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Dr. Nita Mitra
Mr. Mayukh Mazumdar

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Foreword by

Professor (Dr.) Bijan Sarkar

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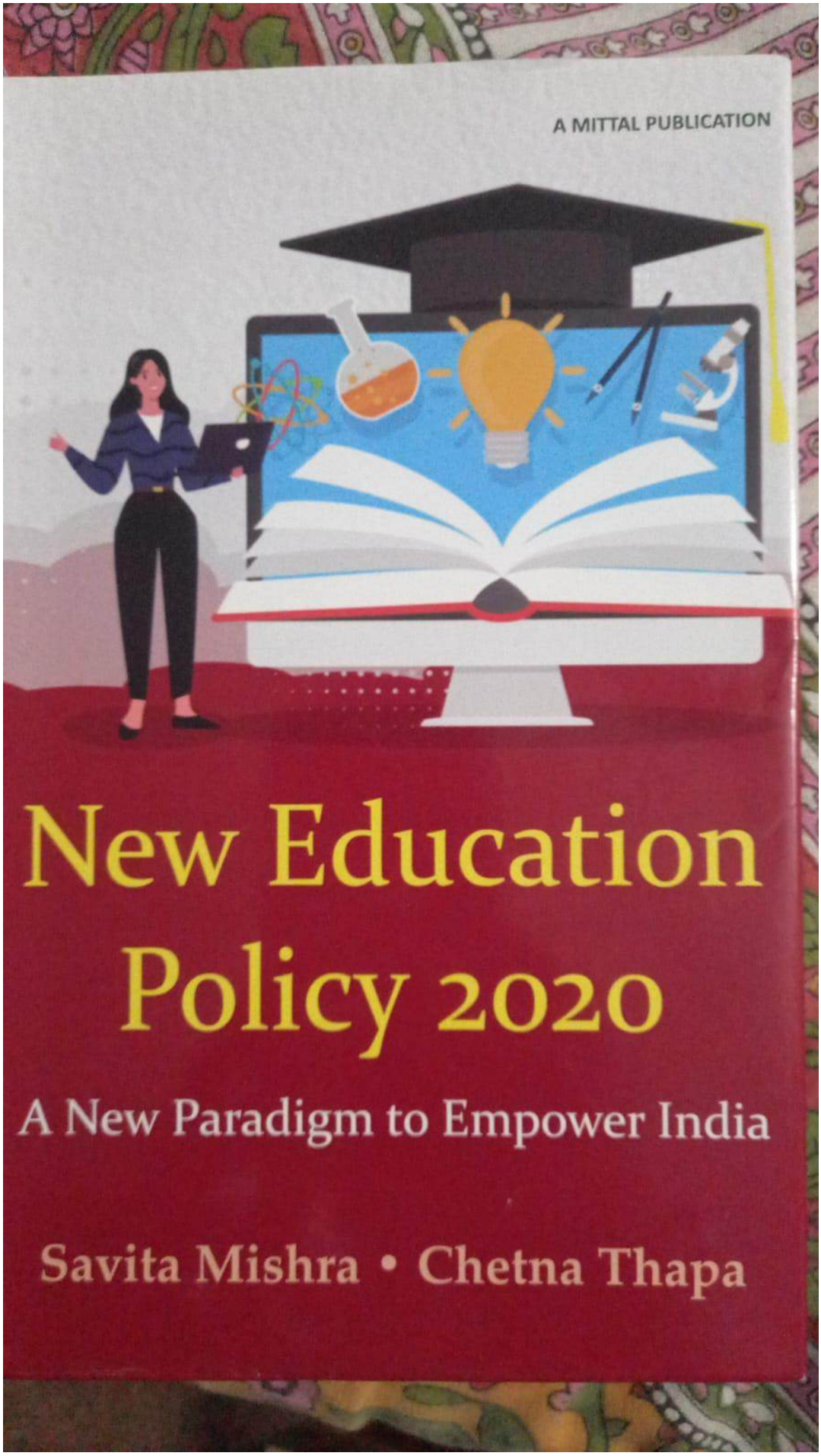
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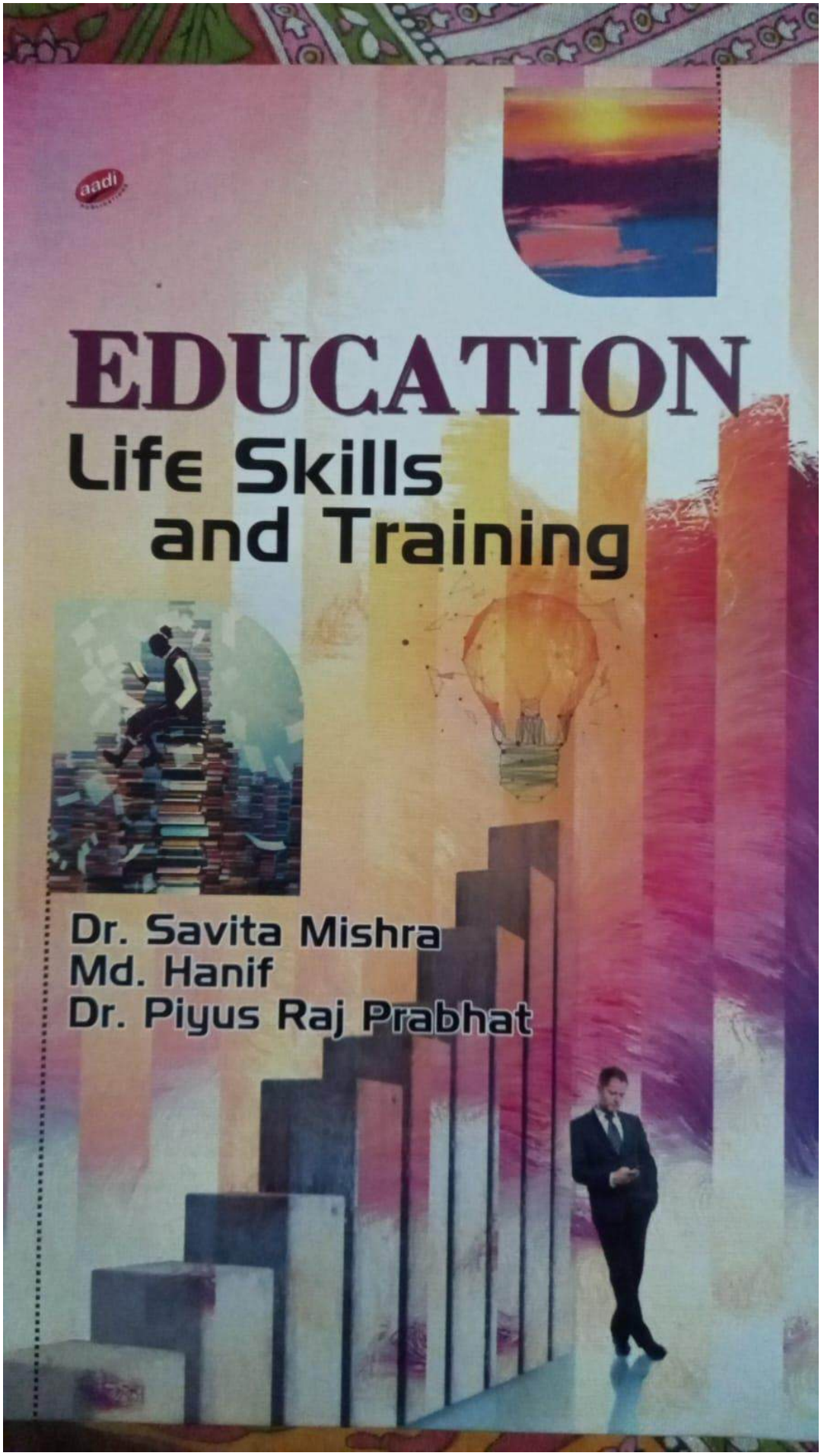
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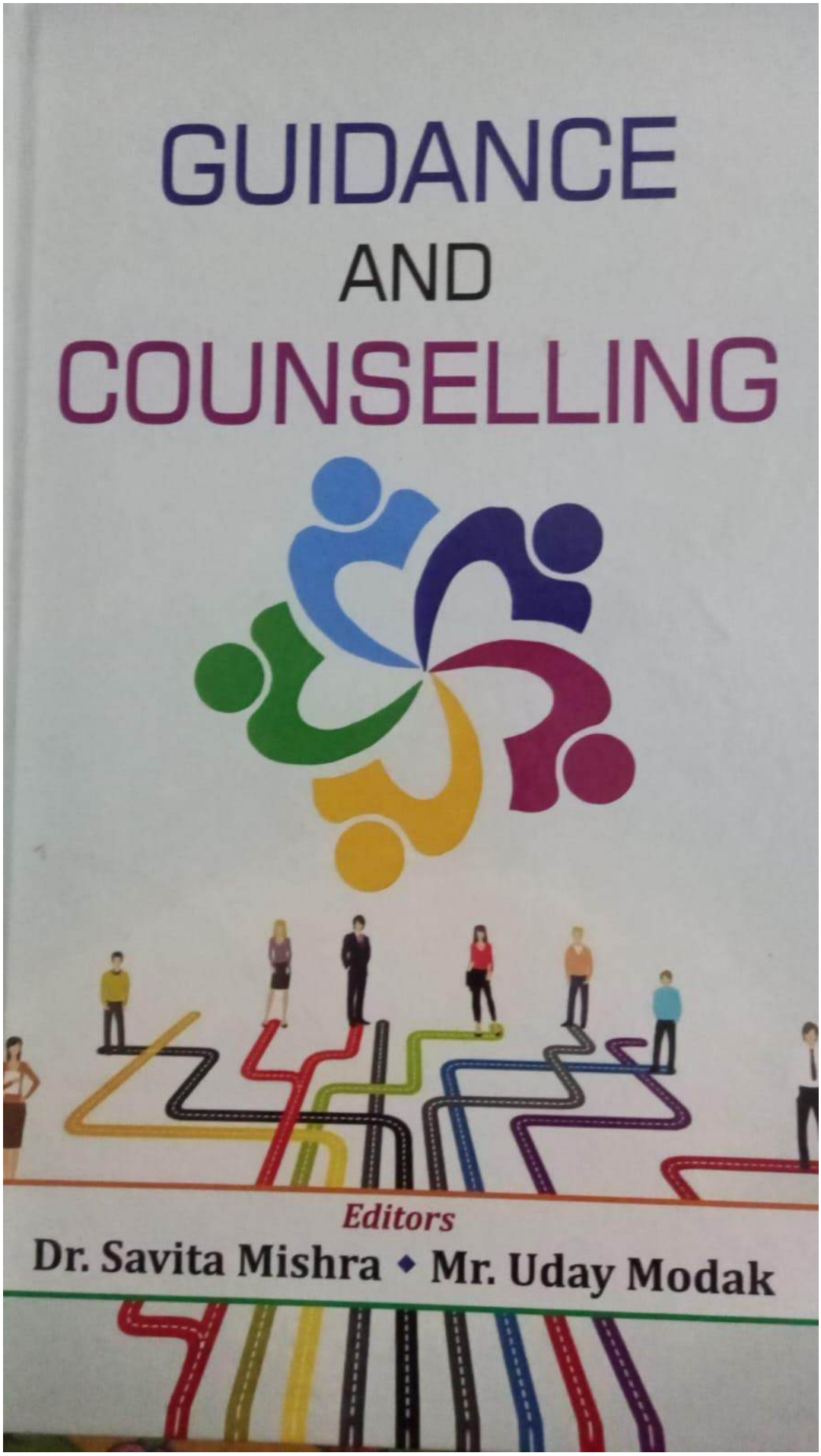
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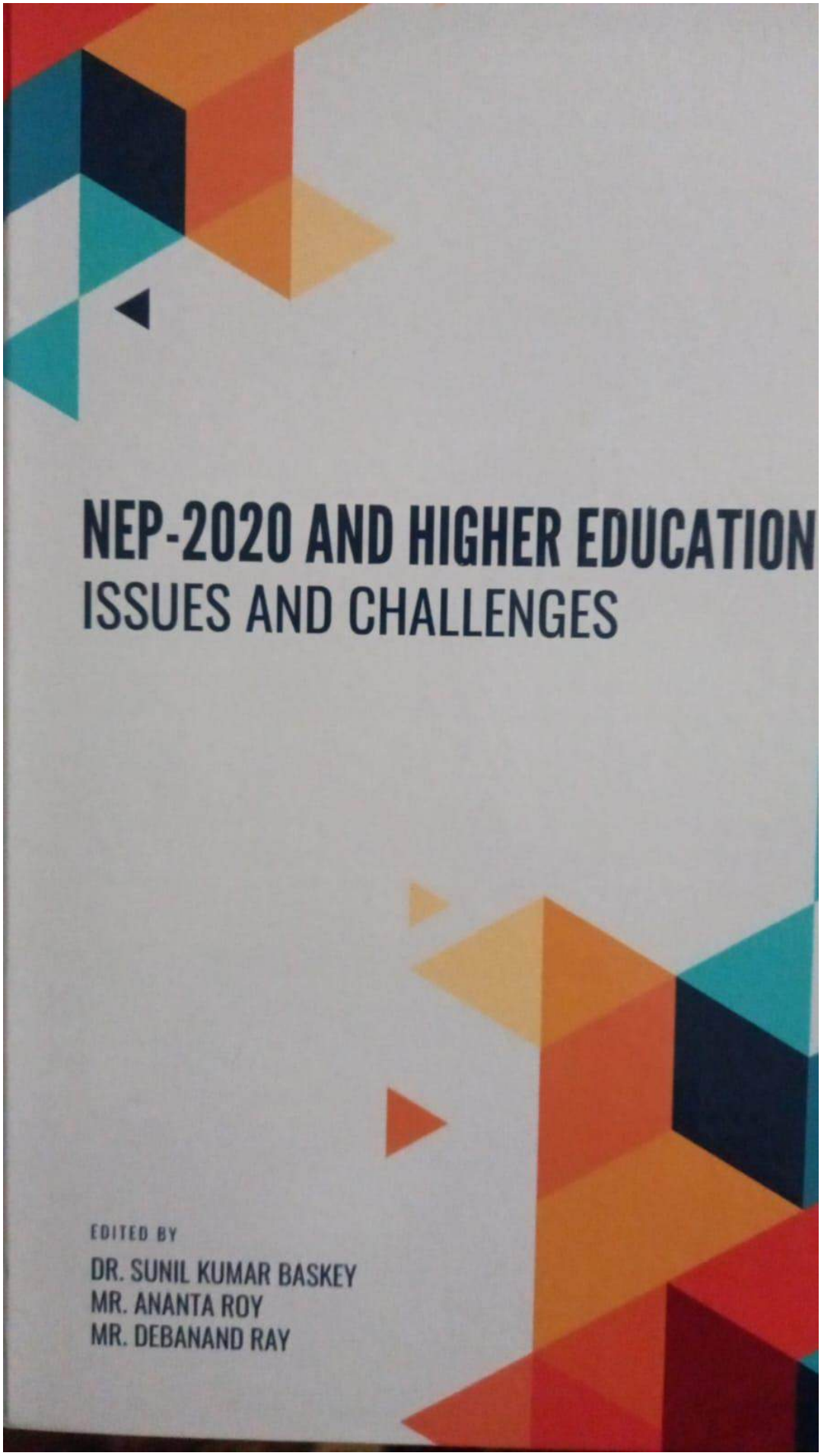
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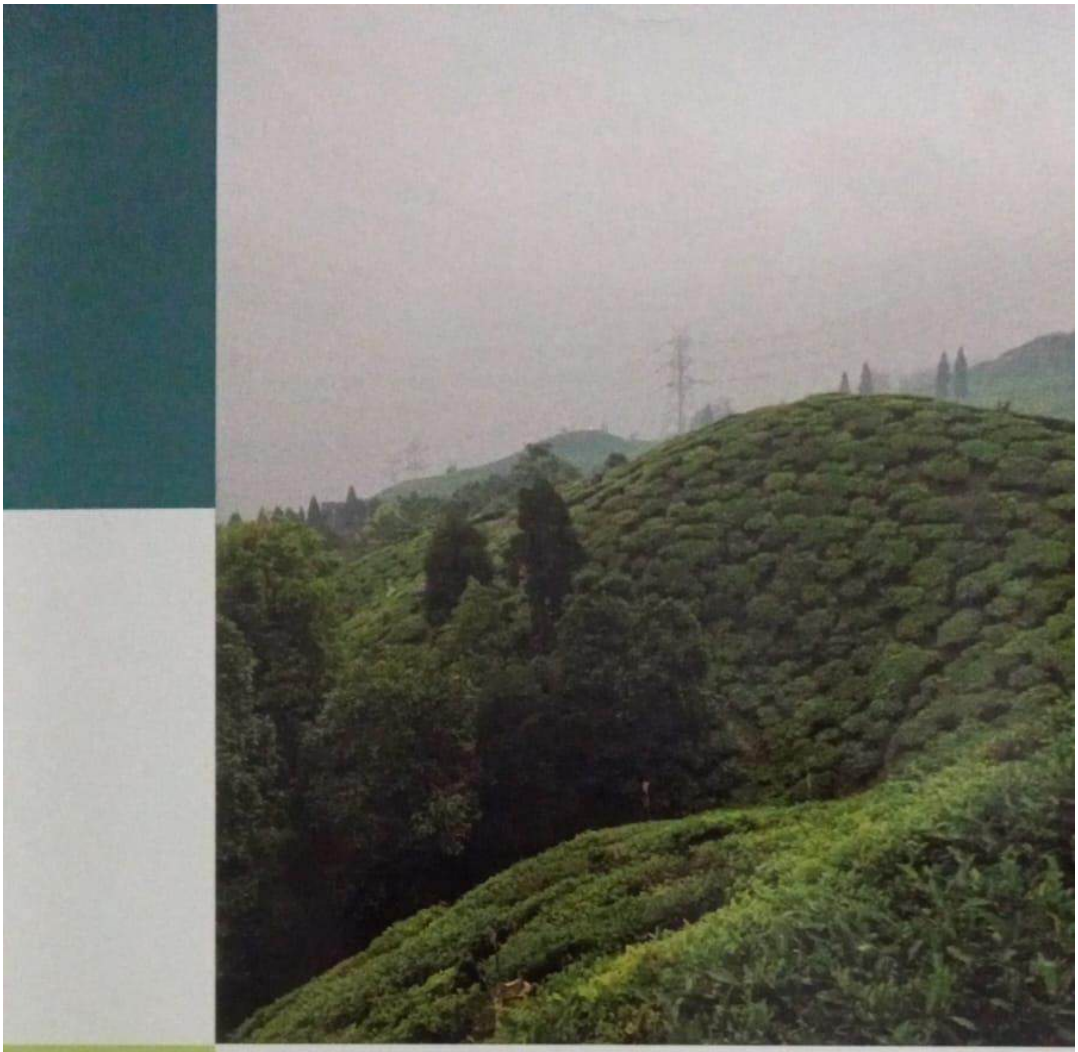

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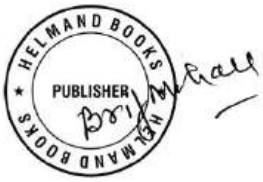

