Measuring Regional Dimensions of Sustainable Livelihood Security Index in Maharashtra

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Abstract

The Sustainable Livelihood Security Index (SLSI) is an integrated effective and advantageous tool to measure agriculture sustainability and livelihood security. The sustainable Livelihood Security Index mechanism can help to track and estimate the agricultural sector's growth and development status. This study deals with to measuring of sustainability of the agriculture sector through the Sustainable Livelihood Security Index. SLSI approach is inclusive tool in terms of ecological, economic, and social aspects and its various sub indicators, which significantly impact the achievement of the Sustainable Development Goal (SDG). The main objective of this study, is to measure regional development of Maharashtra during two time periods, i.e., 2010 and 2019. Finding of study shows that western Maharashtra region is ranked highest and Vidharbha region is least developed in SLSI among all five regions in Maharashtra. The SLSI value of western Maharashtra has improved from 0.525 to 0.546 during 2010-19. However, the Vidharbha region though had lesser SLSI value as compared to other regions of Maharashtra moreover there is improvement in SLSI from 0.289 to 0.330 during same period. Overall SLSI value of Maharashtra state has raised from 0.404 to 0.414 during 2010-19. This reveals that there is positive net change in SLSI to the extent of 2.6% during 2010-19.

1. Introduction

Sustainable livelihood security measurement is crucial aspects in developing economies especially in India, where most of the people depends on agriculture and the allied sector in which agriculture is the primary source of rural livelihoods in India. The food security, poverty, unemployment, livelihood security, and the management and protection of natural resources are directly related to rural livelihoods. The Sustainable Livelihood Security Index (SLSI) is an integrated and broad structure incorporating existing concerns and policy necessities for sustainable development's ecological, social, and economic dimensions (Pani and Mishra 2022; Shridhara et al. 2022; Guha et al. 2018) because sustainable livelihood security depends on improved socio-economic and ecological aspects of the systems practiced by stakeholder (Ravishankar et al. 2022; Bohale HG 2009).

The sustainability measurement of the region from the point of view of the sustainable economic development is necessary to achieve the goal of sustainable development (Krishan et al. 2020). The concept of sustainable development has recently been one of the world's most critical and pressing issues. Such development is necessary mainly to protect the ecosystem and biodiversity. Sustainable agriculture is one of the best solutions to preserve the ecosystem and biodiversity because agriculture has significant environmental impacts. The adverse environmental effects of agriculture are significant and can include contamination and contamination of soil, water, and air. The sustainable agriculture positively impacts the environment by sequestering greenhouse gases from crops and soil or reducing the risk of flooding by adopting certain agricultural practices (OECD 2013; Li and Zeng 2022; Singh and Nayak 2020). Various essential criteria, including economic, environmental, and social indices, may partially measure a region's or an area's sustainability (Krishana et al. 2020; Lampridi et al. 2019). To measure the sustainability of a given region, the Sustainable Livelihood Security Index (SLSI) is an effective tool that combines the different dimensions of inclusive development, i.e., the ecological, economic, and social factors of a region or ecosystem (Guha et al. 2018; Sigh and Nayak 2020). The sustainability of a particular area or region and different sectors is maintained by managing various environmental, economic, and social factors (Krishana et al. 2020; Mutahara et al. 2016).

Maharashtra is the most industrialized state in India for many years. The state is leading in small and micro enterprises with the special export promotion zones overall. It is the second-largest by population (9.3%)and the third-largest state by geographical area, accounting for 9.36% of India's total geographical area. Maharashtra state is spread around five geographical regions, which varies from ecological, economic, and social aspects. The agriculture sector contributes

about 12.1% in Maharashtra state's Gross State Value Added; however, 20.3% to the country's Gross Domestic Product (GoM 2022). The Western Maharashtra region is very widespread for agriculture by soil, climate, and irrigation facilities. According to the 2011 Census, about 63.5% of the population of Maharashtra lives in rural areas, with agriculture serving as their primary source of income. Nearly 30.8% of all workers are working in agriculture, while 69.2% are cultivators. According to Maharashtra's cropping pattern, the state grows grains, pulses, oilseeds, sugarcane, cotton, turmeric, and other crops. Hence, agriculture is the main activity in Maharashtra and accounts more in generation of employment (GoI 2011)

However, we have attempted to evaluate the agricultural sustainability of several regions of Maharashtra over various periods based on ecological, economic, and social factors. These indicators will be crucial in reducing regional imbalance and attaining the objective of sustainable development (Beeraladinni and Patil 2023). The primary goals of the current study were to evaluate regional agriculture-sustainable development in Maharashtra, which would aid researchers and decision-makers in identifying and developing appropriate policies for promoting regional equality through agriculture-sustainable development in Maharashtra.

Figure 1. *Sustainable Livelihood Security Index*

2. Materials and Methods

This section of this study, covers the detailed methodology for measuring regional sustainable livelihoods security of different geographical regions in Maharashtra. The methodology of this study consists coverage, data sources, domains and its indicators, estimation methods, and data analysis is as given below-

Coverage: in this study, we have covered all five geographical regions, viz, Konkan, western Maharashtra, Khandesh, Marathwada, and Vidharbha in the Maharashtra states. To measure the regional progress in Sustainable Livelihood Security Index, we have considered the three key domains in this study: ecological security, economic efficiency, and social equity and its 12 various indicators. This study covers 10 years, from 2010 to 2019, to measure pre and existing conditions of regional development in SLSI of Maharashtra.

Data Sources

This study mostly depends on secondary data; tthe data were collected from various sources viz, Census of India 2011, Forest Department GoI, Agricultural Department GoI, NHRC, HDRs of Maharashtra, Economic Survey Reports GoM, Economic Survey Reports GoM, Economic Survey Report GoI, etc.

