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**Dr. Nitin Punit**

Shivaji College, University of  
Delhi, Delhi, India

**Dr. Rajender Singh**

Shivaji College, University of  
Delhi, Delhi, India

## A statistical analysis of human and environmental indicators to measure development process: A case study

**Nitin Punit and Rajender Singh**

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### Abstract

Human development and environmental quality are two ultimate goals that every society wants to achieve at present. The development can be considered in terms of preferably economic and social parameters. On the other hand, environment relates to the resource potential and pollution level. The focus on one of these two core issues of sustainable development ultimately leads to negligence of another. It is not very easy to decide that the emphasis should be on development process or the environmental quality. Both issues are equally important in terms of human development. However, both of these parameters of sustainability appear quite different in terms of their nature but they have mutual cause and effect relationship. High level of human or infrastructural development is generally believed to be the cause of environmental degradation and depletion of natural resources and *vice versa*.

**Keywords:** Environment, development, economic, pollution, sustainability, relationship, degradation, etc.

### Introduction

High level of human or infrastructural development is generally believed to be the cause of environmental degradation and declining rate of environment quality and natural resources. There has been a long debate between the emphasis on infrastructural development on the one hand and the supporters of better environment quality on the other. Both issues are equally important in terms of human development. Besides, both human development and environment quality have mutual cause and effect relationship.

This paper attempts to contribute to this debate with an empirical analysis. The study is based on all twelve districts of Himachal Pradesh. It tries to analyze the structure of the human development with demographic and infrastructural indicators vis-a-vis the level of environmental degradation. It aims to study the impact of human development on the environmental quality of all districts of Himachal Pradesh. Besides, it also studies that in order to achieve the desired goal of development the quality of environment has been degraded in the district or not.

### Study Area

The state of Himachal Pradesh has been selected as the study area. The state comprises 12 districts – Bilaspur, Chamba, Hamirpur, Kangra, Kinnaur, Kullu, Lahaul & Spiti, Mandi, Shimla, Sirmour, Solan and Una, which are further sub-divided into tehsils and sub-tehsils. Despite its mountainous nature, the state shows diversity not only in terms of human dimensions but also in terms of environmental dimensions. On one hand, there is Shimla district which can be termed as the leading district of Himachal Pradesh because of the state capital in the district. The districts manifest itself as the hub of development activities which creates a gravitational pull not only to attract natural resources but human resources also from the neighboring districts. On the other hand, there is the district like Lahul-Spiti where the development level is very low. Therefore, the state represents drastic change in development level from one district to another.

### Objectives

1. To calculate composite index and component score on the basis of human and environment indicators.
2. To prepare typology of districts on the basis of composite index and component score.

**Corresponding Author:**

**Dr. Nitin Punit**

Shivaji College, University of  
Delhi, Delhi, India

## Methodology

Since it is impossible to measure ecosystem or human wellbeing directly, their assessments include selected indicators of each dimension. It is very much essential to know at the start of an assessment how well a given set of indicators represents a desirable combination of human and environmental conditions. Since indicators require the collection and analysis of often large amounts of data, choosing the wrong ones can be a costly mistake (Prescott-Allen, 2001) [7].

## Selection of Variables

The selection of variables is very significant for methodology which depends on certain considerations. First is data availability as it is very crucial that only those variables should be selected to study for which the data is readily and easily available. Besides, there should be consistent availability of data for the period of study. As both the concepts – environmental and human dimensions – are dynamic in nature therefore a consistent availability of data is very much crucial.

Consequently, it was decided first to take apart the concepts of human and environmental wellbeing to identify the features those need to be measured and those are both representative and measurable. Subsequently, two sets of variables were identified- one reflecting the human dimensions and the other showing the quality of environment. Total nineteen variables were selected and grouped into two sets: Quality of Environment (QOE) and Quality of Life (QOL).

### A. Human Indicators

The indicators selected for assessing the quality of life in each of the twelve districts of the Himachal Pradesh number eight in all. These eight indicators are further subdivided into two groups – human indicators and infrastructural indicators.

### Demographic Indicators

1. Literacy Rate.
2. Urban Population to total population.
3. Unemployment Rate (Percentage of vacancies total no. of applicants).

### Infrastructural Indicators

1. Level of Education (No. of Schools).
2. Medical institutions (No. of Medical Centers).
3. Communication Facilities (No. of Telephones).
4. Availability of Electricity (No. of villages Electrified).
5. Banking Facilities (Credit Deposit Ratio).

### B. Environmental Indicators

To assess the quality of environmental total five indicators were selected. These indicators largely reflect the environmental quality whether upgraded or degraded.

