Bio-Cultural Diversity & Sustainable Development in North East India

Status, Vision & Challenges

litors: Ajeya Jha, Sangeeta Jha & S. Munjal

About the Editors

Dr. Ajeya Jha is presently the Head of the Department of Management Studies, Sikkim Manipal Institute of Technology. He is also a Fellow of Indian Congress of Chemistry and Environment. He has over a decade of teaching experience and his research interests include pharmaceutical marketing, sustainable development, wild-life tourism, natural resource management, and tribal knowhow. Prof. Jha has to his credit 5 books, 6 book chapters, 34 research papers and 200 articles. Also, he has participated in a good number of national and international seminars. He has successfully completed many projects for UNESCO, Indo-Canada Environment Facility, Department of Science and Technology (Government of India), and World Wide Fund for Nature-India.

Dr. Sangeeta Jha is presently the Head of Department of Chemistry, Sikkim Manipal Institute of Technology. She is also a Fellow of Indian Congress of Chemistry and Environment. Her research areas include absorption-desorption studies, polymer composite and photochemistry. She has a teaching experience of over 16 years and has to her credit a good number of research papers published in national and international journals of repute. Also, she has presented papers in many scientific conferences.

Dr. Sonia Munjal is a Reader at Sikkim Manipal Institute of Technology. Her research areas include pharmaceutical marketing and human resource development. She has to her credit many research papers published in journals of repute. Also, she has presented 9 papers in national and international conferences. She is associated with 18 Management Development Programmers and has been a resource person for numerous MDPs and workshops.

Bio-Cultural Diversity and Sustainable Development in North East India

Status, Vision and Challenges

Edited by

Dr. Ajeya Jha
Dr. Sangeeta Jha
Dr. S. Munjal

Readworthy
New Delhi

First published 2009

Readworthy Publications (P) Ltd.

Regd. Off
A-18, Mohan Garden
Near Nawada Metro Station
New Delhi – 110 059 (India)
Phone: 011-2537 1324
Fax: +91-11-2537 1323

Branch
4735/22, Prakash Deep Building,
Ground Floor, Ansari Road, Daryaganj
New Delhi – 110 002 (India)
Phone: 011-43549197
Fax: +91-11-23243060

Email: info@readworthypub.com Web: www.readworthypub.com

Cataloging in Publication Data–DK
Courtesy: D.K. Agencies (P) Ltd. <docinfo@dkagencies.com>

International Conference on Sustainable Regional Development: Status, Challenges, Visions: From the Perspective of Northeast India (2007: Rangpo, India)

Bio-cultural diversity and sustainable development in North East India: status, vision and challenges / edited by Ajeya Jha, Sangeeta Jha, S. Munjal.

p. cm.

Revised version of papers presented at the International Conference on Sustainable Regional Development: Status, Challenges, Visions: From the Perspective of Northeast India, held at Rangpo during 22-24 February 2007.

Includes bibliographical references.

ISBN 13: 978-81-89973-67-4 ISBN 10: 81-89973-67-3

1. Sustainable development–India, Northeastern–Congresses. 2. Regional planning–India, Northeastern–Congresses. 3. Rural development–India, Northeastern–Congresses. 4. Agriculture–Economic aspects–India, Northeastern–Congresses. 5. Environmental economics–India, Northeastern–Congresses. 6. Biodiversity conservation–India, Northeastern–Congresses. I. Jha, Ajeya. II. Jha, Sangeeta. III. Munjal, S. (Sonia), 1955- IV. Title.

DDC 338.954 22

Printed at Salasar Imaging Systems, Delhi - 35

Foreword

Sustainable development is a pattern of resource use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but in the indefinite future. It has gained credence because of strong ecological, economic and ethical wisdom inherent in it. However it does generate enormous debate also. This, because sustainable development is an eclectic concept consequently a wide array of views exist under its umbrella.

The debate however is not about whether or not we should follow sustainable development but is about its exact nature - about what is sustainable. Thus it is urgent to include an objective and scientific approach to define indicators of sustainability and find precise methods to measure them. Only this can transform the broad concept of sustainability into action.

In view of this I am extremely happy to find that Sikkim Manipal Institute of Technology has taken the initiative to conduct an international conference on sustainable development in a regional context - focusing on northeastern region of India. The choice of region is significant for Socio-economic, political and ecological reasons. The Northeastern states of India are a heaven of biological and cultural diversity. The region is a confluence of myriads of ecosystems. People of this region have evolved traditional systems unique for using and managing natural resources on a sustainable basis. The cultural and religious diversity of the region is also noteworthy. Some are Hindus, some are Christians and some others are Buddhist. And some still follow their tribal religious beliefs. Whatever their religion may be, their relationship with nature and bio-diversity is remarkably friendly. This territory, therefore, is an appropriate case for study of regional development efforts.

This book contains some of the papers that were deliberated during the conference. I congratulate the editors of this book and hope they will continue to contribute towards the ultimate objective of evolving sustainable development as an authentic and an actionable discipline.

I wish them the very best for all their future endeavours.

Dr. K, Jaykumar, IAS
Vice Chancellor
Sikkim Manipal University of Health, Medical
And Technological Sciences
Gangtok, Sikkim

Preface

The North Eastern India (NEI) region, as it stands today, presents an appropriate case for study of regional development efforts and results with retrospective effects. The Government of India has been trying to develop this region at par with the national economy through certain policy framework. Under the influence of the policy, various schemes for development of infrastructure and economy have been formulated. In addition, all these states have been declared special category states, which get central assistance based on 90 percent grant and 10 percent loan. The policy of industrial licensing, concessional finance and investment subsidy, growth centre as well as freight equalization of some major industrial inputs have also been used for economic development. At this juncture the most pressing challenge facing the eight states of this region is how to fabricate an economically productive, socially viable, and ecologically sustainable future. The regional industrial growth has not been at par with the efforts, a sizeable number of primary producers are expected to leave agriculture within the next decade, many towns and cities are overloaded with the influx of population from villages, and there is increasing pressure on the agricultural and extractive industries to develop more sustainable forms of production. There are also many opportunities for the region in niche marketing of goods for export; in value addition before the goods are sold; in the provision of public and private infrastructure; and in the creation of new industries in fields such as recreation, retirement and eco-tourism. The tasks are to modify those forms of production which are environmentally harmful, and to ensure that the 'blend' of current forms of production with some of the new innovative options occurs in a manner which benefits the regional economy. That is, it is necessary to ensure that developmental efforts:

- Provide meaningful work and lifestyle options for people.
- Enhance skill development, so that northeastern region does not fall behind the other regions of the country in terms of education levels and training.
- Give towns and villages a stake in the growth of a more productive, more environmentally sound northeast India.
- Do not place new and unrealistic pressures on natural resources.
- Seek to enhance bio-diversity by ensuring that native flora and fauna have a secure future in any plans for regional development.
- Have a sensitivity to earlier periods of environmental destruction, and seek to redress those problems through rehabilitative measures.
- Empower regional communities to develop their own plans and strategies in line with principles of ecologically sustainable development and the needs and interests of local people.
- Find ways of altering the current trajectory of resource extractive industries, so that they are less destructive to the natural environment, and
- Ensure that community processes contribute 'healthy' and productive outcomes from stakeholder interaction at the regional level.