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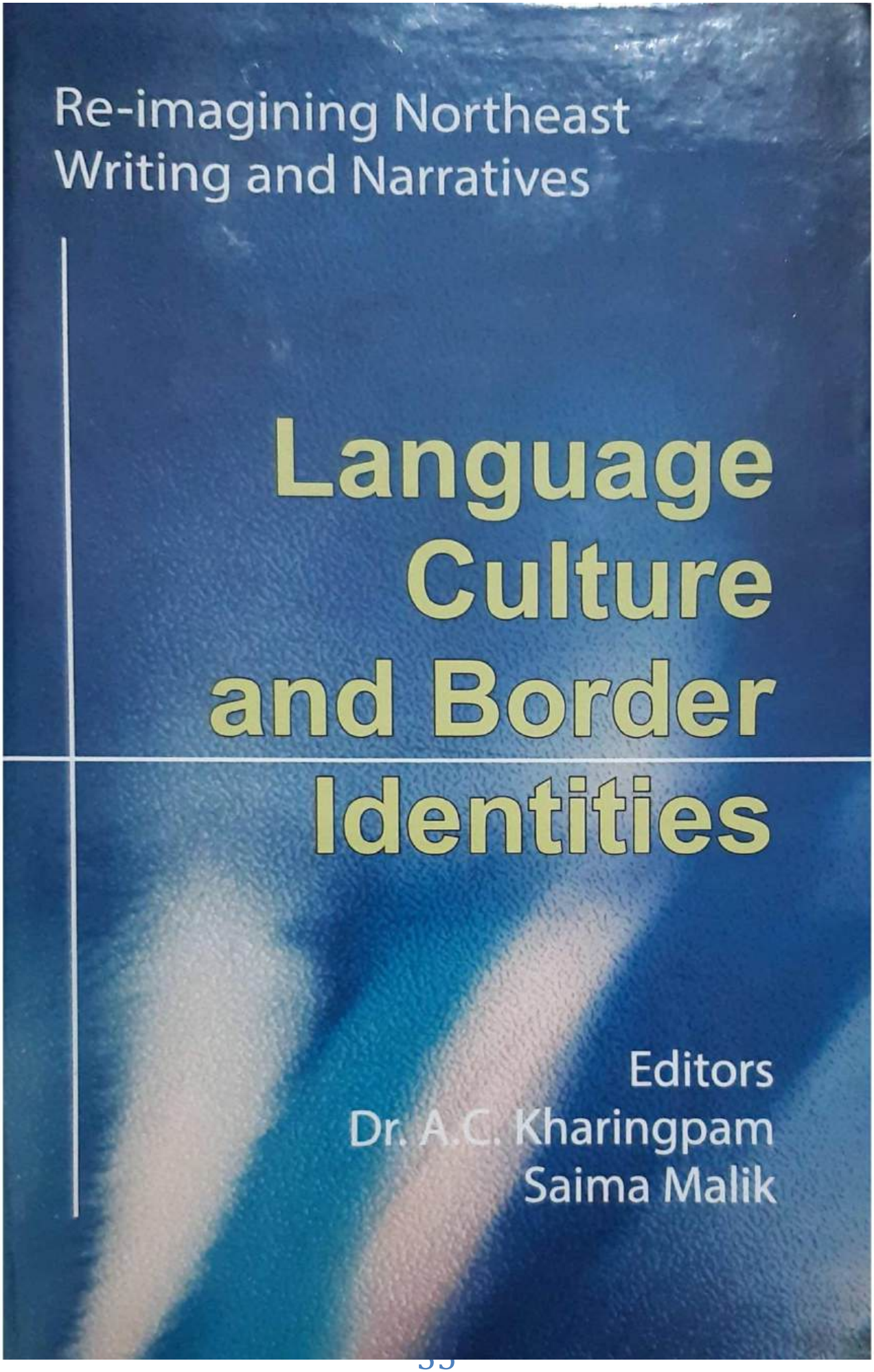
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Language
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and Border
Identities
Editors
Dr. A.C. Kharingpam
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Caste based Exclusions: A Study of Gorkha Dalit Identity and Movement in Darjeeling Hills

Sangam Ghatani

Introduction

The North East of India embraces the seven sister states of Assam, Arunachal Pradesh, Meghalaya, Manipur, Nagaland, Mizoram and Tripura. The inclusion of Sikkim in the North Eastern Council (NEC) in 2002 has officially integrated the state within the socio - economic, political and cultural landscape of the region. In addition, prominent scholars belonging to the region such as Srikant Dutt and A.C Sinha have moved beyond this rigid compartmentalization of the region to include even Darjeeling hills (North Bengal) within the purview of this region. [i]

The ubiquitous presence of diverse ethnic groups in this eastern side of the Himalayas has concocted the region as a hotbed of identity assertions and subsequent mobilizations. A careful study of such mobilizations in the North East becomes increasingly pertinent considering the strategic sensitiveness of the region. Hence, a stable north-east is of vital importance for the Indian nation – state. Among multiple aspirations that harbors the region among various ethnic and caste groups includes the aspirations of Nepali speaking community referred as 'Indian Nepalis' or 'Gorkha' which is in itself a multiethnic, multilingual, multicultural group assimilated into a pan Indian Nepali/Gorkha identity. Though the term 'Gorkha' has been a widely contested nomenclature to categorize the Indian Nepali speaking population and has not been unanimously accepted. Yet, on

"Re-Imagining Northeast Writings and Narratives: Language, Culture, and Border Identity" presents a collaborative effort to critically examine the concept of Northeast India, focusing on its linguistic, geographical, cultural, and social dimensions. Through a compilation of articles and essays, the volume delves into various aspects such as language, literature, culture, challenges, and the complexities of identity within the region. Each contribution offers detailed insights and findings, enhancing our understanding of Northeast India's diverse cultural landscape and the experiences of its people. By addressing themes of spatiality, movement, and responses to representations of the Northeast, the volume aims to deepen scholarly engagement with the region and stimulate discourse on its unique linguistic, cultural, and border dynamics. It serves as a valuable resource for researchers, scholars, and anyone interested in gaining a nuanced understanding of Northeast India and its intricate interplay of language, culture, and identity.

About the Editors

Dr. Kharingpam Ahum Chahong is Assistant Professor of English at Jamia Millia Islamia, New Delhi. Besides teaching literature to students, Dr. Chahong is committed to not only resuscitating the vanishing tribal culture and art forms but also promoting and conserving the endangered tribal languages and literatures. His non-profit organization, the North-east Foundation for Education and Culture (NEFEC) works with grass root educationists to deliver quality education to the lowest rung of the society in the state of Manipur. His essay on literature in Tangkhul language is prescribed by the Tangkhul Literature Society for BA in Manipur University. Dr. Chahong has designed a paper titled "English Writings from the Northeast", which is part of B.A. (H) English and MA (English) syllabus since 2010 in the Department of English, Jamia Millia Islamia. The papers were undoubtedly a first in any Indian University to be taught as a full-fledged independent paper. Dr. Chahong's area of research interest includes, Folk Studies, Tribal Literature, Bible and Translation. Dr. Chahong writes poems in both English and in his mother tongue, Tangkhul.

Saima Malik is a doctoral candidate in the Department of English at Jamia Millia Islamia, New Delhi working on culture, gender and folklore of Kashmir. She has presented her research in many conferences and seminars across India. Having completed her master's from the University of Kashmir she is currently teaching as a guest faculty at DSEU. She also dedicates her time with learning and training herself in the art of translating Kashmiri folklore into English.

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CONTENTS

10

MODERNIZING THE UNDERGRADUATE PHYSICS LABORATORY IN NORTH BENGAL BY INTEGRATING SMARTPHONES AND COMPUTATIONAL ANALYSIS

Bikramjit Chandra

Abstract

The drawbacks in the current undergraduate physics laboratory curricula as specified by the University Grants Commission are discussed with a focus on the continuing use of outdated, confusing or unapproachable methods of data collection and measurement. This causes a loss of focus in the student, along with a lack of understanding and a general dislike for the physics laboratory. This attitude can cause serious deterioration in the psychomotor skills of the student and prevent efficient knowledge transfer from the classroom to daily life. As a way to combat this issue, an argument is made to incorporate the use of smartphones (and associated computational analysis methods) in the collection of data due to their versatility, familiarity and ease of use for the student. Smartphones have already been extensively used to enhance the laboratory experience of students, however, their incorporation in the North Bengal region has been lacking. Methods for incorporating smartphones into the undergraduate mechanics laboratory are then discussed as an illustrative example.

Keywords: *undergraduate physics laboratory, smartphone, data collection, measurement, knowledge transfer*

Introduction

The general laboratory curriculum for a physics undergraduate degree in India has changed little over the past two decades, despite significant revolutions in technology and its social integration during the interim. What we mean by the previous statement is that both the experimental setup and the methods of measurement are still the same as they were two decades before (or even earlier), with few institutions taking advantage of the accessibility and better feedback available through modern, affordable, and commonplace instruments.

In the following document, the author shall argue about some of the drawbacks of current widely-used laboratory procedures that inhibit student learning and knowledge assimilation, and make arguments as to how the use of familiar instruments such as smartphones can reduce, or outright remove, this inhibition, and also discuss the ease with which such devices can be integrated into already existing laboratory setups with little cost.

To justify our statement, we shall take three hand-picked examples from the preliminary undergraduate courses in the physics curricula suggested by the University Grants Commission under the Choice Based Credit System (University Grants Commission [UGC], 2015). The first are two experiments involving an electrical measuring instrument called a ballistic galvanometer, as specified in the laboratory curriculum for the second-semester course: Electricity and Magnetism (UGC, 2015, p. 15). A galvanometer is an instrument that can detect the flow of electric current. The nature of these experiments is not important for this discussion, but the instrument itself is. The ballistic galvanometer was a widely used instrument until it started to get phased out by digital and other improved analog designs during the 1970s and 80s (Crump, 2001). We are spending time and effort teaching a student the intricacies of setting up and calibrating an instrument that has been outdated for at least 30 years and is rarely used today. Additionally, there are other experiments in the same curriculum that do require the use of a galvanometer (the Carey-Foster bridge, for example), but a ballistic galvanometer is rarely used. Instead, the more portable and simpler D'Arsonval/Weston type galvanometer or a digital multimeter is used instead.

The previous example detailed the continuing use of outdated experiments and measurement techniques in the current physics curricula. The next example details an experiment that is not outdated,

but its general procedure makes use of outdated measuring techniques. The experiment is the measurement of the thermal conductivity of copper using Searle's apparatus, as specified in the laboratory curriculum for the third-semester course: Thermal Physics (UGC, 2015, p. 21). This is an excellent experiment that demonstrates a sound practical application of theory to practice, while also familiarizing the student with many practical aspects and difficulties of conducting experiments in thermodynamics. In brief, this experiment involves taking a long, solid copper rod and exposing one end to hot steam while cooling the other end with continuously running tap water over a long period. Temperatures are taken along various points on the rod and also of the water flowing towards the rod and away from the rod. By measuring these values and the time taken for the measurements, we can determine the thermal conductivity of the copper rod.

The experiment was first published in 1905 (Searle, 1905), and the method of temperature measurement that most institutions follow to this day has not changed since then, with maybe the substitution of a digital stopwatch or an electric heater. Most institutions buy the setup as a complete package from a supplier of experimental apparatus (Supertek, n.d., as an example). While there are different suppliers, almost all of them have a similarly constructed setup where the temperature measurement is done using 100Ë%C mercury thermometers. The great drawback of these thermometers is that they are usually very hard to read accurately, especially for a student with poor eyesight, and are fragile and prone to breaking (Geerts, 2002). Instead, they should be using thermocouple temperature sensors (or IC temperature sensors) that are within a similar price range, are extremely robust, have a faster response time than mercury thermometers, and practically have better accuracy as you can directly transfer their readings to a digital display which eliminates visual uncertainty. This very same laboratory curriculum also has two experiments on thermocouples, which means that students can connect knowledge and abilities from multiple experiments together. In addition, liquid thermometers are not commonly used as temperature sensors these days (for the same reasons as listed before) except for special situations, so we are again training our students to use instruments that are already outdated, instead of familiarizing them with ones that are in more general use.

As a final example, let us take the experiment to determine the acceleration due to gravity using Kater's pendulum (UGC, 2015, p. 13). This experiment already faces three shortcomings: (i) while a historically important measurement technique, it has now been completely superseded by more accurate and less complicated apparatus (Torge, 2001), (ii) the additional mathematical and procedural complications involved in conducting this experiment tend to completely overshadow the basic physics principle it is investigating: the motion of compound pendulums, and (iii) the analysis of compound pendulums is already covered by a previous experiment in the same curriculum (determination of acceleration due to gravity using a bar pendulum), a significantly less complicated setup from both a mathematical, conceptual and procedural perspective.

In Kater's pendulum, the traditional method is for the student to observe the tip of the pendulum and measure the time taken for it to complete 40 to 50 oscillations (or more) using a handheld stopwatch. Usually, the oscillations have to be very, very small (only a few degrees off of normal) and observed using a telescope with an in-built crosswire for the required accuracy.

From the author's own experience, this method of observation is absolute drudgery and does a fantastic job of killing any curiosity in the experiment from even the most motivated student. The repetitiveness of the task is taxing to the student's mind and it is easy for them to lose count partway, forcing them to start from the beginning. Additionally, it is a strain on the eye to be staring through the telescope for the extended period that is required to count the oscillations. Also, the 50 oscillations are meant for **one observation**. The experiment usually requires **six** separate observations for different configurations of the pendulum.

From the three examples stated above, we would like to summarize the following points:

- There are still laboratory components in the curricula that train students on outdated experimental techniques, or require the use of outdated equipment, that gives them no benefit outside the classroom.
- Institutions, educators and suppliers of laboratory instruments have not been as enthusiastic as they should be in incorporating modern techniques of measurement that see actual use in industrial and daily life.

- Knowledge and use of techniques from one experiment are not always transferred to another, even when it is beneficial and makes logical sense to do so.
- There is a disconnect between the types of instruments the students see in their laboratory and the instruments that they encounter outside the classroom. This has the debilitating effect of inducing the students to compartmentalize their laboratory knowledge; there is little motivation for the student to try and transfer their conceptual and psychomotor knowledge to situations outside the laboratory. Students might not even be able to recognize that their laboratory knowledge **can** be transferred for use in their day-to-day life.
- Outdated, unfamiliar and unoptimized measurement techniques can distract the student from the learning objectives of the laboratory and inculcate in them a general malaise and distaste for actively participating in the laboratory.

Most institutions in India are required to follow the laboratory curricula as set by their affiliated university, which in turn usually follows the UGC-suggested curricula. Thus it might not be possible for instructors to avoid the issues highlighted in point one (and perhaps point three). However, there is considerable opportunity to ameliorate the issues highlighted in points two, four and five by taking a few steps to modernize the laboratory and make it more approachable to students.

Kharpade (2019) proposed the following goals as the purpose of physics laboratory education:

(i) development of a better and long-lasting understanding of facts, concepts, principles and laws of physics,

(ii) development of procedural understanding/abilities related to modelling, designing experiments, planning measurements/ observations and analyzing data,

(iii) development of experimental skills for the use, alignment and handling of a wide range of laboratory instruments and tools,

(iv) fostering various cognitive abilities like hypothesizing, predicting, observing, classifying, interpreting and inferring,

(v) development of the ability to solve experimental problems based on methods, processes and techniques commonly used in experimental physics,

(vi) training in the handling of experimental data, making the students aware of the uncertainties involved in various measurements and development of abilities for the treatment of data, error analysis and reporting of experimental activities, (vii) development of higher order abilities, such as careful and keen powers of observation, the ability to make accurate measurements, handle measured data for objective reasoning correctly, draw conclusions and make generalizations

(viii) development of interest, motivation, open-mindedness, creativity, curiosity, scientific thinking/attitude, self-activity and independent working habits

(ix) learning to work in a team and collaborate among peers, and

(x) learning to communicate the observations and results. (p. 2)

The points raised by the author actively interfere in the achievements of goals (i) to (viii) as specified by Kharpade with goals (i), (iii), (vi) and (viii) being more severely affected. The general lack of student interest and ability in experimental physics has led to a significant deterioration of necessary skills. Madhurima and VenkataSaravanan (2015) opined that there was a significant deterioration in the hands-on skills of the students and the subsequent lack of what it means to do scientific experiments. They are not aware of concepts such as repeatability, reproducibility, error, accuracy, sensitivity, resolution and precision. Thus the students expect to be hand-held even when they grow to be research scholars. (p. 81)

While statistics for physics students in India are a little hard to get, it is easier with our sister discipline in engineering. Nayak (2018) had written that "less than 25 per cent of Indian graduate engineers are employable... [and] less than 5 per cent of engineers have the analytical skills necessary", while Loyalka et al. (2021) had done an extensive survey of STEM students from India, China, Russia and the US and discovered that while Indian students do improve academically over their course (better than Russia but below China and US), they do not develop any critical thinking skills.

Argument

One of the key issues interfering with the transfer of knowledge from a classroom/laboratory setting to daily life is the "unfamiliarity" of instruments and laboratory equipment that the student uses. That is since the equipment and apparatus are only encountered during

lab hours and at no other time, the student enters "lab mode" only during this time and does not apply the content knowledge when they encounter similar situations in their daily life. Their ability to identify phenomena outside their classroom that are equivalent to their laboratory experiments is also poor since they are contextually used to associating their experiments with the equipment in the laboratory and not with the physical phenomena they are investigating (Lave, 1988; Murphy et al., 1995)

To bridge this gap in knowledge transfer and reduce the student's reliance on context dependence, an approach we champion is to try and incorporate the use of devices and instruments that the student is familiar with and comfortable with. In this day and age, we have one very obvious candidate for a versatile, familiar and commonly available device: the smartphone. Additionally, students should also be trained in the use of modern methods of measurement and experimental analysis, which generally involves the integration of computers into the experiment. As the UGC physics curricula specify computational programming as a compulsory component of the degree (UGC, 2015, pp. 9,18,25,31,37), most institutions should already have their computer labs (or at least access to one). Thus the addition of smartphones and computers should involve a minimal increase in cost.

The familiarity and ease with which our current generation of students regard the smartphone is a well-documented fact (Hänsler, Schlunk & Schulze, 2014). Unfortunately, it is our instructors who are behind in fully utilizing the opportunities that this device provides us as an educational tool.

The sensors that are commonplace in almost every smartphone can be used as measurement and analysis devices in the laboratory. The use of smartphones in the laboratory is not a new topic and has been an avenue of exploration for more than a decade (Countryman & Paesler, 2016; Kuhn & Vogt, 2022; Monteiro & Marti, 2022; Organtini, 2021); however much of this development and incorporation has happened outside of India. There has been much discussion in India about the use of smartphones as a teaching aid in the post-Covid era, but no comprehensive survey has been done on using it as a laboratory measurement device (Madhurima, V., Ramaswamy, R., Chari, D., Nanal, V., & Saha-Dasgupta, T. (2022); Onyema, E. M., Khan, R., Eucheria, N. C., & Kumar, T. (2023)).

