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Estimation of Sediment Yield Rate in the Lower Tlawng Watershed, Mizoram

- Ch. Udaya Bhaskara Rao

Abstract : *Siltation is a serious environmental threat in Mizoram due to unfavourable topographic setting as steep slopes are composed mainly of fragile sedimentary terrain. The present paper is an attempt to study river Tlawng which is the longest river inside Mizoram that drains the state in the central part of the state. The quantitative assessment of discharge and subsequent erosion in the lower Tlawng watershed which spreads in an area of about 490 km^2 has been made in this study to estimate total run-off and resultant siltation with the help of some significant shape parameters of the watershed such as compactness co-efficient index (Cc), circularity ratio (Cr) and roundity factor (Rf). The total sediment yield in the watershed 18210 ha-m/100 km^2/year reveals that the watershed is under high priority zone and needs immediate soil conservation measures to check or at least to minimize further erosion.*

Introduction

Climate, topography, vegetation and lithology of a watershed play a major role in the run-off and subsequent sediment yield. Similarly, the human intervention in the form land use changes has a great influence on the discharge and soil erosion in a drainage basin. Moreover, the morphology of landforms in a drainage basin also has its impact on the magnitude of soil loss and quantum of run-off. The extent of soil erosion depends on various physical and geographical factors such as intensity of rainfall, topography, low soil organic matter content, percentage and type of vegetation, inappropriate farming practices and land marginalization or abandonment (Vukelic-Shutoska *et al*., 2011). It is very much essential to understand the shape of a watershed, the existing topography and the drainage pattern in order to understand the discharge volume in a basin. Mizoram is a highly undulating mountainous terrain composed of several Tertiary sedimentary formations (Ganju, 1975). Water induced erosion is dominant in the terrain with high slopes due to complex physical and geographical conditions together with uncontrolled logging (Spalevic *et al*., 2012). As the topography is young and immature erosion is prevalent in this region. In addition, rainfall is also found to be very high which accelerates erosion causing siltation in streams and rivers thereby reducing their carrying capacity. As the unchecked erosion may lead to physical degradation of land, it is essential to quantify erosion and subsequent sedimentation in order to take appropriate measures for soil conservation at least at watershed level. The present study is an attempt to quantify siltation in the

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lower Tlawng watershed with the help of drainage morphometric parameters.

Materials and Methods

The watershed boundary and drainage network have been delineated from 1:50,000 scale toposheets 84A/9, 84A/10 and 84A/11. The method of Strahler's ranking of streams has been employed for stream ordering in the watershed. The methods proposed by Horton (1932 &1945), Miller (1950), Schumm (1956), Strahhler (1952, 1954, 1956, 1957 & 1964) and Gravelius (1914) have been used to compute various drainage parameters. Digital elevation model at 30 m resolution acquired by Shuttle Radar Topography Mission has been downloaded from United States Geological Survey website used to identify various morphotectonic elements and erosion prone zones. ArcGIS software has been used to digitize drainage network, drainage density and for preparation of slope map of the watershed. Soil erosion intensity zones map has been prepared based on the integration of slope and drainage density layers with the help of ArcGIS software.

Background of the Study Area

The Tlawng watershed is located between $92^0$38'48"-$92^0$38'22" longitudes and 23^0 51'38"-$23^0$26'58" latitudes (Figure1). The watershed falls in five districts including Kolasib, Mamit, Aizawl, Lunglei and Serchhip. It spreads in an area of about 490 km^2 and stretched in north-south direction. The watershed code is 3C2A8 as per watershed atlas of India. It is bounded by the river Tuirial on the east and south, river Tut on the west and north. These rivers run parallel to the river Tlawng. The area is composed of sedimentary rocks such as sandstones, siltstones and shale. The watershed area experiences humid tropical climate with an average annual rainfall of about 250 cm. The main river Tlawng originates at an elevation of about 1395 m above mean sea level in Zopui hills at about 8.5 km east of Lunglei town and runs over a length of about 300 km in Mizoram before its confluence with river Barak in Assam. The Tlawng river flows towards north and it is controlled by faults and fractures to the major extent. Tropical forest spreads over the entire watershed. The total length of the river Tlawng in the watershed is about 134 km. Lengpui, Ailawng, Lungleng-I, Sairang, Samtlang, Khawrihnim, N. Lungleng, S. Sabual and Darlung are the villages located in the watershed with a total population of 12,894 according to 2011 Census. Lau lui, Serlui, Chantelui, Tuikuallui, Durlui, Changpuilui, Kurunglui, Setlaklui and Chengkawllui are the major perennial tributaries to the river Tlawng in the watershed.

Drainage Analysis

Drainage morphometric analysis

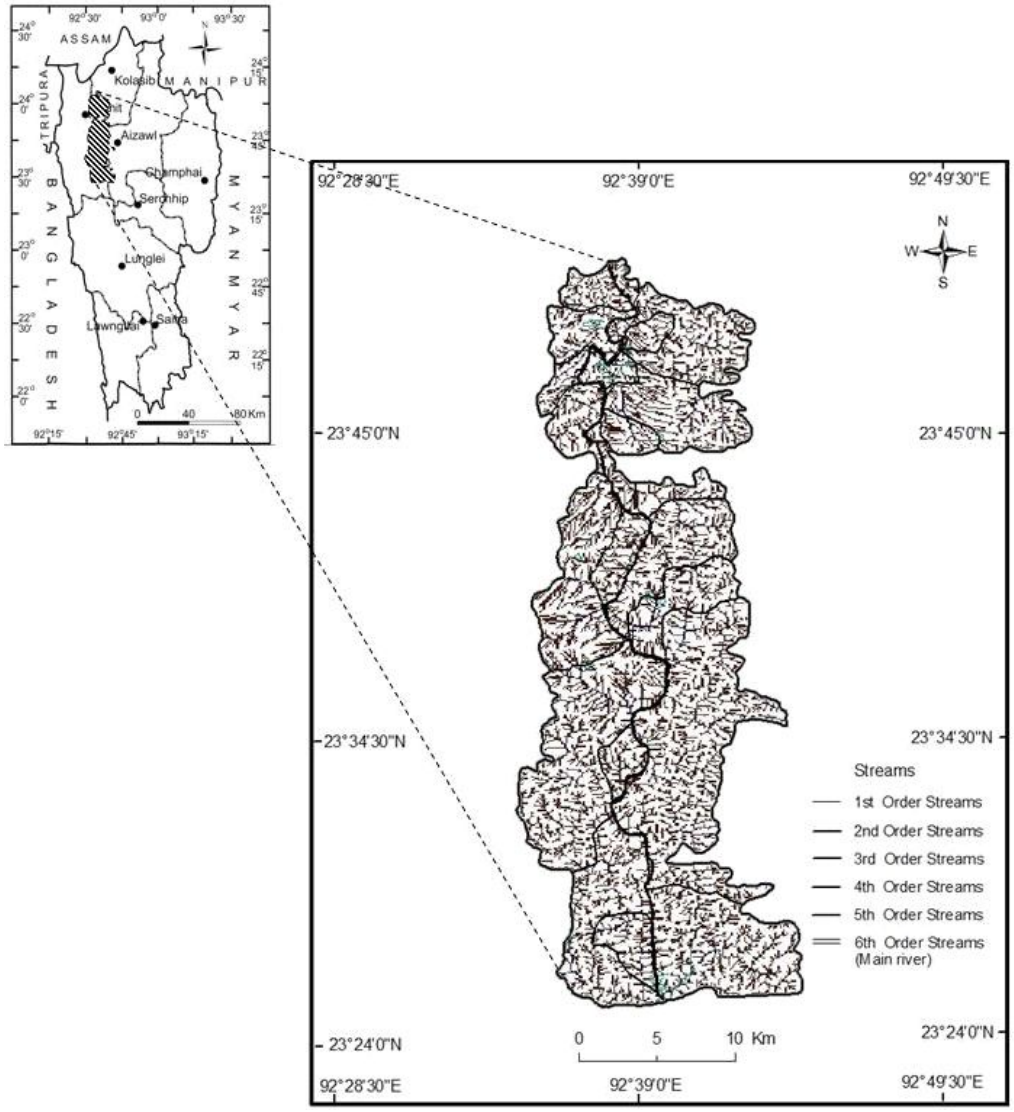

Figure1. Location and Drainage Network Map of the Study Area

is one of the important techniques to understand the physiography of a drainage basin. The three significant factors namely, watershed shape, pattern of drainage network and the topography are essential to assess the process of run-off and the terrain characteristics. As slope is one of the significant topographic factors,it is essential to analyze slope of the area. In the present study, the significant shape parameters such as compactness

co-efficient index (Cc), circularity ratio (Cr) and roundity factor (Rf) have been computed to estimate siltation as shape of the watershed affects the discharge volume and sediment production rate. The Tlawng watershed is an elongated basin. Although sub-dendritic, trellis and parallel types of network are seen at places, dendriatic type of drainage pattern is prominent type in the watershed. A majority of the streams along with the main course of the Tlawng in the watershed area are strongly controlled by the underlying structures due to on-going tectonic activity to a great extent. The significant drainage parameters computed in present study are presented in Table 1.