Data Analysis

Collected data have been tabulated and processed with the help of MS Excel and SPSS basis on the study's objectives. The geometric mean has been used for standardizing the indicator's value and creating SLSI, percentage, average, ratio analysis, line graph, etc., tools and techniques were used to present the study's output.

Methods of SLSI Estimation:

- **Domain and Indicators**

Table 1
Sustainable Livelihood Security Domain and Indicators

Domain	Indicator	Types	Criterion	Source
Ecological Security	• Density of Population	-ve	Ecological degradation	(Pani and Mishra 2022; Raishankar et al. 2022; Krishana et al. 2020; Deshmukh et al.2021; Singh et al. 2010, Guha et al. 2018)
	• Total Livestock	-ve	Pressure on natural resources	
	• Cropping Intensity	+ve	Land use, Soil fertility	
	• Total Forest Area	+ve	Ecological balance	
Economic Efficiency	• Total Foodgrains Production	+ve	Food security	
	• Sugarcane Production	+ve	Income of farmers	
	• Milk Production	+ve	Source of Rural Likelihood	
	• Per Capita GDVA (₹)	+ve	Agriculture output	
Social Equity	• Female literacy	+ve	Educational status	
	• Sex Ratio	+ve	Gender equity	
	• Infant Mortality Rate	+ve	Health services	
	• HDI	-ve	Living standard	

- **SLSI Estimation**:

For sustainability estimation of different regions in Maharashtra, we have used the Sustainable Livelihood Security Index (SLSI) approach regarding ecological, economic, and social security. In this study, the sustainable livelihood framework covers three main domains and around 12 sub-indicators, in addition these indicators we have assembled into positive and negative categories (Pani and Mishra 2022; Lampridi et al. 2019). To estimate Sustainable Livelihood Security Index (SLSI), we have embraced the Pani & Mishara, 2022; UNDPs Human Development Index measurement methods (Pani and Mishra 2022; Deshmuk et al. 2021; Singh et al. 2010; Shridhara et al. 2022; UNDP 2020).

$$SLSI_{ijk} = \left(X_{ijk} - MinX_{ijk}\right) / \left(MaxX_{ijk} - Min_{ijk}\right) - - - - - - - (1)$$

$$SLSI_{ijk} = \left(MaxX_{ijk} - X_{ijk}\right) / \left(MaxX_{ijk} - Min_{ijk}\right) - - - - - - - (2)$$

Here, we have Eq. (1) used to normalize positive indicators, and Eq. (2) is used to normalize negative indicators.

Where, $SLSI_{ijk}$ for the index of i[th] domain (1, 2, 3 ...i), of 'j[th]' denote variables or indicators (1, 2, 3,.. j) of 'k[th]' denote the region (1, 2, 3... k). X_{ijk} denotes the actual value, $MinX_{ijk}$ denotes minimum value, $MaxX_{ijk}$ denotes maximum value of i[th] domain of 'j[th]' variables or indicators of 'k[th]' region.

$$SLSI_{ijk} = \frac{\sum_{i=1}^{i} SLSI_{ijk}}{1/3} \quad ----------(3)$$

Where, $SLSI_{ijk}$ is composite index of i[th] domain of 'j[th]' variables or indicators of 'k[th]' region.

The SLSI is a composite index calculated by taking the geometric mean of each domain's indices. The Sustainable Livelihood Security Index (SLSI) range varies between 0 and 1, which specifies that a value close to 0 indicates a low level, and a value close to 1 denotes a high level of sustainability (Pani and Mishra 2022; Singh et al. 2010; Shridhara et al. 2022; Guha et al. 2018).

$$Improvement = X_2 - X_1 / X_{Max} - X_1 ----------(3)$$

Where, ' X_1 ' and ' X_2 ' denote the indicator's value in the initial and final year, respectively, and 'IX_{Max}' denotes the upper bond. i.e., it chosen to be 1.

Here, additionally, we have used Sen's Improvement Index for analyzing actual enhancement in various region's sustainable livelihood security, which helps to identify actual regional progress and disparities as well as help to design and implicate policy to the policymakers, and researcher regarding sustainable livelihood security in Maharashtra (Chakraborty 2011).

3. Result and Discussion

This part of the present research study covers the essential data of different domains and indicators of SLSI, which are collected from multiple sources. In this section, we have analyzed the data of SLSI indicators for two sources year i.e., 2010 and 2019; through this, we have estimated the SLSI of each district in Maharashtra with critical measures such as ecological security, economic efficiency, and social equity.

Table 2
Regional Ecological Security Indicators of Maharashtra

Region/ Year	Density of Population (Sq. km)		Total Livestock @ (in '000')		Cropping@ Intensity		Total Forest Area*$ (Sq. Km)	
	2011$	2019$	2010	2019	2010	2019	2010*	2019#
Konkan	7086	7086	363	322	109	117	2111.7	2113.2
Western Maharashtra	403	403	1651	1532	127	140	995.0	996.8
Khandesh	316	316	1684	1594	127	137	819.0	815.0
Marathwada	285	285	950	852	156	158	240.4	240.4
Vidharbha	261	261	874	748	131	132	2366.0	2365.0
All Maharashtra	**1670**	**1670**	**1105**	**1010**	**130**	**137**	**1306**	**1306**

*Source: #-Census Govt. of India 2001 *$ - India State of Forest Report, 2009, Forest Survey of India*

#-Handbook of Basic Statistics of Maharashtra 2010–2014 @- krishi.maharashtra.gov.in

*(Note: - * – 2007, # – 2015, $- Census 2011)*

Table 1 indicates the regional performance of ecological security indicators of Maharashtra for two different periods, i.e., 2010 and 2019. We have taken population density, total livestock, cropping intensity, and total forest cove as crucial measures for measuring ecological security. Population density and livestock are negative indicators of ecological security; high population density is responsible for ecological degradation, and excess livestock is pressure on natural resources. While cropping intensity and forest cover are both positive indicators, cropping intensity help improve soil fertility and health and improves forest cover area functional for maintaining ecological balance. Therefore, all indicators are equally important for enhancing ecological security, and ecological security is crucial to sustainable livelihood security (Guha et al. 2018; Sunitha et al.2022).