Since the students tend to initially associate laboratory knowledge with the instruments rather than the concepts, using this familiar item in experiments can be beneficial. The student can be made to understand that physics experiments no longer have to be done in a laboratory setting; with the smartphone in their hand, they could replicate the same experiments within the comfort of their home. While the UGC does specify the type of experiment to be performed, it does not specify **how** the experiment should be performed. This gives the instructor considerable leeway in deciding the procedure and methodology for each experiment. However, as we had discussed earlier, the apparatus suppliers are still behind on the modernization of their equipment, so it is necessary for the instructor to take each experiment and determine the best way to incorporate modern methods of measurement.

There are multiple publications on the incorporation of smartphones as measurement devices for different undergraduate experiments (Kuhn & Vogt, 2022; Organtini, 2021). For this chapter, we will limit our focus to the mechanics laboratory curricula as specified by the UGC. This is usually the first physics laboratory encountered by a student and many of the experiments listed in the curricula can be easily replicated at home with appropriate substitutions. This allows curious, motivated students to easily review or transfer their newly acquired knowledge in a more comfortable, private setting if they so desire.

The mechanics laboratory curriculum consists of 12 experiments (UGC, 2015, p. 13). Expt. 1 does not require the use of a smartphone, while the incorporation of a smartphone in Expt. 2 is dependent upon the instructor and their resources. Expt. 3 requires the use of the accelerometer within the smartphone. Expts. 4-6 and 8-12 use the smartphone's video recording feature that will later be used for analysis. For Expt. 7 (coefficient of viscosity using Poiseuille's method), the standard apparatus is usually accurate and exhaustive enough without the smartphone making a significant contribution. However, an alternate method of determining liquid viscosity has been advanced by Yang, Wang and Liu (2019) which uses smartphones and might be useful as an advanced undergraduate project.

Expt. 3 involves measuring the height of a building using a sextant. A traditional sextant is an instrument used by navigators and sailors when their primary navigation devices fail. Again, this is an instrument that was historically popular but sees little use outside the laboratory

today (Ifland, 2000). The instrument itself is bulky, delicate and good quality sextants are expensive. The smartphone alternative does away with the sextant altogether. Instead, Bouquet, Bobroff, Kolli and Organtini (2020) describe a setup where the smartphone is attached to a hollow cardboard tube, which the student uses to sight the top of the building using their eye. The internal accelerometer then measures the change in angle with respect to the horizontal and the resulting data can be used to determine a very accurate height of the building using trigonometry, as detailed in the paper.

The other experiments all involve observing the motion of an object and measuring either the time of motion or a change in distance (or both). Traditionally, this involves a student staring at the object in motion and counting multiple iterations of repetitive motion with a stopwatch in hand, which can be quite time-consuming and boring.

As we earlier detailed with the traditional method of performing Kater's pendulum experiment, the time taken for about 50-100 oscillations have to be measured six times. However, by setting up the smartphone for video recording, it is enough to record just 5 or so oscillations per observation and then analyse them computationally. A very popular, free option for computational video analysis is Tracker® (Brown, D., Christian, W. & Hanson, R.M., 2023). This software can take video clips and allow the user to calibrate distances, mark points on the video to track the motion of objects, and generate both distance and velocity graphs along with fit curves. The software can track changes in motion for every frame of video, which means a minimum of about 24 measurements per second, depending upon the fps of the recording instrument. Thus only a few seconds of video can create a large amount of precise data points (compared to the traditional five to ten data points of non-computational mechanics experiments), heavily improving the accuracy of even simple experiments with little error-correcting precautions.

Video analysis has its challenges as well. Some sort of calibrating object has to be present in the video to determine distances, the camera must be kept steady and at the right distance to cover the range of motion (a tripod could be helpful), fish-eye and other lens and lighting effects need to be accounted for etc. However, from the author's personal experience, a single two-hour tutorial and demonstration class goes a long way in immediately eliminating many of the issues discussed above. As most of the mechanics experiments can be analysed by video motion alone, which has a common camera setup

procedure, students no longer have to spend time focusing on the nitty-gritty of different measuring techniques but can focus on the experiment and the underlying principles instead.

Smartphones and video analysis techniques can also help keep the costs of laboratory equipment down. We have already covered how the sextant (an instrument used for only one experiment) is made redundant using smartphones. Another example is for Expt. 6 (determination of acceleration due to gravity of a freely falling object). This experiment involves the use of a solid object (like a steel ball bearing) falling between two pairs of light sensors at different heights. As the ball passes in between the sensors, an automatic digital timer records the time of fall which can then be analysed to determine the acceleration due to gravity. Since the ball falls very quickly (about 0.4 seconds for a drop of 1 metre), it is impossible to time this experiment by hand. The Digital Timing setup is relatively expensive compared to other mechanics experiments and is thus not conducted by institutions on a constrained budget (ESAW, n.d., as an example).

With the smartphone approach, aside from the smartphone and the computer, the only additional resources needed are a solid object to drop, a cushion to break the fall, and a metre stick or another similar device to help with distance calibration during video analysis. No expensive sensors and timers are necessary.

Once the use of smartphones as measuring instruments has been established among the students, instructors can improve their familiarity and confidence in the use of digital techniques of measurement, which would make it easier to incorporate sensors (such as a thermocouple or IC temperature sensors in the 3rd-semester Thermal Physics laboratory) and even possibly creating their own sensor/measuring setup using their own IC components and micro-controller hardware like Arduino® during their senior years.

Conclusion

In conclusion, the author would like to reiterate their strong support for the incorporation of smartphones and related analysis techniques in the undergraduate physics laboratory for the following reasons:

- It is easier for the students to connect and engage with the experiment due to their familiarity and comfort with smartphones.

- It unlocks the potential of knowledge transfer from the laboratory to outside the classroom.
- Students can be motivated to conduct their experiments and discover new ones once they see smartphones as an accessible, "always there" measuring instrument.
- Smartphones can reduce laboratory budget costs and allow access to experiments that might have been previously inaccessible to an institution.
- Data collection is easier and can lead to more accurate answers. This leads to less frustration among the students and better focus on the experiment and the underlying physics.
- Smartphones can act as a bridge to more intricate techniques of data collection later, such as the use of Arduino® hardware.

References

Bouquet, F., Organtini, G., Kolli, A., & Bobroff, J. (2020). *61 ways to measure the height of a building: An introduction to experimental practices.* arXiv preprint, arXiv:2010.11606.

Brown, D., Christian, W. & Hanson, R.M. (2023). Tracker (Version 6.1.3) [Computer Software]. Retrieved from https://physlets.org/tracker/

Countryman, C., & Paesler, M. A. (2016). *Enhancing students' understanding of scientific equipment: Smartphones in the laboratory.* arXiv preprint, arXiv:1607.03736.

Crump, T. (2001). *A brief history of science: As seen through the development of scientific instruments.* New York, USA: Carroll & Graf Publishers.

The Engineering and Science Apparatus Worskshop (ESAW). (n.d.). *"g" by free-fall apparatus.* Retrieved July 30, 2023, from https://www.esawindia.com/esaw-g-by-free-fall-apparatus-pm-5009-

Geerts, B. (2002). A thermometer comparison. Retrieved July 16, 2023, from http://www-das.uwyo.edu/~geerts/cwx/notes/chap03/thermometer.html

Hänsler, U., Schlunk, S. & Schulze, J. (Eds.). (2014). *iStage2: Smartphones in science teaching.* Berlin, Germany: Science on Stage.

Ifland, P. (2000). The history of the sextant. Retrieved July 29, 2023, from https://www.mat.uc.pt/~helios/Mestre/Novemb00/H61iflan.htm

Khaparde, R. (2019, August). What are the objectives and goals of physics laboratory courses? A survey of college teachers. *Journal of Physics: Conference Series, 1286(1),* 12037.

Kuhn, J. & Vogt, P. (Eds.). (2022). *Smartphones as mobile minilabs in physics.*

Cham, Switzerland: Springer.

Lave, J. (1988). *Cognition in practice: Mind, mathematics and culture in everyday life*. Cambridge, England: Cambridge University Press.

Loyalka, P., Liu, O. L., Li, G., Kardanova, E., Chirikov, I., Hu, S., ... & Li, Y. (2021). Skill levels and gains in university STEM education in China, India, Russia and the United States. *Nature: Human Behaviour, 5*(7), 892-904. https://doi.org/10.1038/s41562-021-01062-3

Madhurima, V., Ramaswamy, R., Chari, D., Nanal, V., & Saha-Dasgupta, T. (2022). *Response to the COVID-19 pandemic: Physics teaching in India*. arXiv preprint arXiv:2211.13482.

Madhurima, V. & VenkataSaravanan, K. (2015, October). Research based pedagogical protocols for laboratory courses. Paper presented at the 2nd National Conference on Student Driven Research on Inspired Learning, New Delhi, India. Retrieved from https://www.ijsrd.com/articles/NCILP019.pdf

Monteiro, M., & Marti, A. C. (2022). *Mobile devices and sensors for physics teaching*. arXiv preprint, arXiv:2206.12062.

Murphy, P., Issroff, K., Scanlon, E., Hodgson, B. & Whitelegg, E. (1995). Group work in primary science. In Andersen, A.M., Schnack, K. & Sorensen, H. (Eds.) *Science-Natur/ Teknik, Assessment and Learning*. Copenhagen, Denmark: Royal Danish School of Educational Studies

Nayak, A. (2018, March 1). An antidote to rote learning. *Forbes India*. Retrieved from https://www.forbesindia.com/

Onyema, E. M., Khan, R., Eucheria, N. C., & Kumar, T. (2023). Impact of mobile technology and use of big data in physics education during coronavirus lockdown. *Big Data Mining and Analytics, 6(3)*, 381-389.

Organtini, G. (2021). *Physics experiments with Arduino and smartphones*. Cham, Switzerland: Springer.

Searle, G. C. (1905). IX. A method of determining the thermal conductivity of copper. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, 9(49)*, 125-129.

Supertek. (n.d.). *Searle's apparatus for thermal conductivity of copper*. Retrieved July 30, 2023, from https://www.shivsons.com/product/searles-apparatus-for-thermal-coductivity-of-copper/

Torge, W. (2001). *Geodesy* (3rd ed.). Berlin, Germany: Walter de Gruyter.

University Grants Commission. (2015). *Proposed syllabus and scheme of examination for B.Sc. (Honours) Physics*. Retrieved from https://www.ugc.gov.in/pdfnews/7756304_B.SC.HONOURS-PHYSICS.pdf

Yang, Y., Wang, H., & Liu, J. (2011). Mobile phone enabled pervasive measurement of liquid viscosity. *Applied Rheology, 21(6)*, 63890.

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Climate change insecurity of Mountain Ecosystem in the Eastern Himalayas

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CONTENT

Abstract

Title: Climate change insecurity of Mountain ecosystem in the Eastern Himalayas

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In terms of Social Sciences, connectivity is one of the most important things that comes to our mind. It is connectivity that has linked us to one another, depend on each other for different purposes and connectivity is also a facilitative means to achieve political security, economic and socio-cultural stability. It's a means by which we humans fulfill our objectives, and also achieve sustainability.

But what would happen if these means of connectivity falls under security threats?

The regions of Eastern Himalayas, comprising the areas of Nepal, Eastern and Northeast India, Bhutan, The Tibet (Autonomous region), Yunnan region of China and the Northern Myanmar face nontraditional security threats such as climate change, terrorism etc, when it comes to the issues in connectivity.

The leaders of these places have been constantly trying out innovative techniques in order to solve the major issues. The Government of India is also quite keen to boost its Northeast regions through the act East policy that aims to connect Southeast Asia and beyond.

Climate change is one of many possible threats on biodiversity. Climate change may manifest itself as a shift in mean conditions or as changes in the variance and frequency of extremes of climatic variables. These changes can impact on biodiversity either directly or indirectly through many different impact mechanisms. Range and abundance shifts, changes in phenology, physiology, and behavour, and evolutionary change are the most often cited species-level responses. At the ecosystem level, changes in structure, function, patterns of disturbance, and the increased dominance of invasive species are noted concerns.

Ecosystems in the Eastern Himalayas are being impaired and destroyed by a wide variety of human activities. The survival of the ecosystems and wildlife in the EH is being threatened by human activities like timber harvesting, intensive grazing by livestock, and agricultural expansion into forestland.

The region of eastern Himalayas has been prone to an acute change in the climatic environment and as a result this has affected the people living there and its biodiversity. Many respondents of the region associate these climate changes with floods, landslides etc. The lack of systematic research, monitoring and documentation highlights the lack of evidence to determine the impact of climate change on human wellbeing to certainty.

Majority of available research focuses on the adverse impacts of climate change and overlooks both the adaptation mechanisms adopted by local people and new opportunities faced. Thus, this study presented here is concerned with establishing a correlation between biodiversity, ecosystem functioning and ecosystem services for human wellbeing and is motivated by concern about climate change and its effects on the supply of a range of ecosystem services.

In the Eastern Himalayan region, past changes in climate have been recorded and future projections are available; these can provide a starting point for assessing the types of climate

stressors that will impact on various biodiversity management endpoints, in both the terrestrial and in the freshwater systems.

Thus, with this study of mine, a consensus regarding the Nontraditional security threats that prevails in the Eastern Himalayan region will be reached, that has been affecting its connectivity amongst the entire Eastern Himalayan region.

Keywords: Impact; Wetland; Threats; Responses; Adaptation.

INTRODUCTION

Mountains are among the most fragile environments on Earth. They are also rich repositories of biodiversity and water and providers of ecosystem goods and services on which downstream communities (both regional and global) rely. Mountains are home to some of the world's most threatened and endemic species, as well as to some of the poorest people, who are dependent on the biological resources. Realising the importance of mountains as ecosystems of crucial significance, the Convention on Biological Diversity specifically developed a Programme of Work on Mountain Biodiversity in 2004 aimed at reducing the loss of mountain biological diversity at global, regional, and national levels by 2010. Despite these activities, mountains are still facing enormous pressure from various drivers of global change, including climate change. Under the influence of climate change, mountains are likely to experience wide ranging effects on the environment, natural resources including biodiversity, and socioeconomic conditions.

The Hindu Kush-Himalayas, with the highest mountains in the world, situated in developing and least developed countries with few resources for meeting the challenges of developing the detailed scientific knowledge needed to assess the current situation and likely impacts of climate change finds it incredibly hard to cope the effect of climate change .

Recent scientific opinion led by the Intergovernmental Panel on Climate Change (IPCC) is that global climate change is happening and will present practical challenges to local ecosystems. The study highlights the region's vulnerability to climate change as a result of its ecological fragility and economic marginality.

The threats to biodiversity arising from climate change are very acute in the Eastern Himalayan region as the region is rich in threatened and endemic species with restricted distributions. Fragmentation and loss of habitat directly impinge on the survival of species, especially those that are endemic to the region. Species in high altitude areas – especially in the transition zone between sub-alpine and alpine – are more vulnerable to climate change. In addition, the region's wetlands are being affected by the erratic weather observed in many parts of the region.

Climate change, ecosystem services and human wellbeing :

Atmospheric warming affects other aspects of the climate system: pressure and composition of the atmosphere; temperature of surface air, land, water, and ice; water content of air, clouds, snow, and ice; wind and ocean currents; ocean temperature, density, and salinity; and physical processes such as precipitation and evaporation. Climate affects humans directly through the weather, experienced (physically and psychologically) day to day and the impacts of weather on daily living conditions, and indirectly through its impacts on economic, social, and natural environments.

Climate change, including variability and extremes, continues to impact on mountain ecosystems, sometimes beneficially, but frequently with adverse effects on the structure and

functioning of ecosystems. Fortunately, the functioning of many ecosystems can be restored if appropriate action is taken in time.

Humans rely on ecosystems, because they depend on ecosystem services. Ecosystems offer provisioning services (e.g., food, freshwater, fuelwood, biochemicals), regulating services (e.g., climate and disease regulation, pollination), cultural services (e.g., spiritual, recreational, aesthetic value, inspirational), and supporting services (e.g., soil formation, nutrient cycling, primary production). They influence our security, basic materials for a good life, health, social relations, and, ultimately, our freedoms and choices – in short, our wellbeing.

Clearly, the human economy depends upon the services performed 'for free' by ecosystems. Natural ecosystems also perform fundamental life-support services without which human civilisations would cease to thrive. Many of the human activities that modify or destroy natural ecosystems may cause the deterioration of ecological services the value of which, in the long term, dwarfs the short-term economic benefits to society. We are bound to the human perspective, even if we recognise the intrinsic value of ecosystems and biodiversity. Social systems and natural systems are inseparable because ecosystem services weave people into ecosystems.

With the advent of a globalised world, the mutual relationship between humans and mountains is now threatened by a growing population and its increasing demands on ecosystem services, which are beyond tolerance thresholds. Traditional resilience is being rapidly eroded leading to dependence on external inputs and the overexploitation of selective resources, threatening their sustainability. Rapid changes to fragile ecosystems driven by both natural and anthropogenic determinants pose unprecedented threats, not only to the livelihoods of the local people, wildlife, and culture, but also to the billions living downstream, and ultimately to the global environment. Besides demographic and socioeconomic changes, the political economics of marginalisation imposes an additional layer of vulnerability. The inherent environmental fragility of mountain ecosystems and the socioeconomic vulnerability of mountain people have brought the issues of mountain ecosystems to the top of the global sustainability agenda.

The Eastern Himalayas :

The Eastern Himalayas covers an area of 524,190 sq.km, stretching from eastern Nepal to Yunnan in China, between 82.70°E and 100.31°E longitude and 21.95°N and 29.45°N latitude.

The Eastern Himalayan region (EH), with its mountains, valleys, and flood plains, is physiographically diverse and ecologically rich in natural and crop-related biodiversity. It is also significant from geopolitical, environmental, cultural, and ethnic perspectives, and in terms of its ecosystems and the tectonic orogeny of the encompassing Himalayan mountain system. The lowlands are characterised by braided rivers emerging from deeply dissected foothills and converging into slow meandering rivers further downstream. The ecological diversity of the EH is, in part, a function of the large variation in topography, soil, and climate within the region. The human population is also unevenly distributed: the highest population densities are found in the Nepal Terai, West Bengal, and the Assam Duars, and in dispersed pockets. in the Brahmaputra basin, Meghalaya, Tripura, and Manipur. During the past 30

years, the human population of the region has increased at approximately 2.1% annually with higher rates in and around urban centres, and low or sometimes negative growth rates in many of the rural and isolated areas .