Compactness Co-efficient

It is a dimensionless shape factor that gives overall basin compactness. It is ratio of the basin perimeter (Lp) to the basin area (A) (Gravelius, 1914).

$$Cc = \frac{0.282\ Lp}{A^{0.5}}$$

Where 0.282 is a constant

The compactness coefficient value of the Tlawng watershed is 2.33.

Circularity ratio (Cr)

It is similar measure as elongation ratio. It is the ratio of the watershed area (A) to the area of the circle of the same perimeter (Lp) as that of the watershed (Miller, 1953).

$$Cr = \frac{4\pi A}{Lp^2}$$

The value obtained in the present study is 0.18 which is less than specified value 0.50 indicates elongated nature of the basin (Miller, 1953).

Table1. Drainage Parameters

Sl. No.	Parameters	Formula	Value
1	Total number of streams(Nu)	-	3136
2	Total length of streams (Lu)	-	1495
3	Length of main stream	-	134 km
4	Length of the basin (Lb)	-	50 km
5	Watershed area (A)	-	490 km^2
6	Watershed perimeter (P)	-	183.5 km
7	Elongation ratio (Re)	$R_e=2A/\pi/L_b$(Schumm (1956)	0.31
8	Circularity ratio (Cr)	$R_C=4\pi A/P^2$(Miller, 1953)	0.21
9	Compactness co-efficient (Cc)	$Cc = 0.282\ Lp / A^{0.5}$ (Gravelius,1914)	2.33
10	Roundity factor (Rf)	$Rf = \pi\ Lb^2 / 4A$(Chorley *et al.*, 1957)	3.41
11	Relief ratio (Rh)	$R_h=H-h/L_b$(Schumm, 1956)	0.028
12	Relative relief (Rr)	$R_p=H-h/P$ (Schumm ,1956)	0.755
13	Ruggedness number (Rn)	$R_n=HD_d$(Schumm, 1956)	3.86

Roundity factor (Rf)

It is the ratio of the circle having diameter equal to the length of the watershed to the area of the watershed (Chorley *et al*., 1957).

$$Rf = \frac{\pi Lb^2}{4A}$$

The roundity factor value of the Tlawng watershed is 4.

In addition, slope is one of the significant factors of topography in assessing erosion in the area as it controls erosion to a large extent. The slope aspect is found to be a very important element in order to understand the intensity of erosion, infiltration and retention capacity of water. As the watershed is composed of highly undulating terrain, a variety of slope classes are distributed in the area as shown in Table 2.

About 216 km^2 of the watershed is composed of strongly sloping to steep slopes (Figure 2). Similarly, nearly level to gently sloping lands occupy an area of about 175 km^2 in the watershed. Most of the settlements are located on the nearly leveled terrain of the flat topped hills. It is seen in the watershed that the terrain adjoining the main river course and the streams is gently to moderately sloping.

Erosion intensity is the severity of erosion which depends on the existing physical conditions of an area. The erosion in the watershed has been grouped into three main erosion intensity zones (Figure 3) such as (i) high erosion (ii) moderate to high erosion (iii) low to moderate and (iv) low erosion considering the degree of slope and drainage density as the terrain is of sedimentary nature with uniform lithology and uniform distribution of rainfall.

The terrain nearly level to very

Table 2. Distribution of Slope of Tlawng Watershed

Sl. No.	Slope category	Slope class	Geographical area (km^2)	Geographical area (%)	Erosion Intensity
1	0-3%	Nearly level to very gently sloping	47.83	9.76	Low
2	3-5%	Gently sloping	127.19	25.96	Low to Moderate
3	5-10%	Gently to Moderately sloping	98.29	20.06	Moderate to High
4	10-15%	Strongly sloping	127.90	26.10	High
5	15 -35%	Moderately steep to Steep sloping	21.01	4.29	High
6	Above 35%	Very steep sloping	67.52	13.78	High
Total			**489.75**	**100**	

