Measurement Of Regional Disparity By Composite Index Method

Geospatial mapping of composite index of development (non-Agricultural)
For the districts of Assam, 2011

Sanjay Das

Assistant Professor (Sr.)
Department of Geography
Sibsagar Girls' College, Sivasagar, Assam, India

Abstract:
Regional development issues are very complex. Single variable is not sufficient to portray the complexity. Impacts of some variables are not directly observable. Multiple variables may also not be able to tackle the complexity, if those are not properly chosen. Within such constraints the paper studies the level of development on the basis of non-agricultural variables and its regional spatial distribution. It also reveals the development scenario of the industrialization, urbanization, transportation development, physiographic constraints, etc. A composite Index method is selected i.e. First Principal Component method which is very useful and versatile in the construction of composite index. Secondary data are taken from the statistical handbooks of Assam and some basic cartographic and statistical diagrams are used apart from the main method. Outcome of the paper, at least, would be able to give insights to the regional planners.

Index Terms – Regional Development, Composite Index of Development, Principal Component method.

INTRODUCTION:

Regional development is a comprehensive activity to improve the functions of social arrangement, land, education, cultural economy, and community welfare to promote an integrated area by maintaining gaps between regions and preserving the environment in a region (Sulistyorini, 2021). This is an indication of the dynamics of development that requires the availability of adequate infrastructure. Indonesia with its resources scattered in various locations is a valuable capital for national development, especially regional development (Siagian, 2011). Regional development can be interpreted as an effort to organize space and utilize existing resources optimally in order to improve the welfare of people's lives (Nawir, 2022). The development of land use and the unequal distribution of regional infrastructure require an optimal arrangement by adjusting between demand and supply in the use of space the potential for private investment to participate in infrastructure development encourages the government to accelerate infrastructure development (Khaerudin, 2007). Regional disparities are understood as differences in the socio-economic development of regions that are the result of some inequalities (Matlovič et al. 2008).

The identification and measurement of regional disparities is a fundamental aspect in the design of economic policy-making and space-based instruments that are to mitigate or eliminate these inequalities (Wishlade, Yuill 1997).

After independence, India emerged as a federation of a few relatively rich and industrialized states and also of many poor states which subsisted mainly on agriculture with primitive techniques and semi-feudal agrarian relations (H. Pradhan Prasad, 1988). Regional disparities distort the allocation of the scarce resources and usually result in under – utilization or mis-utilization of resources-natural or human. Consequently, there is low level of national income on the one hand and rise in inter-personal inequalities on the other hand. The problems of regional and inter-personal disparities are vulnerable to generate discontent and disbelieve and may endanger. If involved the very integrity of the country, No development is possible in the midst of social tension and civil disturbance (Dr Kamini Khann & Suman Keshav, 2019).

Present research paper focuses on disparities in development in terms of non-agricultural activities in the state of Assam, India. Intra-state comparison with respect to certain variables has been used to shed light on the issue of disparity.

METHODS AND DATABASE:

The problem of regional disparities in regional development has drawn attention of researches and regional planners. Different methods to measure regional disparities are being used in Social and spatial sciences. Apart from using certain traditional measures like mean, range, correlation, standard deviation, etc. a few modern techniques i.e. Ranking method, Mean method, Z-score standardization method, Principal component analysis, Herfindhal index, Index of imbalances, etc. have also been used to measure socio-economic disparities. In this research paper, the First Principal Component method to measure Composite Index is used to study disparities among the districts of Assam. Useful and versatile method of construction of Composite Index is the method of First Principal Component (Dasgupta, 1971 & Pal, 1975).

1. **Composite Index**: Theoretically, a composite index I from variables X_1, X_2,…….X_n is obtained by their weighted sum, as :

$I= W_1X_1 + W_2X_2 + \ldots\ldots\ldots\ldots..W_nX_n$, where W (Eigen vector) is the weight of the corresponding variables.

Practically, Z-Score Standardization method is applied and coordinated with first principal component method.

