"REGIONAL IMBALANCES IN CONCENTRATION OF INSTALLED CAPACITY OF GRID INTERACTIVE RENEWABLE POWER: A GEOGRAPHICAL ANALYSIS"

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Abstract

Resource is the key to operate overall development of the nation. Increasing population and improper management lead to over exploitation of the natural resources, cause scarcity of the conventional resources. The conventional energy resources have become limited due to increasing demand with increasing population and industrialization. So it is necessary to utilize non conventional or renewable energy sources for generating the power for overall development of the nation. By keeping this view this study aims to analyze the gap between production and consumption of conventional resources and also to study implementation of renewable energy sources in India. The present investigation is based on secondary data published by Govt. of India in Energy Statistics. The concentration of installed capacity of Grid Interactive Renewable Power is calculated by the modified formula of Bhatia's (1965) Location Quotient method for delimiting the regional concentration of the renewable power sources for the period of 2007-08 and 2011-12. It is observed that the installed capacity of wind and solar power is increased by 13.42 and 1.23 per cent respectively, where as the installed capacity of Small Hydro Power, Biomass Power and Waste to Energy is decreased. The high concentration of Biomass Power is observed in Chhattisgarh, Waste Energy in Andhra Pradesh, Wind Power in Gujarat, Small Hydro Power in Assam and Solar Power in Lakshadweep during 2007-08. The Utter Pradesh in Biomass and Delhi in Waste Energy were become leading states in concentration during 2011-12. The maps and diagrams are prepared for detailed analysis.

INTRODUCTION

Resource is the key of the development the nation. The conventional power resources become limited to provide the increasing demand of increasing population and increasing industrialization. Most of the energy consumed by the world comes from non renewable resources which are limited in quantities and can be depleted. These resources are fossils, fuels; petroleum, coal and natural gas. Petroleum accounts for approximately 37 per cent of the world's energy consumption. Coal and natural gas together supply approximately 48 per cent. Uranium is another non renewable energy resource used in nuclear power points. It is used for approximately 7 per cent of the world's energy (Diane & Match 2009). These energy resources are utilized by the citizens for standard of living and betterment of the life. The standard of living of the people of any country is considered to be proportional to the energy consumption by the people of that country. In one sense, the disparity one feels from country to country arises from the extent of accessible energy for the citizens of each country. Unfortunately, the world energy demands are mainly met by the fossil fuels today. The geographical non equi-distribution of this

source and also the ability to acquire and also control the production and supply of this energy source have given rise to many issues and also the disparity in the standard of living. (B.Viswanathan 2006).

By considering all these things and scarcity of the conventional or non renewable resources needed to turn over to utilize the renewable resources. The non conventional or the renewable power resources solve various difficulties of the human beings. The over exploitation of the conventional energy sources creates problem like scarcity of resources. By considering the increasing demand of grid power and load shading it is necessary to utilize renewable power resources like Biomass, Waste to Energy, Wind Power, Small Hydro Power and Solar Power etc.

OBJECTIVES:

To study the regional imbalances of Installed Capacity of Grid Interactive Renewable Power in India.

To study the implementation of renewable energy sources in India.

THE REGION:

India is the seventh largest and second most populous country in the world. It extends between the 8^0 4' 28" North to 37^0 17' 53" North latitudes and 680 7' 33" East to 97^0 24' 47"East Longitude. It covers an area of 3287264 sq. km. which is 2.4 per cent of the total world area supports roughly 16 per cent of the world population. Out of total land masses of India 43.3 per cent of area is covered by plains, about 27.7 percent by plateaus, 18.6 per cent by hills and about 10.7 per cent by mountains. Most of the rainfall of the country is received from the south west monsoon which lasts from June to September. The north east monsoon is usually active from October to February. The average rainfall (1130mm.) has considerable variations in space and time and accordingly the flow of water in the river of central and the south India, depends upon the monsoon rainfall. The other source is the snow. The Ganga, Brahamputra, Narmada, Tapi in the Northern part while Mahadevi, Godavari, Krishna, Cauvery and Pennar etc. flow from west to east into the Bay of Bengal in Southern part. Broadly the country has Monsoon climate. The temperature ranges between 10^0C to 37^0 C it increases from north to south and isotherms run across India nearly parallel to the latitude.