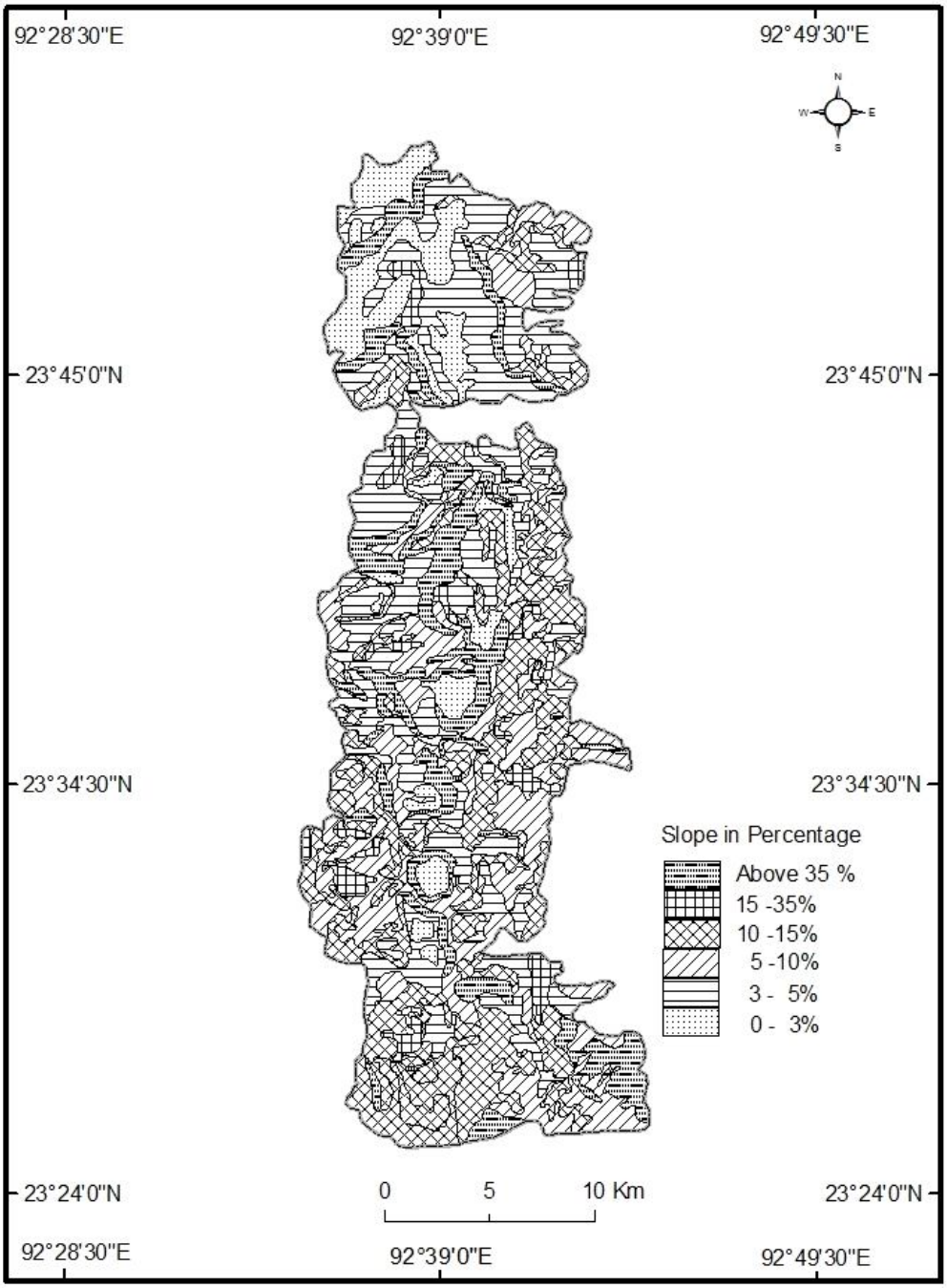

Figure 2. Slope Distribution in Tlawng Watershed

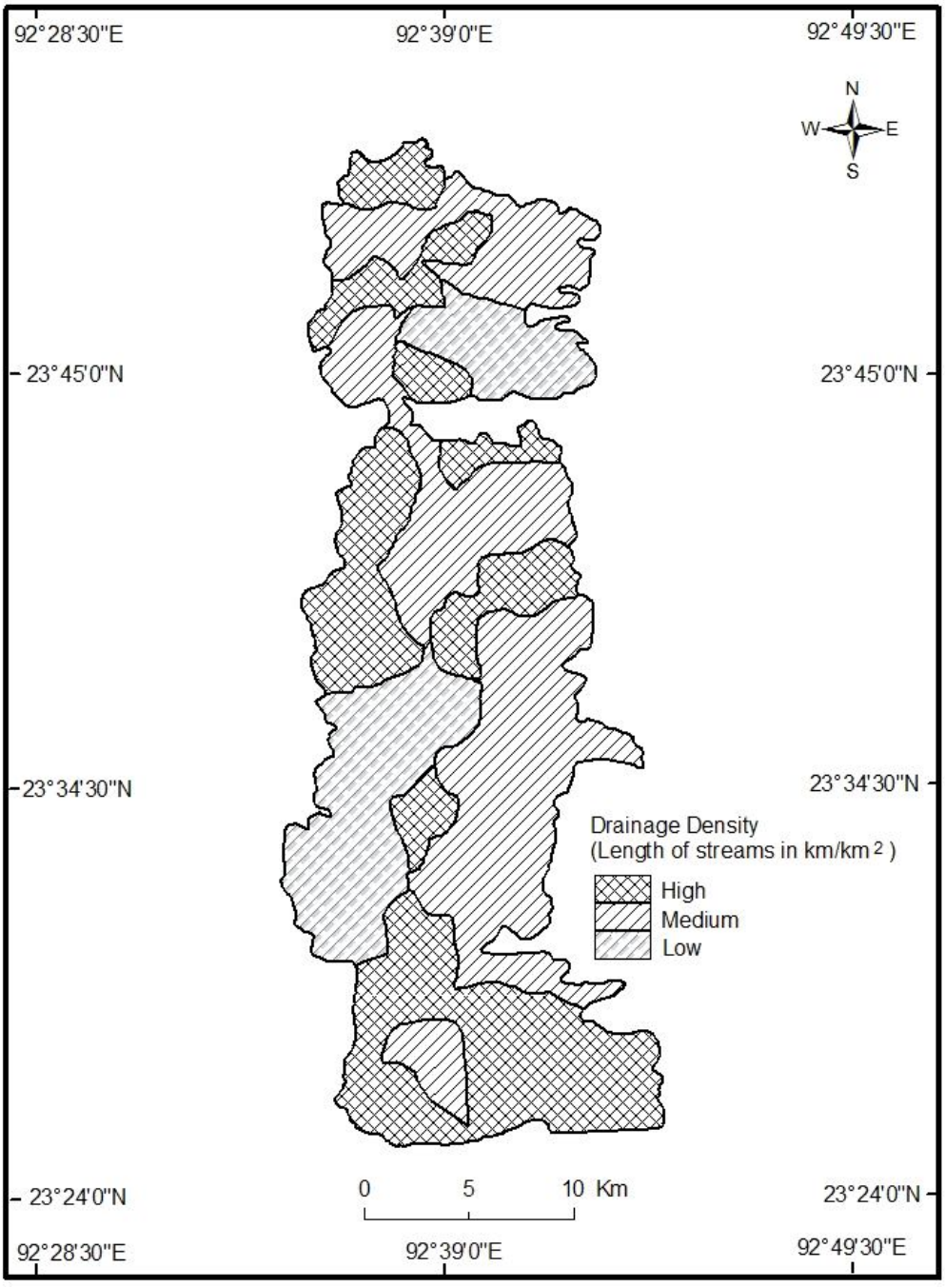

Figure 3. Drainage Density

gently sloping with low drainage density is considered as low erosion zone as infiltration is more in this zone (Figure 4 & Table 3). The gently sloping terrain with low to medium drainage density is considered as low to moderate erosion. Similarly, the gently sloping to moderately sloping terrain with medium to high drainage density is considered as moderate to high erosion zone. The terrain which exhibits 'strongly sloping' to 'very steep sloping' with high drainage density is considered as high erosion zone. It has been observed that about 375 km^2 area of the watershed is prone to high erosion or severe erosion.

Estimation of Discharge and Sediment Yield (Sediment Production Rate- SPR)

Run-off plays a major role in siltation in an area which is fully controlled by the watershed characteristics such as shape of watershed, degree of slope, existing drainage pattern and topography. Run-off is efficient in circular basins in comparison to elongated basins (Singh & Singh, 1997). The estimated average discharge of the Tlawng river is about 184.18 million litres per day as measured in 'area-velocity method' by the Department of Public Health Engineering, Govt. of Mizoram. It is estimated that the annual average discharge is about 66304.8 million litres. The sediment production rate in the watershed is determined by the factors such as roundity factor, circularity ratio and compactness co-efficient. The following mathematical models suggested by Jose and Das (1982) have been used to estimate discharge and sediment production rate in the Tlawng watershed.

Discharge (log Q) = 2238.43 + 22.12 log (100 + Rf) - 608.28 + log (100 +Cr) - 530.02 + log (100+Cc)

Sediment Production Rate (Log SPR) = 4919.80 + 48.64 log (100 +Rf) - 1337.77 log (200+Cr) - 1165.64 (100+Cc)

The values of volume of discharge 32.13 cm/km^2 and the sedimentation rate 18210 ha-m/ 100 km^2/year show that the Tlawng watershed is under top priority zone which needs proper soil conservation measures at least to reduce further erosion and subsequent siltation in the watershed to increase the carrying

Table 3. Erosion Intensity Zones

Sl. No.	Geographical Area (km^2)	Erosion Intensity
1	293.39	High
2	82.16	Moderate to High
3	71.66	Low to Moderate
4	107.88	Low

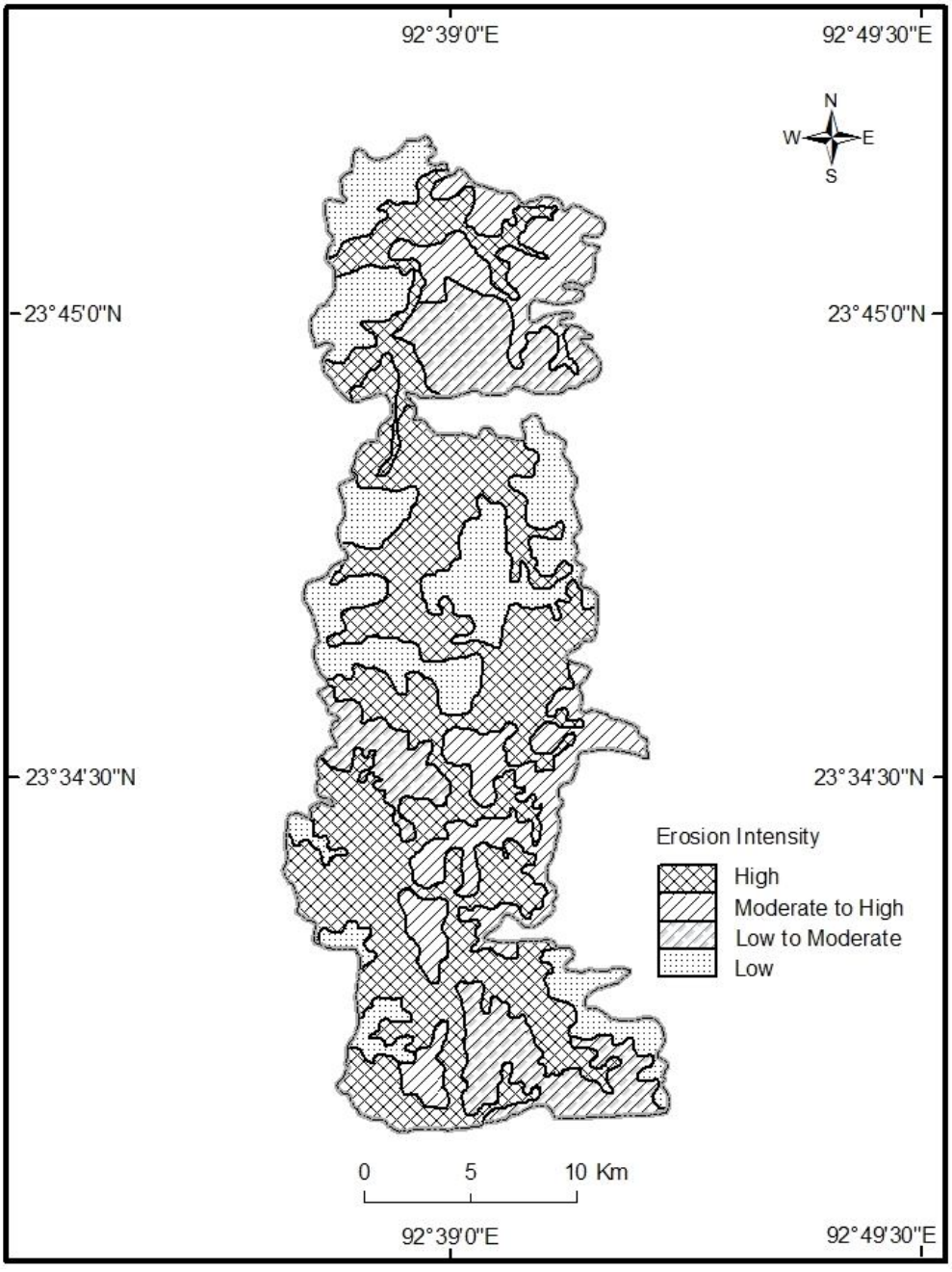

Figure 4. Erosion Intensity Zones

capacity of streams.

