estimate this cost for a competitive firm facing the environmental regulation? It has to be estimated by studying the firm's behaviour in the decision-making regarding pollution loads and the choice of pollution abatement technologies. In response to environmental regulation, firms may adopt different types of technologies to reduce pollution. Jorgenson and Wilcoxen (1990) identify three different responses of firms. First, the firm may substitute less polluting inputs for more polluting ones. Second, the firm may change the production process to reduce emissions. Third, the firm may invest in pollution-abatement devices. In practice, a firm may adopt a mix of these methods. The first two methods are non-separable with the production processes of main products while the third method is known as end-of-the pipe method.

The technology of water or air polluting firms could be described as one of joint production of good and bad outputs, the bad output being the pollution. The assumption of free disposal (a multi-product firm can produce more of one output without reducing the outputs of other goods) that is normally made in the conventional production theory cannot be applied to describe the technologies of polluting firms. Shephard (1970, p.205) noted that:

> ***"...for the future where unwanted outputs of technology are not likely to be freely disposable, it is inadvisable to enforce free disposal of inputs and outputs. Since the production function is a technological statement, all outputs, whether economic goods are wanted or not, should be spanned by the output vector y".***

The distance function approach for describing the production technology of a firm will take in to account this criticism.

3.2. Methodology

The conventional production function defines the maximum output that can be produced from an exogenously given input vector while the cost function defines the minimum cost to produce the exogenously given output. The output and input distance functions generalize these notions to a multi-output case. The output distance function describes "how far" an output vector is from the boundary of the representative output set, given the fixed input vector. The input distance function shows how far is the input vector from the input vector corresponding to the least cost for producing a given vector of outputs.

Suppose that a firm employs a vector of inputs $x \in \Re^N_+$ to produce a vector of outputs $y \in \Re^M_+$, $\Re^N_+$, $\Re^M_+$, are non-negative N- and M-dimensional Euclidean spaces, respectively. Let P(x) be the feasible output set for the given input vector x and L(y) is the input requirement set for a given output vector y. Now the technology set is defined as:

$$T = \{ (y,x) \in \Re^{M+N}_+ \; y \in P(x),\ x \in L(y)\}. \qquad (3.1)$$

The output distance function is defined as,

$$D_O(x,y) = \min\{ \theta > 0 : (y/\theta) \in P(x)\} \ \forall x \in \Re^N_+ . \qquad (3.2)$$

Equation (3.2) characterizes the output possibility set by the maximum equi-proportional expansion of all outputs consistent with the technology set (3.1).

The assumptions about the disposability of outputs become very important in the context of a firm producing both good and bad outputs. The normal assumption of strong or free disposability about the technology implies,

if $(y_1, y_2) \in P(x)$ and $0 \le y_1{*} \le y_1$, $0 \le y_2{*} \le y_2 \Rightarrow (y_1{*}, y{*}_2) \in P(x)$.

That means, we can reduce some outputs given the other outputs or without reducing them. This assumption may exclude important production processes, such as undesirable outputs. For example, in the case of water pollution, Bio Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Suspended Solids (SS) are regulated and the firm cannot freely dispose of them. The assumption of weak disposability is relevant to describe such production processes. The assumption of weak disposability implies,

if $y \in P(x)$ and $0 \le \theta \le 1 \Rightarrow \theta y \in P(x)$.

That means, a firm can reduce the bad output only by decreasing simultaneously the output of desirable produce.

The idea of deriving shadow prices using output and input distance functions and the duality results is originally from Shephard (1970). A study by Fare, Grosskopf and Nelson (1990) is the first in computing shadow prices using the (input) distance function and non-parametric linear programming methods. Fare et al. (1993) present the first study deriving the shadow prices of undesirable outputs using the output distance function.

The derivation of absolute shadow prices for bad outputs using the distance function requires an assumption that one observed output price is a shadow price. Let y_1 denote the good output and assume that the observed good output price (r_1^0) equals its absolute shadow price (r_1^s) (i.e., for m=1, $r_1^0 = r_1^s$). Fare et al. (1993) have shown that the absolute shadow prices for each observation of undesirable output (m=2,.....,M) can be derived as[5],

$$(r_m^s) = (r_1^0) \bullet \frac{\partial D_0(x,y) / \partial y_m}{\partial D_0(x,y) / \partial y_1}. \qquad (3.3)$$

[5] See Fare (1988) for derivation.

The shadow prices reflect the trade off between desirable and undesirable outputs at the actual mix of outputs, which may or may not be consistent with the maximum allowable under regulation (Fare et al. 1993, p. 376). Further, the shadow prices do not require that the plants operate on the production frontier.

3.3. Translog Output Distance Function and Data

In order to estimate the shadow prices of pollutants (bad outputs) for the Indian industry using equation (3.3), the parameters of output distance function have to be estimated. The translog functional form is chosen for estimating the output distance function for the Indian water and air polluting industries which is given as follows:

$$\ln D_o(x, y) = \alpha_0 + \sum\beta_n \ln x_n + \sum \alpha_m \ln y_m + 1/2 \sum \sum \beta_{nn'} (\ln x_n)(\ln x_{n'}) + 1/2 \sum \sum \alpha_{mm'} (\ln y_m)(y_{m'}) + \sum \sum \gamma_{nm} (\ln x_n)(\ln y_m) + \iota_i D_i \quad (3.4)$$

where x and y are respectively, Nx1 and Mx1 vectors of inputs and outputs, and D_i stands for the dummy variables used for time periods and industry specifications. The data used in this paper is from two surveys of water and air polluting industries in India.[6] The data from these surveys provide information about the characteristics of polluting firms for the years 1994-1995, 1996-1997, 1997-1998, and 1999-2000. It consists of sales value, capital stock, wage bill, material input cost, waste water volume, influent and effluent quality for BOD (Bio Oxygen Demand), COD (Chemical Oxygen Demand) and SS (Suspended Solids), capital stock, wage bill, and fuel and material input cost for a sample of 60 firms for the year 1994-1995 and for a sample of 120 firms for the three years during 1996-1999. Thus the data constitute an unbalanced panel. These firms in the sample belong to tanneries, chemicals, fertilizers, pharmaceuticals, drugs, iron and steel, thermal power, refining and others. For estimating the output distance function, the technology of each water polluting plant is described by joint outputs: sales value (good output) and COD, BOD and SS (bad outputs) and inputs: capital, labor, and fuel and materials. Table 3.1 provides the descriptive statistics of variables used in the estimation.

Table 3.1: Descriptive Statistics of Indian Water Polluting Industry

	Mean	Standard Deviation.
T	1802.008	3320.584
M	951.7418	2717.406
W	1165.321	18577.52
KS	2622.139	8660.077
VW	1618054	3798211
Influent (conc.)		
BOD	16352.55	76436.27
COD	109910.4	597266.6
SS	158892.7	1081616
Effluent (conc.) BOD	147.2786	540.3057
COD	753.6231	2925.207

[6] A Survey of Water Polluting Industries in India, 1996 and A Survey of Water and Air polluting Industires in India, 2000, Institute of Economic Growth, Delhi.

SS	124.7263	382.2771
Influent load		
BOD	26459.308	164000
COD	177840.962	5452.796
SS	257096.969	2086.237
Effluent load		
BOD	238.304	138.160
COD	1219,402	1087.005
SS	201.813	304.602
Pollution load		
as per standard		
BOD	48.541	113.946
COD	404.513	949.552
SS	161.805	379.821

Notes:
T: Turnover(Rs.million)
M: Material inputs(Rs. million)
W: Wage-bill(Rs. Million)
K: Capital Stock(Rs. Million)
VW: Waste Water Volume(KL)
BOD Load: Bio-oxygen demand(tons)
COD Load: Chemical oxygen demand(tons)
SS Load: Suspended Solids(tons)

3.4. Estimates of Output Distance Function and Shadow Prices of Bad Outputs

Linear programming technique is used to estimate the parameters of a deterministic translog output distance function (Aigner and Chu, 1968). This is accomplished by solving the problem,

$$\max \sum [\ln D_o (x , y) - \ln 1], \quad (3.5)$$

subject to

(i) $\ln Do (x, y) \leq 0$

(ii) $(\partial \ln D_o (x, y))/(\partial \ln y_1) \geq 0$

(iii) $(\partial \ln D_o (x, y))/(\partial \ln y_i) \leq 0$

(iv) $(\partial \ln D_o (x, y))/(\partial \ln x_i) \leq 0$

(v) $\sum \alpha_m = 1$

$\sum \alpha_{mm'} = \sum \gamma_{nm} = 0$

(vi) $\alpha_{mm'} = \alpha_{m'm}$

$\beta_{nn'} = \beta_{n'n}$

Here the first output is desirable and the rest of (M-1) outputs are undesirable. The objective function minimizes the sum of the deviations of individual observations from the frontier of technology. Since the distance function takes a value of less than or equal to one, the natural logarithm of the distance function is less than or equal to zero, and the deviation from the frontier is less than or equal to zero. Hence the maximization of the objective function is done implying the minimisation of sum of deviations of individual observations from the frontier of technology. The constraints in (i) restrict the individual observations to be on or below the frontier of the technology. The constraints in (ii) imply that the output distance function is non-decreasing in good outputs. In other words they ensure that the desirable outputs have non-negative shadow prices. The constraints in (iii) imply that the output distance function is non-increasing in bad outputs. They restrict the shadow prices of the bad outputs to be non-positive. The constraints in (iv) imply that the output distance function is non-increasing in inputs. The constraints in (v) impose homogeneity of degree +1 in outputs (which also ensures that technology satisfies weak disposability of outputs). Finally, constraints in (vi) impose symmetry. There is no constraint imposed to ensure non-negative values to the shadow prices of undesirable outputs.

Tables 3.2 provides linear programming estimates of output distance function for the Indian water polluting industries. Table 5 provides estimates of shadow prices for bad outputs, BOD, COD, and SS based on the parameters of translog distance function estimated using programming approach. These shadow prices are negative, reflecting desirable output and revenue foregone as a result of reducing the effluent by one unit (ton) per year. For instance, the average shadow price for water polluting Indian industries is Rs. 13,290 for BOD, Rs. 50,623 for COD, and 16,676 for SS per ton at 1996-97 prices. That means the reduction of BOD by one ton reduces Rs. 13,290 worth of production of positive output.

Table 3. 2: Parameter Estimates of Output Distance Function for all Industries with Water

Pollution as Bad Outputs (Weak Disposability)

Parameter	Value	Parameter	Value	Parameter	Value	Parameter	Value
Constant	-2.839						
Y_1	1.202	X_{22}	-0.162	Y_1X_1	-0.14	D1	0.133
Y_2	-0.007	X_{33}	-0.013	Y_1X_2	0.228	D2	-0.059
Y_3	-0.155	Y_{12}	0.004	Y_1X_3	-0.062	D3	-0.034
Y_4	-0.039	Y_{13}	0.025	Y_2X_1	-0.002	D4	0.109
X_1	0.501	Y_{14}	0.008	Y_2X_2	4.12E-05	D5	-0.134
X_2	-1.355	Y_{23}	-0.006	Y_2X_3	-0.001	D6	-0.195
X_3	-0.083	Y_{24}	0.002	Y_3X_1	-0.002	D7	0.132
Y_{11}	-0.047	Y_{34}	-0.003	Y_3X_2	-0.01	D8	-0.152
Y_{22}	0.002	X_{12}	0.142	Y_3X_3	-0.008	D9	0.088
Y_{33}	0.016	X_{13}	0.078	Y_4X_1	-0.000597	D10	0.182
Y_{44}	0.000555	X_{23}	0.034	Y_4X_2	0.0006466	D11	0.171
X_{11}	-0.06			Y_4X_3	-0.003		

Table 3.3: Descriptive Statistics of Estimates of Shadow Prices of Water Pollution for Indian Industries (Rs. million per ton at 1996-97 prices)

Industry/Pollutant	Mean	S.D.	Minimum	Maximum
Overall				
BOD	0.0132901	0.0060858	0.0001130	0.036
COD	0.0506225	0.0266572	0.0003972	0.174
SS	0.0166764	0.0086278	0.0006226	0.068

3.5. Monetary and Physical Accounts

Physical accounts of influent and effluent loads, pollution reduction actually obtained, and pollution reductions required as per the standards for the Indian water pollution industry are reported in Table 3.4. For estimating environmentally-corrected NNP, estimates of net additions to the stocks of pollutants in the environmental media are needed. The effluent loads of BOD, COD, and SS generated by the industry in a given year are additions to the stocks of these pollutants in the environmental media. Depending upon the natural assimilative capacity of the environmental media to absorb certain pollution loads without affecting itself, the industry makes additions to the stocks. If the stocks of pollutants in the environment have already reached the levels at which the natural assimilative capacity is zero, the effluent loads generated by the industry are simply additions to the stocks. Assuming that the standards for water pollution in India are fixed such that the pollution loads generated by the industry after complying with the standards are equal to the natural assimilative capacity of water resources, there will be net additions to the stocks if firms do not meet the standards. For example, the effluent loads of BOD, COD, and SS for the Indian industry are respectively, Rs. 470,700.04, 2408,572.98, and 398,622.71 tons during the year 1997-98. The effluent loads as per the standards are respectively 95,878.58, 798,991.518, and 319,598.582 tons. The difference between the effluent load actually generated by the industry and the effluent load as per the standards could be taken as net addition to the stock of pollutants. In this case, for estimating environmentally corrected NNP after accounting for industrial pollution, only the value of this net addition to the stock of pollutant has to be deducted from the conventional NNP. The net additions to the stocks of BOD, COD, and SS in the environmental media due to industrial pollution in India during the year 1997-98 are estimated as 374,821.457, 1609,581.46, and 79,024.134 tons respectively as given in Table 3.6.

Table 3.5 provides monetary accounts of industrial pollution in India. It provides estimates of monetary values of effluent loads, and load reduction required as per the standards. The monetary value of net additions to stocks of BOD, COD, and SS are estimated as Rs. 74,626.584 million for the year 1996-97, and Rs. 87,780.289 million for the year 1997-98 as reported in Table10. The estimates of net national product (NNP) for India for the year 1996-97, and 1997-98 at 1996-97 prices are given as Rs 10,939,610 million and Rs. 11,731,393. The environmentally corrected NNP for India, corrected for industrial pollution is estimated as Rs. 10,864,983.42 (Rs. 10,939,610 –74,626.584) million for the year 1996-97 and Rs. 11,643,613.3 (Rs. 11,731,393 – 87,780.289) million for the year 1997-98.

Table 3.4: Physical Accounts of Water Pollution Loads for Indian Industry

		Physical Accounts					
		BOD		COD		SS	
		1996-97	1997-98	1996-97	1997-98	1996-97	1997-98
1.	Turnover (Rs. million)	3,025,980.9	3,559,341.2	3,025,980.9	3,559,341.2	3,025,980.9	3,559,341.2
2.	Waste water volume (KL)	27,170,803,344	31,959,937,281	27,170,803,344	31,959,937,281	27,170,803,344	31,959,937,281
3.	Influent Load (tons)	4,431,190.45	52,262,645.39	298,635,385.8	351,272,948.3	431,724,215.7	507,820,055.3
4.	Effluent Load (tons)	400,166.56	470,700.044	2,047,653.041	2,408,572.98	338,889.884	398,622.71
5.	Load reduced (tons)	44,031,023.88	51,791,945.34	296,587,732.7	348,864,375.4	431,385,325.8	507,421,432.5
6.	Load as per the standards (tons)	81,511.368	95,878.58	679,264.206	798,991.518	271,707.36	319,598.582
7.	Load reduction required as per standards (tons)	318,655.192	374,821.457	1,368,388.835	1,609,581.46	67,182.522	79,024.1345

Table 3.5: Monetary Accounts of Water Pollutio Loads for Indian Industries

(Rs. million at 1996-97 prices)

Monetary Accounts							
		BOD		COD		SS	
		1996-97	1997-98	1996-97	1997-98	1996-97	1997-98
1.	Turnover	3,025,980.9	3,559,341.2	3,025,980.9	3,559,341.2	3,025,980.9	3,559,341.2
2.	Waste water volume	27,170,803,344	31,959,937,281	27,170,803,344	31,959,937,281	27,170,803,344	31,959,937,281
3.	Effluent Load	5,318.25	6,255.651	103,657.3161	121,927.99	5,651.463	6,647.591
4.	Load reduction required as per standards	4,234.9594	4,981.4146	69,271.263	81,481.038	1,120.3626	1,317.838
5.	Load as per standards	1083.294	1274.236	34386.052	40446.948	4531.1006	5329.7538

Table 3.6: Physical and Monetary Accounts of Additions to Stock of Pollutants by Indian Industry

Physical Net Addition to the Stock of Pollutants			Monetary Value of Net Addition to Stock of Pollutants (Rs. millions)	
Pollutant	1996-97	1997-98	1996-97	1997-98
BOD	318,655.198	374,821.457	4,234.959	4,981.414
COD	1,368,388.83	1,609,581.46	69,271.263	81,481.037
SS	67,182.523	79,024.134	1,120.362	1,317.838
Total			74,626.584	87,780.289

IV Environmental Accounts for Air Pollution in India

4.1 Welfare Losses from Environmental Pollution

Environmental pollution due to various economic activities could be alternatively accounted in the estimation of ENNP by deducting welfare losses or damages to households from pollution. Households receive damages from pollution if pollution loads exceed the natural regenerative capacity of environmental media or loads correspond to the safe environmental standards. Defensive expenditures incurred by the households in the form of demand for health services (medicines, visits to doctor and hospitalization) or extra premium paid for houses located in less polluted localities for avoiding the damages from pollution form part of final consumption in the conventional national accounts. These defensive expenditures could be taken as a measure of damages from pollution to the households which could have been avoided if pollution is at the safe level. Since environmental quality is a public good, specially designed valuation methods for the non-market valuation have to be used. One such specially designed method called hedonic property prices method is used in this case study of urban air pollution in India. The model is described as follows[7]:

Let the price of i^{th} residential location (P_{hi}) is a function of structural (S_i), neighbourhood (N_i) and environmental characteristics (Q_i).

$$P_{hi} = P_h(S_i, N_i, Q_i) \qquad (4.1)$$

Consider the utility function of the individual who occupies house i as

$$u(X, S_i, N_i, Q_i) \qquad (4.2)$$

where X represents a composite private good that is taken as a numeraire. Assume that preferences are weakly separable in housing and its characteristics. The individual maximizes (4.2) subject to the budget constraint

$$M = X + P_{hi} \qquad (4.3)$$

The first order condition for the choice of environmental amenity q_j is given as

$$\frac{\delta u/\delta q_j}{\delta u/\delta x} = \frac{\delta P_{hi}}{\delta q_j} \qquad (4.4)$$

The partial derivative of (4.1) with respect to one of the environmental quality characteristics q_j like tree cover or air quality gives the implicit marginal price of that characteristic. The implicit marginal price is the additional amount paid by any household to choose a house with the additional amount of that characteristic other things being equal. The individual chooses the level of a characteristic at which her marginal willing to pay for that characteristic is equal to its implicit marginal price.

[7] See Freeman (1993), and Murty and Kumar (2002) for details.

The analysis carried above provides a measure of price or the marginal willingness to pay for house at a particular location and will not provide a marginal willingness to pay function for a housing characteristic. In the second stage, marginal willingness to pay for environmental quality is expressed as a function of q_j given S_i, N_i, and a vector of other environmental characteristics Q_i* and socio-economic characteristics (G_i)

$$b_{ij} = b_{ij} (q_j, Q_i^*, S_i, N_i, , G_i) \qquad (4.5)$$

Equation (4.5) gives the individual's marginal willingness to pay for the improvement in the environmental quality q_j. Assuming that the individual's utility function is weakly separable with respect to the housing characteristics, the welfare changes for large changes in q_j could be estimated. If there is an improvement in the environmental characteristic from q_j^0 to q_j^1, the value individual places on such an improvement (B_{ij}) could be estimated by integrating (4.5) with respect to q_j .

$$B_{ij} = \int_{q_j^0}^{q_j^1} b_{ij} (q_j, Q_i^*, S_i, N_i, , G_i) \, \delta q_j \qquad (4.6)$$

The estimation of marginal willingness to pay for a housing characteristic using the above described model requires the estimation in two stages (Rosen, 1974). In the first stage, the hedonic property price equation (4.1) is estimated and the implicit marginal prices for a given characteristic are computed for all the observations in the sample given the mean values of the rest of the characteristics.

4.2. Data and the Model for Estimation

Data about the structural and neighborhood characteristics of houses and socio economic characteristics of households are obtained through household surveys of Delhi and Kolkata. A sample of 1250 households in each city is chosen. The Delhi survey was conducted during May-June while the Kolkata survey was done during the month of July in the year 2002. There are 7 monitoring stations in Delhi and 22 monitoring stations in Kolkata providing regular monthly data on the air pollution concentrations of SPM, NO_x, and SO_2. The sample of 1250 households in each city was distributed among the areas representing 7 monitoring stations in Delhi and 22 monitoring stations in Kolkata. A sub-sample of households allotted to a monitoring station is drawn from the house locations with in the one kilometer radius of the monitoring station.

Data about the structural characteristics of house; covered area, number of rooms, indoor sanitation, independent house, and a flat in a multistoried building, neighborhood characteristics; distance from business center, highway, slum, industry, and the shopping center, and the environmental characteristics; household perception of local air quality, water quality, and green cover are obtained through the household survey. Also, the data about the house prices; monthly rent for rented houses, and house prices for owner occupied are obtained from the households during the survey.

Information about the demographic characteristics of households such as family size, age and sex composition of the family, the education level of family members, and the occupation of the respondent was collected. Data about the gross annual income of family, family monthly average household expenditure and the household inventory were obtained through the household survey.

The hedonic property value model described in Part II consists of a set of two equations one representing the hedonic price function (equation 4.1) and another representing marginal willingness to pay function (equation 4.5) for estimation. The equations for estimation are given as follows:

$$Ln(Y_1) = a_1 + b_1 Ln(X_1) + b_2 Ln(X_2) + b_3 Ln(X_3) + b_4 Ln(X_4) + b_5 Ln(X_5) + b_6 Ln(X_6) + b_7 Ln(X_7) + b_8 X_8 + b_9 X_9 + b_{10} Ln(X_{10}) + b_{11} X_{11} + b_{12} Ln(X_{12}) + b_{13} Ln(X_{13}) + b_{14} Ln(X_{14}) + b_{15} Ln(X_{15}) + b_{16} Ln(X_{16}) + b_{17} Ln(X_{17}) + u_1 \ldots\ldots\ldots\ldots(4.7)$$

$$Ln(Y_2) = a_2 + g_{19} Ln(X_{19}) + g_{20} Ln(X_{20}) + g_{13} Ln(X_{13}) + g_{21} Ln(X_{21}) + g_{11} Ln(X_{11}) + u_2 \ldots\ldots\ldots\ldots(4.8)$$

The variables used in the estimation of above two equations are described as follows:

Monthly Rent (Y_1): Information on the monthly rents for the house is collected from each household. Imputed monthly rental values were used for the owner occupied houses in Delhi and Kolkata. The data for monthly rents collected through survey is compared with the information about the market rents and property prices collected from the interviews of property dealers from different localities in Delhi and Kolkata.

Structural Characteristics of the House

Covered area (X_1): Data for total covered area of the houses were collected directly from the households and the figures were reported in square yards. In the case of independent owner occupied or rented houses care was taken to account for any uncovered area. For the flats of course no such problems were encountered. In case of multistoried buildings covered area was scaled for the number of floors.

Number of Rooms Including Drawing Rooms (X_2): The total number of rooms including drawing room were considered as a control variable for the monthly rental value of the house.

Indoor Sanitation (X_3): The index for indoor sanitation was constructed out of the following information: Separate Kitchen, Separate Bathrooms and Toilets, and Condition of Indoor Ventilation. The Index ranges from 0 to 6. Whenever a facility was found separately in a house it scored a value of 1 otherwise 0, in this way it can take up a maximum value of 3 where separate Kitchen, Toilet and Bathroom facilities are available. For Ventilation a scale of 1 to 3 was used with higher number denoting better ventilation. These values were then added up to arrive at the composite scale of 0 to 6.

Distance Characteristics:

Distance from Business centre (X_4): The distance from any common Business Centre in the city was collected from each household.

Distance from National highways (X_5): The distance of the house from the National Highways were collected and then an average distance was computed which proxied for the overall distance of the House from these National highways.

Distance from Slum (X_6): Distance from nearby slums was collected for area around each monitoring station in the cities separately.

Distance from Industry (X_7): Distance from nearby industries for each monitoring station in each city was used to control for the extreme conditions of pollution in certain parts of the cities.

Distance from Shopping Centre (X_8): *The distance from the nearest local shopping complex was collected for each monitoring stations in the cities.*

Environmental Variables:

Perception about Air Quality (X_{10}): This is an ordered variable in the range of 1 to 3, which is used to rank the locality in term of the air quality as perceived by the households, higher being the rank, the higher the air quality.

Perception about Water Quality (X_{12}): This is also an ordered variable in the range of 1 to 3, which is used to rank the locality in term of the water quality as perceived by the residents of that area, higher the value, the better the water quality.

Dummy for Adequacy of Green Cover (X_{11}): This is a 1, 0 binary dummy variable, which is used to find out the perception of the household in any locality about the adequacy of the green cover (tree cover) in the place where they stay.

SPM (X13): The average concentration of SPM in µ gms/m3 in the last 6 months from the month of survey for a particular locality is used as the pollution variable.

SO_2 (X_{14}): The average concentration of SO_2 in µ gms/m^3 in the last 6 months for a particular locality is used as the pollution variable.

NO_x (X_{15}): The average concentration of NO_x in µ gms/m^3 in the last 6 months for a particular locality is used as the pollution variable

Other variables:

Business or Salaried Class **(X_9):** Certain colonies inhabited by business community do have very high rental values than their counterparts where salaried class is in majority. X_{10} is a dummy variable assigning 1 to business communities and 0 to salaried class communities.

Variables for the Second Equation:

Marginal Willingness to pay (Y_2): The marginal willingness to pay for unit changes in the concentration of SPM or implicit marginal price for environmental quality is estimated using the following expression.

$$\frac{\partial(Monthly\,Rent)}{\partial(SPM)} = |Coefficient of SPM\_in Eq 4.1| \times \frac{\overline{Monthly\,Rent}}{SPM}$$

Education in Years (X_{18}): *The education variable is constructed by adding up the years of education undertaken by the first five adult members of the family and dividing by 5.*

Annual Gross Family income (X_{19}): It is based on the gross annual family income of the household. In absence of any concrete figures for actual incomes for certain households it was necessary to offer certain income brackets to the respondent to choose from.

Square of SPM (X_{20}): The log value of SPM and the square of the Log value of SPM are used in the second equation keeping in mind the necessary curvature property of the Willingness to pay function. It is expected that pollution, SPM, is positively related to the marginal willingness to pay for reduction in pollution. Alternatively the environmental quality, inverse of SPM, is expected to be inversely related to marginal willingness to pay. The descriptive statistics of all the selected variables under the purview of the present study are presented in the Appendix Tables A4.1, A4.2 and A4.3.

4.3 Estimates of Hedonic Property Price Function Using Pooled Data of Delhi and Kolkata

Estimates of hedonic property price function for using the pooled data of Delhi and Kolkata are provided in Table 4.1. These estimates are corrected for Heteroscedasticity using White's heteroscedasticity consistent standard errors. The coefficient for covered area (X_1) has expected positive signs with 1% and 10% level of significance. The rental value of the house is also found to be increasing with the number of rooms (X_2) and the coefficient of this variable is significant at 1% . The coefficient of index for indoor sanitation (X_3) has a positive sign as expected and is significant at 1% level. The rental value is found to be positively related to the distances of house from the business centre (X_4), national highways (X_5), slums (X_6) and industries (X_7). The coefficients of all distance variables are found to be significant at 1% level. The dummy variable denoting the presence of a slum (X_8) also furnishes a negative coefficient as expected and it is significant at 1%. The coefficients of environmental variables like air quality (X_{10}), adequacy of green cover (X_{11}) and water quality (X_{12}) also have the required positive signs. The coefficient of water supply variable (X_{17}) is insignificant. The dummy variable for business and salaried class (X_9) also has an expected positive sign and it is significant. The coefficient of pollution variable SPM (X_{13}) has the negative expected sign and is significant at 1% level. The coefficient for NO_x (X_{15}) has also negative expected sign and is significant at 1% level. However SO_2 (X_{14}), picks up a positive coefficient and is significant at 10% level. Given that the SO_2 concentrations are below the MINAS standards in both Delhi and Kolkata, further reductions of this pollutant could not be affecting the property prices.

Table 4.1: Estimates of Hedonic Property Price Function Using OLS

Location: ______	**Pooled Data of Delhi and Kolkata**		
Log values of Variables (Expected Signs)	Coefficients (t-statistics)	Log values of Variables (Expected Signs)	Coefficients (t-statistics)
Constant	10.06323*** (19.76)	Distance from Business Centre: X_4 (+)	0.137134*** (7.88)
Covered Area: X_1 (+)	0.034560* (1.62)	Distance from National highways: X_5 (+)	0.058846*** (4.05)
No. of Rooms: X_2 (+)	0.853732*** (18.67)	Distance from Slums: X_6 (+)	0.141984*** (3.30)
Indoor Sanitation: X_3 (+)	0.375379*** (5.47)	Distance from Industries: X_7 (+)	0.102353*** (2.81)
Dummy for Business or salaried class: $^{\$}X_9$ (+)	0.083610*** (2.93)	Dummy for Slums: $^{\$}X_8$ (-)	-0.373213*** (-10.53)
Perception about Air Qlty: X_{10} (+)	0.056361 (1.21)	SPM: X_{13} (-)	-0.629495*** (-9.16)
Adequacy of Green Cover: $^{\$}X_{11}$ (+)	0.060027* (1.67)	SO_2: X_{14} (-)	0.134722* (1.82)
Perception about water Qlty: X_{12} (+)	0.145228*** (2.89)	NO_x: X_{15} (-)	-0.247025*** (-3.87)
Distance from Shopping Centre: X_{17} (-)	0.013567 (0.92)	Water Supply in Hrs: X_{16} (+)	-0.012218 (-0.56)
City Dummy X_{22} (+)	0.654507*** (5.37)		
R^2	0.4809		
Adjusted R^2	0.4770		
F-statistic Prob(F-statistic)	122.0922 0.000000		

*(**) & (***) denotes significance at 10 (5) & (1) % levels. $ denotes variables without log values.

Table 4.2: Estimates of Marginal Willingness to Pay Function Using OLS

Log Values of Variables (Expected Sign)	Coefficient (t-statistics)	Log Values of Variables (Expected Sign)	Coefficient (t-statistics)
Constant	-9.528113* (-1.87)	Sq SPM X_{20} (-)	-0.343254** (-2.22)
Education X_{18} (+)	0.568856*** (9.47)	Perception about Air Quality X_{10} (+)	0.224356*** (5.19)
Income X_{19} (+)	0.581866*** (19.61)	City Dummy X_{23} (+)	0.805351*** (21.39)
SPM X_{13} (+)	2.455464 (1.38)		
R^2	0.444870	F-Statistics	329.7674
Adjusted R^2	0.443521	Probabilities (F)	0.000000

*(**) & (***) denotes significance at 10 (5) &(1) % levels. Sq SPM is Log(SPM) x Log(SPM)

The household specific implicit marginal price for SPM is obtained as the absolute value of derivative of hedonic property value function in equation (4.1 to 4.3) given the observed values of the variables Y_1 and X_{13} for the household. The household marginal willingness to pay function for the reduction in SPM is estimated by regressing the implicit marginal prices on income, education and other socio-economic variables and the SPM concentration (the inverse of the environmental or atmospheric quality). Table 4.2 reports the estimated marginal willingness to pay function. Income and education are supposed affect the household marginal willingness to pay for the reduction of pollution (Y_2) positively. Estimates show that these variables, Education, (X_{18}), and Income (X_{19}), have positive coefficients, which are significant at1% level. The pollution variable SPM (X_{13}) has a positive sign as expected (showing diminishing marginal utility with respect to environmental quality, the inverse of SPM) and is not significant even at 10% level. However the variable, the square of SPM (X_{21}) has a negative sign reflecting the curvature property of marginal willingness to pay function and is significant at 5% level. The variable, environmental perception (X_9) also has a positive coefficient and is significant 1% level. The city dummy variable (X_{21}) is positive and significant at 1% level.

4.4. Physical Accounts of Urban Air Pollution in India

Physical accounts for urban air pollution could be presented in the form of ambient concentrations of pollution in terms of pollution variables SPM, PM_{10}, SO_2 and NO_x . The Central Pollution Control Board (CPCB) provides regular monthly data about ambient air pollution concentration for all the major cities in India during 1990 to 1998. Tables in appendix A10 below provides the ambient concentrations of SPM, SO_2, and NO_x for 15 major cities in India. Tables 4.3 to 4.5 provide the data about the ambient concentration of air pollution during the period 1990-1998 in the residential areas of 15 major cities in India.

The MINAS standards for the annual averages of SO_2, NO_x, and SPM in the residential areas are respectively 60, 60, and 140 (200 for 24 hrs average) $\mu g/m^3$. The annual trends of these pollution parameters in the major cities of India as shown in Tables 4.1 to 4.3 reveal that concentration levels of SO_2, and NO_x are more or less below the safe levels during 1990 to 1998. However, it could be seen that the SPM concentrations are above the MINAS levels in most of these cities. Therefore in developing the monetary accounts of urban air pollution in the next section an attempt is made to estimate the damages to urban households from SPM concentrations exceeding the MINAS standards.

Table 4.3: Trends in annual average SO_2 concentrations in the major cities of India during 1990-98. (Unit µ gm/m^3) Residential Areas

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Mumbai	27.5	21.4	15.9	12.9	29.5	25.9	15	19.6	16.1
Calcutta	29	58	31	40.6	43.6	29.9	19.5		31
Chennai	9.7	7.6	6.8	8.6	7.7	7.8	7.5	9.2	10.5
Bangalore	17.1	18.3					21	30.3	41.6
Ahmedabad	20	31.5	18.4	24.6	30.4	38.3	21.7	14.9	
Hyderabad	6.6	9.5	10.1	7.3	18.3	15.3	14.3	14.9	10.6
Howrah	62.4	55.6	40.6	103.8	89.7	84		82.1	
Patna		9.4	16	108	11.9	26.2	21	20.9	17.1
Bhopal	12	6.4	8.7	6.8	9.8	11.5	14.5	15.8	17.2
Nagpur	8.3	8.3	8.7	7.2	6	8.6	7	7.7	6.1
Pune	12.1	15.7		28.9		7.8	38	50.3	48.1
Jaipur	5.2	6.7	5.8	7.1	8.9	8.56	9.4	7.4	8.5
Kanpur	7.7	8.8	10	11	11.7	13.9	13.8	13.5	16.5
Chandigarh	3.4	3.8		10	3.7		5	6.2	4.8
Pondicherry	3.6	5.5	8.3	11.5	15.6	27.7	32	31.4	29.9

Table 4.4: Trends in NO_x annual average concentrations in some major cities of India during 1990-98. (Units µ gm/m^3) Residential Areas

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Mumbai	27.6	28.3	27.7	33.1	32.4	31.4	37	33.5	22.1
Calcutta	30	41.2	25.3	40	33.3	27.3	27		30.9
Chennai	20	19.4	11.8	18.1	15.3	14.5	9.5	11.7	22.3
Bangalore	11.2	12.1					31	22.1	28.4
Ahmedabad	25.8	32.9	30.1	18.7	21.5	20	13.7	23.3	
Hyderabad	16.8	22.4	22.2	16.4	23.6	28.3	23.6	28.8	33.3
Howrah	74.9	79.6	72	149.4	217.2	212.2		84.3	
Patna		15	25.2	16.1	24.9	29	27.5	24.7	12.9
Bhopal	24.3	5.5	11.5	10.9	15.4	18.2	23	24.8	26.2
Nagpur	8.3	13.7	15	13.1	12.7	15.4	15.8	17.8	17.1
Pune	33.5	25.7		39.7		8.5	38	60.4	56.6
Jaipur	15.4	16.4	22.1	23.3	27.3	25.2	24.6	11.9	20.9
Kanpur	11.2	12.7	15.4	14.8	14	15.6	15.7	17.6	21.8
Chandigarh	12.2	17.7		29.7	19.2		16	4.5	9
Pondicherry	15.4	9.7	16.8	28.4	36.9	50.5	29.5	32.3	40.9

Table 4.5: Trends in annual average concentrations of SPM in some major cities in India during
1990-98. (Unit µ gm/m^3) Residential Areas

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Mumbai	211	267	283	238	209	233	196	327	234
Calcutta	205	338	304	371	326	308	491		267
Chennai	109	118	85	72	104	106	84	101	80
Bangalore	68	60					199	22	153
Ahmedabad	281	307	199	198	316	285	258	244	
Hyderabad	158	184	154	149	137	165	176	135	213
Howrah	402	313	249	383	307	339	283	282	
Patna		234	283	297	222	521	442	416	359
Bhopal	165	153	174	229		218	307	234	319
Nagpur	204	252	208	146	202	196	204	153	158
Pune	216	188		174		79	190	204	332
Jaipur	429	306	298	338	285	219	263	203	222
Kanpur	338	424	329	399	422	434	398	361	417
Chandigarh	222	196		223	154		139	212	280
Pondicherry	112	117	97	144	153	157	186	203	201

4.5 Monetary Accounts of Urban Air Pollution

Welfare gains from reducing SPM from current to the MINAS standards are estimated for some major cities in India using the hedonic property prices model estimated with pooled data for Delhi and Kolkata in Chapter IV. These welfare gains are evaluated by using city specific average concentrations of SPM over the year 1998. In the absence of data about monthly rents of houses for all the major cities considered here, the average of monthly rents for houses in Delhi and Kolkata estimated using the data collected through household surveys are used for the rest of the cities. The welfare gains for Bangalore, Chennai and Nagpur are set to zero because the average concentrations of SPM does not exceed the safe level of 200 µ gm/m^3. But it can be detected from Figures in Appendix A10 explaining the maximum pollution concentration levels in a month in these cities the maximum SPM exposures sometimes exceed the 200 mark by a good margin. With urbanization being common to all the cities of India it may not take long for these cities to come under the spell of air pollution.