DATA BASE METHODOLOGY:

The study is mainly based on secondary data where state is considered as areal unit. The location quotient method of Bhatia (1965) is modified for delimiting the regional imbalances in concentration of Installed Capacity of Grid Interactive Renewable Power in India. The related data have been abstracted through Energy Statistics for the period of 2007-08, ,2009-10 and 2011-12, published by Central Statistics office, Ministry of Statistics and Programme Implementation Government of India. The share of percentage of the renewable power resources is tabulated for analyzing implementation of the grid interactive renewable power resources. The results are represented by the tables and maps.

ANALYSIS:

The installed capacity of major grid interactive renewable power resources in the region is increased. The installed capacity of major Sources was 11329.67 MW in the year of 2007-08 which increased up to four times and went up to 40480.23 MW, during the period of 2011-12. The share of wind power is 69.96 per cent in the year 2007-08 which is increased up to 83.38 per cent in year 2011-12. The share of solar power is also increased tremendously during the study period. It was .02 per cent in the year 2007-08 which is increased up to 1.25 percent in the year 2011-12. (Table 1)

Table 1
Share of Installed Capacity Grid Interactive of Renewable Power in India

Sources	Year					
	2007-08		2009-10		2011-12	
	Power in MW	Share of %	Power in MW	Share of %	Power in MW	Share of %
Biomass Power	1273.88	11.24	1983.98	12.76	2909.98	7.19
Waste to Energy	49.95	0.44	62.15	0.40	89.08	0.22
Wind Power	7925.69	69.96	11028.84	70.95	33754.28	83.38
Small Hydro Power	2078.03	18.34	2461.16	15.83	3219.26	7.95
Solar Power	2.12	0.02	9.53	0.06	507.63	1.25
Total	11329.67	100.00	15545.66	100.00	40480.23	100.00

Source: Data Compiled by the researcher from Energy Statistics

The Concentration of Installed capacity of greed interactive renewable power are analyzed for the period of 2007-08 and 2011-12 are as follows.

CONCENTRATION INDEX:

The location quotient method of Bhatia (1965) is modified for delimiting the regional imbalances in concentration of Installed Capacity of Grid Interactive Renewable Power in India.

Index of Concentration:

$$\textbf{Concentration of Installed capacity} = \frac{\text{Installed Capacity of Power Source 'a' in the areal Unit}}{\text{Total Installed Capacity of all Power Source in the areal Unit}} \div \frac{\text{Installed Capacity of Power Source 'a' in the country}}{\text{Total installed Capacity of all All Power Sources in the Country}}$$

A) BIOMASS POWER:

Globally, India is the forth position in generating power through Biomass and with a huge potential, is poised to become a world leader in the utilization of biomass (Amol Bhavsar 2011). Biomass is the term used for all organic material originating from plants, trees and crops and is essential for the collection and storage of the Sun's energy through photosynthesis. Biomass energy or Bio energy is the conservation of Biomass into useful forms of the energy such as heat, electricity and liquid fuels. Biomass for bio energy comes either directly from the land as dedicated crops or from residues generated in the processing of crops for food or other products such as pulp and paper from the wood industry. (A. V. Herzog et al 2011).

The installation capacity of Biomass in the year 2007-08 was 1273.88 MW whereas it went up to 2909.98 MW during the year 2011-12. The highest installed capacity is observed in Andhra Pradesh was 37.75 MW whereas lowest installed capacity is observed in Gujarat was 0.5 MW during 2007-08. This pattern is changed in 2011-12 and high installed capacity is observed in Utter Pradesh is up to 618.5 MW whereas lower installed capacity is observed in Madhya Pradesh is 4.75 MW.

