Journal of Communicable Diseases
Volume 55, Issue 2 - 2023, Pg. No. 1-8
Peer Reviewed & Open Access Journal

Research Article

Assessment of Human Health Vulnerability in Kalahandi-Balangir-Koraput Region of Odisha, India

Martand Mani Mishra[1], Netrananda Sahu[2], Balaram Pani[3], Ankita Chakraborty[2], Gayatri Mallick[4]

[1]Department of Geography, Dyal Singh College, University of Delhi, Delhi, India.
[2]Department of Geography, Delhi School of Economics, University of Delhi, Delhi, India.
[3]Department of Chemistry, Bhaskarcharya College of Applied Science, University of Delhi, Delhi, India.
[4]Department of Economics, Mewar University, Rajasthan, India.
DOI: https://doi.org/10.24321/0019.5138.202318

I N F O

Corresponding Author:
Netrananda Sahu, Department of Geography, Delhi School of Economics, University of Delhi, Delhi, India.
E-mail Id:
babunsahu@gmail.com
Orcid Id:
https://orcid.org/0000-0001-8505-7185
How to cite this article:
Mishra MM, Sahu N, Pani B, Chakraborty A, Mallick G. Assessment of Human Health Vulnerability in Kalahandi-Balangir-Koraput Region of Odisha, India. J Commun Dis. 2023;55(2):1-8.

Date of Submission: 2023-05-14
Date of Acceptance: 2023-06-20

A B S T R A C T

Background: The impact of climate change on human health in rural and tribal communities has drawn the attention of scientists. One of the most crucial climatic factors in determining the morbidity and mortality linked to vector-borne diseases is rainfall. Socioeconomically, poor communities are anticipated to experience its effects and harshness with greater acuity.

Objective: The main objective of the study is to compare the health vulnerability index (HVI) values for three districts, namely Kalahandi, Balangir, and Koraput, in order to identify which district is most susceptible on the basis of different indicators.

Method: The HVI for each block was calculated using a modified version of the livelihood vulnerability index. Rainfall and malaria were used as indicators for the exposure segment in the HVI calculation. To analyse the vulnerability of each district, in the sensitivity and adaptive capacity, five and eight indicators have been taken respectively.

Result: Based on the data on malaria, the Balangir district experienced extremely low growth, which is quite encouraging for the area. Koraput and Kalahandi have experienced significant negative growth in malaria cases. Overall, the HVI value on the basis of analysis indicates that Koraput district is highly vulnerable and Balangir is the least vulnerable among these three districts.

Conclusion: The Kalahandi, Balangir and Koraput (KBK) districts of Odisha have seen weather variations and disease outbreaks for many years. This research will be of high use in understanding the health vulnerabilities of the districts.

Keywords: Malaria, Rainfall, Health, Exposure, Sensitivity, Vulnerability

Introduction

The interaction of three primary climate factors, namely rainfall, temperature, and humidity, has been shown to have a significant impact on human health in a given geographic region. Human health is a delicate matter, and climatic fluctuations can result in health disasters.[1,2] Its consequences will be borne disproportionately by the most vulnerable communities, especially indigenous people.[3-5] In a variety of ways, the climate is one of the most important elements in determining the occurrence of diseases. Climatic variability and change have resulted in the emergence of a slew of new diseases and have exacerbated the burden of existing ones.

Many authors have labelled Kalahandi, Balangir and Koraput (KBK) as one of the most socioeconomically deprived districts, using it as a synonym for poverty, famine, and death.[6,7] The population of the KBK districts of Odisha is at a higher risk because of the impact of both natural and socio-demographic variables. Due to the disruption of the biological system, the geographical distribution of vector-borne diseases has increased. When it comes to vector-borne diseases, tribals are the most vulnerable. The tribal part of the country is home to over 30% of the country's vector-borne diseases. In the South-Eastern Indian state of Odisha, where it has a seasonal trend, malaria is a serious reason for concern, particularly in the southern region of the ten districts (Koraput, Nowarangpur, Ganjam, Kalahandi, Kandhamal, Malkangiri, Gajapati, Rayagada, Nuapada, and Balangir).[8]

Odisha is India's most vulnerable state to vector-borne diseases,[9,10] and the KBK region is one of the most affected districts in the state. "Tribals" are people who live in a natural setting, far from modernisation, and who have retained their traditional knowledge and beliefs. Even after several decades of independence, the government of this country still finds it difficult to provide basic health facilities to this segment of the population. Poverty, illiteracy, and economic backwardness are all present in this disadvantaged region of Odisha. In terms of health indices, the tribal people are one of the most vulnerable and neglected segments of society.[11] When it comes to tribal lifestyle, culture, customs, and beliefs, the Indian state of Odisha holds a distinct place. Keeping this in mind, the purpose of this research is to provide an in-depth analysis of the climatic variability, the trend of vector-borne diseases, and the vulnerability of the population.