Table 4.4 reports the estimated monthly welfare gains to a representative household in the city from reducing SPM levels to the safe level in all the major cities in India. A representative household in Delhi gets the maximum benefits of Rs. 19870.74 followed by Kanpur (13425.17), Patna (12557.6), Pune (11773.9), and Bhopal (11302.07).

Table 4.6: Estimates of Annual Welfare Gains From Reduction of Urban Air- Pollution in Some Major Cities of India

Cities	Annual gains to a typical household in the Urban cities from 1 unit reduction in SPM concentrations.(Rs.)	Annual gains to a typical household in the Urban cities from reduction in SPM concentrations from the current average to the safe level of 200 μ gm/m^3 (Rs.)
Ahmedabad	138.4356	6091.166
Bangalore	0	0
Bhopal	94.71005	11302.07
Chennai	0	0
Chandigarh	114.7167	9177.34
Hyderabad	164.7063	2113.731
Jaipur	156.3217	3439.077
Kanpur	62.01001	13425.17
Mumbai	146.4688	4931.116
Nagpur	0	0
Patna	79.22777	12557.6
Pune	89.42204	11773.9
Delhi*	126.85	19870.74
Kolkata*	69.49	8435.71

4.6 Welfare Gains from Reducing Urban Air Pollution in India and Environmentally Corrected Net National Product (ENNP)

Damages to local households in each city from the pollution levels exceeding the safe level have to be accounted for in the estimation of environmentally corrected net national product (ENNP). Damages from air pollution to all local households in a city could be estimated given an estimate of number of households and the estimate of annual welfare gain to a typical household in the city. Columns (3) and (4) in Table 10.5 provide the data about the urban population and the number of households in each city. The same table provides estimates of annual welfare gains in each city and the state domestic product (SDP) of the state to which that city belongs. Delhi gets the maximum benefits of Rs.46655.25 million followed by Kolkata (Rs.26635.3 million), Mumbai (Rs.12357.585 million), Kanpur (Rs.6010.366 million), Pune (Rs.5852.1706 million), and Ahmadabad (Rs.4270.456 million).

The annual welfare gains from reduction of air pollution in just one major city of each state in India as a percentage of Net State Domestic Product forms a range of 8.29 to 0 as shown in column (7) of Table 4.2. It may be useful to see the effect of air pollution in all the 15 major cities in India on the estimated Net National Product (NNP). For example the NNP of India for the year 2000-2001[8] is estimated as Rs.16799820 millions at current prices where as the total annual damages from urban air pollution in all the major cities considered in this study are estimated as Rs.111392.2 millions. Therefore the damages from urban air pollution form a

[8] Quick estimate of NNP of India for the year 2000-01 is obtained from Economic Survey, 2001-02, Ministry of Finance Govt. India.

percentage of 0.66 in the NNP of India. The estimation of Environmentally Corrected Net National Product (ENNP), corrected for urban air pollution in 15 major cities, could be obtained by deducting the damages from urban air pollution from the estimate of NNP. The estimated ENNP is obtained as Rs.16688428 millions. Column 8 of Table 10.5 provides estimates of NSDP corrected for urban air pollution in major cities in each state.

Table 4.7: Estimates of Welfare gains from reduction in Urban Air-Pollution in some major Indian cities

Cities	States	Urban Population (Census 2001)	Urban Households (Census 2001)	Welfare Gain to entire Urban Household Rs. Million	NDSP@ (Current Prices) Rs. Million	Gains as a % of NSDP Mean	Corrected NSDP Rs. Million
Ahmedabad	Gujrat	3515361	701090	4270.45571	888220.00	0.48	883862.90
Bangalore#	Karnataka	4292223	824013	0.00	846860.00	0.00	846860.00
Bhopal	Madhya Pradesh	1433875	262510	2966.9052	789460.00	0.38	787223.66
Chennai #	Tamil Nadu	4216268	834825	0.00	1156440.00	0.00	1156440.00
Chandigarh	Haryana/Punjab	808796	180565	1657.10632	416270.00	0.40	416152.03
Hyderabad	Andhra Pradsh	3449878	505615	1068.73394	1105250.00	0.10	1104275.42
Jaipur	Rajasthan	2324319	398124	1369.17896	698770.00	0.20	697670.42
Kanpur	Uttar Pradesh	2532138	447694	6010.36645	1646300.00	0.37	1641464.12
Mumbai	Maharastra	11914398	2506042	12357.585	2122160.00	0.58	2109028.36
Nagpur#	Maharastra	2051320	370314	0.00	2122160.00	0.00	2122160.00
Patna	Bihar	1376950	202997	2549.15557	627590.00	0.41	625041.31
Pune	Maharastra	2540069	497046	5852.17055	2122160.00	0.28	2115692.77
Delhi*	Delhi	12819761	2567740	46655.25	562530.00	8.29	515874.75
Kolkata*	West Bengal	13216543	1050340	26635.3	1223330.00	2.18	1196694.70

* Estimates of welfare gains are based on Individual estimates for the cities of Kolkata and Delhi.

The welfare gains are set to zero because the average pollution concentration of SPM during 1990-98, for these cities are less than the safe level of 200 µ gm/m^3.

@ NSDP Net state Domestic Product is reported in current prices for the year 1999-2000 for most of the states except, Madhya Pradesh (1998-99), Kerala (1998-99), for Delhi, Rajastan and Pondiche

V Conclusion

There are two important aspects in the development of integrated economic and environmental accounting: First is the description of environment in physical terms by defining an asset boundary that is more extensive than that is given in the conventional national accounts. A distinction has to be made between natural and manmade assets. Natural assets consists of biological assets, land and water areas with their ecosystems, subsoil assets and air. The second is the valuation of natural assets. Natural assets provide both marketable and non-marketable services and therefore their valuation requires the use of market and non-market valuation techniques.

The development of environmental accounts as satellite system of core accounts of SNA could be done in three stages. In the first stage review those parts of the conventional SNA that form the conceptual basis for the development of SEEA. The relevant parts of SNA are the supply and use table of produced goods and services, and the non-financial asset accounts that include the opening and the closing balance sheets of produced and non-produced natural assets. In the second stage desegregate SNA classifications without modifying the basic accounting structure to obtain further environmental related information with in SNA. Environmental protection services are identified within intermediate consumption of industries, final consumption by government and households and investment. Non-financial asset accounts are divided in to produced assets of industries and non-produced natural assets. The produced assets are divided in to man made assets and natural assets. In the third stage the environmental accounts are developed as satellite accounts of SNA by combining the concepts of material/ energy and natural resource accounting. The physical accounts of the SEEA extend the SNA without modifying the monetary flow and asset accounts of the SNA. Monetary data in SNA are described in terms of their counterparts in physical terms.

The estimates of physical and monetary accounts of industrial water pollution in India given in this paper provide inputs for developing environmental and economic accounts as satellite accounts to SNA. Estimates of annual net additions to stocks of BOD, COD, and SS by the Indian industry are given. The monetary value of the net additions to socks is estimated as Rs. 87,780.289 million for the year 1997-98. Given the estimate of net national product (NNP) for India for the year 1997-98 as Rs. 11,731,393 million at 1996-97 prices, the environmentally-corrected NNP for India, corrected for industrial pollution is estimated as Rs. 116,436,133 (11,731,393- 87,780.289) millions for the year 1997-98.

Environmentally corrected net national product in India, corrected for urban air pollution, could be estimated by deducting either the damages of air pollution or the cost of air pollution abatement for reducing pollution from the current level to safe level from the NNP estimated using the conventional methods of national income accounting. Physical and monetary accounts of urban air pollution which could again form part of satellite accounts of SNA are provided in this paper. Physical accounts provide ambient pollution concentrations of important air pollutants in major urban areas in India. The hedonic property price method is used to estimate the values households place on reductions in urban pollution. The pooled data obtained form the household surveys in Delhi and Kolkata are used for this purpose. A benefit transfer method is used to extrapolate the damages from urban air pollution in 15 major cities in India.

Annual damages from urban air pollution estimated using the hedonic property prices model in 15 major cities in India amount to Rs. 111392.2 millions at 2001-2002 prices. They form 0.66 percent of NNP in India during the year 2001-2002. The damages to households in at least one city in each state form a range of 8.29 to 0 percent of state domestic product (SDP).

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Natural resource accounting in India
Theory, application and the way forward

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Natural resource accounting - imperatives, objectives & approach

The environment has increasingly come to be recognized as an integral part of the economic system, providing direct resource inputs and waste absorption services in addition to its basic role in life support and provision of other amenities. Growing concern about the unsustainable use of natural resources and implications for the economy and general well being have been important policy issues throughout the last part of the 20th century, motivating the need for a holistic approach to economic decision making. One tool that has received much attention in this debate is the system of national income accounts. The need for natural resource accounting is implicit even in the Hicksian definition of income, the basis for the conventional system of accounts. Hicks defined income as the `maximum amount a country can consume without running down its wealth'. To the extent that depletion and depreciation of natural resources, is excluded from national income aggregates, 'sustainable' income is overstated.

The lack of adequate treatment of environmental issues in conventional national economic accounts is reflected in the following features (Lutz 1993). First, although the depreciation of manmade capital is adjusted against the value of production, no such accounting is done for natural capital such as forests, water, air and soil which not only provide the raw material for production but also render essential waste-absorbing and life-supporting services. Second, natural and environmental resources are generally not included in balance sheets or assessed by environmental quality indicators. Finally, clean-up costs are treated as increases in the national product, which should instead be considered the social costs of maintaining environmental quality.

Thus, as Repetto et al. (1989) put it, *a country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife and fisheries to extinction, but measured income would not be affected as these assets disappeared.* This is particularly relevant for low-income countries, dependent on natural resources for employment, revenues, and foreign exchange.

In response to these shortcomings in the conventional SNA, the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992 recommended that member countries implement integrated environmental and economic accounting. The UNSTAT subsequently initiated the development of a revised system of national accounts- the System of Environmental and Economic Accounts. The London Group on Environmental Accounting was created in 1993 to provide an informed forum for practitioners to share their experience in developing and implementing environmental satellite accounts linked to the economic accounts of the System of National Accounts.

The purpose of the SEEA is to present statistical accounts that permit the investigation and analysis of the interaction between the economy and the environment. Essentially, the system seeks to integrate the concept of **physical sustainability**[9] of natural capital and **economic sustainability** as understood in the traditional Hicksian sense. There are broadly three strands to the accounting system of the SEEA as described by the latest SEEA version of the London Group (London Group 2002).

Environmental statistics and physical accounts of the environment

The first step is to examine physical data and marshal it according to conventions, definitions and classifications of an economic system. Physical accounts enable an analysis of the extent to which the economy is dependent on particular environmental aspects and the sensitivity of the economy to particular environmental concerns. These accounts also provide a measure of sustainability in physical terms.

The SEEA suggests detailed accounts for the flow of natural resources (eg. minerals, energy), ecosystem inputs (eg. air, water) and residuals (eg. solid waste, effluents, emissions), consistent with the supply and use tables of the SNA. These accounts being very data intensive, accounts of a more aggregate nature can be developed to start with. For example, the construction of residual accounts would require the identification of important pollutants/indicators for major economic activities. These would include for instance, oxides of sulphur and nitrogen and particulate matter in the case of air pollution; and BOD (biochemical oxygen demand) and COD (chemical oxygen demand) in the case of water. Data on pollutant concentrations are typically compiled from monitoring stations. Emission / effluent data highlight pollution trends and may also be useful for source apportionment of pollutant concentrations. Emissions/ effluent discharge may be estimated using emission coefficients, which reflect the technological characteristics of the sector/country. Further, as the UN SEEA suggests, only emissions that cannot be safely absorbed by environmental sinks need to be recorded and costed. National or international standards can be used as proxy sustainable emissions.

Likewise, aggregate asset accounts of natural resources can be developed as illustrated in Table 1. The opening stock of the resource is the economically exploitable quantity of reserves available at the beginning of the accounting period. In the period, changes to this stock can result from direct economic use/exploitation of natural assets such as extraction of minerals, logging of forests, fish catch, water abstraction etc. *For renewable resources, `economic use' is a gross concept which includes `sustainable use', made possible by natural regeneration or replenishment, as well as `depletion' which represents exploitation of the resource beyond long term sustainable levels or yields* (UN 2001).

[9] The concept of physical sustainability can take on various dimensions- strong sustainability implies that there is no possibility of substitutability between assets (environmental and produced), while weak sustainability assumes perfect substitutability. A third option is to allow some substitutability but to designate some assets as critical capital for which no substitution is possible (The London Group 2002)

Table 1 Physical asset accounts for some natural resources : a framework

	Non-renewable resources		Renewable resources	
	Land/soil (km^2)	Subsoil assets (tonnes)	Forests (economic functions) (m^3, tonnes)	Fishery resources (m^3, tonnes)
Opening stock	Area of land underlying buildings, land under cultivation, forests and pastures etc.	Proven reserves	Volume of standing timber	Biomass/Virtual Population Analysis (VPA)
Economic use (sustainable use, depletion)		Extraction of minerals (measured in ore or processed form)	▪ Logging ▪ Clearing of forests	Total catch (commercial and non-commercial)
Other accumulation	▪ Changes in land use (transfer of land from one use to another) ▪ Land reclamation (asset increase)	▪ Discoveries ▪ Reassessment of reserves due to changes in technology and relative prices	▪ Natural growth ▪ Natural mortality	Non-cultivated fish stock brought under institutional control
Other volume changes	- Changes in land use and land area due to natural, political or other non-economic causes	Reduction in volume due to natural disasters or other non-economic factors	Reduction in volume due to natural disasters or other non-economic factors (fires, floods, earthquakes)	▪ Natural growth ▪ Natural mortality ▪ Net migration ▪ Natural disasters/ destruction of habitat
Closing stock	Area of land underlying buildings, land under cultivation, forests and pastures etc.	Proven reserves	Volume of standing timber	Biomass

Source. Adapted from UN (2001)

Economic accounts and environmental transactions

These accounts entail the following:

1. Hybrid accounting - comparing physical information about the use of natural resources with information in both physical and monetary terms about the processes of economic production. This involves both the absorption of natural resources into economic products and the absorption by the environment of emissions from economic production. A key policy goal of these accounts is to help maintain or improve economic performance while simultaneously reducing or eliminating the impact on the environment.
2. Environment related economic transactions- identifying expenditure incurred (and other economic instruments used) to alleviate or rectify economic pressures on the environment.
3. Valuation of the degradation of natural resources and the resulting impacts.
4. Implicit valuation of natural resources- establishing the implicit value of the stock of natural resources to examine the contribution of the resources in the production activity of extracting the resource and making it available to other units in the economy.

Several methods have been proposed in the literature and applied in various studies to quantify the value of and the change in the state/stock of natural resources. These methods can be classified as shown in Figure 1 below.

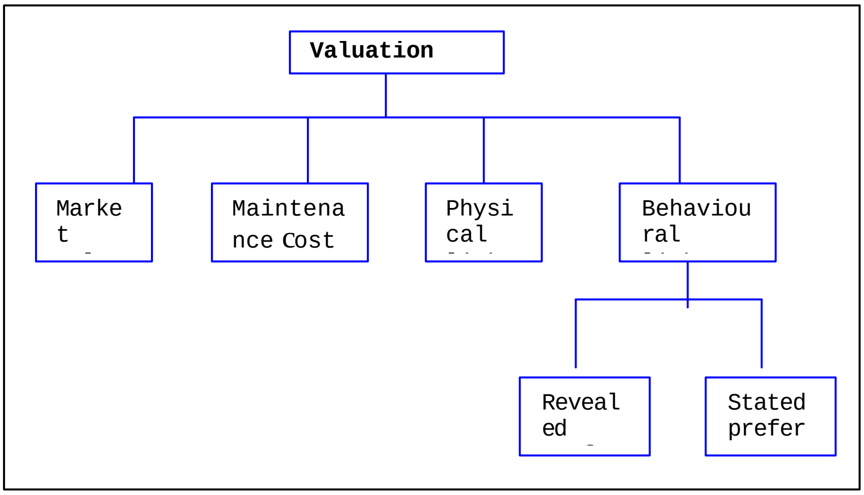

Figure 1 Classification of valuation techniques

Market valuation methods are generally applied to estimate the value of changes in stocks of depletable natural resources such as mineral resources that are transacted in the market. This approach, however, cannot capture environmental services provided by air, land, water and biodiversity for which there is not market. Therefore maintenance cost valuation are used as an alternative or in conjunction with market valuation techniques. Maintenance costs are defined as the costs, which would have had to be incurred during the accounting period to avoid current and future environmental deterioration (UN 2001). The physical linkage methods, on the other hand, employ the causal connection between environmental change and its effects on processes, products or persons (UN 1997), and are often subject to complex statistical problems of establishing response functions. At the other end, the behavioural linkage methods use the behavioural responses of people to environmental change to value environmental goods. These responses may be revealed in the market or stated in a survey. A detailed discussion on some of these methods along with their relative merits and demerits is provided in Annexure 1.

Integrated economic and environmental accounting

The final stage in resource accounting is to develop an extended system of economic and environmental accounts that captures each of the three main environmental functions in national income and wealth aggregates- resource, sink and service functions as follows:

1. Reflecting the depletion of natural resource and augmenting the concept of 'consumption of fixed capital' with "consumption of natural capital"
2. Accounting for environmental protection and other defensive expenditure undertaken to preserve the service function or prevent the overuse of the sink function of the environment
3. Valuing degradation or the overuse of the sink function

Although the SEEA is conceived as a whole which is internally consistent and attempts to address each of the three major environment concerns, the scope of any resource accounting exercise and hence choice of techniques will be sensitive to the priorities and information base in a country. Furthermore, the system is still evolving - while best practices have emerged in certain areas, there is a division of opinion on many others. Very few countries have developed a range of accounts and no country has yet developed a full set of accounts (London Group 2002). With more experience in applying this framework and with better understanding of the environment-economy interactions, the system can be expected to evolve further overtime.

NRA will serve several policy functions. Apart from macroeconomic analysis of environmentally adjusted indicators of wealth/capital, consumption, production, trade, income etc, it will also assist in microeconomic analysis such as for environmental cost internalization or assessment of the scope, amount and effectiveness of environmental protection (expenditures) (Bartelmus 1996). The tool will also facilitate the design of environmental policy such as environmental taxes, or royalty instruments for use of natural resources etc.

In India, several independent studies have been undertaken at the sector/resource level to estimate resource services and costs. A study by TERI, GREEN India 2047 (Growth with Resource Enhancement of Environment and Nature) for instance, estimated the extent of degradation of India's natural resources during the first 50 years of its independence (1947–97) (TERI 1998)- refer Box 1.

There have been, however, no systematic efforts towards integrating such analyses with the system of national accounts in order to evolve a formal system of natural resource accounting at the national or state levels. The Ministry of Statistics and Programme Implementation has in the recent past taken some initiatives to assess and bridge data gaps and evolve a methodological framework for natural resource accounting. The Central Statistical Organization (CSO), as the nodal agency for the development of the statistical system in the country, has, since 1997, been bringing out an annual `Compendium of Environmental Statistics'. In addition, the Ministry has constituted a Technical Working Group on Natural Resource Accounting. As a pilot exercise, the Ministry had commissioned a study on natural resource accounting in Goa, Phase I of which aimed at undertaking resource accounting on the basis of secondary data and identifying areas where additional primary data for the second phase will be necessary (TERI 2002). The following section discussed the key findings from the study and lessons for similar exercises in India.

Box 1 GREEN India 2047: some key findings

The environmental costs in India exceed 10% of the GDP (gross domestic product) in 1997 as a result of loss in agricultural productivity, loss in timber value due to degradation of forests, health costs due to polluted water and air, and costs due to depleted water resources.

- The economic loss of soil degradation resulted in an annual loss of 11%–26% of agricultural output.
- The total growing stock of forest is only 63% of the potential growing stock of the forests on the existing forest area.
- Air pollution has significant impacts on the health of people, specially those residing in urban slums.
- Growing population, poverty, and inadequate access to clean fuels in rural areas have perpetuated the use of biomass fuels, thereby condemning more than 90% of rural households and more than 35% of urban households to higher levels of indoor air pollution.
- The incremental annual cost of ensuring safe drinking water and adequate sanitation facilities to all is estimated at 3 billion dollars.

Source TERI (1998)

Natural resource accounting in Goa - findings and recommendations of Phase I

Goa is one of the more developed states in the country, the economy being dominated by the services sector, mainly government, trade and tourism, though the primary sector - agriculture, fishing and mining- remain important. Figure 2 shows the sectoral composition of the State income.

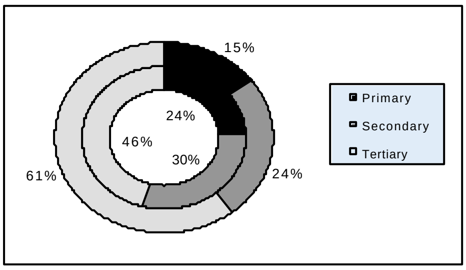

Figure 2 Sectoral composition of State Domestic Product (%) 1980/81 and 1999/2000 (constant 1980/81 prices)

The growth of tourism in the State has catalyzed a number of social and structural transformations, through its impact on migration, urbanization and land-use. Tourism has compounded environmental pressures such as water depletion and deterioration, air pollution and solid waste generation and has had an impact on vulnerable ecosystems in the State such as sand dunes, mangroves and *khazans*.

The primary sector, despite its diminished contribution to the state domestic product (SDP), makes important economic and social contributions. The mining sector makes up around 7% of SDP, and contributes as high as 60% of income in mining talukas of the State though the sector has come under close scrutiny by environmentalists due to its impacts on water, air and land use. At the same time, depletion of iron-ore resources is also raising the issue of sustaining income from the sector. The fishing sector in the State has grown almost seven to eight fold since the liberalization of the State in 1961 and has become progressively mechanized though some view this as adversely affecting breeding grounds and contributing to a decline in near-shore fish catch.

The secondary sector contributes about 24% to the SDP. The composition of industry in Goa indicates the presence of potentially polluting industries as per CPCB's classification of industries (e.g. cement, chemicals, pharmaceuticals etc.) However, vigilant environmental groups in Goa have ensured considerable improvement in environmental management practices in the state. Goa has also witnessed a significant rise in the vehicular population, with the number of private cars registering a 95% rise between 1991 and 1996. Despite these concerns, air quality in the State is within CPCB permissible norms (as noted at the SPCB monitoring stations), the proximity to the sea contributing to the dispersion of pollutants.

Against this general background, the first phase of natural resource accounting examined the following resources for the period 1991 and 1996:

- Land use
- Forests
- Minerals (iron ore)
- Energy and emissions accounts for the transport sector
- Energy and emissions accounts for the domestic sector

While physical accounts were prepared for all sectors, monetary accounting was undertaken for forest (only timber and fuelwood) and mineral (iron-ore) depletion. Annexure 2 sums up the key findings of the study.

The study threw up a number of issues- both methodological and data related that set the stage for future work in natural resource accounting not only for the State but also for the entire country. While some of these are issues that need to be addressed by the government over a long term to ensure systematic flow of information to facilitate resource accounting (such as the case of monitoring soil quality), in other areas, work can be initiated through primary surveys in the short run, which may be attempted in subsequent work for the state. Table 2 summarizes the main recommendations from Phase I for data collection and management and indicates the agency, which could assume the key responsibility for future work. Any future work in the State would also need to study the depletion and degradation of water resources and the depletion of fisheries.

Table 2 Natural resource accounting in Goa- key recommendations from Phase I

	Issue	Action by	Remarks
	A. Land-use changes		
1	Consistent data on land use change across sources	Government of Goa (GoG)	Need for an integrated information system that can be readily accessed and regularly updated
2	Primary reporting system for land use change to be instituted in Goa	GoG	Need for an integrated information system that can be readily accessed and regularly updated
3	Change in land quality over time	GoG/Government of India	Regular field investigation of physical, chemical and biological

			properties of soil
4	Case study to assess environmental, social and economic impact of land use change	Research studies	Detailed and long-term
	B. Forest resources		
5	Consistent data on fuelwood use across sources	GoG/CSO	Need to periodically update fuel consumption norms based on NSS results
6.	Fuelwood consumption in the informal sector e.g. bakeries	GoG/ NSSO	
7	Non-availability of forest-related data including ▪ Species wise production and prices of timber ▪ Production of minor forest products ▪ Species wise data on forest cover, regeneration and afforestation ▪ Costs of extraction of timber, maintenance and protection of forests ▪ Inter-state movement of timber and fuelwood	State Forest Department	
8	Case studies on ecological and recreational benefits provided by forests and availability of non-timber forest products	Research studies	
9	Economic and ecological benefits of mangroves	Research studies	
10	Physical indicators of forest quality of diversity	State Forest Department	
	C. Mineral resources		
11	Gaps in the data ▪ Production, prices and costs by ore grade	Indian Bureau of Mines / Ministry of Coal & Mines (MoCM)	
12	Studies on techno-efficiency of mining practices	MoCM	Comparing current mining practices to those stipulated in the approved mining plan for the State
13	Case studies on the environmental, resource and social costs of mining	Research studies	Detailed and long-term
	D. Energy and emission accounts - transport		
14	Need for more monitoring stations	State Pollution Control Board	
15	Vehicle utilization rates by state	GoG	

16	Estimates of kerosene used for adulteration of diesel	Oil companies/ Research studies
17	Fuel consumption and environmental impact of water transport	Research studies
	E. Energy and emission accounts- domestic	
18	Estimates of LPG use in non-residential sector s	Oil companies/ Research studies

Natural resource accounting in India : challenges and the way forward

The challenge in undertaking NRA in India is threefold- developing an accounting framework that is line with and contributes to ongoing international efforts towards developing the SEEA; encouraging the exercise at the state level in a coordinated and comparable manner; and identifying and bridging data and information gaps over a period of time through appropriate data management and institutional initiatives. The following initiatives will be needed to strengthen and operationalise natural resource accounting in the country:

- Define an SEEA framework for India that could be followed at the national and state levels.

There is a need to define the scope of NRA in the country depending on national priorities, environmental concerns and statistical capabilities; and accordingly adapt the UN SEEA. This will require extensive consultations amongst experts in the field of NRA and the Central Statistical Organization to provide a clear picture of the overall objectives of NRA for the country, the accounting framework and data requirements. The framework should be designed for a long-term analysis, allowing for improvements in the database. Current availability of data, therefore, need not be the most restrictive factor in designing the framework. The database for SEEA should be built up steadily over the years as was done for SNA in the country. Analysis based on second-order solutions could accordingly be refined over time.

- Evolve a consensus on certain conceptual issues

For the sake of regular and comparable natural resource accounting at the national and state levels, a consensus on certain conceptual issues would need to be evolved. These include:

- Choice of valuation methods for particular sectors/resources

  As discussed in Annexure 1, a number of methods may be used to value the same natural resource or its services. Well-known difficulties with some methods such as the willingness to pay restrict their applicability in routine accounting at the national level. The choice of appropriate accounting methods is, therefore, necessary to ensure comparable accounting studies over a period of time.

- Choice of the discount rate

There is considerable debate over the appropriate rate of discount that takes into account environmental/resource use considerations (Box 3). The choice of a discount rate can work in opposite directions. A low rate will accord higher weight to future environmental benefits (or costs) but at the same time can result in higher investment with counter-productive results. Given that choosing the appropriate rate is complicated, environmental externalities may be better addressed through other market or non-market interventions. A process of deliberation and research on this subject needs to be initiated in the country such that a framework for the selection of an appropriate rate (which could change over time) can be evolved.

- Defining the limits to monetary valuation of environmental assets/services

Given the contentious nature of certain valuation techniques, it will be necessary to define clearly areas where monetary valuation should be undertaken and those where (in the immediate future at least) a compilation of physical indicators would suffice as being complementary to the SNA.

- Treatment of defensive expenditure

Defensive expenditure constitutes expenses that people incur as precautionary, when facing the externality effects of environmental degradation. It is argued that since it does not add to welfare but instead help to maintain old levels of welfare by protecting against environmental hazards, it should be classified as fixed capital formation, whereas in practice, it forms part of final demand and adds to the level of GDP (London Group, 2002). On the other hand, it may be argued that defensive expenditure 'adds value' like the services sector, in the absence of which, economic activity would suffer. Also, the concept of defensive expenditure is elusive. As Repetto et al. (1989) put it, *spending on food can be considered a defence against hunger, clothing against cold, and religion against sin*.

Box 3 The debate on the appropriate rate of discount

The basis for the discount rate lies in the social rate of time preference and in the opportunity cost of capital. Typically, the latter implies a higher rate than the former. From an environment standpoint, the choice of a discount rate works in differing directions. With high discount rate, fewer investments are undertaken, particularly investments with long term payoff and large initial costs. This means that preservation of certain natural assets is more likely to be achieved at higher discount rates. On the other hand, higher discount rates imply a more rapid development of exhaustible resources, shorter rotation periods and smaller stocks of renewable resources (Pearce et al. 1991). The debate for and against a low (even zero) discount rate is presented below:

The arguments for the use of zero discount rate include (ADB 1996):

- For very long term impacts that span generations, there is no institutional or financial mechanism for current generations to compensate the future generations for their losses from environmental impacts.
- For any positive non-zero discount rate, the present value of any event more than 15-20 years in the future will be very small. Thus, even extremely severe future impacts or long term health benefits will have little effect on current decisions if they are discounted at a positive rate.
- People living under the veil of poverty have high individual discount rate favouring immediate needs over sustainable practices. This often results in environmental degradation, which can in turn perpetuate poverty. Therefore some have suggested that the use of low discount rates or zero rates would help alleviate this cycle of poverty.
- The quality and the availability of the natural resources and environmental services as a result of the anticipated increase in their use will decline in future. Therefore one might anticipate that the value of the environmental services would rise in future due to their increased scarcity and concurrent increased demand. In contrast, discounting at a positive rate implies a reduced value for environmental services and a zero discount rate at least holds the value of these services constant in the analysis.
- A positive discount rate on future damages or costs is often rationalized as future generations will likely have higher real incomes than the current generations, and this higher income could offset environmental degradation. It is however argued that this may not be the case since even if real incomes are higher, they may not be adequately compensated for environmental damage.

In contrast many arguments are also proposed for the usage of positive (non-zero) discount rates.

- Even where there are valid questions of intergenerational equity, there remains a need to account for time preferences and investment trade-offs within the present generation.
- If zero discount rate is applied across all projects, it would result in more projects being undertaken than when a positive discount rate is used. Unless the externalities of these additional projects are offset, the net result of a zero discount rate can be an increase in environmental burdens rather than a reduction.

Pearce et al. (1991) suggest the following additional reasons why market rates should not be adjusted to the social rates to take account of environmental concerns:

- Calculating the appropriate rate is difficult,
- Lowering the overall rate will result in more investment with its counter-productive results, while a selective lowering of the rate for environmental projects is inefficient and administratively cumbersome, and
- There are alternative ways of dealing with many environmental concerns that are probably more effective. These include better valuation techniques including valuing future costs and benefits, and integrating environmental considerations into all economic decisions.

- Pilot projects to identify data gaps and institutional coordination for data management

There is a need to commission studies such as the one for Goa in different parts of the country to identify limitations in data availability. This will help in identifying key regional environmental issues and the gaps in data vis-à-vis an NRA framework for the country. It will also facilitate an understanding of the necessary institutional arrangements for the collection and collation of data relating to the environment and natural resources. Appropriate training programmes could accordingly be designed.

- Special studies

Special studies will be required to improve the accuracy of environmental valuation in the SEEA. The results from such studies could to used to develop 'environmental impact norms' that can be adapted and used in other similar studies. Such studies could focus on specific economic activities that cause depletion/degradation of the environment. These could either deal with one specific aspect of depletion or degradation across all economic activity or assess the contribution of a particular economic activity (for e.g. mining, tourism, or industry) to different kinds of environmental impacts. Another set of studies could focus on impacts that relate to the geographical or ecosystem characteristics of a region such as coastal areas or agro-ecological zones. Research on the health impact of indoor and outdoor air pollution also needs to be strengthened. Here as in other relevant cases, the poverty and gender aspect of environmental costs should be highlighted at least qualitatively.

- Annual versus benchmark compilations

Given the time and cost implications of an elaborate SEEA, it may be preferable to design `reduced-format' accounts (as suggested by Bartelmus et al. 2001) that will require a lesser degree of integration between environmental and economic data. As against this, benchmark compilations could be carried out every 5-10 years. The existing system of national income accounting does make use of such bench marking for example, in the case of value added estimates for non-timber forest products. These would make use of extensive data sets that accumulate over time and would incorporate the results of detailed environmental studies of the type proposed above.

As the findings of the first phase of the pilot project for Goa indicate, natural resource accounting can provide useful indicators of the direction and extent of environmental change. Even though its coverage has been limited, the study provided important insights into the environmental and resource situation in the state, the emerging trends and need for corrective interventions. As noted above, a study such as this can also provide useful inputs into identifying data requirements and strengthening data management, which is the backbone of a good accounting system. To sum up, improving the information base is a prerequisite for better resource management and it is essential that data collection and collation mechanisms are strengthened and standardized across the country. This is required not only for valuation of natural assets and the cost of their depletion and degradation but also to upgrade the system of environmental statistics. These can by themselves provide useful indicators of environmental change and be instrumental in `greening' development planning in the country.

Annexure 1

Techniques for the economic accounting of depletion and degradation of natural resources

In the conventional system of income accounts, *natural assets are valued in monetary terms only if they are under the controlled ownership of economic agents and provide actual or potential economic benefits to their consumers* (UN 2001). These natural assets can be produced such as agricultural products or non-produced such as mineral deposits or fish and are accounted for as providing positive economic benefits to their owners. Their depreciation, however, is not accounted for, unlike the case with man-made capital. Other environmental assets such as land, water, air, forests and biodiversity are ignored in the SNA[10]. Several methods have been proposed in the literature to quantify the value of and changes in the state of natural resources.

Market valuation of natural resources

These methods are generally used to estimate the value of changes in stocks of depletable natural resources such as mineral resources/or the products thereof that are transacted in the market. These include the following.

Net present value of natural resources

This method is based on the opportunity– cost principle - *economic assets will be acquired and put to a particular use in production, assuming rational behaviour, if their discounted expected net returns exceed the discounted returns from any other investment option available* (Peskin 1989). In the case of non-marketed natural resources, the value of goods extracted from or services provided by these assets may be used for estimating the future sales value, reduced by the exploitation costs (UN 2001). The method could be used to value the resource both at a point in time and the change in the resource value between two points in time as shown below.

At time period T_0, the present value of the resource V_0 is given by

$$V_0 = \sum_{t=0}^{T} \frac{N_t Q_t}{(1+r)^t} = R_0 + \frac{R_1}{1+r} + \frac{R_2}{(1+r)^2} + \Lambda\Lambda + \frac{R_T}{(1+r)^T}$$

Where

N_t = total unit value of the resource less the costs of extraction, development, and exploration

Q_t = quantity exploited during period t

$R_t = N_t Q_t$ = net receipts from the resource in period t

r = rate of discount

The change in the value of the resource between time periods t_0 and t_1 would be given by

[10]Some attempts at integrating environmental assets were made in the 1993 SNA. Refer to Bartelmus. et al.2001 for a discussion.

$$\Delta V = V_1 - V_0 = -R_0 + \frac{V_1}{1+r} \cdot r$$

The method has some shortcomings. First, there is the issue of what component of asset use constitutes income and what constitutes depletion cost or capital consumption. In addition, the choice of discount rate can be a controversial issue.

Further, the application of the method requires extensive information on future stocks, prices and interest rates, which are usually available, if at all, only at the macro-economic rather than sectoral level. It is, therefore, difficult to estimate future returns and costs of natural resource exploitation by economic sector or type of natural resource used in different sectors (Bartelmus et al. 2001). In practice, therefore, two simplified versions of the basic principle of present value are used. These are the Net Price method and the User Cost allowance.

Net Price method

This method determines the value of a resource at the beginning of a period as the volume of the proven reserve times the difference between the average market value per unit of the resource and the per unit cost of extraction, development and exploration (including a normal rate of return on invested produced capital). In the case of non-renewable (mineral) resources, this stock comprises only the `proven reserves, that are exploitable under present economic conditions and, therefore have a positive net price' (Bartelmus et al. 2001).

The Net Price method is based on the Hotelling rent assumption i.e. in a perfectly competitive market the net price of a natural resource rises at the rate of interest of alternative investment, offsetting the discount rate. In principle the net price effective at the time of the resource use should be applied. In practice, the cost of depletion is calculated by multiplying the depleted quantities of natural resources with the average net price at the beginning and end of the accounting period (UN 2001).