It is in this context that Sikkim Manipal Institute of Technology conducted an international conference on sustainable development in the northeastern region of India. The conference had the following broad objectives:

- Develop and understand the multiple meanings of sustainability, and the concepts and theories employed in evaluating sustainable options in the context of northeastern region of India.

- Develop an appreciation/appreciations and recognitions of the diversity of models and options relating to sustainable development.
- Train to think systemically and holistically about human security, economic development, disaster mitigation, environmental management, and impact of technology on living environment.

The present book contains the revised version of the papers presented at the conference. We hope these deliberations will be of great use for researchers, policy makers and development workers.

Contents

	Foreword	*v*
	Preface	*vii*
	Introduction	*xv*
1.	Environmental Quality and Economic Growth: Some Empirical Evidences	1
	Amrita Sengupta (Basu) & M. Mishra	
2.	An Analysis of the Underdevelopment of Nehbandan Region in Iran	20
	Majid Yasouri	
3.	Agro-Processing Industries: Problems and Prospects for Sustainable Development	33
	Pardeep S. Shehrawat	
4.	SARD-M: Horticulture is an Economically Viable and Environmentally Sustainable Driver of Socio-Economic Development in Mountainous Sikkim	50
	J. R. Subba	
5.	Ingenious Agricultural Heritage Systems and Sustainable Agricultural Ecosystems Management in Sikkim	86
	J.R Subba	
6.	Vermitech - An Effective Technology of Organic Waste Management	124
	Ansari, A.A.	
7.	Mainstreaming Climate Change Concerns in Community Based Forest Management	128
	Pradeep Kumar, IFS	

8. Biodiversity, Cultural Diversity and Sustainable Development in North East India 139

Archana Godbole & Jayant Sarnaik

9. Sacred Values and Biodiversity Conservation Around Namdapha National Park in Arunachal Pradesh 158

R. Sarmah, A. Arunachalam & N. Upadhayay

10. Biodiversity as an Agent of Sustainable Rural Livelihoods in Sikkim Himalayas 164

Pradeep Kumar

11. Fog Water Collection in the Northeast India: Problems and Prospects 175

Robert Schemenauer & Ajeya Jha

12. Bamboo Species of North East India: Status, Challenges and Vision 181

Sangeeta Jha; Ajeya Jha & Vandana Suhag

13. Sustaining the Flow of New Breed of Entrepreneurs from the Region: A Study of Women Entrepreneurs in Sikkim 196

H.G. Joshi

14. Mobile and Stationary Applications of Fuel-cell Systems. 210

S.N. Kulkarni & M. Eswaramoorthi

15. Ecotourism in Sikkim: Principles, Achievements, Prospects & Potential Problems 217

Jonas Zwitserlood

16. Growth Restriction of SMEs Located in Remote, Landlocked Areas: A North east India Perspective 227

Laikangbam Dorendro Singh

17. Incubation of Grassroots Innovations for Sustainable Regional Development: An Experience with North East India 238

C.B. Vijaya Vittala & Anand Prakash Tiwary

18. A Comparative Study of the Spread of ICT in the Backward States of India with Special Reference to North Eastern States 252
Laikangbam Dorendro Singh

19. Look East Policy & the North East Region: A Synergistic Perspective for Sustainable Development 261
Anindita Adhikary (Bora), Bedanta Bora and Sonia Munjal

20. Gender and Development: From the Perspective of Northeast India 274
Michele Luxon & Ajeya Jha

21. The Digital Divide: Who, How and Where? 284
Philip Benchaur

Contributors 291
Index 294

Introduction

The Northeastern states of India are ethnically and culturally very rich and distinct from the list of the country. They are inhabited by a majority of the indigenous communities. Also, they have a variety of ecosystems. These communities have their own ancient traditional systems of using and managing the natural resources on a sustainable basis.

Culture diversity of the region is also well known. The tribes have diversity in their religions beliefs and social practices. Some are Hindus, some are Buddhists, and some others are Christians. Some still follow their tribal religious beliefs. Whatever their religion may be, their relationship with nature and biodiversity is remarkably friendly.

But, unfortunately, in the name of development, these communities are being displaced and their bio-cultural diversity is deteriorated. To explore ways to address this problem, Sikkim Manipal Institute of Technology Organized an international conference on sustainable Regional Development: status, challenges, visions—from the perspective of Northeast India from February 22 to 24, 2007, in which leading scholars and experts participated. This book is the collection of the updated version of the papers presented at the conference. In all, there are twenty papers in the book.

The first paper, Environmental Quality and Economic Growth: some empirical evidences, written by Amrita Sengupta (Basu) and M. Mishra, analyzes the relationship between environmental pollution and economic growth. It uses some indicators such as the number of motor vehicles and cement production representing environmental pressure to compare these indicators with economic activity level. Using time series data of environmental quality indicators, environmental quality is analyzed to see how it changes during the process of economic

growth. The hypothesis of the inverted U-shape curve in investigated as well.

The next paper, An Analysis of the underdevelopment of Nehbandan Region in Iran, written by Dr. Majid Yasouri, attempts to investigate the major causes of underdevelopment of Nehbandan region, located in the southern part of khorassan province of Iran, bordering Afghanistan. It also presents several approaches for improving the existing situation. Pardeep S. Shehrawat, in his paper Agro-Processing Industries: problems and prospects for factors responsible for sustainable small scale agro-processing units. Its also assesses the problems encountered by the entrepreneurs in making their units economically viable, and identify the training needs of these entrepreneurs.

The next paper, SARA-M: Horticulture is an Economically viable and environmentally sustainable driver of Socio-economic Development in Mountainous Sikkim by J. R. Subba, tries to examine the existing policies, institutions and processes, and how the imperatives of mountain specified in the mountainous Sikkim are contained or utilized for economic viability and environmental sustainability. In his another paper, Ingenious Agricultural heritage systems and Sustainable Agricultural ecosystems Management in Sikkim, J.R. Subba makes an in-depth study of indigenous agricultural systems of tribal communities of Sikkim and management of ecosystems by them.

Dr. A.A. Ansari, in his paper Vermitech-An Steatite technology of organic waste management, examines the effectiveness of vermintech in the management of organic waste. The paper is based o his study, conducted at the University of Guyana, Georgetown to effectively recycle the organic waste like grass clippings and cattle dung. The locally available earthworm species eisenia fetida was used for the purpose. The next paper by Pradeep Kumar, namely, Mainstreaming climate change concerns in Community Based forest management, discusses how the climate may affect the community based forest

management and where the community-based forest management stands in relation to global warming. It goes on to discuss how some of the existing programmes can be modified to include the concerns of climate change without really diluting the essence of original programmes like forest protection and creating livelihoods. Finally, it suggests the ways of mainstreaming the issues concerning climate in the community forest management.

