URBAN DYNAMICS AND URBAN SPRAWL IN HILL STATIONS OF INDIA: A CASE STUDY OF SHILLONG CITY

F PHIBAWANLANG KHARPRAN[1]*, SUBRATA PURKAYASTHA[2]

[1]School of Human and environmental sciences, North Eastern Hill University, Shillong, India
[2]Department of Geography, School of Human and Environment Sciences,
North Eastern Hill University, Shillong, India
*Email: phibawanlang@gmail.com

Abstract
The hill stations of India are remnants of colonial past built by the British where the scenic landscape and climate similar to Britain attracted the British to set up cantonments and sanatoriums for the British troops and their families. Shillong City whose origin dates back to the 19th century, was the British capital of Assam Province, the administrative seat of undivided Assam after India's Independence and at present the capital of Meghalaya. The city's growth resulted from the continuous influx of population to fulfil the changing socio-economic and political dynamics of the city. This hill station was built by the British with a vision to house a population of less than one lakh. It was then a cluster of a few scattered hamlets, which at present has grown tremendously with 12 contiguous urban units forming the Shillong Urban Agglomeration (SUA). With the help of RS -GIS using Shannon entropy technique as a landscape metric, the urban sprawl of Shillong has been measured from the year 1991 to 2021.The rapid growth has led to an urban sprawl which poses various challenges to the city's environment.

Keywords: Urban growth dynamics, Spatio-temporal analysis, urban sprawl, Shannon entropy, Remote Sensing and Geographical Information System

1. Introduction

The hill stations of India are remnants of the British Raj, located at higher elevations from the nearby plains and valleys usually in the mountain ranges and plateaus of India. The origin of hill stations as urban centres can be traced back to the early 19th century they initially emerged as sanatoriums for recouping ailing British officers and families (Kumar, 2022), but soon the salubrious climate of the hill stations and the scenic beauty attracted the colonial rulers to set up home away from home. The Hill station soon emerged as centres of power where most of the cantonments got located, with this came the British families and their children, which resulted in the opening up of schools to cater to European children which later emerged as boarding schools making the hill stations into educational hubs. Just after the Sepoy Mutiny in 1857, there was a common distrust of the British towards the natives, the hill stations emerged as the exclusive domain of the British where they found refuge from the heat and dust of the Indian plains, especially

during summer and soon they preferred to rule from here (Shekhar, 2018). In the 1860s Shimla, a hill station was declared the summer capital of the British Raj. The major hill stations which emerged are Ottacamund, Kodaikanal, Munnar etc. located in the mountains and plateaus of south India and Darjeeling, Mussoorie, Nainital, Shimla, Shillong, etc. located in northern and eastern India nestled mostly in the Himalayan ranges, except Shillong being located in the highest part of Meghalaya plateau.

Shillong in 1864 was chosen as a Sanatorium for the British officials. Its salubrious climate attracted the British officials to shift their station from Sohra located on the southern slopes of the Meghalaya plateau to Shillong a small hamlet in the northern slopes of Shillong ridge or the Khasi hills, the highest part of the plateau. Accordingly, the land was acquired by British officials from the tribal chiefs or Syiem of Mylliem in exchange for 2000 rupees (Syiemlieh, 1989). By 1874 it emerged as the Capital town of the undivided Assam province. Since its inception as an urban centre, Shillong has been growing. The Shillong Municipality was created in 1904 and this town was built to house a population of less than 10,000. Like most of the Hill stations, the urban centres created by the British suffer from problems of unplanned urbanization suggesting urban sprawl in a fragile environment, leading to various environmental issues.

Robert Pennock (2006), in the Encyclopaedia of Human Geography edited by Barney Warf, has clearly defined Urban sprawl, stating that, "The term urban sprawl is associated with the growth, form, and composition of urban areas and has several commonly used meanings. First, existing development within the generally accepted bounds of an urban or metropolitan area is referred to as urban sprawl is characterized by low-density/intensity uses that are mostly segregated from one another and spread out over the landscape. Second, new development that occurs at the urban fringe or in surrounding rural areas is referred to

as urban sprawl particularly if it is scattered (i.e., interspersed with undeveloped lands), leaps over undeveloped lands, or radiates out from the existing urban area (typically along roadways). Third, the process of urban growth generally characterized by the outward expansion and de-concentration of urban activities and land uses into the surrounding countryside is referred to as urban sprawl".