Conclusion

The present study has revealed the discharge volume and sediment production rate in Tlawng watershed. About 375 km^2 of the watershed is prone to severe erosion mostly due to degree of slope and nature of the sedimentary material. As the watershed is prone to high erosion and falls under high priority zone needs immediate attempts to reduce further erosion and subsequent siltation. Sedimentation production rates are useful for prioritization of watersheds. The present study is useful for management of drainage channels, hydel powerprojects and flood modulation particularly in the lower reaches of the watershed.

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Interpretation of Topographical Maps of Mountainous Areas with Reference to Distance and Slope Analysis: A Case Study of Bungtlang and Its Surrounding Villages

- V. Lalnunmawia

Abstract : *One important task of a geographer is to study the physical environment of a particular area and link it with its cultural environment, such as settlements, population distributions, land-uses, etc. Many scholars in their research works, for studying and analyzing various types of landuse have to go through Satellite Imageries, Areal Photographs and Topographical Maps. In analyzing the relief or slope, one commonly applies Wentworth's Method of Average Slope, Determination method of Relative Relief by Smith, or method of average Slope determination by Raisz and Henry. Here, one has to divide the study area into either squares or blocks to determine the slope characteristics. Sometimes, it is needed to determine the linear slope, instead of average, to detect the single side or line of a hill or even across the valleys. To meet this requirement, one may use mathematical calculation to detect linear slope on topographical maps using lines. However, unlike plain and level areas, there may be distortion of distance in hilly and rugged areas if analyzed on the map scale. To overcome this, attempts have been made to compare the difference between the map distance, actual ground distance and distance by road, which differ mainly due to rugged topography and alternate location of hill ranges, deep valleys.*

Introduction

Slopes are ubiquitous elements of landscape. Nearly all the land surface have slope in one direction or another. Determination of the slopes of a particular area on map with a particular scale is necessarily an applied aspects related to finding out the suitability of sites for various land use purposes. Of the numerous methods for the determination of slope from topographical maps and drawing of profiles for linear representation, Relative Relief analysis method by Smith, Average slope determination method by Wentworth as well as Slope Categories by Raisz and Henry may be regarded as the most popular working methods in geomorphological studies, both for theoretical and applied analysis. But these methods, popularly used, may not give satisfactory result to detect distance and slope for a particular direction for all users and planners, as they summed up areas in square areas as well as an average.

It is in this light that an attempt has been made in the present study to analys the area and its relief by calculating its slope degree on a particular line or direction and find out the degree of slope and actual ground (distance measured on ground, following all hill sides or slopes Figure 2) distance between two particular places or settlements. This is done with the application of Pythagorean Theorem and Tangent angle for its analysis. It is believed that adoption of such a method particularly in a hilly terrain will give better result in determining the distance and

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degree of slopes as well as suitability of sides for various landuse purposes.

The area under study is drained and divided by two south flowing rivers Mat and Tuichang. The area is dominated by three hill ranges aligned in north-south direction. They hinder easy accessibility from any direction. The village Bungtlang has been formerly a centre of village grouping during the insurgency period in Mizoram, wherein its neighbouring villages - Chawngtleng (Keitum), Piler, Lungsai, Chhipphir, Rawpui and Khawnglung were grouped to it. It is passed through by National Highway 54 and served as a market centre for surrounding villages like Lungsai, Chhipphir, Zote, Rawpui and Keitum.

The Study Area

Bungtlang village and its surrounding areas under study is situated in the central part of Mizoram between 23º08'-23º15'N latitudes and 92º48' E - 93º00' E longitudes. Half of its area, i,e., north and northeast areas fall under Serchhip District and another half, i,e., south and south west areas fall under Lunglei District. The central village of the study area, Bungtlang is situated at about 133 km south of Aizawl, the state capital of Mizoram and about 24 km south of Serchhip, a district capital. The area spreads over an area of about 258 km^2.

Objectives

1. To find out the impact of existing method on distance and slope angle measurement in mountainous and hilly areas.
2. To find more suitable method of demarcation area in hilly areas.

Data Base and Methodology

Topographical Map of Survey of India, Sheet No. 84 A/16, surveyed in 1969-'70 on RF 1: 50,000 scale has been used as the master map. Data concerning distances have been collected from various publications of Statistical Handbook of Mizoram. Apart from this, some distances, not recorded in the handbooks are recorded after consulting the concerned villagers. In analysing actual distances on slope, Pythagorean Theorem has been applied. To obtain the linear slope angle, Trigonometric method (tan) has been applied. By applying these two methods, distances of various villages from the centred village are calculated to find difference made by topography between the map (spatial) distance and the actual (ground) distance.

Distance Analysis-Measuring distance on sloping Surface

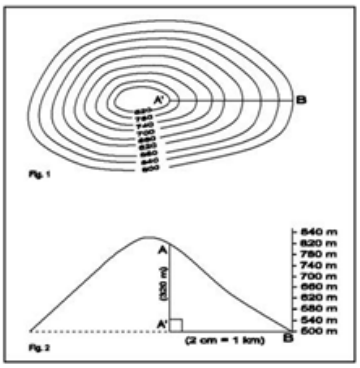
Every topographical map has a particular scale, commonly what we used in India, is the topographical map prepared by the Survey of India with a scale of 1:50,000 or 2cm = 1km. On these maps, one can easily measure distances on the map using the

given scale and calculate distances within it.

But this measurement may be correct only in the case of plain area. Problems arising in measuring distances in the mountainous areas can be cited with diagram.

In Figure 1, one can see the contour line drawn on a map with a R.F. 1:50,000 for conical hill at an interval of 40 m. One has to measure the distance between the peak i.e. A. and its base, B. The distance measured 2 cm on the map which equal 1km on the ground (as indicated from the scale of 1:50,000). But the map shows a mountainous area not a plain. The given scale is applicable only for estimating distances on the plain area. Thus our task is how to calculate the distances on slopes on mountainous and hill areas.

In Figure 2, the distance between A' and B can be measured correctly and directly from the given scale. But the distance between A and B (i.e. side or slope of the area) can be calculated by applying Pythagorean Theorem as -



$$H = \sqrt{p^2 + b^2}$$

Where H = AB (Surface Distance)

p = A' A *(No of contour crossing within the prescribe distance × Contour interval).*

b = A' B *(Distance covered, converted in the same unit distance with the unit used in height)*

$$p = 8 \times 40 = 320$$

b = 1km or 1000m (*2 cm on the map*)

$$H = \sqrt{320^2 + 1000^2}$$

$$H = \sqrt{102400 + 1,000,000}$$

$$H = 1049 \text{ m}$$

Thus the actual ground distance between A and B is 1049 m, where its reduced height at base level (A'B) is 1000 m. There is a variation of 49 m between spatial and ground distance.

As mentioned earlier, the commonly popularly used map for topographical studies in India is Survey of India map at a scale of 1:50,000 with 20 m contour interval. Therefore, to measure distances easily we can prepared a table for learners and users as shown in Table 1.

Slope Analysis-Analyzing degree of linear slope to a particular line or direction

Slope analysis here refers to degree of linear slope at a particular direction. This can be calculated with the formula of :

$$\text{Slope in degree} = \tan \propto = {}^{h}/_{b}$$

Where h = height (i.e. No. of contour crossing the line × contour interval)

b = (base) distance (on the

plane surface calculated from the map scale.)

In Figure 3, we see a contour map of hill side. This map is drawn at a scale of 1:50,000 at an interval of 100 m. Here, a line AB is drawn along the slope representing 1km (i.e. 2 cm on the original map). Based on this scale in the figure, we can calculate the degree of slope using the cited formulae above.

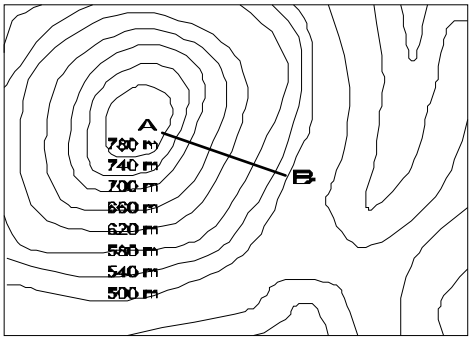


Figure 3 Illustration on Toposheet

$$\text{Slope in degree} = \tan \propto = {}^{h}/_{b}$$

$$= \tan \propto = \frac{7 \times 40}{1000} = 0.$$

$$= \tan \propto = 15°64'$$

Therefore, the degree of slope along AB line is $15^{0}64'$. Using the same method we can calculate the degree of slope of mountainous areas or measures the distances and contour crossing and match with the constructed table to see the degree of slope. Here, the line may not end exactly at the contour line, but one can estimated or imagine and add length of the exceeding portion from the contour interval.

As shown above, one can calculate and construct a more detail table depending on his requirement and used it.