Concerning regional ecological security indicators, the Konkan region had the highest population density of 7086 sq. km, and the Vidharbha region indicated the lowest population density of only 261 sq. km for both periods. While western Maharashtra, Khandesh, and Marathwada regions were between 285 to 403 sq. km in Maharashtra state. In total livestock, the Khandesh region was highest, i.e., 1684, followed by the western Maharashtra region, which was 1651 in 2010 but decreased to 1594 and 1532 in 2020. The Konkan region was observed very lowest, with 363 in 2010, which decreased to 322 in 2019. According to regional cropping intensity, the Mahrathwada was highest at 156 in 2010, which increased to 158 in 2019. Other regions like western Maharashtra, Khandesh, and Vidharbha have been indicated as the lowest. Also, the Konkan region had less cropping intensity, which was 109 in 2010 and slightly increased to 117 in 2019. The total forest cover area of the Konkan region was significantly highest, 2111.7 sq. km in 2010; it slightly increased to 2113.2 sq. km in 2019. However, the Marathwada region observed a significantly less forest cover area, which was 240.4 sq. km in 2010 and remained the same in 2019. Overall performance of ecological security indicators of Maharashtra state, the average population density was 1670 sq. km for both periods, and total livestock was 1105 in 2010, which decreased to 1010 in 2019. The cropping intensity of Maharashtra was 130 in 2010, which increased to 137 in 2019, and the total forest cover area of Maharashtra was 1306 sq. km, which remained the same for both periods.

Table 3
Regional Economic Efficiency Indicators of Maharashtra

Region/ Year	Total Foodgrains Production@ ("00" Tones)		Sugarcane Production @ (Tones)		Milk Production# (Lakh lit.)		Per Capita GDVA$ (₹)	
	2010	2019	2010	2019	2010	2019	2010	2019
Konkan	2802.3	2281.8	-	-	658.8	916.3	116919.4	222081.8
Western Maharashtra	6027.0	5046.6	78173.2	99242.0	6190.1	9923.7	102071.8	188548.8
Khandesh	7967.4	6190.8	20616.6	16023.0	3987.8	6675.6	72039.0	131896.0
Marathwada	4913.6	3660.0	17768.1	13158.5	1855.0	2128.6	66191.3	113457.8
Vidharbha	2916.4	3258.0	509.7	1237.6	988.8	1020.9	67600.9	125754.8
All Maharashtra	**4925.3**	**4087.4**	**29266.9**	**32415.3**	**2736.1**	**4133.0**	**84964.5**	**156347.8**

Source: @- krishi.maharashtra.gov.in $- Economic Survey of Maharashtra 2010 -14,

#- Integrated Survey Scheme, Department of Animal Husbandry, Pune (2010–2014, Reports

Table 2 depicts the regional performance of economic efficiency indicators of Maharashtra state for two time periods, i.e., 2010 and 2019. We have taken food grain, sugarcane, milk, and per capita GDVA as essential measures for measuring economic efficiency, and all are positive. Here, the food-grain and sugarcane production are positive indicators; enhancing total food-grain production indicates adequate food grains to the people and is treated as food security. Sugarcane production is the farmers' most prominent source of income; if they have sufficient income, they must fulfill their bare necessities. In contrast, milk production is one more supplementary source of income for the farmers, and the milk business is well known as the source of rural livelihoods. However, per capita, GDVA is another indicator, the highest per capita GDVA is treated as the significant agricultural output of the state. Therefore, all these indicators are similarly important for measuring economic efficiency and boosting sustainable livelihood security (Guha et al. 2018; Beeraladinni and Patil 2023).

Concerning the regional overview of economic efficiency indicators of Maharashtra state, the Khandesh region was the biggest producer of food grains, which was nearly 7967.4 tonnes in 2010, but it decreased to 6190.8 tonnes in 2019. In comparison, the Konkan region was less in both periods, i.e., 2802.3 tonnes in 2010 and 2281.8 tonnes in 2019. In total sugarcane production, the western Maharashtra region was observed biggest producer, which was 78173.2 tonnes in 2010; it notably increased to 99242.0 tonnes in 2019. The Vidharbha region was lowest in total sugarcane production, 509.7 and 1237.6 tonnes for 2010 and 2019. While in milk production western Maharashtra region was on top in the state for both periods, with 6190.1 lakh lit. in 2010, it notably increased to 9923.7 lakh lit. in 2019. Followed by Khandesh region stood second in milk production for both periods. The Konkan region was lowest in milk production in both periods, which was only 658.8 lakh lit. in 2010, but it slightly increased to 916.3 lakh lit. in 2019. About the regional per capita GDVA, the Konkan region was highest ₹116919.4 9 in 2010, nearly dabbling to ₹222081.8 in 2019.

Maharashtra's total food-grain production was 4925.3 tonnes in 2010, but it decreased to 4087.4 tonnes in 2019; the sugarcane production was 29266.9 tonnes in 2010 which increased to 32415.3 tonnes in 2019. The Maharashtra state indicated remarkably increasing trends in milk production, and per capita GDVA, total milk production was 2736.1 lakh

lit. in 2010, which increased to 4133.0 lacks lit in 2019. Also, the per capita GDVA of Maharashtra state was ₹84964.5 in 2010, which outstandingly increased to 156347.8 in 2019.