Z Score Standardization method = $(X- \bar{x})/ \sigma*v$,

Where X = Each set variables, $\bar{x}$ = Mean of each set of variables, σ = Standard deviation of each set of variables, and v = Eigen vector(s)

2. **First Principal Component method**: The composite index obtained by this method is characterized as having maximum sum of squares of correlation with selected variables. Because of this property it may be considered as the best representative of all the selected variables. The First Principal Component is a linear combination (weighted sum) of the standard scores of the variables. The weights used in this case are the elements of the Eigen Vector **(V),** corresponding to the highest Eigen value **(λ)** of the Correlation Matrix (R).(Mahmood, Dr. Aslam, 2021)

Correlation Matrix (R):

$$R=\begin{pmatrix} 1 & r_{12} & r_{13} & . & . & r_{1p} \\ r_{21} & 1 & r_{23} & . & . & r_{2p} \\ r_{31} & r_{32} & 1 & . & . & r_{3p} \\ . & & . & . & 1 & . \\ . & . & . & & 1 & . \\ r_{p1} & r_{p2} & r_{p3} & . & . & 1 \end{pmatrix}$$

Where, r = Coeffient of Correlation of pn x np matrix (n = 1,2,3...)

Eigen value (λ):

$|\lambda I - A| = 0$ is called the characteristic equation of A. (The solutions of this equation are the Eigen values of A.) If λ is an Eigen value of A , then the subspace $E\lambda = \{v \mid Av = \lambda v\}$ is called the Eigen space of A associated with λ.

Eigen Vector (V):

$Av = \lambda v$, where v gives the eigenvector.

3. **Geospatial mapping**:

Quantum Geographical Information System (QGIS-open source), version-2.40 (Chugiak) is used to join the district wise Composite Indices with the Vector layer (shape file) of Assam to produce a Choropleth map showing district wise spatial distribution of Indices of development.

4. **Microsoft Excel:**

Basic statistics (Mean and Standard Deviation) required in the Composite Index calculation, Correlation Matrix, Eigen values and vectors are calculated in Microsoft Excel of Windows-7 ultimate. Required cartographic diagrams are also drawn with this M.S. office package.

5. **Selection of Variables:**

Variables selected for index of development (non-agricultural) are,

i) Urban Population per 1000 of total population (X_1)
ii) Marginal workers in trade & Commerce per 1000 of total population (X_2)
iii) Workers in registered factories per 1000 of total population (X_3)
iv) Main workers in Household industry per 1000 of total population (X_4)

The above stated variables and ancillary data are collected from the Statistical Handbook of Assam, 2011.

RESULTS :

i) **Correlation Matrix (R) :**

	(X1)	(X2)	(X3)	(X4)
(X1)	1			
(X2)	0.22205	1		
(X3)	0.58125	0.62906	1	
(X4)	-0.13843	0.46001	-0.00058	1

ii) **Eigen Values (λ) of R:**

λ_1	λ_3	λ_2	λ_4
2.0115	1.3038	0.49547	0.18923

Single highest Eigen value (λ_1 = 2.0115) which is greater than unity is selected as the first principal component. Second principal component in this method cannot be considered even though λ_3 being greater than unity. Selected Eigen value accounts for (2.0115/4*100), i.e. 50.3 % variations in the data matrix.

iii) **Eigen Vectors (V) corresponding the first principal component (λ_1):**

Using 2.2846, 2.8903, 3.1097, and 1 as weights for standardized values of X_1, X_2, X_3, and X_4, a weighted sum for each district is worked out.

V_1	V_3	V_2	V_4
2.2846	2.8903	3.1097	1

iv) **District wise Composite Indices:** Table: 1

Composite Index of first district (Say) = $[(X_1-\bar{x}_1)/\sigma_1 *V_1] + [(X_2-\bar{x}_2)/\sigma_2 *V_2] + [(X_3-\bar{x}_3)/\sigma_3 *V_3] + [(X_4-\bar{x}_4)/\sigma_4 *V_4]$

Districts	Composite Index	Districts	Composite Index	Districts	Composite Index
Kokrajhar	-4.59	Dhemaji	-9.71	Cachar	2.86
Dhubri	-3.32	Tinsukia	9.63	Karimganj	-0.89
Goalpara	-1.98	Dibrugarh	12.49	Hailakandi	-2.92
Barpeta	-5.10	Sivasagar	4.72	Bongaigaon	-1.80
Morigaon	-5.62	Jorhat	9.13	Kamrup Rural	9.94
Nagaon	-2.19	Golaghat	0.37	Kamrup Metro	20.70

Sonitpur	2.73	Karbi Anglong	-7.68	Nalbari	1.26
Lakhimpur	-7.35	Dima Hasao	-5.33	Darrang	-6.97

* (X1,…, X4 - Variables of districts ; $\bar{x}_{1,\ldots,} \bar{x}_4$ - Mean of Variables ; $\sigma_{1,\ldots,} \sigma_4$ - Standard deviations of variables)

ANALYSIS:

Composite indices calculated for each districts have been categorized into 6(six) classes of continuous data ranges in table 2. Each range of index has been assigned attributes to define level of development.