During the year 2007-08 the high concentration observed in Chhattisgarh is followed by Uttar Pradesh, Andhra Pradesh, Punjab and Karnataka (Fig1.A). The moderate concentration is observed in Haryana, Tamil Nadu whereas low concentration is observed in Maharashtra, Rajasthan, Madhya Pradesh Gujarat etc. During 2011-12 the high concentration of installed capacity of Biomass power observed in Uttar Pradesh followed by Chhattisgarh and Andhra Pradesh. The moderate concentration observed in Punjab is followed by Haryana, Orissa, Bihar, Maharashtra, West Bengal, Karnataka and Tamil Nadu. The low concentration is observed in Uttaranchal, Rajasthan, Madhya Pradesh and Gujarat. The eastern and north eastern part of India and Kerala, Lakshadweep and Andaman Nicobar has not considered for installation of such Biomass power (Fig.1B).

This situation is changed after five year and new areas of eastern part of India included in installed capacity of Biomass in the year 2011-12 are Bihar, Orissa and West Bengal respectively. Maharashtra has led to moderate concentration by upgrading the installed capacity with above Eastern states during this period.

B) WASTE TO ENERGY:

The installation capacity of waste to energy in 2007-08 was 49.08 MW only, which is increased up to 89.0 MW in the year 2011-12. The highest installed capacity of waste to energy in 2007-08 was 30.25 MW in Andhra Pradesh. It has increased up to 43.16 MW in the year 2011-12.

It is observed that the high concentration of installed capacity of Waste to Energy observed in Andhra Pradesh is followed by Punjab and Uttar Pradesh. The moderate concentration is observed in Madhya Pradesh where as Tamil Nadu, Karnataka, Gujarat and Maharashtra shows low concentration of installed capacity for the year of 2007-08 (Fig 2.A).
The share of installed capacity of Gujarat and Utter Pradesh is decreased in 2011-12 (Fig2.B). During this year Delhi, Andhra Pradesh and Punjab show high concentration of installed capacity, whereas Madhya Pradesh and Utter Pradesh show the moderate concentration. Besides that, Maharashtra, Tamil Nadu and Karnataka show low concentration of installed capacity.

C) WIND POWER:

India rank fifth in the wind energy with installed capacity of 10891 MW (Peter Meisen 2010). The origin of energy is sun. When sun-rays fall on the earth its surface gets heated up and as a consequence unevenly winds are formed. Kinetic energy in the wind can be used to run wind turbines but the output power depends on the wind speed. The installed capacity of wind Power in India in the year 2007-08 is 7925.69 MW, which is increased up to five times i.e. 33754.28 MW during the year 2011-12. The highest installed capacity observed in Gujarat is 20571.35 MW in 2011-12, whereas West Bengal has installed the capacity of 4.3 MW only.

The high concentration of installed capacity in wind power in India observed in Gujarat is followed by Rajasthan, Tamil Nadu and Maharashtra. The moderate concentration is observed in Madhya Pradesh and Karnataka. The low concentration is observed in Andhra Pradesh, Orissa, Kerala and West Bengal in the year 2007-08 (Fig. 3 A). Only western and southern part of India is covered by installation of wind power plants.

The eastern coastal area and the hilly tract of the interior are also suitable for the installation of wind mills. This pattern is remain constant in next five year span in the year 2011-12 (Fig. 3 B).

D) SMALL HYDRO POWER:

This is a non conventional and renewable source it is easy to tap. Quantitatively small volumes of water, with large falls (in hills) and quantitatively not too large volume of water with small falls (such that of canals) can be tapped. The force of the flowing and falling water is used to run water turbines to generate energy (Siddhu 2012).

The installed capacity of small hydro power was 2078.03 MW in 2007-08. The highest installed capacity observed in Karnataka is 440.25 MW and lowest in Goa is .05 MW. During the year 2011-12 the total installed capacity of small hydro power is 3219.26 MW. The highest installed capacity observed in Karnataka is 832.9 MW whereas lowest in Goa is 0.05 MW.

The high concentration of installed capacity of Small Hydro Power is observed in the zone of high rainfall (400 to 1000 Cm) with hilly tract and abundant drainage network with water storage facilities. The high concentration observed in Assam is followed by Bihar, Goa, Himachal Pradesh, Jammu Kashmir and Kerala in the year 2007-08. The moderate concentration observed in Haryana is followed by Orissa, Punjab, Madhya Pradesh, Andhra Pradesh and Karnataka (Fig. 4 A). After the five year (2011-12), the high concentration of installed capacity of the small hydropower is increased and the areas of Punjab, Haryana, Jharkhand and Orissa are included in this category. The areas of Maharashtra are also upgraded from low concentration to moderate concentration of installed capacity of small hydro power (Fig. 4 B).