Table 4
Regional Social Equity Indicators of Maharashtra

Region/ Year	Female literacy# (%)		Sex Ratio# (per '000)		IMR@ (per '000)		HDI*	
	2001	2011	2001	2011	2001	2011	2010$	2019^
Konkan	73.6	80.7	941	949	39	43	0.757	0.788
Western Maharashtra	66.6	74.9	951	953	35	39	0.630	0.759
Khandesh	65.9	68.0	944	944	52	50	0.444	0.693
Marathwada	54.9	67.2	941	934	51	47	0.424	0.606
Vidharbha	66.5	77.8	952	956	59	52	0.421	0.700
All Maharashtra	**65.5**	**73.7**	**946**	**947**	**47**	**46**	**0.535**	**0.709**

Source: #-Census Govt. of India 2001 @- NHRC-Indirect Estimates of District wise IMR 2011

** - HDR Maharashtra 2002. (Note: - $ – 2002, ^ – 2012)*

Table 4 discuss the regional status of social equity indicators which consist of female literacy, sex ratio, infant mortality rate, and Human Development Index of Maharashtra state for two time periods. At this point, the female literacy and sex ratio indicate that education status and gender equality in society are positive indicators; an extraordinary female literacy rate indicates freedom for women and girls and equal opportunities for them. While the outstanding sex ratio represents gender equity and energetic balance in society, the infant mortality rate is a noticeable gauge of the adequate availability and quality of health services to society. The Human Development Index is a very inclusive tool for assessing human well-being, freedom, and choices. Therefore, all these indicators are significant to measure social equity, and social equity by gender, income, freedom, choices, and opportunities is a primary need to attain sustainable livelihood security (Guha et al. 2018).

Relating to the regional outline of economic efficiency indicators of Maharashtra state, the female literacy rate of the Konakn Region was highest at 73.6% in 2010; it also increased to 80.7% in 2019. At that time, the Marathwada region was lowest in both periods, i.e., 54.9% in 2010, and it slightly increased to 67.2% in 2019. In both periods, other regions like western Maharashtra, Kahndesh, and Vidharbha stood between 65.9–77.8%. Regarding the regional sex ratio, the Vidharbha region was highest at 952, followed by western Maharashtra was 951 in 2010; both regions also increased to 956 and 953 in 2019. While Marathwada and Konkan regions were the lowest sex ratio, which was 941 in 2010, accordingly, the Marathwada region decreased to 934 in 2019.

In terms of infant mortality rate, the Vidharbha region was the highest for both periods, which was 59 in 2010 and 52 in 2019. In comparison, the western Maharashtra region was less in both periods, i.e., only 35 in 2010, but it increased to 39 in 2019. In Human Development Index, the Konkan region was observed highest for both periods, which was 0.757 in 2010; it increased to 0.788 in 2019. The Vidharbha region was lowest at 0.421 in 2010 but notably increased to 0.7000 in 2019. Maharashtra's overall female literacy rate was 65.5% in 2010, but it decreased to 73.7% in 2019; the sex ratio and infant mortality rate were 946 and 47 in 2010, the sex ratio slightly increased to 947, and the infant mortality

rate usually decreased to 46 in 2019. The Maharashtra state indicated remarkably increasing trends in Human Development Index which increased from 0.535 to 0.709 in 2019.

Table 5

Regional Ecological Security Index (ESI) of Maharashtra

Region	Ecological Security Index (ESI)				ESI Change		Imp. Index	Rank
	2010	Rank	2019	Rank	%	Rank		
Konkan	0.500	3	0.516	3	3.2	4	0.032	5
Western Maharashtra	0.466	4	0.509	4	9.2	1	0.081	1
Khandesh	0.460	5	0.492	5	7.1	2	0.060	2
Marathwada	0.568	2	0.591	1	3.9	3	0.052	3
Vidharbha	0.569	1	0.586	2	2.9	5	0.038	4
All Maharashtra	**0.513**	**-**	**0.539**	**-**	**5.1**	**-**	**0.054**	**-**
Source: Authors Calculation (Table-2)								

Table 5 shows the regional development in the Ecological Security Index of the Maharashtra state for two different periods, i.e., 2010 and 2019. The ESI of the Vidharbha region was higher (0.569) in 2010, but in 2019 the Marathwada was the highest (0.591) in Maharashtra. The Khandesh (0.460) and Western Maharashtra (0.466) regions were very vulnerable and lowest in the ESI, but both regions showed positive change and positive Improvement Index. The Konkan region observed less or lowest improvement (0.032) in ESI compared to other regions. The western Maharashtra region revealed the highest (9.2%) net change, and it stood on top with the highest Improvement Index (0.081) in ESI in the Maharashtra state from 2010 to 2019. Overall ESI of Maharashtra state was 0.513 in 2010 and 0.539 in 2019; it indicated positive change and medium development during the study period.

Table 6

Regional Economic Efficiency Index (EEI) of Maharashtra

Region	Economic Efficiency Index (EEI)				EEI Change		Imp. Index	Rank
	2010	Rank	2019	Rank	%	Rank		
Konkan	0.242	3	0.239	3	-1.2	3	-0.004	2
Western Maharashtra	0.517	1	0.529	1	2.5	2	0.027	3
Khandesh	0.335	2	0.313	2	-6.7	4	-0.034	4
Marathwada	0.201	4	0.154	4	-23.4	5	-0.059	5
Vidharbha	0.097	5	0.115	5	18.0	1	0.019	1
All Maharashtra	**0.278**	**-**	**0.270**	**-**	**-3.0**	**-**	**-0.012**	**-**
Source: Authors Calculation (Table-3)								

Table 6 reveals the regional development in the Economic Efficiency Index of Maharashtra state in 2010 and 2019. The EEI of the Western Maharashtra region was higher in both years, 0.517 in 2010 and 0.529 in 2019, but it was under the medium development category. The Vidharbha region (0.097) was observed to be very vulnerable in environmental efficiency and also found to be a deficient development category. However, it indicated significant improvement and stood highest in the improvement index (0.019) in EEI from 2010 to 2019. Followed by the Marathwada (0.201) and Konkan (0.242) regions were also in the very low development category, and both revealed a negative improvement in EEI. The Marathwada region observed less improvement and went negative (-23.4%) from 2010 to 2019. Overall EEI of Maharashtra state was 0.278 in 2010 and 0.270 in 2019; it indicated negative change and declined by -3.0% from 2010 to 2019.