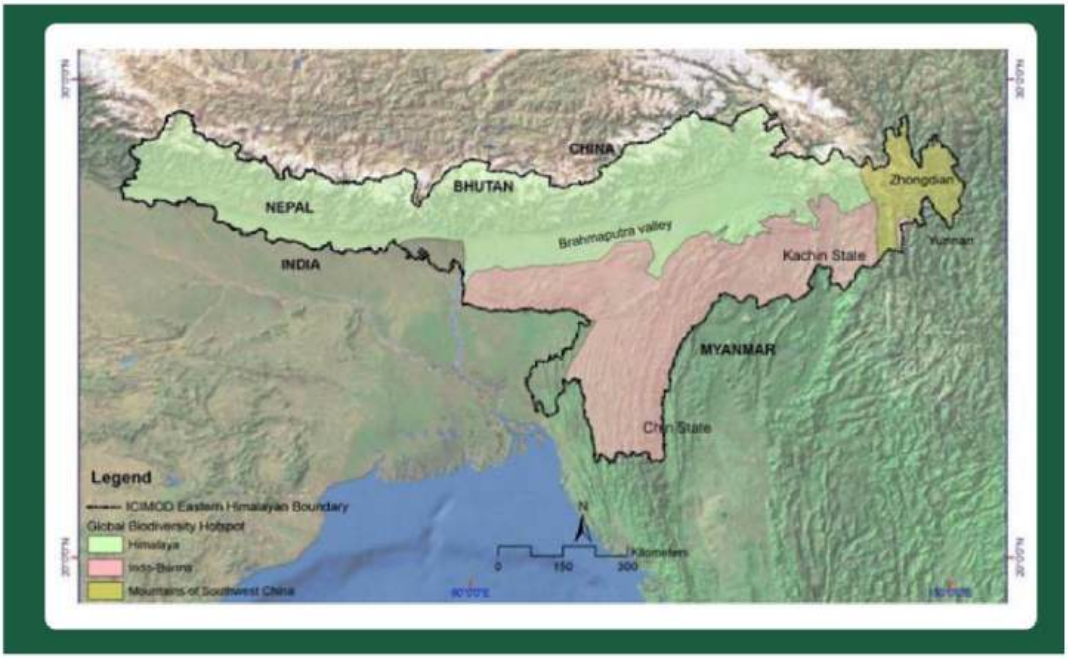
Table 1: **Percentage share of the aerial extent of the Eastern Himalayas by country**

Country	Areas	% of EH area
India	Sikkim, Arunachal Pradesh, Assam, Meghalaya, Nagaland, Mizoram, Manipur, Tripura; and Darjeeling Hills of West Bengal	52.03
Myanmar	Chin and Kachin states	17.90
Nepal	Kaligandaki Valley, Koshi Basin, Mechi Basin	16.08
Bhutan	Whole country	7.60
China	ZhongDian, DeQin, GongShan, Weixi, FuGong	6.26

in the Brahmaputra basin, Meghalaya, Tripura, and Manipur. During the past 30 years, the human population of the region has increased at approximately 2.1% annually (WWF 2005), with higher rates in and around urban centres, and low or sometimes negative growth rates in many of the rural and isolated areas.

This region lies between China and India, the two countries with the fastest economic growth rates and largest populations in the world; hence, there is a great risk of fragmentation of ecosystems as economic development supersedes environmental concerns. The region has multiple biogeographic origins, being at the intersection of the Indo-Malayan Realm, Palearctic Realm, and the Sino-Japanese Region. It also marks the frontier of the collision between the monsoonal and mountain systems associated with intense thunderstorms and lightning. The Eastern Himalayan region also contains numerous 'hotspots' of biodiversity. For all these reasons and more, this region warrants protection in order to maintain ecosystem integrity and adaptability .

Fig 1: The Eastern Himalayan region as defined for the study



The importance of freshwater ecosystems to residents of the EH is difficult to quantify, in part because of the deep attachments that many people have to streams, rivers, and reservoirs in their community. Freshwater resources have multiple, sometimes conflicting, values. These include fishing, swimming, boating, water supply, beauty, flood control, navigation and transportation, and hydropower. Freshwater ecosystems support aquatic plants and animals, as well as organisms in wetland and terrestrial ecosystems that depend upon freshwater. Freshwater ecosystems, like forest and wetland ecosystems, are stressed by habitat alteration, pollution, and non-native invasive species. Stream habitat alterations include dams, road crossings, channelisation, and loss of stream bank vegetation. Dams are built to supply water for human uses, to control flooding, and to generate electricity. Dams also alter stream flow, sedimentation, temperature, and dissolved oxygen concentrations, impairing the ability of streams and rivers to support native fauna, especially freshwater fish, aquatic plants, and benthic microorganisms. The largest electricity-producing structures are in mountainous areas and in future dams are likely to occur in greater numbers in Bhutan, Nepal, and Arunachal Pradesh.

The rate of retreat of glaciers and the thawing of permafrost has rapidly increased in recent times. The region has witnessed unprecedented melting of permanent glaciers during the past three decades, with the vast Himalayan glaciers showing the fast rate of retreat, resulting in increases in glacial runoff and glacial lake outburst floods (GLOFs), and an increased

frequency of events such as floods, mudflows, and avalanches affecting human settlements. GLOFs have occurred in the EH at various locations in Nepal, India, Bhutan, and China. GLOF events can have widespread impacts on socioeconomic systems, hydrology, and ecosystems. Recent studies suggest that loss of glacier volume, and eventual disappearance of many glaciers, may cause water stress to millions of people in India and China. As glacier mass reduces, the reduced volume of runoff will have serious consequences for downstream hydropower and land use systems including agriculture. Other key water-related natural disasters include droughts, floods, landslides, wildfires from lightning, thunderstorms, and cloudbursts.

Earthquakes pose another risk in the region and can amplify the potential impacts of climate change and exacerbate vulnerability. Frequent slope failure, mass wasting, and landslides along the Himalayan foothills are evidence of these reinforcing stresses causing ecological damage and economic losses. The Main Himalayan Seismic Belt, a 50 km wide zone between the Main Boundary Thrust and the Main Central Thrust, is seismically the most active in the region. Massive earthquakes (M>8) have occurred along the detachment surface that separates the under-thrusting Indian plate from the Lesser Himalaya (1897 Assam, 1905 Kangra, 1934 Bihar-Nepal, 1950 Assam). The regions between the epicentres of these earthquakes, known as seismic gaps, are potential sites for future big earthquakes.

IMPACT

A holistic perspective on global climate change has emerged out of the discernible trends: that human activities are responsible for these recent shifts and variability in the physical and biological systems. Climate change is projected to compound pressures on natural resources and the environment associated with rapid urbanisation, industrialisation, and economic development. The impacts of climate change vary across regions and communities. In general, these impacts are most severe in regions that display high vulnerability as a result of a number of factors, including poverty. is clear that the countries most vulnerable to climate change impacts also tend to be the poorest ones, with limited capacity in terms of the instruments needed to address the situation they face (e.g, data and observations, methods and tools, and technical and institutional infrastructure capacity building). The biggest challenge for the EH is to adapt to the impacts of climate change by integrating responses to climate change and adaptation measures into strategies for poverty reduction at the local level to ensure sustainable development. This synthesis also warns that unprecedented stresses on ecosystems from the combination of climate change, associated disturbances (e.g., floods, drought, wildfire, insects, disease), and other global change drivers (e.g., land use change, pollution, fragmentation of natural systems, overexploitation of resources) may exceed the natural resilience of ecosystems. The interaction of climate impacts with rapid economic and population growth, and migration from rural to urban areas, is likely to affect development. Net carbon uptake by terrestrial ecosystems is expected to peak before mid-century, and then weaken or even reverse, thus amplifying climate change.

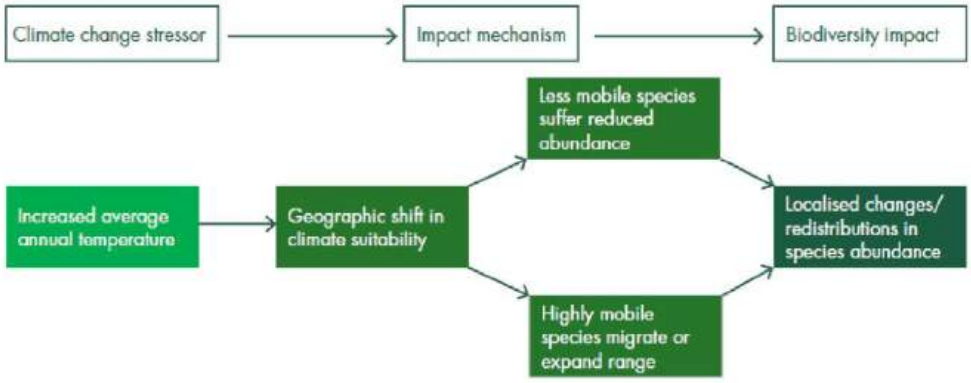
Mountains are susceptible to the impacts of a rapidly changing climate, and provide interesting and unique locations for the early detection and study of the signals of climatic change and the assessment of climaterelated impacts on hydrological, ecological, and societal systems. Climate changes rapidly with altitude over relatively short horizontal distances, as does vegetation and hydrology (Whiteman 2000). In places where climatic change may lead to warmer and drier conditions, mountain vegetation is expected to suffer as a result of increased evapotranspiration. However, contrary to the expectations from the models, Chen et al. (2006) found that average PET trends (1961–2000) on the Tibetan Plateau were negative in all seasons and annually, with an average annual PET trend of −13.1 mm/decade. Such contradictory evidence highlights the reality that ecosystems are complex and highly interconnected, making the effects of climate change extremely difficult to predict. The loss of wetlands is equally difficult to predict. Knowledge of temperature change is particularly important for prediction because it influences activity, feeding, growth, metabolism, and reproduction.

Impacts on biodiversity are also a matter of degree between extremes of significance, as judged by humans, and the 'middle path', a notion of sustainability that ecosystems and biological processes are able to tolerate and absorb certain thresholds of climate change and human activity. As mentioned already, there may be positive as well as negative impacts of climate change. Recent warming is strongly linked to the changes observed in terrestrial biological systems, including the earlier timing of spring events like leaf-unfolding, bird migration, and egg-laying; and pole-ward and upward shifts in ranges of plants and animal species. The present distribution of species in high-elevation ecosystems is projected to shift to even higher elevations, although rates of vegetation change are expected to be slow and

colonisation success will be constrained by the limitations of the highly dissected and steep terrain of the EH mountain range. Studies of satellite observations since the early 1980s indicate that there has been a trend towards the early 'greening' of vegetation in the spring, linked to longer thermal growing seasons due to recent warming (Dye and Tucker 2003). However, observations of such changes are difficult to use in future projections because of the complexities involved in human-nature interactions (e.g., land use change). Declining snow cover may also be at least partially responsible for the higher NDVI (normalized difference vegetation index) values associated with the greening trend Nevertheless, the observed changes are compelling examples of how rising temperatures can affect the natural world and raise questions about how vulnerable populations will adapt to direct and indirect effects associated with climate change.

Climate change is expected to affect the boundaries of forest types and areas, primary productivity, species populations and migration, the occurrence of pests and diseases, and forest regeneration. The increase in GHGs also affects species composition and the structure of ecosystems, which, in turn, affects ecosystem functions (Schutze and Mooney 1994). The interaction between elevated CO2 and climate change plays an important role in the overall response of net primary productivity to climate change at elevated CO2 (Xiao et al. 1998). Climate change will have a profound effect on the future distribution, productivity, and health of forests. There may be a significant reduction in alpine and cryospheric ecosystems. Tropical zones are expected to expand to cover most of the middle mountains and inner valleys of the region.

Fig 2: Climate change impact: Species-level range and abundance shifts



Climate change has the potential to have a profound effect on landscape-level processes, altering both the frequency and extent of major disturbance events . Droughts can lead to insect epidemics and major wildfires over vast areas with significant effects, and both frequency and severity can be expected to increase significantly with climate change. Disturbance processes, such as fire, may lead to some forest ecosystems being converted to grassland ecosystems. Besides direct habitat loss, the interaction between climate and fire regimes has the potential to overshadow the direct effects of climate change on the

distribution and migration of forest species. Changes in disturbance regimes are, therefore, expected to be a major driver of ecosystem-level changes that may include changes in structure (e.g., dominant vegetation, age class distribution, species composition), functioning (e.g., productivity, decomposition, nutrient cycling), and distribution within and across landscapes.

Impacts on Water, Wetlands and Hazards, and Consequences for Biodiversity:

The EH plays a critical role in the provision of water to the Asia continental monsoon. Because of the sensitivity of mountain glaciers to temperature and precipitation, the behaviour of glaciers provides some of the clearest evidence of atmospheric warming and changes in the precipitation regime, both modulated by atmospheric circulation and flow patterns over the past decades (Haeberli and Beniston 1998; WGMS 2000). As mountains are the source of the region's rivers, the impact of climatic change on hydrology is likely to have significant repercussions, not only in the mountains themselves, but also in populated lowland regions that depend on mountain water resources for domestic, agricultural, hydropower generation, and industrial purposes. Significant shifts in climatic conditions will also have an effect on social and economic systems in the region through changes in demand, supply, and water quality. Any shortfall in water supply will enhance competition for water use for a wide range of economic, social, and environmental applications. Such competition will be sharpened as a result of larger populations downstream, leading to heightened demand for irrigation and perhaps also industrialisation, at the expense of drinking water.

Natural systems related to snow, ice, and frozen ground (including permafrost) are being affected through the enlargement and increased number of glacial lakes, increasing ground instability in permafrost regions.

Table 2: **Summary of priority climate change threats to biodiversity in the EH**

Species at risk	Although there could be some benefits for at risk species, in general, there is significant concern for species at risk that are already threatened by small population size, loss of unique habitats, and low reproduction/ dispersal rates (among others). Any potential for climate change to further exacerbate these existing causes could greatly increase the risk of extinction.
Aquatic habitats	Extended summer low flow periods are expected in rainfed streams. This will further increase water temperature, favouring warm water species and altering community structure and functioning. Conversely, in snowmelt and glacier-fed streams, the magnitude and duration of summer floods is expected to increase. In either case, significant impacts on aquatic habitats are expected.
Wetlands	Wetlands are particularly vulnerable to climate change. As physiographically limited systems, they are unable to migrate and, hence, are vulnerable to changes in hydrology, nutrient inputs, and others.
Alpine ecosystems	Given their restricted geographic area and narrow elevation range, alpine ecosystems are particularly vulnerable to climate change. Climate and vegetation change rapidly with altitude over relatively short distances in mountainous terrain. As a result, alpine ecosystems are particularly vulnerable to encroachment by lower elevation ecosystems.
Forest and grassland ecosystems	The current pine bark beetle epidemic is a matter of serious concern. Ongoing concerns include the increased potential for major widespread wildfires and the subsequent potential for transformations in disturbed ecosystems, such as colonisation by invasive species and resultant new species assemblages. Grassland ecosystems may expand in range, yet face threats in terms of lost species diversity.
Invasive species	Climate change may expedite the colonisation of some areas by invasive species in both terrestrial and freshwater realms. Increased frequency and magnitude of forest disturbances will create openings vulnerable to colonisation by invasive plants.
Protected area ecosystems	Protected areas are widely acknowledged as one of the most important management instruments for biodiversity conservation. In the EH, protected area systems are some of the most intricate and complex, maintaining a delicate balance between conservation and sustainable use. The potential for major, long-term ecosystem shifts under a changing climate suggests a need to re-evaluate the protection of representative ecosystems with a stronger focus on the landscape approach as it is based on broad topographical features that do not shift with climate change.

Impact on surface water availability

Water availability, in terms of both temporal and spatial distribution, is expected to be highly vulnerable to climate change. Growing populations and the concentration of the population in urban areas will exert increasing pressure on water availability and water quality. Some areas are expected to experience increases in water availability; other areas will have reduced water resources. The majority of the perennial rivers in the EH receive water from snow and glaciers. The contribution of snow to the runoff of major rivers in the EH is about 10% (Sharma 1993), in contrast to more than 60% in the western Himalayas (Vohra 1981). Because the melting season for snow coincides with the summer monsoon season, any intensification of the monsoon is likely to contribute to flood disasters in the catchments in the EH, although the impact will be less than in the western Himalayas. An increase in surface runoff during autumn and a decrease in spring are projected for the EH. The increase in surface temperature will contribute to a rise in the snow line, which in turn will increase the risk of flooding during the wet season as less precipitation is stored in the form of snow. The supply of water in the EH is limited and governed by the renewal processes associated with the hydrological cycle .

A warming climate will generally enhance the hydrological cycle resulting in higher rates of evaporation and a greater proportion of liquid precipitation (more rain and less snow). The potential changes in precipitation (amount and seasonality) will affect soil moisture, groundwater reserves, and the frequency of flood and drought episodes. Hydrological systems are also controlled by soil moisture, which largely determines the distribution of ecosystems, groundwater recharge, and runoff; the latter two factors sustain river flow and can lead to floods. However, the impacts of these on freshwater biodiversity are uncertain. Given these possibilities, different impacts of these changes to the water cycle will have different consequences in different watersheds.

When summer evapotranspiration is greater than precipitation, surface water flow will decrease in freshwater systems that are not glacier-fed, resulting in shrinkage and desiccation. This will cause small ponds and wetlands that are surface-water fed to contract. A contraction in these water bodies will reduce freshwater habitats, which in turn will reduce freshwater biodiversity through the contraction of habitats, acidification of lakes, and molecular damage associated with UV exposure. Reduced surface water flows will reduce the amount of available cations and thus the buffering capacity of soft-water lakes, accelerating acidification and impacting negatively on organisms that cannot tolerate reductions in PH. The clear water of acidic lakes offers less protection against damaging UV rays.

Impacts on Human Wellbeing

Rising prosperity and climate security are not conflicting objectives. Climate change is providing us with a reminder of the symbiotic relationship between human culture and ecological systems. This relationship is very evident in the EH, where some of the world's most fragile ecosystems are being affected by rapid warming. Indigenous people have become sentinels for a world undergoing climate change and the EH, in effect, a global climate change barometer. The livelihoods of subsistence farmers and pastoral peoples, who make up a large portion of the rural populations, could be negatively affected by such changes.

Climatic changes are predicted to reduce the livelihood assets of poor people, alter the path and rate of national economic growth, and undermine regional food security due to changes in natural systems and infrastructure impacts. Malnutrition, for example, will be further exacerbated due to disruptions to the growing conditions and environmental stresses at critical phenological stages. The flowering and fruiting phenology of many species will alter. Late snowfall could trigger the relative immobilisation of bees due to low temperatures, indirectly affecting the processes of pollination. As its cryospheric water towers are depleted, the Eastern Himalayas is expected to experience excess runoff until the middle of this century, with meltwater flow declining thereafter. Extremes in floods and droughts through much of the century may destroy the food production base of the region (Bruinsma 2003). The food security and wellbeing of its people could suffer as a consequence of greater exposure to water-related hazards.

THREAT

An overall depiction of vulnerability averaged across ecosystem elements uncovered large areas in the EH that would likely be impacted by adverse exposure to climate change stresses. Figure 18a shows the collective relative vulnerability integrated across components of mountain ecosystems and dimensions of susceptibility to climate change impacts. The most vulnerable areas are the whole stretch of the Brahmaputra valley, segments of the lower Gangetic plain falling within the EH, the Terai-Duar tract from Nepal to eastern Bhutan, and the vicinity of Loktat lake in Manipur. Population pressure and devastation of natural biodiversity are the main factors that make these places highly sensitive to climate change. Although agriculturally the most productive area in the region, the people suffer from low per capita human development assets, and from regular disturbances from natural hazards like floods and disease epidemics. Biodiversity is at enormous risk of being degraded further as resource extraction is intensified to cope with the threats to food security and in improvised strategies for relief and recovery following each disastrous event.

In these areas of high vulnerability, the resilience of ecosystems is stretched to the limits, and the adaptive capacity of the resident population is also being eroded in their daily struggle to break out of the poverty trap. These are also potential sites for carbon emissions, offsetting the gains in sequestration offered by the forests in the adjacent mountain areas. Besides intensive agriculture, this stretch of land is also the site of much of the industrial activity in the region, with dense urban settlements and various resource use infrastructure. it is overcrowded with roads. This accounts for the high human influence index associated with high energy consumption and intense disturbance to ecosystems. The carbon balance in terms of the human appropriation of net primary production is already negative in this part of the region.