1. Percentage of Forest Land to Total Land.
2. Percentage of Culturable Wasteland to Total land.
3. Percentage of Barren and Unculturable Land.
4. Percentage of Current Fallow Land to Net Sown Area.
5. Fertilizer Consumption.

As the indicators of ecosystem dimensions itself show that among all seven indicators five indicators (percentage of culturable wasteland, percentage of barren and unculturable land and percentage of current fallow to net sown area) represent the land resource; the status of forest resource is

shown by percentage of forest area to total land; and the fertilizer consumption represents the depletion of land fertility.

## Demographic Indicators

**Literacy rate:** Literacy rate is a positive indicator of development. In Himachal Pradesh, the highest literacy rate was shown by Hamirpur district and the lowest by Chamba district for the year 2011 (Table 1).

**Table 1:** District-wise Literacy Rate in Himachal Pradesh (2011)

District	Male Literacy Rate (%)	Female Literacy Rate (%)	Total Literacy Rate (%)
Bilaspur	92.39	78.90	85.67
Chamba	84.19	62.14	73.19
Hamirpur	95.28	83.44	89.01
Kangra	92.55	80.62	86.49
Kinnaur	88.37	71.34	80.77
Kullu	88.80	71.01	80.14
Lahul & Spiti	86.97	66.50	77.24
Mandi	91.51	74.33	82.81
Shimla	90.73	77.80	84.55
Sirmaur	86.76	72.55	79.98
Solan	91.19	78.02	85.02
Una	92.75	81.67	87.23
Total	90.83	76.60	83.78

**Source:** Census of India 2011 (Prov.), H.P.

### Percentage of Urban population to Total population

It is also referred as a positive indicator of human development. In 2011 the largest percentage of urban population was registered in Shimla district and the lowest percentage was found in Kangra. Lahul & Spiti and Kinnaur are two districts with no urban population (Table 2).

**Table 2:** District-wise urban population in Himachal Pradesh (2011)

District	Total Population	Urban Population	Level of Urbanization (%)
Bilaspur	382056	25126	6.58
Chamba	518844	36191	6.98
Hamirpur	454293	31413	6.91
Kangra	1507223	86359	5.73
Kinnaur	84298	--	--
Kullu	437474	41258	9.43
Lahul & Spiti	31528	--	--
Mandi	999518	62624	6.27
Shimla	813384	201500	24.77
Sirmaur	530164	57238	10.80
Solan	576670	102078	17.70
Una	521057	44917	8.62
Total	6856509	688704	10.04

**Source:** Census of India 2011 (Prov.), H.P.

### Percentage of Vacancies to total no. of applicants

Employment is always considered as the positive indicator of human development. The largest percentage of vacancies to total no. of applicants was calculated in Kinnaur district and the lowest was represented by Lahul & Spiti (Table 3).

### Infrastructural Indicators

There are total five infrastructural indicators selected to show the facilities available in the state of Himachal Pradesh.

**Table 3:** District-wise Employment Statistics in Himachal Pradesh (2011)

District	Applicants on Live Register	Vacancies Notified	Vacancies to Applicants (%)
Bilaspur	52269	100	0.19
Chamba	58139	90	0.15
Hamirpur	65184	87	0.13
Kangra	185273	611	0.33
Kinnaur	7819	1483	18.97
Kullu	49398	73	0.15
Lahul & Spiti	4234	01	0.02
Mandi	147221	228	0.15
Shimla	92810	527	0.57
Sirmaur	49125	1393	2.84
Solan	55681	1542	2.77
Una	58611	597	1.02
Total	825764	6732	0.02

Source: Self analyzed

#### Level of Education (percentage of primary and high/secondary schools)

However the literacy rate has already discussed in the demographic indicators but another indicator selected to study the level of education is percentage of primary and high/secondary schools. It shows the availability of education in the district. Kangra and Mandi together show the highest percentage of primary schools followed by Shimla whereas Kinnaur and Lahul & Spiti show the lowest percentage of primary schools (Table 4).

**Table 4:** District-wise Schools in Himachal Pradesh (2010-11)

District	Primary Schools		High/Sr. Schools	
	No.	(%)	No.	(%)
Bilaspur	600	6	127	6
Chamba	1125	10	172	8
Hamirpur	505	5	134	6
Kangra	1768	16	408	19
Kinnaur	190	2	49	2
Kullu	746	7	105	5
Lahul & Spiti	206	2	35	2
Mandi	1739	16	326	16
Shimla	1625	15	307	15
Sirmaur	988	9	152	7
Solan	769	7	139	7
Una	508	5	140	7
Total	10767	100	2094	100

Source: Self Analysed by Author

In terms of percentage of high/secondary schools Kangra is the leading district followed by Mandi & Shimla whereas Kinnaur and Lahul & Spiti again stand at the bottom with lowest percentage.