Table 1. Calculation of Actual Ground Distance and Degree of Slope on Map (R.F. 1:50,000 or 2cm=1km)

No of contour touching/crossing (20 m interval)	Height from the base (lower base of the line)	Actual ground distances	Average slope (through base line)
1	20 m	1000.20 m	1º14’
2	40 m	1000.80 m	2º29’
3	60 m	1001.80 m	3º43’
4	80 m	1003.19 m	4º57’
5	100 m	1004.98 m	5º71’
10	200 m	1019.80 m	11º30’
20	400 m	1077.03 m	21º80’
30	600 m	1166.19 m	30º96’
50	1000m	1414.21 m	45º
100	2000m	2236.06 m	63º43’

Impact of Topography on Accessibility and Distance Analysis

Of many villages around Bungtlang, the present study covers seven villages located around Bungtlang village. The following Table 2 shows distances and slope in a particular direction from Bungtlang village. In column 3 of the Table, number of contour crossing is shown and is used for calculating slope as well as actual ground distances. Ground distances showed in column 5 is calculated as the actual ground distance. The method of calculating this distance is postulated in part A (Distance Analysis). In column 5, aerial/map distance is shown, which is

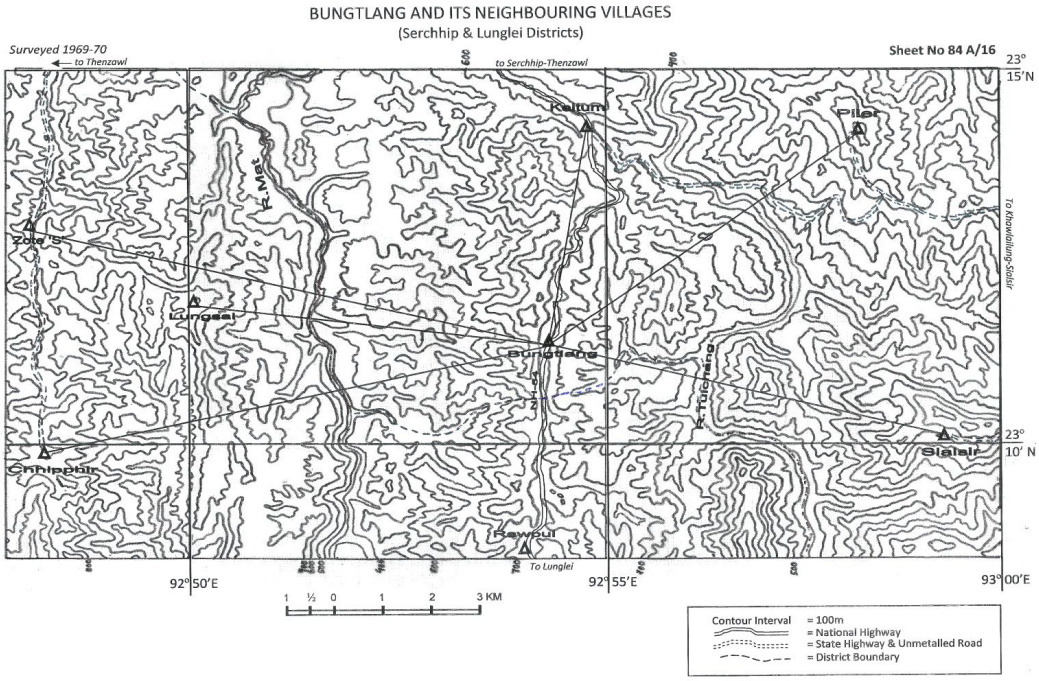


Figure 4. Topographical Map of the Study Area

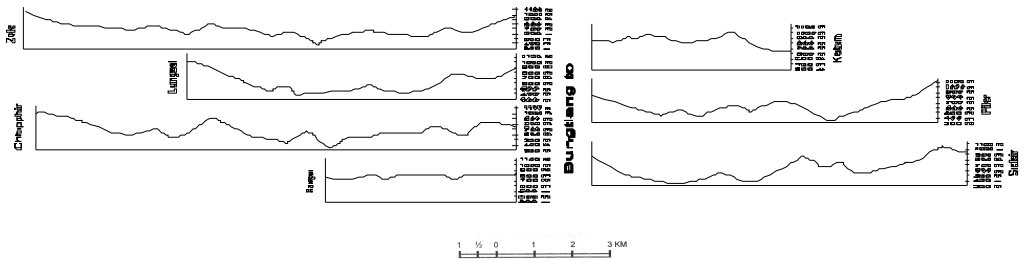


Figure 5. Profiles between Bungtlang Village and its Surrounding Villages

measured from the map space in the original topographic map. Actual and existing road distances are shown in column 6. The method of calculating slope in a particular direction is mentioned in part B of this chapter, which is applied to get the data shown in column 7. The difference of road distance (Column 6) from map distance (column 5) is calculated and shown in the last column.

Study of Table 2 and the study area map (Figure 4) clearly depict the impacts arising out of the topographic features, slopes, reliefs, etc. The difference between - actual ground distance (distance measured/calculated on ground), air distance (distance measured on map on map scale basis) and road distance is lesser in two villages - Keitum and Rawpui from Bungtlang, compared to all other villages. The reason seems that, these two villages located in the north and south are in the same hill range with Bungtlang, where all roads and ranges are aligned to north-south direction without crossing any valley, rivers or rugged topography.

The examination of the difference between column 3, 4 and 5 of the Table 2 in respect of other villages shows a greater percentile difference. Piler and Sialsir, located in separate hill ranges in the east, are separated by Tuichang valley from Bungtlang. In the west, three villages including Zote, Chhipphir and Lungsai are located. These three villages located in separate hill ranges running in north-south direction are separated from Bungtlang by River Mat which also flows in north-south direction.

The difference between spatial distance and actual distance have also been analysed in Table 2. These differences are much lesser compared to the former one. Ground

Table 2. Distances of Neighbouring Villages from Bungtlang

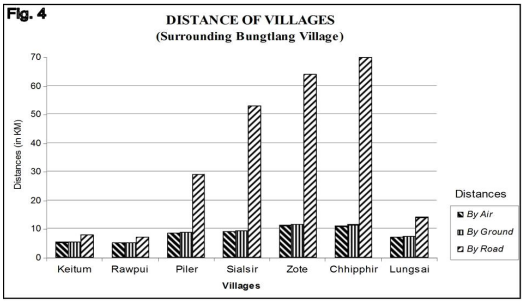
Sl.No. (1)	Bungtlang to (2)	No.of Contour crossing (at 100m interval) (3)	Actual Ground Distance (KM) (4)	Air/Map Distance (KM) (5)	Road Distances (KM) (6)	Slope (in°) (7)	Difference (Road distance from air/map distance (%) (8)
1	Keitum	10	5.4	5.3	8	10°68'	48.14
2	Rawpui	5	5.22	5.2	7	5°49'	34.61
3	Piler	25	8.9	8.5	29	16°39'	241.17
4	Sialsir	26	9.4	9	53	16°11'	488.88
5	Zote	32	11.7	11.2	64	15°95'	471.42
6	Chhipphir	35	11.5	10.9	70	17°81'	542.20
7	Lungsai	20	7.4	7.1	14*	15°72'	97.18
TOTAL			59.52	57.2	231		1923.6

** No road access except footpath*

 # Parenthesis in column headings show column number

distance, here means the distances measured on actual ground, which is observed by using the methods shown in part A (Distant Analysis). Here distance measurement follows the ups and downs of the hill slopes and shows a difference from the spatial map distance. In this case also, same is the situation with the former one, that those location lying in the same hill range shows lesser difference than those lying across the river valley and locating in separate range.

Fig. 4



Thus, the difference in distances between the actual distance, spatial distance and road distance are found more for those villages that are isolated and are separated by deep valleys. In such cases, road developments are hindered by the topographical features, deep river valleys, etc. that is very difficult and expensive to construct roads, bridges, etc and road density also is very low. While making a plan or demarcating boundary of an area for planning , administrative or any other purposes, one has to take into consideration the impact of topographic features. In hilly regions, a village in a map could be located at a far greater distance in actual ground or even farther than another village at a greater distance in a map.

Conclusion

By examining the tables, figures and the given (reduced) map, the study area has a very low density of road network. Locating in an area of poorly developed economy, it is difficult to construct more transport networks amidst adverse topographical structure which entails high capital input. Therefore, in the present situation, it is wise to make all plans and projects following the already developed infrastructure. As mentioned earlier, while making plans, projects and demarcating areas for administrative or planning purposes, planners have to take into consideration the distances based on road networks. Inaccessibility and accessibility to the areas, terrain obstructing road development, etc. of the areas could not be treated like plain areas which have more or less homogenous physical landscape. Therefore, in rugged topography, there could be a lot of distortion between the actual ground distances and the distances observed from a map. From the above study, the relevance of distance analysis may be recognized.