Archana Gudbole and Jayant Sarnaik, in their paper Biodiversity, cultural diversity and Sustainable development in North East India, present a detailed account of bio and cultural diversities in Northeast Indian region and address the key issue of sustainable development. They also look into the solutions for the development of the region within the indigenous knowledge, resource base and the diversity of village and community level institutions functioning in the region.

R. Sarmah, A. Arunachalam and M. Upadhayay in their paper, sacred values and Biodiversity Conservation Around Diamdapha National Park in Arunachal Pradesh, examine the role of sacred values and religions places in the conservation of biodiversity, with special reference to the areas around Namdpha National Park in Arunachal Pradesh. The next paper is written by Praddep Kumar on Biodiversity as an Agent of Sustainable Rural Livelihoods in Sikkim Himalayas. It analyses the role of bio-diversity in the daily lives of rural population, mainly of Sikkim Himalayas. It places equal importance to biodiversity and the people since the concept of sustainability in livelihood is involved.

The next paper, Fog water collection in the Northeast India: Problems and prospects, jointly written by Dr. Robert Schemenouer and Dr. Ajeya Jha, explores the prospects of fog water harvesting in Northeast India. Explaining the technology of fog water harvesting, if analyzes how relevant it is for the northeast region. Also, it discusses the problem that encounter at

the time of its implementation. Dr. Sandana Suhag examine the role of bamboo in the development of Northeast India in their paper Bamboo species of Northeast India: Status, challenges and Vision. They also present a detailed account of major species of bamboo and their current status in region.

H.G. Joshi, in his paper sustaining the flow of New Breed of Entrepreneurs from the Region, makes a critical study of the entrepreneurial skill of women in Sikkim. Presenting entrepreneurial profile of women, he analyses the role of training and support services towards sustainable development of entrepreneurship among the women. In their paper, Mobile and Stationary Applications of Fuel-cell Systems, Dr. S.N. Kulkarni and M. Eswaramoorthi present systems analysis for mobile and stationary applications of fuel-cells. They also make an economic analysis of different fuel-cell systems for stationary applications. The role of ecotourism in the sustainable development of Sikkim is analyzed by Jonas Zwitserlood in his paper ecotourism in Sikkim: Principles, Achievements, prospects and potential problems.

Next comes the paper of Laikangbam Dorendro Sing—Growth Restriction of SMEs Located in Remote Landlocked Areas: A Northeast India perspective. It identifies the factors responsible for the growth restriction of small and medium enterprises (SMEs) in Northeast India, especially in remote landlocked areas—such as small size of domestic market, high transport costs, limited linkage to local, small economy, lack of skilled labour, dearth of competitive support and infrastructural services, and lack of business knowhow. A comparative study of the spread of information and communication technology (ICT) in backward states of India, with special focus on the states of the Northeast is also made by Laikangbam Durendro Singh in his another paper, A Comparative Study of the spread of ICT in Backward states of India with special reference to North Eastern States.

In their paper' Incubation of Grassroots Innovations for Sustainable Regional Development: An Experience with North East India, C.B. Vijaya Vittala and Anand Prakash Tiwary present case studies of innovative indigenous technologies helping sustainable regional development, with special reference to North East India. The contribution of Honey Bee Network towards documenting grassroots innovations has also been highlighted.

In the next paper, Look East Policy and the North-East Region, Anindita Adhikary (Bura), Bedanta Bora and Sonia Munjal attempt to ascertain the prevailing trade scenario in the Northeast region, and explore its prospects and threats across its bordering nations. They also analyze the impact of 'Look East Policy' on sustainable development of the region in terms of synergistic perspective.

The next paper—Gender and Development: from the perspective of Northeast India—by Ms Michele and Ajeya Jha focuses on gender perspective in sustainable development in the northeast region. The last paper, The Digital Divide, by Dr. Philip Benchaur, probes into the extent the digital divide is related to sustainable development, with special reference to Northeastern states of India.

1

Environmental Quality and Economic Growth

Some Empirical Evidences

Amrita Sengupta (Basu) & M. Mishra

1. Introduction

The traditional idea of "the limit to growth" developed by Meadow et al. (1972) shows the effect of economic growth on the environment in terms of a trade-off. This idea is based on two reasons:

- The limited capacity of natural environments to receive the waste generated by the economic system;
- The finite nature of exhaustible resources (Turner et al. 1994).

The critics of the limit to growth points to a number of reasons why there may not be a limit to growth after all. Among these reasons are:

- Positive and increasing income elasticity for environmental quality;
- Changes in the composition of production and consumption;
- Increasing levels of education and environmental awareness;
- Technological progress; and
- More open political systems.

This implies that the economic growth trajectory for environmental problem is likely to depend upon both market forces and changes in environmental policies and regulations.

The emerging consensus is that at least some forms of environmental pollution exhibit the inverted U-shape relationship with economic growth. Figure 1 exhibits the inverted U-shaped curve with pollution level (P) graphed against income level (F). Pollution (P) increases when income level (F) is less than F* and decreases once F exceeds F*. At the point F*, P is not affected by F ($dP/dF = 0$). There is nothing automatic about this relationship. It is not an inevitable relationship between income levels and particular environmental problems. The pattern for each environmental problem is likely to reflect both market forces and changes in environmental policies and regulations.

In Section II, we survey literatures. In Section III.1, we use some indicators such as the number of motor vehicles and cement production representing environmental pressure to compare these indicators with economic activity level. It will show the increasing environmental pressure along the economic growth path. In Section III.2, using time series data of environmental quality indicators, environmental quality is analysed to see how it changes during the process of economic growth. This section investigates the hypothesis of the inverted U-shape curve. Section IV summarises the results.

2. Literature Survey

Lopez (1994), and Selden and Song (1995) focus on the theoretical impact of economic growth on environmental quality. Selden and Song (1995) re-examine the model of Foster (1973) with minor modifications. They provide theoretical insights that embedded in Foster's (1973) model is the possibility of the inverted U-shaped curve, even if this need not occur in all cases. Treating environment as a factor of production and the direct determinant of social welfare, Lopez's (1994) theoretical study shows that in the case of non-homothetic preferences the relationship between