Table 7

Regional Social Equity Index (SEI) of Maharashtra

Region	Social Equity Index (SEI)				SEI Change		Imp. Index	Rank
	2010	Rank	2019	Rank	%	Rank		
Konkan	0.638	1	0.621	1	-2.7	5	-0.048	5
Western Maharashtra	0.599	2	0.603	2	0.5	5	0.008	4
Khandesh	0.468	3	0.487	3	4.0	3	0.035	3
Marathwada	0.422	5	0.471	5	11.6	2	0.085	2
Vidharbha	0.437	4	0.540	4	23.6	1	0.183	1
All Maharashtra	**0.513**	**-**	**0.544**	**-**	**6.1**	**-**	**0.064**	**-**
Source: Authors Calculation (Table-4)								

Table 7 reveals the regional development in the Social Equity Index of the Maharashtra state for two different periods, i.e., 2010 and 2019. The Konkan region was higher in both years, 0.638 in 2010 and 0.621 in 2019; it showed negative trends and declined by -2.7% in ESI from 2010 to 2019. Marathwada region was lowest in both years, 0.422 in 2010 and 0.471 in 2019; it observed positive change and improved by 11.6% in ESI from 2010 to 2019. The western Maharashtra region stood second for both years but was ranked 4th in ESI Improvement Index. Subsequently, Vidharbha region revealed notably positive change and the highest SEI Improvement Index (0.183) compared to other regions of Maharashtra. Overall SEI of Maharashtra state was 0.513 in 2010 and 0.544 in 2019; it specified positive change and improved by 6.1% from 2010 to 2019.

Table 8

Regional Sustainable Livelihood Security Index (SLSI) of Maharashtra

Region	Sustainable Livelihood Security Index (SLSI)				SLSI Change		Imp. Index	Rank
	2010	Rank	2019	Rank	%	Rank		
Konkan	0.426	2	0.425	2	-0.3	4	-0.002	3
Western Maharashtra	0.525	1	0.546	1	4.0	3	0.044	2
Khandesh	0.416	3	0.422	3	1.3	2	0.009	3
Marathwada	0.364	4	0.350	4	-3.8	5	-0.022	4
Vidharbha	0.289	5	0.330	5	14.3	1	0.058	1
All Maharashtra	**0.404**	**-**	**0.414**		**2.6**	**-**	**0.018**	**-**

Source: Authors Calculation (Table- 5, 6 & 7)

Table 8 reveals the regional development in the Sustainable Livelihood Security Index, with its key domains, viz. ecological security, economic efficiency, and social equity in the Maharashtra state during two different periods, i.e., 2010 and 2019. According to data and results, it observed the western Maharashtra region was highest ranked 1st in SLSI for both years, i.e., 0.525 in 2010 and 0.546 in 2019; it showed significant positive change and increased by 4.0%. However, the Vidharbha region observed less development in SLSI, 0.289 in 2010 and 0.330 in 2019, which remarkably indicated the most significant net change in SLSI with 14.3% from 2010 to 2019. The Konkan and Marathwad regions revealed low development with negative improvement for both periods. The Vidharbha region showed deficient development in SLSI and put 5th rank, but it also indicated the highest Improvement Index (0.058) with rank 1st from 2010 to 2019 compared to other regions in Maharashtra. Overall development progress of Maharashtra state in SLSI was 0.404 in 2010 and 0.414 in 2019; it stated significant positive change and improved by 2.6% from 2010 to 2019.

Table 9
Regional Categorization of Maharashtra by Sustainable Livelihood Security Index Indices

Category	Year	Ecological Security Index	Economic Efficiency Index	Social Equity Index	Sustainable Livelihood Security Index
Very High *(> 0.800 above)*	2010	-	-	-	-
	2019	-	-	-	-
High *(0.700-0.799)*	2010	-	-	-	-
	2019	-	-	-	-
Medium *(0.500-0.699)*	2010	Vidharbha, Marathwada, Konkan, Maharashtra	Western Maharashtra	Konkan, Western Maharashtra, Maharashtra	Western Maharashtra
	2019	Vidharbha, Marathwada, Konkan, Western Maharashtra, Maharashtra	Western Maharashtra	Konkan, Western Maharashtra, Vidharbha, Maharashtra	Western Maharashtra
Low *(0.300–0.499)*	2010	Western Maharashtra, Khandesh,	Khandesh	Khandesh, Vidharbha, Marathwada	Konkan, Khandesh, Marathwada, Maharashtra
	2019	Khandesh	Khandesh	Khandesh, Marathwada	Konkan, Khandesh, Marathwada, Vidharbha, Maharashtra
Very Low *(< 0.299)*	2010	-	Konkan, Marathwada, Vidharbha, Maharashtra	-	Vidharbha
	2019	-	Konkan, Marathwada, Vidharbha, Maharashtra	-	-

Source: Complied Author

Table 9 remarkably observed that in this study, no regions in Maharashtra in the high and very high category of sustainable livelihood Security index and its indices for the study period. Khandesh region was less developed in ecological security, economic efficiency, social equity, and sustainable livelihood security index in Maharashtra for both 2010 and 2019. Regarding economic efficiency, only western Maharashtra was in a good position and was more highly developed than other regions during the study period. The Maharashtra state indicated medium development status regarding ecological security, economic efficiency, and social equity. However, it was in the low development category of the sustainable livelihood security index for both periods.