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Agricultural Development Disparities in Mizoram

- K. Vanrammawia

Abstract: *Agriculture occupies a very important place in the economy of Mizoram as majority of the population derived their livelihood from agriculture and its allied sectors. An examination of the level of agricultural development in the state by using Principal Component Analysis reveals that despite underdeveloped state of agriculture, there is some sort of inter-district disparity within the state that the southern regions of Mizoram have shown lower pace of agricultural development in comparisons to their counterparts. The study also found that there is a close interrelationship between rural poverty incidence and level of agricultural development thereby implying that any policy towards agricultural development should have an overall impact on reducing regional disparity as well as poverty incidence in rural areas of Mizoram.*

Introduction

Regional inequality is a development challenge in most developing countries, especially those with large geographic areas under their jurisdiction (Reddy, 2013). Many development theories showed that regional disparities are inherent in the process of development. From the days of classical economist to the present, there is general belief that development is bound to be undemocratic because it does not take place in every ingredient of a nation simultaneously (Saikia, 2012). Regional differences, to a large extent, are built-in due to large unequal natural endowments and lack of infrastructural facilities which form the basis for rapid economic growth (Krishnaiah & Reddy, 1998). Regional disparity or inequality may give rise to the feeling of self-alienation, separatist aspirations, and other aspects of social and political unrest.

Regional disparity in India is a matter of serious concern from past to present (Sarkar, 2011). The evil of regional disparities in India became more intensified and is on the rise only after independence when national government started its planned development programmes through Five Year Plans since 1951 (Saikia, 2012). In the early phases of the plan period, development efforts were mainly confined to sectoral economic development with greater emphasis on raising the per-capita income of the people. As a result, certain areas went ahead leaving others lagging behind and thereby creating disparity among the different states of India. Despite several policies and flagship programmes, the country has not been able to remove inequality in various aspects of development. There is a sharp difference in the development of both economic and social sector across the states and regions of the country. Among these, disparities in agricultural development as well as its reduction is no less important as the preponderance of the

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population especially in rural areas who mainly derived their livelihood from agriculture and its allied sectors.

Various studies on the disparities of agricultural development have been made in India (Tiwari, 2008), Sarkar, 2011), Reddy, 2013), Jena, 2014). Most of these studies are state-specific and a study on agricultural development disparities in North-east India especially in Mizoram is scanty and of limited available. Moreover, most of the studies simply revealed the general existence of disparities in agricultural development and does not relate with the magnitude of poverty. Against this backdrop, an attempt is made in this paper to fill these gaps by studying the disparities of agricultural development in Mizoram.

Agriculture is a prime sector of the economy of Mizoram where expansion of industrial sector is limited and of negligible. As per the Economic Classification of Workers in 2001 Census, about 60 per cent of total workers are directly engaged in agriculture and its allied sector. Due to the implementation of various policies by the government, the state agriculture, although remained underdeveloped, has been moving towards the process of development. However, like other parts of the country, there is some sign of agricultural development disparities across state which may pose a serious threat to the inclusiveness as well as development of the state especially in rural areas. The main objective of this study is, therefore, to analyze the present pattern of inter-district disparities of agricultural development in Mizoram. It also seeks to identify the main determinants of agricultural development in the state and examine the association of level of agricultural development with the incidence of rural poverty within the state.

Sources of Data

The present study is based on the secondary data published by both the central and state governments. Data on agricultural development for the year 2010-11 is drawn from the publication of state government viz Statistical Abstract 2010-11 published by Directorate of Agriculture, Economic Survey 2012-13 published by Planning and programme implementation Department, Statistical Handbook 2012 published by Directorate of Economics Statistics. The study also used the estimated rural poverty incidence of Mizoram based on the un-tabulated primary data of 66th round of National Sample Survey (NSS) on Consumption Expenditure Survey (CES) covering the period of 2009-10 published by Ministry of Statistics and Programme Implementation, Government of India.

Methodology

A. Selection of Indicators

The level of agricultural development is affected by several factors and it cannot be captured on the basis of single indicator. The present study therefore selected the following indicators to measures agricultural development in the state:

X1: Percentage of Net Sown Area to total land area.
X2: Percentage of Total Crop Area to total cultivatable area.
X3: Cropping Intensity.
X4: Percentage area of Wet Rice Cultivation (WRC) to total cultivatable area.
X5: Percentage area of Principal crops to total cultivatable area.
X6: Yield per Hectare of Principal Crops.
X7: Percentage area of Commercial crops to total cultivatable area.
X8: Yield Per Hectare of Commercial crops.
X9: Percentage of agricultural workers to total main workers.
X10: Consumption of fertilizers (Kg/ hectare).
X11: Percentage of net irrigated area to net sown area.

B. Method

This study has used descriptive statistics and Principal Component Analysis (PCA) to find out inter-district disparities as well as determinants of agricultural development in the state. Principal Component Analysis (PCA) is a special case of the more general method of factor analysis. It is a technique to find a few set of orthogonal (uncorrelated) linear combination of original variables called Principal Components which can be used to summarize the data, losing as little information as possible. In other words, it is a computational process in which a group of variables is reduced in number to a more fundamental set of variables that can explain most of the variance of the original data set. This technique was suggested and used to minimize the problem of multicollinearity (Olorunsanyha et al., 2003). Thus, Principal Components (P_i's) are a new set of artificial variables formed from a linear combination of standardized original variables (Z_j's) with weights corresponding to Eigenvalues derived from the correlation matrix of the variables. The principal components have been extracted by Kaiser's criteria which considers only the components having Eigenvalue greater than one. The standard form of Principal component is given as follows:

$$P_1 = {}^{a}11^{z}1 + {}^{a}12^{z}2 + \ldots\ldots + {}^{a}1n^{Z}n$$
$$P_2 = {}^{a}21^{z}1 + {}^{a}22^{z}2 + \ldots\ldots + {}^{a}2n^{Z}n$$
$$P_i = {}^{a}ii^{z}1 + {}^{a}i2^{z}2 + \ldots\ldots + {}^{a}in^{Z}n$$

This can be written as

$$\square\square\square = \sum_{\square=1}^{\square} \square_{\square\square} z_i$$

Where P_i= Principal components 1,2...n

aii= Factor loading or weights of the variables;

$$Zi = \frac{Xi - \mu i}{\sigma_i}$$

i.e standardized variables of X_i, $X_2 \ldots X_n$, where μi is the mean of Xi's and σ_i is the standard deviation of Xi's.

To know the ranking of each district on agricultural development, a Composite Index for Agricultural Development (CIAD) of each district has been determined with the help of the following formula:

$$\text{CIAD} = \frac{\sum Pi}{\sum W} = \frac{\text{Total Principal Component Score}}{\text{Total Weight}}$$

Further, to examine the degree of association between agricultural development and rural poverty, this study has calculated correlation coefficient between the rural poverty index and composite index of agricultural development (CIAD).

Results and Discussion

Table 1 gives the descriptive statistics of each indicators of agricultural development. It can be observed that there is a wide inter-district variation in certain indicators of development viz net sown area, total crop area, area of Wet Rice Cultivation (WRC), net irrigated area, area of principal crops and commercial crops.

The percentage of net sown area (X_1) and total crop area (X_2) to total cultivable area are considered to be important indicators as they have a greater implication on the other indicators of agricultural development. It can be observed from the Table 1 that both Serchhip and Kolasib districts showed a relatively higher value on these indicators while Lunglei and Lawngtlai districts have a lower Net sown area and total crop area. This variation may be ascribed to the differences in topographic structures as well as density of population.

With the transition from Jhum to settled cultivation, the percentage area of Wet Rice cultivation (X_4) and availability of irrigational facilities (X_{11}) are considered to be an important indicator of agricultural development. Despite a negligible irrigational facilities as well as low percentage of WRC area to total cultivable area in the state, there is a significant variation among districts which is indicated by higher coefficient of variation on these indicators. The percentage area of Wet Rice cultivation and net irrigated area are comparatively higher in Kolasib and Champhai Districts. This may be due to the advantageous geo-physical endowment as a large part of these districts are covered by plain areas which is highly suitable for carrying wet rice cultivation with irrigational facilities. It may also be noted that some sort of colonial imprints on agricultural sector could be traced back that the introduction of wet rice cultivation in Champhai valley

by Col. Shakespeare, the first superintendant of Lushai Hill in 1898 may have a cascading effect on the higher percentage area of wet rice cultivation in this district. The percentage area of commercial crops to total cultivable area (X_7) is another important indicator with the advent of commercialization of agriculture. It can be again observed that both Serchhip and Kolasib districts enjoyed advantageous position in comparison to the other districts. One thing to be noted is that these districts are located near the state-capital Aizawl and the neighboring Cachar districts of Assam where a ready market is available to dispose agricultural products. Subsequently, the

Table 1. Descriptive Statistics of Various Indicators of Agricultural Development in Mizoram, 2011-2012