Urban sprawl has been viewed by several scholars as an undesired form of urban growth. Although an accurate definition of urban sprawl is a subject of debate, a consensus is that urban sprawl is characterized by an unplanned pattern of urban growth, driven by a multitude of processes and leading to inefficient utilization of resources. This form of urban growth usually poses serious implications on the availability and accessibility to basic urban amenities and infrastructural development of the area (Sudhira et al. 2004, Bhatta et al 2010).

Location And Extent of The Study Area

Shillong city is the capital of Meghalaya, one of the small states in India. It forms the Shillong Urban Agglomeration (SUA) consisting of 12 urban unit viz. Shillong municipality, Shillong cantonment and the census towns (Mawlai, Pynthorumkhrah, Nongthymmai, Madanriting, Nongmynsong, Umpling, Mawpat, Nongkseh, Umlyngka and Lawsohtun). The Shillong Urban Agglomeration have an area of 60.82 sq.km with a latitudinal and longitudinal extension of 25°66' N to 25°55' N and 91°86' E to 91°95' E respectively. The altitude of the area varies between 942 metres to 1927 metres above mean sea level, an average altitude of 1,496 m above sea level, with the highest point being Shillong Peak at 1,966 m. It is linked with Guwahati, the capital of Assam by National Highway 40 at a distance of about 100 km. There is a minor airport at Umroi, 35 Km from Shillong. The location map of Shillong city is shown in Figure 1.
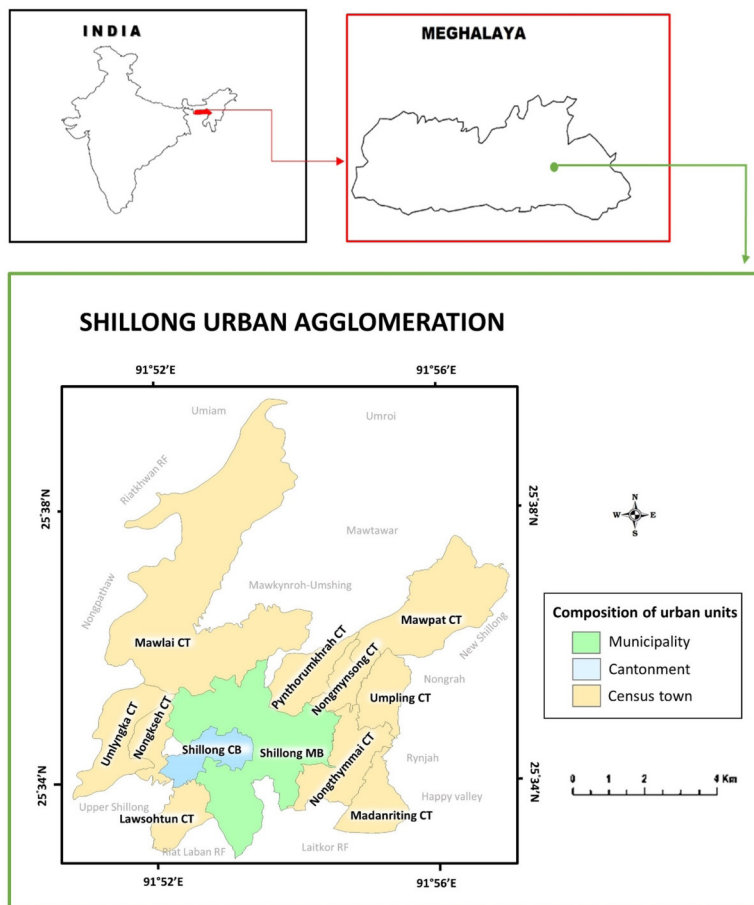
Fig. 1. The figure above shows the location of Shillong Urban Agglomeration in the state of Meghalaya and India. The location of the different urban units forming the agglomeration and their composition is clearly depicted in the map

Objective Of the Paper

The main aim and objective of the present paper is firstly, to highlight the urban dynamics since the time of its origin which led to the growth of the city. To analyze the urban sprawl of Shillong Urban Agglomeration and examines the environmental challenges which this hill station faces.