economic growth and pollution depends on the elasticity of substitution between conventional factors of production and pollution and on the relative degree of curvature of consumers' utility. According to Lopez (1994), the lower the elasticity of substitution and relative curvature coefficient increases, the more likely it is that pollution increases with income. Under certain conditions, an inverted U-shaped relationship between pollution and income is derived for the non-homothetic preference case. However, Common (1995) points out that for some impacts, irreversible damage may occur before the top of the inverted U-shaped curve is reached, and that the relationship need not hold for all impacts. Grossman and Krueger (1993, 1995), Shafik (1994), Selden and Song (1994), and Holtz-Eakin and Selden (1995) have conducted empirical studies on this issue. Grossman and Krueger (1993) explore some of the empirical evidence that bears on the likely environmental impacts of an increase in per capita GDP. By using cross-country panel data of the Global Environmental Monitoring System (GEMS), Grossman and Krueger (1993) find that emission levels of sulphur dioxide (SO_2) and dark matter suspended in the air increase with per capita GDP at low levels of national income, but decrease with per capita GDP at higher levels of income (ie., inverted U-shape relationship). For the mass of suspended particles, however, in a given volume of air, the relationship between pollution and per capita GDP is found to be monotonically decreasing. Grossman and Krueger (1995) investigate the issue with more broad set of environmental indicators than their study in 1993. Grossman and Krueger (1995) find little evidence that environmental quality deteriorates steadily with economic growth. Rather, they find for most indicators that economic growth brings an initial phase of deterioration followed by a subsequent phase of improvement. Shafik (1994) uses a wide range of environmental quality indicators. He finds that environmental problems of safe water and sanitation improve with rising incomes. Others worsen and improve (i.e., particulate SO_2) and some others worsen steadily (i.e., dissolved oxygen, solid

wastes, and carbon emissions). Selden and Song (1994) focuses on emissions of four important air pollutants (i.e., suspended particulate matter, SO_2, oxides of nitrogen, and carbon monoxide). They find an inverted U-shape relationship for all four air pollutants. Holtz-Eakin and Selden (1995) examines the relationship between economic growth and CO_2 emissions. By using global panel data, they find a diminishing marginal propensity to emit (MPE) carbon dioxide as per capita GDP rises. Despite the diminishing MPE, their forecasts indicate that global emissions of CO_2 will continue to grow. Previous empirical studies conduct econometric analysis with the cross-country panel data. The basic models used by those studies define each pollutant as a function of per capita GDP. For example, Shafik (1994) uses various kinds of environmental indicators and test basic models (i.e., linear, quadratic and cubic models). By using estimated results, Shafik (1994) finds which model has the best explanatory power for each environmental indicator. In addition to per capita GDP, variables of population density (Selden and Song, 1994), fixed country and year effects (Holtz-Eakin and Selden, 1995 and Grossman and Krueger, 1993,1995), time trend (Shafik, 1994), or lagged income (Grossman and Krueger, 1993,1995) are used as exogenous variables in the estimated equations. It is not certain whether the hypothesis of inverted U-shape relationship between economic growth and the environment holds true in every country. Even if it holds true with some countries, it does not necessarily hold true with other countries.

3. Economic Growth and Environment

3.1 ENVIRONMENTAL PRESSURE OF ECONOMIC GROWTH

An assessment of the environmental pressure of economic growth requires an appropriate choice of variables. In practice, the complex composition of the environment creates difficulties in measuring the change in its quality, because economic activity usually exerts pressure on many facets of the environment. There is no unobjectionable way to aggregate such impacts into a single

measure of change. In explaining the environmental pressure of economic growth, we use some indicators such as total deforestation of the land area; number of motor vehicles; cement production; fertiliser production; primary energy (solid, liquid, gas and electricity) consumption; and newsprint paper production. These indicators are generally considered as the main source of each category of environmental pollution. For example, the number of motor vehicles, cement production and primary energy consumption are considered as the main source of air pollution.

Economic growth is conventionally defined in terms of expansion of gross domestic product (GDP). Following Radetzki (1992), however, we use the concept "economic density" which is defined as GDP divided by population and the surface of a country (= National Land) to measure the level and intensity of economic activity in a given area. The economic density, measured in 1985, prices increased about 5.44% per annum during 1965 to 1994. However, data on indicators show an average annual growth rate of those indicators exceeding that of economic density. The fact that economic growth has generated environmental pressure is supported by the fact that the growth rates of almost all of indicators as the source of pollution are far higher than that of economic density during the periods of economic growth. This seems to support the argument for "the limit to growth." Despite the increasing environmental pressure during the periods of economic growth, however, it is commonly accepted that it is an over-simplification to see the relationship between economic growth and the environmental quality simply in terms of a trade-off. Even if the economic growth process causes environmental pressure, structural changes in industries, and stricter environmental regulations followed by the increased demand for better environmental quality can contribute to the reduction of environmental degradation. In addition, technological innovation and increased environmental awareness during the process of economic growth process can

contribute to its reduction. Although evidence seems to suggest that economic growth puts pressure on the environment, detailed analysis is needed to find the exact environmental impacts of economic growth.

3.2 ECONOMIC GROWTH AND ITS IMPACT ON ENVIRONMENTAL QUALITY

Unlike previous studies, which mostly used cross-country data, this section uses time series data. We focus on the relationship between each indicator of environmental quality and per capita income taking into account other factors influencing environmental quality such as environmental policy and industry structure. The main difficulty of our analysis is the limitation of environmental data for the period of the 1960s and 70s. Many environmental data are available from early 1980s onwards. Therefore our regression analysis does not present a complete picture of the historical changes in environmental quality.

A. Data and Overview

Based on The Environmental Yearbook, various time-series data indicating environmental quality of upper middle income countries are used. Firstly, the annual growth rate of deforested area is used for the extent of natural resource depletion. Secondly, the annual levels of Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), and Total Suspended Particulate (TSP) are used for industrial and energy-related air pollutants. CO_2 emission levels from primary energy consumption are calculated by using the CO2 emission coefficients for different kinds of primary energy. Thirdly, for water quality, we use the average annual Biochemical Oxygen Demand (BOD) level. Fourth, the daily discharge volumes of domestic and industrial wastes, measured by generation source, are also used for waste management and control. As mentioned earlier, data for most indicators were available only after the early 1980s. This limitation of data, however, indirectly means that till the early 1980s the problem of environmental degradation was left

untouched. It is commonly accepted that environmental degradation received no public attention during the 1960s, 70s and early 80s. The horizontal axes in Figure 2, represent the level of per capita GDP, while the vertical axes represent the levels of various kinds of environmental quality indicators. Overall, the relationship between economic growth and environment cannot be simply explained in terms of trade-off or inverted-U shape relationships. For example, some indicators such as CO_2 and industrial waste worsen as per capita income increases, but other indicators such as water quality and domestic waste show the inverted U-shape relationship. Therefore, the relationship between economic growth and environment depends on each environmental quality indicators.

B. Some Econometric Regressions

To assess the relationship between economic growth and environmental quality in any given country, it is important to consider the interrelated impacts of the following five determinants of environmental quality–

- per capita income (e.g. per capita GDP);
- population density;
- technologies;
- the level of environmental policies; and
- endowments such as climate, geography and resource endowments.