#### Medical Institutions (percentage of primary health centers and community health centers)

To represent the availability of medical facilities in the district two indicators are selected- the community health centers and the primary health centers.

The highest percentage of community health centers is found in Kangra followed by Mandi and Shimla for both data years whereas Kinnaur, Lahul & Spiti and Sirmaur are the lowest. In terms of primary health centers, Kangra is the leading district followed by Shimla and Mandi in 2011 (Table 5).

**Table 5:** District-wise Health Facilities in Himachal Pradesh (2010-11)

District	CHC		PHC		Total
	No.	%	No.	%	
Bilaspur	6	8	30	7	36
Chamba	7	9	42	9	49
Hamirpur	5	6	26	6	31
Kangra	14	18	77	17	91
Kinnaur	4	5	21	5	25
Kullu	6	8	17	4	23
Lahul & Spiti	3	4	16	4	19
Mandi	12	16	61	13	73
Shimla	7	9	77	17	84
Sirmaur	3	4	36	8	39
Solan	5	6	31	7	36
Una	5	6	19	4	24
Total	77	100	453	100	530

Source: Self Analysed by Author

#### Communication (percentage of telephone connections)

Telephone connection displays the level of communication facilities available in the district. In reference to the state of Himachal Pradesh Kangra is the largest district followed by Shimla and Kullu. Lahul & Spiti and Kinnaur are the districts with lowest percentage telephone connections (Table 6).

**Table 6:** District-wise Telephone Connections in Himachal Pradesh (2005-06)

District	Telephone Connections	Telephone Connections (%)
Bilaspur	25725	5
Chamba	19733	3.8
Hamirpur	45323	8.8
Kangra	112390	21.7
Kinnaur	9608	1.9
Kullu	30513	5.9
Lahul & Spiti	2355	0.5
Mandi	69606	13.4
Shimla	83153	16.1
Sirmaur	25654	5.4
Solan	53107	10.3
Una	40458	7.8
Total	517625	100

Source: Self Analysed by Author

#### Electricity (percentage of electrified villages)

Electricity facility has become the basic need of present time. The percentage of electrified villages shows whether the electricity facility is under the reach of rural people or not. In Himachal Pradesh, the data shows that the electricity is available at very good rate in villages. There are total seven districts out of twelve in Himachal Pradesh show the hundred percent availability of electricity in villages in 2011 (Table 7).

#### Banking (credit deposit ratio)

The credit deposit ratio is generally used to reveal the saving of people in the district. The largest credit deposit ratio is found in Sirmaur district whereas the lowest credit deposit ratio is shown by Lahul & Spiti and Hamirpur (Table 8).

**Table 7:** District-wise number of Electrified Villages in Himachal Pradesh (2010-11)

District	Inhabited Villages	Electrified Villages	% of Villages Electrified
Bilaspur	965	965	100.00
Chamba	1118	1118	100.00
Hamirpur	1635	1635	100.00
Kangra	3619	3619	100.00
Kinnaur	234	214	90.60
Kullu	172	172	100.00
Lahul & Spiti	287	267	91.29
Mandi	2833	2830	99.68
Shimla	2520	2449	97.18
Sirmaur	966	966	100.00
Solan	2388	2388	100.00
Una	758	575	75.86
Total	17495	17209	98.37

Source: Self Analysed by Author

**Table 8:** District-wise Deposits and Advances of Scheduled Commercial Banks in Himachal Pradesh (2010-11), (Rs lakhs)

District	No. of Banks	Deposits (D)	Credits (C)	C-D Ratio
Bilaspur	56	1126	409	36.32
Chamba	58	1086	382	35.17
Hamirpur	71	2075	428	20.63
Kangra	199	5895	148	25.24
Kinnaur	24	352	145	41.19
Kullu	67	1613	752	46.62
Lahul & Spiti	11	151	34	22.52
Mandi	125	2785	1086	39.0
Shimla	171	9532	349	36.62
Sirmaur	66	1021	914	89.52
Solan	131	3210	2459	76.60
Una	74	1999	705	35.27
Total	1053	30847	12296	39.86

Source: Self Analysed by Author

### Environmental Indicators

To assess the quality of environment, a set of six indicators has been selected. All six indicators of environmental quality are based on status of natural resources. The dynamic nature of environment allows us to classify the environment quality indicators. The environmental indicators which are used in the study can be categorized into positive and negative indicators based on their influence on the environment.