Materials and Methods

Study Area and Population

The districts of KBK are among the most impoverished in Odisha. The Kalahandi district is situated between latitudes 19°8′ and 20°25′ N and longitudes 82°32′ and 83°47′ E. The Balangir district is located between latitudes 20°9′ and 21°4′ N and 82°41′ and 83°32′ E longitudinal extension, and the Koraput district is situated between latitudes 18°13′ and 19°10′ N and longitudes 82°5′ and 83°23′ E. Traditional tribal culture in this region (including languages), knowledge, and livelihood are all intertwined with local ecosystems. This region in Odisha is rich with natural resources such as green cover and minerals, as well as low-cost labour resources. Despite its magnificent past and abundant natural resources, this region is now known for its backwardness, health problems, poverty, and other social and economic prejudices. The KBK region has an average annual rainfall of 1100 to 1400 mm and is situated in India's sub-humid temperate zone. About 90% of the annual rainfall falls during the monsoon season (June to October), with the rest of the year being essentially dry. Two of the wettest months of the year are July and August. These districts are situated in the seventh agro-climatic zone and experience periods of dry, hot, and subhumid weather. 45 °C and 12 °C, respectively, are the mean maximum and minimum temperatures throughout the summer and winter seasons. The availability of doctors and health personnel is not equally distributed and varies widely. Five major diseases have been identified by the state government in KBK and have been termed the *panchvyadhi*. These diseases include malaria, diarrhoea, leprosy, acute respiratory infections, and scabies. Malaria is most prominent in the districts[12,13] with it being endemic in mostly the tribal-dominated regions of KBK. It is the most prominent public health issue prevailing in the KBK regions.

Data Source

The study's major goal was to compare the health vulnerability index (HVI) values for the three districts i.e., KBK and find the district that is most vulnerable to climatic factors, particularly rainfall and vector-borne disease (malaria), in terms of human health. Based on the suggestion of the Intergovernmental Panel on Climate Change (IPCC), we have classified many indicators into three major categories: exposure, sensitivity, and adaptive capacity.[14] The study's dataset was compiled from secondary sources. Official publications from the central and state governments, as well as data from the district health department, are among the most important sources.

Exposure Data: Daily rainfall data for each district were gathered from a database maintained by the Odisha Rainfall Monitoring System (ORMS), the Government of Odisha, from 2005 to 2020. Malaria data were gathered from the Government of Odisha's district statistical handbooks for KBK.

Sensitivity Data: Census of India (2011), District Rural Development Agency, KBK, Deputy Director, District Planning and Monitoring Unit, Office of the Rural Water Supply and

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202318

Sanitation, KBK, Odisha, and District Social Welfare Officer, State Government of Odisha provided data on vulnerable population and infrastructure indicators.

Adaptive Capacity: Data on healthcare capacity were provided by the Rural Health Mission of KBK, Odisha, Chief Medical Officer, KBK, Inspector of Homeopathy, KBK, and Inspector of Ayurveda, KBK, State Government of Odisha.

Methodology

Steps to Calculate the Health Vulnerability Index (HVI) of KBK Districts

Step 1: Indicators

Values for all the indicators are to be standardised for all the districts.

The steps can be broadly summarised as:

$$(\mathrm{Ix}) = \frac{\mathrm{Ib} - \mathrm{I\,(min)}}{\mathrm{I\,(max)} - \mathrm{I(min\,)}}$$

Where,

Ix: Standardised value for the indicator,

Ib: Value for the Indicator I for a particular district, b,

I (min): Minimum value for the indicator across all the districts, and

I (max): Maximum value for the indicator across all the districts.

Step 2: Profiles

Indicator index values are combined to get the values for the profiles.

$$(P) = \sum_{i=1}^{n} \frac{Indicator\ Index}{n} i$$

Where,

n: Number of indicators in the profile, and

Indicator Index **i:** Index of the ith indicator.