To assess the effect of economic growth on environmental quality, we should focus on the relationship between environmental quality and per capita income, taking into account these other determinants of environmental quality. Per capita income (per capita GDP) serves to analyze directly the effect of economic growth on environmental quality. Population density is also an important factor influencing environmental quality. For technology that can affect environmental quality

directly, a time trend can be used as a proxy in regression model. Treatment of environmental policies which reflect social decisions about the environment is complicated. Since we desire to assess both the direct and indirect effect of growth on the environment, this variable that is the endogenous consequences of economic growth should be omitted from this analysis. In the case of "endowments" such as climate and location, it can be accounted for by having the intercept in regression model. Of course, there are also exogenous factors-e.g. the composition of output, regulations and taxes influencing fossil fuel consumption, the level of education, patterns of urbanisation and sub-urbanisation, the political structure, etc. that affect emissions. Those potential variables that are endogenous consequences of growth also should be omitted from the model. As for the correct specification of the model, we tested linear, linear-log and double-log functions. A time trend variable was also included to test for the significance of technological change. Results obtained, however, indicate that the variable is insignificant for most cases. The following six basic models seem best to fit the empirical data:

- $Ei = \alpha 0 + \alpha 1 \ln Yi + \alpha 2 \ln Di + ei$
- $Ei = \beta 0 + \beta 1 \ln Yi + \beta 2 (\ln Yi)\, 2 + \beta 3 \ln Di + ei$
- $Ei = \varphi 0 + \varphi 1 \ln Yi + \varphi 2 (\ln Yi)\, 2 + \varphi 3 (\ln Yi)\, 3 + \varphi 4 \ln Di + ei$
- $\text{Ln } Ei = \gamma 0 + \gamma 1 \ln Yi + \gamma 2 \ln Di + ei$
- $\text{Ln } Ei = \lambda 0 + \lambda 1 \ln Yi + \lambda 2 (\ln Yi)\, 2 + \lambda 3 \ln Di + ei$
- $\text{Ln } Ei = \mu 0 + \mu 1 \ln Yi + \mu 2 (\ln Yi)\, 2 + \mu 3 (\ln Yi)\, 3 + \mu 4 \ln Di + ei$

In these equations, Ei is an indicator of environmental quality of type i, Y is per capita GDP, D is population density (population per square metre) and e is a stochastic error term. Equations (i) and (iv) explains improvements or deterioration of environmental quality with higher per capita income. Equations (ii) and (v), on the other hand, explain the inverted U-shaped curve. To exhibit a meaningful inverted U-shape relationship, $\beta 1$

and $\lambda 1$ must be positive and $\beta 2$ and $\lambda 2$ must be negative. Population density (D) is expected to show a negative sign, which implies a sparsely populated country is less likely to be concerned about reducing per capita pollution levels than a more densely populated one. Our estimated results for all environmental quality indicators show that the relationship between economic growth and environmental quality varies with different kinds of environmental quality indicators. For many environmental quality indicators, the results show that population density is not a significant variable.

C. *Interpretation of the Estimated Results*

A. Deforestation

Deforestation is one of the environmental indicators that unambiguously worsens as income rises. The double-log specification with two variables works best, although the linear-log form and the double-log specification with four variables are also significant. The association between increasing deforestation and increasing income is explained by industrialization requiring increasing areas for industrial zones and factories, and by an increase of population resulting in deforestation for construction of houses and facilities.

B. Water Pollution (BOD)

The most socially controversial item in addressing environmental problem is the surface-water pollution. The water quality rarely exceeds the poor international water-quality standard of third grade. The level of BOD had increased till 1984 but then decreased as per capita GDP. The improvement of water quality is the result of huge investment by Government and private sector on the waste-water discharge facilities for water quality protection. Considering the historical water pollution problems during 1970s and 80s, we may cautiously postulate an inverted U-shape relationship between economic growth and water pollution. Our estimation, however, shows

that BOD decreases with income (i.e., the double-log specification with two variables fits best). This different outcome is mainly caused by the lack of data.

C. DISPOSAL OF WASTES

While water quality is clearly the single most important environmental issue in the public mind, just as complex are the challenges posed by the disposal of wastes. Unlike other pollution which affects people who step outdoors, wastes can be disposed of in isolated localities and, if disposed of properly, can have a relatively small impact on human health (Shafik, 1994). The small and crowded country has had difficulty in finding landfill space to dispose of either construction wastes or ordinary domestic wastes. In practice, landfill capacity has recently been a chronic problem, especially in the major metropolitan areas. The total disposal volume of wastes have been increasing with increasing per capita GDP. Wastes are divided into two kinds in terms of their sources: domestic and industrial.

In the case of domestic wastes, the estimated result follows the inverted-U shaped curve. The regression for daily disposal of domestic wastes shows that the double-log and quadratic specification has most strongest explanatory power, implying that pollution from domestic wastes gets worse initially as a country becomes richer, and then improves. We also see that domestic wastes follow the inverted U-shaped curve. The steadily increased amount of domestic waste disposal began to decrease from 1992. The decreasing trend has been continuing to date. In addition, a massive national programme (initiated on January, 1, 1995) of "a volume-based system" of waste disposal charge has contributed to the reduction of domestic waste by 31% in 1995. The newly launched system is expected to contribute to further decline of the disposal in the future. On the other hand, the disposal of industrial waste is one environmental indicator that is unambiguously increasing with rising per capita GDP (i.e., the double-log equation with two variables fits best). This is caused by the continuous

increase of industrial activities (especially the progressive increase of construction wastes) in step with a rise of per capital GDP.

D. AIR POLLUTION

Air pollution levels are high by world standards in all major cities. Although some progress has been made in recent years, the citizens of major cities suffer from the effects of air pollution. For the case of domestic air quality, four indicators are tested: SO_2, NO_2, TSP, and CO_2, respectively. However, because of the lack of data for the periods of early economic growth (1960s and 70s) for some indicators, a clear relationship between economic growth and those indicators cannot be found from the regression. Considering environmental policies and industrial structures, however, we can presume indirectly the relationships of those indicators with economic growth. In the case of SO_2 and NO_2 emissions, the regression results are inconsistent with other empirical studies. For SO_2, the double-log and cubic model fits the best. On the other hand, the linear-log and quadratic specification has the strongest explanatory power for emissions of NO_2. These results are also caused by the lack of environmental data. However, it is critical to note that the environmental policies, especially for air pollution, were effective only from the early 1980s given that the permissible air discharge standard for SO_2 and NO_2 was set in 1979 and 1983, respectively. Since there was no special regulation of air pollution before that time, we can assume that the level of SO_2 and NO_2 increased since 1960s (the early stage of economic growth) to early 1980s. Therefore, the levels of SO_2 and NO_2 seem to represent the decreasing stage after the turning point in early 1980. This downward movement is assisted by the government regulations for reduction of SO_2 level such as substitution policy toward low-sulphur and cleaner burning fuels and technologies in industrial sites and motor vehicles.

The most evident air pollution problem is the restricted visibility in most major cities. The incessant construction dust,

traffic jams, and industrial emissions have led to high level of total suspended particulate (TSP) in the atmosphere. However, the TSP level has decreased since 1985. The reduction is mainly supported by the stricter regulation of TSP levels such as permissible air discharge standards of TSP set in August, 1983. Our estimation result for TSP also shows the decreasing TSP with per capita GDP (i.e., linear-log model with two variable works best). However, based on other sources such as 'An Environmental White Book' (various volumes) describing environmental quality, we can clearly presume that the TSP level had increased during 70s and early 80s. Even if the data does not exist to support this argument, this argument is acceptable. Accordingly, the decreasing TSP represents the declining stage after the turning point (around 1985) of the inverted-U shaped curve. The CO2 emission from primary energy consumption which is the main source of climatie change shows increasing trend since early stage of economic growth. The increasing dependence on liquid energy and electricity as substitute of solid energy as a result of fuel-substitution policy since the late 1980s has not supported the reduction of CO2 emission. This increasing trend of CO2 emission is mainly caused by the progressive increase of total primary energy consumption accompanied with economic growth. Our regression analysis also shows that double-log model with two variable fits best.