### Positive Indicators

#### Percentage of forest land to total geographical area

The forest, generally, implies a continuous vegetation cover whether densely or openly associated. It is regarded as a positive variable in reference to environmental quality. The proportion of forest land in a state denotes the forest resource reserved for the future. The availability of forest resource is a positive indicator of environmental quality. In terms of percentage of forest land Mandi is the largest district followed by Kangra (Table 9).

**Table 9:** District-wise Forest Land in Himachal Pradesh (2007-08), (In '000 ha)

S. No.	District	Geographical Area	Forest land	Forest land as % of Geographical Area
1.	Bilaspur	111.8	14.0	12.52
2.	Chamba	692.4	272.0	39.28
3.	Hamirpur	110.2	18.3	16.60
4.	Kangra	577.7	232.5	40.24
5.	Kinnaur	624.2	37.5	6.0
6.	Kullu	54.7	NA	NA
7.	Lahul & Spiti	911.2	135.4	14.85
8.	Mandi	397.8	175.2	44.04
9.	Shimla	508.9	130.4	25.62
10.	Sirmaur	224.8	48.3	21.48
11.	Solan	21.1	0.4	1.89
12.	Una	154.9	8.2	5.29
	Total	4389.7	1083.1	23.89

Source: Self Analysed by Author

#### Percentage of culturable wasteland to total geographical area

Cultural wasteland is also considered as the positive indicator of environmental quality as it implies the availability of land for expansion of agricultural activities without negative impact on the environment. The highest percentage of culturable wasteland is found in Una district whereas Lahul & Spiti display the lowest percentage (Table 10).

**Table 10:** District-wise Culturable Wasteland in Himachal Pradesh (2007-08), (In '000 ha)

S. No.	District	Geographical Area	Culturable Wasteland	Culturable Wasteland as % of Geographical Area
1.	Bilaspur	111.8	6.2	5.54
2.	Chamba	692.4	6.4	0.92
3.	Hamirpur	110.2	12.2	11.07
4.	Kangra	577.7	29.1	5.03
5.	Kinnaur	624.2	3.5	0.56
6.	Kullu	54.7	2.4	4.38
7.	Lahul & Spiti	911.2	0.6	0.06
8.	Mandi	397.8	4.5	1.13
9.	Shimla	508.9	21.2	4.16
10.	Sirmaur	224.8	12.5	5.56
11.	Solan	21.1	1.4	6.63
12.	Una	154.9	23.2	14.97
	Total	4389.7	123.2	2.80

Source: Self Analysed by Author

#### Percentage of current fallow land to total net sown area

The proportion of net sown area currently left under fallow land reflects the chances of natural rejuvenation of the soil without excessive chemical fertilizers. Kinnaur district shows the highest figure in this category for whereas the lowest ranked district was Chamba (Table 11).



**Table 11:** District wise Current Fallow Land to Total Net Sown Area in Himachal Pradesh (2007-08), (in '000 ha)

S. No.	District	Net Sown Area	Current Fallow land	Current fallow land as % of net sown area
1.	Bilaspur	30.4	1.7	5.59
2.	Chamba	41.7	2.2	5.28
3.	Hamirpur	35.8	4.9	13.69
4.	Kangra	116.9	10.0	8.55
5.	Kinnaur	7.9	1.7	21.52
6.	Kullu	37.2	3.2	8.60
7.	Lahul & Spiti	3.3	NA	NA
8.	Mandi	86.4	9.8	11.34
9.	Shimla	67.5	13.1	19.41
10.	Sirmaur	40.5	5.2	12.84
11.	Solan	3.3	0.5	15.15
12.	Una	37.0	3.5	9.46
	Total	507.9	55.8	10.99

Source: Self Analysed by author

**Table 12:** District wise Barren and Un-culturable Land in Himachal Pradesh (2007-08), (In '000 ha)

S. No.	District	Geographical Area	Barren and Un-culturable Land	Barren and Un-culturable land as % of Geographical Area
1.	Bilaspur	111.8	4.4	3.94
2.	Chamba	692.4	5.3	0.77
3.	Hamirpur	110.2	13.6	12.34
4.	Kangra	577.7	14.6	2.53
5.	Kinnaur	624.2	133.3	21.36
6.	Kullu	54.7	1.2	2.19
7.	Lahul & Spiti	911.2	415.8	45.63
8.	Mandi	397.8	21.0	5.28
9.	Shimla	508.9	15.7	3.09
10.	Sirmaur	224.8	8.5	3.78
11.	Solan	21.1	1.9	9.0
12.	Una	154.9	22.2	14.33
	Total	4389.7	657.5	14.98

Source: Self Analysed by Author

### Percentage of fertilizer consumption

The percentage of fertilizer consumption is also used as a negative indicator of environmental quality because the excessive use of fertilizer results into the loss of soil

fertility. Shimla and Kangra are the two largest district in terms of fertilizer consumption followed by Una and Mandi whereas Kinnaur and Lahul & Spiti are two lowest districts in reference to fertilizer consumption (Table 13).