Step 3: Vulnerability Index

The three contributing factors are combined to calculate the HVI as shown below:

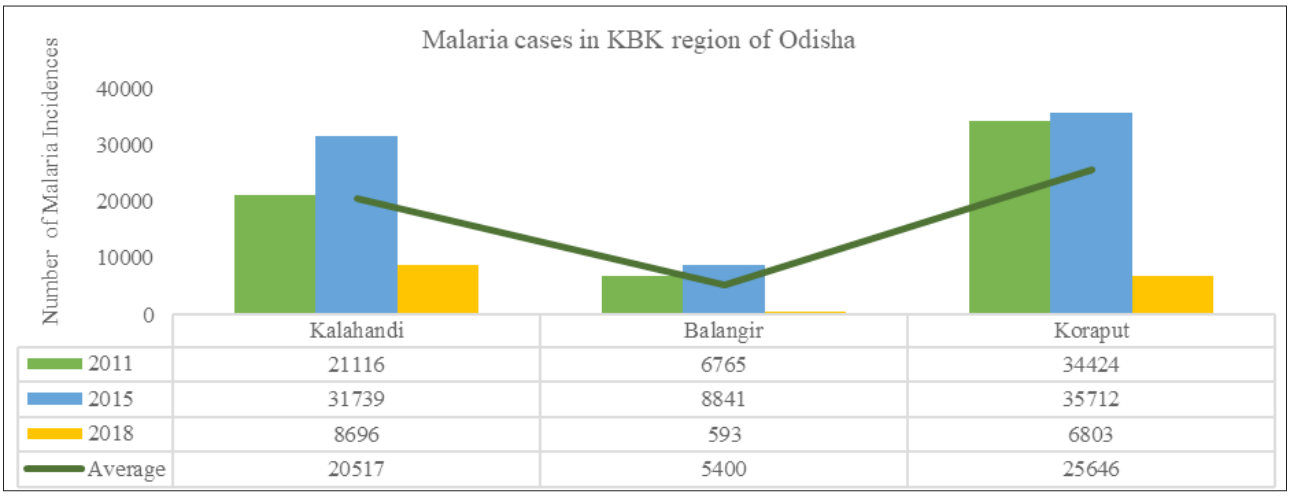
Vulnerability Index = (Exposure - Adaptive Capacity) x Sensitivity

Result and Discussion

Understanding the Situation of Malaria in the KBK Region

Odisha, in India's eastern region, is the worst-affected state, accounting for 45% of the country's total malaria cases [7,14] Among the KBK districts, Koraput and Kalahandi in Odisha have been recognised as the state's most susceptible areas in terms of malaria-related morbidity and mortality.[12,15] This sickness has been disastrous on various occasions throughout history, resulting in several deaths. *Plasmodium falciparum* (*P. falciparum*) and *Plasmodium vivax* (*P. vivax*) are the two types of malaria parasites mainly present in KBK districts.[13] In this part of the study, we have taken the total malaria incidences for the KBK districts mainly for three years (2011, 2015, and 2018) during a time span of eight years. Data on malaria have been collected from the district statistical book for the years 2011, 2015, and 2018 available for all three districts.

The goal of the study is to look at the temporal aspects of malaria incidences in KBK districts and see how they changed from 2011 to 2018. Balangir district was the least affected by malaria incidences. A similar pattern has been observed for all three districts between 2011 and 2018. Cases were low in the year 2011 in comparison to 2015. After the year 2015, there was a very sharp decline in cases in the year 2018 for all three districts.



	Kalahandi	Balangir	Koraput
2011	21116	6765	34424
2015	31739	8841	35712
2018	8696	593	6803
Average	20517	5400	25646

Figure 1.Annual Number of Positive Malaria Incidences in the Kalahandi-Balangir-Koraput Districts of Odisha in the Years 2011, 2015, and 2018

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202318

For looking into the trend of annual malaria cases, the following formula was applied:

Percentage growth rate $= \frac{A-\bar{A}}{\bar{A}} \times 100$ (1)

Where,

A: Yearly malaria cases

$\bar{A}$: Yearly average malaria cases (2011 to 2018)

For all three districts, the growth rate has been recorded as positive during the years 2011 and 2015. In the year 2011, the highest percentage growth was seen in the Koraput district and the lowest in Kalahandi. In the year 2015, Balangir recorded the highest growth followed by Kalahandi and Koraput. In the year 2018, a high negative growth was observed in Balangir, followed by Koraput and Kalahandi which is a very positive sign for the region. This section of the research was carried out to discover the malaria trend in KBK over the last eight years. People do not take care of adequate mosquito protection techniques due to the high incidence of illiteracy and poverty, according to various pioneer works on KBK. Mosquitoes are attracted to people who live in huts or kuchcha dwellings, which are common in forested areas.[16] The high incidence of malaria, particularly in the Koraput and Kalahandi districts, is due to the rough topography of the districts, a lack of health infrastructure, poor societal knowledge, and the inaccessibility of the malaria control programme to the majority of the population.