2. Materials and methods

This research paper uses remote sensing and GIS technique in conjunction with analysis of secondary data. The data base and methodology followed is clearly described as follow:

Materials Used

- Secondary data on population has been derived from Census of India which include District Census Handbooks for the year 1991, 2001 and 2011; and relevant reports from different government agencies.
- For analysing the urban sprawl of the study area, the present work uses two thematic layers (administrative boundary and built-up area). Survey of India Toposheet No 78 O/14 at a scale of 1:50,000 was used to identify

the administrative boundary of SUA. Landsat Satellite imageries: Landsat-5, Landsat-7 and Landsat-8, were downloaded from USGS Earth Explorer for the years 1991, 2001, 2011 and 2021. ArcGIS 10.4 have been used for digitizing the built-up area and sprawl analysis of SUA.

Methodology

The methodology followed for the present work is given as follow:

- Firstly, the urban dynamics of Shillong city has been discussed by analysing the population growth and the distribution of population of the SUA and its different units from the year 1901 onwards, the statistical diagram presented is base on the data provided in Census reports of India.
- Secondly, the boundary of SUA has been digitized using GIS software from the Toposheet number 78 O/14. The satellite imageries for the years 1991, 2001, 2011 and 2021 were processed in the software to obtain the built-up area.
- Using different tools of analysis, the spatial distribution of built-up area within the boundary of SUA was observed for each temporal span (1991-2001-2011-2021), by dividing the area into concentric buffer zones of 1km intervals from the city centre and into four cardinal directions zones i.e. North-West, North-East, South-East And South-West (clockwise at 90-degree interval).
- For analysing urban sprawl Shannon entropy method was adopted following Bhatta (2009). Shannon entropy measures the distribution of variables or uncertainty of the occurrence of a variable in a data set. Using Microsoft Excel software the Shannon entropy value (Hn) has been computed with the help of the equation as follows:

$$H_n = - \sum_{i=1}^{n} P_i \ log_n(Pi)$$

where, Pi = proportion of the variable in the 'i' column (i.e., the proportion of built-up area in '*i*' zone, calculated by: percentage of built-up area in 'i' zone/sum of percentage built-up area for all zones) and N=total number of observations. The entropy value has been calculated separately for each cardinal Direction zone. The total number of observations or N = 10 (which is the total number of buffer zones in the study area) and the computed value of log(N) = 2.30. The value of entropy ranges from 0 to log(N). A value of 0 indicates that the distribution is very compact and concentrated, while values closer to log(N) reveal that the distribution is much dispersed. Higher values of entropy indicate the occurrence of sprawl.

3. Results and discussion

Urban dynamics and population growth of Shillong City

Urban growth results from many factors such as economic, political, demographic, socio-cultural technological development etc. Michael Pacione (2005) in his book Urban Geography: A Global Perspective states that "Demographic changes are among the most direct influences on urbanisation and urban change. Movements of people, into and out of cities, shape the size, configuration and social composition of cities. Shillong since its inception has grown rapidly as a resulting from the on-going urban dynamics.