E) SOLAR POWER:

Solar energy is an important, clean, cheap and abundantly renewable energy (Naval Singh 2009). India promises to become one of the world's largest photovoltaic energy markets. The country has the best solar resources in the world with 260 -300 clear sunny days per year, on the other hand, it is confronted with continuous electricity shortages (Peter Meisen 2010). The concentration of installed capacity of the solar power in 2007-08 shows that, Lakshadweep, Pondicherry, Andaman and Nicobar have high concentration because none of the other means of other power is installed in these areas. Besides that, Punjab and Uttar Pradesh shows high concentration (Fig 5A), where as moderate concentration is observed in Uttaranchal is followed by Madhya Pradesh, West Bengal, Arunachal Pradesh and Rajasthan which receives the temperature up to 25^0 C to 27.5^0C. The low concentration observed in Kerala is followed by Andhra Pradesh and Tamil Nadu.

This pattern is changed in the year of 2011-12. The areas of Gujarat and Chhattisgarh are implemented and installed solar photovoltaic units and noted as moderate concentrated areas. The areas of Haryana, Jharkhand and Orissa show high concentration of installed capacity of solar power. The areas of Uttar Pradesh followed by Maharashtra, Madhya Pradesh, Karnataka, Kerala, Tamil Nadu and Arunachal Pradesh show low concentration of Installed capacity of Solar Power. (Fig. 5 B)

FINDINGS AND RECOMENDATIONS:

The physiography and the climate of the region show that, the region has large extent of potential for installation of all types of the non conventional or renewable power resources. But it is observed that, this strength is not utilized properly in the region. Only few states have given importance for installation of above renewable power sources. So it is needed to promote the misleading states for implementation or installation of above power sources. The hilly and the states of high rainfall have good potential for installation of small hydro power projects but not taped properly. So it is needed to tap such water bodies for increasing installed capacity of small hydro power. It is noted that, about 50 per cent of the India potential for installation of waste to energy power projects but half of the country is away from this. The agricultural and domestic waste should be useful for generation of the energy so it needs more concentration on it. The temperature of the region ranges between 10^0C to 37^0C which is quite suitable for installation of the solar power in all the states. It is needed to increase the social and environmental awareness among the people by using the renewable sources. It will be easy to find solution on load shading in agricultural sector by using solar power for operating the electric motors for agricultural practices. Participation of NGO's and big industrialists lead to promote for the installation of such renewable power plants and equipments for industrial, agricultural and even for domestic purpose.

Concentration of Installed Capacity of Biomass Power In India

2007 - 08	2011 - 12
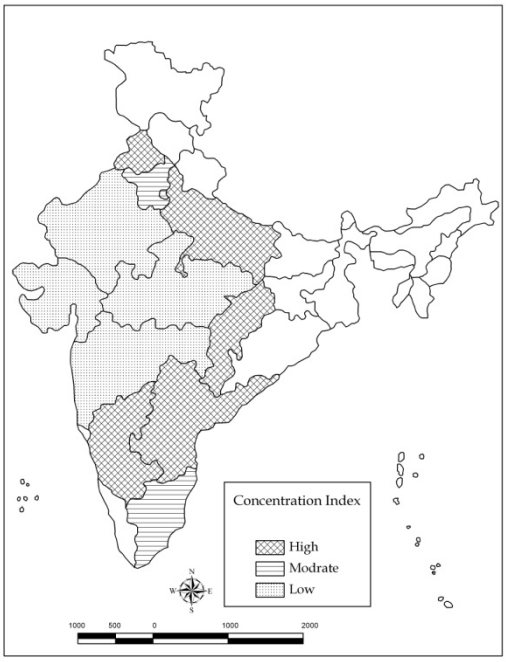	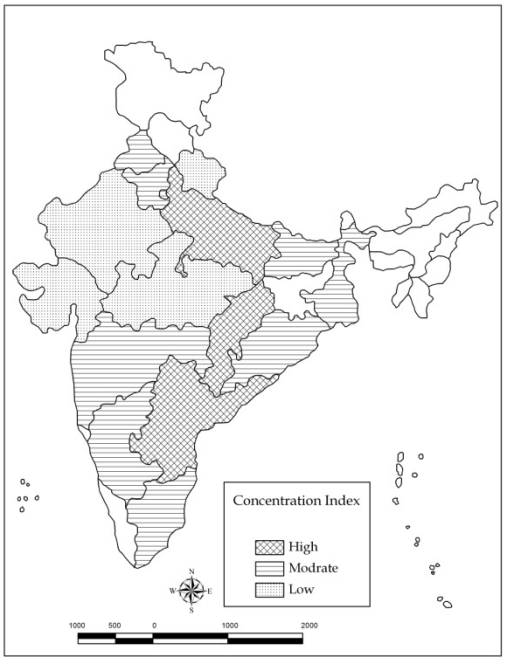
Fig. No. 1 A	Fig. No. 1 B

