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Sustainable livelihood security in Odisha, India: A district level analysis

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ABSTRACT

Sustainable livelihood security (SLS) is an integrating framework that encompasses current concerns and policy requirements for ecological, social, and economic dimensions of sustainable development. It carries particular importance for developing economies. This study intends to verify the relative status of SLS of the 30 districts in Odisha, which is a backward state in eastern India. In this study, a total of 22 relevant indicators relating to the three components of SLS—ecological security, social equity, and economic efficiency have been taken, based on various kinds of government reports. The principal component analysis (PCA) was used to ascertain the indicators and the importance of each of them to the corresponding component of SLS. The ecological security index (ESI), social equity index (SEI), economic efficiency index (EEI), and composite sustainable livelihood security index (CSLSI) of each district of Odisha were calculated through the min-max normalization technique. The results revealed that there are wide variations in SLS among the districts of Odisha. In this study, the districts are categorized into four levels based on the scores of ESI, SEI, EEI, and CSLSI as very low (<0.400), low (0.400–0.549), medium (0.550–0.700), and high (>0.700). According to the classification result of CSLSI, 2 districts are found to be in the very low category, 20 districts are under the low sustainability category, 8 districts are in the medium category, and none of the districts are found to be in the high sustainability category. The district of Sambalpur ranks the highest with a CSLSI score of 0.624. The bottom five districts are Gajapati, Bolangir, Nabarangpur, Kandhamal, and Malkangiri, having the CSLSI scores of 0.438, 0.435, 0.406, 0.391, and 0.344, respectively. The result of this study suggests that region-specific, systematic, and proactive approaches are desirable for balanced development in Odisha. Further, policy intervention is required to implement more inclusive tribal welfare policies.

1. Introduction

Livelihood security is a prime concern for developing economies all over the world. Especially in India where most of its population depends on agriculture, livelihood plays a vital role. Livelihood security has a direct linkage with poverty, unemployment, food security, and management and conservation of natural resources (Nath and Behera, 2011). A livelihood comprises the abilities, skills, proficiencies, and assets (both material and social) required for a way of life. It becomes sustainable when it can maintain and enhance the current capabilities and assets without exhausting the future means of livelihood and natural resource base (Chambers and Conway, 1992; Scoones, 1998). The sustainable livelihood framework is a conscious effort for the selection of factors and indicators given the long-term goal of poverty alleviation (Gregoire, 2012; Satpati and Kumar Sharma, 2021), and the enhancement of livelihood sustainability and resilience (Ifejika Speranza et al., 2014; Mutahara et al., 2016; Pandey et al., 2017).

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The idea of sustainable livelihood security (SLS) emanated from the basic concept of sustainable development. The Brundtland Commission (1987) introduced the concept of sustainable development and endorsed the idea in the first United Nations Human Development Report (UNDP, 1990). Subsequently, the importance of operationalizing and achieving internationally agreed development indicators for the attainment of sustainable development was emphasized in the World Summit on sustainable development at Johannesburg in 2002 (Kates et al., 2005; Sajjad and Nasreen, 2016). With relevant progress, various composite indicators were developed. Among those composite indicators of sustainable development, like environmentally adjusted net domestic product (EDP), well-being index (WBI), index of sustainable economic welfare (ISEW), city development index (CDI), and sustainable livelihood security index (SLSI), SLSI takes a holistic approach integrating the economic, social, and ecological issues for the evaluation of the relative sustainability status of the cross-sections (Parris and Kates, 2003; Singh and Hiremath, 2010). The analytical framework of SLSI was first proposed by Swaminathan (1991) to check the presence of the necessary conditions for the attainment of SLS. Later, Saleth and Swaminathan (1993) empirically applied it as a relative measure both in time and space within the framework of sustainable development. The underlying idea is that access to resources and an economically efficient system can substantially reduce the pressure on the environment and ensure sustainable development. Also, the sustenance of economic growth is feasible in an ecologically secured environment. The literatures on SLS have enriched three crucial dimensions of human survival, i.e., ecological feasibility, economic competence, and social equitability (Swaminathan, 1991; Saleth and Swaminathan, 1993; Hatai and Sen, 2008; Singh and Hiremath, 2010; Guha et al., 2018).

The empirical applications of SLS are found mainly in developing countries (Swaminathan, 1991; You and Zhang, 2017; Mabhaudhi et al., 2019; Murniati and Mutolib, 2020; Etana et al., 2021). In these economies, economic progress has been constrained by spatial and social diffusion, resulting in a continued scarcity of livelihood resources (Patidar, 2019). Accordingly, a growing focus is made on measuring the SLS status of these regions for sustainable development (Krishna et al., 2020). In India, research on sustainable livelihood was started in the year of 1991 by Swaminathan (Swaminathan, 1991). Empirical evidence from India suggests that the relative status of SLS (Singh and Hiremath, 2010; Kumar et al., 2014; Sajjad et al., 2014; Guha et al., 2018) and its three components, namely economic efficiency, social equity and ecological security, vary widely across regions (Kumar and Begum Irfan, 2018; Singh and Nayak, 2020).

This study is an empirical illustration of SLSI from Odisha, a state in India. Despite achieving impressive economic growth, the state is still the most backward or underdeveloped among the states and union territories (Sahu and Panda, 2018). The Raghuram Rajan Committee has reported Odisha as the least developed state in India based on ten economic development subcomponents including poverty, health, education, and basic amenity (Minsitry of Finance, Government of India, 2013). In the National Institution for Transforming India (NITI) Aayog's sustainable development goals (SDGs) ranking list (2020–2021), Odisha has been placed among the bottom five states as a performer (NITI Aayog, 2021). In spite of various endeavours to improve livelihood since India's independence, Odisha's livelihood security status is still abysmal. Huge regional disparity and inequality among the districts in the socio-economic indicators characterize the economy of Odisha (Panda, 2015; Sahoo and Paltasingh, 2019), posing severe threats to a secure and sustainable livelihood. Sustainable livelihood research in Odisha has hardly been found in recent literatures. In order to plug up this gap in literature, this study tries to investigate the relative SLS performance of the districts of Odisha through the construction of composite sustainable livelihood security index (CSLSI). Based on this evaluation, different areas of concern and priorities have been identified at the district level for policy intervention to enhance SLS status. The discussion has been made based on principal component analysis (PCA) which can boost the explanatory power of index-based models by simplifying the contribution indicators of each index relating to livelihood security (Erenstein, 2011; De and Das, 2021).

2. Data sources and research methods

2.1. Study area

Odisha (17.78°–22.73°N, 81.27°–87.29°E) is located in tropical climatic zone with high temperature and humidity, covers an area of around 1.56×10^5 km^2 (comprising 4.87% of India's total land area), and owns a 450 km coastline. The state is bounded by West Bengal in the northeast, Jharkhand in the north, Andhra Pradesh and Telangana in the south, and Chhattisgarh in the west, and surrounded by the Bay of Bengal in the east. Odisha comprises 30 administrative districts, which are divided into 10 agroclimatic zones (Fig. 1). Odisha is vulnerable to climate change (Mishra et al., 2016). Many natural disasters like cyclones, droughts, and floods adversely affect the livelihood and the development edifice of economy of Odisha (Bahinipati and Venkatachalam, 2015). The population density of Odisha is 270 people/km^2, the sex ratio is 979 females per 1000 males, and the literacy rate is 73.00%, of which 82.00% for males and 64.00% for females (Office of the Registrar General and Census Commissioner, 2011). The state is bestowed with substantial natural resources, and the growth rate of economy is above the national average. According to the 2020–2021 Odisha economic survey, more than 70.00% of the population live in villages (Planning and Convergence Department, Government of Odisha, 2021), depending directly or indirectly on agriculture. However, results of 2019–2020 Odisha economic survey show that agriculture and its allied activities account for a lower percentage of the state's gross value addition (19.90%) compared to industry (39.60%) and service sectors (40.50%) (Planning and Convergence Department, Government of Odisha, 2020). The incidence of poverty is another primary concern for Odisha. About 29.35% of the total population is poor in terms of the headcount ratio calculated by the national multidimensional poverty index (NITI Aayog, 2021).