The least vulnerable places are in Bhutan, the Zhongdian of China, the Chin and Kachin states of Myanmar, Mizoram, and pockets in Sikkim and Nepal. Low vulnerability scores in places could be largely attributed to the values assigned to human pressure, biodiversity, and forest cover. Factor weightings could have reduced the bias and improved the overall interpretation, but identifying reliable weights would add a whole new methodological dimension to this assessment. Nonetheless, weighting indicators could be considered for similar studies in the future.

From all the vulnerability analyses, one common aspect that stood out was the consistent projection of vulnerability for the Terai belt in south-east Nepal extending between the districts of Parsa and Jhapa. This might be considered a hotspot of vulnerability in the EH. There are several possible reasons for this outcome ranging from intense human pressure, low socioeconomic services, few productive livelihood assets, poor health and chronic disease outbreaks, land degradation, and deforestation, the impacts of which are further aggravated by extremes of weather and climatic variability including recurrent floods. Other important locations of vulnerability are the Brahmaputra valley, the lower Gangetic plain of North East India, and a few highly localized sites that may be a true manifestation resulting from the complex physiography and diversity in nature and society, or artifacts from raster data integration. Other factors that could predispose areas to vulnerability include the following:

- Poverty and low human development, which make the poor intrinsically vulnerable because they have fewer resources with which to manage risks. There is a two-way interaction between climate-related vulnerability, poverty, and human development
- Disparity in human development – inequality within countries is another marker for vulnerability to climate shocks. Gender inequalities intersect with climate risks and vulnerabilities. Women's historic disadvantages, such as their limited access to resources, restricted rights, and muted voice in shaping decisions, make them highly vulnerable to climate change. Lack of climate-defense
- Lack of climate-defense infrastructure that could serve as a buffer between risk and vulnerability; for example, flood defense systems, water infrastructure, early warning systems, and so forth.
- Limited access to insurance against climate related losses. There is an inverse relationship between vulnerability, which is concentrated in poor areas, and insurance, which is concentrated in more affluent, urban places.

Threat in ecosystems:

Mountains exhibit high biodiversity, often with sharp transitions in vegetation sequences, subsequently ascending into barren land, snow, and ice. In addition, mountain ecosystems are often endemic, because many species remain isolated at high elevations compared to lowland vegetation communities that can occupy climatic niches spread over wider latitudinal belts. The response of ecosystems in mountain regions will be most important at ecoclines (gradual ecosystem boundaries), or ecotones

Mountain ecosystems are being continuously threatened by global change, including climate change. Management practices and the underlying socioeconomic changes have pushed the ecological resilience of mountains to their limits. Land use is the major driving force that could result in near complete loss of alpine vegetation by the end of the current century. Natural ecosystems are being continuously replaced or modified by agricultural systems.

RESPONSE

The questionnaire surveys carried out in the North East states of India and Bhutan as part of this assessment came up with some enriching insights into what ordinary people perceive as climate change and the perceived impacts on their livelihoods and livelihood strategies. Although perceptions were varied depending on place, ethnicity, culture, and socioeconomic background, there was a clear idea among participants of the atypical changes in the environment. Most of the participants immediately talked about changes in weather patterns, shortages of water for irrigation and household use, increasing uncertainty in rainfall, and the emergence of new, and increase in the incidence of existing, pests and diseases in humans, animals, and plants. Such changes are evidenced by cases like the soya bean failure in Manipur due to excessive rain in the 2004/05 growing season; the decline in the number of indigenous fish with the introduction of brown trout in Bhutan; wild mushrooms growing in unexpected places; and increasing incidence of wild forest fires. On the positive side, there are reports of more areas becoming suitable for the cultivation of staple cereals, increases in the productivity of oranges in Helipong village in Tuensang, and improvements in apple quality in Bhutan in places where previously low temperatures in late summer cut short the fruit development stage. People are mostly concerned about the adverse changes that may disrupt the flow of ecosystem services that sustain rural communities ensuring food security, curing illness, and providing cash income and spiritual comfort by being at peace with nature.

Many communities have adapted and continue to adapt to environmental changes. In food production, they maintain a portfolio of crop species and varieties to adjust the cropping pattern and crop calendar to the prevailing and anticipated changes in the growing environment. In extreme cases, people migrate to more benign environments and reconnect with new sets of ecosystem services.

Awareness of climate change is fairly high in terms of relating natural hazards to perturbations in the environment as a result of anthropogenic interventions and disturbances linked to the indiscriminate use of natural resources. The participants' understanding of the adaptation and mitigation aspects of dealing with such environmental threats is, at best, tenuous as their experiences with problem resolution are not always limited to climate considerations. This was expected as coping mechanisms in terms of adjustments and interventions cannot be elucidated meaningfully from the climate change perspective alone, because most impacts we attribute to climate change are indeed consequences of several interacting stresses. People have always responded to changes in the environment and, in the process, have accumulated a vast amount of indigenous and appropriate knowledge and technologies for minimizing adverse impacts while taking advantage of new opportunities. Deductions from people's perceptions, however, are limited to a time scale within the range of human memory, while climate change impacts may become evident only after hundreds of years. In documenting people's perceptions, it is important to be mindful of the accuracy of the information that is provided and reasons why some information cannot be provided. Of course, perceptions are likely to be biased toward the response of agricultural crops or components of ecosystems that impinge on livelihoods or that are conspicuous enough to be considered. A verification means must be integrated into the information collection system. Perceptions are mostly associated with climate variability, rather than change.

Specific and relevant to the EH, a series of consultative workshops with stakeholders, partners, and government actors identified several impacts attributed partially or wholly to climate change based on informed perceptions and investigative research on aspects confined to or of relevance to the EH. Examples of the impacts of climate change are listed in Table 20, without taking into account any changes or developments in adaptive capacity or mitigation measures. The impacts listed are not exhaustive for the region, but merely restricted to the ecosystem resources and services within the scope of the project intervention.

ADAPTATION

Sometimes climate change adaptation is seen as competing with the human and economic development needs of the world's poor. Climate change can be perceived as a problem distant in time, uncertain in its effects, and of less consequence than present-day poverty. Adaptation and mitigation may, therefore, seem less urgent and less compelling than increasing development efforts for the world's poor. But climate hazards are immediate, they are growing, they threaten the quality of life and life itself, and they directly impact on the goals of development. In this assessment, the direct link between climate stresses and human poverty is reconfirmed through intense exploration of transmission mechanisms and channels of human vulnerability in the face of interacting and reinforcing multiple stresses.

There is general agreement that humans have already had an overwhelming impact on natural ecosystems and that this interferes with the functioning of ecosystems in ways that are detrimental to our wellbeing. Ecosystem services are essential to human civilisation, but human activities are already impairing the flow of ecosystem services on a large scale. If current trends continue, humanity will dramatically alter virtually all of the Earth's remaining natural ecosystems within a few decades. The primary threats are: land use changes that cause loss of biodiversity; disruption of carbon, nitrogen, and other biogeochemical cycles; human-caused non-native species invasions; releases of toxic substances; possible rapid climate change; and depletion of stratospheric ozone. Fortunately, the functioning of many ecosystems could be restored if appropriate action is taken in time. However, attempts to take timely action to minimize climate-related risks are often hampered by the following:

1. The perception by some decision makers that the impacts of climate change are distant and speculative and, therefore, do not warrant immediate action
2. The difficulty in making site-specific predictions 2. about future climate at a scale relevant to ecological processes
3. The global nature of climate change requiring largescale efforts to integrate local, regional, and national activities

Expectations in terms of adaptation within the region have enriched available options and established a context for evaluating the relevance of such options with a specific focus on the EH. Three rounds of stakeholder consultations provided a proper forum for close interaction to identify issues, impacts, and trends, and to make recommendations on adaptation strategies and governance issues for the conservation and management of vulnerable mountain ecosystems under changing climatic scenarios. The outputs from the discussions and recommendations synthesized much of what we already know, and have applied to the real world situation with varying degrees of success. These dialogues contributed to the process of identifying the promising alternatives that could strengthen current practices and help in replicating emerging approaches in addressing climate change issues.

Hazards

In addition to short-term approaches such as response and recovery, there is a need to think about the long-term goal of awareness, preparedness, and risk reduction. From the natural hazards perspective, responding to climate change involves an iterative risk management process that includes both adaptation and mitigation, as neither on its own can address all potential climate change impacts. At the policy level, adaptation needs to be mainstreamed into the planning process and integrated into sectoral development programs and activities. At the institutional level, capacity building is an obvious priority to enhance the knowledge and information base, strengthen networks across agencies and governments, and promote regional cooperation. Adaptation options include, among others, improvement of observation and forecasting, development of early warning systems, mapping of hazards and vulnerabilities, community awareness and participation, and forest and water conservation. Engineering works are alternative options for adaptation through risk mitigation

Adaptations are mostly aimed at eliminating projected climate change impacts. However, in some cases adaptations can be aimed at exploiting a climate change opportunity. Regardless of whether or not countries around the world succeed in achieving major reductions in GHG emissions, climate change models predict that excess greenhouse gases already in the atmosphere will drive climate change and its impacts for centuries to come. As a result, the need to implement activities aimed at adapting to the potential changes is imperative.

CONCLUSION

The Eastern Himalayas is vulnerable to climate change due to its ecological fragility and economic marginality. Recent studies confirm its vulnerability, with analysis and predictions showing increasing magnitude of change with elevation, both in mean shifts in temperature and in greater stretch in precipitation variation. As a biodiversity hotspot, the source of the headwaters of four major Asian river systems, and home to millions of the poorest in the world, the Eastern Himalayas presents a unique case in which poverty is not always correlated with desertification and degradation, nor does it seek paybacks from the downstream majority thriving on the ecosystem services flowing out of it. Climate change is poised to alter this status quo with far-reaching consequences for the condition of biodiversity, quality of ecosystem flow downstream, and the wellbeing of the people in the region.

The impact of climate change on biodiversity must be assessed in conjunction with coexistent impacts on the other components of ecosystems and on the socioeconomic condition of the human population occupying the same geographic space. Similarly, just as climate change is coupled with other environmental changes, vulnerability must be assessed in the context of the dynamic flux of both socioeconomic and biophysical factors. The environmental changes the region is experiencing do not influence biodiversity in isolation. Rather, the diversity in ecosystems and the variability in environmental factors like weather, climate, and water interact in a mutually reinforcing manner to create the diversity of life and the huge variety of ecosystem services that emanate from such interactions. However, this ecological equilibrium in the flow of material and energy and the mechanism of connections and feedbacks are being rapidly eroded by human interference with the climate system.

According to current trends and future climate projections, higher temperatures, greater rainfall variability, increased concentration of atmospheric CO2, and more frequent extreme events are likely scenarios until the end of the 21st Century. The environmental consequences of this faster than natural evolution of climate are going to impact on all spheres of life and life support systems on Earth.

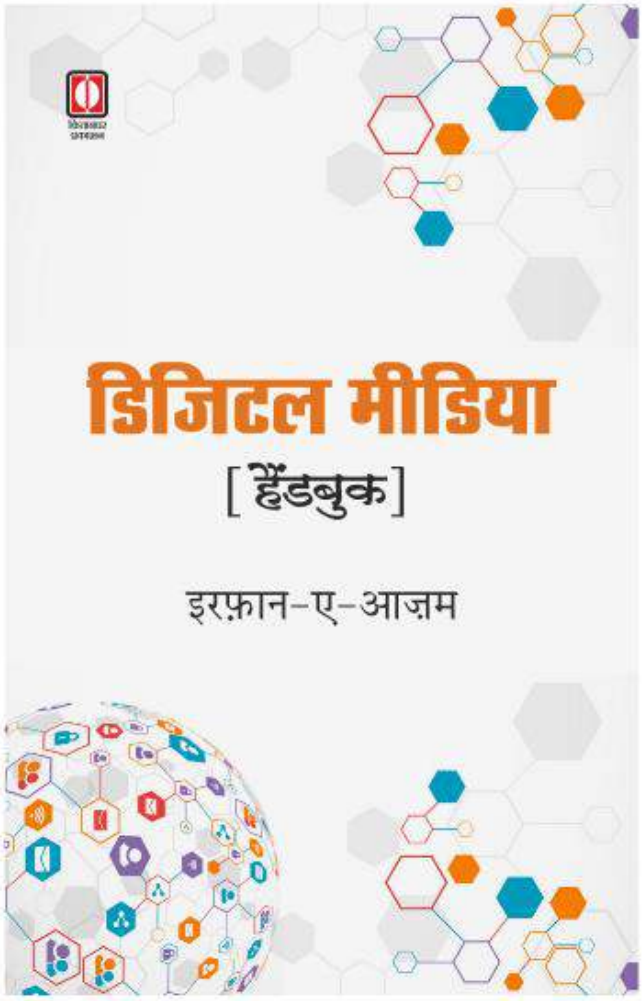
It is becoming clear that the Eastern Himalayas can expect major transformations in biodiversity across all systems (terrestrial, freshwater) and all levels (genetic, species, ecosystem) under a changing climate. It is now more urgent that ever to identify clear management objectives to guide management priorities. Our experiences and lessons suggest that maintaining ecosystem resilience, while focusing on the underlying structure, functions, and processes of ecosystems, should be a priority. Creating protected areas and biodiversity networks, minimizing habitat fragmentation, and managing invasive species are the obvious starting points for biodiversity management in response to climate change. The scope for better options for managing biodiversity with climate change than we already know is rather limited. In short, we know in principle what to do; what is not well known is where, when, and how to do it.

Many of the impacts elucidated here are based on imperfect knowledge from limited species and location responses to climate change factors. There are conflicting inferences about the response of ecosystems to CO2 enrichment under climate change, which remain unresolved. However, a new understanding is emerging that the impact of elevated CO2 will vary with elevation and is unlikely to be a long-term response. This is corroborated by the limitation in the non-structural carbon pool and observations that CO2 concentration is lower at higher altitudes. Investigation into some of the alpine species carbon assimilation mechanisms suggested that their growth is not always limited by low temperature/ low CO2 conditions; stomatal conductance was found to be regulated more by endogenous biorhythms than by atmospheric conditions in some alpine species. Vegetation dynamic models do not always take non- climatic factors into account, making predictions about species distribution and range shifts questionable. Some species have wider altitudinal spreads and do not pose an immediate threat of colonizing vegetation belts higher up, while other species represent edaphic (soil-related) rather than climatic climax. These are some of the issues that need further scientific investigation.

In the Eastern Himalayas, past changes in climate have been recorded and future projections are available; these can provide a starting point for assessing the types of climate stressors that will impact on various biodiversity management endpoints in terrestrial and freshwater systems. It is high time that we moved beyond the planning and background reporting stage; we need to move from concepts and theories into the sphere of implementation. The priorities must be explicit and achievable, without being vaguely all-encompassing, and management options must be considered on a case-by-case basis. There is a need to guard against management inactivity in the face of the major uncertainties raised by climate change. In all cases we should be looking for 'no-regret' actions. These are actions that perform well irrespective of climate change. Features of no-regret options are their relatively low lifecycle cost, short completion horizon, and limited risk to other management objectives.

REFERENCE

- Nakamura , Hajima, [1971],Ways of thinking of Eastern people: India-China-Tibet-Japan , University of Hawaii press books
- Tiwari, R.C, [2003], Geography of India , Prayag Pustak Bhawan ,Allahabad
- Singh ,Dr I , [2006], Cultural Geography , Alpha Publication, New Delhi
- Tirtha ,Ranjit, [2002], Geography of India , Rawat Publication
- Climate Change Impact and Vulnerability in the Eastern Himalayas – Synthesis Report-[2010]-Macarthur Foundation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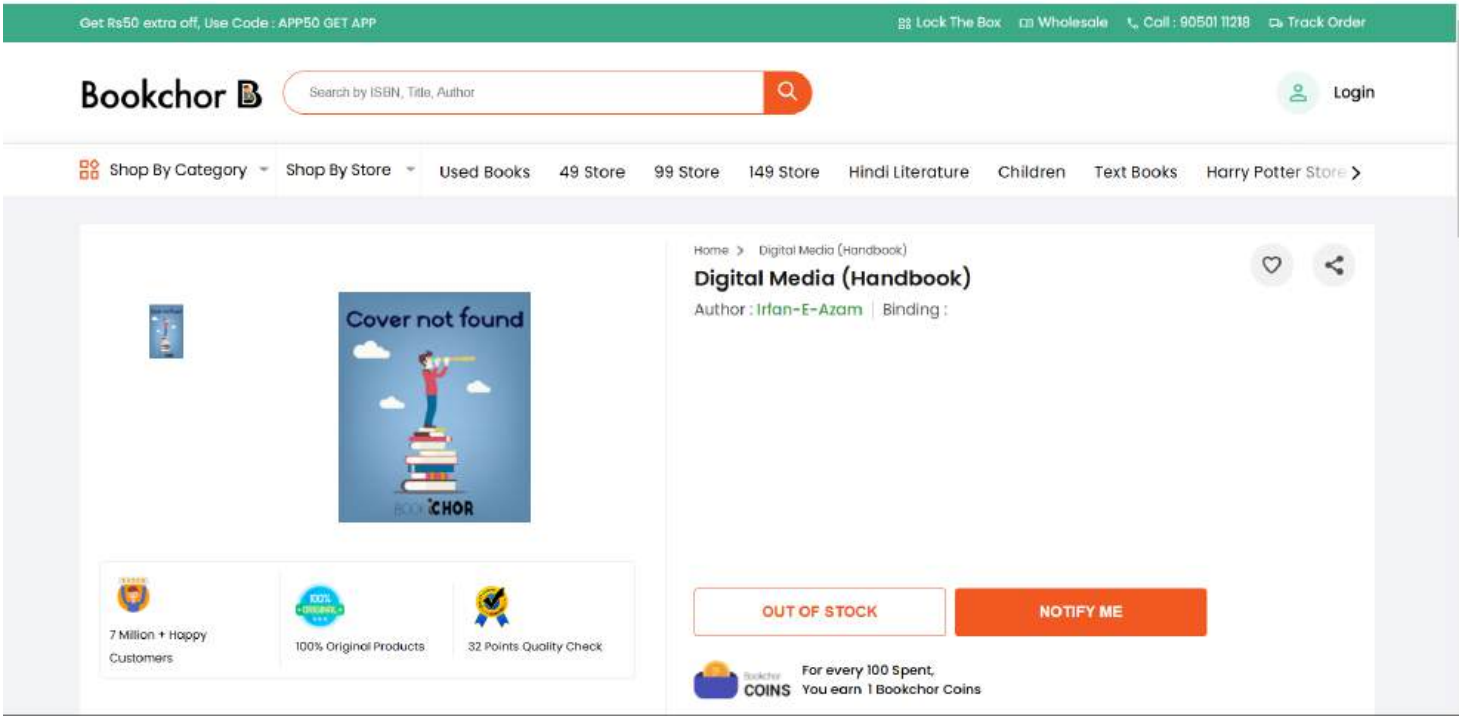
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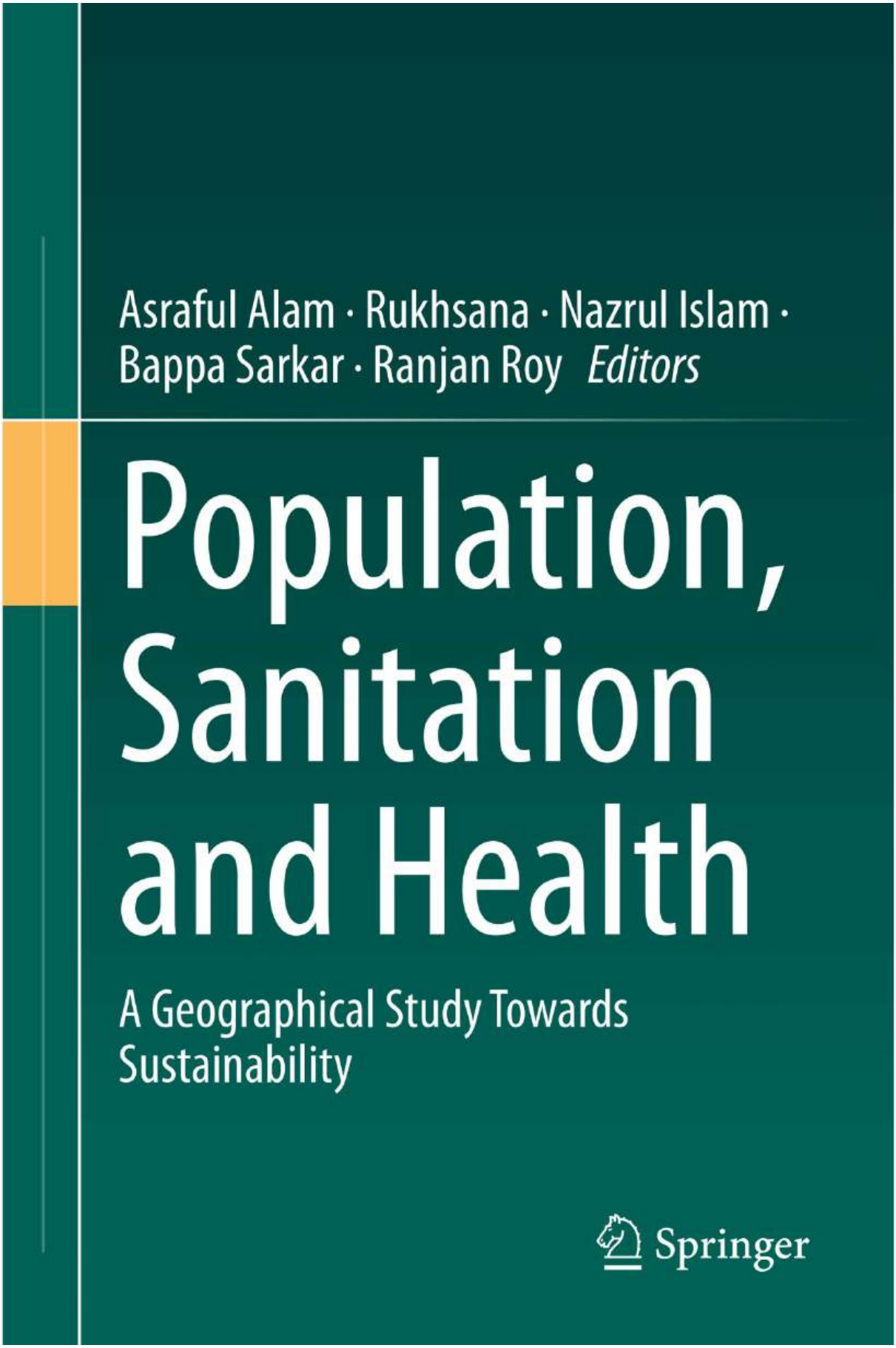
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Chapter 22
Impacts of Socioeconomic Factors and Child Healthcare Practices on Child Morbidity of Indo-Bangladesh Border Districts of India: A Spatio-Statistical Analysis from NFHS-5 Data