Concentration of Installed Capacity of Waste to Energy in India

2007 - 08	2011 - 12
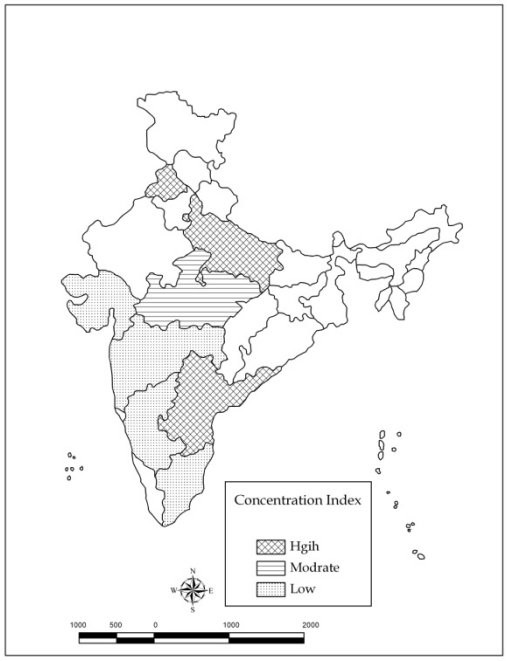	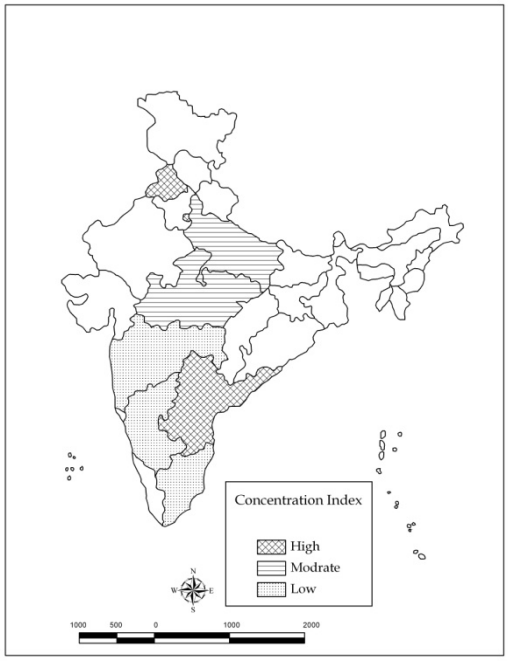
Fig. No. 2 A	Fig. No. 2 B