2.2. Selection of indicators

We selected the indicators based on the existing literatures and their availability and quantifiability in this study, as there is no universally accepted set for the measurement of livelihood security (Parris and Kates, 2003). This study identified 22 relevant indicators under 3 broad components, i.e., ecological security, social equity, and economic efficiency, for the measurement of SLS. Table 1 describes the indicators, their linkages with SLS, and the supportive literatures. The rationale behind the indicators selection is briefly discussed below.

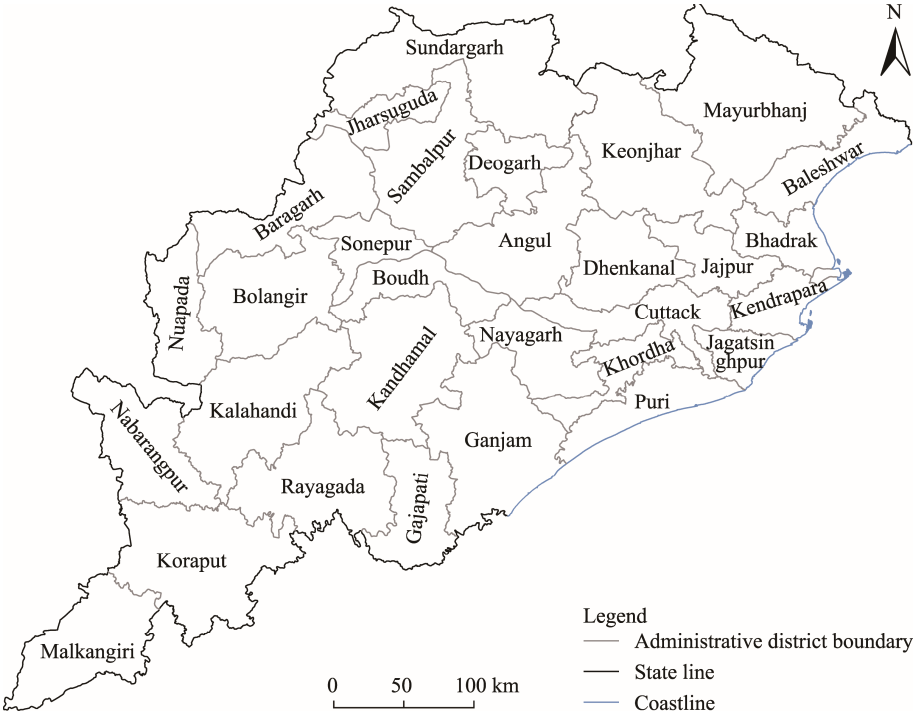

Fig. 1. Distribution of the 30 districts of Odisha.

Ecological resources have been an essential source of livelihood from the primitive stage till now and have a significant influence on the livelihood of today and the future. Therefore, the availability, appropriate management, and conservation of ecological resources are essential requirements for SLS attainment. In this study, the indicators for ecological security are cropping intensity, population density, deviation of annual rainfall, proportion of wasteland area, groundwater resource potential, and proportion of forest area. In Odisha, the share of primary agriculture and allied sectors has declined from 26.00% (2000–2001) to 21.27% (2020–2021). However, around 49.00% of the total workforce is dependent on agriculture. This indicates a high dependency ratio on agriculture in Odisha (Indian National Statistical Office, 2019). The state is experiencing a decline in the gross cropped area from 9.01×10^6 hm^2 (2014–2015) to 8.32×10^6 hm^2 (2019–2020), which worsens the situation further (NABARD, 2022). Because of this, cropping intensity is considered a relevant variable of ecological security toward sustainable livelihood. Population density is another important indicator of ecological security. Higher population density may threaten sustainable development by posing pressure on fragile and marginal land, forest, and overall ecological security. Rainfall affects the potential productivity of any region. Odisha is located in a tropical sub-humid climatic zone where crop productivity is primarily dependent on monsoon. Therefore, deviation of annual rainfall is a critical parameter to influence ecological security. Increased share of wasteland is ecologically unsuitable for any region, as it is economically unproductive and leads to environmental degradation. Groundwater is an important resource for various purposes, and its efficient management is essential for sustainable development. Forest helps in balancing ecosystem and managing climate. It has immense ecological and economic benefits to a particular region or ecosystem and helps reduce the adverse effects of climate change and natural disaster. Forest offers food, timber, raw materials, and good environmental conditions to boost agricultural productivity and healthy living, and provides livelihoods to millions of people.

Social equity minimizes social exploitation and ensures equitable distribution of resources that are essential for SLS. The determining indicators for social equity are female literacy rate, pupil-teacher ratio and dropout rate in primary education, sex ratio, household with electricity, household using clean fuel for cooking, household with improved sanitation facility, household with improved drinking water, and infant mortality rate. High female literacy rate and sex ratio indicate the progress of economy in terms of increased social and economic participation of females. These indicators act as a guard against social exploitation. Pupil-teacher ratio and dropout rate in primary education are two essential characteristics of the status of education which is a fundamental requisite to reflect the state of living and human development in a region. SLS is an interrelated and hierarchical process requiring sustainability both at the household and macro levels. The indicators of households with electricity, improved drinking water, improved sanitation facility, and clean fuel for cooking reflect the sufficiency of infrastructure at the household level.

An economically efficient system ensures the optimum use of human, economic and natural resources. It assures the present development needs of society for a secured livelihood. The indicators of economic efficiency are NIA to NSA, proportion of operational land holdings, proportion of main workers, squared poverty gap, per capita income, population served per bank, and per capita foodgrain production in this study. Increasing population and decreasing area under cultivation are the co-existing characteristics of the economy of Odisha. In this context, the proportion of operational land holdings, NIA to NSA, and per capita foodgrain production are assumed to be important indicators for assessing economic efficiency. Per capita income and proportion of main workers are relevant indicators to reflect the economic condition or the standard of living in a particular district. The population served per bank indicator exhibits the financial infrastructure The squared poverty gap indicator shows the severity of poverty among the poor by taking into account the inequality among the poor (Directorate of Economics and Statistics, Government of Odisha, 2017).

2.3. Data sources

The data of this study were from Census of India 2011 (Office of the Registrar General and Census Commissioner, 2011); Agricultural Census 2015–2016, Odisha (Directorate of Economics and Statistics., Government of Odisha, 2016); Compendium of Environment Statistics, Odisha (Directorate of Economics and Statistics and Planning and Convergence Department, Government of Odisha, 2016); National Family Health Survey (NFHS–4), India, 2015–2016 (IIPS and ICF, 2017); District Statistical Handbooks (Directorate of Economics and Statistics, Government of Odisha, 2018); and School and Mass Education (OPEPA, 2018).