The value of the resource at time T using the Net Price method would be given by

$$V_t = (p_t - c_t)Q = N_t.\sum_{t=0}^{T} Q_t$$

Where

p_t= price of the resource in period t

c_t= unit cost of extraction, development and exploration (including a normal rate of return on invested produced capital)

Nt = pt - ct = unit value of the resource less the costs of extraction, development, and exploration

Qt = Quantity exploited during period t

Similarly, the change in the value of the resource between time periods T_0 and T_1 would be given by:

$$\Delta V = V_1 - V_0 = (Q - Q_0)N_0 - Q.N_0 = -Q_0.N_0$$

User Cost allowance

El Serafy suggests that total resource rent cannot be deducted from GDP, acknowledging the fact that a resource-rich country has a real income advantage in comparison with a resource-poor country. A portion of the rent should be counted as value added, the reward for human effort. The idea is to convert a time-bound stream of (net) revenues from the sales of an exhaustible natural resource into a permanent income stream by investing a part of the revenue, that is, the `User Cost' allowance over the lifetime of the resource. Only the remaining amount of revenues should be considered `true income' (El Serafy as cited in Bartelmus et al. 2001). Explicitly, R is the annual net revenue from the sales of the resource, assumed constant over its lifetime (of n years), 'true income' X can be calculated such that R-X represents the 'capital' element whose accumulated investment at an interest rate r during the n years would create a permanent stream of income of X per annum.

In other words,

$$R_0 + \frac{R_1}{1+r} + \frac{R_2}{(1+r)^2} + \Lambda\ \Lambda + \frac{R_T}{(1+r)^T} = X + \frac{X}{1+r} + \frac{X}{(1+r)^2} + \Lambda\ \Lambda + \frac{X}{(1+r)^T} + \Lambda\ \Lambda\ \infty$$

With R assumed to be constant (=R), this would give the true income X, as

$$X = R\left[1 - \frac{1}{(1+r)^{T+1}}\right]$$

and the `user cost' element as

$$R - X = R\left[\frac{1}{(1+r)^{T+1}}\right]$$

Apart from the simplifying assumption that the net revenue remains constant over time, the controversy surrounding the choice of the discount rate and the question of availability of appropriate investments of the User Cost allowance also impair the general validity of the approach (Bartelmus et al. 2001).

Concern has also been expressed over the use of market prices for valuation of natural resources. Market prices are often not reflective of the social marginal value of natural resources, in that there may not be a relationship between the market price of a natural resource and changes in the stock of the resource. For instance, Huhtala et al. (2001) show on the basis on a detailed quantitative analysis for Finland and Sweden that there was no long-term equilibrium relationship between timber prices and stocks in the two countries.

These concerns, notwithstanding, the Net Price method and User Cost methods have been used extensively in valuing mineral resources. Repetto et al. (1989) used the Net Price method to value petroleum products in Indonesia. The UNDP-supported natural resource accounting study for the Philippines employed the User Cost method to value mineral resources in the country while it used the Net Price method to value forest resources and fisheries. The Yamuna sub-basin study (TERI 1997) used both the Net Price method and the User Cost method to estimate the value of mineral reserves (rock phosphate, feldspar, and quartz). The Net Price method has also been used extensively for the valuation of timber (see for instance Repetto et al. 1989 for valuation of timber in Indonesia).

The methods differ in their simplicity and data requirements. Though the User Cost method is a simplified version of the present value method, assuming a constant income stream, it requires the choice of an appropriate discount rate. The Net Price method requires information only on current prices and costs. The method however works under the restrictive assumptions of homogenous stocks and competitive markets. In actuality, marginal exploitation costs may increase with lower quality of resources extracted, and the rents on the marginal tonnes would increase at a rate lower than the discount rate. The estimates of the value of depletion are also higher if average costs are used instead of marginal costs, the latter being generally higher. The Net Price method tends to overstate capital consumption, thus representing an upper limit of depreciation, whereas the User Cost allowance implicitly assumes full substitutability of natural capital by other production factors, thus representing a lower limit. The two techniques together can provide a range of cost estimates.

Maintenance valuation of environmental assets

The market-value approach covers only those natural assets that are connected to actual or potential market transactions. These do not cover the environmental services provided by air, land, water and biodiversity. Nor can it account for all environmental functions of 'economic' assets if those functions have not been reflected in the economic (market) valuation of natural assets (Bartelmus et al. 2001). Therefore maintenance cost valuation can be used as an alternative or in conjunction with market valuation techniques. Maintenance costs are defined as the costs, which would have had to be incurred during the accounting period to avoid current and future environmental deterioration (UN 2001). The rationale behind the approach is based on the following two criteria (Bartelmus et al. 2001):

- Application of the sustainability concept

- Extension of the conventional concept of replacement cost of fixed capital to valuing the use of non-produced natural assets

The sustainability concept reflects a conservationist view of the environment, stressing the need to maintain at least the current level of environmental quality given the long-term costs of disturbing the environment and the possible irreversibilities of environmental impacts. The approach is also consistent with the treatment of man-made capital in conventional income accounts. In the case of sub-soil assets, replacement cost could in principle, be calculated in terms of the required exploration and development costs, which, however, may be highly speculative. In addition, given the finite nature of these assets, the weak sustainability concept – the possibility of substituting sub-soil assets by other forms of capita (human, natural or man-made) to maintain income levels (rather than particular categories of natural capital) – may be justified here. This approach is implicit in the User Cost method.

The maintenance-cost concept also implies that uses of the environment that have no impact on nature have a zero monetary value. Thus water abstraction, fishing or logging within the natural recharge/regenerative capacity would entail no economic cost.

The value of environmental cost depends on the avoidance, prevention or restoration activities chosen. Box 2 lists some of the activities that can be used to represent maintenance activities.

Box 2 Prevention and restoration activities in maintenance costing

Five types of measures for preventing environmental deterioration or restoring environmental quality by economic activities can be distinguished:

(a) Reduction or abstention from economic activities (value added foregone);

(b) Substitution of the outcomes of economic activities, i.e. production of other products or modification of household consumption patterns (incremental costs);

(c) Substitution of the inputs of economic activities without modifying their outcomes (outputs) by applying new technologies etc. (incremental costs);

(d) Activities to prevent environmental deterioration without modifying the activities themselves (e.g. by end-of-pipe technologies);

(e) Restoration of the environment and measures diminishing the environmental impacts of economic activities.

Source. United Nations 1993a, Ch. IV.C as cited in UN 2001

The avoidance cost method has been attempted by Murthy (1999) to estimate the value of water quality preservation (Kadekodi 2000). Using cost norms from survey data, the study estimated the cost structure of effluent treatment plants (ETP) in major industries of the country and the total value added by all ETP activities if all industries were to adhere to water quality standards. Assuming full employment, this estimate would reflect the `value added lost' due to the diversion of resources from the production of other goods and services in the economy. Assuming preservation of water quality as a public good, this value added lost would provide an account of the value of quality preservation.

The maintenance cost approach has also been used in accounting for the forestry sector in Thailand (Sadoff 1994). The cost of replanting the forest area cleared each year, and maintaining it to a harvestable age was estimated (the per unit cost of reforestation, calculated as the sum of the present discounted costs of establishing a forest plantation and maintaining it until a harvestable age, was multiplied by the net deforestation in each period). This would be the amount required to be set aside in the year deforestation occurred in order to fund complete forest regeneration. This amount also represents the user-cost penalty for each period that needs to be subtracted from the forestry sector income.

Physical linkage methods

These methods depend on the causal connection between environmental change and its effects on processes, products or persons (UN 1997). This method, also known as the damage cost or the dose-response approach seeks to estimate environmental value by establishing linkages between the physical effects of some environmental change on some other factors such as human health and productivity, agricultural output or value of property. These impacts are then quantified (using market prices, in many cases) to arrive at the value of environmental damage, using for instance the cost of illness (hospital expense, including loss of wages to the patient and the attendant). These methods are riddled with complex statistical problems of establishing response functions as also contentious issues such as the statistical value of life.

The physical linkage methods have been used extensively in studies to value the health impact of air and water pollution in India. These include a study by Brandon and Hommann (1995) on country-wide costs of premature deaths, hospital admissions and sickness due to air and water quality deterioration in India; one by Parikh et al. (1995) to assess the impact of air pollution on health in Chembur, Bombay; and another supported by the World Bank to study the linkage between health, particularly child mortality, and the quality of drinking water quality in Andhra Pradesh. The last study also attempted to assess the nature and scale of health risks posed by water pollution from industrial, agricultural, municipal and other sources. The physical linkage method has also been used to estimate productivity losses due to soil degradation (Repetto 1989; Narain and Girisha 1999), though the studies recognize the complexities in establishing clearly the causes of soil erosion and land degradation.

Behavioural linkage methods

These methods use behavioural responses of people to environmental change to value environmental goods. The techniques to capture behavioural responses can be classified depending on whether preferences are revealed in the market or are stated in a survey.

Revealed Preference method

In the Revealed Preference method, the value of an environmental amenity is estimated indirectly from the price of a commodity, whose market value at least partly reflects environmental amenities. The value of an unpriced amenity is inferred using statistical analysis to examine how a change in the amenity affects the observed purchase price of related private goods (UN 1997). For example, in the hedonic price approach, a preference shown for an environmental amenity is reflected in the price: for instance, higher value of property in greener or quieter areas. This method was used by Parikh et al (1995) in estimating the effects of air pollution in Chembur, Bombay. However, it was difficult to establish any result conclusively due to the phenomenal pressure on housing in the city.

In the Travel Cost Approach, the expenditure incurred in visiting a site is treated as a revelation of the consumer's preference for the environmental/ recreational services provided by it. This method uses the travel costs incurred by the individual to reach the site as a surrogate for the willingness to pay for using the site. Since the travel costs vary across individuals living at different distances from the site, the data can be used to derive the demand curve for the site services. Travel costs would include actual transportation costs, fees paid at hotels and at times, the opportunity cost of travel time spent on journey. It is most commonly used for assessing the value of national parks meant for preservation of flora and fauna. Chopra (1998) conducted a study using the travel cost approach to determine the value of tourism, and the nature of demand for it at the Bharatpur National Park, Rajasthan. The study revealed that the demand for tourism services provided by the National Park was fairly insensitive to the price and in case of redistribution of costs and benefits from the Park through an increase in the entry fee, the demand is not affected.

Stated Preference method

Stated preference and contingent valuation methods assume that people respond to hypothetical market situations, as if these were actual markets (UN 1997). In a contingent valuation (CV) survey, respondents are presented with the opportunity to express their willingness to pay or accept compensation for a change in the level of environmental amenities. Stated preference methods are viewed with scepticism since these are riddled with free-rider attitudes, short-sightedness or ignorance about long-term environmental impacts, and issues related to the effects of income levels and distribution, besides generally requiring much time and money. These difficulties limit the applicability of the approach in routine accounting at the national level.

The approach has been used for the valuation of environmental facilities such as forests, common lands, water bodies, and biodiversity. The Yamuna sub-basin study used the WTP method for the valuation of forest resources in the Yamuna Sub-basin (Chopra and Kadekodi 1997). Respondents were asked to indicate their willingness to pay for forest plantation and protection based on some hypothetical situation. The results indicated that people's concern for protection of forests revealed through their WTP was directly related to the extent of degradation in their respective areas. One of the most high-profile uses of the CV method in water resources management has been in the regulation of the Glen Canyon dam on the Colorado River in Arizona (gNee 2001). A contingent valuation study was conducted to determine the adverse impacts of the dam on downstream ecosystems in the Grand Canyon. The CV study revealed the concern of the people about threatened and endangered aquatic species, the birds, native vegetation which were all getting adversely affected by the `unnatural' water flows, following which the Grand Canyon Protection Act of 1992 was formulated to prevent its further deterioration.

Annexure 2

Key findings of NRA Phase I

	Sector/Resource	Objective	Approach		Key results		Remarks
			Physical accounts	Monetary accounts	Physical accounts	Monetary accounts	
1.	Land	- Develop physical accounts for various land use categories - Examine the role of mining and tourism in land–use change -Analyze trend in agricultural productivity	-Opening stock–closing stock approach that accounts for the change (additions and reductions) in area under each land–use category. Land use categories analyzed were forests; net area sown; land under miscellaneous tree crop & groves; permanent pastures & other grazing land; land not available for cultivation; and cultivable wasteland -Case study approach to analyze land use changes due to mining and tourism -Agricultural productivity analyzed using data on crop area, yield and production of major		- No major land use change except for the year 1992-93, as per published data - Unpublished data indicate conversion of agricultural land to non-agricultural uses as follows: - DoA[a] : 684 ha - TCPD[b]: 1108 ha - Agricultural land conversion highest in coastal talukas, which are tourist attractions. - Land conversion caused by mining - 1045 ha of land brought under mining during 1988-97 - Agricultural production remained stable or marginally declined except for the year 1996-97		- Land use statistics for Goa not updated regularly -Inconsistent data from different sources

	Sector/Resource	Objective	Approach		Key results		Remarks
			Physical accounts	Monetary accounts	Physical accounts	Monetary accounts	
			crops				
2.	Forests	-Prepare asset accounts for forests -Estimate depletion due to production of timber and fuelwood and adjust the SDP	Opening stock-Closing stock approach that traces the changes in the forest stock due to - Additions: regeneration & reforestation/afforestation etc. and - Reductions- on account of extraction, deforestation and natural degradation from fires/ insect infestation	Net price method Physical quantities of reserves and changes therein valued at the prevailing average net price per unit of the resource	- No net depletion - Net increase in the forest stock of around 2% -Fuelwood : the major source of change in forest volume followed by diversion of forest area	- 2% rise in value of stock (Rs 554- Rs 567 crore in Scenario I in study period) - Value of stock in 93/94 : Rs. 3246-5299 crore if some environmental amenities were included - Contribution of forestry to SDP underestimated by atleast 18% even when only timber and fuelwood production included	- Inconsistent data on fuelwood consumption from different sources - Alternative scenarios of fuelwood consumption Scenario I: DPSE estimates Scenario II: TERI estimates based on NSS data - Data on interstate movement of fuelwood needs to be nalyzed
3.	Iron ore	-Prepare asset accounts	Opening Stock-Closing stock	-Net Price method	- 26% decline in stock over study period	- At constant prices the value	-Sensitivity analysis

	Sector/Resource	Objective	Approach		Key results		Remarks
			Physical accounts	Monetary accounts	Physical accounts	Monetary accounts	
		- Estimate the cost of depletion and adjust SDP	approach that traces the changes in mineral stock due to - Accretions : new discoveries and - Reductions- extraction, other factors like flooding, caving in of mine roof etc.	- User Cost method: decomposes resource rent into a *capital component* that needs to be reinvested to compensate for depletion; and an *income* component that can be consumed		of depletion at 6% rate of discount varied between Rs 27 crore in 92/93 to Rs 70 crore in 95/96. - As % of value added, depletion (at 6%) varied between 26%-45% - If some environmental costs of mining were included, the cost of depletion (at 6% rate of discount) in 96/97 rose from 37% to 41% of value added	carried out at three rates of discount (0%, 3% and 6%) to estimate user cost - Environmental costs as assessed in another study. These included groundwater depletion; loss of forests and agricultural land; health costs from air and water pollution; and decline in agricultural productivity.
			Physical accounts		Physical accounts		

	Sector/Resource	Objective	Approach		Key results		Remarks
			Physical accounts	Monetary accounts	Physical accounts	Monetary accounts	
4.	Transport sector-energy consumption and emissions	- Estimate fuel consumption - Prepare emission accounts	- Estimate source inventory (by type of vehicle) - Estimate fuel consumption using vehicle utilization & fuel efficiency norms - Estimate emissions using emission factors		- Two wheelers made up largest (70%) share of the fleet - 70% increase in vehicles over the study period - Largest increase in 'private cars and jeeps' (95%) followed by 'taxis and auto-rickshaws' (70%), and two-wheelers (65%) - 60% increase in estimated consumption of HSD, 68% in MS - 60% rise in emission of most pollutants - Two wheelers- largest source of CO, HC - Goods vehicles: largest source of NOx, SPM and SO_2		- Some discrepancy between estimated consumption and reported sales of diesel and MS
5.	Domestic sector-energy consumption and emissions	- Estimate fuel consumption - Prepare emission accounts	- Estimate fuel consumption by type (fuelwood, kerosene, LPG and electricity) based on NSS household consumption data and population estimates - Estimate emissions using emission factors		- Increase in the consumption of electricity (43% in rural and 153% in urban households) and LPG (180% in both urban and rural households) - 30% decline in the consumption of fuelwood - Kerosene consumption declined in urban areas (20%) but increased in rural (39%) - Decline in emission s due to shift towards cleaner fuels-total emissions of both CO and SPM declined by more than 20%		- Wide discrepancy between estimated consumption and reported sales of LPG and kerosene

[a] Directorate of Agriculture , [b] Town and Country Planning Department
HSD – High Speed Diesel, MS – Motor Spirit ; CO – Carbon Monoxide, HC – Hydrocarbons, NOx – Oxides of Nitrogen, SPM – Suspended Particulate Matter, SO_2 - Sulphur Dioxide

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Data Need For Solid Wastes Management
Including Hospital Wastes

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In the early days of our civilization the disposal of waste was not a serious problem as it is at present. This was mainly due to the fact that the availability of land for the assimilation of waste was large. But with the growing population the pressure on the land is increasing day by day and what to talk about availability of land for the assimilation of waste even housing needs in the metros and class "A" cities can not be fulfilled. However in the rural areas the availability of land and the type of wastes do not pose severe threat to the living conditions of rural masses but the practice of dumping wastes on roads and on the land of unconstructed plots or houses may cause epidemics. That is why we have to think how to manage the solid wastes properly and in the most appropriate way. In the context of urban places solid wastes can be classified into three broad categories:

1. Municipal solid wastes
2. Industrial Solid wastes
3. Hospital wastes

Municipal Solid Wastes It is basically heaps of garbage consisting of everyday items such as food scraps, papers, bottles, used batteries, packaging material etc. The proportion of different constituents of wastes depend upon the locality and season.

Industrial Solid Wastes Industrial wastes can be hazardous and non-Hazardous. Further, non hazardous wastes can be degradable and non degradable. Fruit processing industries, cotton mills, paper mills, textile mills, sugar mills etc. generate bio- degradable waste Thermal power plants, non ferrous metal industries, fertilizer industries etc. generate non-biodegradable waste.

Hospital Waste Waste generated from Hospital activities is considered as potentially hazardous. It includes wastes like sharps, soiled wastes, disposable anatomical wastes, cultures, discarded medicines, chemical wastes etc. Health care establishments in India were not giving due attention to their waste management. Realising the gravity of the issue the Central Board took up the matter in right earnest with the ministry of environment and forests. This led to the notification of Bio-medical waste (Handling and Management) Rules 1998. Now that there is legal binding on the health care establishments, they are slowly streamlining the process of waste segregation, collection, treatment and disposal. Many of the larger hospitals have either installed the treatment facilities or are in the process of doing so. As per the rule 1998 mentioned above, the Bio-medical waste has been grouped into the following categories.

i) **Human Anatomical Waste**: Human tissues, organs, body parts etc.

ii) **Animal waste :** Animal tissues, organs, body parts, carcasses, bleeding parts, fluid blood and experimental animals used in research, waste generated by veterinary hospitals, colleges, discharge from hospitals, animal houses.

iii) **Microbiology & Biotechnology Waste :** Wastes from laboratory cultures, stocks or specimens of micro-organisms, live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures.

iv) **Waste Sharps :** Needles, syringes, scalpets, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps.

v) **Discarded Medicines and Cytotoxic Drugs:** Wastes comprising of outdated, contaminated and discarded medicines.

vi) **Soiled waste:** Items contaminated with blood and body fluids including cotton. dressings, soiled plaster casts, linens, bedding, other materials contaminated with blood.

vii) **Solid waste:** Wastes generated from disposable items other than the waste sharps such as tubings, catheters, intravenous sets etc.

viii) **Liquid waste:** Waste generated from laboratory and washing, cleaning, house-keeping and disinfeeting activities.

ix) **Incineration Ash:** Ash from incineration of any bio-medical waste.

x) **Chemical waste:** Chemicals used in production of biological, chemicals used in disaffection, as insecticides, etc.

<u>Data needs for solid wastes Management</u> So far as the availability of data in this sector is concerned, very little data is available and that too is on the basis of some studies and surveys. A system should be established to obtain the statistics of Municipal waste, Hospital waste and industrial wastes. Data is also required for the assessment of various components of the solid wastes of a particular place. As per report of High Power Committee on Urban solid waste management in India, 1995 there are no reliable figures available on the quantum of waste generated per bed per day either out patient or inpatient care in Indian hospital. In USA amount of hospitals waste generated is 6670 tones per day that is 10% of the 158 million tones of municipal waste produced annually. The per patient per day hospital waste varies from 1 Kg. to 5 Kg. Currently USA Hospital designate 15% of their total hospital waste as infectious waste. In India if we consider 1 Kg waste is generated per day per bed then about 7 lac Kgs of hospital waste is generated by Indian hospitals.

However as per "Health Information of India-1993, published by Central Bureau of Health Intelligence, Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India", there are 596203 beds in health care sector in India. Assuming infectious bio-medical waste generation as 250 gm/bed/day, the estimated quantity of infectious bio-medical waste generated out of above numbers of beds is approximately 150 MT/day as on 01.01.1993.

Number of Beds and Estimated Quantity of Infectious Bio-Medical Waste in the Country as on 01.01.1993

S. No.	States/Union Territories	*Total no. of beds	#Estimated quantity of infectious bio-medical waste generation (Kg/day)
1	Andhra Pradesh	26791	6698
2	Arunachal Pradesh	2476	619
3	Assam	12661	3164
4	Bihar	29090	7273
5	Goa	3644	911
6	Gujarat	58984	14746
7	Haryana	7028	1757
8	Himachal Pradesh	3852	963
9	Jammu & Kashmir' 89	8202	2051
10	Karnataka	37929	94811
11	Kerala	77199	19300
12	Madhya Pradesh	18141	4534
13	Maharashtra	78920	19730
14	Manipur	1561	299
15	Meghalaya	1867	467
16	Mizoram	1304	326
17	Nagaland	1050	263
18	Orissa	14494	3624
19	Punjab	14671	3668
20	Rajasthan	20465	5115
21	Sikkim'92	575	144
22	Tamil Nadu'86	48780	12195
23	Tripura	1730	433
24	Uttar Preadesh'86	47278	11820
25	West Bengal	54767	13692
26	A & N Islands	576	144
27	Chandigarh	500	125
28	Dadra & Nagar Haveli	70	18
29	Daman & Diu'92	150	38
30	Delhi	18770	4693
31	Lakshadweep	70	18
32	Pondicherry'92	2608	652
	Total	596203	149051

*Source: Health Information of India-1993, Central Bureau of Health Intelligence, Directorate General of Health Services

Assuming infectious bio-medical waste generation as 250 gm/bed/day.

It is also very essential to separate general waste and Bio medical waste from the doorstep of hospital; for example the empty cartons of medicines purchased by the hospital fall under general waste. Similarly the solid wastes of a canteen operated inside a hospital also fall under general waste. Therefore, it is advisable for local municipal corporation to collect general waste from the doorstep of hospital. It is also advisable the Bio medical wastes of hospital which have been categorised in the rules 1998 should be kept in a separate specific colored container.

While hospitals are considered to be the primary generators of medical waste, there are other agencies too which generated quite a large quantity of Medical waste such as Nursing Homes, Private Physicians, home care provision diagnostic labs etc. Few data are available regarding compositions of hospital waste although it is heterogeneous mixture of many materials such as plastic (14% by weight), dry cellublosic solid (45% by weight), wet Cellublosic solid (18% weight), noncombustible (20% by weight) and others.

In order to assess the waste generation and management practices in different hospitals of Lucknow, a waste quantification was carried out by a team of Central Pollution control Board etc. in three types of hospitals run by Government, private and missionary.

A <u>Government Hospital</u> Infectious and non-infectious waste are being dumped together within the hospital premises. Present waste management practice is to collect all type of waste in common bin, which is placed outside the ward. From there it is taken to disposal point within premise near roadside. Finally hospital depends on mercy of corporation who generally lifts it 2-3 days frequency. Hospital is not having any treatment facilities for infectious solid waste and liquid waste. It was observed that hospital disposing their laboratory waste into the municipal sewer without proper destruction of pathogens, which finally reaches to River Gomti.

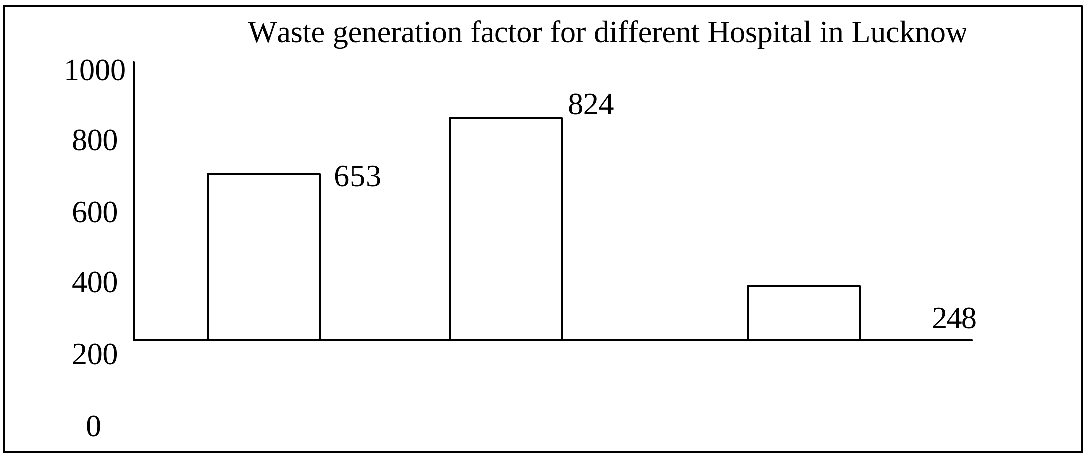
It was seen that hospital is openly dumping their waste and making them freely accessible to rag-picker who used to collect infectious waste.

B <u>Private Hospitals</u> Existing management practice is to collect all type of waste and take to roadside where it is finally lifted to outskirts of city through contractor. This hospital is not equipped with any treatment of Bio-medical waste. Liquid waste generated from pathological laboratory is flushed into the sewer without any proper treatment. In this hospital, waste segregation has not come into practice due to non-awareness about Bio-medical rule. Hospital administration is careless in waste management.

C <u>Missionary Hospital</u> The hospital administration has attempted to segregate the waste at source. Separate bins are provided for collection of glassware, disposable and soiled waste which bear the name. Needle destroyer is provided to inactivate/destroy the needle. The hospital administration is aware of the rules and taken steps to provide better treatment facility. Hospital waste is being incinerated in diesel fired incinerator.

Safai Karamcharis are provided with protected gloves and shoes during collection and disposal. Liquid waste generated from the laboratories have been found to be disinfected. Left over human organs usually preserved in formaldehyde after pathological examination, was buried in backyard 3 feet underground. It was observed that Glass slides and test tubes, which are frequently reused in laboratory was cleaned up regularly, disinfected and heated at a high temperature to make them infection free.

Waste Generation Factor Quantification of infectious waste was carried out in the above hospitals for 3 days. The objective was to develop WGF for different type of hospitals. During quantification in Govt. Hospital, the waste was not segregated at source due to lack of sufficient number of bins and staff and waste was quantified at outskirts of hospital.



Common Management practices in Hospitals of Lucknow Lucknow Nagar Nigam has installed the incinerator for treatment of Bio-medical waste but no separate team/committee/Authority has been formed for collection, treatment including transportation of waste from door step of hospitals. Only 4 hospitals in Lucknow are equipped with incinerator for their waste treatments but none of them are operational except one at SGPGI. Not a single, hospital/nursing home is following any guideline as prescribed in notification. Infectious waste is being mixed with garbage and finally disposed to outskirts of city. Many govt. hospitals and other were found to store infectious waste alongwith other waste for 4-5 day without any treatment at their premises. Such carelessness finally poses threat to human health. Community rag picker are themselves exposed to various disease due to callousness of hospital. Similarly, Municipal Corporation is taking waste from the private nursing home without any treatment given by hospital authority.

Conclusion On the basis of study, it can be concluded that

- The waste generation factor depends on medical facilities provided and management practices adopted by the hospitals.
- Private hospitals are generating the Bio-Medical waste in the range of 650-825 gm/bed/day without any waste management practice.
- The government hospitals were found to generate 220-250 gm/bed/day without any waste management practice.
- In missionaries' hospitals, some efforts have been noticed to manage the bio-medical waste.

The bio-medical waste generated from the hospitals can be managed properly if we are able to develop awareness amongst the health care professionals working in the hospitals and playing key role in generation of bio-medical waste making them responsible for proper segregation of bio-medical waste at the source of its generation.

Each and every hospital will have to develop Management strategies for bio-medical waste and should also make efforts to minimize the quantum of bio-medical waste.

The hospitals should also try to share the facilities on Zonal basis NGO's and private sector should come forward for creation of common treatment facilities. Industries should come with technology for bio-medical waste. The technology that will be cost effective safe and echo-friendly.

Data Need for Assessment of Agro -Environmental Pollution

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Modern agriculture largely depends upon soil fertilizer, pesticides, water and the crop to be grown. Mechanization of agriculture enables to decrease the labour intensity and hard manual work but on the other hand, modern existing technical systems can cause air, water, soil and the biota pollution. In addition, the crop production engineering have a great influence on soil erosion, soil compaction and chemical pollution. The problem of soil degradation has resulted from the impact of agricultural machinery chassis and application of chemicals. To slow down a further deterioration of soil is a difficult, long term problem, as the soil has to be not only conserved but also improved in order to meet the needs of the future generations. Yield per unit time and land has increased markedly during the last years in crop production, a result intensified crop management involving improved germplasm, greater inputs of fertilizers and pesticides, production of two or more crops per year on the same land and irrigation. Meeting future food demand while minimizing expansion of cultivated area will depend primarily on continued intensification of these same four systems. At present, the rate of increase in yield potential is much less than the expected increase in demand. Achieving consistent production at these high levels without causing environmental damage requires improvement in soil quality and precise management of all production factors in time and space. Therefore, the research and development of new ecological friendly technical systems, is and will continue to be the major importance in developing sustainable agriculture. But erratic use of chemicals, water and fertilizers is making the agro-environment polluted. Recently the present day society is much more concern about the pollution. Unfortunately , the extent and the intensity of pollution caused by different practices in agriculture are not attended in a systematic fashion. However, a lot of research work has been carried out in relation to agro-environmental pollution but the data of those research works are not pooled out systematically in which assessment of the level of pollution can be done properly. A huge amount of data is needed for assessment of the extent of pollution considering all aspects of agro-environment. It would be worth mentioning here that still all spheres of pollution related to agro-environment are not attacked by scientists.

Data need for assessment of fertilizer pollution

With the invent of high yielding varieties of crops, fertilizer consumption has been increased many fold. The nitrogenous fertilizer are used abundantly and haphazardly in our country for improved crop production without keeping in mind the extent of pollution that can cause so many problems to the society particularly to the mankind. Uncontrolled use of nitrogenous fertilizer can cause different human diseases like Al-Alzheimer Perkinsonism, Blue baby syndrome (Methemoglobinemia), respiratory troubles, skin diseases and above all the cancer in different forms, leachable nitrate (NO_3) nitrogen form is poisoning the under ground water tremendously. Nitrate nitrogen may be found 27 m below the substratum. Again, the pottable water may contain higher concentration of nitrate-nitrogen which can cause human injury through direct consumption. Therefore, at least the following data are needed for assessment of pollution caused by improper fertilization of soils.

i. ***Detailed survey data of the level of nitrate nitrogen in ground water all over the country***
ii. Detailed data of nitrate concentration is pottable water throughout the country.
iii. Nitrate concentration in fodder and vegetable crops under different agro-climatic situation particularly in N-fertilized soil system.

Like macro-nutrients heavy metals particularly Cr, As, Pb, Hg were found to pollute the agricultural environment. Although all these elements are not added to soil through fertilizers but may come into the soil system through sewage, sludge particularly in cities and suburb areas. The element As may present in under ground water in toxic amount. Vegetables grown in these areas contain toxic levels of heavy metals which lead to cause some chronic diseases when consumed by human beings. Systematic data of such type of pollution caused by heavy metals are lacking . Therefore, following data are needed for assessment of heavy metal pollution.

i. Micro level survey data of Arsenic concentration in ground water throughout the country.
ii. Heavy metal concentrations particularly Cr, Pb and Hg levels in vegetable crops which being cultivated in swedge-sludge added soil systems.
iii. Regular monitoring data of Boron content of the irrigation water used by the farmers.

Apart from the above , data of the radio active isotope elements which are contaminating the agricultural lands are lacking. Therefore, a detailed survey data of the contamination caused by radio active wastes particularly when used as land fills are needed to assess this type pollution of soil.

Data need for assessment of pesticidal pollution

Till date more than 10,000 species of insects, 600 weed species, 1500 plant diseases, 1500 species of nematodes are known to be injurious to humans, animals and plants. Since early Greek civilization chemicals have been used to control these pests. With the invent of synthetic pesticide in the middle of the twentieth century, the use of chemicals become wide spread.

Pesticides have provided many benefits to the society. They have helped to control mosquitoes and other vectors of human diseases. Pesticides reduce the spoilage of food. But on the other hand, these pesticides move into the soil and pollute the agro-environment particularly those are not readily biodegradable, Moreover, plant residues containing these chemicals are consumed by such soil organisms as earthworms, the chemicals concentrate in the earthworm bodies. When birds and fish eat the earthworms, the pesticides can build up further to lethal levels.

It is reported that vegetables, fruits and even fishes are containing the lethal level of residual pesticides which are causing not only different human hazards but also polluting the future agro-environment as a whole.

Although a significant amount of research works have been conducted in order to estimate the extent of pollution through pesticidal application in soils and crops but till date no systematic efforts have been made to record all these data in a simple volume in which the intensity of pollution by this factor can be assessed. Apart from that more data are needed in another direction to assess the pesticidal pollution caused to the society. These data will be related to :

i. Detailed survey data of the pesticide concentration in under ground water upto block level.
ii. Residual concentration of pesticides in different crops particularly in vegetables and fruits which are directly consumed by human beings.
iii. Residual pesticide levels in soil after the harvest of a particular type of crop.
iv. The amount of organic manure used now-a-days to rectify the pesticidal pollution.
v. Resistance developed to soil microorganisms due to hapazard use of pesticides.

Data need for assessment of salinization :

Contamination of soils with salts is one form of soil pollution which is primarily agricultural in nature. Salts built up in irrigated soils. Salts accumulate in soils because more salts move into plant rooting zone than move out. This may be due to application of salt ladden irrigation waters or it may be caused by irrigating poorly drained soils. Salts move up from the lower horizons and concentrate in the surface soil layers.

In India about 7.0 M hectares of land are salt affected and these areas are increasing rapidly day by day due to inundation of sea water, improper use of irrigation water as well as poor drainage system and squeezing the cultivable land. No systematic study has been conducted to generate data with respect to pollution caused due to salinization. Therefore, the following data are required to assess the quantum of pollution caused by salinization :

i. Land area becoming saline every year due to improper use of irrigation water.
ii. Factors causing the problem of salinization
iii. The extent of loss of forest or crop vegetation as well as cultivable land due to inundation of sea water.

Data need for assessment of soil sedimentation

Degradation of natural resources possesses a serious threat to human life on earth. Precious natural resources like soil and water are not exploited scientifically in our country. Of the total area, about 187 M ha has been affected by various land degradation problems supposed to loss of nutrients 5.37 to 8.4 M tonnes. Pollution caused by soil sedimentation modifies the agro-environment . Suspended sedimentation is usually eroded top soil, the most fertile portion of the soil. The eroded top soil is deteriorated and may carried away by water to some other fertile soil where it becomes a liability. Water reservoirs can be filled by sediments, decreasing their storage capacity. Suspended solids reduce sunlight penetration into water thereby reducing microscopic sized organisms. Sediment on land can cover good soil with poor or even rocky debris. Therefore soil sedimentation is also creating pollution problem in other ways to the agro-environment. The following research data are needed in this field to asseses the extent of pollution by soil sedimentation.

i. In general how much of areas of land are eroded every year particularly due to water erosion.
ii. In general, how much areas of cultivable land are wasted due to soil sedimentation.

iii. What is the fertility level of the eroded soil as well as sedimented soil.
iv. Due to sedimentation how many ponds, basins and ditches are becoming unusable for agriculture.

All those discussed above, are some of the contaminants that pollute the agro-environment . Still there are so many other pollutants which directly or indirectly pollute the agro-environmental scenario. Data of those research areas which have been touched or untouched are needed for assessment of the agro-environmental pollution. Data related to the following areas are to be recorded to assess the agro-environmental pollution in detail.

** Jute is rotten in stagnant fresh water for extraction of fibre from the sticks. Data are not available to know how much amount of fresh water in these areas are polluted due to jute fibre extraction and what is extent of pollution with respect to agro-environment.

** Reports are needed to know the quantum of surface water used either from pond, river or any other ditches for agricultural purposes throughout the year. Data are not also available with respect to consumption of ground water for agricultural use.

** There is steady decline in the level of ground water as well as total number of tanks, ponds and ditches etc. which are earlier in use for agricultural purposes. An estimation of decline of water in these areas of agriculture over the years is of utmost important to register the agro-environmental pollution.

** Data are required to know the decay in the depth and area of wet lands which are generally used for rice cultivation in the country.

** Constant data are needed to make a comparison in decay of water bodies and water flow passages in earlier days with that of the present time and to focus the future problem in this regard.