Category sl. no	Range of Indexes	Attributes	Districts under category
1	< -5	Very Low	Dhamaji, Lakhimpur, Morigaon , Barpeta, Karbi Anglong, DimaHasao, Darrang
2	-5 to 0	Low	Kokrajhar, Dhubri, Goalpara, Nagaon, Karimganj, Hailakandi, Bongaigaon
3	0-5	Moderately Low	Sonitpur, Sibsagar, Golaghat, Cachar, Nalbari
4	5-10	Moderately High	Tinsukia, Jorhat, Kamrup Rural
5	10-15	High	Dibrugarh
6	>15	Very High	Kamrup Metro

Table: 2 Categorization of districts as per ranges of Composite Indices

In table 3, district wise of assigned attributes have been evaluated on the basis of physical set up and socio-economic status of the districts under different category. It gives a relatively clear picture of the levels of development.

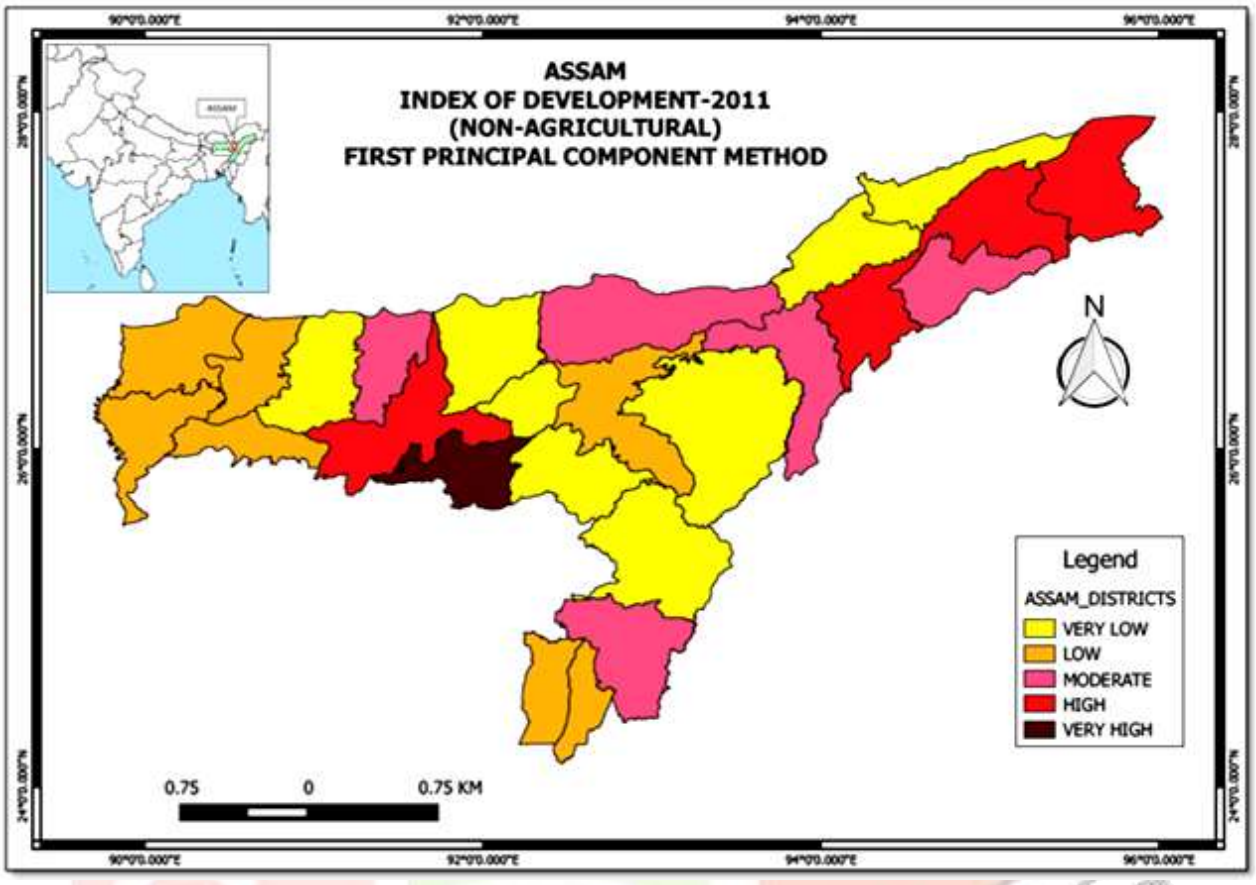
Attributes	Districts under category	Evaluation
Very Low (< -5)	Dhamaji, Lakhimpur, Morigaon, Barpeta, Karbi Anglong, DimaHasao, Darrang	Occurrence of seasonal flood, foot hill areas along Assam-Arunachal Pradesh and Assam-Bhutan with flood bearing rivers and channels, hills of Kopili formation (late Eocene period) and Plateaus of extension of Deccan Plateau, rain shadow areas of central Assam, undulating terrain, dominance of SC and ST population, high rate of intra and inert-state migration of labourers and low development of industries and urban areas since independence. Regional economy appears to be heavily dependent on traditional /semi-modern Agrarian systems.
Low (-5 to 0)	Kokrajhar, Dhubri, Goalpara, Nagaon, Karimganj, Hailakandi, Bongaigaon	Abundance of swampy and low lying areas, presence of undulating residual hills, some areas bordering international boundary, growing tendencies to migrate nearby West Bengal for jobs, Occurrence of Floods (Brahmaputra and Barak), and slow but growing development of industries and urban areas, direct rail and road connectivity to mainland India, abundance of fertile river sand bars, rain-shadow areas of