Air pollutants studied in this paper such as SO_2, NO_2, CO_2 and TSP are generally regarded to be highly correlated. However, our studies show different results: SO_2, NO_2 and TSP exhibit inverted U-shape relationships with economic growth, while CO_2 emission appears to rise monotonically with income. This exceptional result on CO_2 emission which is costly to abate and has primarily global effects, however, is consistent with the recent finding by other empirical studies such as Diwan and Shafik (1992) and Holtz-Eakin and Selden (1995).

Figure-1

Inverted U Shaped Curve

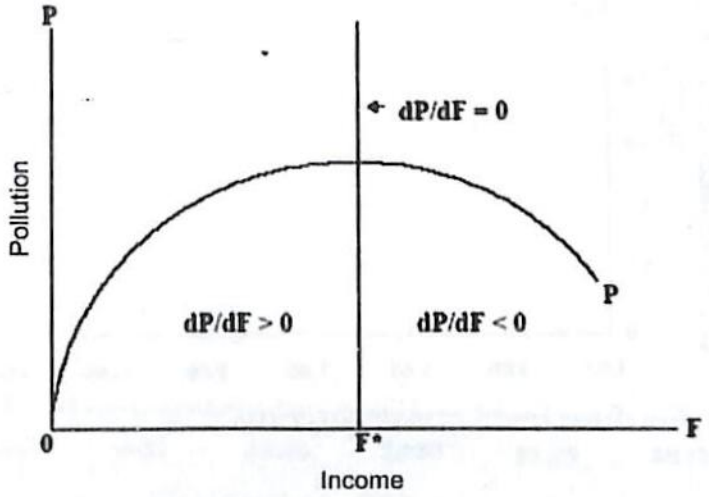
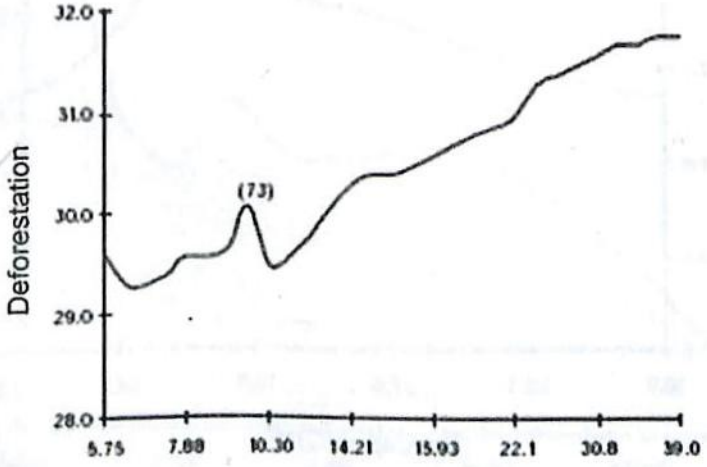
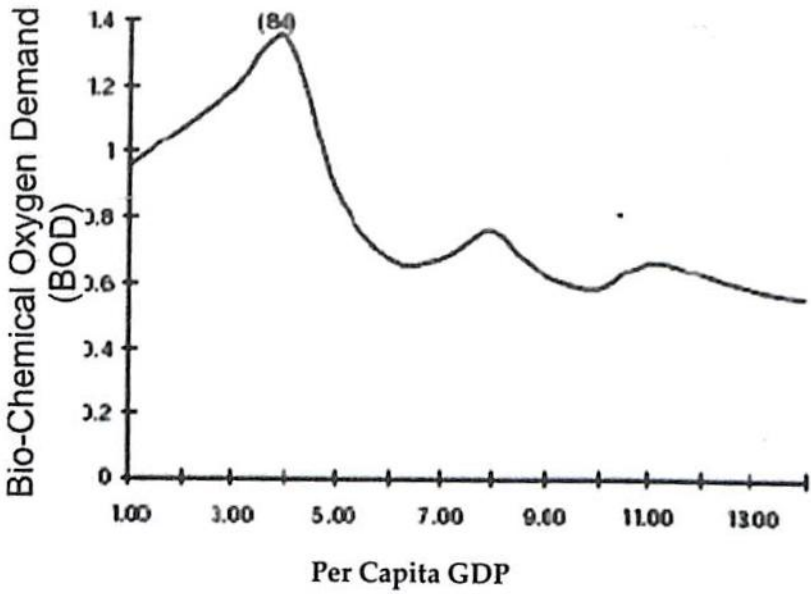
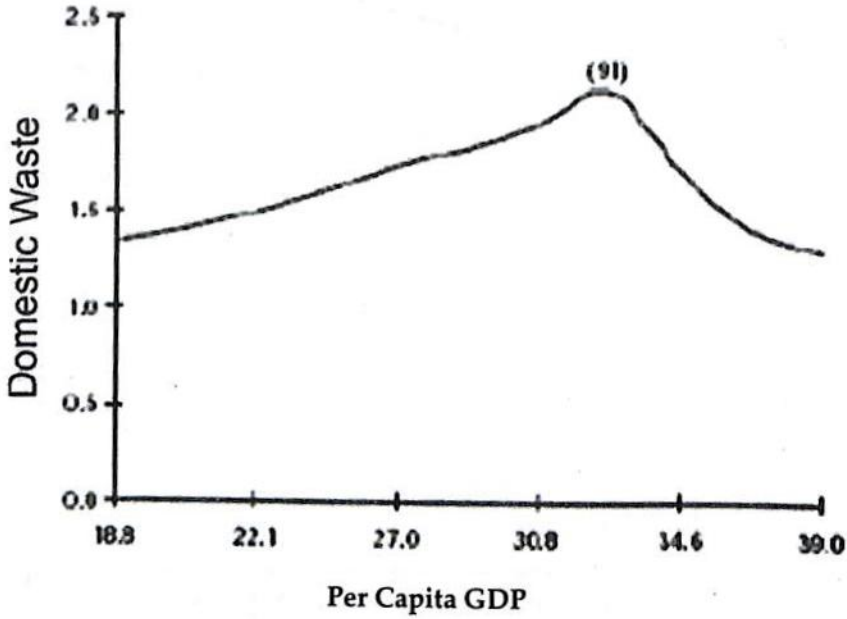