2.4. Computation of index values

To reduce complexity and enhance replicability, all the indicators have been normalized by employing the 'min-max normalization' technique in keeping with Saleth and Swaminathan (1993) who follow the approach underlying the measurement of the physical quality life index-human development index (Saleth and Swaminathan, 1993; Singh and Hiremath, 2010; Garai et al., 2019). After constructing the index values for all the three components of SLS, CSLSI was constructed by assuming equal weights to the component indices.

$$\mathrm{SLSI}_{ij} = \frac{X_{ij} - MIN_j X_{ij}}{MAX_j X_{ij} - MIN_j X_{ij}}, \tag{1}$$

$$\mathrm{SLSI}_{ij} = \frac{MAX_j X_{ij} - X_{ij}}{MAX_j X_{ij} - MIN_j X_{ij}}, \tag{2}$$

$$\mathrm{CSLSI}_{j} = \frac{\sum_{i=1}^{I} W_{ij}\mathrm{SLSI}_{ij}}{I}, \tag{3}$$

where i represents the component (i=1, 2, 3); j represents the district (j=1, 2, 3,…, 30); SLSI_{ij} is the value of SLSI for the i^{th} component of j^{th} district; X_{ij} represents the value of the indicator corresponding to i^{th} component for the j^{th} district; $MIN_j X_{ij}$ indicates the minimum value of X_{ij} of district j; and $MAX_j X_{ij}$ indicates the maximum value of X_{ij} of district j; CSLSI_j is the composite sustainable livelihood security index value relating to a given district j; W_{ij} in Equation 3 reflects the weight assigned to the i^{th} component of j^{th} district of SLSI; and I is the total number of components and the value of I is 3 in this study. The indicators that are supposed to have positive implications on the status of sustainable livelihood are computed by using Equation 1. On the other hand, the indicators which have negative implications are computed using Equation 2.

CSLSI is used to measure the relative livelihood sustainability of the districts of Odisha in this study. It is cross-sectional and is the arithmetic average of the three component indices (ecological security, social equity, and economic efficiency). After normalizing the indicators across the districts, we constructed the PCA matrix to allot factor loadings to different indicators for the respective components.

2.5. Principal component analysis (PCA)

PCA is one of the oldest multivariate techniques, first devised by Pearson (1901) and developed by Hotelling (1933). The method is used to understand the spatial variations at the district level involving several interrelated multidimensions variables. It is chosen for two essential purposes, i.e., firstly, the method reduces the dimensionality of data set; secondly, it interprets the data in terms of the principal components. PCA transforms the original variables to a new set of variables called principal components. These principal components are uncorrelated and ordered so that the first principal component contains the maximum variation in all of the original variables. It has wide applications in spatial and longitudinal analysis (Jollife and Cadima, 2016; Rajesh et al., 2018).

Before running PCA, Kaiser-Meyer-Olkin (KMO) assessment is performed to test the sampling adequacy of the various indicators. The KMO statistics provide the strength of the relationship among the variables. The value lies between 0 and 1. If the calculated KMO is equal to or higher than 0.600, the data are acceptable for the performance of PCA, otherwise they are considered inappropriate for PCA (Libório et al., 2020; De and Das, 2021). All calculations for the present study have been made using IBM SPSS Statistics 20 analytical software (IBM, Armonk, New York, USA).

3. Results

After normalizing the indicators, we performed PCA and varimax with Kaiser normalization rotation to analyse the ecological security, social equity, economic efficiency, and the composite sustainable livelihood security (CSLS). Since all the calculated KMO values are greater than 0.600, all the indicators have been retained for the present analysis. Further, the statistics results of Bartlett's test of Sphericity are significant (P<0.01) in all the cases. For PCA in this study, we took the indicator whose factor loading is greater than 0.100.

3.1. Ecological security indicators

Table 2 represents the computed principal components and rotated component matrix for six ecological security indicators. The first two principal components explain 65.55% of the overall variation of the data for ecological security. The first principal component (PC1) accounts for 33.14% and the second principal component (PC2) for 32.41% of the total variance. PC1 is found to have a high association with cropping intensity (–0.782), population density (0.732), deviation of annual rainfall (0.729), and proportion of forest area (0.529). PC2 for ecological security component is highly correlated with the proportion of wasteland area (0.900) and groundwater resource potential (0.622).

Table 1
Description of the 22 indicators relating to sustainable livelihood security (SLS).

Component	Indicator	Description of indicator	Linkage	Reference
Ecological security index (ESI)	Cropping intensity	Ratio of gross cropped area to net sown area (NSA; %)	Positive	Sajjad et al. (2014); Chandna and Mondal (2020)
	Population density	Number of people in unit area (people/km^2)	Negative	Kumar et al. (2014); Garai et al. (2019); Kundu et al. (2021)
	Deviation of annual rainfall	Deviation of actual annual rainfall from normal (mm)	Negative	Erenstein (2011); Mishra et al. (2016); Singh and Nayak (2020); Swain et al. (2020)
	Proportion of wasteland area	Percentage of wasteland area to total geographical area (%)	Negative	Sahoo and Swain, (2013); Tripathi et al. (2019)
	Groundwater resource potential	Depth of aquifer (m)	Positive	Kumar et al. (2014); Gogoi et al. (2019); Krishna et al. (2020)
	Proportion of forest area	Percentage of forest area to total geographical area (%)	Positive	Singh and Hiremath (2010); Kundu et al. (2021); Mishra et al. (2022)
Social equity index (SEI)	Female literacy rate	Ratio of literate females to all the females (%)	Positive	Singh and Hiremath (2010); Garai et al. (2019); De and Das (2021)
	Pupil-teacher ratio in primary education	Ratio of number of pupils enrolled to number of teachers at primary school (%)	Negative	Mohapatra and Suar (2008); Guha et al. (2018)
	Dropout rate in primary education	Ratio of number of dropout pupils to number of pupils enrolled at primary school (%)	Negative	Iwasaki (2016)
	Sex ratio	Number of females per thousand males (*n*)	Positive	Nayak (2016); Singh and Nayak (2020)
	Household with electricity	Percentage of households with electricity (%)	Positive	Das et al. (2021a, b)
	Household using clean fuel for cooking	Percentage of households using clean fuel for cooking (%)	Positive	Manjula and Gopi (2017)
	Household with improved sanitation facility	Percentage of households with improved sanitation facility (%)	Positive	Cronin et al. (2014); Tripathi (2015); Mutahara et al. (2016)
	Household with improved drinking water	Percentage of households with improved drinking water (%)	Positive	Mutahara et al. (2016); Singh and Nayak (2020); Das et al. (2021a)
	Infant mortality rate	Number of infant deaths per thousand live births (*n*)	Negative	Saleth and Swaminathan (1993); Kumar et al. (2014); Krishna et al. (2020)
Economic efficiency index (EEI)	NIA to NSA	Percentage of net irrigated area (NIA) to NSA (%)	Positive	Sajjad et al. (2014); Gogoi et al. (2019); Satpati and Kumar Sharma (2021)
	Proportion of operational land holdings	Percentage of operated area to total area of land holdings (%)	Positive	Swaminathan (1991); Saleth and Swaminathan (1993); Krishna et al. (2020)
	Proportion of main workers	Percentage of main workers to total workers (%); main workers are someone who works for more than six months a year	Positive	De and Das (2021); Satpati and Kumar Sharma (2021)
	Squared poverty gap	The square of poverty gap (%); the poverty gap is a ratio showing the average shortfall of the total population from the poverty line	Negative	Gregoire (2012)
	Per capita income	Per capita income (USD)	Positive	Garai et al. (2019); Sahoo and Senapati (2020); Singh and Nayak (2020)
	Population served per bank	Average number of people served per bank (*n*)	Negative	Erenstein (2011); Singh and Nayak (2020); De and Das (2021)
	Per capita foodgrain production	Per capita foodgrain production per year (kg/a)	Positive	Singh and Hiremath (2010); Sajjad et al. (2014); Krishna et al. (2020)

Note: Indicators with positive or negative impacts on SLS are assigned positive or negative linkage.

Table 2
Results of principal component analysis (PCA) for the six ecological security indicators.

Indicator	Factor loading	
	PC1	PC2
Cropping intensity	–0.782	0.185
Population density	0.732	–0.572
Deviation of annual rainfall	0.729	0.143
Proportion of wasteland area	0.111	0.900
Groundwater resource potential	–0.132	0.622
Proportion of forest area	0.529	–0.605

Note: PC1, the first principal component; PC2, the second principal component.