**Table 13:** District wise Fertilizer Consumption in Himachal Pradesh (2010-2011), (Metric Tonnes)

S. No.	District	Total Fertilizer Consumption (N+P+K)	% of Fertilizer Consumption
1.	Bilaspur	2288	4.15
2.	Chamba	1320	2.39
3.	Hamirpur	2592	4.70
4.	Kangra	8945	16.22
5.	Kinnaur	251	0.46
6.	Kullu	5051	9.16
7.	Lahul & Spiti	408	0.74
8.	Mandi	6646	12.05
9.	Shimla	12477	22.63
10.	Sirmaur	3567	6.47
11.	Solan	4063	7.37
12.	Una	7525	13.65
	Total	55133	100.00

Source: Self Analysed by Author

### Mean deviation method

The technique is applied to interpret the relationship between human development and the environment by reducing the multidimensional data into a single dimension. Firstly, the actual data of human indicators and the environmental indicators was converted into percentages. Secondly, the mean was calculated indicator wise by adding

the percentage values and dividing by the total number of districts. Subsequently, the percentage values are divided by the mean in regard to positive indicators viz, sex ratio, literacy rate, etc. for human development and forest, culturable wasteland, etc. for environmental quality. In terms of negative indicators the mean is divided by the percentage values for both types of indicators.

The calculated values of all human indicators and environmental indicators were added and divided by the total number of indicators. In other words, the calculated values were added and the sum total was divided by eight (number of variables) for human indicators and five for environmental indicators. The process is followed for all districts. Thus, the state wise composite score of both types of indicators are calculated. Then each district was assigned a rank based on its composite score where rank 1 was assigned to a state exhibiting low composite score and vice versa.

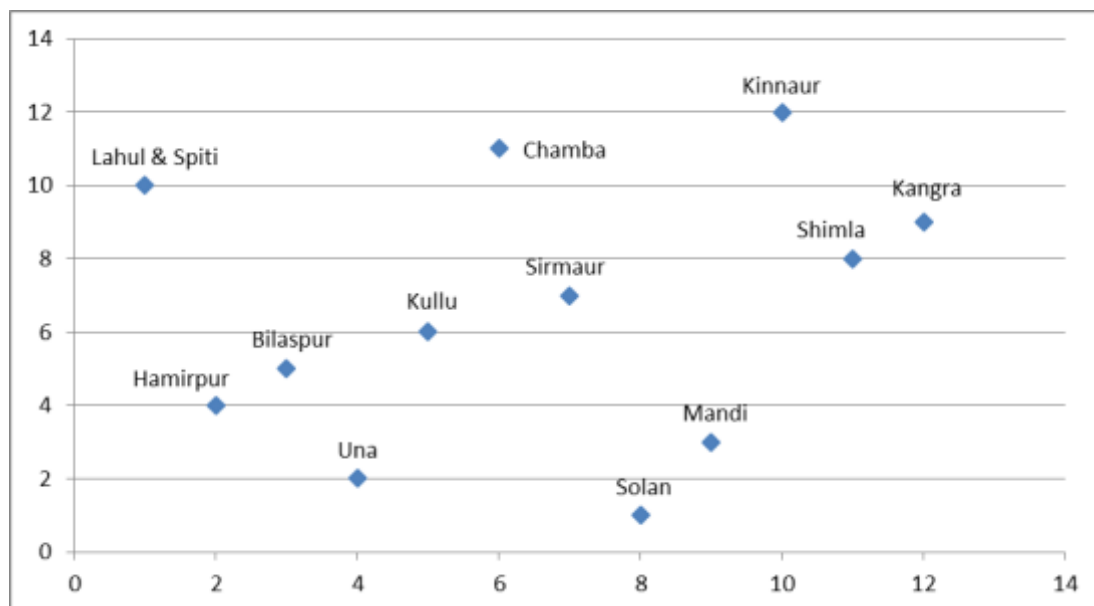
### Level of Human development and level of Environmental Degradation (2010-11)

The high human development and high level of environmental degradation is shown by the districts of Kangra and Mandi in 2010-11. Shimla is still coming under the category of high human development but in terms of environmental degradation it has improved from high environmental degradation to medium environmental degradation district. Kinnaur is still ranked as the low environmental degradation district but in terms of human development it has upgraded from medium to high category (Fig.1).