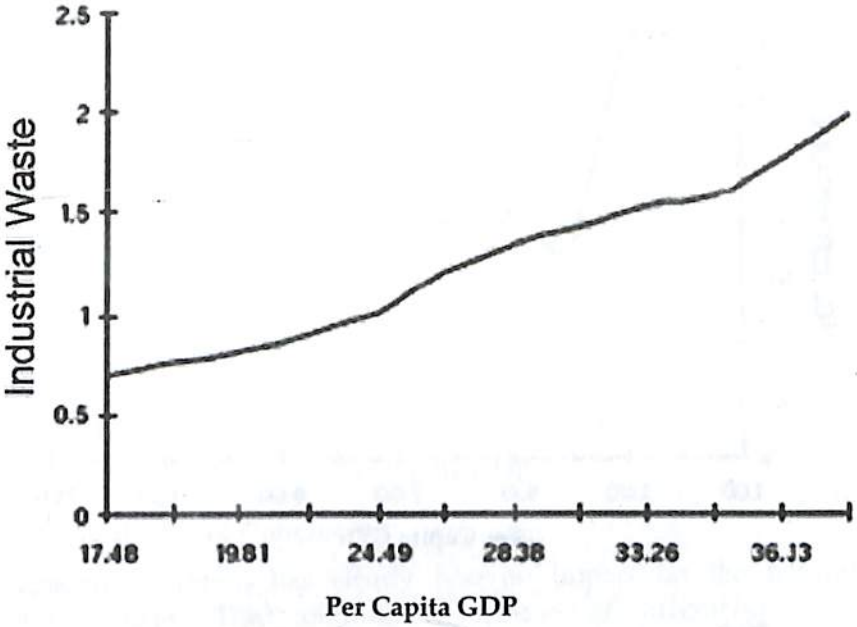
Figure-2

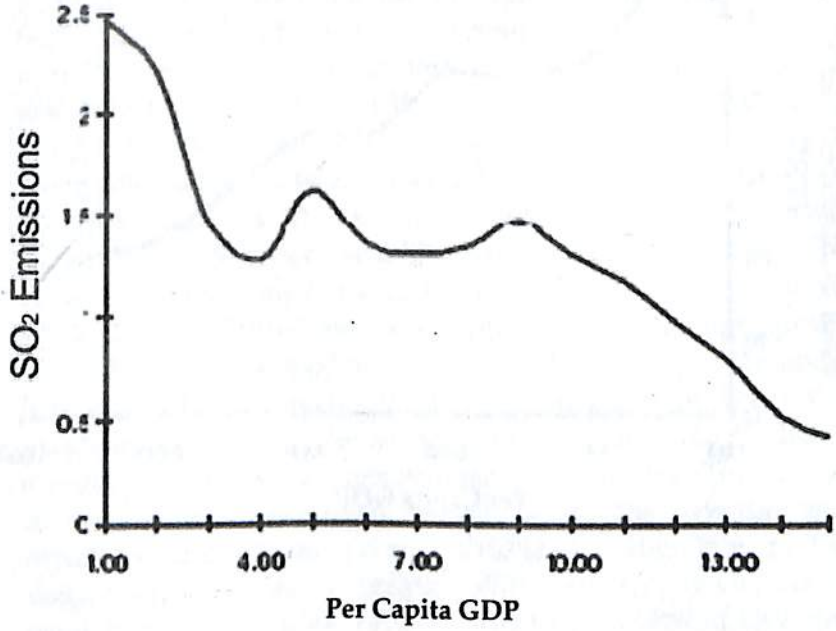
Relationship between different environmental quality indicators and per capital GDP

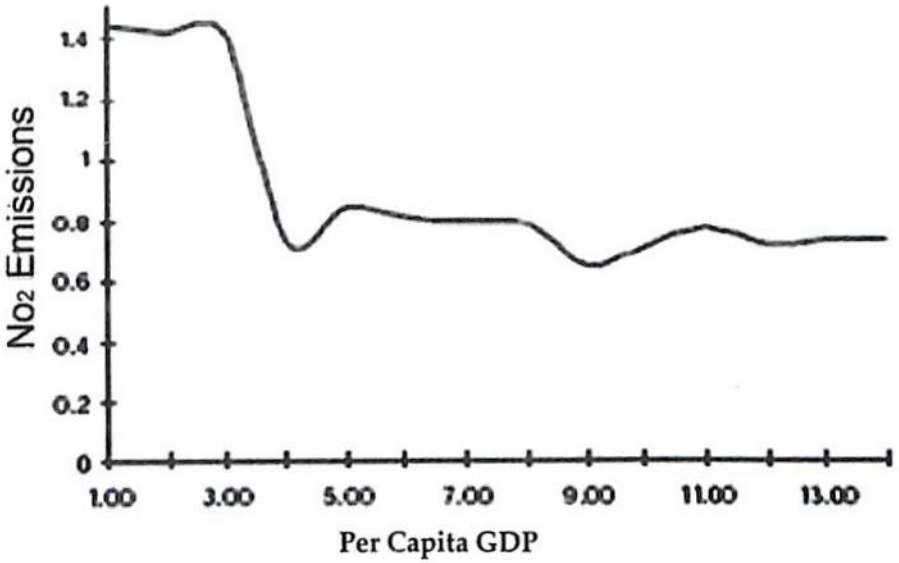


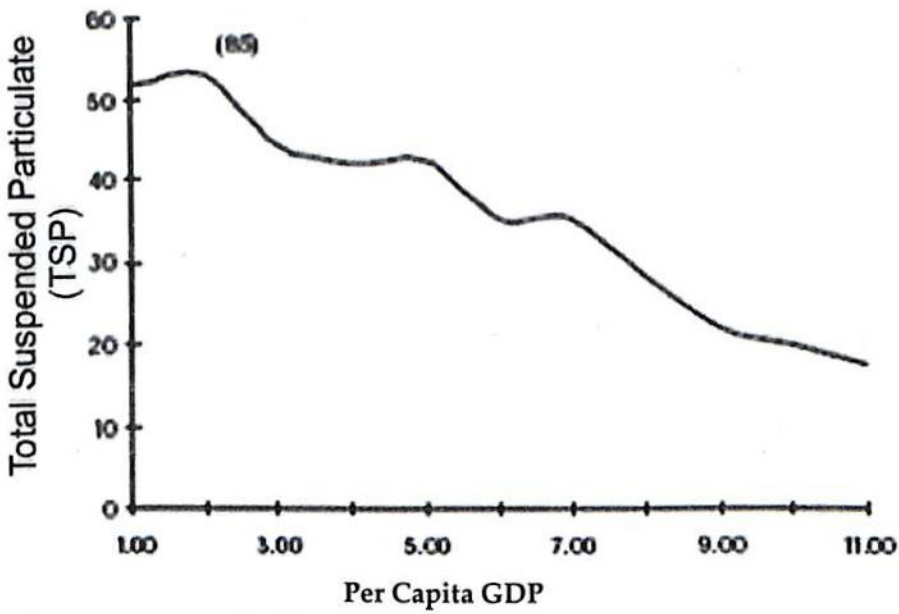

Bio-Chemical Oxygen Demand (BOD)
(80)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1.00
3.00
5.00
7.00
9.00
11.00
13.00
Per Capita GDP