** The rate of decline in paddy field due to paddy-fish culture which are disbalancing the agro-ecosystem. Research data are needed in this area of agriculture. It is also reported that some of the species of the fishes are about to extinct. It is desirable to know the extent of decline of these species from the nature.

** Mechanical ploughing goes to more depth and hence surface soil becomes loose in rainy season and a quantity of soil gets washed off. Data are needed to estimate the extent of this washed off soils to know the decline in fertility level of the eroded soils as well as the quantum of the sedimented soil.

** Due to construction of new railway lines and metal roads the cultivable lands are decreasing with time. Again, adjacent to these railway lines and roads, the ditches which temporarily hold water are not available now-a-days. The decline in land and water sources should be measured in order to estimate the extent of pollution in this area.

** The rapid growth of population leads to construct buildings for dwelling purposes which in turn decreasing the land as well as soil resources. Again, the bricks prepared from soils are not inter convertible and biodegradable and hence polluting the agro-environment. An estimate in this vital aspect of pollution should be done with time. The agricultural lands converted to brick fields and other industrial use particularly at the riverside should be measured, the data of which will be of immense help to know the extent of pollution in this area.

** Destruction of natural crop sequence (like pulses after cereals etc.) due to project oriented cultivation practices (like growing of early variety vegetable etc.) is creating problem in the agriculture sector. Data related to such area are not available.

** Irrespective of qualities, rapid growth of a particular crop may earn immediate profit but in the long run peoples demand for quality may lead to ruin the agro-product eg. tea, pineapple in hilly or terai areas.

** Data about recent trend in conversion of small agricultural lands into quick growing forestry (like subabul, sudan cotton , silver pine, Acacia etc.) are not available. Quantitative study of removal of soil nutrients by these forest products from adjacent lands are not measured.

** Repeated cultivation on the same land by not allowing any current fallow causes disturbances to cattle, goats. These cattles can improve the soil fertility through their excreta. But now-a-day this grazing facilities in irrigated agricultural are decreasing due to lack of fallow lands which in turn disbalancing the agro-environment. A measurement of pollution in these areas can be made.

** Intensive cultivation of waterlogged paddy generating Methane along with other gasses which disturb the ozone shields and encouraging penetration of ultra violet rays in the earth and pollute the environment . An estimation of the extent of pollution in these areas are urgently needed.

** Easy availability of pesticides leads to the destruction of not only agriculture but also livestock particularly due to hazardous use, sometimes even causes homicide. Data related to this matter is not available.

** Excess production of food grains and vegetable crops leads to the production of huge agro-waste due to lack in market facilities. These wastes are polluting the agro-environment to some extent. Data with respect to the extent and type of pollution by these wastes are unknown.

Pollution of agro-environment is of great concern in present day society. But the nature and extent of pollution in this areas are not well documented. If database of the extent of pollution is made then only control measures can be adopted efficiently and effectively. By this paper an effort has been made to highlight the need of data for assessing the extent of agro-environmental pollution in the country. No doubt more subjects are left behind in these areas. Generation and documentation more of data in this line will help in tackling the agro-environmental pollution in a better way in future days.

Data Need for the Assessment of Environmental Problems in the Area of Agriculture

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INTRODUCTION

"The world is made for man, not man for the world" Francis Bacon wrote 400 years ago. The unprecedented increase in population and in the scale and intensity of human activities over the past century have reached a point where they are impacting on the resource and life-support systems on which human life and well being depend. Our fate is literally in our own hands. What we do or fail to do in managing the processes by which we are shaping our future will be its principal determinant.

Agriculture is the main activity of natural development on land. The modern 'growth models' forced farmers in general and Indian farmers in particular to shift their cultivation practices. Though this increased production rapidly it was soon seen to be unsustainable. All these landed Indian farmer at a crossroad. 100 million Indian farmers have contributed significantly in producing food for nearly one billion people and livelihood for 700 million people of the country. We could move from food shortage to self-sufficiency and then to export.

Agricultural statistics is also growing along with the development of Agriculture. In order to achieve the goal of an economically sound and stable society through environmental friendly system of agricultural production, it is essential to have a sound and well knit statistical system for collecting, compiling, analysing and desciminating data. In the present Agricultural Statistics Scenario, the data is only available at district/block level. A comprehensive data storage system at small area is also essential for assessing environmental problems in the area of Agriculture.

HISTORY OF AGRICULTURAL STATISTICS SYSTEM

India has a well-established and internationally acknowledged Agricultural Statistics System. It is a decentralised system with the State Governments – State Agricultural Statistics Authorities (SASAs) to be more specific – playing a major role in the collection and compilation of Agricultural Statistics at the State level while the Directorate of Economics and Statistics, Ministry of Agriculture (DESMOA) at the Centre is the pivotal agency for such compilation at the all-India level. The other principal data-gathering agencies involved are the National Sample Survey Organisation (NSSO), and the State Directorates of Economics and Statistics (DESs).

The Agricultural Statistics System is very comprehensive and provides data on a wide range of topics such as crop area and production, land use, irrigation, land holdings, agricultural prices and market intelligence, livestock, fisheries, forestry, etc. It has been subjected to review several times since independence so as to make it adaptive to contemporary changes in agricultural practices.

The Technical Committee on Coordination of Agricultural Statistics in India (1949) under the Chairmanship of Shri W.R.Natu was the first to examine the Agricultural Statistics System after independence. It mainly focused on standardising concepts and definitions, devising uniform forms of returns for collection of data and suggesting the scope of enquiry in respect of areas where the system of land records did not exist. The Committee also suggested among other measures, a pattern of organisation for collection of Agricultural Statistics at different levels.

The National Commission on Agriculture (1976), while critically reviewing the entire range of Agricultural Statistics made far-reaching recommendations to lay a strong foundation for statistical operations and to help the Government in formulating appropriate strategies.

While reviewing the functions of the Central Statistical Organisation (CSO) with reference to different sectors of the economy, the High Level Evaluation Committee (1983) under the Chairmanship of Professor A.M.Khusro, brought to light important data gaps including methodological gaps and made a number of recommendations to improve the system. It emphasised the need for building up a strong database for Agricultural Statistics so as to aid planning and policy formulation. It also identified newly emerging areas such as crop estimates at the local-level Community Development Block (C.D.Block), and crop forecasting and recommended development of suitable methodologies for quantitative measurement of important parameters in those areas.

The recent Workshop on Modernisation of the Statistical System in India (1998) considered various measures required to modernise the system by identifying the lacunae, and suggested the use of latest techniques including information and communication tools to improve the timeliness, reliability and adequacy of Agricultural Statistics.

The National Statistical Commission took note of the findings and recommendations of all these important bodies in the context of the prevailing status of Agricultural Statistics and attempted a fresh analysis focusing its attention on an identification of the deficiencies of the system and the remedial measures required to set them right. The Commission was assisted in this task by detailed documentation furnished by the Secretariat and the Central and State Government agencies. It also benefited from personal interaction with the representatives of these agencies. The Conference of Central and State Statistical Organisations (held in October 2000) also provided valuable inputs on the issues under consideration.

DEVELOPMENT OF ENVIRONMENT STATISTICS AND INDICATORS

The United Nations Statistics Division (UNSD) provided a broad Framework for Development of Environment Statistics (FDES) in 1982. The FDES provides a useful approach for the development and organisation of Environment Statistics. It comprises five broad components namely, biodiversity, atmosphere, land/soil, water and human settlements. In India, a multidisciplinary Working Group was constituted in July 1986 under the Director General, CSO with members from Central and State Governments and research institutions, for suggesting a list of variables to be included in FDES. The FDES for the country was prepared based upon the broad framework provided by UNSD and was officially adopted in 1997. Based on this framework, the CSO brought out a Compendium of Environment Statistics in 1997 and this has now become an annual publication of CSO. The Compedium provides valuable information on the present status of the five broad components of environment identified by UNSD. Apart from the CSO, various ministries and departments of Central and State Governments collect information related to Environment Statistics and the same are published in various publications namely, Forestry Statistics, The State of Forest Report, Inventory of Forest Resources of India, State Environment, etc. by organisations within the Ministry of Environment and Forests; Agriculture Statistics at a Glance and Fisheries Statistics by the Ministry of Agriculture; Water Statistics by Ministry of Water Resources, etc. Most of these publications are annual, but the time lag in bringing out the publications in respect of the Ministry of Environment and Forests is about 3 to 5 years. Information on some indicators is also being collected by other agencies like the Central Pollution Control Board, Registrar General, Ministry of Urban Development, Tata Energy Research Institute, etc. the Ministry of Environment and Forests has established in 1982 an Environmental Information System (ENVIS) (Appendix I) for maintaining information on various aspects related to environment. As environment is a multi-disciplinary subject involving complex subjects like bio-diversity, atmosphere, water, land and soil and human settlement, it is very difficult to collect and analyse data and study inter-relationships. There are several agencies for collection and analyse data and study inter-relationships that could meet the growing demand of various stakeholders, both Government and non-Government as well as outside agencies for environmental data.

The United Nations in 1997 has suggested a list of indicators on environment for which a regular set of information needs to be maintained. The selection of environmental indicators relevant to environmental phenomenon of each country is a crucial activity in any environment statistics programme. The selection of such indicators should be made in close collaboration between data users and producers. As a part of the Asian Development Bank's Project in 1996, a suggestive list of environment indicators (Appendix II) required to be maintained by India, was recommended.

SUSTAINABLE ECONOMY AND ENVIRONMENTAL CONCERNS

Our generation has to make an immediate choice between building sustainable economy and living with an unsustainable one till it declines. Caught up in this economic excitement, we seen to have lost sight of the deterioration of environmental systems and resources. At the dawn of the new century several well-established environmental trends are shaping the future of civilisation like population growth, rising temperature, falling water tables, shrinking cropland per person, collapsing fisheries, shrinking forests, and the loss of plant and animal species.

If world grainland productivity, which climbed by 170 per cent over the last half-century, were to rise rapidly over the next half-century, the shrinkage in cropland area per person might not pose a serious threat. Unfortunately, the rise is slowing. From 1950 to 1990, world grain yield per hectare increased at more than 2 per cent a year, well ahead of world population growth. But, from 1990 to 1999, it grew at scarcely 1 per cent a year. While biotechnology may reduce insecticide use through insect-resistant varieties, it offers little potential for raising yields.

The greatest challenge for humanity is to protect and sustainably manage the natural resource base on which food and fibre production depend, while feeding and housing a growing population.

DATA ON LAND AND SUSTAINABLE AGRICULTURE

Land degradation and soil loss threaten the livelihood of millions of people and future food security, with implications for water resources and the conservation of biodiversity. There is an urgent need to define ways to combat or reverse the worldwide accelerating trend of soil degradation, using an ecosystem approach, taking into account the needs of populations living in mountain ecosystems and recognizing the multiple functions of agriculture. The greatest challenge for humanity is to protect and sustainably manage the natural resource base on which food and fibre production depend, while feeding and housing a population that is still growing. The international community has recognized the need for an integrated approach to the protection and sustainable management of land and soil resources, as stated in decision III/11 of the Conference of the Parties to the Convention on Biological Diversity, including identification of land degradation, which involves all interested parties at the local as well as the national level, including farmers, small-scale food producers, indigenous people (S), non-governmental organizations and, in particular, women, who have a vital role in rural communities. This should include action to ensure secure land tenure and access to land, credit and training, as well as the removal of obstacles that inhibit farmers, especially small-scale farmers and peasants, from investing in and improving their lands and farms.

DATA ON LAND DEGRADATION

Various agencies have been involved in building up data on Land Degradation. The Space Application Centre (SAC) is already at an advanced stage with the approach of Remote Sensing through Forecasting Agricultural output using space, Agro-meterology and land Land based observations (FASAL). Data on Land Degradation can also be collected through the land-based observations. The Ministry of Agriculture, Government of India and National Crop Forecasting Centre (NCFC) may contribute in this area by collecting data on land degradation. The National Bureau of Soil Survey and Land Use Planning, Nagpur under ICAR has already furnished land degradation data on 1:250,000 Scale for the states and the country as a whole. It is also learned that further retirement on the existing mapping on 1:4.4 million scale under Global Assessment of Soil Degradation (GLASOD) guidelines. As per the latest data available nearly 150 million hectares of land are degraded constituting 54.6 percent of total geographical area. The areas suffering due to water and wind erosion are 109.7 and 11.7 million hectares respectively. The area under water logging, salinization/alkalization and other problems are 9.0, 9.2 and 10.3 million hectares, respectively.

LAND USE STATISTICS

At present in the existing pattern of Agriculture Statistics data on Land use are compiled either from village records or through EARAS Survey. Only nine fold classification is adopted under Land Use Statistics. They are

1)Forests 2) Area Under Non-agricultural use 3) Barren and uncultred land 4) Permanent Pastures and other Grazing land 5) Miscellaneous Tree Crops 6) Culturable waste Land 7) Fallow land other than current fallow 8) Current Fallow 9) Net area sown. The details are given in Appendex III

To have a detailed and environment friendly policy on Agriculture the data based on land utilization has to be widened. The vital information on social Forestry, marshy and water logged land, built-up land etc. are to be added. The land use Statistics collected by National Remote Sensing Agency (NRSA) according to a 22 fold classification can be used for such Policy Frame Work. The details of 22 fold classification is appended as Appendix IV. The introduction of the same in the TRS/EARAS surveys is a herculian task. Collecting one time data on all these parameters may be thought of. Periodical updation can also be introduced at five year interval. A separate scheme can be introduced in all TRS/EARAS States.

DECENTRALISED PLANNING PROCESS AND ASSESSMENT OF ENVIRONMENTAL PROBLEMS

Collection, compilation and disimination of data base on Agriculture in the environmental perspective would involve huge tasks for the co-ordinated efforts of statisticians, economist and environmentalists. The macro level data on Agricultural situation would only help to formulate policies at State or National level. After 73rd and 74th amendments in the constitution the country is heading towards decentralised planning. The exploitation of resources potential at micro level should be planned in accordance with the policy frame work under environment programme. A specific format for collection of environmental data and information should be designed at panchayat level or microwatershed level. This should be standardised aggregated and used for micro level environment planning and protection. The periodic analysis and reporting of environmental conditions and trends like

a) Biophysical environment.

b) Socioeconomic environment.

c) Natural disaster.

will help to adopt environmentally sound policies and environmental standards.

INSTITUTIONAL MECHANISM FOR ENVIRONMENT STATISTICS ON AGRICULTURE

An institutional mechanism under the ageis of State Departments of Economics and Statistics to collect and collat panchayat level data, on the following parameters, has to be established.

Table I

Land	Agriculture
Water	Population
Agricultural labour	Holdings Social group & gender wise
Socio-economic conditions of holders	Biological, Physical and Chemical characteristics of the atmosphere,
Hydrosphere	Lithosphere and biosphere
Geology	Bio/ego-chemistry
Resource capability/ potential etc	Physical properties
Bio diversity (diversity of flora, fauna, micro-organisms etc)	Changes in the environment & acid rain
Global warming	Land/water degradation
Natural disaster. (flood, drought, cyclone, earthquake, forest fires, land slides etc.)	The Climatic conditions
Temperature	Rainfall
Ground Water Resource	Humidity

Land for Agricultural use	Soil Condition
Agricultural Crops produces & vegetation	Genetic Species and rare species
Tribal population	Livestock population
Land use	Other Natural resources
Pesticide consumption	Fertilizer consumption
Percentage conversion of agricultural land to Industry	Degraded forest and woodland area
Percentage conversion of agricultural land to Settlements	Percentage conversion of agricultural land to Pastures
* Percentage conversion of agricultural land to Dams/reservoirs and	* Level of Contaminants/ Pollutants in the environmental media

as described in the ENEP/EAP-AP documents Standard Statistical Classification for Environment. UN/ESCAP, 1994 United Nations Economics Commission for Europe.

Bench mark data can be collected on the above variables at Panchayat level for the limited purpose of environment planning. This should not be combined for deriving any other estimates.

DATA ON MICRO WATERSHED LEVEL

The concept of integrated watershed development is that the development and management of the resources in the watershed so as to achieve higher production that can be sustained without causing any deterioration in the resource base or causing no ecological imbalances. This calls for the formulation and implementation of a package of programs for action for optimum resource use in the watershed without adversely affecting the soil and water base or life supporting system. The concept assume more importance in the context of planning for sustained development. The watershed development aim at preventing watershed degradation that results from the interaction of physiographic features, eliminate unscientific land use, inappropriate cropping pattern, soil erosion thereby improving and sustaining productivity of resources leading to higher income and living standard for the inhabitants in the watershed area. Therefore it involves restoration of the ecosystem and protecting and utilizing the locally available resources within a watershed to achieve sustainable development.

Watershed management, though less focussed earlier, has a history of about 50 years in India. Multiple agencies have been involved in the growth and development of watershed programmes. Biophysical aspects of watershed management were first started in the Damodar-Barakar basin under Damodar Valley Corporation, Hazaribagh by establishing a Soil Conservation Department during 1949-50. The focus on watershed research was further sharpened with the establishment of a network of Soil Conservation Research Demonstration and Training Centres at Dehra Dun, Chandigarh, Agra, Kota, Vasad, Hyderabad, Bellary and Ootacamund (now Udhagamandalam) by the Union Ministry of Agriculture in 1954 to provide necessary research back up and trained manpower and these centres become part of the Indian Council of Agricultural Research (ICAR) in 1969.

These Research Centres established 42 small research watersheds for monitoring surface water hydrology, natural vegetation successions, impact of biotic interferences, etc., during 1956. The Centrally sponsored scheme of "Soil Conservation in the catchments of River Valley Projects" was launched by the Soil and Water Conservation Division of the Union Agriculture Ministry in 1961-62 for watershed protection in 27 catchments (Table 3). Watershed technologies were first demonstrated in actual field through the eye opening model Operational Research Projects (ORPs) on watersheds at Sukhomjri (Haryana) representing Shiwalik foot hills, Fakot (U.P.hills) representing middle Himalayas and G.R.Halli (Karnataka) representing red soils of low rainfall region. The people's participation was the key to the success of these projects. During this period between 1980-81, watershed programmes were initiated under Flood Prone Rivers Project by the Soil and Water Conservation Division of Union Agriculture Ministry.

Table 2

Growth of nationally and internationally funded organized Watershed management programmes in India

Schemes/ Projects	Year of launch	Watershed Nos./area	Sponsoring Agencies
1	**2**	**3**	**4**
Research Watersheds	1956	42 Nos.	Min. of Agri., GOI/CSWCRTI,ICAR
Soil Conservation in RVP catchments	1961-62	29 catchments in 9 States	Min. of Agri., GOI
Operational ResearchWatersheds	1974	4 Nos.	CSWCRTI, ICAR

Watershed Managementin Catchments of Flood Prone Rivers	1980-81	10 catchments in 8 States	Min. of Agri., GOI
Model Watersheds	1983	47 Nos.	CSWCRTI & CRIDA, ICAR
Watershed Development in Rainfed Areas	1984	28 Nos. (3.47 lakh ha)	World Bank (A.P., Karnataka, M.P.& Maharashtra)
Watershed Development in Ravines Area	1987	0.62 lakh ha	EEC
Drought Prone Area Programme (DPAP)	1987*	91 districts 615 blocks	MRAE, GOI
Desert Development Programme (DDP)	1987*	21 districts 131 block	MRAE, GOI
Western Ghats Development Programme (WGDP)	1987*	158 blocks 5 States	Union Planning Commission
Indo-German Watershed Project	1990-91	Maharashtra	Germany
Indo-German Bilateral Project	1990-91	Monitoring	Germany
NWDPRA	1991	2497 Nos.	Min. of Agri.,GOI
IWDP(Hills & Plains)	1991	1.12 lakh ha	World Bank
Comprehensive Watershed Development Project	1991	1.13 lakh ha	DANIDA (Karnataka, Tamil Nadu and Orissa)
Rel Majra Watershed Project	1991	1 No.	CSWCRTI, ICAR/Min. Of Env.,GOI
Doon Valley Project, U.P.	1993	1.72 lakh ha	EEC
Integrated Wasteland Development Project (IWDP)	1994	25 States	MRAE,GOI
Indo-Swiss Participatory Watershed Development	1995	0.35 lakh ha	Swiss Government

Attappady Wasteland Comprehensive Environment Conserva tion Project, Agali, Kerala	1996	507 Km 2	JBIC, Japan

MRAE – Ministry of Rural Areas & Employment

*Since Programmes adopted watershed appreach

Source: Sikka and Samra (2000)

As a result of the achievements and benefits of model ORPs, forty seven model watersheds were established in different agro-ecological regions of the country in 1983 for joint development by the Central Soil and Water Conservation Research and Training Institute (CSWCRTI) and Central Research Institute for Dryland Agricualture (CRIDA) of the Indian Council of Agricultural Research, State Governments and State Agricultural Universities (Dhryvanarayana et al., 1987). Based on the successful results of model watersheds in drought alleviation during the drought of 1987, number of nationally and internationally funded watershed development projects/programmes started (Table 1). Major nationwide watershed programmes included Drought Prone Area Programme (DPAP) and Desert 1987, National Watershed Development Programme for Rainfed Agriculture (NWDPRA) in 1991 and Integrated Wastelands Development Project (IWDP) on watershed basis since 1994. World Bank, DANIDA, EEC, German, Swiss and Japanese aided Watershed Projects are implemented in the country. Apart from these national/international level programmes, a number of State Government sponsored and NGOs supported watershed programmes subsequently started during eighties and nineties.

An attempt on pilot basis has already been made in Kerala and Kerala DES has conducted a Socio-Economic Survey at Amachal Watershed Project in Thiruvananthapuram district. All the parameters detailed in the previous paragraphs were not included in this survey as the same was done on RRA (Rapid Rural Appraisal) and PRA (Participatory Rural Appraisal methods and with in a limited time frame. Summary Findings of the same is appended as Appendix V. This can be improved further to suit the needs for assessing the environmental problems in the area of Agriculture.

Appendix I

Environmental Information System (ENVIS)

Realising the importance of Environmental Information, the Government of India, in December 1982 established an Environmental Information System (ENVIS) as a plan programme. It is a decentralised system with a network of subject oriented Centres ensuring integration of national efforts in environmental information collection collation, storage, retrieval and dissemination to all concerned. The focus of ENVIS since inception has been on providing environmental information to decision-makers, policy planners, scientists and engineers, research workers, etc. all over the country. ENVIS due to its comprehensive network has been designed as the National Focal Point (NFP) for INFOTERRA, a global environmental information network of the United Nations. Presently, the ENVIS network consists of a Focal Point at the Ministry of Environment and Forest and the 25 ENVIS Centres set up in different organisations/ establishments in the country in selected areas of environment. These centres have been set up in the areas of pollution control, toxic chemicals, central and offshore ecology, environmentally sound and appropriate technology, bio-degradation of wastes and environment management, etc.

2. The long-term and short-term objectives of the ENVIS are as follows:

Long-term objectives:

- To build up a repository and dissemination centre in Environmental Science and Engineering;
- To gear up the modern technologies of acquisition, processing, storage, retrieval and dissemination of information of environmental nature; and
- To support and promote research, development and innovation in environment information technology

Short-term Objectives:

- To provide national environmental information service relevant to present needs capable of development to meet the future needs of the users, originators, processors and disseminators of information;
- To build up storage, retrieval and dissemination capabilities with the ultimate objectives of disseminating information speedily to the users;
- To promote, national and international cooperation and liaison for interchange of environment-related information;
- To promote, support and assist education and personnel training programmes designed to enhance environment information processing and utilisation capabilities;
- To promote exchange of information amongst developing countries.

Appendix II

Suggestive List of Environmental Indicators as recommended by Asian Development Bank in its Project on Institutional Strengthening and Collection of Environment Statistics

I. FLORA

A. Threatened species as percentage of total native species

Flowering Plants

(a) Rare
(b) Vulnerable
(c) Endangered' endemic

Non-Flowering plants

(a) rare
(b) vulnerable
(c) endangered' endemic

B. Extinct species as percentage of total native species.

C. Possibility extinct species as percentage of total native species.

II. FAUNA

A. Threatened species as percentage of total native species

Vertebrates

(a) rare
(b) vulnerable
(c) endangered' endemic

Non-Vertebrates

(a) rare
(b) vulnerable
(c) endangered' endemic

B. Extinct species as percentage of total native species.

C. Possibility extinct species as percentage of total native species.

III. CONSERVATION MEASURES

A. Within habitats *(in situ)*
  (a) Bio sphere reserves
  (b) National Parks
  (c) Sanctuaries
  (d) Reserve forests
  (e) Other protected measures

B. Outside habitats (*ex situ*)
  (a) Botanic gardens
  (b) Gene banks
  (c) Others

IV. AIR/ATMOSPHER E

A. Ambient air quality in major cities

	Annual Average Ug/m3	24 hour average Ug/m3
(a) Concentration of SOx		
(b) Concentration of NOx		
(c) Concentration of SPM		

B. Emissions as per WHO National Standard (e.g.ppm.Ppv)

(a) CO
(b) HC
(c) Pb concentration
(d) CO2
(e) Others (e.g.CHs, CFCs, etc.)

C. Energy consumption

(a) Percentage of the households using different fuels for cooking
 (i) Cow dung
 (ii) Electricity
 (iii) Coal Coke
 (iv) LPG
 (v) Fuelwood
 (vi) Solar power
 (vii) Biogas
 (viii) Kerosene

(b) Electricity generation
 (i) Renewable (mgw)
 (ii) Non-renewable (mgw)

(c) Meteorological information
 (i) Rainfall
 (ii) Humidity
 (iii) Wind speed

(iv) Others

V. WATER

A. Fresh water

(a) Surface water
 (i) Rainfall
 (ii) River water quality standard
 -DO level
 -BOD level
 -COD level
 -Total solids
 -Coliform concentration
 -Heavy metal concentration

(b) Ground water
 (i) pH
 (ii) Turbidity
 (iii) Metal concentration
 (iv) Ar, F, Cl, NO3

B. Marine water

(a) Length of marine coastline (km)
(b) Area (sq. km)
(c) Population (m)
(d) Coastal vegetation
 (i) Mangroves as percentage of total forest cover
 (ii) Lagoons

(iii) Estuaries
(iv) Coral reefs
(e) Relative fragility, %
(f) Preservation area, %

V. LAND/SOIL

A. Land use (million ha)
(a) Geographic area (sq. km.)
(b) Reporting area for land utilisation

B. Forest areas
(a) Forests
(b) Not available for cultivation
(i) Non-agricultural
(ii) Barren and uncultivated land
(c) Other cultivated land
(i) Permanent pastures and other grazing land
(ii) Miscellaneous tree crops and groves
(iii) Cultivated wasteland
(d) Gross cropped area
(e) Cropping intensity.

C. Wetlands

D. Irrigated are

E. Soil erosion
(a) Percentage are
(b) Pesticide level
(c) Consumption of fertilisers (t)

F. Land area on waste disposal
(a) Industrial
(b) Municipal
(c) Hazardous
(d) Mining
(e) Others.

VI. HUMAN SETTLEMENTS

A. Total population
(a) Urban
(b) Rural

B. Population below poverty line
(a) Urban
(b) Rural

C. Slum population (class-wise)

D. Number and percentage of facilities
(a) Dwelling units
(b) Sanitation
(c) Drinking water
(d) Others

E. Urban agglomeration

F. Life expectancy and mortality rates and causes.

VII. NATURAL DISASTERS

A. Flood Periodicity affected population
B. Cyclones
C. Drought
D. Earthquake
E. Landslides
F. Avalanche
G. Typhoon
H. Others

VIII. OTHER ECONOMIC AND INSTITUTIONAL INDICATORS

A. Total expenditure
B. Expenditure for environmental protection
C. Percentage of national expenditure

Appendix III
Nine-fold classification of Land Use*

Statistics on land use are collected at present, in the form of a nine-fold classification on a yearly basis. Out of a geographical area of 329 million hectares (reporting area) statistics are available only from 305 million hectares (non-reporting area), which makes some areas to the extent of 7% still not covered or classifiable under the nine-fold classification. The reporting area is classified into the following nine categories:

1. **Forests:** This includes all lands classed as forest under any legal enactment dealing with forests or administered as forests, whether state-owned or private, and whether wooded or maintained as potential forest land. The area of crops raised in the forest and grazing lands or areas open for grazing within the forests should remain included under the forest area.
2. **Area under Non-agricultural Uses:** This includes all lands occupied by buildings, roads and railways or under water, e.g. rivers and canals and other lands put to uses other than agriculture.
3. **Barren and Un-culturable Land:** includes all barren and unculturable land like mountains, deserts, etc. Land which cannot be brought under cultivation except at an exorbitant cost, should be classed as unculturable whether such land is in isolated blocks or within cultivated holdings.
4. **Permanent Pastures and other Grazing Lands:** includes all grazing lands where they are permanent pastures and meadows or not. Village common grazing land is included under this head.
5. **Land under Miscellaneous Tree Crops, etc.:** This includes all cultivable land which is not included in 'Net area sown' but is put to some agricultural uses. Lands under Casurina trees, thatching grasses, bamboo bushes and other groves for fuel, etc. which are not included under 'Orchards' should be classed under this category.
6. **Culturable Waste Land:** this includes lands available for cultivation, whether not taken up for cultivation or taken up for cultivation once but not cultivated during the current year and the last five years or more in succession for one reason or other. Such lands may be either fallow or covered with shrubs and jungles, which are not put to any use. They may be assessed or unassessed and may lie in isolated blocks or within cultivated holdings. Land once cultivated but not cultivated for five years in succession should also be included in this category at the end of the five years.
7. **Fallow Lands other than Current Fallows:** this includes all lands, which were taken up for cultivation but are temporarily out of cultivation for a period of not less than one year and not more than five years.
8. **Current Fallows:** This represents cropped area, which are kept fallow during the current year. For example, if any seeding area is not cropped against the same year it may be treated as current fallow.
9. **Net area Sown:** This represents the total area sown with crops and orchards. Area sown more than once in the same year is counted only once

Appendix IV

Twenty two-fold Classification of Land Use*

The National Remote Sensing Agency (NRSA) conducted a land use survey using Remote Sensing Technique in the year 1988-89 at the behest of the Planning Commission in which they had classified the land by visual interpretation technique and digital techniques into twenty two-fold. The definitions of the 22 categories adopted by them are as follows:

1. Built up land

It is defined as an area of human habitation developed due to non-agricultural use and that which has a cover of building, transport , communication utilities in association with water vegetation and vacant lands.

Agricultural land

It is defined as the land primarily used for farming and for production of food, fibre, and other commercial and horticultural crops. It includes land under crops (irrigated and unirrigated), fallow, plantation, etc.

2. Crop Land

It includes those lands with standing crop (*per se*) as on the date of the satellite imagery. The crops may be of either *Kharif* (June-September) or *Rabi* (October-March) or *Kharif Rabi* Seasons.

3. Fallow land

It is described as agricultural land which is taken up for cultivation but is temporarily allowed to rest un-cropped for one or more seasons, but not less than one year. These lands are particularly those which are seen devoid of crops at the time when the imagery is tamen of both seasons.

4. Plantations

It is described as an area under agricultural tree crops, planted adopting certain agricultural management techniques. It includes tea, coffee, rubber, coconut, arecanut, citrus, orchards and other horticultural nurseries.

Forest

It is an area (within the notified forest boundary) bearing an association predominantly of trees and other vegetation types capable of producing timber and other forest produce.

5. Evergreen/Semi-evergreen forest

It is described as a forest, which comprises of thick and dense canopy of tall trees, which predominantly remain green throughout the year. It includes both coniferous and tropical broad-leaved evergreen trees. Semi-evergreen forest is a mixture of both deciduous and evergreen trees but the latter predominate.

6. Deciduous forest

It is described as a forest which predominantly comprises of deciduous species and where the trees shed their leaves once in a year.

7. Degraded forest or Scrub

It is described as a forest where the vegetative (crown) density is less than 20% of the canopy cover. It is the result of both biotic and abiotic influences. Scrub is a stunted tree or bush/shrub.

8. Forest Blank

It is described as openings amidst forests without any tree cover. It includes opening of assorted size and shapes as seen on the imagery.

9. Forest Plantations

It is described as an area of trees of species of forestry importance and raised on notified forest lands. It includes, eucalyptus, casuarina, bamboo, etc.

10. Mangrove

It is described as a dense thicker or woody aquatic vegetation or forest cover occurring in tidal waters near estuaries and along the confluence of delta in coastal areas. It includes special of the general Rhizophora and Aviccunia.

WASTELANDS

It is described as degraded land, which can be brought under vegetative cover with reasonable water and soil management or on account of natural causes. Wastelands can result from internal/imposed constraints such as, by location, environment, chemeical and physical prosperities of the soil or financeial or management constraints (NWDB, 1987).

11. Salt-affected land

The salt-affected land is generally characterised as the land that has adverse effects on the growth of most plants due to the action or presence of excess soluble or high exchangeable sodium. Alkaline land has an exchangeable sodium percentage (ESP) of about 15, which is generally considered as the limit between normal and alkali soils. The predominant salts are carbonates and bicarbonates of sodium. Coastal saline soils may be with or without ingress or inundation by seawater.

12. Waterlogged land

Waterlogged land is that land where the water is at/or near the surface and water stands for most of the year. Such lands usually occupy topographically low-lying areas. It excludes lakes, ponds and tanks.

13. Marshy/Swampy land

Marshy land is that which is permanently or periodically inundated by water and is characterised by vegetation, which includes grasses and weeds. Marshes are classified into salt/brackish or fresh water depending on the salinity of water. These exclude Mangroves.

14. Gullied/Ravenous land

The gullies are formed as a result of localised surface runoff affecting the friable unconsolidated material in the formation of perceptible channels resulting in undulating terrain. The gullies are the first stage of excessive land dissection followed by their networking which leads to the development of ravenous land. The word ‘ravine’ is usually associated not with an isolated gully but a network of deep gullies formed generally in thick alluvium and entering a nearby river, flowing much lower than the surrounding high grounds. The ravines, are extensive systems of gullies developed along river courses.

15. Land with or without scrub

They occupy (relatively) higher topography like uplands or high grounds with or without scrub. These lands are generally prone to degradation or erosion. These exclude hilly and mountainous terrain.

16. Sandy area (costal and desertic)

These are the areas, which have stabilised accumulations of sand in-site or transported in coastal riverine or inland (desert) areas. These occur either in the form of sand dunes, beaches, channel (river/stream) islands, etc.

17. Baren rocky/Stony waste/Sheet rock area

It is defined as the rock exposures of varying lithology often barren and devoid of soil cover and vegetation and not suitable for cultivation. They occur amidst hill forests as openings or scattered as isolated exposures or loose fragments of boulders or as sheet rocks on plateau and plains. It includes quarry or gravel pit or brick kilns.

WATER BODIES

It is an area of impounded water, areal in extent and often with a regulated flow of water. It includes man-made reservoirs/lakes/tank/canals, besides natural lakes, rivers/streams and creeks.

18. River/Stream

It is a course of flowing water on the land along definite channels. It includes from a small stream to a big river and its branches. It may be perennial or non-perennial.

19. Reservoir/Lakes/Tanks/Canal

It is a natural or man-made enclosed water body with a regulated flow of water. Reservoirs are larger than tanks/lakes and are used for generating electricity, irrigation and for flood control. Tanks are smaller in areal extent with limited use than the former. Canals are inland waterways used for irrigation and sometimes for navigation.

OTHERS

It includes all those, which can be treated as miscellaneous because of their nature of occurrence, physical appearance and other characteristics.

20. Shifting Cultivation

It is the result of cyclic land use practice of felling of trees and burning of forest areas for growing crops. Such lands are also known as *Jhum* lands.

21. Grassland/Grazing land

It is an area of land covered with natural grass along with other vegetation, often grown for fodder to feed cattle and other animals. Such lands are found in river beds, on uplands, hill slopes, etc. Such lands can also be called as permanent pastures or meadows. Grazing lands are those where certain pockets of land are fenced for allowing cattle to graze.

22. Snow-covered/Glacial area

It is snow-covered areas defined as a solid form of water consisting of minute particles of ice. It includes permanently as on the Himalayas. Glacier is a mass of accumulated ice occurring amidst permanently snow-covered areas.

Appendix V

Summary of Findings

The area of Amachal watershed covers wards of Amachal and part of Chadramangalam of Kattakkada Panchayat, Vellanand Block in Thiruvananthapuram District.

This survey covers all the households and all the holdings of the project area.

The main objective of this survey is to collect benchmark data of the project area on different parameters such as socio-economic status of the households, cropping pattern, etc.

The total geographical area of the Amachal Watershed project is 104.26 ha.

Net Area sown – 22141 cents which accounts for about 86%

Land under non-agricultural use 2798 cents.

Total cultivable area is 22953 cents

Total cultivated area is 22794 cents.

The project area indicates a multiple cropping pattern.

Coconut is the principal crop (59%)

Rubber (30%) Banana and other Plantain (13%) and Tapioca (13%)

Paddy area accounts for about 2.43% production 5.179 tonnes.

Coconut production is 198434 Nos. (Nuts)

Productivity of coconut in the project area is 3686 Nos. Per hectare, paddy 2333 Kg/ha, tapioca 17334 Kg/ha, plantain 4420 Kg/ha and Banana 10269 Kg/ha.

The total number of households in the project area is 510

The total population is 1984 persons. 49% are males and 51% are females.

Sex ratio is 1058 per thousand males.

Average size of family is 3.89

Out of the total 510 households 64.51% are Hindus, 26.47% Christian and 9.02% Muslim.