The values in Figure 2. and Figure 33 illustrate the growth rate of population and its distribution among the different urban units since its first census recorded in 1901. After Independence Shillong saw a spurt in its growth as the decadal growth rate of the population was 53.2% in 1951. In 1961 the growth rate was 75% since new towns were included in the agglomeration and SUA expanded spatially; the urban units within SUA included the Shillong cantonment, Shillong Municipality and the townships of Mawlai and Nongthymmai with a population of around 100,000 persons. Shillong thus
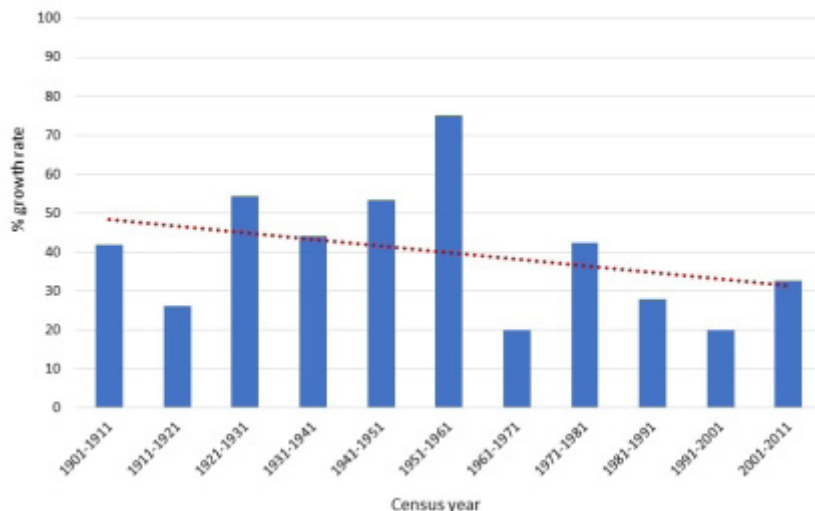
Fig. 2. The chart shows the decadal growth rate of population in percentage since the first census recorded in 1901 for Shillong/ Shillong Urban Agglomeration. (Data source: Census of India, 2011)
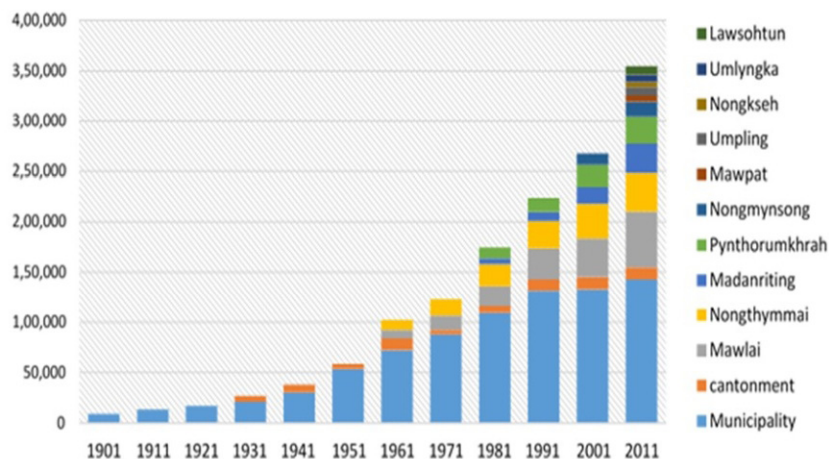

Fig. 3. The composite bar diagram shows the distribution of population among the different urban units of Shillong Urban Agglomeration from the decade 1901 to 2011 as recorded in census of India

emerged as an urban agglomeration and retained its capital status of the state of undivided Assam. The high rate of population growth in the 1951 and 1961 censuses can be attributed to the fact that with the partition of the country, a segment of the Hindu population from adjacent East Pakistan seek refuge here. After independence, Shillong like other hill stations of India changed and became more populous due to both natural increase and migration.

In 1971 Meghalaya attains statehood and was created from the hill districts of Khasi- Jaintia and Garo hills of Assam, this was in response to the hill state movement of the three major tribes who were seeking self-determination under the constitution of India. At that time SUA consisted of 4 units and the decadal population growth was 19.88% which is less than the previous decade's growth rate. As the offices of Assam government shifted from Shillong to Dispur

the new capital of Assam, with this a good chunk of the population also shifted. But Shillong still retained its capital status as the most important and largest urban centre of the newly created state of Meghalaya where besides administrative functions and educational institutions, trade and commerce emerged, with it the size of the urban agglomeration increased to include 12 units of which 10 are census towns supporting a population of 3,50,000 (2011 census).

It is important to mention here that as per Niti Aayog's report (2021), the census towns of India are rural entities suggesting unplanned haphazard urban growth lacking in basic urban amenities. Such urban centres were outside the preview of planning till recently and are outgrowths due to rapid population increase. These often manifest spatially into urban sprawl. To further understand the processes leading to urban sprawl a spatio-temporal analysis of built-up area is made in the following paragraph.