Health Vulnerability Index Assessment for the Population of KBK Region in Changing Climatic and Socio-economic Scenarios

The process of identifying and categorising elements associated with exposure, sensitivity, and adaptive capacity is known as vulnerability assessment. In the assessment approach, it is necessary to study the population's sensitivity and adaptive capacity in order to comprehend the impact of any given component. In the field of health research, vulnerability assessment in relation to climate patterns and diseases is a well-established concept.[17-19] It's a way to quickly determine health vulnerability zones using a complicated set of data on climate, disease, demographics, economy, and health.

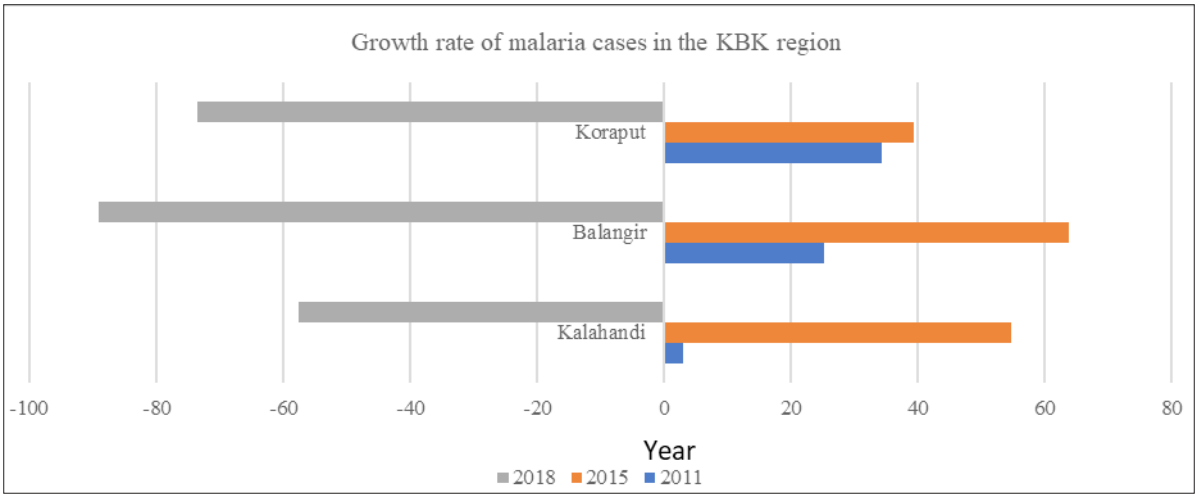


Figure 2.Yearly Percentage Growth of Malaria Cases in the KBK Districts of Odisha

Table 1.Indicators Used for the Calculation of HVIComponent

	Profile	Indicators
Exposure	**Rainfall and disease factor**	Annual average rainfall (2005-2020) Rainfall in monsoonal season (JJAS) (2005-2020) Number of malaria cases (2011, 2015,2018)
Sensitivity	**Vulnerable Population**	% population of SC in the total population % population of ST in the total population % population below poverty line (BPL) distance on road from the state headquarter Literacy rate

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202318

	Healthcare Capacity	Availability community health centres Availability primary health centres Availability of doctors Availability of functional beds in each block Availability of homeopathic dispensaries Availability of doctors (Homeopathic) Availability of dispensaries in (Ayurvedic / Unani) Availability of doctors (Ayurvedic and Unani)