**Table 14:** Mean Deviation Ranking of Human and Environmental Indicators 2010-11

Districts	Human Composite Score (x axis)	Environmental Composite Score (y axis)
Bilaspur	3	5
Chamba	6	11
Hamirpur	2	4
Kangra	12	9
Kinnaur	10	12
Kullu	5	6
Lahul & Spiti	1	10
Mandi	9	3
Shimla	11	8
Sirmaur	7	7
Solan	8	1
Una	4	2

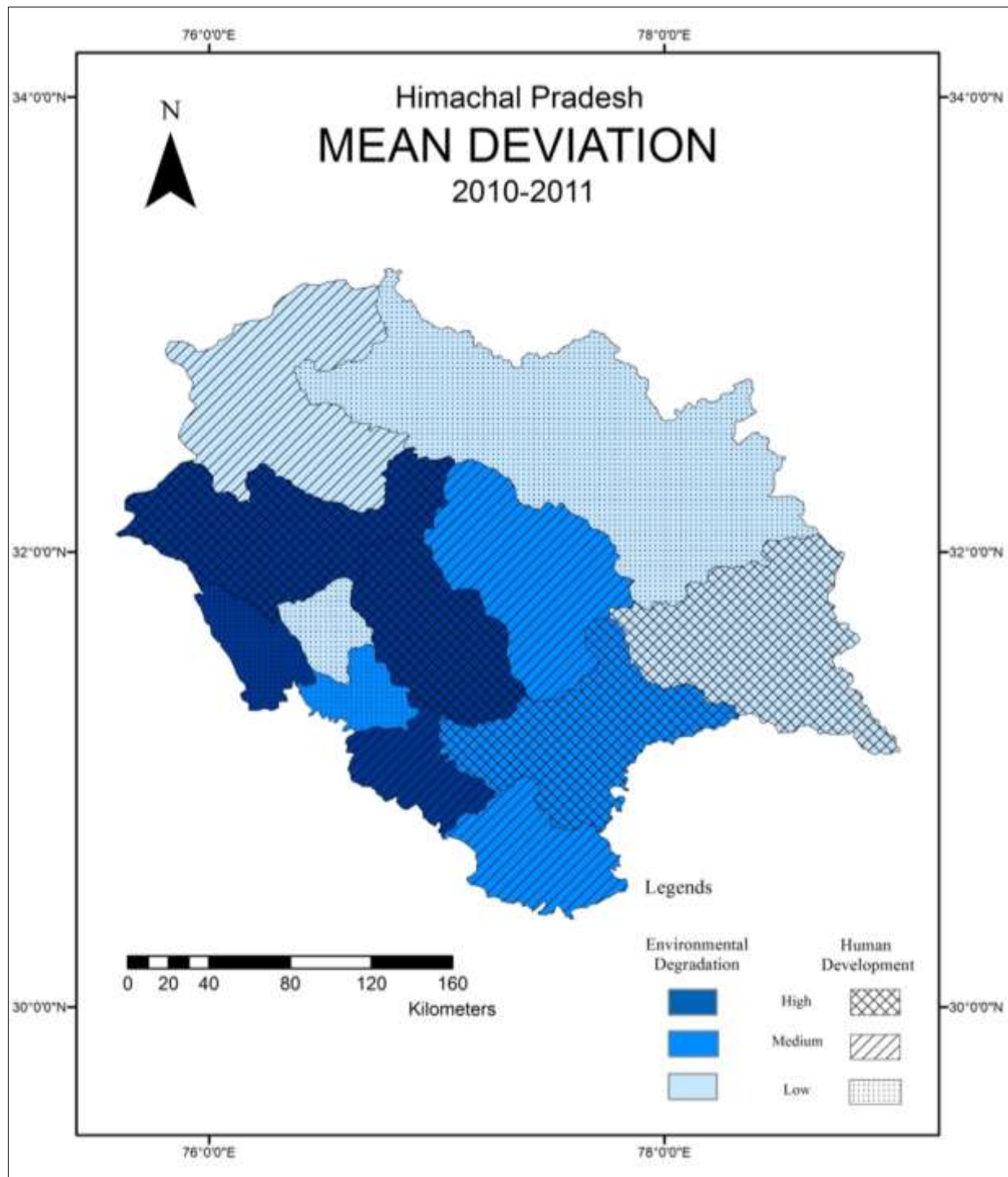
**Source:** Self Analysed by Author



**Fig 1:** Environment Composite Score and Human Composite Score (2010-11)

Solan district has continued with same level of high environmental degradation but the human development level has degraded from high to medium category. Sirmaur is still representing the same category of medium level in terms of both dimensions but now it is accompanied by Kullu district. Chamba is the only district with medium human development and low level of environmental degradation.