Concentration of Installed Capacity of Wind Power In India

2007 - 08	2011 - 12
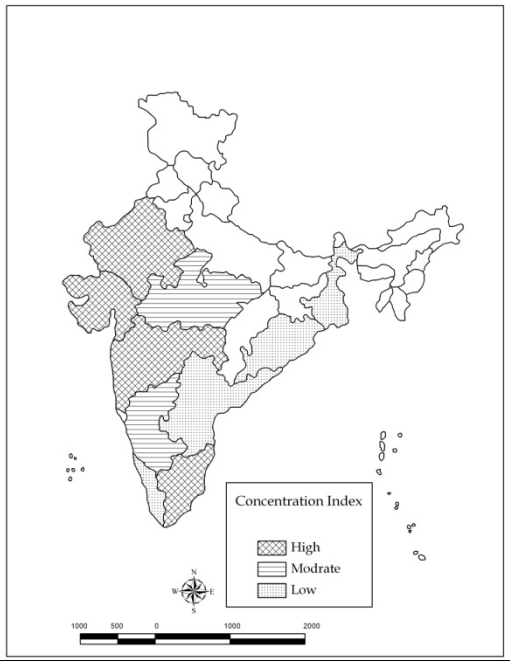	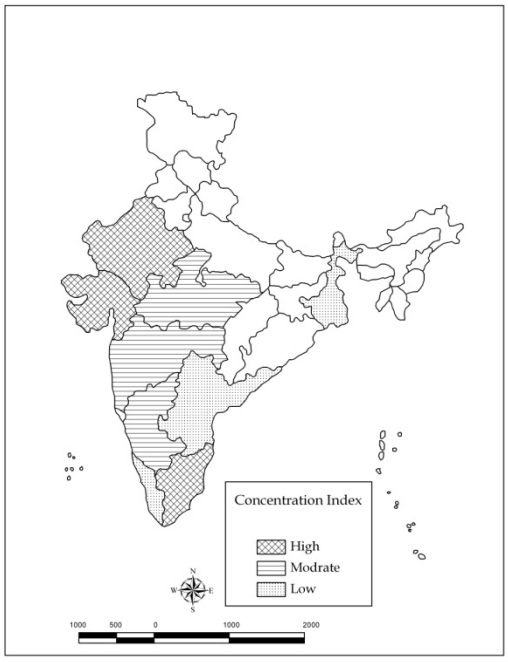
Fig. No. 3 A	Fig. No. 3 B

Concentration of Installed Capacity of Small Hydro Power In India

2007 - 08	2011 - 12
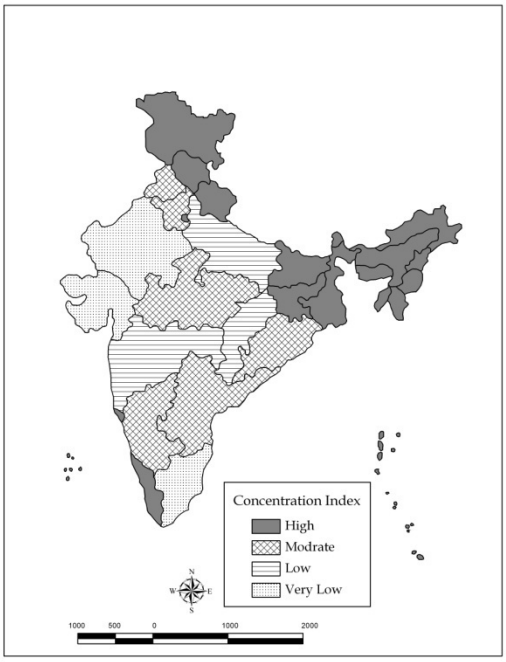	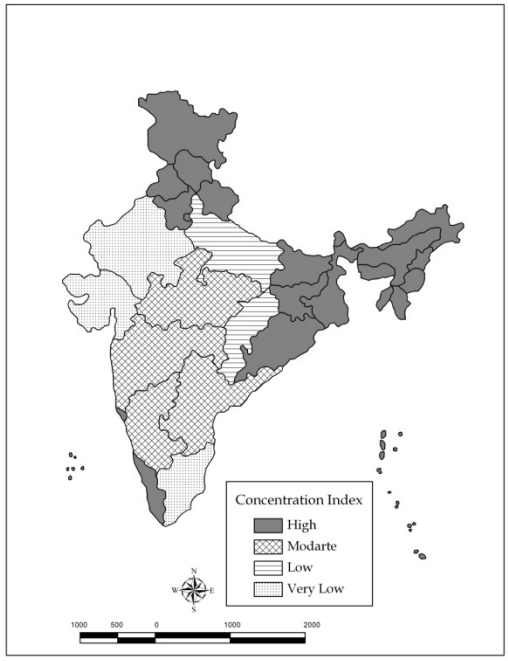
Fig. No. 4 A	Fig. No. 4 B