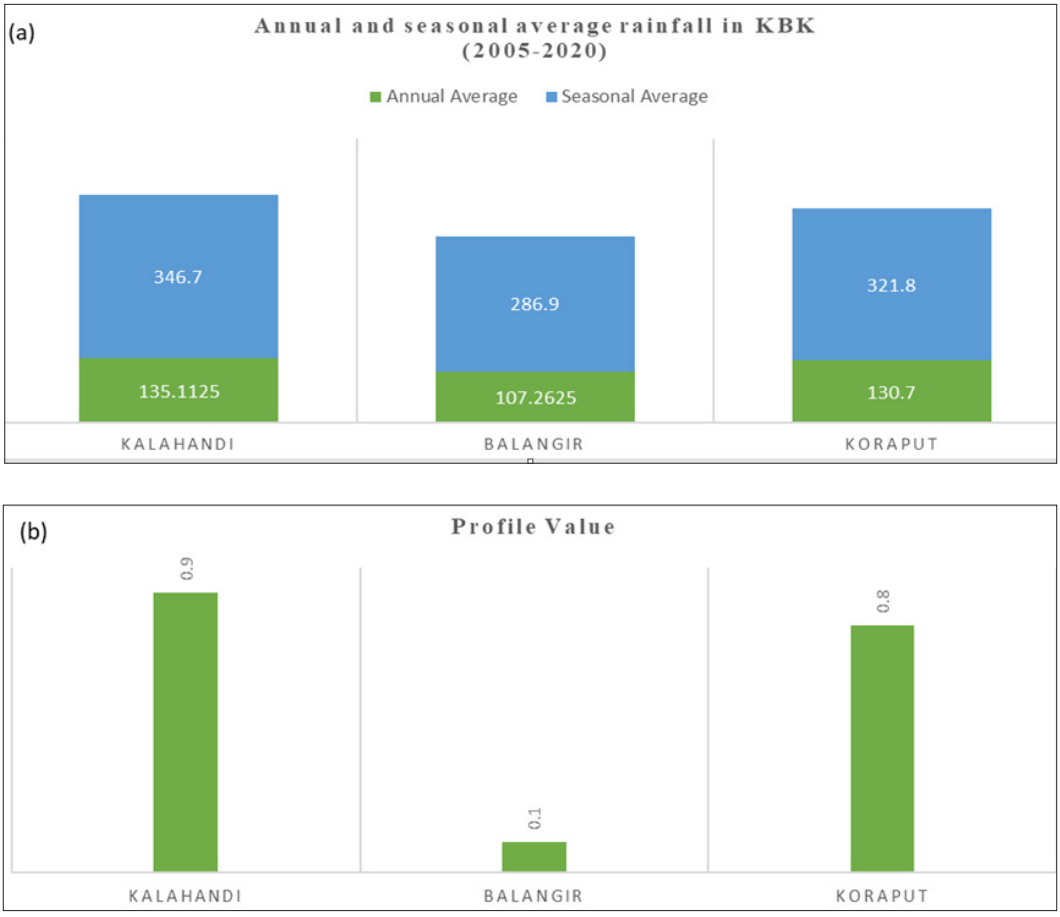


Figure 3(a).Annual and Seasonal Average Rainfall in KBK (2005-2020)
(b).Final Value of Profile for the Exposure Section

Exposure: Rainfall has been regarded as a climatic aspect of exposure because there is relatively little change in temperature between the districts. The Balangir district is the least exposed district, followed by Koraput and Kalahandi, according to the final value for the exposure section. The combination of annual seasonal rainfall and average malaria cases makes the profile value for the exposure section (Figure 3b).

Sensitivity: To determine the level of sensitivity, data from population and infrastructure vulnerability-defining indicators were taken into consideration.

People from the marginalised class (SC and ST) are more vulnerable due to their low literacy, poor economic situation, and living conditions.[20] They have been used as study indicators in this investigation. Poverty has a major role in increasing disease-related mortality, which is why we used the proportion of the population living below the poverty line as an indicator in each district. Koraput has a very high sensitivity profile value because of a high percentage of the population belonging to the marginalised class of society and the BPL category in comparison to Kalahandi and Bolangir.

The sensitivity of the districts is increased by a higher percentage of the population living below the poverty line, having poor sanitation, and a low percentage of communities covered by rural drinking water supply, all of which contribute to their vulnerability.