According to social group SC is 9.78% and ST 0.76%, OBC 43.19% others 46.27%.

Among the population age group below 6 years accounting 8%, 8-18 shares 23%, 19-55 group 56% and 56-65 and above accounted to 13%.

Out of total persons married accounted to 49.75% unmarried 40.53 and widowed and separated 9.72%.

Out of 1984 persons 1729 are literates whereas 96 are illiterates. 159 children are below aged 6 years.

673 persons have qualification above S.S.L.C and 1056 are below S.S.L.C.

50% of the population under income earning group earns their income from agriculture and allied sectors. 5% are self-employed and artisans and 8% are regular salaried persons.

Regarding the reasons for working out side the Panchayat 63.64% reported for high wages, whereas due to unemployment 30% remaining due to other reasons.

25 persons are handicapped by birth where as 39 persons are handicapped/disabled after birth. The disabled persons due to old age is accounted to 33 persons.

The health status of persons indicates that 1725 are free from serious diseases and 259 persons reported various diseases.

Out of 1984 persons 79 reported regular habit of drinking liquor. 246 persons are occasional users of liquor and 1659 persons are not in the habit of using liquor.

In the project area 471 house holds are having owned houses and 39 households are sharing with other households.

Out of 471 houses 151 houses are in good conditions. 159 are in partially good condition 127 houses are in poor conditions which included huts also. 34 houses are in dilapidated conditions.

404 houses are possessing independent latrine facilities and 67 houses are not having independent latrines.

As the source of drinking water of house holds well accounts to 95% and 5% other than well including public tap.

73% of houses are electrified and 27% are not electrified. Regarding the facilities/services such as pucca road, hospital, market, transportations, etc. are available within the range of 2 Km.

Distribution of households according to monthly consumer expenditure reveals that about 52% of the house holds come within the range of Rs.1000 to 3000, 19% in Rs.3001-4000 range and 20% earn Rs.4000/- and above. Only 9% fall below Rs.1000/-

341 households reported multiple sources of income. 775 households are having income from gainful activity. 114 households receive income from pension, rent and foreign receipts.

Households benefited with various income generating schemes of the different departments and agencies are analysed. Among those RDP rank Ist with 81 beneficiaries, Kudumbasree 2nd with 75, SHG with 62 and other Development programmes 47 beneficiaries.

The nature of assistance required by the households for income generating activities are also analysed. It reveals that most of the households preferred financial help. Assistance b y way of farm inputs and technical guidance, etc. are the other preferences.

Different loans from various agencies have been availed by the households in the project area for various purposes.

632 outstanding loans from various sources have been reported. Of which, 38% from co-operative institutions and 16% from Bank. 12% from money lenders and 4% from relatives and friends.

Complex trends are noticed in the purpose of loans. Among the purposes house construction and maintenance stands first with 33%, agriculture 21%, self-employment 17% domestic including ceremonial expenses 17% and education and medical stands the lowest with 12%.

The enquiry on the requirement of assistance of households for soil and water conservation work, contour bunding stands first with the preference of 279 households which includes 262 financial and 17 technical support. The terace bunding preferred by 130 households which includes 125 financial and 5 technical assistance.

Coming to the water conservation, financial assistance for irrigation well b y 66 cases and rainwater harvesting preferred by 46 and 33 in financial, 13 in technical assistance. The renovation of wells stands first under the water conservation work with 120 cases.

In the project area bovine cattle population that includes milch cows, buffallow accounted to 88 numbers whereas ovine includes goat, numbered to 72. Layers and fowls are accounted to 648.

The average monthly production of milk is estimated to 10200 leters.in the project area and egg production estimated to 6168 numbers. It also indicates that most of the households expressed their preferences in diary activities, milk production and other milk products and for that, they demand financial assistance.

Homestead/backyard poultry farm and egg production are the main choices of the households especially having small extent of land holding.

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Comprehending Technological Disasters in India

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ABSTRACT

An analysis of the technological disasters in India has been carried out on the basis of the OFDA/ CRED International Disaster Database, EM-DAT being maintained by the Universite' Catholique de Lonvain, Brussels, Belgium. Road transport remains the most hazardous activity in India, and there is an increase in the overall disaster related deaths. The Govt. of India, however needs to create its own technological disaster database, since the EM-DAT database has certain lacunae.

Introduction

In the era of fast advancing technology, the recurrence of disasters has become a common phenomenon. Though, the developed countries are paying a great deal of attention to comprehend this menace and to formulate policies leading to disaster mitigation [1-3], the developing countries are still lagging far behind. As a consequence, substantial amounts of resources are lost in enforcing a *status quo* in developing countries after disaster occurrence, thereby leading to their increased marginalisation. India despite having made big advances in some areas of science and technology has not been able to evolve a strategy to cope up with the recurrence of disasters. An attempt has been made in this paper to highlight the trends of technological disaster occurrence in India during the past 25 years (1975-2001).

The Centre for Research on Epidemiology of Disasters (CRED) at the Universite' Catholique de Louvain, Brussels, Belgium, and the US Office of Foreign Disaster Assistance (OFDA) maintain online Database on disasters EM-DAT [4]. The criteria for data to qualify as a disaster are:

1) 10 or more people killed, or
2) 100 peopled reported affected, or
3) A call for International assistance, or
4) Declaration of a state of emergency

As per the CRED criteria, a disaster is called a significant disaster if it qualifies one of the following [5]:

1. No of deaths per event - 100 or more

2. Significant damage – 1% or more of the total annual GNP
3. Affected people – 1% or more of the total national population.

Classification

The classification of the disasters as given in the literature is not very explicit. We propose a simple system of classification of disasters:

Disasters	**1.Natural Disasters (brought out by forces of nature)**	**i) Geophysical**	**Earth quakes Volcanoes Landslides Storms Cyclones etc.**	
		ii) Hydrological	**Floods Drought etc.**	
		iii) Biophysical	**Epidemics Famine Wild fire etc.**	
	2. Anthropogenic Disasters (brought out by Man, his actions or his agents)	**iv) Technological**	**Industrial**	
			Transport	**• Air • Rail • Road • Water**
			Civil structure failures	
			Biomedical	***• Food poisoning*** **• Intoxication • Medical negligence**
		v) Civil strife	**War Terrorism Riots Genocide**	

Disaster Data Analysis

The occurrence of disasters in India is a regular feature and takes a heavy toll of its economy. The country suffers a loss of more than 1.6 million US $ per annum in addition to causing a loss of life and mental agony to about 63 million people [6]. Poorly managed transport system, haphazard urbanisation and ill planned growth of the industry have put the population at the threshold of dangers emanating from pollution, resource depletion and deforestation. An analysis of the data on technological disasters has been carried out to study the trends in disaster occurrence in the recent past on the basis of EM-DAT data with certain modifications.

Road transport is the most disastrous of all the disasters with an average toll of 324 disaster related deaths per year (Table 1). Average number of events in road transport is 9.11. The worst bus accident took a toll of 110 lived when an overcrowded bus plunged into a river. MIC gas tragedy that occurred at Bhopal in the year 1984, was one of the most expansive disasters which killed 2500 people and more than 1,00,000 injured. Analysis of data for the Annual frequency and Return period for significant disasters (Deaths =100) are given in Table 2. It reveals that the significant rail disasters have the highest annual frequency and the minimum return period.

Table 1. Disaster related deaths, average and extreme events

S. No.	Disaster	Events/ year	Deaths/ year	Maximum killed in a single event	Year	Place
1	Industrial	1.62	140	2500	1984	Bhopal (M.P.)
2	Air transport	0.60	50	351	1996	Near Delhi
3	Rail transport	3.41	159	350	1995	Firozabad (U.P.)
4	Road transport	9.11	324	110	1987	Mainpur (U.P)
5	Water transport	3.05	185	438	1988	Katihar (Bihar)
6	Civil structure failures	1.82	149	1335	1979	Morvi (Gujarat)
7	Biomedical	1.07	67	200	1992	Cuttack (Orissa)

Table 2. Annual frequency and Return period of Significant Disasters (deaths = 100)

S.No.	Disaster	Annual frequency	Return period (y)
1	Industrial	0.07	13.50
2	Air transport	0.13	7.67
3	Rail transport	0.33	3.00

4	Road transport	0.06	18.00
5	Water transport	0.17	5.75
6	Civil structure failures	0.28	3.60
7	Biomedical	0.29	3.50

The cumulative frequency graphs for technological disasters are given in Fig. 1-7. A concave curve is an indication of an increase in the rate of disaster related deaths with time. A convex curve on the other hand signals a decreasing trend and an intermediate curve close to the average line hints at disaster related deaths continuing at an average rate. There is a slight increase in the disaster related deaths in industrial disasters over the past 10 years. The air transport disasters showed an increase since 1987. The occurrence of biomedical disasters have however, declined over the past few years. Disaster related deaths show a declining trend with magnitude (Fig. 8-14). Modal frequency generally occurred at 20-30 deaths.

Data Needs for Technological Disaster Management

A critical study of the EM-DAT database for India reveals that there are serious lacunae in the data base presentation and classification. Thirteen of the biomedical disasters have been treated under industrial disasters that in the present paper have been shifted to the biomedical category. Similarly, the miscellaneous category under technological disasters also includes civil strife disasters. It is therefore recommended that India should have its own comprehensive disaster database to cover all disasters under appropriate categories for disaster management and mitigation.

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Fig. 1. Industrial disasters

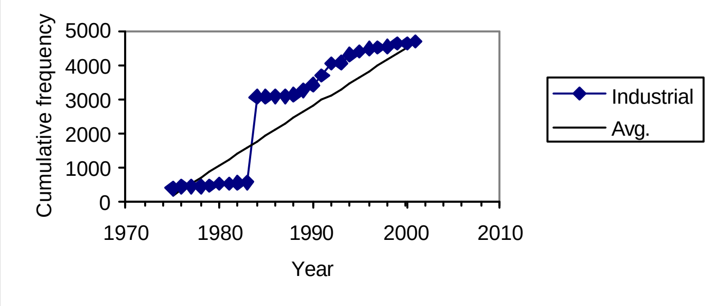


Fig. 2. Air transport disasters

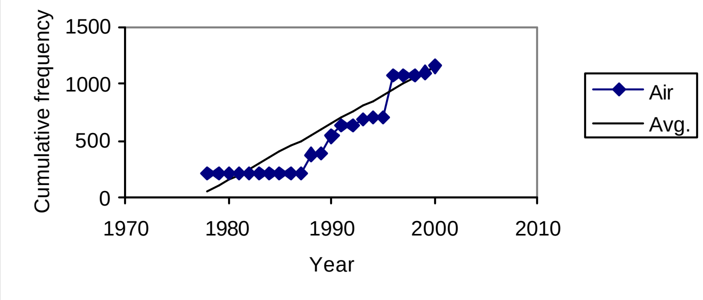


Fig. 3. Rail transport disasters

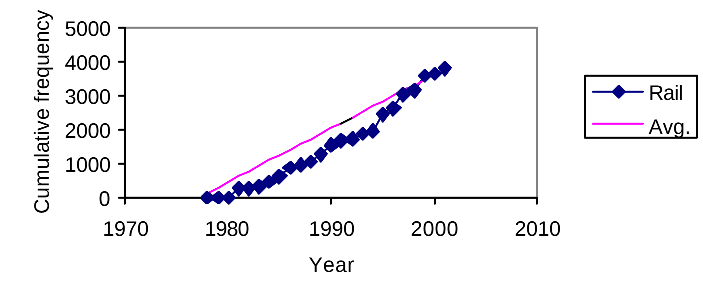
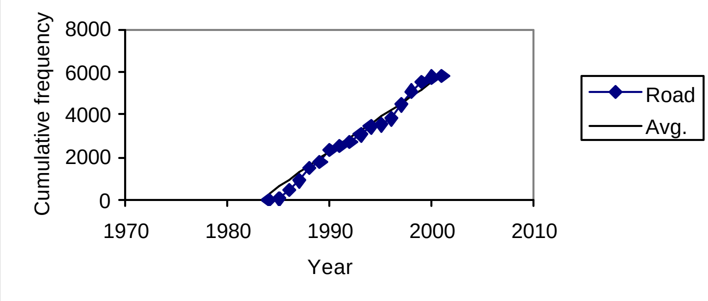
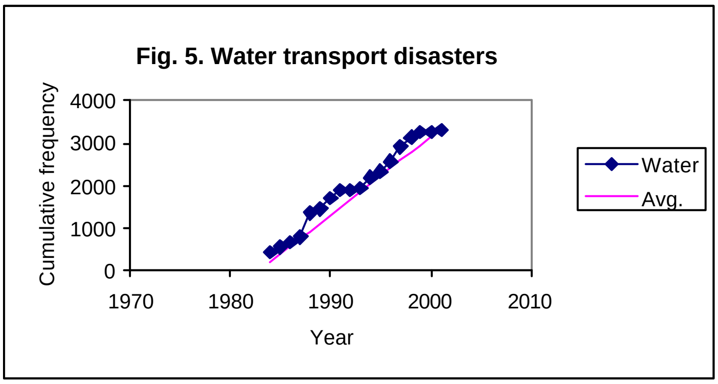
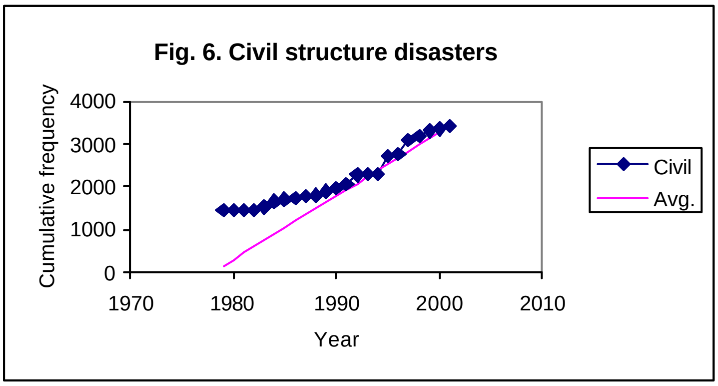


Fig. 4. Road transport disasters







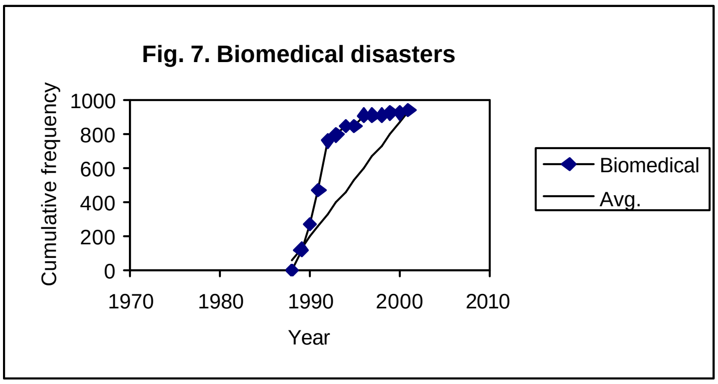


Fig. 1-7. Cumulative frequency of technological disasters.

Fig. 8. Industrial disasters

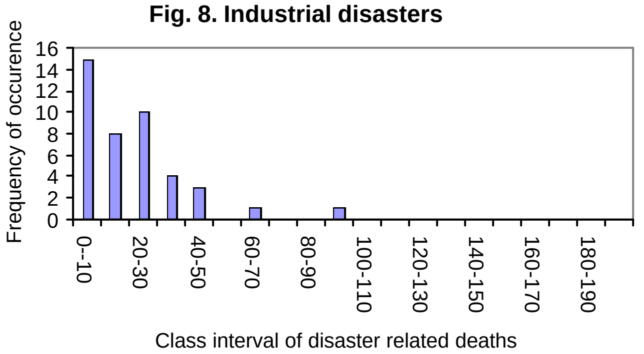


Fig. 9. Air transport disasters

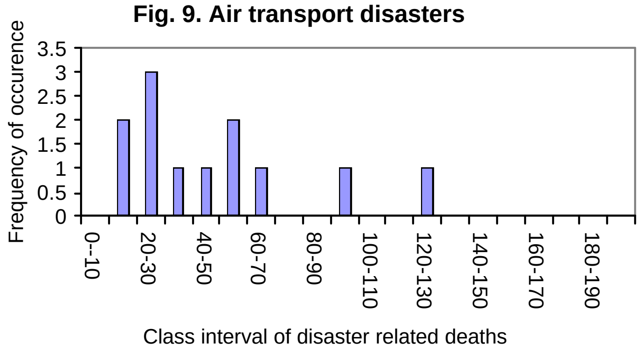


Fig. 10. Rail transport disasters

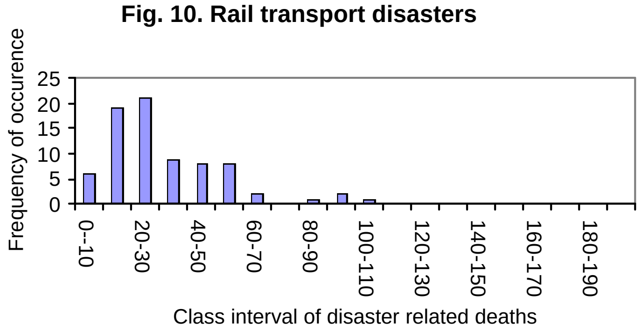
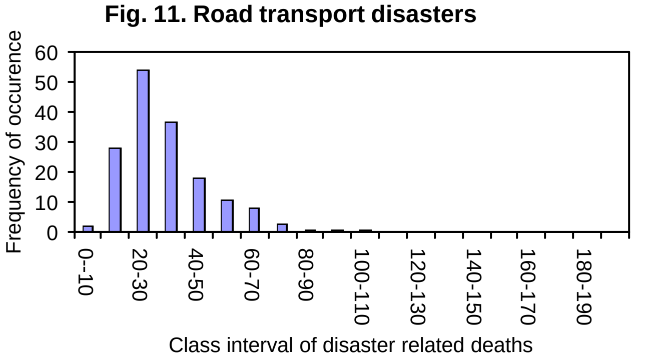


Fig. 11. Road transport disasters



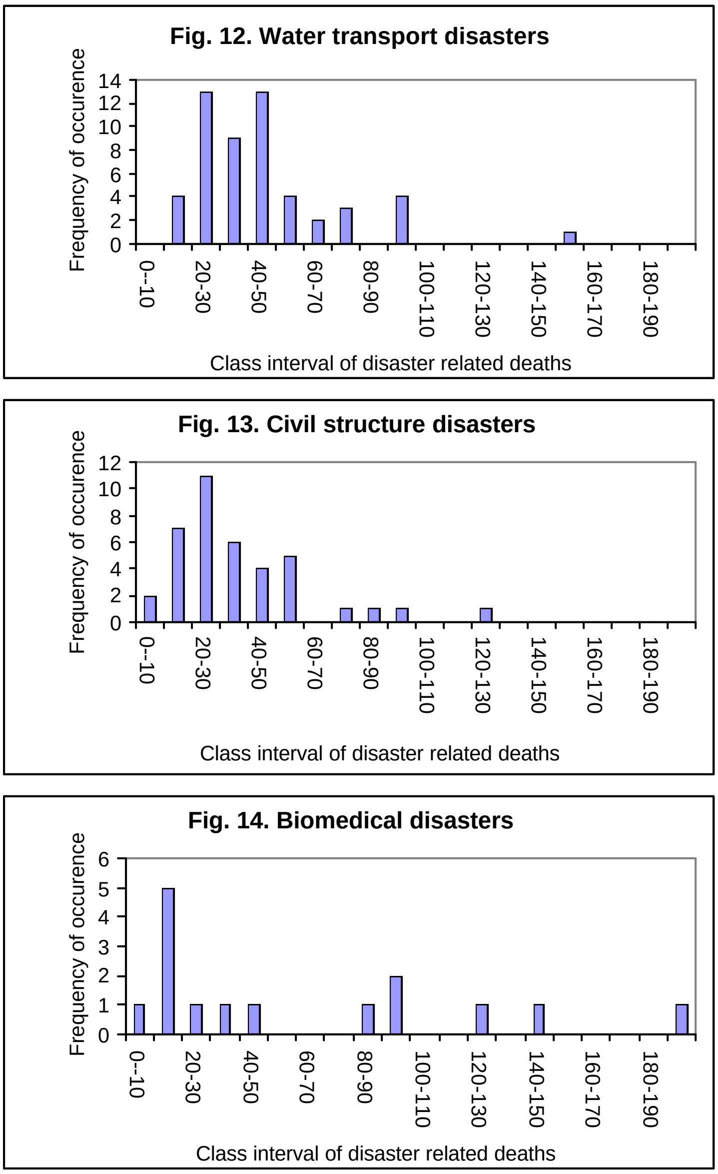


Fig. 8-14. Frequency of technological disasters against magnitude.

Matrix Model for Inventorisation in Life Cycle Assessment of a Product

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A matrix model has been proposed to inventorise the process inputs and outputs in the Life Cycle Assessment (LCA) of a product, process or activity. The model may find use in the development of indigenous LCA methodology and generation of data for environmental outputs and resource depletion in the life cycle of a product.

Introduction

ISO 14000 series defines six main areas as tools to manage environmental programmes and to provide an internationally recognized framework to measure, evaluate and audit these programmes [1]. These are

i) Environmental Management Systems
ii) Environmental Auditing
iii) Ecolabelling
iv) Environmental Performance Evaluation
v) Life Cycle Assessment (LCA)
vi) Environmental Aspects in Product Standards

Life cycle analysis has emerged as important tool to quantify the environmental impacts of any product, process or activity from cradle to grave. The ISO 14000 series standards define the principles and guidelines of LCA (14040), goal identification (14041), impact assessment (14042) and improvement assessment (14043) [2]. Typically, LCA requires 4 steps [3]:

i) To define the scope of study as to what issue are to be included or excluded.
ii) To decide about the life cycle stages to be addressed.
iii) To develop an inventory of the results.
iv) To make judgment about results obtained.

LCA methodology

There are two main stages in LCA methodology [4]:

i) **Inventorisation:** This describes the raw materials, semifurnished/ furnished products and energy consumed, and emissions occurring in the life of a product.
ii) **Impact assessment (LCIA):** This describes the impact of emissions and resource depletion on the environment.

Inventorisation

The life cycle inventory of an industrial process consists of process inputs and process outputs as given in Fig. 1.

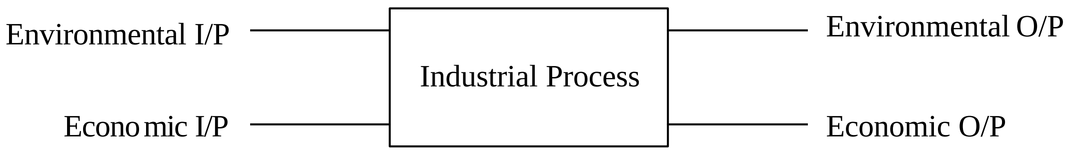

Fig. 1: Inventory Process

Process inputs:

i) Environmental input: It consists of input of raw materials and energy resources.
ii) Economic input: It consists of input of semifurnished/ furnished products consumed, which are outputs from other processes.

Process outputs:

i) Environmental output: It consists of output of emissions.
ii) Economic output: It consists of output of products, semifinished products or energy.

The inventory process is subject to variations in defining of system boundaries, generation of byproducts, geographical variations, obsolescence of data and many other factors.

Life Cycle Impact Assessment

There are several procedures to define the impact of emissions and depletion of resources on the environment. The method proposed by Society of Environmental Toxicology and Chemistry (SETAC) has three steps: i) Classification and characterization, ii) Normalisation and iii) Evaluation

In first step, the substances are grouped into classes according to their effects on the environment eg., emissions with green house effect, ozone layer depletion, heavy metals, carcinogens, human toxicity, acidification, eutrophication, solid waste etc. Each substance is multiplied by weighting factor known as characterization eg., human toxicity weighing factor for CO is 0.012, for NO_X is 0.78, for SO_2 is 1.2. Effect score is calculated for each class.

In the normalisation step, the effect score of a class is scaled to known total effect of the class. The normalized effect score of a class is then multiplied by weighting factor to give relative importance of the effect, known as evaluation.

The LCA requires an extensive databank and complex series of computations. Specialised software and databases are required to be developed. Some of the specialised softwares are SimaPro [4] and EIOLCA [5]. Some other important websites for LCA are given under references [6-11].

LCA depends on a number of factors, such as raw materials used, process involved, technology used, type and quality of fuel consumed, mode of transportation, distance covered by the process inputs and outputs, the environmental damage caused during the LCA vary from region to region. However no database and LCA software are available for products, processes and commodities in India. There is thus a need to evolve indigenous technology and software for LCA. We present here a matrix model to compute the process inputs and outputs for an industrial process as a first step to LCA.

Consider a manufacturing process given in Fig. 2. A product C_1, is produced from process inputs, B_i's, each of which in turn is produced from several other inputs, Ai's. X_i's denote the environmental outputs.

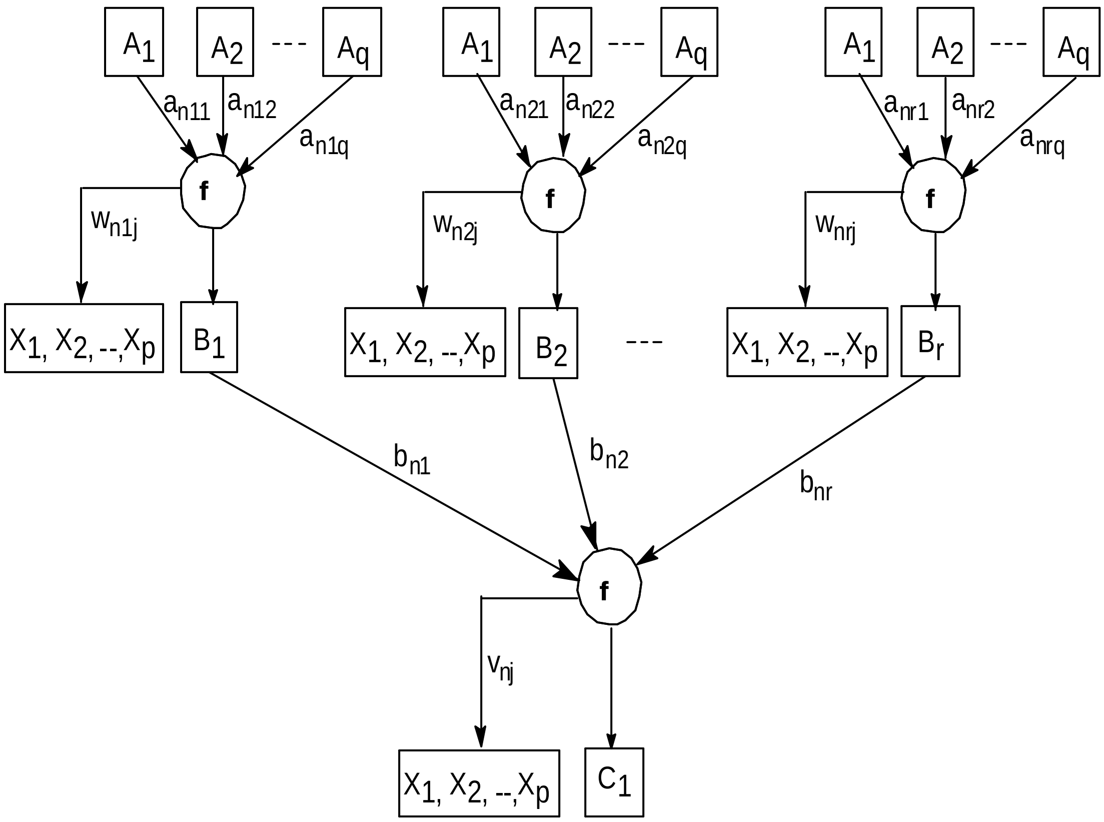

Fig. 2: Manufacturing Process

The process as given in Fig. 2 may be represented in the form of chemical equations as given below:

$$b_{n1}B_1 + b_{n2}B_2 + \text{-----} + b_{nr}B_r \longrightarrow C_1 + v_{n1}X_1 + v_{n2}X_2 + \text{-----} + v_{np}X_p$$

$$a_{n11}A_1 + a_{n12}A_2 + \text{-----} + a_{n1q}A_q \longrightarrow B_1 + w_{n11}X_1 + w_{n12}X_2 + \text{-----} + w_{n1p}X_p$$

$$\vdots$$

$$a_{nr1}A_1 + a_{nr2}A_2 + \text{-----} + a_{nrq}A_q \longrightarrow B_r + w_{nr1}X_1 + w_{nr2}X_2 + \text{-----} + w_{nrp}X_p$$

Where

v_{ni}'s is the amounts of X_i's produced per unit production of C_1 in n^{th} stage from B_i's,

w_{nij}'s is the cumulative amounts of X_j produced for the production of 1 unit of B_i in the n^{th} stage, and

a_{nij}'s is the cumulative amounts of A_j consumed for the production of 1 unit of B_i in the n^{th} stage.

Matrix model for environmental outputs

$$\begin{bmatrix} v_{n1} & w_{n11} & w_{n21} & w_{n31} & \text{----} & w_{nr1} \\ v_{n2} & w_{n12} & w_{n22} & w_{n32} & \text{----} & w_{nr1} \\ v_{n3} & w_{n13} & w_{n23} & w_{n33} & \text{----} & w_{nr3} \\ \vdots & \vdots & \vdots & \vdots & & \vdots \\ v_{np} & w_{n1p} & w_{n2p} & w_{n3p} & \text{----} & w_{nrp} \end{bmatrix}_{p,(r+1)} \begin{bmatrix} 1 \\ b_{n1} \\ b_{n2} \\ b_{n3} \\ \vdots \\ b_{nr} \end{bmatrix}_{(r+1),1} = \begin{bmatrix} w_{(n+1)11} \\ w_{(n+1)12} \\ w_{(n+1)13} \\ \vdots \\ w_{(n+1)1p} \end{bmatrix}_{p,1}$$

Matrix model for resource depletion

$$\begin{bmatrix} a_{n11} & a_{n21} & a_{n31} & \text{----} & a_{nr1} \\ a_{n12} & a_{n22} & a_{n32} & \text{----} & a_{nr1} \\ a_{n13} & a_{n23} & a_{n33} & \text{----} & a_{nr3} \\ \vdots & \vdots & \vdots & & \vdots \\ a_{n1q} & a_{n2q} & a_{n3q} & \text{----} & a_{nrq} \end{bmatrix}_{q,r} \begin{bmatrix} b_{n1} \\ b_{n2} \\ b_{n3} \\ \vdots \\ b_{nr} \end{bmatrix}_{r,1} = \begin{bmatrix} a_{(n+1)11} \\ a_{(n+1)12} \\ a_{(n+1)13} \\ \vdots \\ a_{(n+1)1q} \end{bmatrix}_{q,1}$$

Combined matrix model for environmental outputs and resource depletion

The models given above can be combined into a single model by taking maximum of the p and q values as rows of the multiplicand matrix. The columns will then be 2r+1. This matrix will carry zero values for dummy elements.

$$
\begin{bmatrix}
v_{n1} & w_{n11} & w_{n21} & w_{n31} & \cdots & w_{nr1} & a_{n11} & a_{n21} & a_{n31} & \cdots & a_{nr1} \\
v_{n2} & w_{n12} & w_{n22} & w_{n32} & \cdots & w_{nr1} & a_{n12} & a_{n22} & a_{n32} & \cdots & a_{nr1} \\
v_{n3} & w_{n13} & w_{n23} & w_{n33} & \cdots & w_{nr3} & a_{n13} & a_{n23} & a_{n33} & \cdots & a_{nr3} \\
\vdots & \vdots & \vdots & \vdots & & \vdots & \vdots & \vdots & \vdots & & \vdots \\
v_{np} & w_{n1p} & w_{n2p} & w_{n3p} & \cdots & w_{nrp} & a_{n1p} & a_{n2p} & a_{n3p} & \cdots & a_{nrp}
\end{bmatrix}_{p,(2r+1)}
\begin{bmatrix}
1 & 0 \\
b_{n1} & 0 \\
b_{n2} & 0 \\
b_{n3} & 0 \\
\vdots & \vdots \\
b_{nr} & 0 \\
0 & b_{n1} \\
0 & b_{n2} \\
0 & b_{n3} \\
\vdots & \vdots \\
0 & b_{nr}
\end{bmatrix}_{(2r+1),2}
=
\begin{bmatrix}
w_{(n+1)11} & a_{(n+1)11} \\
w_{(n+1)12} & a_{(n+1)12} \\
w_{(n+1)13} & a_{(n+1)13} \\
\vdots & \vdots \\
w_{(n+1)1p} & a_{(n+1)1p}
\end{bmatrix}_{p,2}
$$

Program in C++ for combined matrix model for inventorisation (lca.cpp)

```
//Matrix model for environmental outputs and resource depletion
# include<iostream.h>
# include<stdio.h>
# include<stdlib.h>
# include<conio.h>
void main()
{
 int p,r,q,maxpq;
 float w[3][50][50];
 float v[50][3],b[50][3];
 FILE *f;
 clrscr();
 cout<< "PROGRAM FOR MATRIX MODEL FOR INVENTORISATION IN LIFE CYCLE ASSESSMENT\n\n";
 cout<< "Developed by\n\nDr. A.K. Thukral and Er. B.P. Singh\n\n";
 cout<< "Guru Nanak Dev University, Amritsar-143005, India\n\n\n";
 cout << "Enter total number of environmental outputs (Xi's)\n";
 cin >> p;
 cout << "Enter total number of process inputs (Bi's) for production of C1\n";
 cin >> r;
 cout << "Enter total number of process inputs (Ai's) for production of Bi's\n";
 cin >> q;
 maxpq=(p>q)?p:q;
 for(int i=0;i<=2;i++)
  for(int j=0;j<=49;j++)
   for(int k=0;k<=49;k++)
        w[i][j][k]=v[i][j]=b[i][j]=0.0;
 for (i=1;i<=r;i++)
 {
  cout << "\n\n** Enter values for the production of 1 unit of B"<<i<<" **\n";
  for (j=1;j<=p;j++)
   {
    cout<<"Enter cumulative amount of environmental output X"<<j<<" released:";
    cin>>w[1][j][i];
   }
  for (j=1;j<=q;j++)
   {
    cout<<"Enter cumulative amount of process input A"<<j<<" consumed:";
    cin>>w[1][j][i+r];
   }
 }
 cout << "\n\n**** Enter values for the  production of 1 unit of C1 ****\n";
 for (i=1;i<=r;i++)
 {
```

```
   cout<<"Enter amount of B"<<i<<" required:";
   cin>>b[i][1];
   b[i+r][2]=b[i][1];
  }
  cout << "\n\n**** Enter values for the  production of 1 unit of C1 ****\n";
  for (i=1;i<=p;i++)
  {
   cout<<"Enter amount of environmental output X"<<i<<" released:";
   cin>>v[i][1];
   w[1][i][0]=v[i][1];
  }
  b[0][1]=1;
  for(i=1;i<=maxpq;i++)
   for(j=0;j<=r;j++)
        {
          w[2][i][1]=w[2][i][1]+w[1][i][j]*b[j][1];
          w[2][i][r+1]=w[2][i][r+1]+w[1][i][j+r]*b[j+r][2];
         }
  f=fopen("lca-out.txt","w");
  fprintf(f,"%s","\nMatrix 1\n");
   for(i=1;i<=maxpq;i++)
   { fprintf(f,"\n");
     for(j=0;j<=2*r;j++)
         fprintf(f,"%8.2f",w[1][i][j]);
   }
   fprintf(f,"%s","\n\nMatrix 2\n");
   for(i=0;i<=2*r;i++)
   {
     fprintf(f,"\n");
     for(j=1;j<=2;j++)
          fprintf(f,"%8.2f",b[i][j]);
   }
   fprintf(f,"\n\nResultant matrix represents the cumulative amounts of Xi's produced for the");
   fprintf(f," \nproduction of 1 unit of C1 in the first column and");
   fprintf(f,"\ncumulative amounts of Ai's consumed for the production of 1 unit of");
   fprintf(f," C1 in the \nsecond column. Zero values represent dummy elements.");
   fprintf(f,"\n\nResultant Matrix is\n\n");
   for(i=1;i<=maxpq;i++)
   {
     fprintf( f,"%8.2f    %8.2f\n",w[2][i][1],w[2][i][r+1]);
   }
   fclose(f);
   cout<<"\nThe output of the program is stored in file 'LCA-OUT.TXT' \n";
 getch();
}
```

The program lca.cpp when executed will give output in the file named lca-out.txt in the same directory from where the program is executed.

Sample execution of the program

A sample execution of program representing input data and output produced is given below. Here in *n* represent input quantities for 4 environmental outputs, 3 process inputs (Bi's) for production of C1 and 2 process inputs (Ai's) for production of Bi's. Matrix 1 and 2 will list the input data and resultant matrix will represent the cumulative amounts of X_i's produced for the production of 1 unit of C_1 in the first column and cumulative amounts of A_i consumed for the production of 1 unit of C_1 in the second column. Zero values represent dummy elements.