4. Conclusion

In conclusion, the Sustainable Livelihood Security Index is a comprehensive tool for evaluating the sustainability of regional agriculture. Also, SLSI helps policymakers to design a policy to reduce regional imbalance in terms of

ecological, economic, and social perspectives. As a policy tool, it observed that in this study, Vidharbha was ecologically well developed but economically and socially significantly less developed region in Maharashtra. However, western Maharashtra was ecologically less developed but economically and socially well-developed for both periods. Only the western Maharashtra region was found not very high but medium developed, and reaming 4 regions under very low or low developed in Sustainable Livelihood Security Index in both 2010 and 2019.

The western Maharashtra region was highest at 0.525 in 2010 and 0.546 in 2019, which reveals a significant positive change in SLSI. Vidharbha region is significantly less developed, with 0.289 in 2010 and 0.330 in 2019, which indicated positive change with 14.3%, also the highest improvement index (0.058) from 2010 to 2019 in Maharashtra. Overall development progress of Maharashtra state in SLSI was 0.404 in 2010 and 0.414 in 2019; it stated significant positive change and improved by 2.6% from 2010 to 2019. In both periods, no any regions in Maharashtra were in the high or very high category in SLSI, which specifies most of the regions in Maharashtra required immediate attention with specific thematic areas, i.e. ecological and economic factors that should be focused on to enhance sustainable development livelihood security.

Declarations

DECLARATION/ CONFLICT OF INTEREST

Authors declared that there is no conflict of interest or any other financial interest.

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Figures

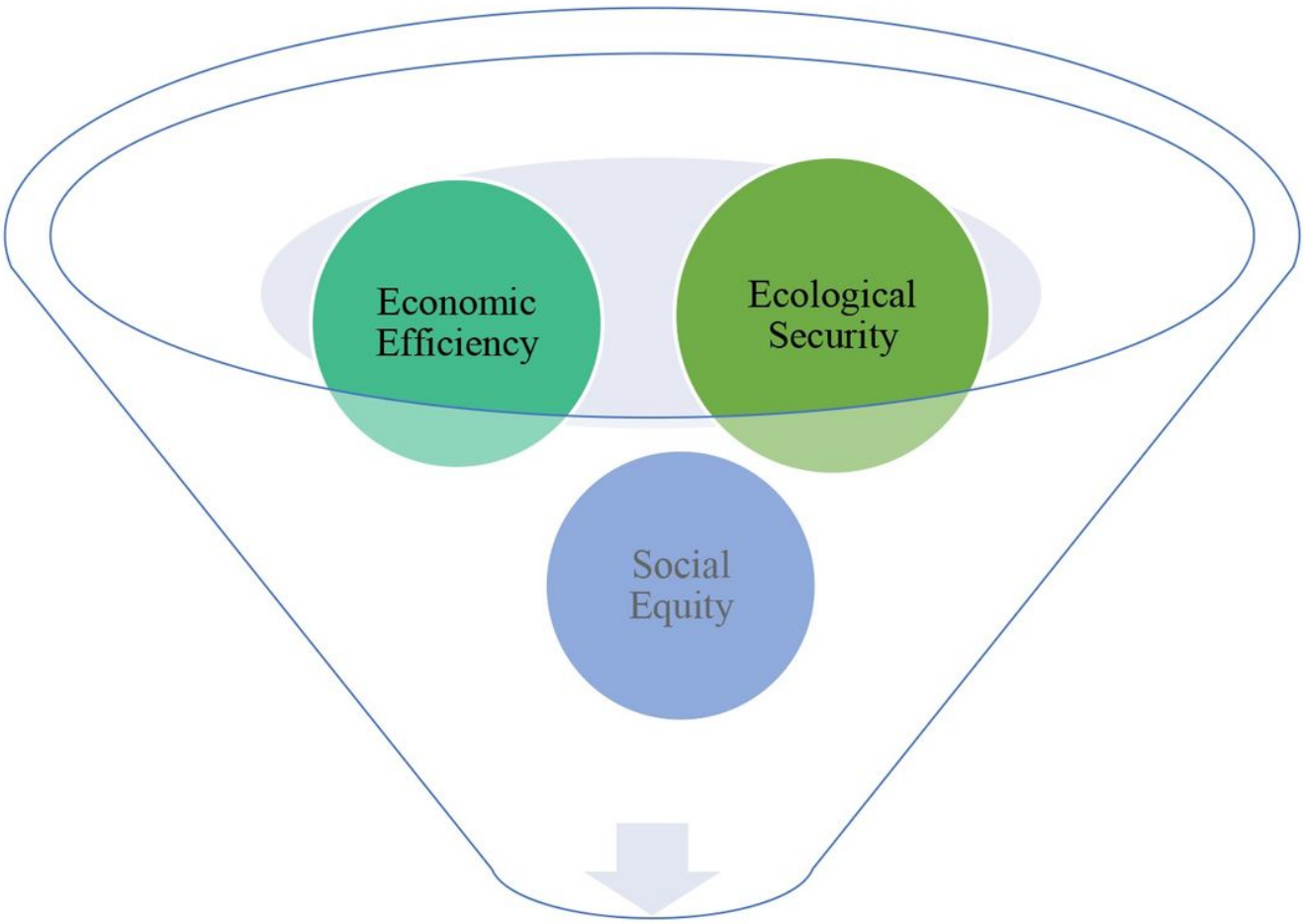
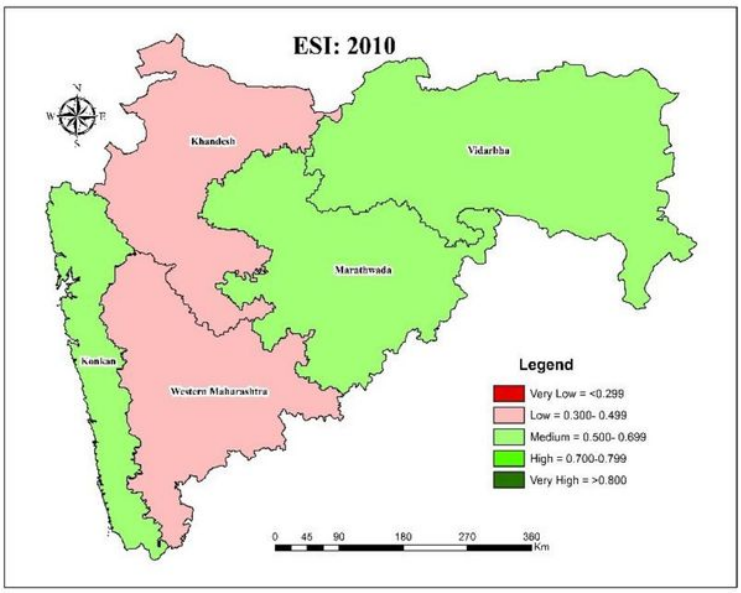