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202318

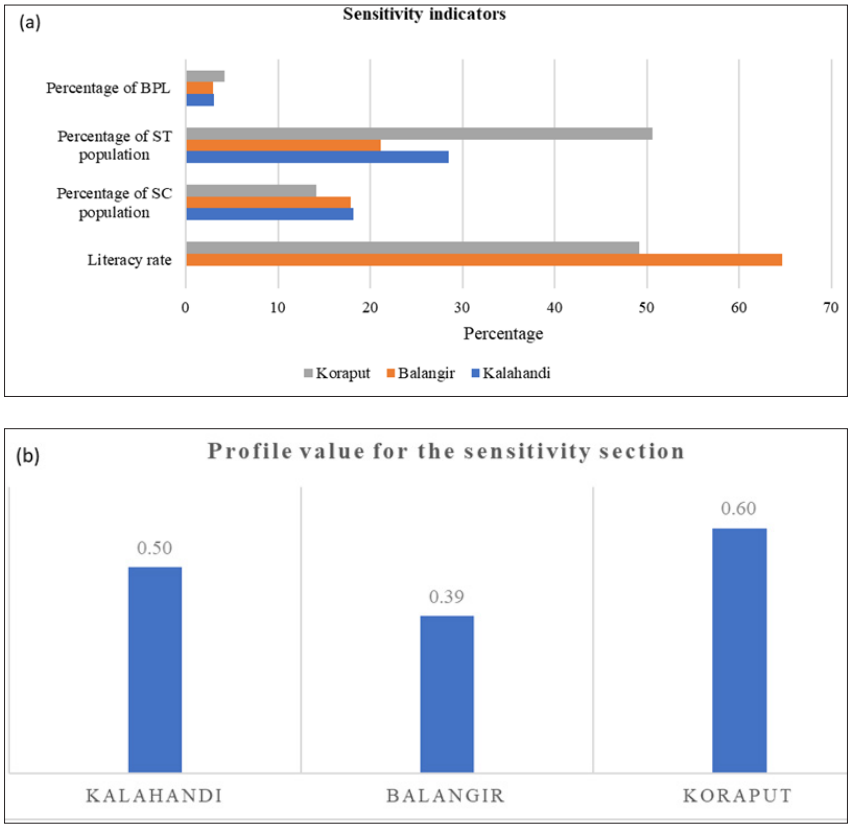


Figure 4(a).Values of Sensitivity Indicators in the KBK Districts
(b).Final Sensitivity Profile Value for the Districts

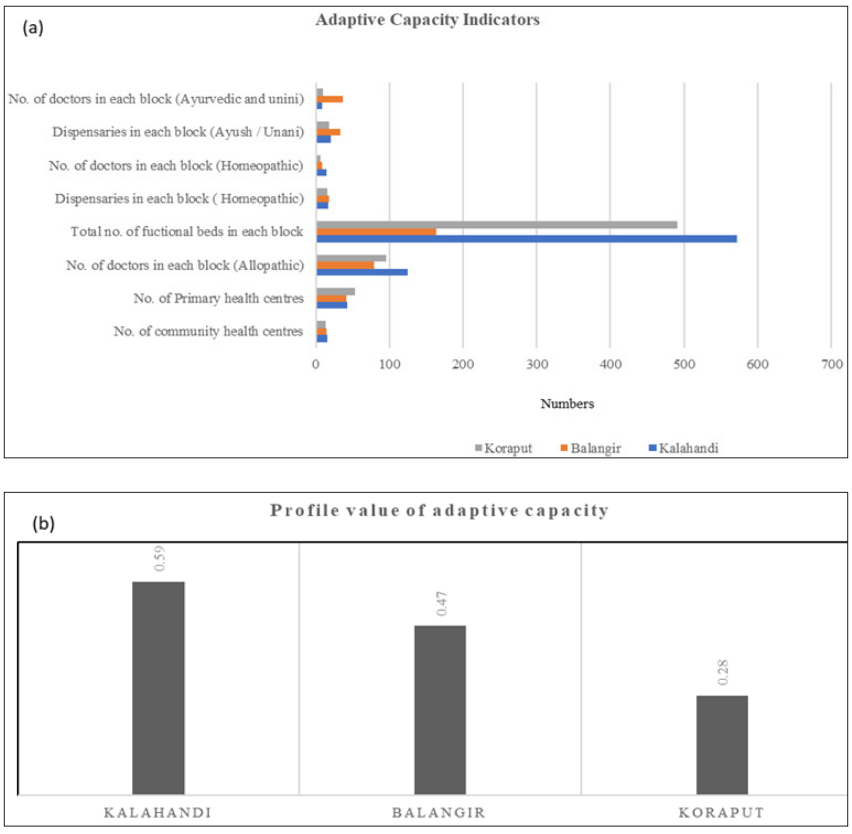


Figure 5(a).Values of Adaptive Capacity Indicators in KBK districts
(b).Final Adaptive Capacity Profile Value for the Districts