Una is still representing the same category previous decade with low human development and high level of environmental degradation. Bilaspur is the only district under the category of low human development and medium level of environmental degradation. Hamirpur and Lahul & Spiti represent the category of low human development and low level of environmental degradation.



**Map 1:** Himachal Pradesh Mean deviation 2010-2011

### Composite Index

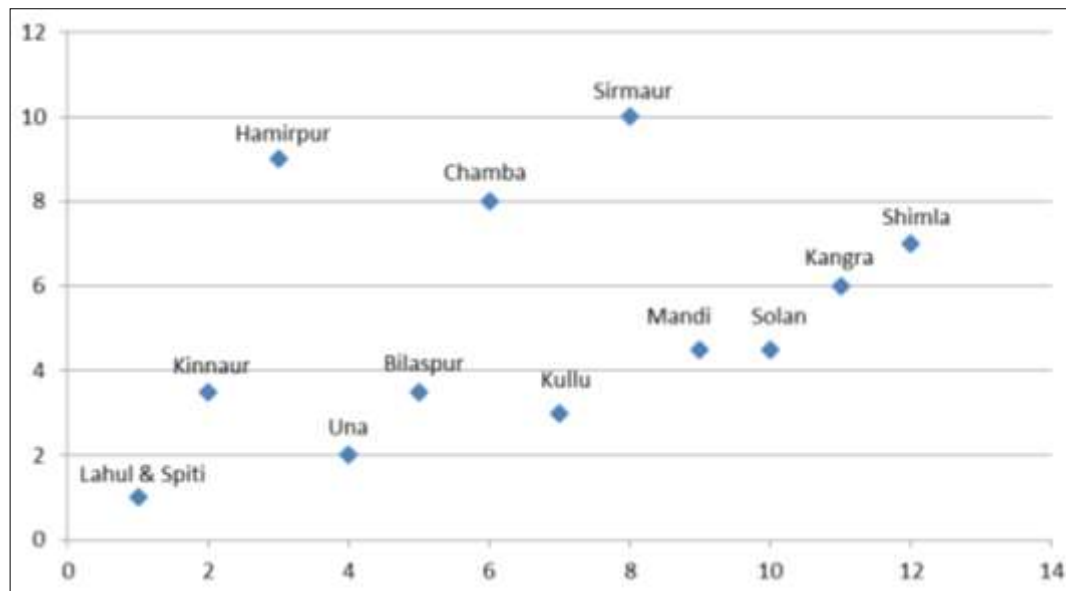
Another statistical technique that is used to analyze the data is composite index method. The technique is very simple based on the rank allotted to each district with reference to the ranks obtained by the other districts in reference to each indicator. The total number of districts was twelve therefore the ranks range from one to twelve.

The district scored lowest is ranked as one. If two or more districts were showing the same value the same rank is given to each of them then averaged by dividing by number of districts having same rank. The rank allotted to the next district in order of value then is given on the basis of number of ranks already allotted. The same method of ranking is applied to each indicator following which a

composite index is obtained by adding the ranks scored by each country for all the indicators.

### Level of Human Development and Level of Environmental Degradation (2010-11)

Shimla is representing the same category of previous decade with high human development and high level of environmental degradation. The districts of Kangra, Mandi and Solan are also falling in the previous decade category of high human development and medium level of environmental degradation. There is no district in the category of high human development and low level of environmental degradation (Fig 2).

**Fig 2:** Environment a Index and Human Index (2010-11)

The category of medium human development and high level of environmental degradation is represented by three districts namely Sirmaur, Kullu and Bilaspur. Chamba scored medium in terms of both dimensions- human development and the environmental degradation. Una,

Kinnaur and Lahul & Spiti ranked under the category of low human development and high level of environmental degradation.

Finally, Hamirpur is the only district with low human development and low level of environmental degradation.

**Table 15:** Composite Index Ranking 2010-11

Districts	Human index (x axis)	Environmental index (y axis)
Bilaspur	5	3.5
Chamba	6	8
Hamirpur	3	9
Kangra	11	6
Kinnaur	2	3.5
Kullu	7	3
Lahul & Spiti	1	1
Mandi	9	4.5
Shimla	12	7
Sirmaur	8	10
Solan	10	4.5
Una	4	2