Sanjoy Barman, Arjun Saha, Sangita Karmakar, Ranjan Roy, Nazrul Islam, and Bipul Chandra Sarkar

22.1 Introduction

The National Health Mission (NHM) has reported that estimated figures of 26 million children are born in India each year. According to the 2011 Census of India, the proportion of children belonging to 0–6 years old accounts for 13% population of the country (https://censusindia.gov.in/census.website/). Child health protection and improvement is of fundamental importance. The most important thing a society can do is invest in its children for their better future (Lister, 2008). In recent decades, the world has seen tremendous progress in child health and a decrease in their mortality rate. However, five million children globally died before they turned 5 years of age in 2021. The cause of many of these tragedies was the deprivation of children's basic rights to proper health care, vaccinations, sanitation, safe drinking

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water, and nutritious food. A considerable number of child deaths continue to occur due to inadequate efforts being made to address preventable infectious and communicable diseases (UN IGME, 2023).

Child morbidity refers to a state of illness, which may be physical or mental as result of disease, impairment, or injury in a child. Morbidity is departure from health (Last, 2001). Childhood morbidity, therefore, is a significant issue with respect to public health around the world as it affects children's overall growth and development as well as well-being adversely. As per the latest National Family Health Survey (NFHS), most Indian states have experienced a reduction in child mortality in the last half a decade (http://rchiips.org/nfhs/). Despite the decline, the infant mortality rate in India is the worst among developing countries. In this context, different studies have explored several socioeconomic conditions, and healthcare activities for both mother and child have a significant role in health status of children. An investigation by Pradhan and Arokiasamy (2010) analyzed that the socioeconomic disparity in case of child survival is a major health concern in India. Literacy rate is likely to increase better child health status. Fujii et al. (2018) carried out a study in rural areas that shows electrification has potential to improve the household environment and child nutrition. Similarly, Chen et al. (2019) also explored that access to electrification in rural areas has increased the utilization of health services through availability of necessary devices and equipments in Gujarat, India. Li et al. (2018) analyzed the role of water treatment on nutritional profile of children. They examined that household water treatment increases the potentiality of gaining normal weight among young children in India. Mallick et al. (2020) in their research pointed out that proper sanitation system has a positive result in the reduction of diarrhea prevalence among children under 5 years old in India. Another study by Gouda et al. (2015) in their research pointed out that the absence of improved sanitation, proper drinking water source, clean drainage facility, and cooking fuel are responsible for the case of diarrhea prevalence, acute respiratory diseases, and, consequently, resulting in higher infant and under-five deaths. Aziz et al. (2022) examined that health insurance among children has comparatively better health status than noninsurance. The study also confirms that the health insurance is not opulence but a need that can improve child health profile. In 1952, India introduced the first family planning program at the national level in the world (Kongawad & Boodeppa, 2014). Rana et al. (2019) in their study identified the importance of birth planning in improving nutritional and health outcomes of both child and mother in India. Proper childbirth planning could help to reach the targets of the SDG 3. Arroyave et al. (2021) attempted a study in low- and middle-income countries that shows that access-to-antenatal care (ANC) services are directly related to improved childbirth outcomes and significant reductions of child malnourishment and mortality. Effectively, ANC visits reduce probability of stunting and underweight birth as well as neonatal and infant mortality. Dixit et al. (2013) discussed the actual importance of receiving ANC on child immunization. They explored that ANCs are the conventional services that can provide health education

and awareness among women during pregnancy on the good effects of child immunization in India. Additionally, Murhekar and Kumar (2021) analyzed that vaccination against childhood diseases is a crucial public health interventions. Saha and Paul (2021) in their study pointed out that the place of delivery is a vital aspect in safe delivery and better health outcomes for both child and mother. More precisely, Jain et al. (2012) also explored that institutional delivery improves healthcare practices or health-seeking behavior related to newborn care that is positively associated with lower childhood morbidity.

In India, the government has introduced several health-related strategies and programs for the development of people's healthy lives. The child health programs under the NHM are comprehensively integrated interventions aimed at improving child survival and addressing factors that contribute to infant and under-five mortality (National Health Mission, 2013). Child survival has improved significantly in the last two decades, although India did not meet the Millennium Development Goals, 2015 (Srivastava et al., 2021). In 2015, the countries over the world (United Nations members) agreed to adopt the 2030 Agenda for Sustainable Development (United Nations, 2015). Among the goals of this agenda, Goal 3 is about good health and well-being, which is challenging for many countries. A recently published report by Bill and Melinda Gates Foundation's Goalkeeper stated that most of the member countries are on track to meet almost none of the goals. As per the prediction of the report, India too will not achieve many targets under Sustainable Development Goals by 2023. It is projected that India will not reach the targets for stunting; neonatal, child, and maternal mortality; and tuberculosis (Goalkeeper, 2022). In India, more than one-third of children are stunted or malnourished. Healthcare provision is poor in many parts of the country, and the rural households have significant difficulties in access to healthcare facilities (Pappachan & Choonara, 2017). The Indo-Bangladesh border adjacent areas are mainly rural and are characterized by several physiographical, socioeconomic, and political obstacles. Modern means of transportation and communication are rare in many parts of this region. Being remote, proper healthcare facilities and other public services are not evenly distributed throughout the region, which eventually impacts the maternal and child healthcare outcomes. Majority of the workforce is engaged in primary economic activities, and their educational attainment status is comparatively low. In addition, considerable population adjacent to border sides is engaged in antisocial activities such as smuggling as a source of occupation (Rammohan, 2011). Consequently, lack of awareness among people has become an issue to achieve their healthy lives. Therefore, keeping these aspects in mind, this study focuses on the impact of some selected socioeconomic and healthcare parameters on childhood morbidity in the Indo-Bangladesh border districts of India and also to study the changes of these parameters with respect to physiographical changes in this area, and this work is a first kind of this to study in this area, which is a newness of this work.

22.2 Study Area

India shares its longest border with Bangladesh. The Indo-Bangladesh is 4096 km long, which is the fifth-longest international border by land in the world. The Indian parts of state Mizoram, Tripura, Meghalaya, Assam, and West Bengal are situated along the border (Joseph et al. 2013). Among them, West Bengal shares its maximum border length with Bangladesh. It is 2217 km long that constitutes both vast riverine and land portion. Assam shares an international boundary of 262 km long with Bangladesh comprising the massive riverine edge and low-lying area. In Meghalaya, the border is 443 km long, constituting the plateau region. The border in Tripura is mainly in the plains, and the border length is 856 km. Mizoram shares the shortest boundary with Bangladesh with a length of 180 km international border across the hilly region (Jamwal, 2004). A total of 32 districts include Darjeeling, Jalpaiguri, Koch Bihar, Uttar Dinajpur, Dakshin Dinajpur, Malda, Murshidabad, Nadia, North 24 Parganas, and South 24 Parganas in West Bengal; Cachar, Karimganj, South Salmara Mankachar, and Dhubri in Assam; East Jaintia Hills, South West Khasi Hills, East Khasi Hills, South West Garo Hills, South Garo Hills, West Jaintia Hills, and West Garo Hills in Meghalaya; Mamit, Lunglei, and Lawngtlai in Mizoram; and Dhalai, Sepahijala, Khowai, North Tripura, Gomati, South Tripura, West Tripura, and Unakoti in Tripura cover the actual Indian side of the Indo-Bangladesh border, and these districts are taken as our study area (Fig. 22.1). Rural area is the home to bulk of population of these Indian states; more than 70% of total population lives in rural areas. According to the Census of India, 2011, the share of children (0–6 years old) accounts for 11.59%, 14.86%, 19.16%, 12.47%, and 15.36% of the total population in West Bengal, Assam, Meghalaya, Tripura, and Mizoram, respectively (https://censusindia.gov.in/census.website/). Both sides of the Indo-Bangladesh border are thickly populated right up to the international border. In the Indian side, there are more than 100 villages, which are located right up to the borderline. The population in many places in the Indian part consists of migrants. Sizeable population in these areas is involved in smuggling as an income source. There are also some urban centers that straddle the border, such as Hili (Rammohan, 2011).

22.3 Materials and Methods

22.3.1 Data Source

The entire work is based on secondary data, and information on different parameters has been collected from National Family Health Services of fifth round (NFHS-5). District-wise survey-based fact sheet data of parameters have been used. The Ministry of Health and Family Welfare of Govt. of India and the International

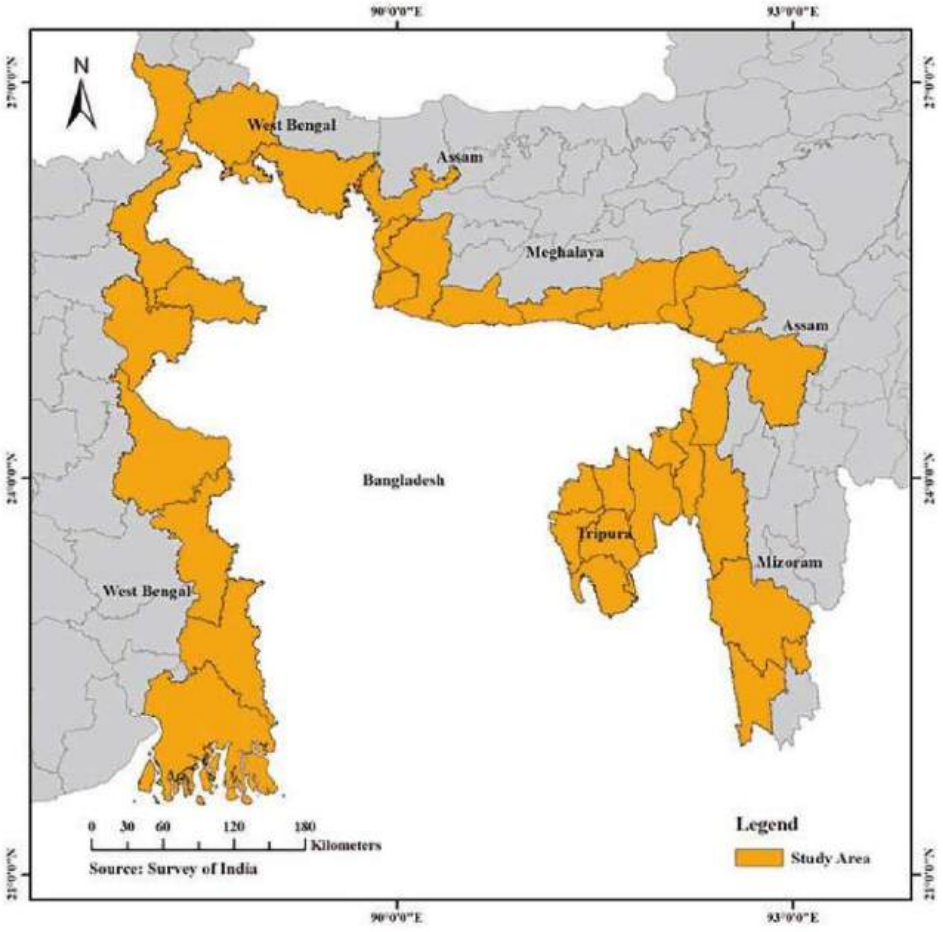

Fig. 22.1 Location map of the study area

Institute of Population Studies (IIPS), Mumbai, conducted the entire survey and published the report in 2019–2020. Fact sheets are publicly available on the following website (http://rchiips.org/nfhs) and can easily be accessed without any prior request.

22.3.2 Details of Parameters

As this work deals with impact of socioeconomic and healthcare conditions on child morbidity, parameters from these three parts have taken, and their details are given below.

22.3.3 Socioeconomic Condition

Some practices and facilities that are practiced in household and strongly associated with better child health are taken in this work as socioeconomic factors. Total of six factors have been taken in socioeconomic part, and these are women literacy rate, availability of electricity, availability of safe drinking water, improved sanitation facility, use of clean fuel, and health insurance coverage.

22.3.4 Healthcare Condition

Total of four factors as healthcare condition are taken in this work, and these include the use of family planning method, 4 antenatal care visits, institutional births, and fully immunization. These four factors collectively mark a positive effect on child morbidity of under-five age children only when these are fully and effectively used by people.

22.3.5 Child Morbidity

The major five problems and diseases that a newborn child face at the time of birth and after birth are taken in this work, and these comprise the prevalence of diarrhea, acute respiratory infection or ARI, stunting, wasting, and being underweight.

22.3.6 Statistical Analyses

After collecting and compiling all the data from fact sheet, standardization technique has been used for all the parameters to get the standard value. Dimension index (DI), a data standardization technique, has been developed by Iyengar and Sudarshan in 1982 (Mallick, 2021) and has been used in this work. The standardization has been performed using Eq. (22.1), and the results of DI lie between 0 and 1.

$$\text{Dimension index}\left(\text{DI}\right) = \frac{X_{\text{ld}} - X_{\text{ldmin}}}{X_{\text{ldmax}} - X_{\text{ldmin}}} \tag{22.1}$$

Finally, composite score of socioeconomic condition, healthcare facilities, and child morbidity is calculated by summing up all the respected DI values. This score has been used in identifying spatial distribution of these facilities.

Spearman's rank correlation has been used separately two times to find out the relation between socioeconomic DI value and child morbidity DI value and

healthcare facilities' DI value with child morbidity DI value. To identify the relation between child morbidity with all the parameters of socioeconomic and healthcare condition, Pearson's correlation coefficient has been used in this work, and composite score of child morbidity and DI value of all parameters have been taken to get the result.

To identify the determinants of socioeconomic and healthcare facilities on child morbidity of under-five age children, simple linear regression technique has been used through which the major causes of child morbidity are taken out.

22.4 Results and Discussion

22.4.1 Geospatial Variation of Socioeconomic Condition, Healthcare Status, and Child Morbidity

Composite score of respective three categories have been used to perform the spatial variation of these three statuses. Table 22.1 represents the composite score of these three statuses. All the districts of five states are classified into three and termed as low, moderate, and high. In socioeconomic condition, of 32 districts, 7 districts include North 24 Parganas, West Garo Hills, South Garo Hills, East Khasi Hills, West Tripura, Mamit, and Lunglei. Being lies in a hilly area, Mamit and Lunglei of Mizoram score highest in utilizing socioeconomic attributes, and these scores are 5.26 and 5.22, respectively. Condition of Assam is devastating as of four bordered districts, three fall in low category, and the values are 1.80, 2.63, and 2.23 for Cachar, Karimganj, and South Salmara Mankachar, and this Cachar district also represents the lowest score among these 32 districts (Fig. 22.2).

Condition of healthcare facilities is quite better than the socioeconomic condition of 32 districts, 11 districts lie in the high category in utilizing healthcare facilities (Fig. 22.3). North 24 Parganas of West Bengal scores highest among these all districts, and the district holds a value of 3.86, and the lowest score has been found in West Jaintia Hills of Meghalaya, which is 0.64. North 24 Parganas lies in the vicinity of Kolkata, and also, some parts of this district fall under the Greater Kolkata region, so it is obvious that the socioeconomic condition of this district should have better condition which actually the result reflects.

As both the socioeconomic conditions and healthcare status are high in North 24 Parganas, child morbidity status is low in this district with a composite value of 1.16. Interesting fact is that, with a moderate condition of healthcare status and high socioeconomic condition, all the districts fall in the lower category of child morbidity condition (Fig. 22.4). Composite values of Mamit, Lunglei, and Lawngtlai are 0.20, 0.55, and 0.93, respectively. This is because of the effective literacy in the state, which shows its impact on every aspect.