Figure 1

Sustainable Livelihood Security Index



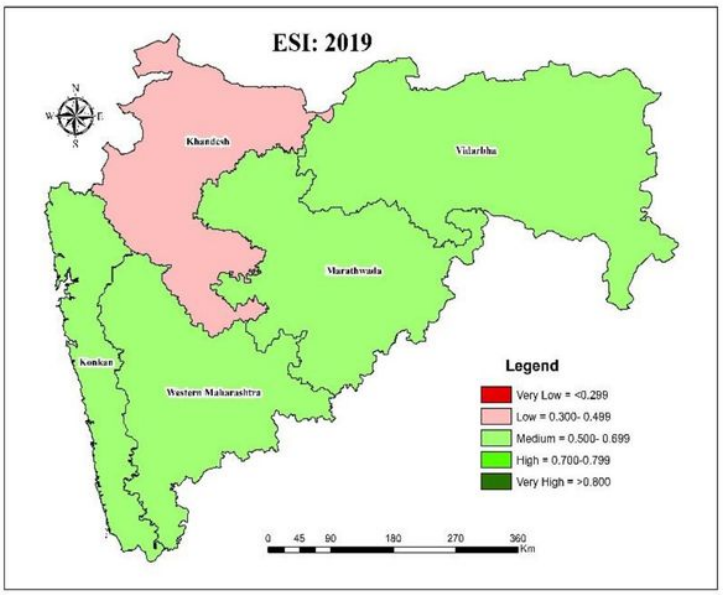


Figure 2

Regional Ecological Security Index (ESI) of Maharashtra

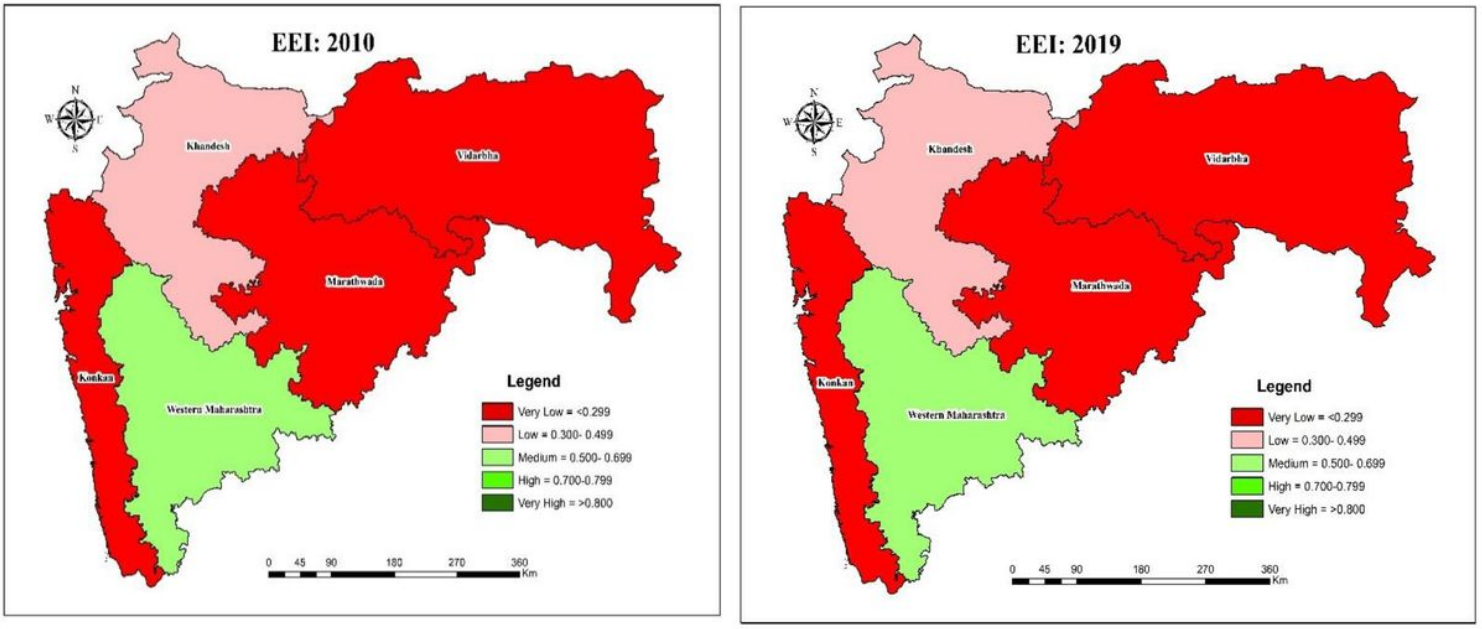


Figure 3

Regional Economic Efficiency Index (EEI) of Maharashtra