Zone-wise spatio-temporal analysis of the built-up area in SUA

Several scholars have done a spatio-temporal analysis for measuring urban growth emphasising the expansion of the built-up area. (Kumar et al 2018, Shaw and Das 2018, Verma et al 2017). The scholars observed the growth of built-up in urban
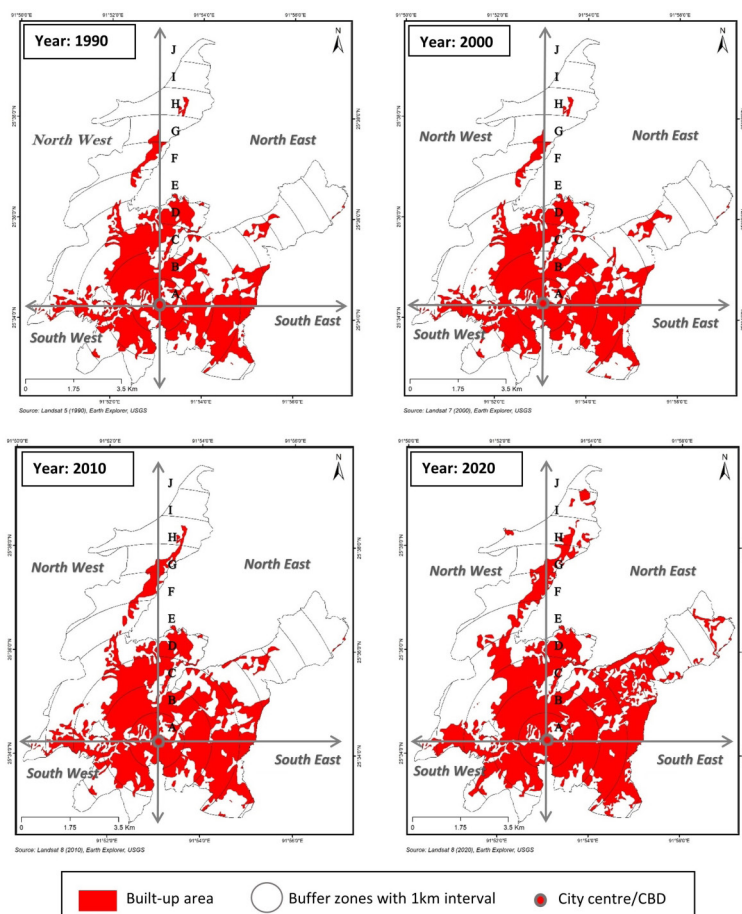

Fig. 4. Shows the distribution of built-up area in Shillong Urban Agglomeration for different time period. The distribution of built-up area is shown in concentric buffer zones of 1km interval from the city centre (which is the earliest settlement of the area) and how it spreads in four cardinal direction zones. Data source: prepared by author

areas by dividing the area under observation; either into cardinal direction zones to know the direction of growth or by using buffer or concentric ring zones from the city centre to analyse the distribution based on distance location. In this paper, both the mentioned techniques are followed to analyse spatial growth of built-up area which is illustrated in the map (Fig. 4).

A buffer analysis of built-up area for each direction zone, from the year 1991 onwards is presented in Fig- 5. It indicates that with the increasing distance from the city centre, the percentage of built-up area decreases. However, the percentage of built-up area in the buffer zone covering the outer rings has increased in every decade suggesting a horizontal spatial growth. The city's spatial growth is solely influenced by the growing population which results in an ongoing population spill from the core urban unit which is the Shillong Municipality to the surrounding periphery rural villages. These rural villages over the years have attained