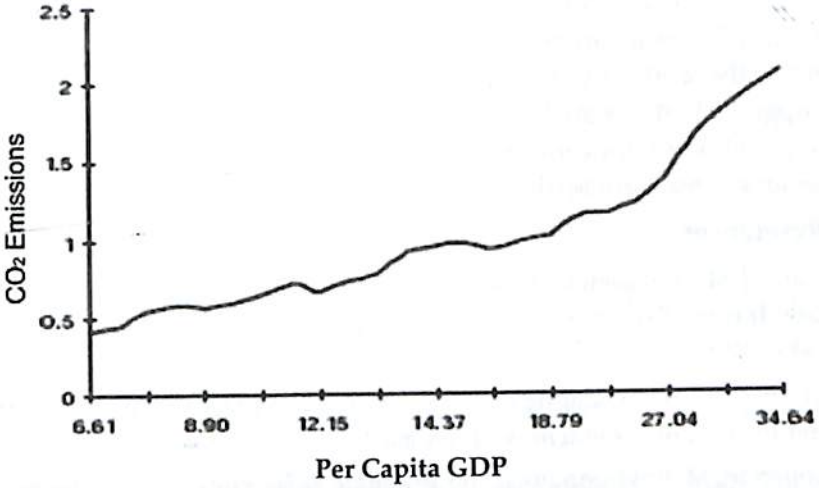

Domestic Waste
(91)
2.5
2.0
1.5
1.0
0.5
0.0
18.8
22.1
27.0
30.8
34.6
39.0
Per Capita GDP


Industrial Waste
2.5
2
1.5
1
0.5
0
17.48
19.81
24.49
28.38
33.26
36.13
Per Capita GDP


SO2 Emissions
1.00
4.00
7.00
10.00
13.00
Per Capita GDP


No2 Emissions
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1.00
3.00
5.00
7.00
9.00
11.00
13.00
Per Capita GDP


Total Suspended Particulate (TSP)
60
50
40
30
20
10
0
1.00
3.00
5.00
7.00
9.00
11.00
Per Capita GDP



4. Summary and Conclusion

Economic growth has clearly had an impact on the natural environment. The continuous increase of production and consumption activities in the course of economic growth have inevitably placed environmental pressures. The evidence shown in Section III.1 has confirmed this. Section III.2 analysed how rising economic activity, while causing environmental problems, can also help to redress them if appropriate policies and regulations are put in place. From the analysis, some very clear patterns of environmental degradation emerged. Some environmental quality indicators such as CO_2 emission, deforestation and industrial waste have worsened steadily with rising per capita GDP. However, other indicators (SO_2, NO_2, TSP, BOD and domestic waste) have worsened but then improved with economic growth. This supports the hypothesis of an inverted-U shape relationship between environmental quality and economic growth. The turning points at which the relationship with per capita GDP changes direction varies across environmental indicators. This usually coincided with the time period when the environmental regulation and policies became stricter, and therefore, perhaps also became more effective. With stricter environmental regulations and policies, private industries are forced to expend more resources on pollution abatement and control activities. Also

with increased income following economic growth, people become more aware of the environmental problems and therefore, force the authority to enforce more control. This then tends to suggest that people's awareness of the problem and the application of appropriate policies and investments are important factors in the fight against environmental degradation.

References

Antle, J M. "Environment, Development, and Trade between High- and Low-Income Countries." *American Journal of Agricultural Economics, 75,* 1993: 784-88.

Antle, J. M. and Heidebrink G. "Environment and Development: Theory and International Evidences." *Economic Statistical Yearbook,* 1991: 91-13.

Common, M. Environmental and Resource Economics: An Introduction. Longman, 1995.

Diwan, I. and Shafik N. "Towards a North-South Deal on the Environment." In *International Trade and the Environment, World Bank Discussion Paper No. 159,* by P. Low (ed), 263-286. World Bank: Washington, DC., 1992.

Eder, Norman R. *Poisoned prosperity: development, modernization, and the environment in South Korea.* Armonk, NY: M.E. Sharpe, 1996.

Grossman, Gene M, and Alan B Krueger. "Environmental impacts of a North American free trade agreement." In *The U.S. Mexico Freed trade Agreement,* edited by Barber P. Cambridge, MA: National Breau of Economic Research, 1993.

Grossman, Gene M, and Alan B Krueger. "Economic Growth and the Environment." *The quarterly journal of economics. 110,* 1995: 353-78.

Han, Sang-Wook. *Environmental Issues and Projects.* Management Institute: Asia-Pacific Environment, 1994.

Holtz-Eakin, D, and T M Selden. "Stoking the fires? CO2~ emissions and economic growth." *Journal Of Public Economics, 57,* 1995: 85-101.

Jung, T. and Choi K. "Energy in Import Industry: Effeects of Carbon Tax." *Environment Economic Review 3 no.1,* 1994: 187-99.

Kim, J. and Jeon E "Strategies for Developing Responsive Solid Waste Management: An Institutional Arrangement." *Journal of Environmental Studies 28* (National University. The Times, March 25,1994), 1991.

Lim, J. "The Dynamic Relationship Between Environmental Quality and Long-Run Endogenous Economic Growth." Paper presented at the *Environment, Trade and Growth Conference.* Melbourne, Australia, 20-22 August,1996.

Lopez, R. "The Environment as a Factor of Production: The Effects of Economic Growth and Trade Liberalization." *Journal Of Environmental Economics And Management*, 27, 1994: 163-84.

Meadow, D.H Meadows, D.L. and Randers J. "Pollution Control and Abatement Expenditure in OECD Countries." In *Limit to Growth, New York: Universe Books, 1972,* by Environment White Book, Varioous Volumes. OECD Ministry of Environment. Paris: OECD Environment Monographs 75, 1993.

Radetzki, Marian. "Economic growth and environment." In *International Trade and Environment World Bank,* by In Low D.(ed). Stockholm: SNS, 1992.

Ruttan, V.W. "Technology and the Environment." *Journal of Agricultural Economics 53,* 1971: 707-17.

Selden, T M, and D Song. "Environmental Quality and Development: Is There a Kuznets Curve for Air Pollution Emissions?" *Journal Of Environmental Economics And Management, 27,* 1994: 147-62.

Selden, T M, and D Song. "Neoclassical Growth, the J Curve for Abatement, and the Inverted U Curve for Pollution." *Journal Of Environmental Economics And Management, 29,* 1995: 162-68.

Shafik, N. T. "Economic Development and Environmental Quality: an Econometric Analysis." *Oxford Economic Papers, 46,* 1994: 757-73.

Sibert, H. "Environmental Quality and the Gains from Trade." *Kyklos 30 (Fasc.4),* 1980: 657-73.

Turner, R Kerry, David W Pearce, and Ian Bateman. *Environmental economics: an elementary introduction.* New York: Harvester Wheatsheaf, 1994.

Department of International Economics and Social Affairs. United Nations Energy Statistical Yearbook, Statistical Office: Various Volumes.

Development and the Environment. World Development Report1992, Washington DC: The World Bank, 1992.