PROGRAM FOR MATRIX MODEL FOR INVENTORISATION IN LIFE CYCLE ASSESSMENT

Developed by

Dr. A.K. Thukral and Er. B.P. Singh
Guru Nanak Dev University, Amritsar-143005, India

Enter total number of environmental outputs (Xi's)
4
Enter total number of process inputs (Bi's) for production of C1
3
Enter total number of process inputs (Ai's) for production of Bi's
2

** Enter values for the production of 1 unit of B1 **
Enter cumulative amount of environmental output X1 released:*1*
Enter cumulative amount of environmental output X2 released:*2*
Enter cumulative amount of environmental output X3 released:*3*
Enter cumulative amount of environmental output X4 released:*4*
Enter cumulative amount of process input A1 consumed:*5*
Enter cumulative amount of process input A2 consumed:*6*

** Enter values for the production of 1 unit of B2 **
Enter cumulative amount of environmental output X1 released:*7*
Enter cumulative amount of environmental output X2 released:*8*
Enter cumulative amount of environmental output X3 released:*9*
Enter cumulative amount of environmental output X4 released:*10*
Enter cumulative amount of process input A1 consumed:*11*
Enter cumulative amount of process input A2 consumed:*12*

** Enter values for the production of 1 unit of B3 **
Enter cumulative amount of environmental output X1 released:*13*

Enter cumulative amount of environmental output X2 released:*14*
Enter cumulative amount of environmental output X3 released:*15*
Enter cumulative amount of environmental output X4 released:*16*
Enter cumulative amount of process input A1 consumed:*17*
Enter cumulative amount of process input A2 consumed:*18*

**** Enter values for the production of 1 unit of C1 ****
Enter amount of B1 required:*19*
Enter amount of B2 required:*20*
Enter amount of B3 required:*21*

**** Enter values for the production of 1 unit of C1 ****
Enter amount released for environmental output X1 released:*22*
Enter amount released for environmental output X2 released:*23*
Enter amount released for environmental output X3 released:*24*
Enter amount released for environmental output X4 released:*25*

The output of the program is stored in file 'LCA-OUT.TXT'

Matrix 1

22	*1*	*7*	*13*	*5*	*11*	*17*
23	*2*	*8*	*14*	*6*	*12*	*18*
24	*3*	*9*	*15*	0	0	0
25	*4*	*10*	*16*	0	0	0

Matrix 2

1	0
19	0
20	0
21	0
0	*19*
0	*20*
0	*21*

Resultant matrix represents the cumulative amounts of Xi's produced for the production of 1 unit of C1 in the first column andcumulative amounts of Ai's consumed for the production of 1 unit of C1 in the second column. Zero values represent dummy elements.
Resultant Matrix is

X1	A1
X2	A2
X3	0
X4	0

Proposed strategy for LCA in India

LCA is a sequential process and process inputs and outputs will vary from industry to industry. LCA may be carried out in 4 phases as given below:

1. Data may be generated with resource based industries like oil, gas, coal, petrol etc., and mining and metallurgical industries. Each unit may be asked to furnish data for inputs and outputs in terms of per unit number, weight or volume of product generated and for unit sale price per year.
2. Each major industrial unit or activity may be asked to provide input-output data.
3. Data may be generated for small scale industries.
4. Complete LCA data may be generated within defined system boundaries.

This is therefore to conclude that LCA data needs be generated in conformation with the international standards to promote the growth of healthy industry. The proposed matrix model may be helpful for inventorisation of industrial products, processes and activities, and pave a way for Life Cycle Assessment in India.

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BIOMEDICALWASTE MANAGEMENT IN WEST BENGAL

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Introduction

Biomedical waste considered to be special categories of solid waste, which is generated from [primary, secondary and tertiary level of health centres, hospitals, nursing homes, health care units, dispensaries and also medical research units. For a long time, there was no special care for such waste collection, handling and disposal. In 1996, in World Bank assisted health programme this problem came into surface. Subsequently, Ministry of Environment and Forests, Govt. of India, passed a notification in 20th July 1998 on the Biomedical Waste (Management and Handling) Rules 1998, as a part of provision made in sections 6, 8 and 25 of the Environment (Protection) Act, 1986.

The major focus of the rules are as follows:

a) Biomedical waste shall not be mixed with other waste,
b) No untreated biomedical waste shall be kept stored beyond a period of 48 hours,
c) Biomedical waste shall be treated and disposed off in accordance with the prescribed schedules,
d) The Govt. of every state shall established a prescribed authority with such members as may be specified for granting authorization and implementing these rules,
e) Every institution/occupier handling biomedical waste must abide by stipulated guideline of the rules and also submitted a report on annual basis in form-II for getting license or consent of operation from the granting authority. In addition they must maintain a records related to the generation, collection, receipt, storage, transportation, treatment, disposal and or any form of handling of biomedical waste in accordance with these rules and any guidelines issued.

In West Bengal, State Health Service Development Project (SHSDP) introduced this rule since 1998. Subsequently Kolkata Municipal Corporation (KMC) also imposed the above regulation within the KMDA area. As per the provision of the rule, the responsibility to monitor management of Biomedical Waste rests with the State Pollution Control Board (SPCB). Thus there are there agencies looking after the implementation of the rules. But in practice, state wide no uniform system exists. Producers of biomedical waste handling and management range from no segregation, no disinfections and open dumping on recent ground to those exhibiting efforts to make proper segregation, collection, disinfections and disposal. Most of the private establishment, the practices are either followed in casual way or not all.

Collection, segregation, storage, treatment and disposal methodologies in practice

As per provision of Biomedical Waste (Management and Handling) Rules, 1998, the following categories of waste were recognized along with collection methods, treatment and disposal requirements were given in Table I. However, in general radioactive waste was not considered in the rule properly. But as Institutional Practice such waste must be disposed by deep burial in lead container within a cemented chamber at least a depth of 1.0 to 1.5 meter in confined area.

Table-I: Categories of Biomedical Waste, their treatment & disposal process

Waste category	Color code of collection containers	Treatment process/ disposal methods
Category No. 1: Human anatomical waste (surgical materials)	Yellow basket or polybag	Incineration or deep burial
Category No. 2: Animal waste (Experimental animals and their discharges)	Yellow basket or polybag	Incineration or deep burial
Category No. 3: Microbiology and Biotechnology waste (cultures, vaccines, microbes etc.)	Yellow basket or polybag	Autoclave or hydroclave
Category No. 4: Waste sharps (Needles, Syringes, scalpels, glass etc)	Blue basket or polybag	Chemical disinfections/autoclave
Category No. 5: Discarded medicines & cytotoxic drugs	Black basket or polybag	Incineration or confined landfill.
Category No. 6: Solid waste (infected viz dressing, blood fluids, plasters solid linen)	Red/Yellow basket or	Autoclave/ Incineration
Category No. 7: Solid waste (disposable tubes & catheters).	Red basket or polybag	Chemical disinfections/autoclave
Category No. 8: Liquid waste (Floor washing)	Red basket or polybag	Chemical treatment
Category No. 9: Chemical waste (disinfected chemicals)	Black basket or polybag	Chemical treatment & Municipal landfill
Category No. 10: Incinerated ash (infected incinerated materials)	Black basket or polybag	Chemical treatment & Municipal landfill
Category No. 11: General waste from wards	Black basket or polybag	Municipal landfill

Though four different kinds of containers is mentioned for collection and handling of different categories of biomedical wastes, most of the well managed hospital, three categories of containers were utilized in the following manner.

Type I- Yellow/Blue containers for collection of surgical/ anatomical waste, animal waste, cytological drugs etc.

Type II- Red containers for collection of microbiological work, infected solid waste, chemical waste as well as sharp waste which was already crushed in the words.

Type III-Black containers for collection of all other waste of the words including general waste.

Biomedical waste were collected in each wards separately in each basket and then sent to central treatment and disposal site every day by mechanized carriage. Sharp waste must be crushed in the wards by needle crusher and syringe cutters and disposed in respective collection container.

From each wards to the treatment site routine collection and transportation specially trained personals were employed. Treatment and storage site is also located within the premised of the institution/occupiers. Autoclaving or chemical treatment usually made in such site in regular basis and then stored in colour polybag as per prescribed code for collection by the special van of municipality in regular basis. Normally autoclaved or chemically treated waste can be dispose in the container of normal municipal solid waste. Only surgical waste and cytotoxic drugs were stored in special containers then such bags should be transferred to the special vehicles of municipality for confined dumping at solid waste disposal site. These are some records for day to day collection such waste made by the KMC.

There is no centralized incineration facilities by KMC or major hospitals except some private hospital have small incineration facilities.

Most of the institution/occupier have no records of quantity of different categories of waste. By & large from sample survey it is estimated that total waste generated per bed per day about 1 kg of which 38% is infectious or hazardous categories and rest 62% nonhazardous type.

At present major hospitals and few nurshing home or medical research centre followed such practices, off course in very unregulated manner. This is mostly confined in city, not even in district town or village health centres.

STATUS OF WEST BENGAL HEALTH SERVICE PROGRAMME:

Up to 1999, there were 99 rural hospital, 244 block primary health centre, 919 Primary health centre and 8126 sub centres. In cities and municipalities, there were 7 medical college Hospital, 2 P.G teaching hospitals, 2 dental college, 2 ID hospitals, 5 Mental hospitals, 12 T.B. hospital, 1 Leprosy hospital, 47 state hospitals and also 15 subdivisional hospitals. In addition over 3000 nursing homes and medical research centres were distributed in the state. Thus the network required to implement the rule is extremely high, which SPCB could not manage due to very less staff members.

Some short term studies were conducted by DISHA, A Calcutta based NGO in 2002, where they reputed in ten sub divisional or district hospital of West Bengal, the average occupancy number varies from 195 to 500 and the total waste generated per bed per day ranging from 0.44 to 0.88 kg of which average infectious waste is over 30% (Table 2). It is further noted that 50% of infectious waste after treatment can be composted over 41% recyclable after treatment and remaining 7 to 8% could be incubated or dumped in confined place.

Table 2: Biomedical waste generation status of selected hospital in West Bengal

Hospitals	Total Occupancy	Average total waste generated per bed per day (Kg)	Biomedical waste of infectious categories (%)
1. Vidyasagar State General Hospital	195	0.886	21.29
2. Bangur District Hospital	460	0.762	27.08
3. Howrah District Hospital	416	0.632	34.33
4. Kalyani State General Hospital	401	0.744	24.91
5. Diamonharbar State General Hospital	205	0.667	27.71
6. Berhampore District Hospital	643	0.447	34.22
7. Krishnanagar District Hospital	555	0.698	33.69
8. Barasat District Hospital	281	0.728	31.05
9. Chinsuru District Hospital	421	0.79	26.87
10. Midnapore District Hospital	500	0.779	25.61

In addition there is a great need for awareness and necessity of such management practices among the grass root level employees associated with state health service programme either in govt. or private health centres. By and large, the sanitary conditions of state run medical facility units is extremely poor. Recycling of some disposed waste from hospitals, should be completely stopped. These were many complicated area lies in the rules too. It must be simplified at least to introduce the practices.

In some city privatization of biomedical waste handling and management were already initiated. KMC is really unable to handle such waste even they are charging rents. Thus private supports system is required for effective implementation at least in cities & township area.

As per the provision of the rule, effective authority must be created by the state govt. for proper implementation in the state in near future. Some private institution, took up their own initiative for proper implementation.

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Chapter Four

Technical Papers not presented

ENVIRONMENT AND SOLID WASTE MANAGEMENT

*Dr. O. Prasad**

1. **Introduction**

The nation is gripped with the dilemma of poverty and environment. In fact fighting poverty and protecting environment are the two sides of the same coin. Both are compatible, having mutually reinforcing goals rather than a zero-sum game. Thus one can very well say that the environment and development are the two sides of the same coin. The first five-year plan laid emphasis on food production and subsequent plans likewise fixed priorities to other sectors of economic activities so as to enable the country to tread the path to progress. It led to ferocious assault on environment for several decades now. The industrial revolution, scientific innovations and inventions of new and magic materials and devices converted economy from prudent management of resources for sustenance and basic need of satisfaction into a process of commodity production for profit maximization. Industrial activity created limitless appetite for resource exploitation and modern technological processes provided ethical license to make such exploitations possible. But there is a need to stop it beyond the carrying capacity of the mother earth otherwise the excessive use of fertilizers, pesticides and large-scale deforestation for construction of canals and industries are leading to water and air pollution beyond tolerance.

The deteriorating rural amenities and environment is one cause of urban growth. The intricate relationship between demographic trends and the sustainable development is undoubtedly significant. Massive urban consumption of resources and production of waste are necessary outcome of such a situation. When these wastes are not collected and disposed regularly they are many a time hazardous. But the situation is not as dismal as it seems to be. There are ways and means to deal with the situation so as to move the wheels of development yet causing minimum damage to the environment.

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2. Global Environment Facility

The international community has already taken cognizance of the prevailing disastrous conditions and an organization was created in 1990. This was set up with an initial funding of US $ 1.2 billion. The US replenished the fund by another $2 billion in 1994. India is also a contributory to this organization and its contribution was limited to US $9 billion in 1994. India once again contributed the same amount in February 1998. Let us also not forget that India is a recipient country too. 230 projects were allocated in June 1997. The funding to these projects was to the tune of US $ 1594 million. The fund was raised by grants from UNDP to the extent of 51%; 44% by World Bank; 4% by UNEP and 1% by other implementing agencies. In India these allocations were made to diverse and varied portfolios. India got US $ 146.18 million in January 1999. The amount came from UNDP and World Bank to the extent of 31.88 and 115 million US $ respectively. It is also to be noted that India is the second highest recipient in the world from these funding. The funds are being utilized in seven operational projects, five PDF projects and seven pipeline projects covering focal areas of bio-diversity and climate changes projects. Sixth Conference of parties to Basel Convention on the control of Trans Boundary movements of hazardous wastes and their disposal was held on Dec. 12, 2002 in Geneva. The Secretary general, United Nations Organizations in his message to the convention stated, " Hazardous wastes are not like other substances or products, they require permanent vigilance to ensure that they do not cause any harm to the human health or contaminate environment. The volume of hazardous wastes is to the tune of 150 million tons which is simply not sustainable". It was therefore recommended that help be rendered to developing countries with economies in transition, which often lack skills and establishments needed to manage hazardous, and other wastes in environmentally sound manner.

3. The Problems

The holistic approach required an overall consideration of sustainable development of all those techniques, which can reduce the environmental hazards. Though the plurality of environmental hazards or pollution are well known, yet it is proposed to throw a bird's eye view on them except the management of Solid Waste for which some detailed information particularly with respect to the State of Bihar State is presented hereunder.

The depletion of the energy resources and continuous pressure on the demand of oil and gas have compelled the modern world to think in terms of renewable source of energy. But the ever-increasing consumption of these energy resources has resulted in the augmentation of Green House gasses. The atmospheric pollution caused by petroleum driven machines and Suspended Particulate Matters (SPM) has already disrupted the Eco-system to some extent. The air quality is being monitored presently at two locations in Patna and the time-series data are given in the following table.

Ambient Air Quality

Year	SO2				NO2				Suspended Particulate Matter			
	Min.	Max.	Mean	N	Min.	Max.	Mean	N	Min.	Max.	Mean	N
Location: Beltron Bhawan, Shastri Nagar, Patna												
1996	4.0	18.0	9.0	75	5.0	36.0	18.0	75	73	406	177	76
1997	4.4	16.8	10.1	32	5.6	25.7	13.1	32	78	271	158	18
1998	4.7	17.9	10.1	49	5.7	21.6	12.6	49	96	345	187	25
1999	4.4	18.2	8.6	-	5.1	21.2	10.6	-	42	477	187	-
2000	3.0	18.0	8.9	47	3.8	21.5	11.1	47	38	327	152	234
2001	4.0	16.0	8.6	68	5.0	22.0	11.4	68	41	682	194	339
Location: Gandhi Maidan, Test Centre, Patna												
1996	10.0	166.0	33.0	65	7.0	101.0	37.0	64	1	2418	706	64
1997	12.0	37.8	37.8	44	14.5	46.2	30.5	44	223	1236	648	22
1998	11.3	40.3	40.3	54	14.6	53.1	28.6	54	222	1002	526	27
1999	6.1	27.7	27.7	-	7.7	31.7	20.4	-	65	1199	553	-
2001	4.8	28.6	17.2	58	6.1	32.5	19.6	58	81	1192	445	29

The monitoring of water quality is also constantly being carried out. It has been observed that the solutions to these problems of air and water pollution are often confusing, as even the fuzzy information available on this aspect in the state is either scanty or scattered. It has already been explained that the present paper will not digress our attention to other problems than the core of it, which is built around urban solid waste. Some light is thrown on rural waste too to enable a comprehension of the traditional management of the rural waste.

4. Solid waste Management

The rural solid wastes generally comprise of wastes from agriculture and agro-based industries, animal wastes and the likes. In addition to these wastes there is another waste known as community waste and it comprises of night soil. The comparative low output of the rural waste does not immediately necessitate intervention as the rural areas have the capacity to absorb them without any significant harm.

The rapid urbanization warrants immediate and sustainable attention to the management of urban solid waste. These solid wastes are generated by domestic, commercial and industrial activities. In fact the urban solid wastes comprise mainly of (i) Municipal waste and (ii) Hospital waste. Both the Municipal Solid Wastes (MSW) and the Hospital Solid Wastes (HSW) comprise of biodegradable wastes, recyclable wastes and the inert wastes.

Bhide struck an estimate of per capita solid wastes of various cities for mid-seventies and it was reportedly in the range of 150-350 gm per day per person. The same was re-estimated to be in the range of 320-530 gm per day in late eighties. The larger towns distinctly showed higher per capita waste generation.

The wastes collected are generally not weighed but a volume of these wastes suggest that their generation will go to the tune of 300 million tons by the year 2047 and the task of handling them will be equivalent to the task currently faced in moving total coal produced in the country. The MSW generally comprises of paper, plastics, metals, rubber, inert materials and the biodegradable ones. A study carried out by NEERI in 1995 in different cities of India showed the following composition.

Proportion of Constituents of Solid Wastes

Population Range (in million)	Paper, Leather & Synthetics	Rubber	Glass	Metal	Total Compostable mater	Inert material
0.1 to 0.5	2.91	0.78	0.56	0.33	44.57	43.59
0.5 to 1.0	2.95	0.73	0.56	0.32	40.04	48.38
1.0 to 2.0	4.71	0.71	0.46	0.49	38.95	44.73
2.0 to 5.0	3.18	0.48	0.48	0.59	56.67	49.07
>5	6.43	0.28	0.94	0.80	30.84	53.90

The weight-values given above are in percentage and while they were wet. The HSW also comprise of some recyclable material and certain infectious materials like cotton and bandages etc in addition to radioactive materials. The disposable syringe and injecting needles are also infectious but can be recycled after destroying them properly. It is also necessary that the biomedical wastes be stored separately so as to protect the recyclable wastes from getting contaminated. A separate study has estimated that the waste generated in Patna is to the tune of 360 gm. per capita per day.

The chemical analyses of these wastes by NEERI gave an estimate of the evolution of Nitrogen (N) as 0.56% to 0.71%. The Phosphorus (P) and Potassium (K) content were in the range of 0.52% to 0.82% and 0.52% to 0.83% respectively. The C/N ratio was found to be 21% to 31% and it had a total calorific value of 800-1010 kcal/kg. The density of the waste was between 330-560 kg/m.

The analytical report is suggestive of waste disposal being viewed as a resource for fuel. After separation and size reduction of the wastes the combustible could be transformed into pellets. It is reported that TERI has developed a high rate digester for fibrous and semi solid municipal wastes with the promise of revolutionizing the waste disposal. Their effort is termed as TEAM (TERI Enhanced Acidification and Methanation) Process and is claimed to be quick in digesting. They are economically viable and suitable for food and agro-based industries and markets. The salient features of TEAM have been enumerated as:

(i) It lowered the retention time (7 days) and the plant area for the whole process to make it economically viable as the requirements are much less as compared to the conventional single phase reactors (30-40 days) or aerobic composting (3-6) months).
(ii) It is said to have adopted a technology suitable to small entrepreneurs.
(iii) Low water consumption because of reuse of UASB reactor overflow to acidification reactor.
(iv) Production of quality biogas, which can be used for power generation or thermal application as per need.
(v) The decrease in total volume of the feedstock after decomposition is more than 50%.
(vi) The residue after drying is good manure.

An experimental plant for processing 50 kgms. Of vegetable waste per day is operational in TERI Campus at Gurgaon and efforts are under way to upscale it.

Thus it appears that the TEAM process is superior to Vermiculture- an aspect of biotechnology adopting anaerobic adsorption process involving the use of the worms as natural and versatile bioreactors with leaching control.

Bihar state continues with almost primitive and traditional ways of collection, transportation and disposal of these wastes. The usual manual small carts collect indiscriminately thrown domestic refuse and the half extracted sludge from the choked drains from the streets and lanes and dump them on the main roads to be transported to the disposal sites erratically. The scavengers and rag pickers foraging through the wastes are undoubtedly an unhygienic practice. It however contributes to recycling efforts to the extent of 5-10% of the total waste. The useful materials for the recycling are segregated and provide a sort of subsistence to the poorest stratum of the society. The provision of autoclave is too costly and may be needed as auxiliary instrument for the disposal by incineration or otherwise which are yet to be installed for the purpose. In an attempt to minimize the problems of Hospital Waste Management a project costing Rs. 62 Lakhs has been taken up for the installation of an incinerator at Indira Gandhi Institute of Medical Science, Patna. It will have the capacity to process 250 kg of waste per hour and is claimed to be the first of its kind in entire Eastern India. The private hospitals and nursing homes will also be eligible to utilize its services by making a payment at the rate of Rs 3 per bed. The toxic gas from the incinerator may not harm the health of the city with its proposed 100 feet high chimney. But so far the practices adopted for the disposal of the waste are highly deficient.

5. <u>Recommendations:</u>

(a) The unhygienic practices of the rag pickers can be reduced to a great extent if the segregation and storage of waste is carried out at its source namely the households and the establishments. They can transfer these segregated recyclable items from the waste to the rag pickers or hockers who make rounds of the street.

(b) The hospitals and nursing homes must segregate the bio-degradable wastes and some other wastes (including radio active wastes) which can be infections and harmful to health from the recyclable ones. The bio-medical wastes together with the used cotton and bandages etc. must be sent to the incinerators, which are to be installed as per law, enacted through, Government of India notification no. 460 dated 20.07.1998 and its different amendments thereafter.

(c) The inert materials as waste through construction of meubles or immeubles should be collected in special bins for the purpose.

(d) The MSW/HSW should be primarily collected in bags and should be handed over to the waste collector as and when they come to them.

(e) The biodegradable waste should be dispensed with using the new technologies developed by TERI Scientist as long as a better, more economic and viable solution is not found out.

(f) As long as alternative scientific arrangements are not available the wastes should be disposed by proper selection of site for filling, keeping in mind the following parameters.

(i) Away from habitation so that it does not cause nuisance to people by emitting foul smell, flies and unhygienic conditions.

(ii) The site should have impervious soil strata and leaching be controlled.

(iii) Good approachable road.

(iv) It should be large in size.

(g) Bihar state should be given a special status as far as the management of solid waste is concerned. This will be in tune with the recommendations and suggestions given by the Secretary General, UNO in his message on the occasion of Conference in Geneva on Trans Boundary Movements of Wastes.

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Data Need for Assessment of Environment Problems In the Forestry & Wildlife Sector

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Forest and Environment

Environment includes water, air, land and the interrelationship, which exists among and between water air, land, and human beings, other living creatures, plants, microorganisms and property. The human race has always had impact on environment. The dynamic global ecosystem is bound to change by human intervention and natural causes. In recent past the human actions were limited to specific places and also they were limited in magnitude. These changes were gradual. In the past century, and more so in its second half, the rapid population growth and heavy industrilisation reached to a point where we cannot dare to consider the environment change an unrelated phenomena. The main elements of natural resources namely, air, water, soil are deteriorating. The worldwide degradation of the forests is of primary concern. This degradation in the forests of India and sub-continent has reached almost to point of no return. The forest loss is not simply the unavailability of important wood (fuel and industrial wood), minor forest products, source of paper pulp, but the loss is more disastrous than our imagination. It is loss of habitat for wildlife, the irreversible loss to valuable plant species, the loss of biodiversity and hence affecting to the natural gene pool. This imbalance collectively creates the environmental problem to which entire world is concerned with. The forest are vital component of the dynamic nature of ecosystems, hence the forest loss brings about the environment change, mostly harmful, at large level even encompassing a greater region of the continents or even the global disturbances. The important thing to note is that the adverse effect is not confined to the disturbed zone but its ill effects could be felt at different parts of the globe. For example, Forest damage due to acid rains is caused by a chemical industry situated far away from the damaged forest.

Conventionally, we had been monitoring and quantifying this natural resource, forest in static way. Simply noting the area of forest, species wise distribution, categorizing the forest by species, wastelands etc. Later, it was inventoried by crown widths, regeneration and few other categories. But in the present scenario it is desired that we had to incorporate various other components to our information regarding the forests and their interaction with environment.

Global Warming - A Related Issue

There are many extraneous and inter connected activities which play a crucial role in changing the environment by affecting our forests. The most relevant issue is of global warming, increasing the mean surface temperature of earth. Although global warming is concerned with agriculture activities also but forest ecosystem stores 20 to 100 times more carbon per unit area than the croplands. As we know that main cause of this phenomena is emission of three main greenhouse gases, namely carbon dioxide, Methane and Nitrous oxide, but we are not aware of exact emission of these gases from our forest ecosystems. The information is important for planners and managers to take action to bring down these emission rates if they are more than agreed international norms. Also, the related problem is how our forest is being affected by these changes.

If we emphasize on the effect of global warming on forests, there could be three main effects. Firstly, Forest range could shift. Also, the forest composition (predominance of species) is feared to change. Secondly, the productivity of forest is bound to decline. Lastly, there could be changes in tree physiology and growth. Increased stand decline and tree mortality are likely from insect pest population and tree disease responses to raised temperature and moisture. It is desirable from us to evaluate our forests in context of above scenarios.

Environmental Stresses on Forests

There are countless issues related to forest and environment interactions. The forests are under high pressure for their valued products as the population is increasing and agricultural lands are being carved from these already diminishing forests. The forest are being encroached by people fully depending on the forest products. Today, there are about 100 million forest dwellers in the country living in and around forest lands and another 275 million for whom forests have continued to be an important source of their livelihoods and means of survival (Lynch, 1992). Another considerable fact is the low productivity of our forests. The Forest Survey of India estimates the productivity of entire forest 0.7 cum/ha/year. These levels are quite low than potential estimate at 2 cum/ha/year. The appropriate data regarding these interventions are of great need to administrators, policy makers and social activists. Few environmental problems related to the forest and forest ecosystems are discussed in brief.

a. Forests and Climate Change

The global warming is caused by emission of green house gases, mainly carbon dioxide. The average global temperature has risen by 0.6-degree centigrade in the last 130 years. It is now accepted that anthropogenic climate change is occurring. UN Intergovernmental Panel on Climate Change (IPCC, 1995) in its report stated that ' the balance of evidence suggests a discernible human influence on global climate' (Houghten *et al.* 1995). These greenhouse gases are both produced by natural phenomena as well as human actions. Major natural sources of green house gases related to forest ecosystems include wetlands, wild ruminants and small herbivores and termites, wildfires and natural land ecosystems including forest, savannah and pastures.

The anthropogenic activities are causing significant increases in emission of green house gases into the atmosphere. The main activities responsible for release of major green house gases are burning of fossil fuel, deforestation (mostly by burning) to make land available for agriculture and grazing, and burning of wood and charcoal for fuel. Forests are largest sources of carbon emission in the atmosphere. Data pertaining to release of CO_2 from these activities is needed for nationwide assessment.

b. Pollution

The pollutants of greatest concern globally are Sulpher dioxide (SO_2), Ozone (O_3), Carbon monoxide (CO), Nitrogen Oxide (NO_2), Hydrocarbons and Particulates (PM_{10}). The vegetation, soils and the aquatic environment are more important sinks than atmosphere for many pollutants. The trees and forests are more effective at removing pollutants from the atmosphere because of their high leaf areas. The pollutants effect on trees could be direct as well as indirect.

In direct effect the pollutant enter directly into the trees. The pollutants enter vegetation through stomata or they deposit on the leaf surface. They damage leaves by high acidic rains. The pollutants have detrimental effect on plant metabolism and physiology when they enter leaves via stomata (Wellborn 1994).

In indirect effect, for example, the pollutants alter the soil quality. The pollutants also effect on other components of ecosystem indirectly such as damage to mycorrhizal fungi, insect pests and fungal pathogens.

c. Atmospheric Concentration of Carbon dioxide

Increase in the atmospheric concentration of CO_2 is assumed to be the primary driving force of anthropogenic greenhouse effect and thus climate change. However, the atmospheric concentration of CO_2 (˜240ppm) directly affects the plant growth positively. If the environmental factors as nutrients and water availability are below optimum, trees suffer from increased stress in elevated CO_2. Hence the data is required for nationwide CO_2 release.

Use Remote Sensing in Forestry Data Acquisition

Conventionally, our National Forestry Inventories (NFI) are based on field observations. Later, aerial photographs were used in some cases. At the end of 1970s attempts were made to use Landsat Multispectral Scanner (MSS) for making NFIs.

In the case of forestry, remote sensing can be useful in the identification and analysis of forest areas, i.e. their location and size, state of degradation and the level of human pressure visible through heavy deforestation, fires and agroforestry. With high-resolution satellites, certain physiognomic parameters related to various cover classes permit the discrimination of forest, woodland and scrubland, while floristic parameters permit the determination of broad-leaved, coniferous and mixed stands. Satellite remote sensing can also assist in forest management by providing information on accessibility, e.g. topography, paths or roads, and also permit yearly or even monthly monitoring of main forest stands and logging over very large areas such as provinces or countries. The data available is very helpful in addressing the environmental issues related to forests.

Limitation of Remote Sensing

Needs for information about the forests are as varied. The increasing complexity of the demand for forest-related data and the growing sophistication of remote sensing techniques have led to an ambiguous situation with respect to the technology. Remote sensing techniques operated on national scales can bypass locally significant data. High accuracy is possible when distinguishing between the most contrasted situations (e.g. forest cover and clearings), but the level of accuracy is less certain when there is a higher complexity of the association of vegetation forms (e.g. in successional stages). Also, there are limitation in the identification and measurement of the process of forest degradation.

Application of Environmental Data in Forestry Sector

a. Assessment of Carbon Sequestration by Indian Forests

The forests are being considered as major sinks of atmospheric carbon dioxide. In order to assess the capacity of absorption of CO_2 by plants and forests is a stupendous work. There have been worldwide attempts to assess the carbon sequestering capacities of natural vegetation. Various factors determine the growth of trees and forests. These factors vary spatially as well as temporarily. Growth rate of tree species varies significantly across regions due to variations in climate and soil conditions. The annual incremental growth declines from lower to higher altitudes and from wetter to drier regions, due to changes in temperature, length of daylight and growing season, soil conditions, and so on (Dabas and Bhatia 1996). Due to these facts, tropical and subtropical climates, rather than temperate climate, support ample forest growth.

A number of studies have analyzed the potential of forestry options for abatement of carbon emissions (IPCC 1992; Myres and Goreau 1991; Ravindranath and Somashekhar 1995). It is recognized that reforestation on a suitable scale could sequester carbon in order to counter global warming (Myres and Goreau 1991).

With the help of contributing quantitative environmental characteristics, Global Climatic Models (GCMs) are prepared. These models require accurate data inputs. Further, models are used to present future scenarios relating to climate change. In the current studies, the data available from various sources has been used to assess the carbon sequestering options in India. There is a considerable degree of variation among studies in terms of their assumptions, methodology, estimated figures, and so on. More reliable data and proven methodologies can further improve the estimations. (" Carbon Sequestration options in the forestry sector in India: A review"; Ravindranath and Somashekhar).

b. Watershed Conservation

Forests have an important role for the conservation of water and soil resources through the protection of hill and mountain slopes from erosion by rainfall and the flooding rivers. Protection of sloping land and soils is the single most important physical and biological function of forests. In this regard quantitative as well as pictorial data related to the following issues is required:

- Topography and climate (rainfall)
- Location of roads and drainage
- Cutting system used, number and volume of trees per hectare cut

c. Conservation of Biological Diversity

Conservation of genetic forest resources and the maintenance of biological diversity is essential for sustaining the productive and protective values of all forestlands. Data relating to the following issues will help manage and protect forest from environmental degradation:

- Recognizing the sites where localized or rare species of plants and animals are known or thought to exist.
- Determining the sites having endangered or rare plants or animal species.
- Defined boundaries of forestland to be reserved and protected from wood production.

d. Wildlife Conservation

The growing interest in conserving wildlife in forest through the creation of protected areas is common practice in our country. Forest planners and managers may need the following type of data in order to contribute towards effective wild life conservation:

- Data regarding the protected areas representing all major forest types, especially having a high species diversity and endemism.
- The data regarding demarked corridors connecting the two or more forests is of vital importance. These corridors provide undisturbed habitat access that allows free movement of animals in either direction.

Quantitative Indicators - A Comprehensive Approach

Forest resource assessment and representative forest parameters could be considered as the indicators of sustainable forest. These indicators help in understanding the forest in all its facets including the environmental stress on them. The forest could be categorized according to following criteria in accordance to its functions and interaction. The italicized headings could be considered the quantitative indicators.

a. Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles

Area of forest and other wooded land, classified by forest type and by availability for wood supply, and share of forest and other wooded land in total land area.
Growing stock on forest and other wooded land, classified by forest type and by availability for wood supply.
Age structure and/or diameter distribution of forest and other wooded land, classified by forest type and by availability for wood supply.
Carbon stock of woody biomass and of soils on forest and other wooded land.

b. Maintenance of forest ecosystem health and vitality

Deposition of air pollutants on forest and other wooded land, classified by N, S and base captions.
Chemical soil properties (pH, CEC, C/N, organic C, base saturation) on forest and other wooded land related to soil acidity and eutrophication, classified by main soil types.
Defoliation of one or more main tree species on forest and other wooded land in each of the defoliation classes "moderate", "severe" and "dead”.
Forest and other wooded land with damage, classified by primary damaging agent (abiotic, biotic and human induced) and by forest type.

c. Maintenance and encouragement of productive functions of forests (wood and non-wood)

Balance between net annual increment and annual fellings of wood on forest available for wood supply.
Value and quantity of marketed roundwood.
Value and quantity of marketed non-wood goods from forest and other wooded land.
Value of marketed services on forest and other wooded land.
Proportion of forest and other wooded land under a management plan or equivalent.

d. Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems

Area of forest and other wooded land classified by number of tree species occurring and by forest type.
Area of regeneration within even-aged stands and uneven-aged stands, classified by regeneration type.
Area of forest and other wooded land, classified by "undisturbed by man", by "semi- natural" or by "plantations", each by forest type.
Area of forest and other wooded land dominated by introduced tree species.
Volume of standing deadwood and of lying deadwood on forest and other wooded land classified by forest type.
Area managed for conservation and utilisation of forest tree genetic resources (in situ and ex situ gene conservation) and area managed for seed production.
Number of threatened forest species, classified according to World ***Conservation Union (IUCN) Red List*** categories in relation to total number of forest species.

Area of forest and other wooded land ***protected to conserve biodiversity, landscapes and specific natural elements.***

e. Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)

Area of forest and other wooded land designated to prevent soil erosion, to preserve water resources, or to maintain other forest ecosystem functions.

Area of forest and other wooded land designated to protect infrastructure and managed natural resources against natural hazards.

f. Maintenance of other socio- economic functions and conditions

Number of forest holdings, classified by ownership categories and size classes.
Contribution of forestry and manufacturing of wood and paper products to GDP.
Net revenue of forest enterprises.
Gross fixed capital formation in forestry.
Number of persons employed and labour input in the forest sector, classified by gender and age group, education and job characteristics.
Frequency of occupational accidents and occupational diseases in forestry. Consumption per head of wood and products derived from wood.
Imports and exports of wood and products derived from wood.
Share of wood energy in total energy consumption, classified by origin of wood.
Paper recovered for use as raw material as percentage of total consumption of paper and paperboard.
Area of forest and other wooded land where public has a right of access for recreational purposes and indication of intensity of use.
Number of sites within forest and other wooded land designated as having cultural or spiritual values.

Conclusion

The physical environment determines the growth, survival, structure and extent of forest ecosystems. We consider environmental stress to occur when environmental factors are outside the range tolerated by animal and plant life. In order to maintain and manage these valuable natural resources it is essential to quantify the magnitude of these environmental stresses. Quantifying these stresses need a vast infrastructure and skilled persons. In developing countries, with fewer alternatives to sustain life, forests are exerting population pressure. The previous data regarding the loss of resources and fast human growth show a clear correlation between them.

The Data is needed for sustainable management of forests. Environmental effects on the forests and wildlife are matter of national as well as global concern. The human activities are contributing to the environmental stress is in various ways as agricultural activities (through carbon release), disturbance in forest ecosystems, Pollution and interfering with physical environment which in turn affect forests and wildlife.

With the emergence of new technologies, it is possible to collect data regarding the NFIs and environmental data fast and accurately. Remote sensing, Aerial photography, computers, specially built models, and development of new statistical methodologies and packages assisted by computers, has made it possible to monitor and measure our forests factors interacting with them. We could think of considering few indicators, covering all facets of forests.

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Determining Pollution Load in the Factory Sector based on ASI1997-98

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Introduction

Two major challenges face the human race at the advent of the twenty-first century. The first relates to major insult to the environment and the depletion of the natural resources including the threat of climate change. The second stems from the continued existence of poverty and hunger in several parts of the globe with an estimated number of 2.8 billion people living at incomes below $2 a day. Both these challenges underline the importance of all countries in the world pursuing the goal of sustainable development. Solutions to these problems require unprecedented efforts on the part of governments, corporate organizations, and civil society. The role of science and technology in any set of solutions would be paramount. Also relevant to the pursuit of sustainable development is the need to ensure equitable growth in different parts of the world, such that the rich and prosperous do not impose a footprint on the earth's ecosystem larger than their share and one that allows the poor of the world to lift themselves out of poverty using environmental services in a sustainable manner. Therefore, there is no denying that the measurement of development in an economy must be linked with sustainability. Among the indicators of development industrial growth is an important factor in a country like India where nearly 20% of GDP is contributed by the manufacturing sector. Again to focus on a sustainable growth in this sector, the pollution abatement policy becomes an issue. But, it is a global happening that environmental regulations always add to the private cost of the polluters and consequentially this affect the sustainability of industrial growth.