District	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Aizawl	6.101	6.268	102.737	0.102	2.531	1.639	3.819	7.871	33.580	81.591	2.453
Champhai	6.820	6.985	102.428	1.235	3.783	2.109	2.746	6.915	83.140	81.290	23.056
Kolasib	13.621	14.082	103.391	2.931	6.932	1.794	7.340	5.607	80.210	86.122	22.084
Lawngtlai	4.326	4.641	102.204	0.532	2.487	1.081	1.864	6.969	84.910	75.083	7.704
Lunglei	4.327	4.421	102.172	0.111	1.929	1.507	1.540	7.143	90.460	76.589	2.902
Mamit	5.682	5.724	100.732	0.220	2.284	1.452	3.462	5.478	86.270	68.033	3.904
Saiha	5.919	6.011	101.555	0.341	1.786	1.235	3.860	6.375	67.130	66.225	2.619
Serchhip	14.610	14.707	100.663	1.236	5.073	1.730	9.720	7.918	77.370	66.165	9.812
Mean	7.676	7.855	101.985	0.838	3.351	1.568	4.294	6.785	75.384	75.137	9.317
Std. Deviation	4.073	4.124	0.950	0.963	1.813	0.325	2.821	0.918	18.282	7.678	8.594
C V	53.068	52.508	0.932	114.842	54.109	20.737	65.703	13.537	24.252	10.219	92.245
Minimum	4.326	4.421	100.663	0.102	1.786	1.081	1.540	5.478	33.580	66.165	2.453
Maximum	14.610	14.707	103.391	2.931	6.932	1.794	9.720	7.918	90.460	86.122	23.056

Table 2. Result of PCA/ Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumula-tive %	Total	% of Variance	Cumula-tive %
1	5.53	50.30	50.30	5.53	50.30	50.30	4.91	44.64	44.64
2	2.42	21.96	72.26	2.42	21.96	72.26	2.95	26.86	71.50
3	1.67	15.18	87.44	1.67	15.18	87.44	1.75	15.94	87.44
4	0.79	7.14	94.58						
5	0.43	3.92	98.50						
6	0.13	1.20	99.70						
7	0.03	0.30	100.00						

Extraction Method: Principal Component Analysis.

location factor may have a further implication on a higher percentage area of commercial crops in these districts.

Table 2 showed the detailed results of the PCA which reveals the variance explained by the components at the initial situation, after extraction and after rotation. The components have been extracted using Kaiser's criteria and rotated imposing Varimax rotation method. This study has considered three principal components which have Eigenvalue greater than one. Rotation Sum of square loadings indicated that the first principal component has explained 44.64 per cent of total variation of agricultural development of the states. The second and third principal components have explained 26.86 per cent and 15.94 per cent respectively. The three components altogether accounts for 87.44 per cent of the total variation in the agricultural development of the state.

Table 3 represents the weights or rotated factor loadings of each indicator so as to identify the determinants of agricultural development in the state. The weights or factor loadings of the selected indicators of agricultural development are computed by using the Eigen value of the first three principal components. The indicators which have the highest factor loading on component 1 are percentage of Net Sown Area to total

Table 3. Weights of Indicators

Variables	Component 1	Component 2	Component 3	Total Weight
X1	5.507	0.023	-0.018	5.511
X2	5.497	0.078	-0.005	5.570
X3	-0.305	2.277	-0.114	1.858
X4	4.307	1.163	0.595	6.066
X5	4.966	0.919	0.292	6.177
X6	2.954	1.228	-0.136	4.046
X7	5.307	-0.485	-0.232	4.590
X8	0.167	-0.184	-1.374	-1.392
X9	0.231	-0.366	1.436	1.301
X10	0.214	2.368	-0.082	2.499
X11	3.078	1.529	0.638	5.244
Total	31.921	8.549	1.001	41.471

land area, percentage of total cropped and WRC to total cultivable area, percentage area of principal crops and commercial crops to total cultivable area, percentage of net irrigated area to net sown area, yield per hectare of both principal and commercial crops. These indicators altogether explained the highest percent of total variation of agricultural development and therefore, they are the most important indicators or determinants of the state agricultural development. Similarly, for component 2, both the indicators viz cropping intensity and consumption fertilizers have the highest loading. It tells that these indicators explained the second largest variance in the sample and they are the secondary determinants of agricultural development. Finally, only one indicator, percentage of agricultural workers to total main workers loads highest in component 3 which conforms that it is the supplementary indicators of agricultural development in Mizoram.

Table 4 showed an overall composite index of agricultural development (CIAD) each district in Mizoram. It can be observed that Kolasib District stood at first position in terms of agricultural development. This District is blessed with a good geo-physical setting where there exist large plain areas suitable for carrying agricultural activities and also supplemented by better and easy accessibility of both Aizawl and Cachar (Assam) market to dispose agricultural products. The second position goes to Serchhip District, followed by Champhai, Aizawl, and Mamit Districts respectively. The three Southern Districts viz Lawngtlai, Lunglei and Saiha ranked sixth, seventh and eighth respectively implying the existence of regional disparities in terms of

Table 4. Composite Index of Agricultural Development (CIAD) and Rank of Districts

District	Z1	Z2	Z3	CIAD	Rank
Aizawl	-3.951	2.195	-6.147	-0.406	4
Champhai	7.714	8.206	1.535	0.421	3
Kolasib	47.557	13.986	4.296	1.588	1
Lawngtlai	-22.043	-2.317	0.420	-0.577	6
Lunglei	-24.055	-2.064	-0.274	-0.636	7
Mamit	-15.677	-7.746	2.209	-0.512	5
Saiha	-17.876	-7.346	-0.761	-0.627	8
Serchhip	37.262	-4.914	-1.277	0.749	2

agricultural development between southern and northern parts of the state. Apart from the physical factors, the main reasons for this disparity in agricultural development may be due to remoteness coupled with poor transportation and communication system, work culture and mismatch of various agricultural developments policies.

In a highly agrarian economy, agriculture and poverty form an inseparable aspect of the state economy. Any public policy measures for agricultural development shall invariably acts as the programme for poverty alleviation of the state. To examine this proposition, Table 5 depicts that there is a significant inverse relationship between rural poverty incidence (PI) and composite index of agricultural development (CIAD). This implies that for a highly agrarian state, agricultural development is a must for poverty alleviation which can be brought about by removing the defects that exist both in physical as well as institutional factors of agricultural development.

Table 5. Estimated Rural Poverty Incidence (PI) and Composite Index of Agricultural Development (CIAD) in Mizoram

District	Rural Poverty Incidence (PI)*	Composite Index of Agricultural Development (CIAD)	r
Mamit	30.44	-0.512	
Kolasib	3.19	1.588	
Aizawl	39.21	-0.406	
Champhai	29.73	0.421	-0.907**
Serchhip	22.68	0.749	
Lunglei	36.89	-0.636	
Lawngtlai	41.62	-0.577	
Saiha	31.47	-0.627	

* Thanga, James L.T. (2012): Rural poverty: A socio-economic dimension in Mizoram, *Geographic*, Vol. 7.
Estimation of rural poverty incidence is done using poverty line for Mizoram recommended by Tendulkar Committee for the year 2009-10 which is fixed ar Rs 850.00 for Rural areas using the 66th Round of National Sample Survey on Consumer Expenditure covering the period of 2009-10.

** *Correlation is significant at the 0.01 level (2-tailed).*

Conclusion

An examination of the level of agricultural development in Mizoram reveals that despite the slow pace of agricultural development of the state, there is unequal progress among Districts in terms of various indictors of agricultural development. It may be noted that the southern districts of the state are least developed, especially in percentage area of Wet Rice Cultivation (WRC), area of principal and commercial crops, net irrigated area etc., which are the key determinants of agricultural development in the state. The study also established an interrelationship between rural poverty incidence and agricultural development which therefore implies that any public policy towards agricultural development should have an equivocal impact on reducing regional disparities as well as poverty incidence in rural areas of Mizoram.

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Dynamics of Agricultural Land Use and Rural Road Connectivity

- Lianhmingthanga
- James L.T. Thanga

Abstract : *Improvement in road connectivity is considered to have multiple effects on socio-economic development as well as agriculture development in rural areas. The areas experience change in livelihood activities with the improvement in road connectivity. This in turn results in alteration of cropping patterns which further resulted in changes in agriculture land use. Attempt has been made in this study to examine the relationship between rural road connectivity and changing dynamics of agricultural land use in Mizoram, India. The study observed a declining intensity of jhum practice in rural areas with better access to road connectivity while this trend is positively correlated by the increasing intensity of plantation.*

Introduction

Roads are considered a catalyst for the process of social and economic development (Rostow, 1962). As they are an important factor that enhances grassroots development (Adedeji, 2014), the need for rural roads and its resultant effect on the rural communities' economy cannot be overstressed because an extensive, adequate and efficient rural feeder road network serves as one the channels for the collection and movement of goods and services, movement of people and dissemination of information (Umoren *et al*., 2009). Not only does it harness development potential (Bourdet, 1998), improvements in road network has multiple effects on socio-economic development like increased household income (Jacoby, 2000), per capita consumption growth (Castaing, 2011), greater employment opportunities (Windle and Cramb, 1997), better access to education (Khandker *et al*., 2009) and health care delivery (Mu & van de Walle, 2007) and reduction in poverty (Gachassin et al., 2010).