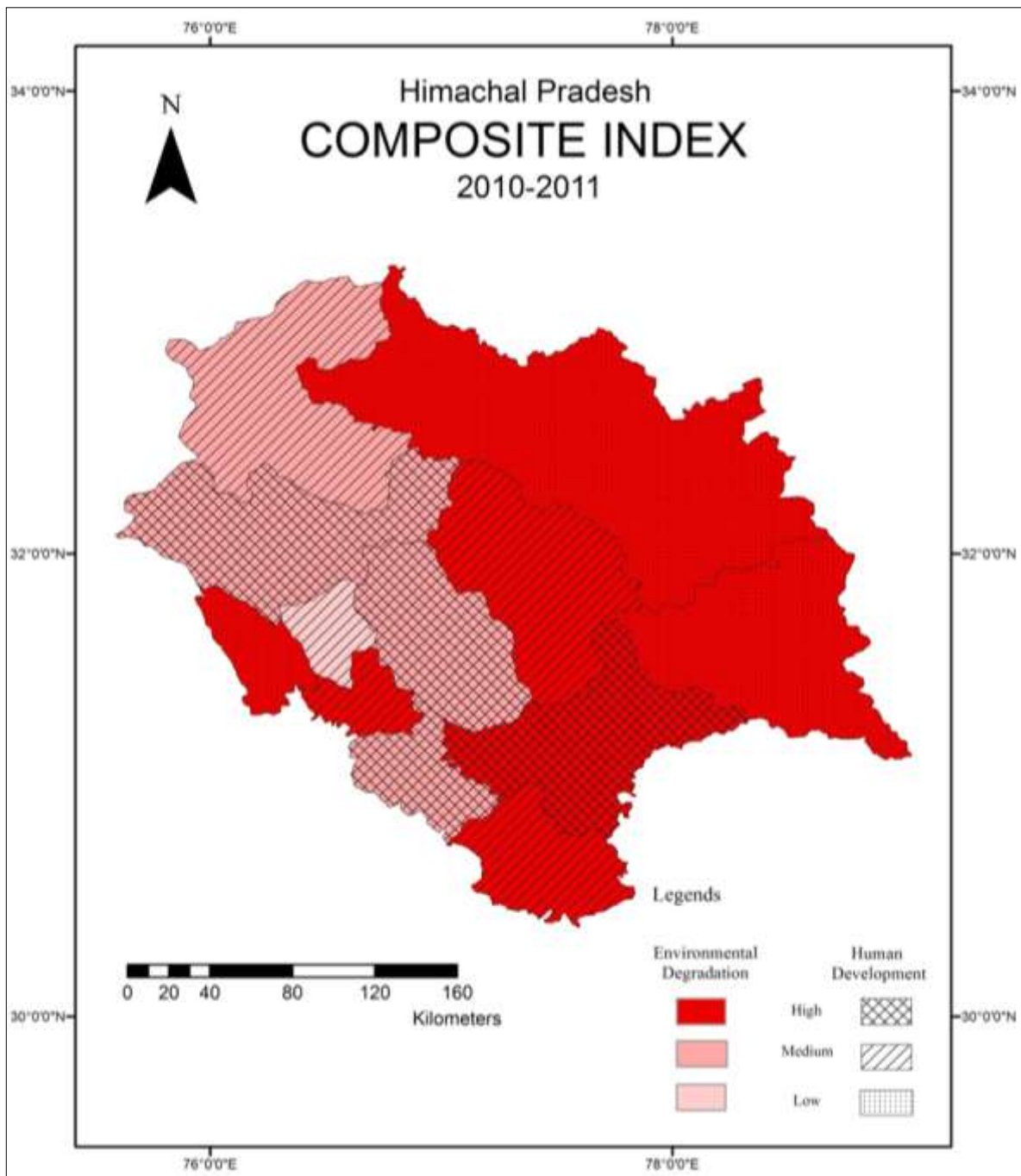
**Table 16:** Typology of districts based on Mean Deviation Method

2010-11		Environmental Degradation		
		High	Medium	Low
Human Development	High	Kangra Mandi	Shimla	Kinnaur
	Medium	Solan	Sirmaur Kullu	Chamba
	Low	Una	Bilaspur	Hamirpur Lahul & Spiti

**Table 17:** Typology of districts based on Composite Index

2010-11		Environmental Degradation		
		High	Medium	Low
Human Development	High	Shimla	Kangra, Solan, Mandi	
	Medium	Sirmaur, Kullu Bilaspur	Chamba	
	Low	Una, Kinnaur Lahul & Spiti		Hamirpur





**Map 2:** Himachal Pradesh composite index 2010-2011

### Conclusion

Effective assessment of ecosystem and human wellbeing relies on carefully selected indicators that represent both dimensions accurately. This study meticulously chose variables like literacy rates and forest coverage, ensuring robust representation of human and environmental conditions. Such strategic selection mitigates data collection costs and enhances assessment reliability.

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