3.2. Social equity indicators

Principal components and the rotated component matrix of nine social equity indicators are presented in Table 3. It reveals that the first three principal components of social equity explain 74.80% the overall variance of data, where PC1 accounts for 31.42%, PC2 for 28.02%, and the third principal component (PC3) for 15.37%. PC1 is found to have a strong association with female literacy rate (0.810), pupil-teacher ratio in primary education (–0.797), and dropout rate in primary education (0.734). This indicates the significant role of education in social equity on the enhancement of SLS. PC2 is mainly correlated with the household using clean fuel for cooking (0.943) and household with improved sanitation facility (0.877). PC3 is associated with the household with improved drinking water (0.842) and infant mortality rate (0.627).

Table 3
Results of PCA for the nine social equity indicators.

Indicator	Factor loading		
	PC1	PC2	PC3
Female literacy rate	0.810	0.447	-
Pupil-teacher ratio in primary education	–0.797	-	0.371
Dropout rate in primary education	0.734	0.120	0.329
Sex ratio	–0.689	–0.506	–0.152
Household with electricity	0.636	0.574	-
Household using clean fuel for cooking	-	0.943	-
Household with improved sanitation facility	0.316	0.877	-
Household with improved drinking water	0.111	–0.196	0.842
Infant mortality rate	-	0.147	0.627

Note: PC3, the third principal component. “-” reflects factor loading lying between –0.100 and 0.100.

3.3. Economic efficiency indicators

PCA performed for seven economic efficiency indicators is shown in Table 4. It reveals that the first two principal components of economic efficiency explain 62.80% of the overall variance of data, where PC1 accounts for 37.17% and PC2 for 25.63%. PC1 is primarily associated with ratio of NIA to NSA (factor loading is 0.766), proportion of operational land holdings (–0.748), and proportion of main workers (0.710). PC2 is highly correlated with per capita income (0.899), population served per bank (0.608), and per capita foodgrain production (–0.580).

3.4. Sustainable livelihood security indicators

The factor loadings of associated 22 indicators for the CSLS are provided in Table 5. The first six principal components explain 80.19% of the overall variance of the original data set, of which the first two components take a significant share of 41.00%. It is evident that PC1 has a high correlation with the household with improved sanitation facility (0.852), proportion of main workers (0.851), household using clean fuel for cooking (0.838), household with electricity (0.809), per capita foodgrain production (–0.721), population served per bank (0.715), female literacy rate (0.696), and sex ratio (–0.650). This indicates that the government of Odisha should focus more on social equity and economic efficiency to boost SLS. PC2 is found to have a high association with proportion of forest area (–0.908), household with improved drinking water (0.835), and population density (–0.622). PC3 is primarily associated with the dropout rate in primary education (0.803), deviation of annual rainfall (0.681), and squared poverty gap (0.678). The fourth principal component (PC4) is highly correlated with NIA to NSA (0.786), cropping intensity (0.724), and pupil-teacher ratio in primary education (–0.576). The fifth principal component (PC5) has a strong correlation with groundwater resource potential (0.885), per capita income (0.613), and proportion of wasteland area (0.553). The infant mortality rate indicator (0.740) is highly correlated to the sixth principal component (PC6).

3.5. Results of constructed indices

The ESI, SEI, EEI, and CSLSI for each district of Odisha have been measured in this study. Table 6 illustrates the constructed index results and benchmark ranking for all the districts. Mayurbhanj is found to be in the best position, and Malkangiri receives the lowest score in ecological security measurement. This may be due to the biodiversity conservation on the Similipal Biosphere Reserve in Mayurbhanj. At the same time, the poor cropping intensity, degradation of forest ecology, and increase in area of wasteland are among the most important causes that could lead to the lowest score in ecological security of Malkangiri. In social equity measurement, Khordha is revealed to be the best performing district because of its better score in household with electricity, household with improved drinking water, household using clean fuel for cooking, household with improved sanitation facility, pupil-teacher ratio in primary education, and low level of dropout rate in primary education. This may be due to the modernization and urbanization of this district (Directorate of Economics and Statistics, Government of Odisha, 2018). Kandhamal is the worst performing district because of its meagre score in the above parameters. Therefore, SLS can be enhanced in the district by focusing more on development on the social front. However, Kandhamal possesses the 12th position in ESI. It gives an impression that the economy of Kandhamal can be improved through proper and systematic management of its ecology. Moreover, Sambalpur has scored the first position in economic efficiency measurement. The factors with more weightage in this component are proportion of main workers to total workers, population served per bank, and proportion of operational land holdings. Besides, the district has a low measure of squared poverty gap. On the other hand, Malkangiri, which is at the bottom, has a high squared poverty gap, low per capita income, and low NIA to NSA.

Table 4
Results of PCA for the seven economic efficiency indicators.

Indicator	Factor loading	
	PC1	PC2
NIA to NSA	0.766	–0.264
Proportion of operational land holdings	–0.748	-
Proportion of main workers	0.710	0.409
Squared poverty gap	0.564	0.191
Per capita income	–0.135	0.899
Population served per bank	0.576	0.608
Per capita foodgrain production	–0.532	–0.580

Note: "-" reflects factor loading lying between –0.100 and 0.100.

Table 5
Results of PCA for the 22 indicators relating to composite sustainable livelihood security (CSLS).

Indicator	Factor loading					
	PC1	PC2	PC3	PC4	PC5	PC6
Household with improved sanitation facility	0.852	-	0.112	0.184	-	0.156
Proportion of main workers	0.851	0.406	-	0.180	-	-
Household using clean fuel for cooking	0.838	-	-	-	0.150	0.297
Household with electricity	0.809	0.136	0.187	0.285	–0.291	–0.132
Per capita foodgrain production	–0.721	0.148	0.106	–0.165	–0.338	0.176
Population served per bank	0.715	-	0.366	0.150	0.113	–0.134
Female literacy rate	0.696	0.294	0.477	0.281	0.128	–0.219
Sex ratio	–0.650	–0.174	–0.504	–0.118	-	-
Proportion of forest area	–0.203	–0.908	-	–0.158	-	-
Household with improved drinking water	–0.168	0.835	-	-	-	0.258
Population density	–0.584	–0.622	-	–0.326	–0.223	0.146
Dropout rate in primary education	0.272	0.264	0.803	-	–0.158	-
Deviation of annual rainfall	-	–0.313	0.681	–0.233	-	0.340
Squared poverty gap	0.251	0.275	0.678	0.159	0.335	-
NIA to NSA	0.197	0.327	-	0.786	0.191	0.122
Cropping intensity	0.455	0.238	-	0.724	-	0.114
Pupil-teacher ratio in primary education	–0.201	0.323	–0.520	–0.576	0.138	0.256
Proportion of operational land holdings	–0.396	-	–0.304	–0.501	-	0.404
Groundwater resource potential	-	-	-	0.217	0.885	-
Per capita income	0.427	–0.269	-	–0.421	0.613	-
Proportion of wasteland area	-	0.480	0.435	-	0.553	–0.289
Infant mortality rate	-	-	-	-	-	0.740

Note: PC4, the fourth principal component; PC5, the fifth principal component; PC6, the sixth principal component. "-" reflects factor loading lying between –0.100 and 0.100.

The data in the last two columns of Table 6 reveal the district-wise overall sustainable livelihood performance and the ranking results. It reflects the inter-district variations among the districts of Odisha towards the achievement of SLS. The CSLSI is computed between 0 and 1, where 1 represents maximum sustainability, and 0 defines no sustainability. However, this index value does not mean an accurate measurement of the sustainability of livelihood security; instead, the value of the index focuses on a variation in the relative ranking position of the studied districts. So far, Sambalpur (0.624) is in the first place of CSLSI, whereas Ganjam get the second position (0.605), and Sundargarh and Jagatsinghpur (0.595) get the third place. Malkangiri, on the other hand, is the least performing district in sustainable livelihood, with a CSLSI value of 0.344. Kandhamal (0.391), Nabarangpur (0.406), and Bolangir

(0.435) are ranked the second, third, and fourth from bottom, respectively; the positions of these four districts in the ranking reveal an alarming scenario.