Industrial Pollution

Pollution intensive industries contribute around 60% of the total NVA (Ref Chaudhuri & Ray, Staff Papers 2000, Vol 1, No.2).The problem of industrial pollution is not new but what is new is the dimension of the problem and bare fact that this world is no longer large enough compare to the ability of the people to pollute it. An industrialized economy generates more pollution all other thing being equal growth of industry reduces the environmental quality. On the other hand growth of industry promotes richer citizens which usually demand higher level of environmental quality therefore development has its basic problem in natural resource depletion.

Historically every society or nation always tried to regulate the environmental degradation through economic measures and laws and regulations. But the fact is that as environment protection takes up more and more of a country's national income, the time will come when the cost of pollution abatement will matter most. Though environmental protection costs money the information on pollution abatement cost is scarce. The following table shows the pollution abatement expenditure for some developed countries as a percentage of GDP. For India during 1997-98 this percentage based on ASI 1997-98 was found very low to the tune of 0.27% only.

*The views expressed in the article are of the authors and not necessarily of the Organisation to which they belong

Table 1: Pollution Abatement Expenditures for Selected Countries, as a Percentage of GDP

Countries	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
United states	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.3	1.4	1.4
France	0.9	0.9	0.9	0.8	0.9	0.8	1.0	1.0	1.0	1.0
West Germany	1.5	1.5	1,4	1.4	1.5	1.5	1.6	1.6	1.6	1.6
Netherlands	-	1.2	-	-	1.3	1.5	1.5	-	1.5	-
United Kingdom	1.6	-	-	-	1.3	1.3	-	-	-	1.5

Source: Jaffe et al. (1995)

Nevertheless the cost of a few percent of GDP put a correct prospective on environmental protection, it ranges into hundreds of billion of dollars per year to a country, which may be unbearable to a developing country. Therefore the knowledge of pollution abatement cost is a necessary input in understanding an economy. In Annual Survey of Industries 1997-98 an effort was made by C.S.O., Govt. of India to collect pollution abatement cost from the factory sector of the country. The table below shows the expenditure incurred by different industrial sectors in pollution abatement.

Table 2: Showing Pollution Abatement Measures taken and Extent of Abatement achieved Industry-wise

Major industries (2-digit NIC code)	Total No. of factories	Factories which have taken Abatement Measures for							
		Air Pollution		Sound Pollution		Surface Pollution		Water Pollution	
		(No.)	Extent (%)	(No.)	Extent (%)	(No.)	Extent (%)	(No.)	Extent (%)
[I]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Food Products (20)	14695	1389	9.45	93	0.63	110	0.75	1446	9.84
Other Food Products (21)	8109	1340	16.52	167	2.06	156	1.92	1553	19.15
Beverages, Tobacco & Products (22)	8668	236	2.72	19	0.22	20	0.23	350	4.04
Cotton Textiles (23)	9227	1338	14.50	124	1.34	77	0.83	1487	16.12
Wool, Silk man-made Fibre Textiles (24)	3989	669	16.77	24	0.60	15	0.38	939	23.54
Jute and other Veg. Fibre Textiles (25)	503	58	11.53	9	1.79	5	0.99	55	10.93
Textile Products (incl. Wearing Appr) (26)	5409	372	6.88	36	0.67	7	0.13	326	6.03

Wood and Wood Products (27)	3787	213	5.62	18	0.48	1	0.03	105	2.77
Paper and Paper Products (28)	6304	356	5.65	12	0.19	39	0.62	597	9.47
Leather & Products of Leather, Fur (29)	1742	154	8.84	8	0.46	23	1.32	583	33.47
Basic Chemicals & Chemical Products (30)	9357	2652	28.34	262	2.80	284	3.04	3056	32.66
Rubber, Plastic, Petro & Coal products (31)	7597	1270	16.72	140	1.84	150	1.97	1192	15.69
Non-Metallic Mineral Products (32)	11376	1618	14.22	99	0.87	49	0.43	675	5.93
Basic Metal & Alloys Industries (33)	6915	2068	29.91	169	2.44	96	1.39	1322	19.12
Metal Products & parts (34)	8243	637	7,73	97	1.18	50	0.61	572	6.94
Machinery & Equipments (35)	8208	605	7.37	100	1.22	30	0.37	584	7.12
Machinery & Equip (Electronics, etc.) (36)	5743	554	9.65	72	1.25	28	0.49	531	9.25
Transport Equipment & parts (37)	3999	460	11.50	80	2.00	27	0.68	458	11.45
Scientific equipments watches, clocks (38)	2243	132	5.88	20	0.89	2	0.09	133	5.93
Repair of Capita goods (39)	2240	105	4.69	17	0.76	5	0.22	90	4.02
Electricity (40)	3644	2365	64.90	1088	29.86	358	9.82	1444	39,63
Gas & Steam generation and distribution (41)	80	14	17.50	2	2.50	3	3.75	15	18.75
Water works & Supply (42)	293	3	1.02	0	0.00	0	0.00	8	2.73
Non-conventional Energy generation & distr. (43)	4	1	25.00	0	0.00	0	0.00	0	0.00
Storage&Warehousing Services (74)	1078	41	3.80	3	0.28	4	0.37	65	6.03
Repair Services (97)	1966	131	6.66	52	2.64	18	0.92	135	6.87
TOTAL	135431	18792	13.88	2718	2.01	1564	1.15	17733	13.09

Table 3: Showing Expenses for Pollution Abatement Measures Industry-wise

Vlajor Industries	Gross Value of Plant & Machinery used for pollution control (in Rs. Lakh)	Running expenses for Pollution Control (in Rs. Lakh)
Food Products	21937	863
Other Food Products	8301	480
Beverages, Tobacco & Products	18607	1039
Cotton Textiles	38897	4209
Wool, Silk & man-made Fibre Textiles	19928	3498
Jute and other Veg. Fibre Textiles	326	23
Textile Products (incl.Weating	2994	1973
Wood and Wood Products	510	9
Paper and Paper Products	33290	1413
Leather & Products of Leather, Fur	2902	1264
Basic Chemicals & Chem. Products	206864	15716
Rubber, Plastic, Petrol & Coal	26541	3072
Non-Metallic Mineral Products	78464	1104
Basic Metal & Alloys Industries	99954	12682
Metal Products & parts	2183	761
Machinery & Equipments	3782	1968
Machinery & Equip. (Electronics, etc.)	7946	555
Transport Equipments, watches,	6953	1268
Scientific equipments, watches, clocks	712	55
Repair of Capital goods	45	13
Electricity	49233	1796
Gas & Steam generation anc distribution.	8	65
Water works & Supply	8	12
Son-conventional Energy generation & distribution		13
Storage & Warehousing Services	29	4
Repair Services	94	49
All Industries	630509	53905

Arthur C. Pigou argued for the imposition of taxes on generators of Pollution. As the social cost of pollution is always better than the private cost to the polluter, the government should intervene with a tax or cess to make pollution most costly to the polluted so that the polluter will produce less pollution to save cost. Such Pigovian fee is often argued against subsidies for the polluters who cannot afford to pay tax. But in comparing a subsidy for pollution control with a tax, which can be calculated on equimarginal principle, both result in the same marginal conditions for pollution emission. However, the subsidy results in excess production in the polluting industry in both the short and long run.

In this paper, attempt has been made to understand the pollution load within a particular industry group in terms of the cost of pollution abatement and the degree of abatement achieved according to the size of the industry based on invested capital.

Analysis of pollution load

Pollution Load is devised to be an indicator or sensetizer, which determines the comparative rank of stress of an industry which has taken up abatement measures to reduce industrial pollution vis-a-vis other industry. This indicator will be useful (a) to determine a single quantitative indicator which takes into account all pollution factors of an industry, (b) to quantify the degree of stress on an industry for pollution control, (c) to identify the weaker area and its spatial distribution over industries and geography and (d) to monitor the load over a period of time for macro level policy suggestion on pollution abatement policy.

The domain of study will be the factory sector covered in ASI 1997-98 and 2-Digit NIC-87 industry groups under different category of Invested Capital.

Definition:

Invested Capital (IC) = Fixed Capital + Physical Working Capital

v IC is considered to be Low if IC is less than Rs. 3 Crore which will consist of a stratum, say S1

v IC is considered to be Medium if 1C is greater than or equal to Rs. 3 Crore and less than Rs. 25 Crore which will consist of a stratum, say S2

v IC is considered to be High if 1C is greater than or equal to Rs. 25 Crore, which will consist of a stratum, say S3

Now, the Pollution Load, say Pi is defined as:

Pi =? Ri*Li /? Ri, for ith. Stratum of industry Group,

where Ri= Cost for Pollution Abatement by the industry in the ith stratum

Li= (l-Ai)*(1-W i)*(l-Ki)*(l-Ni),

where Ai= Degree of abatement of Air pollution

Wi=Degree of abatement of Water pollution

Ki= Degree of abatement of Surface pollution and

Ni= Degree of abatement of Noise pollution

Here, for the sake of simplicity we have assumed that (a) The Pollution Characteristics within a particular 2-digit industry group will be similar among the industries within a particular Si and 0<Li<l that is, even after treatment the degree of abatement is always non-zero but less than 100%.

Limits and Extremities:

v 0<Pi<100

v Pi=0 => Ri=0, that is if industry does not incur any cost for pollution abatement then it is out of the definition of load having no load

v Pi=100 => Li is almost 1, that is even after incurring cost, the degree of abatement is insignificant.

The study has certain limitations, which is described below:

v The missing data on pollution abatement were replaced by the group average at factory level

v Some data on Surface Pollution may suffer from definitional problem at field level data collection.

v Some non-operative costs may be reported in some Ri at factory level

v In a few cases pollution data at factory level contain extreme figures, which may not be practical.

Findings

v Industry with lower IC have higher pollution load

State wise analysis of the pollution abatement cost data shows the following features The pollution load values for the states of Andhra Pradesh, Gujarat and Karnataka are presented in Annexure I.

Andhra Pradesh : For industry groups 20, 22, 24, 29, 31, 32, 35, 38 and 39 the Pollution Load is very high to the tune of 80 and above. This information is in respect of factories whose invested capital is less than Rs.3 crores. In these sectors implementation of pollution abatement measures is apparently difficult. The GVA contribution of these sectors is fairly high. For the industry groups from 40 onwards have zero pollution load i.e. these units are not spending anything for pollution abatement though the total GVA is very much considerable.

Assam : In this state the pollution load is hi general low. The industry groups which have considerable pollution load in the sector where the invested capital is less than Rs. 3 Crores, are 23, 25, 28, 30, 31, 33, 34, 74. In these sectors implementation of pollution abatement measures is apparently difficult. It is interesting to note that the GVA of these industries is not very high as compared to other states.

Bihar : The main industries which have high pollution load are 20, 25, 28, 34, 35, 40, 97. Here it is The GVA figures show different magnitudes from high to even negatives. In these sectors implementation of pollution abatement measures is apparently difficult.

Goa : The pollution load is generally very low in Goa. The only industry having high pollution loads are 22, 31, 35, 97, 38. In these sectors implementation of pollution abatement measures is apparently difficult.

Gujarat : For industry groups 20, 22, 26, 29, 31, 34, 35, 74 the Pollution Load is very high to the tune of 80 and above. This information is in respect of factories whose invested capital is less than Rs.3 crores. These above-mentioned sectors have difficulties in implementing the pollution abatement measures.

Haryana : For industry groups 20, 22, 32, 34, 35,37, 97 the Pollution Load is very high to the tune of 70 and above. This information is in respect of factories whose invested capital is less than Rs.3 crores. The GVA contribution of these sectors is fairly high. In these sectors implementation of pollution abatement measures is apparently difficult.

Himachal Pradesh : For industry groups 20, 29, 31, 35, 97 the Pollution Load is very high to the tune of 80 and above. In these sectors of industries there is apparent difficulty in implementing pollution control measures. This information is in respect of factories whose invested capital is less than Rs,3 crores. The GVA contribution of these sectors is fairly high.

Jammu & Kashmir : In this state the pollution load is almost negligible in case of units where the invested capital is less than Rs.3 Crore. Here it is feasible to implement pollution control measures.

Karnataka : For industry groups 20, 30, 32, 38, 39 the Pollution Load is very high to the tune of 80 and above. This information is in respect of factories whose invested capital is less than Rs.3 crores. The GVA contribution of these sectors is fairly high. In these sectors implementation of pollution abatement measures is apparently difficult.

Kerala : For industry groups 22, 32, 33, 35 the Pollution Load is very high to the tune of 70 and above. This information is in respect of factories whose invested capital is less than Rs.3 crores. The GVA contribution of these sectors is fairly high. In these sectors of industry difficulties arise to implement pollution control measures.

Madhya Pradesh : For industry groups 28, 29, 31, 32, 34 the Pollution Load is very high to the tune of 70 and above. This information is in respect of factories whose invested capital is less than Rs.3 crores. The GVA contribution of these sectors is fairly high. In these sectors implementation of pollution abatement measures is apparently difficult.

Maharashtra : For industry groups 22, 26, 29, 39, 41, 42, 74, 97 the Pollution Load is very high to the tune of 80 and above. This information is in respect of factories whose invested capital is less than Rs.3 crores. However, the GVA contribution of these sectors is not as high as the industry sectors where the expenditure in pollution abatement is low. In these sectors implementation of pollution abatement measures is apparently difficult.

Manipur,Meghalaya and Nagaland : For these states, the pollution load is zero for almost all the industry groups except for industry group 28 in the case of Nagaland. GVA contribution is low for almost all the industry groups as compared to other states. In these states, expenditure for pollution control measures is very low. Orissa : For industry groups 20, 23, 30, 31, 33, 35 the Pollution Load is very high to the tune of 70 and above. This information is in respect of factories whose invested capital is less than Rs.3 crores. The GVA contribution of these sectors is not very high , limited to four digits only. In these sectors of industry there is difficulties in implementing pollution abatement measures.

Punjab : Though Punjab is one of the developed states in India, the Pollution Load in the industrial sector is not very high meaning that the industrial sectors finds less stress in pollution abatement and it may be presumed that the pollution control measure is successfully running in the state. The industry groups with lower invested capital but with high pollution load are 29, 33. The GVA contribution in respect of the first sector is not very significant. In these two sectors there is difficulty in implementing pollution abatement measures.

Rajasthan : For industry groups 20, 23, 26, 28, 30, 32, 33, 35, 97 the Pollution Load is very high to the tune of 70 and above. This information is in respect of factories whose invested capital is less than Rs.3 crores. The GVA contribution is negative in case of industry group 33. GVA contribution of the other industry groups is in four digits except for group 20. In these sectors implementation of pollution abatement measures is apparently difficult.

Tamil Nadu : For industry groups 24, 26, 42, 74, 97 the Pollution Load is very high to the tune of 70 and above. This information is in respect of factories whose invested capital is less than Rs.3 crores. In respect of other industry groups it is quite low. The GVA contribution of industry group 24 is negative, is very low for industry groups 42,74. The contribution is high for industry group 26 in this category. In these sectors there is apparent problems in implementing the pollution abatement measures.

Tripura : For industry group 23 the Pollution Load is very high to the tune of 86.6. This information is in respect of factories whose invested capital is less than Rs.3 crores. However, the GVA contribution of these sectors is not very high. Also the sector 20 has quite high pollution load. These two sectors have real problem of implementing pollution control measures. It is also of concern that the industry groups 22, 24, 25, 26, 27, 28, 29, 31, 33, 40, 42 and 97, the pollution load is zero. These sectors are not apparently spending in pollution control measures.

Uttar Pradesh : For industry groups 23, 27, 31, 35, 37, 39, 41, 74, 97 the Pollution Load is very high to the tune of 70 and above. The GVA contribution in respect of industry groups 35 and 37 is very high and in respect of other groups it is low(in four digits). For these industry groups there is apparent difficulty in implementing the pollution abatement measaures.

West Bengal : For industry groups 32, 33, 35, 97 the Pollution Load is very high to the tune of 70 and above.. The GVA contrib ution of industry groups 32 and 97 is in four digits but in respect of the others it is very high. In these industry groups, the pollution abatement is apparently difficult.

Andaman & Nicobar Islands : the pollution load is zero. In this island there is apparently not expenditure on the pollution abatement measures.

Chandigarh : For industry groups 20, 34, 37, 97 the Pollution Load is very high to the tune of 70 and above. The GVA contribution of these sectors is very low. Apparently, there is difficulty in implementing the pollution abatement measures.

Dadra & Nagar Haveli : For industry groups 20, 26, 31 the Pollution Load is very high to the tune of 70 and above. The GVA contribution of these sectors is very low. In case of industry group 20 the GVA contribution is very low. In these three industry groups there is difficulty in implementing pollution abatement measures.

Daman & Diu : For industry groups 20, 22, 30, 31, 35 the Pollution Load is very high to the tune of 70 and above. The GVA contributio n of industry groups 20,22 and 35 is very low but in case of 30 and31 it fairly high. For these industry groups, there is apparent difficulty in implementing pollution control measures.

Delhi: For industry groups 22, 24, 26, 28, 30, 31, 32, 33, 34, 35, 37, 38, 39, 91, 97 the Pollution Load is very high to the tune of 70 and above. The GVA contribution of industry groups 26,35 is fairly high and it is zero for industry group 91. For other industry groups it is fairly high. For these industry groups have apparent difficulty in implementing the pollution control measures.

Pondicherry : For this UT the pollution load is very low. In most of the industry groups the expenditure for pollution abatement is zero. The GVA contributions from the industry groups having low invested capital are also low. Apparently, the industry in this state does not spending money in pollution abatement measures.

v Large scale industries have low pollution load :

V

In almost all the industry groups in all the states the pollution load is generally low in case of units in which the invested capital is more than Rs. 3 Crores and above i.e. the large scale units. The GVA contribution of these sectors is very much high. The industry groups in which pollution load is high are given in the following table. In these sectors, apparently there is difficulty in implementing pollution control measures.

Table 4: Showing the Industry Groups with high Pollution load

State	Industry Group	Stratum	Pollution load	GVA (In Rs.Lakh)
Andhra Pradesh	24	S3	43	5680
Goa	38	S3	58.5	1586
Gujarat	26	S3	39	1974
Haryana	23	S3	33.1	2157
	38	S3	58.5	5684
Madhya Pradesh	23	S3	29.3	34349
Maharashtra	29	S3	49.9	3219
	38	S3	41.6	36493
	39	S3	68.2	11828
Orissa	35	S3	32	2753
Uttar Pradesh	29	S3	49.9	2009
West Bengal	40	S3	51	368038

v Electricity sector has lower pollution load in comparison to the GVA contributed by this sector. This is the sector where there is less number of units where the invested capital is less than Rs.3 Crores. The following table will show the pollution load of the electricity sector and the contribution of this sector in the GVA state wise. In most of the cases the pollution load is low. This sector is apparently not spending for pollution abatement measures.

In respect of Bihar, the pollution load is at comfortable level. In other states, the spending for pollution abatement purposes is abysmally at a low level. The number of units with lower 1C and higher pollution load are larger in number with significant total GVA contribution.

Table 5: Showing Pollution load of the Electricity sector and the contribution of this sector in GVA

State	Stratum	No. Of units	Pollution Load	GVA (In Rs Lakh)
Andhra Pradesh	S2	8	0	1702
	S3	100	0	233692
Assam	S3	67	32	1234
Bihar	SI	39	100	26231
	S2	3	75.6	554
	S3	174	0.4	182369
Goa	S3	31	0	6935
Gujarat	S3	148	15.7	333079
Haryana	S3	150	0	16079
HimachalPradesh	SI	5	0	355
	S2	2	0	10302
	S3	120	0	31142
Jammu & Kashmir	S3	61	0	4834
Karnataka	SI	2	0	609
	S2	3	0	4510
	S3	152	0	151888

State	Stratum	No. Of units	Pollution Load	GVA (In Rs Lakh)
Kerala	SI	2	0	-202
	S2	2	0	390
	S3	16	0	40516
Madhya Pradesh	SI	2	0	0
	S2	4	0	1116
	S3	75	0	106162
Maharashtra	SI	3	0	209
	S3	813	0	701876
Manipur	SI	1	0	0
	S2	4	0	242
	S3	1	0	6129
Meghalaya	S3	4	0	2028
Nagaland	S3	1	0	-410
Orissa	SI	1	0	58
	S3	65	2.77	267282
Punjab	SI	3	0	459
	S3	250	0	80399
Rajasthan	SI	1	0	47
	S2	1	0	380
	S3	171	0	230769
Tamil Nadu	S2	1	0	267
	S3	157	0	227117
Tripura	SI	8	0	1352
	S2	2	0	173
	S3	2	0	855
Uttar Pradesh	SI	4	0	508
	S3	104	26.8	496764
West Bengal	SI	7	0	266
	S3	840	51	368038
Andaman & Nicobar Islands	S3	29	0	-744
Chandigarh	SI	1	0	32
	S3	1	0	939
Delhi	S3	1	4.51	102635
Pondicherry	S2	2	0	1274

Conclusion

This paper attempts to find an explanation that why the small manufacturers are not geared up to take measurers on pollution abatement by obeying the standard norms of Pollution Control Board. It may be noted that the pollution load here is not given in physical terms as understood by the Pollution Control Board. This is not the load of pollutants on the environment. This indicates a relative stress on an industry for then-expenditures and capital investment in pollution abatement and degree of non-performances of such measures. One should think in this way that if he spends a good amount on the education of his children and they do not perform to the ambient standard of your society then he feels a stress. We have worked to assess this stress in industries. An alternative attempt using non-market valuation technique can also be imposed but we need to have fresh survey for it. Location and concentration wise the small manufacturers are concentrated mainly within the residential areas and they jointly make more damage to the environment. Often the 'shut down' orders are imposed upon them but such practice in long run adversely affects the national economy both in terms of aggregate income and employment. This paper has shown by a mathematical sensitizer that the industries with lower invested capital in the business face high degree of pollution load than that the industries with high capital investment. This is an index, which can also measure the degree of resistance within the industries to make further investment for abating pollution only. It may also suggest the policy makers to initiate common affluent treatment plant and provide subsidy to eliminate the pollution. Pollution tax will not be a solution, as it will lead higher load for already loaded industries with low investment.

Annexure I

Table Showing State-wise Pollution Load according to Invested Capital under different Industries

Andhra Pradesh

NIC-87 Code	Stratum	No. of Units	Pollution Load	GVA (in Rs. Lakhs)
20	S1	5143	89	52502
20	S2	110	4.59	55594
20	S3	55	4.42	60334
22	S1	2254	86.9	16464
22	S2	3758	7.5	45313
22	S3	4	2.38	15617
23	S1	889	86.6	20785
23	S2	57	53.6	9985
23	S3	13	0	12060
24	S1	114	82.8	1624
24	S2	7	0	3247
24	S3	2	43	5680
25	S1	46	0	154
25	S2	5	0	4921
26	S1	71	0	626
26	S2	19	82.1	3480
26	S3	1	0	235
27	S1	101	0	394
27	S2	5	0	3188
28	S1	328	0	12156
28	S2	5	16.1	9938
28	S3	15	0.15	13342
29	S1	17	81.9	243
29	S2	5	42.8	131
30	S1	499	16.2	12320
30	S2	130	31.2	36436
30	S3	46	39.2	69991
31	S1	568	86.6	25984
31	S2	34	16.5	6351
31	S3	2	0	21421
32	S1	1868	92.1	15718
32	S2	73	51.5	32114
32	S3	21	8.52	70695
33	S1	254	19.6	11245
33	S2	15	23.7	3682
33	S3	28	0.04	80261
34	S1	667	0	6678
34	S2	28	0	6368
34	S3	10	0	5036
35	S1	680	95.1	12506
35	S2	37	65.5	27305
35	S3	20	22.4	121339
37	S1	105	0	4801
37	32	23	0.35	11988

NIC-87 Code	Stratum	No. of Units	Pollution Load	GVA (in Rs. Lakhs`
37	S3	2	0	3809
38	S1	64	96	889
38	S2	3	0	724
38	S3	6	0	11427
39	S1	292	96	18143
39	S2	3	96	4864
40	S2	8	0	1702
40	S3	100	0	233692
42	S1	29	0	952
42	32	1	0	146
74	S1	46	0	1716
74	S2	1	0	46
97	S1	121	0	4556

Gujarat

NIC-87 Code	Stratum	No. of Units	Pollution Load	GVA {in Rs.Lakhs)
20	S1	1086	90.2	14294
20	S2	77	21.5	24705
20	S3	42	7.96	57558
22	S1	167	90.6	1846
22	S2	20	0	5910
22	S3	1	0	318
23	S1	811	93.5	14391
23	S2	69	14.2	15452
23	S3	29	6.15	73086
24	S1	997	93.3	37555
24	S2	225	40.8	26168
24	S3	20	0.17	31312
25	S1	1	0	12
26	S1	213	96	4719
26	S2	8	0	1694
26	S3	2	39	1974
27	S1	229	0	1544
27	S3	11	0	14
28	S1	536	19.8	15089
28	S2	33	42.3	4785
28	S3	7	19.5	4541
29	S1	10	81.9	196
29	S2	4	0.82	308
30	S1	1296	29.5	33401
30	S2	289	27.9	120551
30	S3	147	0.4	707706
31	31	687	57.7	13518
31	32	96	59.9	8842
31	S3	7	0.4	271180
32	S1	1393	20.8	10900
32	S2	63	19.3	10980
32	S3	29	0.67	108461
33	S1	723	48.1	18125
33	S2	102	23.1	15260
33	S3	59	0.59	127840
34	S1	910	94.1	10915
34	S2	29	0	2736
34	S3	12	0.49	6133
35	S1	1787	95.1	40272
35	S2	172	54.5	53154
35	S3	28	0.09	68956
37	S1	192	0	10155
37	S2	61	62.4	10794
37	S3	3	14.3	4621
38	S1	210	96	6881
38	S2	23	0.86	8581
39	S1	113	0	8317

NIC-87 Code	Stratum	No. of Units	Pollution Load	GVA {in Rs. Lakhs}
39	S2	16	0	10670
40	S3	148	15.7	333079
41	S2	14	0	2041
41	S3	1	0	1356
42	S1	14	0	495
42	S2	1	0	32
43	S2	1	0	395
74	S1	23	93.2	774
74	S2	1	0	83
91	S1	14	0	280
97	S2	23	0	765

Karnataka

NIC-87 Code	Stratum	No. of Units	Pollution Load	GVA (in Rs. Lakhs`
20	S1	1054	83.8	28096
20	S2	69	18.6	30434
20	S3	22	11.6	34905
22	S1	170	39.2	5157
22	S2	22	15.2	5134
22	S3	5	0	47011
23	S1	420	72	9345
23	S2	24	16.6	6527
23	S3	5	0	14749
24	S1	128	0	1128
24	S2	18	84,3	6741
24	S3	15	3.04	55153
25	S1	5	0	41
26	S1	512	96	24424
26	S2	55	4.8	24227
26	S3	5	0.01	2289
27	S1	165	0	1354
28	S1	318	58.8	7576
28	S2	17	19.6	4167
28	S3	5	0	19268
29	S1	44	66.9	2356
29	S2	25	0	6314
29	S3	3	0	224
30	S1	327	73.3	18037
30	S2	61	2.79	22766
30	S3	11	0.56	11729
31	S1	342	0.92	6454
31	S2	13	0.01	3977
31	S3	5	14.1	26313
32	S1	394	90.3	8328
32	S2	30	0	3446
32	S3	10	0.26	48618
33	S1	178	0	5918
33	S2	40	49.3	27370
33	S3	17	10.6	11080
34	S1	437	25	7273
34	S2	7	6.48	3723
34	S3	13	45.3	6675
35	S1	900	2.17	43123
35	S2	188	46.7	77107
35	S3	41	11	108821
37	S1	130	0	8061
37	S2	30	0.01	9419
37	S3	5	0	35208
38	S1	118	91.2	4173
38	S2	17	0	454
38	S3	4	10.8	8101

NIC-87 Code	Stratum	No. of Units	Pollution Load	GVA (in Rs. Lakhs`
39	S1	147	96	8123
39	S2	12	0	5377
39	S3	61	0	40123
40	S1	2	0	609
40	S2	3	0	4510
40	S3	152	0	151888
41	S1	1	0	45
41	S2	2	67.5	525
42	S1	15	0	472
42	S2	2	0	118
91	S1	3	0	90
95	S1	6	0	1055
96	S1	23	0	302
97	S1	27	0	232
97	S2	5	0	684

All India

NIC-87 Code	Stratum	No. of	Pollution Load	GVA (in Rs.
XX	XX	136001	17.4	19823672

e-GOVERNANCE APPLICATION FOR ENPLAN UTILIZING ENVIRONMENTAL STATISTICS

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INTRODUCTION

Human habitat, environment and endeavour are in a constant state of flux. Planning and execution of programmes towards its betterment require a very large amount of data monitoring in a time sequential mode and a study of interaction between various components of the system.

The task of a planner essentially involves weaving together the geographic location, specific resource database with socio-economic phenomena and the environmental impact in order to understand and formulate policy decisions towards development of an area. The database required as such would depend on the level of planning exercise and the level at which the exercise would be applied and also the level of development of thrust envisaged in the process.

The diversity and complexity of environmental problems require correspondingly higher levels of knowledge processing so that the present and the coming generations ultimately learn to address ecological problems more systematically rather than emotionally.

The endeavour towards integrating databases like socio-economics, natural resources and environment offers many tangible solutions. An attempt is made in this document towards e-Governance application for environmental planning.

NATURAL RESOURCES AND DEVELOPMENT

Resources given to the humanity by Nature have a vital bearing on the Socio-economic life of the country. The information about their occurrence and their utilization enables to analyse as to how best these could be used for the maximum benefit of the society.

The resource-availability is a static concept (if confined to a point of time) as well as a dynamic concept (if one considers resources over a period of time). They are essentially variable, although their availability cannot be predicted with any certainty.

There are two important aspects which need attention in regard to available of Natural Resources. Their supply is limited at a point of time. They are not a given quantity. The nature and amount of resources that a country has at a point of time are dependent upon the discoveries made and knowledge applied to their use, which is turn are linked with the society's requirements determined by economic and social conditions. The resources grow as more and more effort and knowledge are brought to bear on them. Many resources now available never existed in the past in the sense that man had no knowledge of them. The amount of resources may also undergo changes with the passage of time.

Natural resources of a country influence not only economic growth, but also its economic structure. The type of resources available, their quantities, their distribution within the different parts/regions of a country determine to a considerable extent the type and scale of industries that can be developed. The agro-climate of a country, for instance, affects, agricultural products that can be produced economically. Similarly, the occurrence of water, winds, fossil fuels etc., shape the energy-pattern.

There is now greater awareness of the role that natural resources play in socio economic life. And there is greater concern shown about their proper utilization and conservation. This interest has been further heightened by the dangers that pollution of water, air etc., pose on account of indiscriminate and improper use of these resources.

Initial economic activity takes place and has in the past taken place with man working upon natural resources. Making fire, cultivation of plants, domestication of animal, making of pottery, making of tools etc., all were directly based upon Nature. With the advancement of science and technology, man-produced capital acquired increasing importance. Natural resources came to be used by man directly or/and with the help of capital for the production of goods.

A look at the abundant resources of India, an overwhelming part of which lies untapped, is enough to convince one that India's poor live in a rich country. In fact one can even define poverty of the people in terms of the per capita unutilized resources. To use these resources, keeping in view the current and future needs, should be the imperative requirement. For the prosperity that can flow from the utilization of these resources has to be spread over time so that the present and future generations can benefit from them.

The impact of environmental degradation in conjunction with depletion of natural resources has a dominant role in the socio-economic development.

The situation until recently, was such that concern over environmental quality was ignored in the process of marshalling resources to meet priority development goals. Higher agricultural productivity, maximizing incomes and boosting living standards, balanced development among states and improved health care are but a few of such goals. Development thus proceeded rapidly, with industrialization being the favoured path for accelerated socio-economic growth through increases in output, income and job opportunities.

The very process of rapid development spanning mining, forestry, estate development, agriculture, land settlement, urbanization and industrialization brought to the fore problems of a second order, namely, damage and disruption to the environment, which not only began to emerge but also gain in significance from year to year.

The diversity and complexity of environmental problems require correspondingly higher levels of knowledge processing so that the present and the coming generations ultimately learn to address ecological problems more systematically rather than emotionally

ENVIRONMENTAL PLANNING (ENPLAN)

The environmental implications of poverty and under-development and the inter-relationships between development, environment, population and resource must be taken into account in the process of development and planning. It is essential to avoid environmental degradation and necessary give to future generations the benefits of sound environment management. There is a need to ensure an economic development which is environmentally sustainable over the long run and which protects the ecological balance.

The environmental policies that evolved over the years are generally consistent with the concept of sustainable development. Some of the significant features of the policies include the following elements;

- maintain the quality of the environment relative to the needs and aspirations of the growing populations;

- preserve a country's unique and diverse cultural and natural heritage;

- minimise the impact of growing population and human activities relating to mineral exploitation, deforestation, agriculture, urbanization, tourism, and the development of other resources both renewable and non-renewable, on the environment through restorative and preventive measures;

- balance the goals of socio-economic development and the need to bring the benefits of development to a wide spectrum of the population with the preservation and protection of the environment through proper environmental management; and

- promote greater cooperation and increased coordination in environmental management at all levels of the governments.

The lack of due attention to environmental factors in development planning has led to significant environmental degradation, irreversible loss of precious ecological and other natural resources, and in many instances proved hazardous to life and property resulting in, unanticipated social costs, loss of amenity and quality of life.

Of underlying importance is the striking of balance between development and environmental protection and a need to place more emphasis on preventive approaches to environmental management than on curative measures. Accordingly, there has emerged a clear need to modify the traditional methodology and approach of project evaluation adopted by development planners and decision-makers as they are based purely on economic considerations. It is imperative that environmental dimension be incorporated into the development planning process from the outset.

The objective of integrated economic-cum-environmental planning is to prepare good plans, which direct wise investment decisions, thus contributing to sustainable development and benefiting the whole population. A 'good plan' is one which enables there by economic, social, natural resource, and environmental objectives to be satisfied; identifies development strategies which enable all the objectives to be satisfied; and identifies development and projects which are consistent with and facilitates the stated objectives and strategies.

The new strategy is termed YOJANA and the new initiative and the programme envisages provision of secure basic life support systems to the poorer sections of the society at the village level including women and judicious utilization of land, water and biological resources in these areas with an integrated view of ecological, economic and sociological aspects, keeping the man as the focal point. The active participation of the people particularly women in the fulfillment of there basic needs is considered as an essential component of the suggested strategy. YOJANA provides a monitoring and decision support system.

This is the ENPLAN

ENVIRONMENTAL INFORMATION

Any planning requires information. The concept of information is defined as anything that helps in forming, augmenting or altering local schemata around which environmental experience is gained. Spatial information becomes a subset of environmental information. Spatial information can be gleaned from 1) primary and 2) secondary sources. Under primary sources, a lot is gained from direct sensory experience.

The environmental quality varies from region to region within a country/state depending upon the assimilative capacity of a region, population density and the quantity of pollutants causing social damage, the level of valuation and appreciation of the surrounding environment by people in a region etc. All these factors together accord different values regarding the environmental quality to different regions within the country / state.

ENVIS Programme

The Environmental Information System (ENVIS) in the country was established by the Ministry of Environment and Forests, Government of India with has at present a network of 24 centers on various subject areas and a focal point in the Ministry.

The Ministry has launched a major initiative under the World Bank assisted Environment Management Capacity Building Technical Assistance Project (EMCBTAP) to expand the network and the reach through involvement of additional institutions / organizations in State Governments, academic sector, corporate sector, NGO Sector and others.

The project also aims at broadening the ambit of ENVIS to include varying subject-areas, themes, local conditions, issues, information/data needs of the country pertaining to environment and planned to be achieved through enlargement of participating institutions in various sectors and through introduction of modern means of information and communication technologies. The institutions, called ENVIS-EMCB nodes will be assigned a specific subject area in the field of environment and will be responsible for collection, collation and dissemination of relevant information through web-enabled mechanisms.

The proposed programme envisages development of nation wide web enabled network on Environmental Information System.

Under the World Bank Assisted Programme, the ENVIS node network including the ENVIS Centre dealing with various themes and subject areas as well as State Centres having Geographical Coverage extending over the respective states would ultimately reach between 90 and 100.

Environmental Statistics

It is necessary to recognizing the importance of environmental statistics and to develop a system that could meet the growing demands of various governmental agencies, environmentalists and public for data on various aspects of environment. Considering this, the Government of India formulated various working groups, which in turn identified the requirements of such a system and its content covering:

ii. Social and economic activities, natural events

ii. Environmental impacts of activities/events

iii. Responses to environmental impacts

iv. Inventories and stocks

v. Monitoring of the state of environment and its evolution over time, the influences of human activities and natural events on the environment

vi. Evaluation of the performance of projects, programs and plans

vii. Identification of areas of action and the effectiveness of measures taken for environmental protection

The above prioritization would also lead to natural resource accounting. The computation of certain indicators would form the ultimate end products that would provide the basis for a decision support system based on environmental statistics.