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202318

Table 2. Final HVI Value for KBK Districts of Odisha

District	*Exposure*	*Sensitivity*	*Adaptive Capacity*	*Vulnerability Index*
Kalahandi	0.92	0.5	0.6	0.16
Balangir	0.01	0.4	0.5	-0.19
Koraput	0.81	0.6	0.3	0.32

Adaptive Capacity: Adaptive capability is an important factor to consider when assessing a society's vulnerability. It improves the understanding of climate-related concerns and aids in reducing the population's impact.[21]

In the area of healthcare adaptation capabilities, the availability of dispensaries, number of physicians from various medical specialities, and total number of functional beds in hospitals, and other such factors were all taken into account. Due to the presence of superior medical facilities, Kalahandi has a higher capability for adaptation than Bolangir and Koraput.

Exposure and sensitivity play a positive influence in boosting risk factors in the vulnerability index assessment, whereas adaptive capability minimises it. The formula for calculating HVI is (Exposure - Adaptive Capacity) x Sensitivity. The HVI has a range of values between +1 and -1. Low vulnerable districts are those that are close to a negative value and highly vulnerable districts are those that are showing positive value. In the final value, Koraput has been categorised as a highly vulnerable block among the KBK districts followed by Kalahandi. The value of Bolangir is negative which signifies its low vulnerability.

Conclusion

Rainfall and vector-borne infectious diseases have been linked in a number of epidemiological studies conducted globally.[22-24] These diseases spread quite quickly in underdeveloped areas as a result of numerous contributing factors, including demographics, social structure, economic situation, and the effect of rainfall on diseases. A variety of other elements, such as a vulnerable population, inadequate infrastructure, education, and a lack of healthcare capacity, as well as exposure to rains and vector-borne diseases, all contribute to aggravating susceptibility, especially in backward tribal communities.

Several health issues brought on by rain can be avoided with properly thought-out adaptation strategies. This kind of assessment of health vulnerability is essential for policymakers and will be very helpful in pinpointing both, the sensitive areas as well as the people. Like other underdeveloped areas, KBK has raised serious concerns for the government, academicians, and researchers. The study intends to highlight the health vulnerabilities of the district in terms of diseases and weather patterns. Understanding these factors and how they relate to problems in the economy, infrastructure, and demographics will surely help legislators better grasp the district's current situation and come up with and implement effective policies that would lead to a solution.

Acknowledgement

We would like to express our heartfelt gratitude to the Faculty Research Programme (FRP) of the Instituteof Excellence (IoE), University of Delhi for funding the research Project titled "Climatic variability and its impact on the vector-borne diseases in KBK districts of Odisha, India" with the Ref. no./IoE/2021/12/FRP for their generous funding and support towards our minor research project. The financial assistance provided by the university has played a pivotal role in the successful execution of our research endeavour. We are indebted to the university for recognizing the potential of our research and providing the necessary resources to bring my ideas to fruition.It is with immense appreciation that we acknowledge their contribution to the success of our minor research.

Source of Funding:

Faculty Research Programme (FRP) of the Institute of Excellence (IoE), University of Delhi.

Conflicts of Interest: None

References

1. Last JM. Global change: ozone depletion, greenhouse warming, and public health. Annu Rev Public Health. 1993;14(1):115-36. [PubMed] [Google Scholar]
2. Portier CJ, Tart KT, Carter SR, Dilworth CH, Grambsch AE, Gohlke J, Hess J, Howard SN, Luber G, Lutz JT, Maslak T, Prudent N, Radtke M, Rosenthal JP, Rowles T, Sandifer PA, Scheraga J, Schramm PJ, Strickman D, Trtanj JM, Whung PY. A human health perspective on climate change: a report outlining the research needs on the human health effects of climate change. J Curr Iss Glob. 2013;6(4):621. [Google Scholar]
3. Mishra MM, Sahu N, Pandey BW, Singh RB. Assessing human health vulnerabilities in the blocks of Kalahandi district of Odisha, India. Disaster Adv. 2021;14(4):32-40. [Google Scholar]
4. Hotez PJ, Kamath A. Neglected tropical diseases in sub-Saharan Africa: review of their prevalence, distribution, and disease burden. PLoS Negl Trop Dis. 2009;3(8):e412. [PubMed] [Google Scholar]