For ease of interpretation, all the 30 districts are categorized into 4 sustainability levels based on the scores of ESI, SEI, EEI, and CSLSI as very low (<0.400), low (0.400–0.549), medium (0.550–0.700), and high (>0.700). The pictorial depiction is presented in Figure 2. For CSLSI, 2 districts (Kandhamal and Malkangiri) are found to be in the very low category, 20 districts under the low sustainability category, 8 districts in the medium, and none in the high sustainability category.

Table 6
Score and ranking of ecological security index (ESI), social equity index (SEI), economic efficiency index (EEI), and composite sustainable livelihood security index (CSLSI) for the 30 districts of Odisha.

District	ESI	Rank	SEI	Rank	EEI	Rank	CSLSI	Rank
Sambalpur	0.612	7	0.619	9	0.640	1	0.624	1
Ganjam	0.625	3	0.671	3	0.520	10	0.605	2
Sundargarh	0.616	4	0.651	7	0.519	11	0.595	3
Jagatsinghpur	0.615	5	0.613	10	0.556	6	0.595	3
Cuttack	0.530	15	0.661	6	0.572	5	0.588	4
Bargarh	0.581	9	0.546	15	0.599	2	0.575	5
Khordha	0.354	27	0.772	1	0.573	4	0.567	6
Angul	0.613	6	0.560	14	0.484	15	0.553	7
Keonjhar	0.629	2	0.479	22	0.528	9	0.545	8
Puri	0.470	21	0.601	11	0.545	7	0.539	9
Baleshwar	0.493	18	0.664	4	0.456	18	0.537	10
Jharsuguda	0.422	24	0.693	2	0.488	14	0.534	11
Sonepur	0.455	22	0.544	16	0.582	3	0.527	12
Nayagarh	0.601	8	0.565	13	0.394	24	0.520	13
Kendrapara	0.419	25	0.663	5	0.461	17	0.514	14
Koraput	0.511	16	0.488	20	0.508	13	0.502	15
Boudh	0.552	11	0.514	18	0.426	21	0.497	16
Jajpur	0.346	28	0.599	12	0.537	8	0.494	17
Mayurbhanj	0.698	1	0.449	25	0.325	28	0.491	18
Bhadrak	0.346	28	0.621	8	0.483	16	0.484	19
Deogarh	0.561	10	0.458	24	0.430	19	0.483	20
Rayagada	0.546	13	0.479	22	0.420	22	0.482	21
Nuapada	0.495	17	0.523	17	0.429	20	0.482	21
Dhenkanal	0.534	14	0.477	23	0.430	19	0.481	22
Kalahandi	0.477	20	0.410	28	0.514	12	0.467	23
Gajapati	0.448	23	0.504	19	0.362	25	0.438	24
Bolangir	0.483	19	0.415	27	0.407	23	0.435	25
Nabarangpur	0.401	26	0.486	21	0.330	27	0.406	26
Kandhamal	0.548	12	0.289	29	0.335	26	0.391	27
Malkangiri	0.319	29	0.443	26	0.269	29	0.344	28

4. Discussion

The present study sheds light on both the opportunities and challenges for the 30 districts of Odisha to unravel appropriate development policies for a secured and sustainable livelihood for people. Despite the accelerating economic growth of the state in recent years, the state has not been able to achieve a balanced development among districts (Panda, 2015; Sahoo and Paltasingh, 2019). The unbalanced structure is evident from the district-wise index values of different components of SLS reflected in the present study. The relative SLS reflected through the value of CSLSI reveals Sambalpur as the best performer among all the districts. Forests cover 54.83% of the total area of the district, and the district gets its maximum revenue from forest-based items (Directorate of Economics and Statistics, Government of Odisha, 2018). The pattern of land redistribution and the proportion of potential land holdings have positively contributed to the agricultural production of this district over the years (Gaurav and Mishra, 2016). The district is a reservoir of many important minerals and raw materials (Das and Acharya, 2016) and is famous for its textiles and handlooms. In terms of socio-economic indicators, the district's performance is impressive. The bottom five districts appearing in the district-wise CSLSI ranking (Table 6) are Gajapati, Bolangir, Nabarangpur, Kandhamal, and Malkangiri. Among these, Bolangir, Nabarangpur, and Malkangiri are coming under the KBK (undivided Koraput, Bolangir and Kalahandi districts) region. Again, Kandhamal and Nabarangpur districts have been documented as the least improved districts according to NITI Aayog (2018). Furthermore, it has come to know that in all the bottom five districts, the scheduled tribe population constitutes the majority of the total population, which hints towards the group's vulnerability in terms of their livelihood. The result is consistent with the empirical findings of Singh and Hiremath (2010) for the districts of Gujarat.

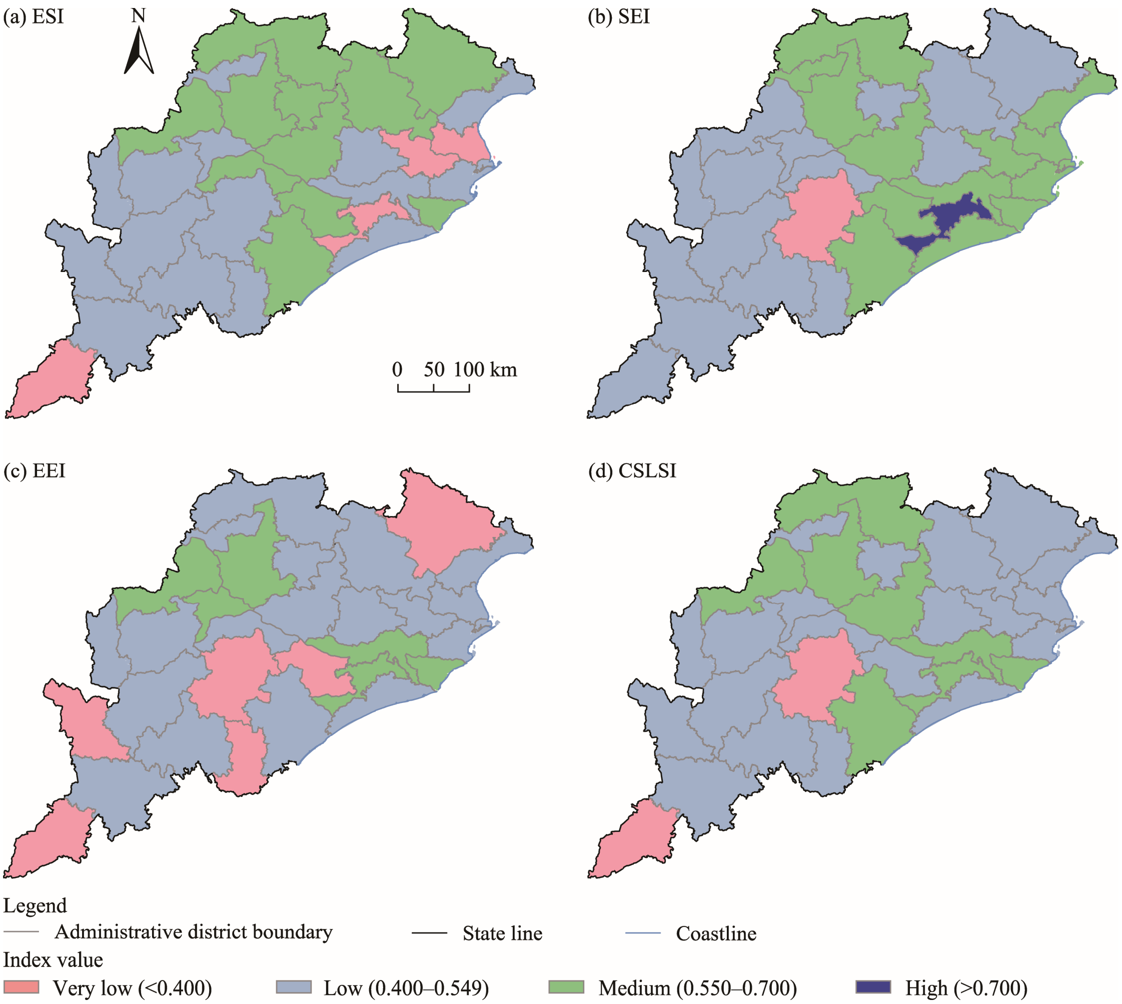

Fig. 2. Spatial distribution of the four levels of ecological security index (EEI, a), social equity index (SEI, b), economic efficiency index (EEI, c) and composite sustainable livelihood security index (CSLSI, d) in each district of Odisha.