Environmental statistics help gauge the well being of a country and can indicate the first signs of a malaise. Unless existing databases are enlarged and new parameters brought in, the developing countries face the danger of becoming one of the ecologically dustbins. It is knowledge that can embody and add value to the reconceptualisation of environmental strategies and conservation measures being initiated in a country.

THE e-GOVERNANCE APPLICATION

The world has moved from industrial era to the present day knowledge era, the factors of production are changing. Industrial society was built around materials and machines and in this knowledge era the people become the focal point.

The Internet is an important element in this knowledge era. The Internet is a vast collection of inter-connected networks that use a common language called TCP/IP. The Internet rose from the Arpanet and today links billions of computers in almost every country of the world.

The e-Governance is to govern utilizing these technologies of communications networking Internet and e-Commerce to provide good governance for the people.

Good governance is a sine qua non for the orderly functioning of society. The government / State seeks to further improve its citizen and business interfaces and intra-governmental processes with a better use of Information Technology. e-Governance, while using IT as a strategic tool attempts to simplify procedures and revamp processes, that will bring about several benefits including any-time, any where services to citizens.

e-Commerce in its simplest definition is doing business electronically, specifically over the Internet. Though the Internet did not create e-business, of the many changes it has wrought, the most important has been its catalytic role in the explosive growth of e-business. Today, for example, India has over 300 Internet service providers (ISPS) competing in terms of price and introducing more innovative services.

An attempt is made here to present e-Governance for its functionality in the Indian context in respect of environmental concerns towards ENPLAN.

A few of the most commonly referred environmental concerns related to planning and establishment of industrial and infrastructure project as well as area specific developmental programmes are examined in the light of e-Governance application.

- Municipal Solid Waste Disposal Sites
- Hazardous Wastes Landfill Disposal Sites
- Biomedical Waste Disposal Sites

- Coastal Installation like Ports, Harbours,
- Offshore Installations and Intake and discharge installations for industries
- Major Petrochemical Industries
- Power Plants
- Special Economic Zones
- Eco-tourism Projects
- Pipeline Corridors
- Super Highways
- Inland Waterways
- International Air Ports

Some of the General Issues of importance in regard to Environmental Concerns could be listed as follows. These are described in brief.

Sustainable Development

Environmental despoilment and depletion of natural resources affect not only the present but also the future generations.

Sea Level Rise

The impact of sea level rise envisaged in the next decade and further on, is of great environmental concern for India and also for the Indian islands. There is a requirement to build a specific database of attributes, which would indicate the impact of sea level rise.

Environmental Audit/Statement

The Environmental Statement was initially meant to be a management tool based on the concept of self-regulation and need not necessarily be submitted to the Government. It was supposed to be a voluntary policy that can be adopted by an industry as part of its eco-safety operations. However, the Indian Government has made it compulsory for an industry to submit its EA/ES report.

STATE OF ENVIRONMENT REPORT (SOER)

The State of the Environment of a region or country refers to the prevailing conditions from two perspectives - biophysical condition and socio-economic condition. State of the

Environment Reporting (SoER) provides a general picture of the state of the bio-physical and socio-economic condition and an understanding of how human activities affect the environmental conditions and its implications on human health and economic well-being. It also provides an overview of the outcome of responses such as policy initiatives, legislative reform and changes in public behavior.

The national SoER must include information addressing global, universal and regional issues. For example, climate change and ozone layer depletion are obviously global issues. Global and regional issues also need local and national level actions to aid the action at the global level. Universal issues such as population pressure, affect all countries, but need local level action to change. The report has to seek to assess environmental information and issues against the principles of ecologically sustainable development. The report has to be guided by a conceptual framework that facilitates the development of information to provide answers for fundamental issues such as the environmental conditions and trends, the human and natural causes of these changes, the bio-physical and socio-economic implications and societal responses for protecting the environment.

Users of SoE Products

The needs of SoE information users are important in determining the most appropriate SoE reporting system. The SoE reports have a large pool of potential users for both the monitoring and reporting functions of the system. Below is a list of potential users:

- the general public, as well as certain specific community interest groups;
- schools, at the primary, secondary and tertiary levels;
- industry groups;
- government decision - makers;
- natural resource planners and managers;
- the print and electronic media; and
- international agencies.

Each of these groups has its own set of needs and expectations from the SoE reports. The level of details needed will vary greatly from the scientists to the schools.

Some of the potential products of the SoE reporting program that may be produced and used by different users are listed below:

- State of the environment report and summaries, subject specific reports, technical papers and reports, methods and applications;

- Indicator bulletins, with information about specific issues;
- Educational and public awareness kits;
- Brochures, newsletters, videos and computer based information;
- An atlas of the nation's environment; and
- Integrated data sets for analysis and use in models and maps.

CONCLUSION

The State of Environment Reports at various levels of administration and ecozonation, the e-Governance applications which supports a technical, rational and scientific decision making process and web-based distributed information system with the integrated database of environmental and general statistics are essential elements of the planning exercise towards sustaina ble development.

Chapter Five

Summary of Technical Sessions

Concluding Remarks and Recommendations

Summary Record of The Proceeding of the Technical Sessions

There were four technical sessions in the seminar. These are:

a) Review of work done towards improvement of Environment Statistics
b) Development of framework for Natural Resource Accounting for India
c) Database need for assessment of Environment problems
d) Issues on Management of Environment

In all fifteen (15) technical papers were received. However three (3) papers could not be presented due to absence of the concerned paper presenters. The summary of technical papers presented in various technical sessions is given in the following paragraphs.

Technical Session -I : Review of work done towards improvement of Environment Statistics

This Session was chaired by Prof. Amitava Kundu of Jawarlal Nehru University, New Delhi. There were two papers presented in this session. The first one was from the Central Statistical Organisation on *Work undertaken by CSO in the field of Environment Statistics,* presented by Shri Rajesh Bhatia, Assistant Director, CSO and the second paper on *Data need for forest resource reporting* jointly written by Prof. Ranajit Chakrabarty and Prof. A. Pal and was presented by Prof. Ranajit Chakrabarty, Dean and Head, Department of Business Management, Calcutta University.

I. Work undertaken by CSO in the field of Environment Statistics by Shri Rajesh Bhatia

Shri Bhatia gave a historical background on how the Environment Statistics Unit was set up in CSO in 1996 as a consequence of deliberations in the Fifth and Seventh Conference of the Centre and State Statistical Organisations. He also mentioned that CSO undertook an ADB sponsored project on "Institutional Strengthening and Collection of Environment Statistics" and under the project a Steering Committee on Environment Statistics was constituted with an objective to give guidance for preparation of framework for the development of environment statistics. This had resulted in the publication entitled "Compendium of Environment Statistics" which contained data on various aspects of environment and was published in 1997.

In the area of Natural Resource Accounting (NRA), CSO adopted a three-pronged strategy, namely, a) examination of available statistics for green accounting; b) firming up of methodologies and c) taking up of supplementary sectoral studies. Accordingly, TERI was given a Pilot project at Goa with the following objectives :

- Development of physical accounts of natural resource depletion or enhancement and environmental degradation or improvement;

- Valuation in economic terms, natural resource depletion or enhancement and environmental degradation or improvement (to the extent possible);
- Adjustment of state domestic product to account for natural resource depletion or enhancement and environmental degradation or improvement.

The final report of the Phase-I, which was based on secondary data, was made available in 2001. The following sectors were covered in the first phase of the project, namely, a) Land Use; b) Forests; c) Minerals (Iron Ore); d) Energy emission accounts for domestic sector and e) Energy and emission accounts for transport sector.

In order to provide a common platform for interaction between data users and producers as well as policy makers, the CSO has been organising National workshop on Environment Statistics from time to time. The first one was organized in Goa during January 12-13, 1998. The second one was held in Hyderabad during 6-7, April 2000 and the third one was held in Trivendrum during February 8-9, 2001.

Towards capacity building CSO has been organising training programme on environment Statistics from time to time.

//. Data need for forest resource reporting by Prof. Ranajit Chakrabarty:

In this case study the authors examined the data produced by various central and state government organisations/ agencies and had shown how statistical data could be used in a systematic manner to strengthen *Control* measure of resources. The controlled function of forest management included three major activities, namely, a) measurement of forest inventory, b) recording of forest inventory, and c) reporting of forest inventory. Dr. Chakraborty summarised the National Forest policy of 1988 which worked as a control measure. He studied data of forest cover for six districts of West Bengal for the years 1988, 1991, 1994, 1997 and 2000 as depicted by the records of State Forest Department and that by the Forest Survey of India and observed that the data generated by the State Forest Department were better than those by the forest survey of India. The authors then examined pros and cons for development of accounting model based on flow of resources and suggested a simple design. However, the authors observed that the unit of measurement of forest inventories is in square kilometres so far as West Bengal is concerned, which is not appropriate for accounting system as the flow i.e. increase or decrease in forest resources during a period of time of plantation, natural growth, felling of trees or pruning of branches can not be measured in sq.km or Hectare. Hence in their study the cubic metre was considered as the unit of measurement of forest resources. Prof. Chakraborty was of the opinion that this would be suitable for measurement of both stock and flow.

The authors, in their case study, computed stock of forest inventory in hectares as on April 1, 1996 and April 1, 2001 and flow of forest inventory in cubic meter for the years 1996-97 to 2000-

01. The study attempted to introduce an accounting model in the recording and reporting system of forest resources in West Bengal. The Statistical data generated by different authorities at different levels had been applied to produce the statement of forest account for the Kharagpur Social forestry division of West Bengal.

Prof Kundu, the chairman of the session thanked Shri Bhatia for his excellent presentation on the past work done by the CSO on Environmental Statistics. The chairman also thanked Prof. Chakraborty for his thought provoking presentation on the methodology for generating Environmental Statistics pertaining to the forestry sector. The chairman also invited comments/ feedback from the participants.

Prof. Murty, IEG felt the need for more coordinated efforts in this area in view of fragmented nature of activities presently going on for development of environment statistics. He was also of the opinion that in the forestry sector there is a need to generate data on stock, flow in terms of activities. Dr. Madhu Verma. IIFM expressed the need for compilation of all India report based on "State of environment reports[1]' published by various governments. It was pointed out that only the government of Tamil Nadu has brought out state Compendium of environment statistics. Prof Tiwari, NEHU appreciated the work done by Prof. Chakrabarty but felt the need for more study on ***non-timber forest products,*** where data availability was much poor. Dr. Datt, TERI felt the need for standardisation of methodologies under one umbrella. Prof. Thukral suggested for collection of forest canopy data along with forest cover data. The need for recording forest data in cubic meter for estimating timer was well appreciated. The Director, DES, Arunachal Pradesh mentioned that many projects relating to environment statistics could not be carried out in his State due to lack of staff in the Directorate of Economics & Statistics, Arunachal Pradesh, Many participants were of the view that the CSO should take the leading role for bringing out environment statistics at the state level following similar concepts, coverage and methodology, which is a prerequisite for the development of natural resource accounting. Dr. Saha mentioned that, as explained in the paper presented by Shri Bhatia, the CSO is taking keen interest in this subject after the historic Stockholm Conference in 1972. The annual publication entitled Compendium on Environment Statistics is the product of such initiatives. The States also require taking similar initiatives for which the CSO will provide all technical cooperation. Dr Saha further mentioned about the studies which have been recently taken up by the CSO in the various sub-sectors like air, water, land, mining etc., as a follow up of the Goa project on natural resource accounting.

Prof Kundu thanked the experts for their observations made on the papers presented in the session and appreciated the role performed by the CSO in respect of bringing out environment statistics. He further mentioned that there are a number of websites, which are bringing out various kinds of reviews on environment on different subjects in major sectors. We should utilise this modern technology fully to acquaint ourselves with the latest development in this area. The chairman also felt that the concern for the important environmental parameters had to be based on comparable framework otherwise there would be problem of cross-sectional comparability and for this purpose the CSO should continue to take the leading role.

Technical Session II: **Development of framework for Natural Resource Accounting for India**

Prof. B.B.Bhattacherjee, Director, Indian Institute of Economic Growth aired this session. Four papers were presented in this session. These are:

a) Accounting for Ecosystem Diversity: Theory and Practice by Dr. A.Mishra and M. Mishra, CMDR, Karnataka

b) Development and Harmonization of Framework for Natural Resource Accounting in India - An experience from forestry and wetland ecosystem by Dr. Madhu Verma, IIFM, Bhopal

c) Measuring Environmentally Corrected Net National Product: Case Studies of Industrial Water Pollution and Urban Air Pollution in India by Prof. MN.Murty, IEG, New Delhi

d) Natural Resource Accounting in India: Theory, application and concerns by Dr. Divya Datt, TERI, New Delhi

I. ***Accounting for ecosystem Diversity: Theory and Practice*** by
Dr. A.Mishra:

The first paper was presented by Dr. Arabinda Mishra. This paper primarily talked about quality aspect of an ecosystem. It pointed out the demerits in finding out *Total Economic Value* (TEV) for economic valuation of ecosystem. Dr. Mishra highlighted the ecological significance of ecosystem diversity to the system itself. According to the authors, the TEV failed to capture the "true value" on account of critical role of ecosystem, namely, *ecosystem diversity* due to limited understanding of the full complexity of the biotic and abiotic interactions of the structure of ecosystem and not possible to gauze full range of functions of ecosystem. Moreover, the non-anthropocentric interactions (biotic-biotic, biotic-abiotic, aboitic-abiotic) within the ecosystem could not find any place in the TEV scheme.

Dr. Mishra confessed that the valuation methodology of ecological contribution to the ecosystem diversity was in evolving stage. He mentioned about various experiments which were going on for building up the technique of valuing ecological services to ecosystem diversity.

In order to demonstrate diversity within cultivated landscape, which was relatively easier than accounting of diversity associated with natural ecosystem, Dr. Mishra used the data of cropping pattern and crop violation and soil problems in irrigated command areas of the State of Karnataka. The paper included the formulation of various Diversity Indices. He used the data of

Karnataka and computed Shannon Diversity Index for crop grown in five sub-zones of the dry agro-climatic zone of Karnataka. On the basis of the case study, Dr. Mishra stressed the need for building up physical accounts of ecosystem diversity.

II. ***Development and Harmonization of Framework for Natural Resource Accounting in India - An*** *experience* ***from*** *forestry* ***and wetland ecosystem*** by Dr. Madhu Verma:

The second paper was presented by Dr. Madhu Verma. At the outset, Dr. Verma described the essentialities of SEEA- System of Integrated Environmental and Economic Accounting, which involved the three stages, namely, a) Physical accounting, b) Monetary valuation and c) Integration with national income accounts.

She described how the UNSD proposed the satellite system for environmental accounting that did not make any change in the core system of SNA, but proposed establishing linkages between the SNA and the integrated economic and environmental accounting.

In her paper she had quoted the works done by different researchers for developing NRA including FRA (Forest Resource Accounting) and she was of the opinion that the natural resources could be separated as a set of activities of an Input-Output table used by the Central Statistical Organization. In that case, she argued, the outflows from such natural resource sectors would be absorbed by other sectors of the economy. She also mentioned that NRA could be generated by taking into account the depletion of natural resources using cost based approaches like user cost method and depreciation or net price method.

At the end, she posed various problems for computation of NRA like lack of availability of specified format for data generation and data for valuation in Indian context. Among major limitations she mentioned about the chances of overlapping of values, which might lead to double counting.

III. ***Measuring Environmentally Corrected Net National Product*** *: Case* ***Studies of Industrial Water Pollution and Urban Air Pollution in India***
by Prof. M.N.Murty:

Prof. M.N.Murty of the Indian Institute of Economic Growth presented the third paper. Prof. Murty discussed the methodology of natural resource accounting as given in the United Nations System of Integrated Economic and Environmental Accounting (SEEA). Various methods of valuation of environmental services were also studied. In this paper, physical and monetary accounts of industrial water pollution and urban air pollution were developed. The data used in this paper were from two surveys of water and air polluting industries in India, namely, 'A Survey of Water Polluting Industries in India, 1996' and 'A Survey of Water and Air

Polluting Industries in India, 2000' conducted by the Institute of Economic Growth, Delhi. The data from these surveys provided information about the characteristics of polluting firms. The monetary accounts developed in this paper explained the cost of reducing the water pollution from the current level to the safe standards and damages avoided to local households by reducing the urban air pollution from current level to safe standards.

III. *Natural Resource Accounting in India: Theory, application and concerns* by Dr. Divya Datt:

The last paper of the session was by Dr. Divya Datt of TERI. In the first part of her paper she described the theoretical aspect of natural resource accounting based on SEEA. She then described the experience of TERI relating to Phase-I of Goa project of the Ministry of Statistics and PI, which was undertaken by them based on secondary data. She also presented salient features of the Goa project and mentioned the key findings as well as existing data gaps.

Finally, she discussed on NRA framework for India, which could be used at national and state levels. She was of the opinion that framework should be dependent on national priorities. This needed evolving of consensus on certain conceptual issues like choice of valuation methods, choice of discount rates, defining the limits to monetary valuation of environmental assets/ services. She emphasised the need for special studies to improve the accuracy of valuation. She also advocated for reduced format as suggested by Bertelmus and other experts.

The chairman thanked all the experts for presenting their papers and offered his brief comments on the four papers. He then requested the participants to make their observations on these papers. A number of observa tions were made on all the four papers presented in this session. At this stage, the Director, DES Arunachal Pradesh expressed his concern due to improper representation of North Eastern States in the workshop. The important observations made on the four papers are as follows:

Prof. Kundu thanked Dr. Mishra for his paper. He, however, opined that the formulation of diversity index is to be looked into more closely. On the paper by Prof. M.N. Murty, Prof. R, Chakrabarty expressed his doubt on use of Hedonic method, which produced very low value of the statistic " R~ ". He suggested some alternatives also to Prof. Murty. On the papers presented by Dr. Verma and Dr. Datt, Prof Bhattacharjee commented that the accounting system of 'National Account' and 'Natural Resource accounting' were not exactly one. But when measuring impact, care had to be taken for the welfare implication carrying the impact on the entire economy. He also pointed out that natural resources were basically stock concept while the income would be flow concept. Prof. B.B.Bhattacherjee, therefore, felt that the reference of "Hicks" concept is to be used judiciously.

Technical Session -Ill: Database need for assessment of Environment problems

The third session was held on 23rd April 2003. It was chaired by Prof. Amitava Kundu. Three papers were presented in this session. These are:

a) Data need for Solid waste Management including hospital wastes by Shri O.K.Saxena, Director of Economics and Statistics, Government of Uttar Pradesh

b) Data Need for Assessment of Agro-Environmental Pollution by Prof. M. M. Adhikary, Dean, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohonpur, West Bengal

c) Data Need for Assessment of Environmental Problems in the Area of Agriculture by Shri Meera Sahib, Director of Economic and Statistics, Government of Kerala.

I. ***Data need for Solid waste Management including hospital wastes*** by Shri O.K.Saxena:

In his paper Shri O.K.Saxena highlighted the importance of proper waste management, particularly solid waste management in the context of urban areas. Broad classification of the solid waste was also discussed giving special emphasis on hospital wastes. The paper then discussed the data needs for solid waste management pointing out the scarcity of available data in this field. It was also suggested that a system should be established to collect the statistics of municipal wastes, hospital wastes and industrial wastes. The paper then briefly discussed the results of a study carried out by a team of Central Pollution Control Board in three types of hospitals run by Government, Private and Missionary in order to assess the waste generation and management practices in different hospitals in Lucknow, leading to quantification of infectious waste in the form of a waste generation factor. In the end, the paper emphasized the need of awareness about proper segregation and management of bio-medical wastes.

II. ***Data*** *Need for* ***Assessment of Agro-Environmental Pollution*** by Prof. M. M. Adhikary:

Dr. M.M.Adhikary presented the second paper. Dr. Adhikary stressed on the need for assessment of pollution of the agro-environment and its protection. For that he expressed the need for information on the nature and extent of pollution in this zone. The paper discussed on the data need for assessment of

a) Pollution due to uncontrolled use fertilizer
b) Pollution due to use of pesticides
c) Presence of heavy metals in sewage water
d) Soil salinization
e) Soil sedimentation

He mentioned the details of indicators for which data were needed for the country as such.

///. ***Data** Need for **Assessment of Environmental Problems in the Area of Agriculture*** by Shri Meera Sahib:

In his paper Shri Meera Sahib discussed the history of agricultural statistics system in India, the development of environment statistics and indicators as well as the notion of sustainable economy. The paper elaborately discussed the availability of data on various issues like agriculture, land degradation and land use statistics. Further, the institutional mechanism for environment statistics on agriculture was also discussed in detail.

The above papers were well appreciated. Shri Meera Sahib requested Shri Nath to include collection of a few environmental indicators in the forthcoming pilot to be undertaken by the CSO in vario us States for the development of database at local level under the guidance of a High Power Committee under the Chairmanship of Dr. S.P.Gupta, Member, Planning Commission.

Technical Session-IV: Issues on Management of Environment

This session was chaired by Prof. S.C.Santra, Department of Environmental Science, University of Kalyani, Nadia, West Bengal. Three papers were presented in this session. These are:

a) Comprehending Technological Disasters in India by Renu Bhardwaj, M.S.Bhatti and A.K.Thukral, Guru Nanak University, Amritsar

b) Matrix Model for Inventorisation in Life Cycle Assessment of a Product by Prof. A.K.Thukral and B.P.Singh, Guru Nanak University, Amritsar

c) Biomedical Waste Management in West Bengal by Prof. S.C.Santra, Department of Environmental Science, Kalyani University, West Bengal.

I. ***Comprehending Technological Disasters in India*** by Renu Bhardwaj:

Ms. Renu Bhardwaj presented the first paper. She briefly enumerated the concepts and classification of disaster including natural disasters brought out by the forces of nature. Further, a brief analysis of the data on technological disasters has been carried out to study the trends in disaster occurrence in India in the recent past on the basis of EM-DAT database being maintained by the Centre for Research on Epidemiology of Disasters (CRED) at the *Universite' Catholique de Louvain,* Brussels, Belgium and the US Office of Foreign Disaster Assistance (OFDA). It revealed that the road transport was the most disastrous of all the disasters and significant rail disasters had the highest annual frequency. It was also pointed out that there was a marginal increase in the disaster related deaths in industrial disasters over the past 10 years. The occurrence of biomedical disasters had, however, been declined over the past few years. This paper also highlighted the lacunae in the database presentation and classification and emphasized the need of a comprehensive disaster database in India.

//. ***Matrix Modelfor Inventorisation in Life Cycle Assessment of a Product*** by Prof. A.K.Thukral:

The next paper was presented by Prof. A.K.Thukral. In this paper Prof. Thukral described the concept of Life Cycle Analysis and its various stages which emerged as important tool to quantify the environmental impacts of any product, process or activity. He mentioned that LCA would be taking up a frontline position in view of implementation of ISO 14000 standards on environment which might become essential for exporting any product abroad. The paper also discussed the method to define the impact of emissions and depletion of resources on the environment. The paper also proposed a matrix model to inventories the process inputs and outputs in the Life Cycle Assessment (LCA) of a product, process or activity. It was also mentioned that the model might be useful in the development of indigenous LCA methodology and generation of data for environmental outputs and resource depletion in the life cycle of a product. He also included the source codes of software for LCA developed under his supervision.

III. ***Biomedical Waste Management in West Bengal*** by Prof. S.C.Santra:

The last paper of this session and of the two-day workshop was from Prof. S.C.Santra on Biomedical Waste Management in West Bengal. This paper examined various aspects of biomedical waste management including legislative provisions made by the Government of India in this regard. This paper also enumerated various methodologies of biomedical waste collection and treatment used in practice. In particular, this paper also highlighted the status of West Bengal Health Service Programme and emphasized the need for awareness and necessity of management practices among the grass root level employees associated with state health service programme.

All the papers were well taken by the participants. In reply to a question from Prof. Thukral, the Chairman explained that the minimum standards of 10 microns was to be followed for use of plastic bags which was recommended for segregation of hospital waste according to different gradation for disposal. Prof. Thukral pointed out that pollution abatement was not enough but by the life cycle analysis (LCA), which was a new technique, would make production technology environment friendly from export point of view.

Valedictory Session and recommendations:

The valedictory session was chaired by Prof. B.B.Bhattacherjee, Director, Institute of Economic Growth, Delhi. Prof. Bhattacherjee initially summarised all the important issues and views expressed in the workshop during the discussions held on 22nd and 23rd April 2003. He then invited suggestions from the participants, which should be included as the recommendations of the workshop. The chairman also mentioned that the suggestions should be constructive so that what emerged from this Workshop, the CSO, State Statistical Departments and other Research Organisations would be able to carry forward and follow up actions. He suggested that in the light of what should be the concrete proposal that should emerge on three aspects i.e. (1) Methodological aspects of the Environmental Statistics on the value and quality of Environmental Statistics; (2) Process and Dissemination of data; (3) Organisational part of these data - the role of CSO and State Statistical Departments and others. Dr. Saha said that the recommendations of this Workshop could be categorized in two groups (1) General and (2) Specific. The comments received from various participants are summarised at Annexure-I.

The Chairman expressed his happiness on the suggestions received from the participants. He observed that most of suggestions were extremely useful and well conceived. He felt that in future one complete session might be devoted on the environmental issues of the State/ region where such organisation would be held. He also appreciated the need for more research in developing sampling design in collection of environmental data. He wondered whether it would be possible to include one chapter on North East in the compendium of environment statistics.

The deliberations of the workshops posed many challenges for proper development of environment statistics in India for which it would need long term policy measures. After a detailed deliberations it was decided to record the following recommendations of the two-day workshop:

a) The CSO might expand the scope of its interaction by associating the international experts and organisations.

b) CSO must try to standardize the concepts for data collection on environment related indicators, in consultation with all State Directorates

c) An expert group might be constituted in CSO to look at the various suggestions emerged in the two-day workshop and examine the indicators presently being compiled in the Compendium, to suggest about their periodicity, inclusion or exclusion, spatial level of desegregation etc. The weakness of the data may be indicated whenever necessary.

d) The CSO should go ahead with methodological study for NRA including one at Meghalaya, taking into account all studies and recommendations by committees etc., made so far.

e) Steps may be taken by all the Directorate of economics & Statistics of North Eastern Region to ensure collection of reliable information on Environment Statistics on a regular basis.

f) For effective documentation on "Environmental Statistics", Directorate of each State should have more effective initiative.

g) The State DES should be entrusted with the task of computing state NRA. CSO may provide necessary technical and financial assistance for the same.

h) Need for preparation of Directory of Organisation/ institutions in the country involved in Environmental research /study / training including development of database of Environment Statistics.

i) The role of remote sensing data may be explored in creation of database of environment statistics.

j) Organization of workshops/ seminars on various specific subjects / sectors so that subject/ sector wise specific guidelines/ standard methodologies may be firmed up

k) In future more such workshops should be held in different parts of the country and there should be more local participation. One full technical session might be devoted based on regional problems and developments.

1) It may be explored whether various universities and research institutes could be taken as partner for field validation of various environmental Data.

At the end, Shri W.L. Lyngdoh, Director of Economics and Statistics, Government of Meghalaya, thanked all the participants for making the workshop a success. He also expressed his sincere thanks to all the officers and staff of Director of Economics and Statistics, Government of Meghalaya, for their immense contribution in organising the Workshop.

Annexure-I

Summary of the Suggestions received

S. No.	Name	Suggestions Received
1.	Prof. Amitava Kundu	• A small group can be constituted in CSO to look at the indicators presently being compiled in the Compendium, to suggest about their periodicity, inclusion/ exclusion, spatial level of disaggregation etc. The weakness of the data may be indicated whenever necessary. • CSO should constitute a high power committee to make specific recommendations to Government with regard to data compilation and methodology for NRA, taking into account all studies and recommendations by committees etc. made so far. • Information on environmental economic assets (non-man made), owned by individuals or institutions (that fall within national account framework as per SNA 93) must be generated in a spatially and temporally comparable basis. Special emphasis must be given to forest resources, water quality, water table and land use. • Attempt must be made to collect data on environmental assets (not owned by individual or institutions) and changes over time that have significant effect on human health. • CSO must try to standardize the concepts for data collection on environment related indicators, in consultation with all State Directorates. • Steps may be taken to ensure that reliable information are available for all NE states separately on a regular basis.

2.	Dr. B. B. Bhattacharya	▪ There should be more local participation giving information on regional problems and developments. The state should conduct more seminars so that local experts can interact with national and international experts on various aspects of statistics and development.
3.	Shri S. K. Nath	▪ States should come forward with "Compendium of Environment Statistics" ▪ Need for coordination with international organisations / bodies. ▪ Need for preparation of Directory of Organisation/ institutions in the country involved in Environmental research /study / training including development of database of Environment Statistics.
4.	Prof. S. C. Santra	▪ For effective documentation on "Environmental Statistics", Directorate of each State should have more effective initiative. ▪ There could be many more areas identified for environmental stock taking as model study. The area could be solid waste management, water resource management for sustainable development, land quality and management issues, natural disaster issues etc. ▪ In remain regions universities and research institutes may be taken as partner for field validation of various environmental Data.
5.	Dr. Arbinda Mishra	▪ Identifying the state-specific problems in collection and presentation of statistics relating to environment. State government officials can share their concerns on this area and participants would came to know of the extent of uniformity in data availability in the country as far as environmental problems are concerned. ▪ Role of remote sensing data, the scope of its

		application and the level at which it can be carried out can be discussed. Particularly, what type of data is already available and how future data collection can be moulded in areas of interest to the CSO may be identified.
6.	Shri A. Meera Sahib	▪ The State DES should be entrusted with the task of computing state NRA. CSO may provide necessary technical and financial assistance for the same.
7.	Dr. Madhu Verma	▪ Compile a list of works done regarding NRA and put them on website ▪ Involve all concerned to develop a toolkit for NRA in India such that it could be used widely. ▪ Bring out policy papers on NRA – sector wise.
8.	Prof. Ranajit Chakrabarty	▪ All agencies, universities and institutes who are working in the field of Environment Management and Control should collaborate with CSO in data collection and compilation.
9.	Prof. M. M. Adhikary	▪ There should be a common platform to collect the data on various aspects.
10.	Prof. M. N. Murty	▪ It is important to bring out a compendium of research organisations, universities, departments, government departments involved in the research studies, data collection, teaching, and training in Environmental Accounting in the country. Efforts have to be made to have representatives of theses agencies in the future workshops.
11.	Dr. B. K. Tiwari	▪ A network of institutions/ individuals working in the field of environment statistics may be evolved and established. The CSO may act as nodal agency for the purpose. ▪ Parameters/ datasets to be included in compendium

		may be identified by a committee of experts. The geographical unit unto which level the data to be included in the country / state/ district compendium of environment statistics may also be decided / provided by this committee. ▪ Publication of compendium of environment statistics of North Eastern India as well as individual states needs to be taken up on priority. For this purpose a nodal agency may be identified.
12.	Shri O.K. Saxena	▪ Financial and technical support should be provided to states by the Ministry of Statistics and PI for the collection and maintenance of environment statistics at the district and state level.
13.	Shri H. I. S. Grewal	▪ More such workshops should be held in different parts of the country.
14.	Dr. Divya Datt	▪ A directory / website/ abstract journals on studies, national and international relating to NRA, is needed
15.	Shri Rajesh Bhatia	▪ Organization of workshops/ seminars on various specific subjects / sectors so that subject/ sector wise specific guidelines/ standard methodologies may be firmed up.
16. 17.	Shri N. Thawg Dr. O. P. Singh	▪ Sample Surveys may perhaps be conducted with an objective to study the livelihood of people with special reference to Tribal people, who are entirely dependent on forest and forest related products. ▪ There is need for generating base line data on some newly emerging environmental aspects such as pollution by biomedical wastes, non-biodegradable wastes, water pollution and scarcity etc. particularly in ecologically sensitive areas. Hence, local need based working groups of experts may be formed for generation of data on specific areas of environment. ▪ There is a need for prioritisation of areas on which data can be collected and collated under environment statistics.

Annexure-II

List of Participants

Distinguished Guests:

1. **Shri D. D. LAPANG, Hon'ble Chief Minister of Meghalaya**

2. **Shri J. Tayeng, Chief Secretary to the Govt. of Meghalaya**

Ministry of Statistics and Programme Implementation

3. Shri. K. K. Jaswal,
   Secretary to Govt. of India
   Ministry of Statistics and Programme Implementation

4. Dr. Vaskar Saha,
   Additional Director General
   Central Statistical Organisation

5. Shri. S. K. Nath,
   Deputy Director General.
   Central Statistical Organisation

6. Shri. Rajesh Bhatia,
   Assistant Director,
   Central Statistical Organisation

7. Shri. M. P. Diwakar,
   Senior Investigator,
   Central Statistical Organisation

8. Shri Vijay Kumar,
   Computor (Senior Scale)
   Central Statistical Organisation

9. Shri Satyender Kumar,
   Computor (Senior Scale)
   Central Statistical Organisation

Central Ministries/Organisation

10. Prof. Amitabh Kundu,
Centre for Development Studies,
Jawahar Lal Nehru University,

11. Prof. M. N. Murty
Institute of Economic Growth,
University of Delhi

12. Prof. S. C. Santra
Kalyani University, WB

13. Prof. Ranjit Chkravorty,
Calcutta University

14. Prof. M. M. Adhikari
Bidhan Chandra Krishn Viswavidyalaya, WB

15. Dr. A. K. Thukral,
Prof. of Environmental Sciences,
Guru Nanak Dev University,

16. Prof. B. B Bhattacharya
Director,
Institute of Economic Growth,
University of Delhi, Delhi Enclave,

17. Prof. B. K. Tiwari,
North Eastern Hill University

18. Dr. Madhu Verma,
Associate Professor,
Forests Resource Economics & Management,

19. Dr. Renu Bhardwaj,
Reader
Guru Nanak Dev University,

20. Dr. O. P. Singh,
Reader
Centre for Environmental Studies,
North Eastern Hill University

21. Ms. Divya Datt,
Research Associate,
TERI

22. Dr. Arbinda Mishra,
CMDR, Karnataka

23. Shri T. G. Momin,
APRO,
DIPR

24. Shri T. T. C. Marak, IFS
Chief Conservator of Forest,
SF & Environment, Shillong

25. Shri Sunil Kumar, IFS
Chief Conservator of Forest (WL), Shillong

26. Shri M. K. Das,
North East Hill University

State Representatives

27. Shri Duyu Pussang,
Director
SSB, Arunachal Pradesh

28. Shri A. Meera Sahib,
Director,
DES, Govt. of Kerala

29. Sh. Ranvir Gupta,
Economic Advisor,
Haryana

30. Shri N. Thong,
Director,
SSB, Nagaland

31. Shri M. A. Kakroo,
Director,
SSB, Jammu and Kashmir

32. Shri O. K. Saxena,
Director,
SSB, Utter Pradesh

33. Shri H. I. S. Grewal,
Economic Advisor,
SSB, Punjab

Workshop Team (DES Meghalaya)

34. W. L. Lyngdoh,
Director
DES, Shillong

35. Shri J. B. Momin,
Joint Director

36. Shri A. Marbarng,
Deputy Director

37. Shri A. M. Syim,
Deputy Director

38. Shri W. S. Lyngdoh,
Research Officer

39. Shri P. G. Momin,
Research Officer

40. Shri E. Warkao,
Research Officer

41. Shri S. S. Mawlong,
Research Officer

42. Shri A. Kanti,
Research Officer

43. Shri A. M. Laloo
Research Officer

44. Shri V. D. Iawphnaw,
Research Officer

45. Shri M. L. S. F. Marwein
Research Officer

46. Shri R. Kharmaw,
DSO

47. Shri M. Rapthap
DSO

48. Shri S. Das
SO

49. Shri L. M. Syenhil
SO

50. Shri M. Khapani,
SO

51. Shri A. D. Chaudhry
DSO

52. Shri O. Bani,
DSO

53. Shri K. Nanguyanh
SO

54. Shri T. Momin,
SO

55. Shri B. Lyngdoh,
DSO

56. Shri M. B. Lehar

57. Shri A. Lyngdoh

58. Shri G. C. Momin

Annexure -III

Fourth National Workshop on Environment Statistics
Shillong April 22-23, 2003

Day: 1. (22.4.03)

Inaugural Session: 9 AM to 11 AM

1. Welcome Address by the Director, DES, Meghalaya
2. Address by Dr. V. Saha, ADG
3. Address by Shri J. Tayeng, Chief Secretary, Govt of Meghalaya
4. Inaugural Address by the Hon'ble Chief Minister, Govt. of Meghalaya
5. Keynote Address by Secretary, Ministry of Statistics & PI
6. Vote of thanks by Shri S.K. Nath, DDG

Technical session: I (11.30 to 12.30PM)

" Review of work done towards improvement of Environment Statistics"
Chairperson: Prof. Amitava Kundu

Technical Session: II (2 PM to 4.30 PM)

"Development of Framework for Natural Resource Accounting for India"
Chairperson: Prof. B.B.Bhattacherjee

Day: 2 (23-4-03)

Technical Session: HI (8.30 AM to 11.00 AM)

"Database need for Assessment of Environment Problems"
Chairperson: Prof. Amitava Kundu

Technical Session: IV (11.45 AM to 1.00PM)

"Issues on Management of Environment related Problems"
Chairperson : Prof. S. C. Santra

Valedictory Session (2.00 PM to 3.30 PM)

Chairperson: Prof. B.B.Bhattacherjee