the status of the census town and got agglomerated into the city. It is interesting to note that both the South-East zone and South-West zones of SUA show an uneven pattern of built-up distribution. The presence of steep slopes and highly forested areas of the Shillong range in the South hinders developmental activities in these areas. The effect of relief features on urban growth is also noticed in the North West zone. The deep valleys in the western part of the city prevent the urban spill towards the west (i.e. the northern part of Nongkseh and Umlyngka) but are directed towards the east in the northern part of Mawlai (Mawiong area) where the highway NH-40 serves as a growth impetus. Thus, rapid growth in the concentration of built-up area is very evident in the North East Zone. In 2021 the concentration of built-up area was higher in all the buffer zones as compared to the last three decades suggesting rapid urban sprawl. However, the highest concentration of built-up area is observed in the North-Eastern direction.
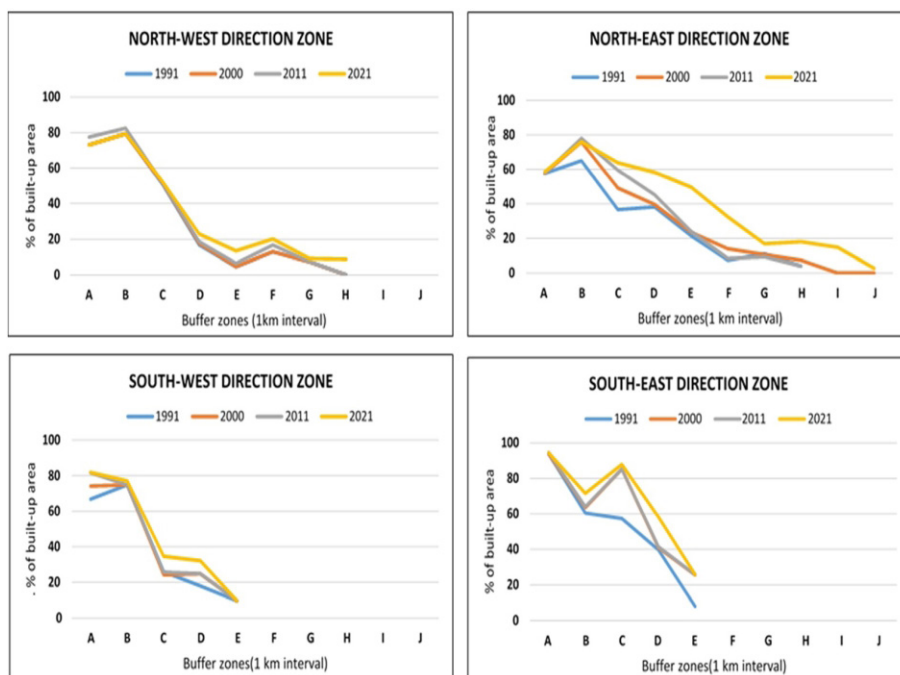

Fig. 5. The diagrams show the trend of distribution of built-up area (in percentage) for the year 1991-2001-2011-2021 with a buffer interval of 1km from the city centre, in different direction zones of the Shillong Urban Agglomeration. Data source: prepared by author

This rapid physical expansion of SUA is due to the presence of the new Shillong Township which is being developed by the Government of Meghalaya towards the north-eastern part of the city. The New Shillong Township was initiated in the 1990s as a response to the concerns about the expansion of the built-up area in the southern part of the city, which is an ecologically sensitive zone being the highest part of the plateau.

Urban sprawl analysis

From the above analysis, one can visualise that the direction of growth in the SUA is mostly towards the north and north-eastern direction. Features of urban sprawl are noticed (Fig. 4) in the North-west zone, where the growth is concentrated in a linear form along the main artery towards the north i.e. the National Highway NH40 connecting Shillong and Guwahati and a discontinuous urban growth or frog leap type of urban sprawl is also noticed in the North-East direction, especially towards Mawpat area.

Analysis of urban sprawl using Shannon entropy

To determine whether the urban growth within the boundary of SUA has taken the form of urban sprawl or not, an analysis was made using Shannon entropy which helps in quantifying urban sprawl. The entropy value ranges from 0 to log(N). The log(N) value computed for the study area is 2.30. The entropy values calculated as given in Table-1 highlights that, the entropy value in different zones of SUA for different periods

i.e. from 1991 to 2021, is higher than the halfway mark of log(N) i.e. 1.15, in all four zones. As the entropy values are much higher than the halfway mark of log(N), the city is said to be experiencing sprawl with an increasing tendency. The entropy value has been increasing since the year 1991, which means these zones are sprawling, especially towards the North East zone which has the highest entropy value of 2.06 in the year 2021. This can be attributed to the fact that under the Greater Shillong Master plan area, the new township of Shillong is planned here, taking advantage of these various institutes and new settlements have come up here.