5. Dash SP. Development and poverty in an Indian state: a study of KBK districts of Orissa. Soc Chang. 2007;37(2):76-98. [Google Scholar]
6. Tripathy SN. Evaluating the role of microfinance in mitigating the problems of distress out-migrants: a study in KBK districts of Orissa. Microfin Rev. 2015;7(2):26-38. [Google Scholar]
7. Pradhan A, Anasuya A, Pradhan MM, Ak K, Kar P, Sahoo KC, Panigrahi P, Dutta A. Trends in malaria in Odisha, India—an analysis of the 2003–2013 time-series data from the National Vector Borne Disease Control Program. PLoS One. 2016 Feb 11;11(2):e0149126. [PubMed] [Google Scholar]
8. Karmakar M, Pradhan MM. Climate change and public health: a study of vector-borne diseases in Odisha, India. Nat Hazards. 2020 Jun;102(2):659-71. [Google Scholar]
9. Pradhan MM, Meherda PK. Malaria elimination drive in Odisha: hope for halting the transmission. J Vector Borne Dis. 2019;56(1):53. [PubMed] [Google Scholar]
10. Mishra MM, Sahu N. Climate and disease vulnerability analysis in blocks of Kalahandi District of Odisha, India. Indian J Public Health. 2022;66(1):20-6. [PubMed] [Google Scholar]
11. Panda BB, Mohanty I, Rath A, Pradhan N, Hazra RK. Perennial malaria transmission and its association with rainfall at Kalahandi district of Odisha, Eastern India: a retrospective analysis. Trop Biomed. 2019 Sep 1;36(3):610-9. [PubMed] [Google Scholar]
12. Mishra MM, Sahu N, Mallick G, Pani B. Trend of malaria incidences and its association with rainfall in Kalahandi District of Odisha, India. Indian J Public Health. 2023;67(1):166-9. [PubMed] [Google Scholar]
13. Hahn MB, Riederer AM, Foster SO. The livelihood vulnerability index: a pragmatic approach to assessing risks from climate variability and change—a case study in Mozambique. Glob Environ Chang. 2009 Feb 1;19(1):74-88. [Google Scholar]
14. Kumar A, Chaturvedi HK, Mohanty AK, Sharma SK, Malhotra MS, Pandey A. Surveillance based estimation of burden of malaria in India, 2015–2016. Malar J. 2020 Dec;19(1):156. [PubMed] [Google Scholar]
15. Mishra MM, Sahu N, Mallick G, Pani B. Knowledge, perception, and behaviour concerning impact of climate variability on health: a cross-sectional study in the tribal-dominated Kalahandi District of Odisha, India. J Commun Dis. 2022;54(2):39-48. [Google Scholar]
16. Bao J, Li X, Yu C. The construction and validation of the heat vulnerability index, a review. Int J Environ Res Public Health. 2015 Jul;12(7):7220-34. [PubMed] [Google Scholar]
17. Moore M, Gelfeld B, Okunogbe A, Paul C. Identifying future disease hot spots: infectious disease vulnerability index. Rand Health Q. 2017;6(3):5. [PubMed] [Google Scholar]
18. Sahu N, Mishra MM. Assessing the vulnerability index of COVID-19 pandemic in India. Geogr Environ Sustain. 2021 Dec 29;14(4):131-9. [Google Scholar]
19. Mishra MM, Sahu N. Assessing waterborne disease vulnerabilities in the blocks of Kalahandi District of Odisha, India. Indian J Community Med. 2022;47(2):229-34. [PubMed] [Google Scholar]
20. Smit B, Wandel J. Adaptation, adaptive capacity and vulnerability. Glob Environ Chang. 2006 Aug 1;16(3):282-92. [Google Scholar]
21. Tabachnick WJ. Challenges in predicting climate and environmental effects on vector-borne disease episystems in a changing world. J Exp Biol. 2010;213(6):946-54. [PubMed] [Google Scholar]
22. Hunter PR. Climate change and waterborne and vector-borne disease. J Appl Microbiol. 2003;94:37-46. [PubMed] [Google Scholar]
23. Martens WJ, Jetten TH, Rotmans J, Niessen LW. Climate change and vector-borne diseases: a global modelling perspective. Glob Environ Chang. 1995 Jun 1;5(3):195-209. [Google Scholar]

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202318