		central Assam. Regional economy appears to be heavily dependent on semi-modern Agrarian systems.
Moderate (0-5)	Sonitpur, Sibsagar, Golaghat, Cachar, Nalbari	Occurrence of moderate seasonal flood, slow but growing development of industries and urban areas, flagship industries, like ONGC, OIL-India, Refinery, Power projects, Pharma Industries, Cottage industries, Central government office complexes, etc. exist in this region, Connected to major rivers for river transportation, potential for tourism industry, growth of Big & small industries, industrial growth centre and sheds, public sector undertaking establishments, agro-industries, etc. Regional economy is partly based on primary economy and partly based on non- agricultural secondary, tertiary and quaternary activities.
High (5-15)	Tinsukia, Jorhat, Kamrup Rural	Well connected with Rail , Roads and cargo Air transportation and connected with neighboring states, Urbanization growing rapidly, industrial growth centres, sheds, estates are coming up, tea industries are flourishing, OIL , refinery and Coal industries are serving the areas, Food processing and horticultural research developed agro industries, regions have class-I and class-II cities, increasing rural-urban migration within the region, service sectors are also increasing, forest based industries are growing in upper Assam area, engineering industries, software park, renewable energy park, chain marketing of super markets, pharma industries , etc. are the flagship non agricultural sectors. High urban population due rural-urban migration. Regional economy is based on secondary, tertiary and quaternary activities.
	Dibrugarh	
Very High (>15)	Kamrup Metro	

Table :3 Evaluation of attributes of each categories of development for groups of districts

Geospatial mapping:

Composite Indices are further grouped into five categories for the convenience assessment, evaluation and mapping.



Map-1 Geospatial mapping of Composite Indices of development, Assam (Source: Author, 2011)

Conclusion:

Mathematically, first principal component so far selected in the construction of composite indices is accountable for 50% of the variations in the data matrix. Therefore, numbers of interrelated variables to be chosen for composite index analysis need to be increased to find out more causes enabling researchers to micro level analysis of the administrative as well as spatial units with highest accuracy. It is because of the fact that disparity in development is a multifaceted issue and concern as well for Indian nation and its federation. Indian economy is still largely dependent upon agriculture with the huge population base, time has now knocked at the doors of the government and the corporate to gear up the generation of avenues in the non-agriculture sectors i.e. industry, trade and commerce, service sectors, etc. Of course, the federal units must be provided with equal schemes and facilities to minimize the level disparity.

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