Pattern of urban sprawl in SUA

The land use map prepared for the year 2020 (Fig-6) clearly shows the city is experiencing an urban sprawl; since we are noticing leaps of built-up area over undeveloped lands such as forest cover, agricultural land, and waste land etc., especially in the North East direction zone. This frog leap pattern of built-up distribution is noticed in Mawpat town. This interspersed distribution of built-up area is also noticed in the west direction zone. The built-up patches here, leap over forest lands and take a ribbon pattern distribution outward from the main built-up area, along the National Highway passing through the Mawiong area of Mawlai Township.

The land use pattern is changing in Shillong and the fragile environment of the hill station is crumbling under population pressure and infrastructural growth resulting

Table 1. Shannon Entropy Value in Four Direction Zones of SUA (1991-2021)

Year	Northwest direction	Northeast direction	Southeast direction	Southwest direction
1991	1.57	1.80	1.43	1.37
2001	1.57	1.85	1.52	1.38
2011	1.60	1.78	1.52	1.37
2021	1.78	2.06	1.43	1.42

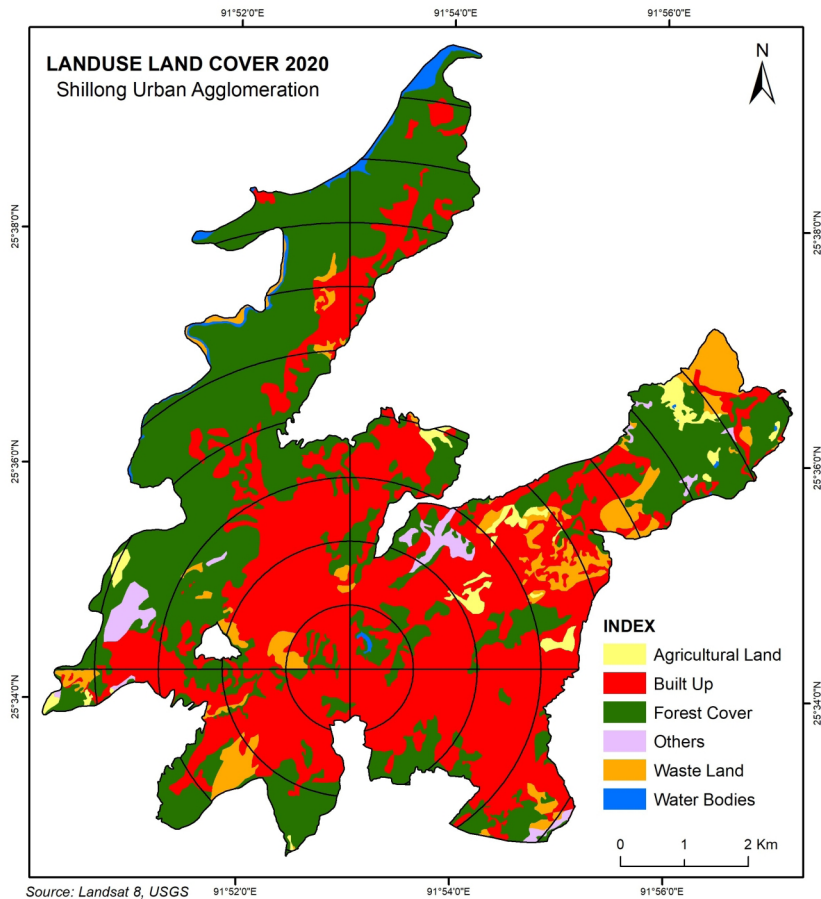Natural Log(N) Or Log_n (10) = 2.30 (Source: Author's Calculation)

Fig. 6. The map prepared by the author, shows the distribution of the different categories of Land-use/Land-cover within the boundary of Shillong Urban Agglomeration in the year 2020

in urban sprawl. The unplanned haphazard growth of settlements on the slopes resulting in soil erosion and deforestation triggering landslides and improper drainage facilities causes urban floods, traffic bottlenecks are common here as the roads cannot be widened not only due to terrain characteristics but also land laws which restrict the acquisition of land from the tribal areas under the Sixth Schedule of the constitution of India. These factors are making the city center more congested and hinders urban planning causing urban sprawl in Shillong and its surrounding.