Table 22.1 Composite score for socioeconomic condition, healthcare status, and child morbidity among under-five age children

State	Districts	Child morbidity	Socioeconomic status	Healthcare status
West Bengal	Darjeeling	2.09	3.81	3.79
	Jalpaiguri	1.39	3.27	3.76
	Koch Bihar	1.34	3.38	3.66
	Uttar Dinajpur	2.61	2.33	3.05
	Dakshin Dinajpur	1.60	3.16	3.54
	Malda	2.19	2.72	3.41
	Murshidabad	2.19	2.72	3.35
	Nadia	1.55	3.24	3.26
	North 24 Parganas	1.16	4.17	3.86
	South 24 Parganas	1.84	3.66	3.74
Assam	Cachar	1.99	1.80	1.75
	Karimganj	3.06	2.63	2.18
	South Salmara Mankachar	2.12	2.23	1.88
	Dhubri	2.81	3.03	1.81
Meghalaya	East Jaintia hills	2.67	3.17	1.50
	South West Khasi Hills	2.80	3.71	1.45
	East Khasi Hills	2.67	4.27	0.90
	South West Garo Hills	2.56	3.33	1.94
	South Garo Hills	1.53	4.04	2.14
	West Jaintia Hills	3.01	2.38	0.64
	West Garo Hills	2.15	4.60	2.27
Mizoram	Mamit	0.20	5.26	2.24
	Lunglei	0.55	5.22	2.05
	Lawngtlai	0.93	3.35	1.06
Tripura	Dhalai	1.93	2.65	2.71
	Sepahijala	1.60	3.48	2.36
	Khowai	1.67	3.33	2.40
	North Tripura	1.67	3.07	2.79
	Gomati	1.84	3.40	2.29
	South Tripura	1.79	3.06	1.89
	West Tripura	0.82	4.23	3.31
	Unakoti	1.75	2.39	1.49

22.4.2 Relation Between Child Morbidity with Socioeconomic and Healthcare Status

In this work, relation between child morbidity with socioeconomic condition and healthcare status has been identified in two ways. Firstly, Spearman's rank correlation has been performed between the composite score of child morbidity and

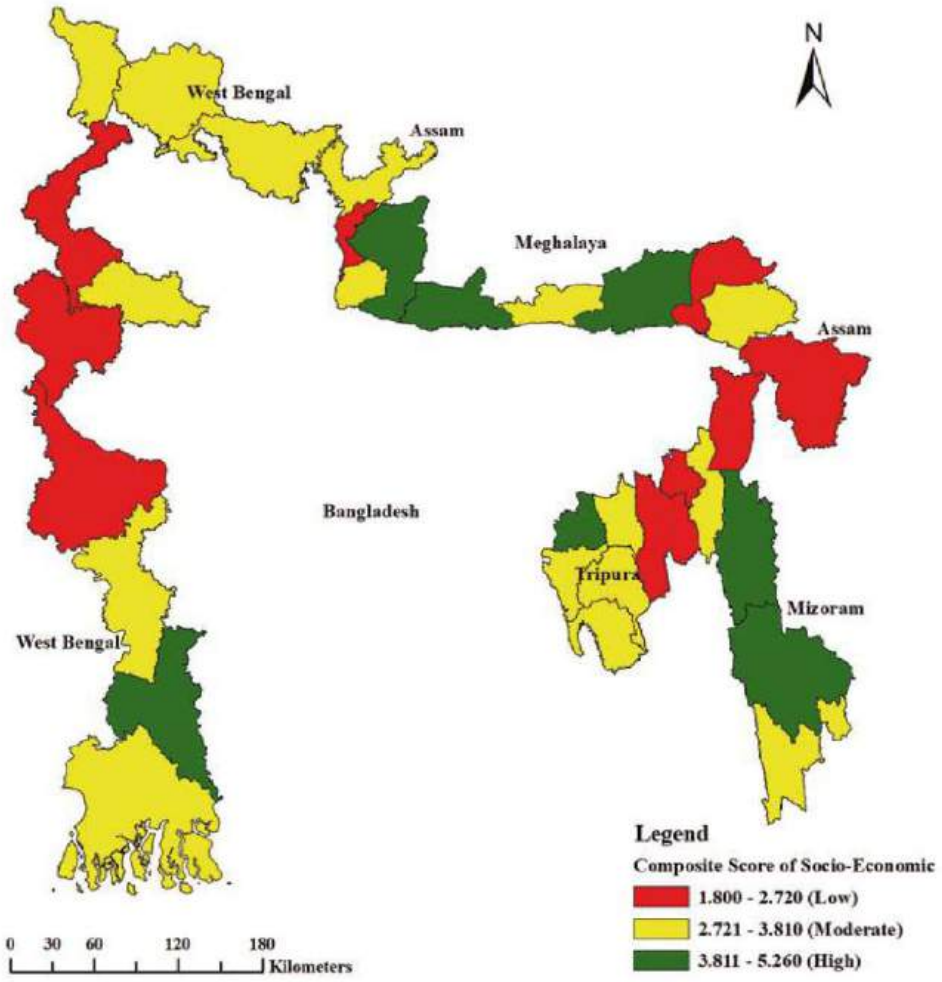

Fig. 22.2 Spatial variation of socioeconomic condition

socioeconomic condition, and child morbidity with healthcare status. Secondly, composite score of child morbidity is compared with dimension index value of each parameter of socioeconomic and healthcare status by Pearson's correlation coefficient to identify the association of particular parameter with child morbidity. Coefficient value of child morbidity with socioeconomic condition is −0.528 (Table 22.2), which shows a moderate negative relation between these two and implies that if the socioeconomic conditions are uplifted, then it is possible to reduce the child morbidity of under-five age children. The same case is for the health care also. The coefficient value in this case is −0.377, which is weak negative association between these two. Both of these are also statistically significant and account for 99% and 95%, respectively, with a "*p*"-value of 0.002 and 0.037, respectively.

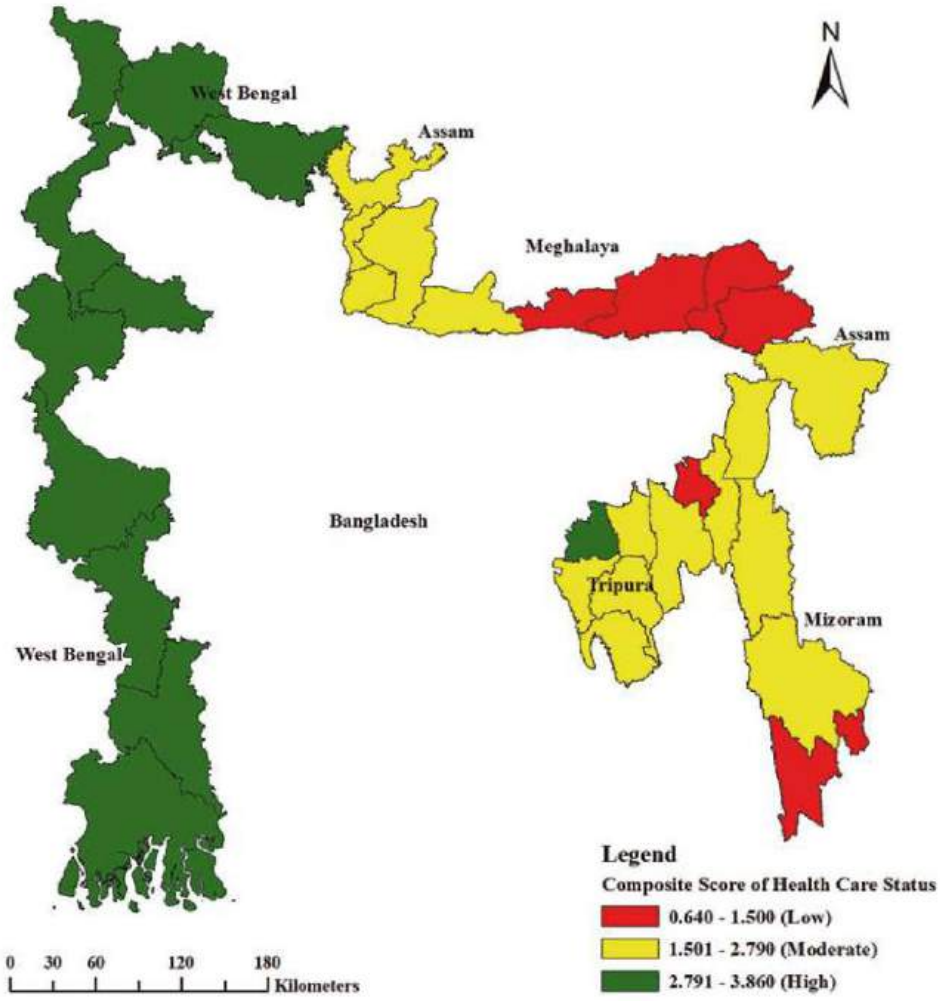

Fig. 22.3 Spatial variation of healthcare status

Table 22.3 and Fig. 22.5 represent Pearson's correlation coefficient between child morbidity and parameters of socioeconomic and healthcare status. Results show that there is relationship between child morbidity with availability of electricity (coefficient −0.495, $p = 0.005$), improved sanitation facility (coefficient −0.488, $p = 0.005$), use of clean fuel (coefficient −0.623, $p = 0.000$), and institutional births (coefficient −0.462, $p = 0.009$). These all are negatively correlated with child morbidity, which implies that every increase of one unit in electricity, sanitation, clean fuel, and institutional birth can reduce 0.495, 0.488, 0.623, and 0.462 units of child morbidity in these 32 bordered districts.

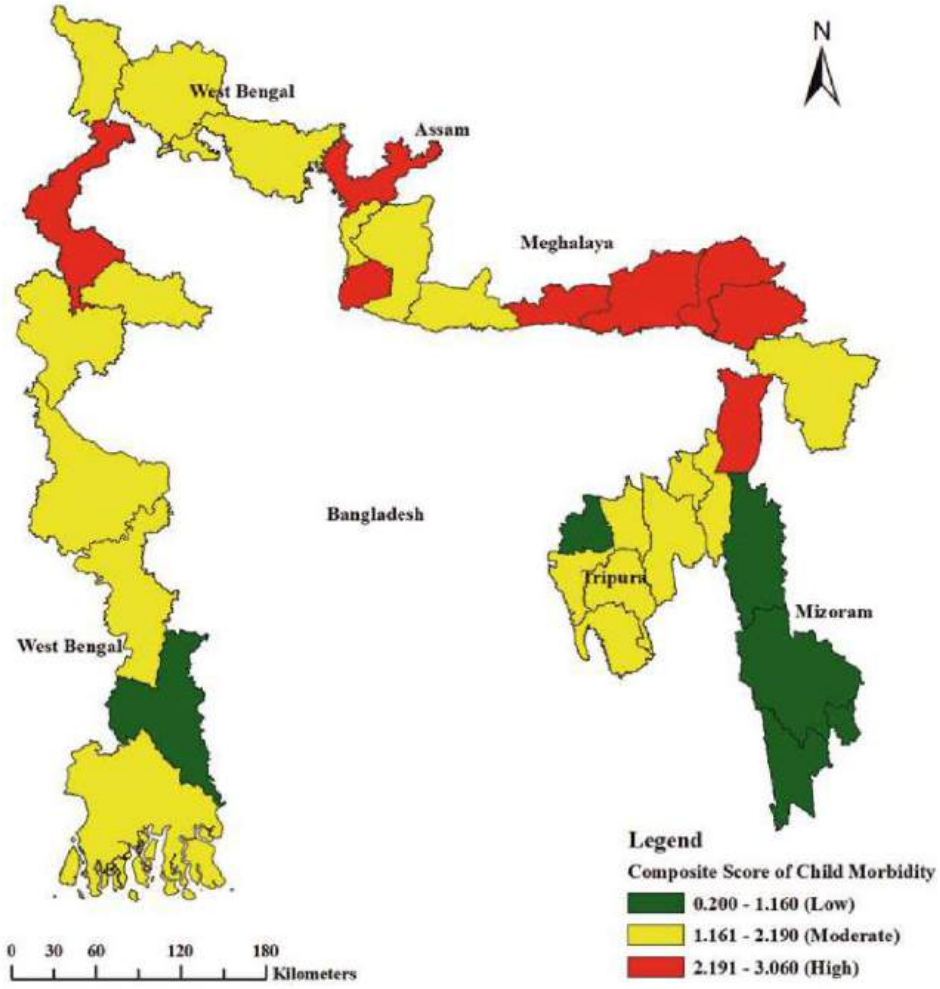

Fig. 22.4 Spatial variation of child morbidity

Table 22.2 Spearman's rank correlation coefficient with child morbidity

Spearman's rank correlation coefficient with child morbidity	Coefficient	*p*-Value
Socioeconomic condition	−0.528**	0.002
Healthcare services	−0.377*	0.037

*denotes correlation coefficients significant at the 0.05 level
**denotes correlation coefficients significant at the 0.01 level

Table 22.3 Pearson's correlation coefficient with child morbidity

Factors	Correlation coefficient	*p*-Value
Women literacy rate	−0.330	0.070
Availability of electricity	−0.495**	0.005
Availability of safe drinking water	−0.330	0.070
Improved sanitation facility	−0.488**	0.005
Use of clean fuel	−0.623**	0.000
Health insurance coverage	0.354	0.051
Use of family planning method	−0.159	0.394
4 antenatal care visits	−0.160	0.391
Institutional births	−0.462**	0.009
Fully immunization	−0.261	0.157

**denotes correlation coefficients significant at the 0.01 level

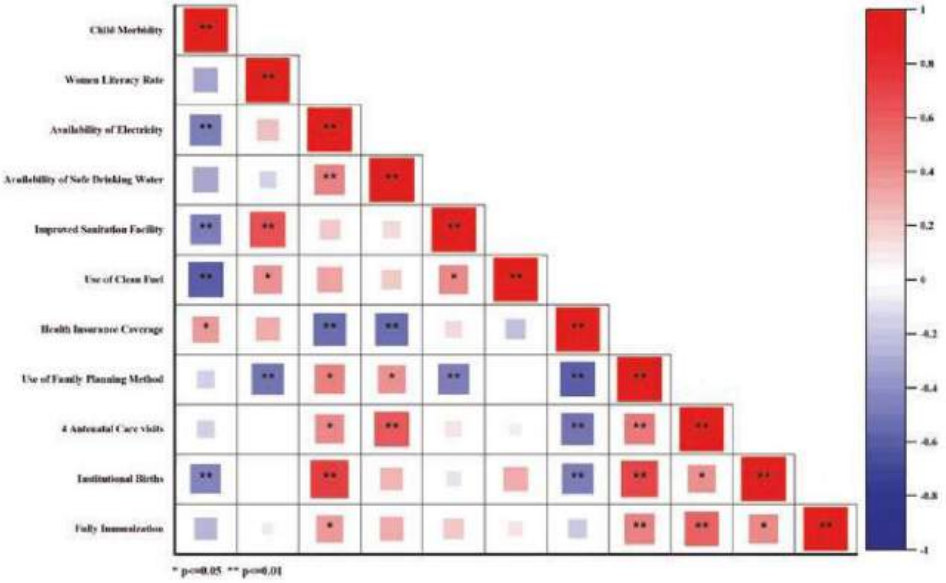

Fig. 22.5 Pearson's correlation coefficient between child morbidity and parameters of socioeconomic and healthcare status

22.4.3 Determinants of Child Morbidity

To identify the determinants of child morbidity among ten parameters of socioeconomic and healthcare status, simple linear regression has been used. Regression model implies that improved sanitation facility, 4 antenatal care visits, and institutional births have a significant impact on child morbidity and these three explain about 69% of the total variability of composite score of child morbidity. These all values are in a negative condition, which justifies that every one-unit increase in sanitation facility, antenatal care visit, and institutional birth can reduce the child morbidity by 0.57, 0.46, and 0.47 units, respectively (Table 22.4).

Table 22.4 Determinants of child morbidity using simple linear regression

Model		Unstandardized coefficients		Standardized coefficients			95.0% Confidence interval for *B*	
		B	Std. error	Beta	*t*	Sig.	Lower bound	Upper bound
1	(Constant)	3.538	0.641		5.518	0.000	2.201	4.876
	Women literacy rate	−0.610	0.692	−0.210	−0.881	0.389	−2.054	0.834
	Availability of electricity	0.724	0.682	0.270	1.062	0.301	−0.698	2.147
	Availability of safe drinking water	−0.686	0.528	−0.260	−1.298	0.209	−1.787	0.416
	Improved sanitation facility	−1.483	0.624	−0.569	−2.376	0.028	−2.785	−0.181
	Use of clean fuel	−0.516	0.512	−0.171	−1.008	0.326	−1.585	0.552
	Health insurance coverage	0.525	0.511	0.228	1.027	0.316	−0.540	1.590
	Use of family planning method	−0.611	0.722	−0.261	−0.846	0.407	−2.118	0.895
	4 antenatal care visits	−1.111	0.556	−0.458	1.997	0.006	−0.050	2.271
	Institutional births	−1.154	0.649	−0.468	−1.779	0.009	−2.507	0.199
	Fully immunization	−0.144	0.515	−0.059	−0.279	0.783	−1.218	0.931
	R^2	0.686						
	N	32						

22.5 Conclusion

The overall development of a country depends on its socioeconomic development and the health of its children. This study examines the relationship between socioeconomic conditions, access to healthcare services, and child morbidity status in Indian districts sharing border with Bangladesh. It identifies the districts with poor socioeconomic conditions and poor healthcare status where the child morbidity is high. Mamit, one of the districts of Mizoram state, has the highest socioeconomic standing and the lowest child morbidity rate, whereas Karimganj, one of the districts of Assam, has the worst child morbidity rates, with lower healthcare status and lower socioeconomic conditions.

The outcome of Spearman's rank correlation demonstrates a negative association between child morbidity status with socioeconomic conditions and healthcare services. This suggests that child morbidity can be decreased with an improvement in the socioeconomic situation and the state of healthcare services. The findings indicate that among the socioeconomic factors, electricity, improved sanitation, use of clean fuel, and institutional birth appear to be substantially associated with child morbidity status where the child morbidity can be significantly decreased with the

improvement of these facilities. Thus, the findings of the study will be helpful for the planners in developing strategies to lower child morbidity in areas with poor socioeconomic conditions and inadequate access to healthcare service.

Declaration
Funding: This work has not been covered by any grant.

Conflict of Interest: We do not have any conflict of interest regarding this article's research, authorship, and publication.

Data Availability: Data and materials that have been used in this work are openly available in different repositories.