In Odisha, the participation of tribals' workforce is below 50.00%, the literacy rate is 52.24%, and the unemployment rate is excessive when compared with different social categories (Office of the Registrar General and Census Commissioner, 2011; Ambagudia, 2019). Traditionally, they depended more on agriculture and forest resources for their livelihood. However, the slow pace of growth of agriculture and substantial loss of forest cover (Mishra et al., 2022) have marked alternative employment structures, which are insecure and unsustainable for these regions. This is clearly reflected in the large-scale distress migration and ultimate poverty in the KBK region (Breman, 2010; Meher, 2019).

The estimated indicators of cropping intensity, deviation of annual rainfall, groundwater resource potential, household with improved sanitation facility, and household using clean fuel for cooking are very low for the five bottom districts. Indian states like Punjab, Sikkim, Haryana, and West Bengal come under the very high cropping intensity state category, whereas Odisha falls under the low cropping intensity state category (Khan et al., 2022). In all the bottom four districts, low cropping intensity is one of the major hindrances to attain ecological security and an important reason for large-scale seasonal out-migration (Parida, 2016). Limited water availability (ground, surface, and storage water) for irrigation relates to the low cropping intensity in the concerned districts, which is evident from the lower value of NIA to NSA. Appropriate measures to enhance the cropping intensity and the selection of low water requiring crops can help secure the livelihood of people, which of course, depend upon some structural, institutional arrangement and community farming in special cases for an effective outcome (Chandan and Mondal, 2020; Brahmanand et al., 2021). Exhaustion and worsening of river and surface storage water in Odisha have led to over-dependence on groundwater for domestic, agricultural, and industrial purposes (Directorate of Economics and Statistics, Government of Odisha, 2016). Therefore, the poor availability of groundwater resources may impose further pressure on economic activities in the districts. Judicious water conservation measures like the creation of ponds and tanks in hard rock regions, drainage line treatments, and check dams can help the development of groundwater resources (Gogoi et al., 2019).

Proportion of wasteland area indicator for the Gajapati is very low among the ecological security indicators. Out of the total 3850.00 km^2 area of Gajapati District, wasteland constitutes 1132.18 km^2. The major portion of wasteland is land with scrub, followed by underutilized or degraded notified forest land (Mishra et al., 2010). This huge potential of wasteland can be treated and reclaimed for appropriate production activity, which can significantly contribute to the livelihood and food security.

Safe drinking water, improved sanitation facility, and clean fuel for cooking at the household level are important parameters to maintain social equity, avert illness, increase productivity, and ultimately maintain a secure livelihood. However, the burden of diarrhoea due to poor sanitation and unsafe drinking water in Odisha is much above the national average (Cronin and Dutta, 2011). Cost-benefit analysis of this dilemma reveals that Odisha could gain 4 billion USD if full sanitation is achieved by 2025 (Cronin et al., 2014). The bottom four districts have very poor scores in the said indicators. These districts are exposed to unhygienic living conditions (Pothal and Panda, 2018). An effective roll-out of Swachha Bharat Abhiyan (PMINDIA, 2014) and a well-funded central scheme should be prioritized in the concerned districts. Despite governmental efforts through several policies (e.g., Pradhan Mantri Ujwala Yojana) for a universal and affordable clean fuel for cooking like liquefied petroleum gas (LPG), effective and equitable access is a far reality for the tribal-dominated districts of Odisha (Ministry of Petroleum and Natural Gas, Government of India, 2016). A more inclusive policy initiative for domestic cooking energy is desirable (Manjula and Gopi, 2017). Further, Nabarangpur has the highest dropout rate at the primary level of education and a low female literacy rate, although the district's pupil-teacher ratio at primary school is the lowest. Therefore, an in-depth evaluation and framework for the education system are suggested for the district. The wide disparity in per capita income, Nabarangpur being at the bottom among the districts, is observed. The growth trajectory of Odisha in the last few decades reveals that the tertiary sector is the fastest-growing sector compared to the primary and secondary. Although this has leaded to faster growth of the state's economy, it has widened the disparity among the districts. Tertiary sector activities are concentrated in some coastal districts, whereas the primary sector dominates the rest part of the economy of Odisha. Thus, district-specific disparities in per capita income can be reduced with increased focus to boost the growth of the primary sector. A similar outcome is deduced through convergence analysis by Sahoo and Senapati (2020) for the districts of Odisha.

5. Conclusions

SLS can adequately clarify the differences in the viability of living conditions between the districts. It can also identify the power and weaknesses of each district and has immense importance for the long-term achievability of SDGs. In the present study, CSLSI has been constructed for all the 30 districts of Odisha by taking 3 major components, i.e., the ESI, EEI, and SEI. The study has tried to examine the status of the livelihood sustainability for the districts of Odisha with 22 indicators. PCA technique has been used to unravel the variable weights and factor components having a major influence on SLS. This gives an impression of the opportunities for the sustainable and secured livelihood of people in each district. The value of CSLSI reveals that Sambalpur secures the first position, and Malkangiri occupies the last position among the districts, followed by Kandhamal and Nabarangpur. Again, for both ESI and EEI, the place of Malkangiri is the last, and for SEI it possesses the fourth position form the last. In the SEI ranking, Kandhamal represents the last place due to the low scores of household with improved drinking water, household with improved sanitation facility, and household using clean fuel for cooking indicators. The unbalanced development has put a serious question mark on a secured livelihood across the districts of Odisha, particularly the western and southern tribal-dominated districts. Despite the fact that a number of central and state government programmes are conducted in those districts in general and the KBK region in particular, they still lag behind other districts in terms of social and economic equity and environmental sustainability. The region-specific, systematic, and proactive approaches are desirable for balanced development.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Ambagudia, J., 2019. Adivasis, preferential policy and the state in Odisha. Social Change. 49(2), 199–215.

Bahinipati, C.S., Venkatachalam, L., 2015. What drives farmers to adopt farm-level adaptation practices to climate extremes: Empirical evidence from Odisha, India. Int. J. of Disaster Risk Reduct. 14(part 4), 347–356.

Brahmanand, P.S., Behera, B., Srivastava, S.K., et al., 2021. Cultivated land utilization index vis-a-vis cropping intensity for crop diversification and water resource management in Odisha, India. Curr. Sci. 120(7), 1217–1224.

Breman, J., 2010. Outcast Labour in Asia: Circulation and Informalization of the Workforce at the Bottom of the Economy. New Delhi: Oxford University Press, 343–391.

Brundtland, G.H., 1987. Report of The World Commission on Environment and Development: Our Common Future. [2021-10-08]. https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf.

Chambers, R., Conway, G.R., 1992. Sustainable rural livelihoods: practical concepts for the 21st century. In: IDS (Institute if Development Studies) Discussion Paper 296. Brighton: Institute of Development Studies, 1–24.

Chandna, P.K., Mondal, S., 2020. Assessment of cropping intensity dynamics in Odisha using multitemporal Landsat TM and OLI images. J. Appl. Remote Sens. 14(1), 018504, doi: 10.1117/1.jrs.14.018504.