Concentration of Installed Capacity of Solar Power In India	
2007 – 2008	**2011 -2012**
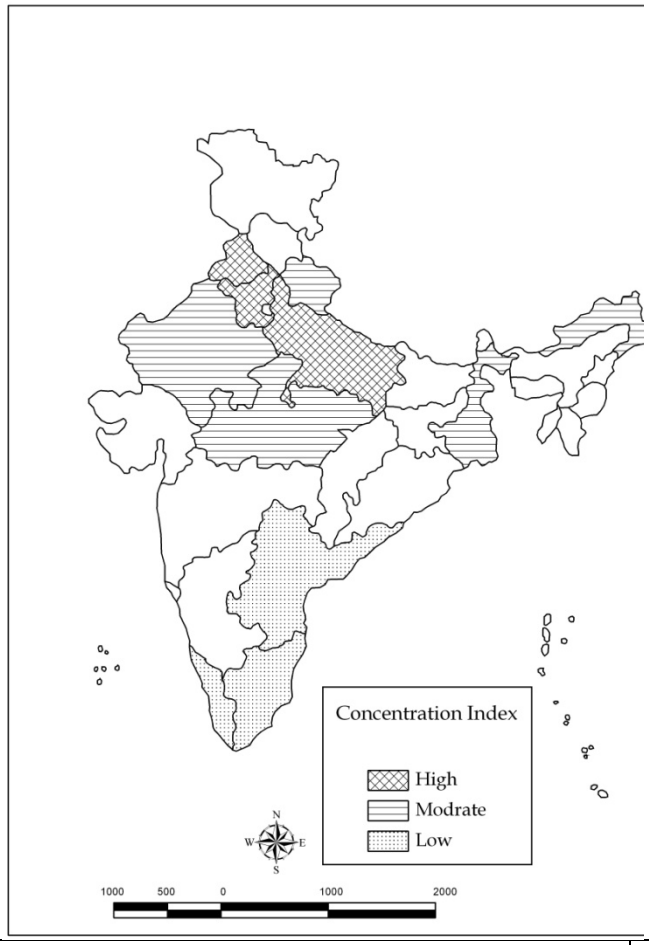	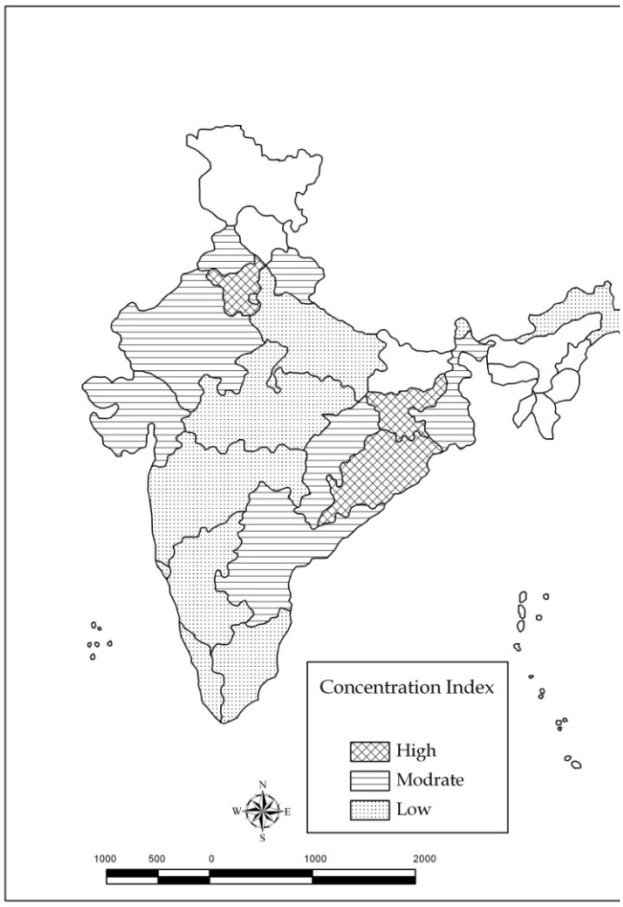
Fig. No. 5 A	Fig. No. 5 B

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