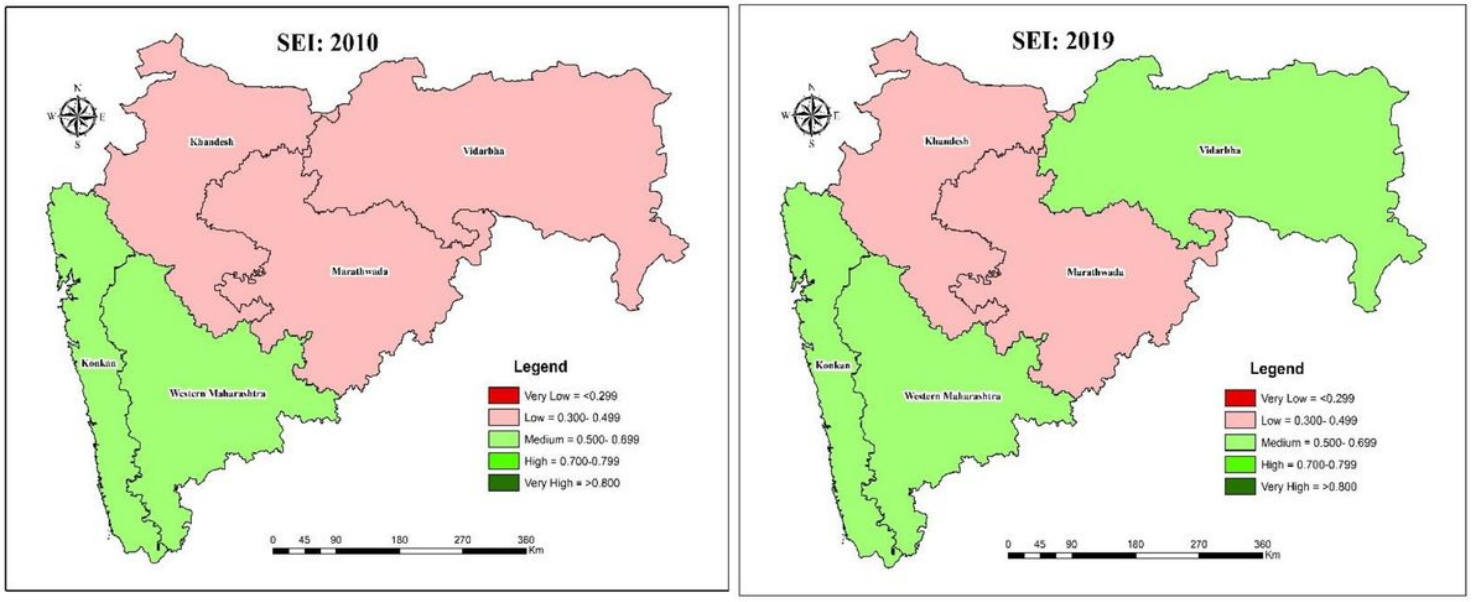


Figure 4

Regional Social Equity Index (SEI) of Maharashtra

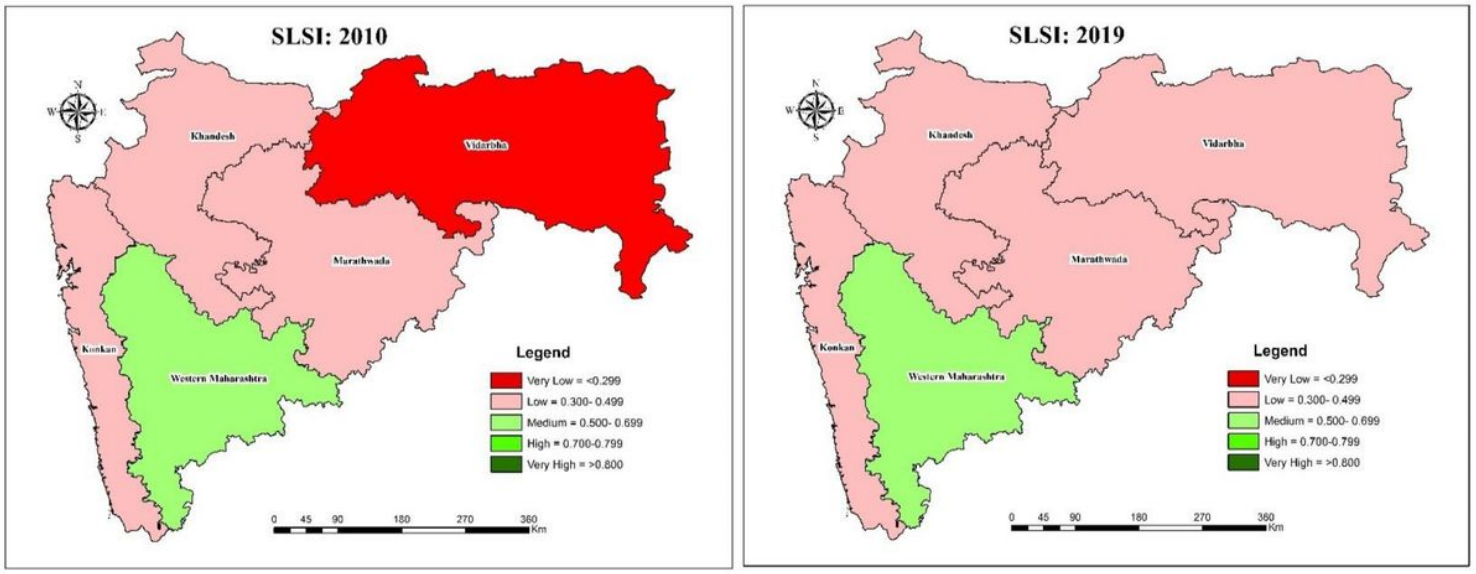


Figure 5

Regional Sustainable Livelihood Security Index (SLSI) of Maharashtra