Cronin, A.A., Dutta, S., 2011. Disease burden linked to incomplete water and sanitation coverage in Orissa, India. In: Prakash, A., Vs, S., Chourey, J., (eds.). Interlacing Water and Human Health: Case Studies from South Asia. London: Sage Publications, 137–158.

Cronin, A.A., Ohikata, M., Kumar, M., 2014. Social and economic cost-benefit analysis of sanitation in Odisha State, India. J. Wate Sanit. Hyg. Dev. 4(3), 521–531.

Das, A., Acharya, S., 2016. Mining and Odisha's economy. In: Nayak, P.B., Panda, S.C., Pattanaik, P.K., (eds.). The Economy of Odisha: A Profile. New York: Oxford University Press, 1–46.
Das, A., Das, M., Rejjak, A., 2021a. Evaluating profile of well-being status (material) of bottom ten backward districts in India: a household level analysis. GeoJournal. 86, 1671–1689.
Das, M., Das, A., Mandal, A., 2021b. Assessing the level of living condition in Bundelkhand region of Central India: a household level analysis. GeoJournal. 86, 2723–2745.
De, D., Das, C.S., 2021. Measuring livelihood sustainability by PCA in Indian Sundarban. Environ. Dev. Sustain. 23, 18424–18442.
Directorate of Economics and Statistics, Government of Odisha, 2016. Agricultural Census 2015-2016, Odisha. Government of Odisha, 3–16.
Directorate of Economics and Statistics, Planning and Convergence Department, Government of Odisha, 2016. Compendium of Environment Statistics, Odisha. Government of Odisha, 248–257.
Directorate of Economics and Statistics, Government of Odisha, 2017. Depth and Severity of Poverty in Rural Odisha: A District Level Estimation. Government of Odisha, 1–38.
Directorate of Economics and Statistics, Government of Odisha, 2018. District Statistical Handbooks. Government of Odisha, 1–123.
Erenstein, O., 2011. Livelihood assets as a multidimensional inverse proxy for poverty: A district-level analysis of the Indian Indo-Gangetic Plains. J. Hum. Dev. Capab. 12(2), 283–302.
Etana, D., Snelder, D.J.R.M., van Wesenbeeck, C.F.A., et al., 2021. The impact of adaptation to climate change and variability on the livelihood of smallholder farmers in Central Ethiopia. Sustainability. 13, 6790, doi: 10.3390/su13126790.
Garai, S., Ghosh, M.K., Maiti, S., et al., 2019. Development and application of dairy-based sustainable livelihood security index in the districts of West Bengal, India: A tool for dairy development planning. J. Rural Stud. doi: 10.1016/j.jrurstud.2019.01.017.
Gaurav, S., Mishra, S., 2016. Land ownership and tenancy in Odisha. In: Nayak, P.B., Panda, S.C., Pattanaik, P.K., (eds.). The Economy of Odisha: A Profile. London: Oxford University Press, 1–38.
Gogoi, U., Sahu, S., Mohapatra, P.K., et al., 2019. Ground water-based irrigation in the State of Odisha: the way forward. [2021-09-28]. https://doi.org/10.13140/rg.2.2.12544.69122.
Gregoire, C., 2012. Caribbean sustainable livelihoods: the development of a concept. World J. Sci. Technol. Sustain. Dev. 9(2), 136–146.
Guha, S., Mandla, V.R., Barik, D.K., et al., 2018. Analysis of sustainable livelihood security: A case study of Allapur S Rurban cluster. Journal of Rural Development. 37(2), 365–382.
Hatai, L.D., Sen, C., 2008. An economic analysis of agricultural sustainability in Orissa. Agricultural Economics Research Review. 21, 273–282.
Hotelling, H., 1933. Analysis of a complex of statistical variables into principal components. J. Educ. Psychol. 24(6), 417–441.
Ifejika Speranza, C., Wiesmann, U., Rist, S., 2014. An indicator framework for assessing livelihood resilience in the context of social-ecological dynamics. Global Environmental Change. 28, 109–119.
IIPS (International Institute for Population Sciences), ICF (Inner City Fund), 2017. National Family Health Survey (NFHS-4), India, 2015-16: Odisha. Mumbai: IIPS, 1–6.
Indian National Statistical Office, 2019. Periodic Labour Force Survey (PLFS)—Annual Report 2017-18. [2021-09-12]. https://cse.azimpremjiuniversity.edu.in/wp-content/uploads/2019/02/Annual-Report-PLFS-2017-18_31052019.pdf.
Iwasaki, S., 2016. Linking disaster management to livelihood security against tropical cyclones: A case study on Odisha state in India. Int. J. Disaster Risk Reduct. 19, 57–63.
Jollife, I.T., Cadima, J., 2016. Principal component analysis: a review and recent developments. Philos. Trans. R. Soc. A-Math. Phys. Eng. Sci. 374(2065), 20150202, doi: 10.1098/rsta.2015.0202.
Kates, R.W., Parris, T.M., Leiserowitz, A.A., 2005. What is sustainable development? Goals, indicators, values, and practice. Environment Science and Policy for Sustainable Development. 47(3), 8–21.
Khan, W., Ansari, S.A., Ali, T., 2022. Economic reforms and agriculture in India: A state-wise analysis of post-reforms period. J. Public Aff. 22(1), e2390, doi: 10.1002/pa.2390.
Krishna, V.R., Paramesh, V., Arunachalam, V., et al., 2020. Assessment of sustainability and priorities for development of Indian west coast region: an application of sustainable livelihood security indicators. Sustainability. 12(20), 8716, doi: 10.3390/su12208716.
Kumar, A., Begum Irfan, Z., 2018. Assessment of the sustainable livelihood security of the ecologically vulnerable Indian State-Uttarakhand. Asian Journal of Geological Research. 1(3), 1–8.
Kumar, S., Raizada, A., Biswas, H., 2014. Prioritising development planning in the Indian semi-arid Deccan using sustainable livelihood security index approach. Int. J. Sustain. Dev. World Ecol. 21(4), 332–345.
Kundu, A., Dutta, D., Patel, N.R., et al., 2021. Evaluation of socio-economic drought risk over Bundelkhand Region of India using analytic hierarchy process (AHP) and geo-spatial techniques. J. Indian Soc. Remote Sens. 49(6), 1365–1377.
Libório, M.P., da Silva Martinuci, O., Machado, A.M.C., et al., 2020. Principal component analysis applied to multidimensional social indicators longitudinal studies: limitations and possibilities. GeoJournal. 87, 1453–1468.
Mabhaudhi, T., Nhamo, L., Mpandeli, S., et al., 2019. The water-energy-food nexus as a tool to transform rural livelihoods and well-being in Southern Africa. Int. J. Environ. Res. Public Health. 16(16), 2970, doi: 10.3390/ijerph16162970.
Manjula, M., Gopi, G., 2017. Universal access to clean cooking energy and the need for an inclusive policy: Evidence from analysis of cooking fuel use in Odisha and Tamil Nadu. Decision. 44(3), 193–207.
Meher, S.K., 2019. Impact of distress seasonal migration from a socio-economic perspective: a case study of Nuapada District in Kalahandi Balangir Koraput Region of Odisha. Indian Journal of Labour Economics. 62(4), 763–782.
Minsitry of Finance, Government of India, 2013. Report of the Committee for evolving a composite development index of states. Raghuram Rajan Panel. New Delhi, India.
Ministry of Petroleum and Natural Gas, Government of India, 2016. Pradhan Mantri Ujwala Yojana. [2021-10-11]. https://www.india.gov.in/spotlight/pradhan-mantri-ujjwala-yojana#tab=tab-1.
Mishra, D., Sahu, N.C., Sahoo, D., 2016. Impact of climate change on agricultural production of Odisha (India): a Ricardian analysis. Reg. Envir. Chang. 16, 575–584.
Mishra, M., Santos, C.A.G., do Nascimento, T.V.M., et al., 2022. Mining impacts on forest cover change in a tropical forest using remote sensing and spatial information from 2001–2019: A case study of Odisha (India). J. Environ. Manage. 302(part B), 114067, doi: 10.1016/j.jenvman.2021.114067.
Mishra, P., Tripathy, B., Mohapatra, A.K., et al., 2010. Dynamics of Wastelands in Orissa State-An Approach Through Satellite Remote Sensing. [2021-09-23]. http://cesorissa.org/PDF/Newsletter22.pdf.
Mohapatra, B., Suar, D., 2008. Technological capital and sustainable livelihood: Does technological capital of watershed influence sustainable livelihood? International Journal of Rural Management. 4(1–2), 213–236.
Murniati, K., Mutolib, A., 2020. The impact of climate change on the household food security of upland rice farmers in Sidomulyo, Lampung Province, Indonesia. Biodiversitas. 21(8), 3487–3493.
Mutahara, M., Haque, A., Shah Alam Khan, M., et al., 2016. Development of a sustainable livelihood security model for storm-