References

Arroyave, L., Saad, G. E., Victora, C. G., & Barros, A. J. (2021). Inequalities in antenatal care coverage and quality: An analysis from 63 low and middle-income countries using the ANCq content-qualified coverage indicator. *International Journal for Equity in Health, 20*, 1–10. https://doi.org/10.1186/s12939-021-01440-3

Aziz, N., Liu, T., Yang, S., & Zukiewicz-Sobczak, W. (2022). Causal relationship between health insurance and overall health status of children: Insights from Pakistan. *Frontiers in Public Health, 10*, 934007. https://doi.org/10.3389/fpubh.2022.934007

Chen, Y. J., Chindarkar, N., & Xiao, Y. (2019). Effect of reliable electricity on health facilities, health information, and child and maternal health services utilization: Evidence from rural Gujarat, India. *Journal of Health, Population and Nutrition, 38*, 1–16. https://doi.org/10.1186/s41043-019-0164-6

Dixit, P., Dwivedi, L. K., & Ram, F. (2013). Strategies to improve child immunization via antenatal care visits in India: A propensity score matching analysis. *PLoS One, 8*(6), e66175. https://doi.org/10.1371/journal.pone.0066175

Fujii, T., Shonchoy, A. S., & Xu, S. (2018). Impact of electrification on children's nutritional status in rural Bangladesh. *World Development, 102*, 315–330. https://doi.org/10.1016/j.worlddev.2017.07.016

Goalkeepers. (2022). *2022 Goalkeepers report: The future of progress – Halfway into the sustainable development goals era, it's time to change our approach*. Bill & Melinda Gates Foundation. Retrieved March 29, 2023, from http://www.gatesfoundation.org/

Gouda, J., Gupta, A. K., & Yadav, A. K. (2015). Association of child health and household amenities in high focus states in India: A district-level analysis. *BMJ Open, 5*(5), e007589. https://doi.org/10.1136/bmjopen-2015-007589

Jain, A., Baliga, B. S., Rao, S., Shankar, M. V., & Srikanth, B. K. (2012). Does institutional delivery help in improving infant and child health care practices and health promotion related parameters? A study from Bellary, Karnataka. *BMC Proceedings, 6*(5), 1–2). BioMed Central. https://doi.org/10.1186/1753-6561-6-S5-O22

Jamwal, N. S. (2004). Border management: Dilemma of guarding the India-Bangladesh border. *Strategic Analysis, 28*(1), 5–36.

Joseph, J., Narendran, V., & Rajan, S. I. (2013). Neither here nor there: An overview of South-South migration from both sides of the Bangladesh-India migration corridor.

Kongawad, D. P., & Boodeppa, G. K. (2014). National family planning programme--during the five year plans of India. *Journal of Evolution of Medical and Dental Sciences, 3*(19), 5172–5179. https://doi.org/10.14260/jemds/2014/2569

Last, J. M. (2001). *A dictionary of epidemiology* (4th ed.). Oxford University Press.

Li, W., Liu, E., & BeLue, R. (2018). Household water treatment and the nutritional status of primary-aged children in India: Findings from the India human development survey. *Globalization and Health, 14*(1), 1–8. https://doi.org/10.1186/s12992-018-0356-7

Lister, R. (2008). Investing in children and childhood: A new welfare policy paradigm and its implications. In A. Leira & C. Saraceno (Eds.), *Childhood: Changing contexts* (Vol. 25, pp. 383–408). Emerald Group Publishing Limited.

Mallick, R. (2021). Impact of socio-economic variables and child health care on under-five child health status in West Bengal, India. *International Journal of Research Publication and Reviews, 2*(1), 146–154.

Mallick, R., Mandal, S., & Chouhan, P. (2020). Impact of sanitation and clean drinking water on the prevalence of diarrhea among the under-five children in India. *Children and Youth Services Review, 118*, 105478. https://doi.org/10.1016/j.childyouth.2020.105478

Murhekar, M. V., & Kumar, M. S. (2021). Reaching zero-dose children in India: Progress and challenges ahead. *The Lancet Global Health, 9*(12), e1630–e1631. https://doi.org/10.1016/S2214-109X(21)00406-X

National Health Mission. (2013). *Ministry of Health and Family Welfare, Government of India.* Retrieved March 29, 2023, from http://nhm.gov.in/

Pappachan, B., & Choonara, I. (2017). Inequalities in child health in India. *BMJ Paediatrics Open, 1*(1), e000054. https://doi.org/10.1136/bmjpo-2017-000054

Pradhan, J., & Arokiasamy, P. (2010). Socio-economic inequalities in child survival in India: A decomposition analysis. *Health Policy, 98*(2–3), 114–120. https://doi.org/10.1016/j.healthpol.2010.05.010

Rammohan, E. N. (2011). The Indo-Bangladesh border. *Journal of the United Service Institution of India, CXLI*(586), 1–6.

Rana, M. J., Gautam, A., Goli, S., Reja, T., Nanda, P., Datta, N., & Verma, R. (2019). Planning of births and maternal, child health, and nutritional outcomes: Recent evidence from India. *Public Health, 169*, 14–25. https://doi.org/10.1016/j.puhe.2018.11.019

Saha, R., & Paul, P. (2021). Institutional deliveries in India's nine low performing states: Levels, determinants and accessibility. *Global Health Action, 14*(1), 2001145. https://doi.org/10.1080/16549716.2021.2001145

Srivastava, S., Upadhyay, S. K., Chauhan, S., & Alagarajan, M. (2021). Preceding child survival status and its effect on infant and child mortality in India: An evidence from National Family Health Survey 2015–16. *BMC Public Health, 21*(1), 1577. https://doi.org/10.1186/s12889-021-11569-z

UN IGME. (2023). *Levels & trends in child mortality: Report 2022, estimates developed by the United Nations Inter-agency Group for Child Mortality Estimation* (p. 2023). United Nations Children's Fund.

United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development.* Retrieved March 28, 2023, from https://sdgs.un.org/

EXAMINING THE INFLUENCE OF DIGITAL MEDIA: AN ANALYSIS OF THE GORKHALAND MOVEMENT OF 2017

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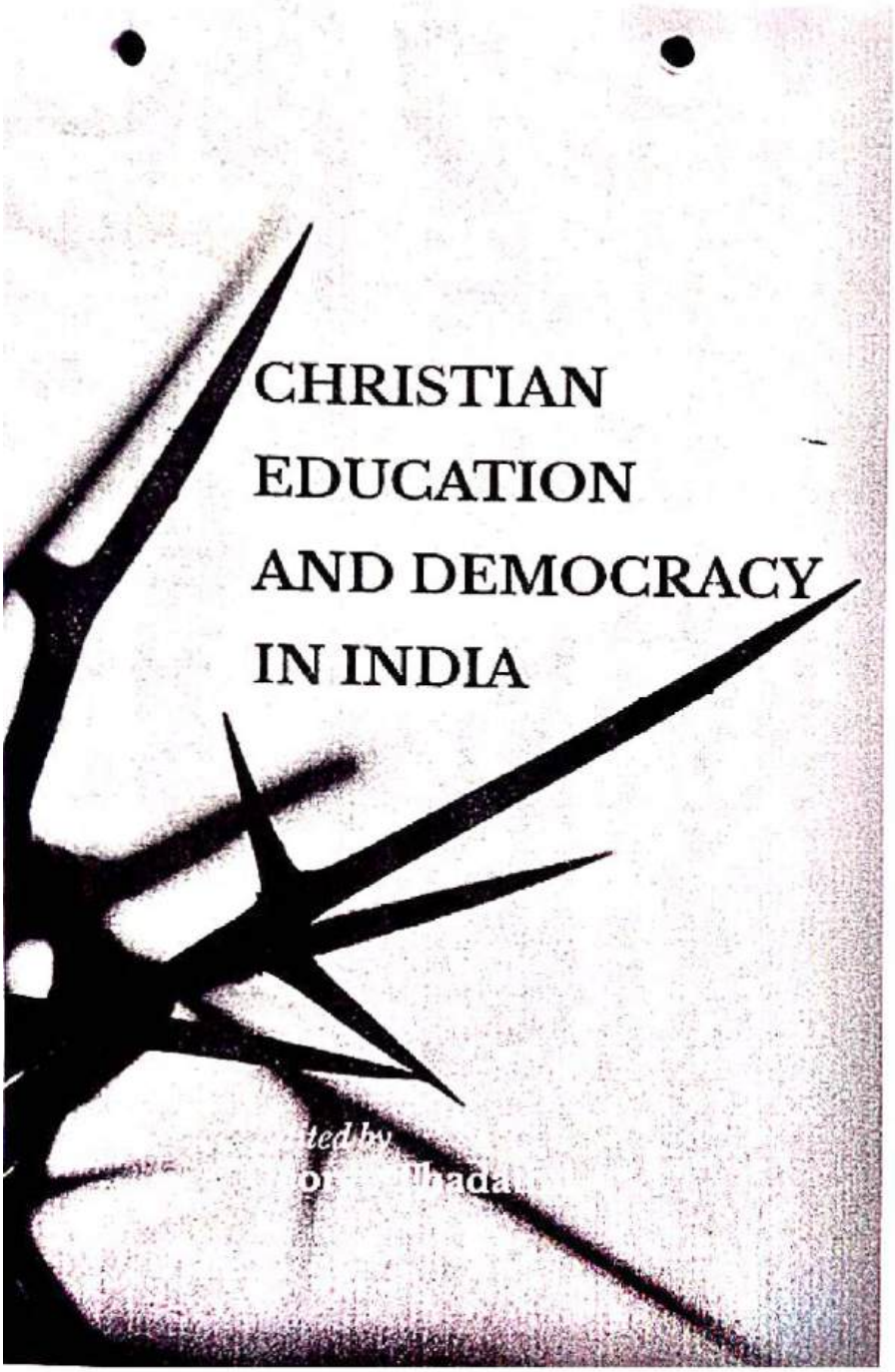
Abstract

"Regional movements" have emerged as a prominent aspect of Indian politics since the country's inception as a democratic republic. These movements are an anticipated occurrence due to India's diverse character in terms of social, cultural, and political dimensions. While various regional movements can be categorized based on their characteristics, origins, aims, duration, and intensity, it is possible to identify commonalities in the methods or approaches employed across different periods. The modus operandi that the regional movements follow can be distinctly identified from the conventional system that the movements follow. Numerous factors can be attributed to driving this evolution, but the significance of digitalization in this context cannot be overstated. Digitalization has sparked a profound revolution in how we communicate, exert influence, regulate, and share information, consequently laying the foundation for what we may call "Digital Politics." In the current landscape, digital politics has become an indispensable tool for both the movement's stakeholders and the Government. As a result, the dynamics of regional movements have undergone a significant transformation. In contrast to the traditional movements of the past that operated exclusively in physical spaces, contemporary movements now manifest on two fronts: physical, on-the-ground activities and digital platforms. This relevance is particularly evident in the Gorkhaland Movement, where digital politics has become vital in recent years. The movement has taken on new forms, evolved, and maintained its presence on digital platforms. The research intends to analyze the role of regional politics within the Gorkhaland Movement, serving as a case study illustrating the substantial influence of digital politics in regional movements.

Keywords: Digital Politics, digital Media, Gorkhaland Movement, Regional Movement, and Identity Politics.

Introduction

The popularization of the internet has introduced various approaches for sharing perspectives, viewpoints, and communication styles. The emergence of the internet has transformed the conventional concept of governance into "digital politics." This digital landscape has ushered



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07

The Role of Higher Education in Democratizing Peoples: A Local History

George Thadathil & Terence Mukhia

This co-authored chapter addresses the role Catholic higher education has played in the process of democratizing people by presenting in the first part an overview and in the second a closer look at the history of the arrival and spread of Christian Education in one location, Darjeeling, wherein this micro impact study as a participant observer has been attempted.

India is a country of 1.4 billion people with 30 million Christians. India has 42,000 colleges and 1200 universities. It has only four catholic and another four Christian universities. There are over 400 Christian-managed colleges and more than 250 among them are Catholic colleges spread across the country with higher concentration in the south of India. Their location reflects the spread of Christian communities with strongholds being in the South-West and North-East. The uneven spread and the impact of education in these institutions are making way for the increased presence of private players in higher education. The influence of these Christian educational institutions have had on society, especially in the development process and growth of specific communities is what needs to be looked at in order to assess their contribution towards the overall development of a democratic mindset in the country.

The history of Christian higher education in India is linked with the history of colonialism. Though much has been said

indigenous people of the hills make them readily wanted and amiably desired even in the metros and in the service industry given their congenial dispositions.

The learning disabilities that are structured into the poor village-level education, and lack of adequate qualified teachers have to be helped overcome with the assistance provided by way of institution-level remedial coaching and additional opportunities for performance. The interactions with students from other campuses and engagements with the local youth for recreational and social awareness-related activities strengthen the personality formation of the graduate. The approach to study seen more in terms of its applicability comes easier to a lot many of the tribal students than the abstract thinking processes. However, the easy polarisation of the capabilities of students from diverse communities cannot be substantiated as over the years one does observe the qualitative improvement of new generations of students from an erstwhile average educational background. It substantiates the general claim that education is a proven agent for the overall enhancement of the capabilities of a people.[45] The value modulation in the process is a factor needing further assessment in as much as it might seem that the more educated one becomes the rethinking of the given values and received notions of propriety undergoes scrutiny and it gives way to a phase of uprootedness and alienation prior to reconciliation and recovery of self.

[45] "The demand for English medium schools in Darjeeling has increased and is still one of the important needs. The Christian Educational Institutions in Darjeeling having always given importance to English language as a medium of instruction ... have not only captured the aspirations of the people but also placed them in a position to avail of the global openings in the job market." (Madhyam Moktan, "A Glimpse of Christian Educational Institutions in Darjeeling and English Language" in *Salesian Journal of Humanities & Social Sciences*, Vol. VI, No. 2 (December 2015) ISSN: 0976-1861 | DOI: 10.51818/SJHSS.06.2015.105-111 | Page No: 105-111)

The Christian contribution to the world of education, whether it be in the small village of Sonada, in India or in the modern city of Avila, in Spain consists probably in addressing the fundamental question of what it means to 'be' or even better to 'become' a Christian or be a sympathizer to the Christian Vision today. The openness to the 'other' of another faith, another language, another culture in the very process of one's self-understanding helps reconfigure the given normativity and aspire for new grounds of relational, non-dogmatic dialogical existence. The coming together of universities from across the world can create a cross-fertilization of Inter-denominational and Inter-religious uniqueness in terms of its openness to the other as witnessed in earlier centuries in this very land.[46]

[46] The first part of this chapter is a modified version of the original presentation made at the World Conference of Catholic Universities, Avila, 12-14 August 2011, under the Core Area: The Catholic University's response to the Great Challenges of Humanity, in the Sub theme: The influence of *catholic university education* on society in the XXI century and was entitled: "The Role of Catholic Institute of Higher Education in Democratizing Peoples". For more about the organization of International Federation of Catholic Universities, see http://www.fiuc.org/rubrique23_en.html The Location of Avila in Spain, where the conference took place is the point of reference for the concluding comment. The second part is a revised version of the earlier published article by Terence Mukhia and George Mathew, "Impact of Christian Educational Enterprises on the Natives of Darjeeling Hills" in *Salesian Journal of Humanities and Social Sciences*, Vol. VI, No. 2, "Christian Education and Making of Democratic India," (December 2015): 93-104.

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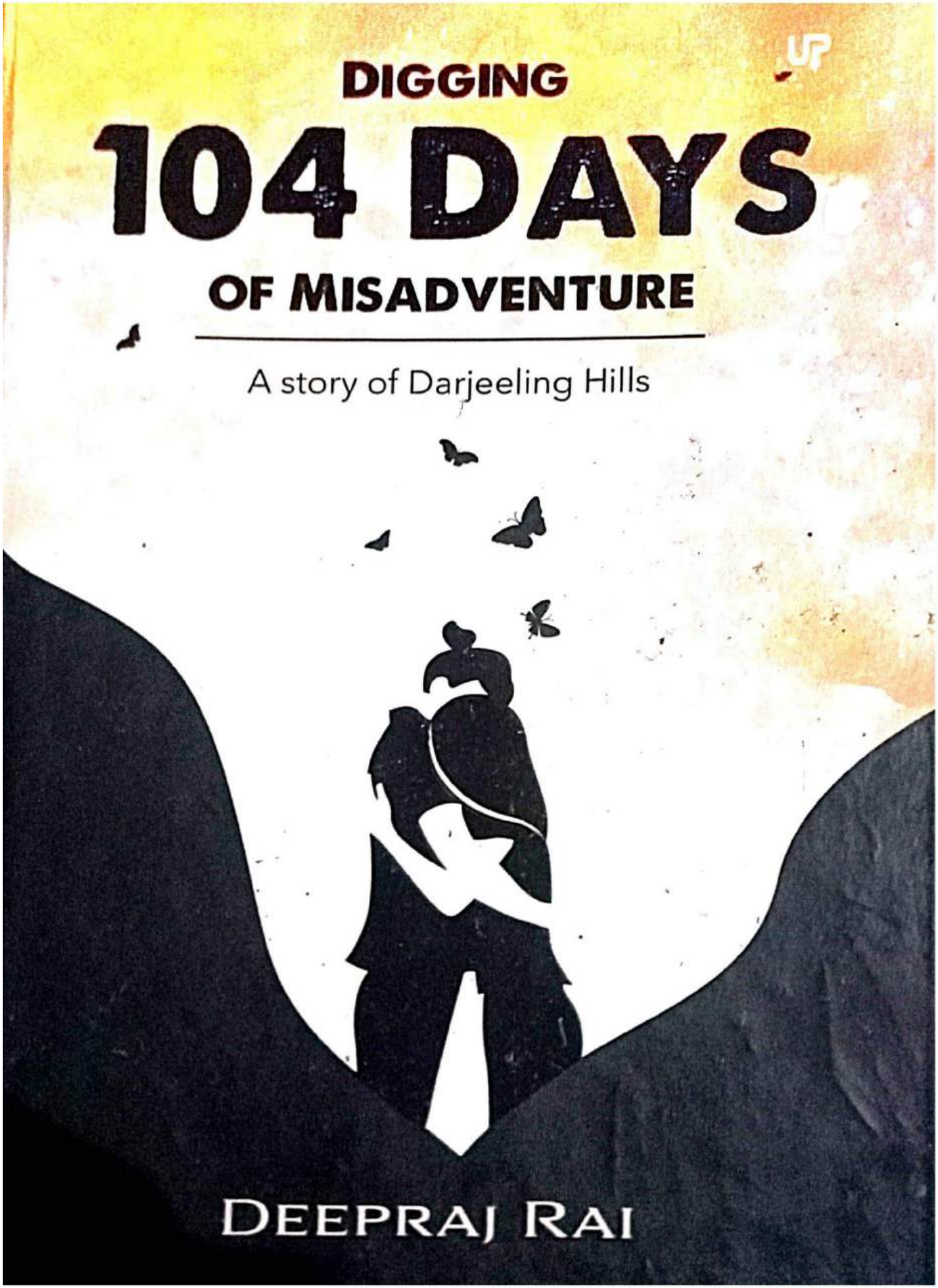

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DIGGING
104 DAYS
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A story of Darjeeling Hills

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In 2017, there is yet another revolution in the Darjeeling Hills. This time, the statehood revolution was sparked by claims of the alleged imposition of Bengali language into state schools, including those in the hills, leading to the longest-ever closure of 104 days, which effectively brought the entire Northern West Bengal hills into a stand still. The three young people from the hills, Dhiraj, Sachita, and Arun, became entangled in a revolution-related upheaval that they were unable to escape. These main characters in the book provide a window into trauma and colossal denial. It is the first novel to fictionalize the 104-day devastation and suffering that the entire Darjeeling Hills experienced.

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