4. Conclusion

Urbanization of SUA is neither planned nor addressed, besides the cantonment and Shillong municipality all the other units of SUA are census towns and rural entities being part of the urban sprawl impacting the fragile environment of the hill station. The Niti Aayog Report 2021 mentions that if we are to achieve clean and healthy cities, urban planning needs to be revamped where there is coordination between the professional urban planners, the administrators and citizens along with the understanding of multiple disciplines like economics, finance, project management, architecture, engineering, sociology, demography, mapping technology

etc. to make plans more specific and goal-oriented in addressing the unique problems associated with the personality of the urban area, in this case, a hill station. Hence implementing the plans which need to be followed by feedback and review for future courses of action is the need of the present hour.

Declaration

The authors declare that there is no conflict of interest. The research work is part of an ongoing PhD thesis of the author, titled: "Spatio-temporal analysis of urban growth in Shillong urban agglomeration and quality of life". The work has not been published nor under consideration for publication in other journals.

5. References

NITI Aayog annual report 2020-2021, Government of India.

Paul, S., & Dasgupta, A. (2013). Spatio-temporal analysis to quantify urban sprawl using geoinformatics. International Journal of Advances in Remote Sensing and GIS. 2277 – 9450

Census of India 2011 - Meghalaya - Series 18 - Part XII A - District Census Handbook, East Khasi Hills. (2021, June 3). https://censusindia.gov.in/nada/index.php/catalog/862

Bhatta, B (2009) Analysis of urban growth pattern using remote sensing and GIS: a case study of Kolkata, India, International Journal of Remote Sensing, 30:18, 4733-4746, DOI: 10.1080/01431160802651967

Bhatta, B., Saraswati, S., & Bandyopadhyay, D. (2010). Urban sprawl measurement from remote sensing data. Applied Geography, 30(4), 731–740. https://doi.org/10.1016/j.apgeog.2010.02.002

Sudhira, H., Ramachandra, T. V., & Jagadish, K. S. (2004). Urban sprawl: metrics, dynamics and modelling using GIS. International Journal of Applied Earth Observation and Geoinformation, 5(1), 29–39. https://doi.org/10.1016/j.jag.2003.08.002

Shaw, R., & Das, A. (2018). Identifying peri-urban growth in small and medium towns using GIS and remote sensing technique: A case study of English Bazar Urban Agglomeration, West Bengal, India. The Egyptian Journal of Remote Sensing and Space Science, 21(2), 159–172. https://doi.org/10.1016/j.ejrs.2017.01.002

Verma, S., Prakash, S., & Mandal, N. R. (2017). Analysing Urban Sprawl and Shifting of Urban Growth Centre of Bengaluru City, India Using Shannon's Entropy Method. Journal of Settlements and Spatial Planning, 8(2), 89–98. https://doi.org/10.24193/jssp.2017.2.02

Kumar, M., Singh, R. P., Pravesh, R., Kumar, P., Tripathi, D. M., & Sahu, N. (2018). Urban Growth Dynamics and Modelling Using Remote Sensing Data and Multivariate Statistical Techniques. Current Science, 114(10), 2080. https://doi.org/10.18520/cs/v114/i10/2080-2091

Kumar, A., Sharma,S., Saini,A., Shrivastava,B., Kumar,G. (2022). Evolution of Indian Hill Stations During the British Era: Problems and prospects of development. Journal of the International Society for the Study of Vernacular Settlements, 9(2), 114-129. https://isvshome.com/pdf/ISVS_9-2/ISVS9.2.8Ashwani_Kumar.pdf

Pacione, M. (2005). Urban Geography: A Global Perspective. In Routledge eBooks (2nd ed.). London. https://doi.org/10.4324/9780203023525

Pennock, R. (2006): Urban sprawl. In: Warf, B. (Ed) (2006): Encyclopaedia of Human Geography. SAGE Publications. New Delhi. Pg. 527-528.

Shekhar, R. (2018). Hill Stations in India: Growth and Challenges. The research journal of social sciences. 9(12). ISSN 0025-1348 (P), 2456-1356 (O)

https://www.researchgate.net/publication/339078328

Syiemlieh, D.R., (1989). British Administration in Meghalaya: Policy and Pattern, Heritage Publishers, New Delhi.