surge hazard in the coastal areas of Bangladesh. Stoch. Environ. Res. Risk Assess. 30, 1301–1315.
NABARD (National Bank for Agriculture and Rural Development), 2022. State Focus Paper 2022-2023. Odisha Regional Office, 30–55.
Nath, P.K., Behera, B., 2011. A critical review of impact of and adaptation to climate change in developed and developing economies. Environ. Dev. Sustain. 13, 141–162.
Nayak, C., 2016. Gender perspective of rural livelihood and household income: case study of a village in Odisha. Journal of Indian Economy. 3(2), 95–114.
NITI (National Institution for Transforming India) Aayog, 2018. Transformation of Aspirational District. [2021-10-02]. https://www.niti.gov.in/sites/default/files/2018-12/AspirationalDistrictsBaselineRankingMarch2018.pdf.
NITI Aayog, 2021. India National Multidimensional Poverty Index Baseline Report Based on NFHS (National Family Health Survey)-4 (2015–16). [2021-10-08]. https://www.niti.gov.in/sites/default/files/2021-11/National_MPI_India-11242021_0.pdf.
Office of the Registrar General and Census Commissioner, 2011. Census of India 2011. New Delhi: Ministry of Home Affairs, Government of India.
OPEPA (Odisha Primary Education Programme Authority), 2018. School and Mass Education. Government of Odisha, 22–46.
Panda, S.C., 2015. Economic growth, inequality, and poverty in Odisha. In: Panda, R., Meher, R., (eds.). Trend, Magnitude and Dimensions of Inequality in Post-Reform India. New Delhi: Concept Publishing, 13–31.
Pandey, R., Jha, S.K., Alatalo, J.M., et al., 2017. Sustainable livelihood framework-based indicators for assessing climate change vulnerability and adaptation for Himalayan communities. Ecol. Indic. 79, 338–346.
Parida, J.K., 2016. MGNREGS, distress migration and livelihood conditions: a study in Odisha. Journal of Social and Economic Development. 18, 17–39.
Parris, T.M., Kates, R.W., 2003. Characterizing and measuring sustainable development. Annu. Rev. of Environ. Resour. 28, 559–586.
Patidar, H., 2019. Livelihood security in rural India: reflections from some selected indicators. Forum Dev. Stud. 46, 147–185.
Pearson, K., 1901. Principal components analysis. The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science. 6(2), 559–572.
Planning and Convergence Department, Government of Odisha, 2020. Odisha Economic Survey 2019–2020. Cuttack: Odisha Government Press, 1–30.
Planning and Convergence Department, Government of Odisha, 2021. Odisha Economic Survey 2020–2021. Cuttack: Odisha Government Press, 1–25.
PMINDIA (Prime Minister of India), 2014. Swachh Bharat Abhiyan. [2021-09-21]. https://www.pmindia.gov.in/en/major_initiatives/swachh-bharat-abhiyan.
Pothal, S.P., Panda, B.K., 2018. Dietary intake and nutritional status of tribals in Odisha. Asian Journal of Multidimensional Research 7(9), 120–133.
Rajesh, S., Jain, S., Sharma, P., 2018. Inherent vulnerability assessment of rural households based on socio-economic indicators using categorical principal component analysis: A case study of Kimsar region, Uttarakhand. Ecol. Indic. 85, 93–104.
Sahoo, P., Paltasingh, K.R., 2019. Examining growth-inequality nexus in post-reform Odisha: a sectoral decomposition analysis. Journal of Development Policy and Practice. 4(1), 12–34.
Sahoo, P., Senapati, A.K., 2020. Growth and regional disparities in Odisha: an analysis in the post-reform period. Arthritis: Journal of Economic Theory and Practice. doi: 10.1177/0976747920961934.
Sahoo, R., Swain, M., 2013. Contribution of common property resources for sustainable rural livelihoods in Odisha: Prospects and constraints. Journal of Rural Development. 32(3), 245–261.
Sahu, J.P., Panda, S., 2018. Political regime persistence and economic growth in Odisha: an empirical assessment of the Naveen Patnaik Rule. Econ. Bull. 38(1), 610–622.
Sajjad, H., Nasreen, I., Ansari, S.A., 2014. Assessing spatiotemporal variation in agricultural sustainability using sustainable livelihood security index: Empirical illustration from Vaishali district of Bihar, India. Agroecol. Sustain. Food Syst. 38(1), 46–68.
Sajjad, H., Nasreen, I., 2016. Assessing farm-level agricultural sustainability using site-specific indicators and sustainable livelihood security index: Evidence from Vaishali District, India. Community Dev. 47, 602–619.
Saleth, R.M., Swaminathan, M.S., 1993. Sustainable livelihood security at the household level: Concept and evaluation methodology. In: Proceedings of an Interdisciplinary Dialogue on Ecotechnology and Rural Employment. Chennai: Centre for Research on Sustainable Agricultural and Rural Development, 105–122.
Satpati, S., Kumar Sharma, K., 2021. Livelihood options and livelihood security among tribal in South Western Plateau and Highland Region in West Bengal. Journal of Land and Rural Study. 9(1), 119–139.
Scoones, I., 1998. Sustainable rural livelihoods: A framework for analysis. In: IDS Working Paper 72. Brighton: Institute of Development Studies, 1–22.
Singh, P.K., Hiremath, B.N., 2010. Sustainable livelihood security index in a developing country: A tool for development planning. Ecol. Indic. 10(2), 442–451.
Singh, S., Nayak, S., 2020. Development of sustainable livelihood security index for different agro-climatic zones of Uttar Pradesh, India. Journal of Rural Development. 39(1), 110–129.
Swain, M., Sinha, P., Pattanayak, S., et al., 2020. Characteristics of observed rainfall over Odisha: An extreme vulnerable zone in the east coast of India. Theor. Appl. Climatol. 139, 517–531.
Swaminathan, M.S., 1991. Strengthening the linkage between ecological security and livelihood security in rural areas. Asia-Pacific Journal of Rural Development. 1(2), 1–15.
Tripathi, M.N., 2015. Swachh Odisha: a case on attempting to inculcate healthy sanitation practices in rural Odisha. South Asian Journal of Business and Management Cases. 12(2), 109–127.
Tripathi, R., Moharana, K.C., Nayak, A.D., et al., 2019. Ecosystem services in different agro-climatic zones in eastern India: impact of land use and land cover change. Environ. Monit. Assess. 191, 98, doi: 10.1007/s10661-019-7224-7.
UNDP (United Nations Development Programme), 1990. Human Development Report 1990. United Nations Development Programme. New York, USA, 208–214.
You, H.Y., Zhang, X.L., 2017. Sustainable livelihoods and rural sustainability in China: Ecologically secure, economically efficient or socially equitable? Resour. Conserv. Recycl. 120, 1–13.