On the other hand, proper land use practices have been rightly viewed to have effects on the economy and environment as it has major impacts not only the livelihood of rural population but also on natural resources (Henriques et al., 2011). This is even more so in developing countries as the main occupation of the people is agriculture. Coupling this phenomenon with the growing attention towards sustainable development, land use is an integral part of development processes that cannot be viewed in isolation from other critical elements of that process, namely social and economic planning (Thomas, 2001).

Road connectivity poses a

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dilemma because improvement of roads has traditionally been one of the most important tools for rural development which is in favour of the rural poor (Lipton & Ravallion, 1995; Creightney, 1993) but is simultaneously linked to ecological disturbance and natural resource degradation because it facilitates deforestation (Chomitz & Gray, 1996). However, from a general economic perspective, rural roads provide the important connectivity with growing markets adjacent to rural areas and also lessen input costs and transaction costs of rural producers and consumers (Llanto, 2012) and are often a key spatial determinant of land use conversion (Ahmed *et al*., 2013). In addition, better accessibility to agricultural land or markets as a consequence of road connectivity can encourage people to convert lands (Munroe *et al*., 2004) while at the same time reduces travel times and transportation costs for farmers (Dorosh *et al*., 2009) which would confer substantial benefits on average, much of it going to poor households (Jacoby, 2000). On the flipside, a deplorable state of rural roads affects the quality of farm produce and leads to reduction in cost of the product while at the same time reducing the quality of life and well being of farmers (Ikejiofor & Ali, 2014). Additionally, an intense increase in road density on its turn affects changes occurring in land use and occupation (Freitas *et al*., 2009). With the development of roads, agricultural productivity tend to increase through expansion of crop production (Soares-Filho et al., 2004), and the greater access to markets through rural roads may promote expansion of production into forest area and other fragile lands (Angelsen, 1999). In a nutshell, rural road improvements lead to substantial reduction in freight charges, increase in household income, more employment opportunities, and expansion of cultivated land (APERP, 1997).

Thus, road connectivity may be considered as one of the significant factors that has bearing on the changing dynamics of agricultural land use. To test this hypothesis, attempt is made in this study to examine the relationship between road connectivity and status of rural land use by treating rural areas of Mizoram, India as a case.

Methodology

1. Data Source

The study covered 704 inhabited villages identified by the 2011 Census. However, some of the villages hypothesized to be having the same characteristics and those comparatively smaller were merged together thus making the number of villages a total of 517 which accounted for a total rural population of the state i.e. 5,25,435. The key variables of the study and their respective data sources are enumerated as follows:

a) Connectivity Variables

The study introduced four sets of connectivity variables. They are All Weather Road (AWR) connectivity i.e. whether the village is connected with AWR or not; Main Transport Route, i.e. whether it lies along the main transport route or outside; Distance of the village from AWR; Road Density, i.e. the village area falling within 1 km from motorable road.

For AWR Connectivity, the data was obtained from Mizoram State Public Works Department and the Village Councils which were contacted through letters and through telephonic enquiry. The study found the total number of connected villages to be 270 while 247 villages are not connected with AWR. The data for Main Transport Route, however, was determined through interview of various stakeholders, particularly vehicle owners, transport operators and knowledgeable persons. The study identified 112 villages to be along the main transport route while the remaining 405 villages lie outside the route.

For the third variable of Distance from AWR, data was obtained from two sources - from the Public Works Department, Government of Mizoram and the Village Council of the villages where bulk of it was attained from the latter. The village councils that could be communicated through telephones were asked the distance of their village from nearest AWR while those that cannot were contacted using letters. Lastly, the data for the fourth variable adopted as a parameter of road connectivity i.e., village's Road Density was determined through the estimated area of the village within 1 km from motorable road obtained from the Geographic Information System (GIS) data of Mizoram Remote Sensing Application Centre (MIRSAC). To work this variable out, technical assistance from a GIS expert was sought.

b) Agricultural Land Use Data

Lack of detailed village data about agricultural land use precludes analysis of the impact of road connectivity on agricultural land use. Instead this study used the GIS data derived through satellite map as given by MIRSAC to represent the different statuses of land use of the villages. Here, the variables of interest are area of wet rice cultivation (WRC), agricultural plantation area, and forest area - all represented as ratios to total area of the village; and average area under Jhum cultivation per households denoted in hectares.

2. Analytical Tools

The relationship between road connectivity and land use patterns of the villages was examined using two major analytical tools. First, to test the significance of difference across villages of different road connectivity conditions, t-test for difference of means had been adopted. Secondly, to examine the

pattern of relationship of differences across the road connectivity variables, the Dummy Variable Regression Model is adopted as the main connectivity variable (AWR Connectivity) cannot be readily quantified and so is assigned binary number 1 and 0 for connected and otherwise.

Due care was taken to avoid specification error in the modelling so as to ensure absence of theoretical inconsistency in our making of statistical inference and conclusion. The status of the village whether it is located along the main route was found to be overlapping with its status on AWR connectivity because those located along main route are connected by AWR. The dummy variable of main route was thus excluded to avoid the problem of dummy variable trap in estimation. Selection of 'AWR Connectivity' rather than 'Main Transport Route' status may be justified on ground that the former showed better significance of difference in most of the cases and that it is the most commonly accepted indicator of rural road connectivity in economic literature (Parida, 2014; Ibok & Daniel, 2013; Ulimwengu *et al*., 2009; Mu & van de Walle, 2007; Khandker *et al*., 2006). Since the model involves both dummy and quantifiable independent variables, it is appropriate to adopt Analysis of Covariance (ANCOVA) dummy regression model. Therefore, the following regression model is estimated:

$$Y_i = \beta_0 + \beta_1 D_{1i} + \beta_{2X1i} + \beta_{3X1i} + U_i$$

Where Y_i = Agriculture development variable(s) obtained from the study areas.
β_o = Intercept term
D_{1i} = 1, if the village is connected with AWR
= 0, otherwise
X_{1i} = Road Density (village area within 1 km)
X_{2i} = Distance of Village from nearest AWR (km).
U_i = Error term

General Observations

Table 1 and 2 shows the land-use data with respect to the four classifications. Some notable observations can be derived from the two tables. First, the percentage of WRC area to total village area is higher in villages connected with AWR and in villages that are within 15 km of the nearest AWR. However, it is lower in villages with high road density and those along main transport route than their respective adversaries. This is due to the fact there are villages connected with AWR but not along the main route that have large tracts of land under WRC. The cases of Buhchangphai, Meidum and Bukvannei villages of Kolasib districts may be cited. Possessing WRC areas of 22.69 per cent, 19.48 per cent and 14.72 per cent respectively, they are among the villages having the highest area under WRC in the whole study area. As such, the percentage is higher

for villages outside main route since these percentages shoots up the average percentage of the category.

Second, it can be stated that agricultural plantation area is highly correlated with road connectivity

Table 2. Classification I and II, Land-use Pattern

Figures in average unless and otherwise specified

Sl. No.	Cases	Road Connectivity		Main Transport Route		Total
		Connected with AWR	Not Connected with AWR	Along Main Route	Outside Main Route	
1	WRC Area (%)	0.85	0.83	0.69	0.89	0.84
2	Agriculture Plantation Area (%)	0.31	0.09	0.45	0.14	0.20
3	Forest Area (%)	73.88	76.27	75.57	74.88	75.03
4	Jhum Size per Household (Hectare)	3.44	4.36	2.81	4.17	3.88
5	Average Area of the Village (sq km)	37.86	36.43	40.34	36.30	37.18
6	Area within 1km from motorable road (sq km)	11.73	2.98	14.17	5.72	7.55

Source: MIRSAC, 2014

Table 2. Classification III and IV: Land-use Pattern

Figures in average unless and otherwise specified

Sl. No.	Cases	Distance from AWR			Road Density		Total
		AWR	Within 15 km	Outside 15 km	Below 7.5 km	Above 7.5 km	
1	WRC Area (%)	0.85	1.05	0.58	1.01	0.60	0.84
2	Agriculture Plantation Area (%)	0.31	0.08	0.10	0.11	0.34	0.20
3	Forest Area (%)	73.88	75.19	77.52	74.75	75.42	75.03
4	Jhum Size per Household (Hectare)	3.44	4.27	4.45	3.85	3.91	3.88
5	Average Area of the Village (sq km)	37.86	33.37	39.94	30.65	46.50	37.18
6	Area within 1km from motorable road (sq km)	11.73	4.03	1.79	1.31	16.46	7.55

Source: MIRSAC, 2014

because the percentages for villages with better road connectivity is significantly higher. Considering the topography of Mizoram, WRC might not be a practicable option for the agricultural sector because the area for such cultivation would be limited by the state's terrain. An alternative practice to move the people away from the unsustainable practice of Jhumming to sustainable cultivation would be agricultural plantation/settled cultivation of horticultural crops, rubber, etc. As such, the prevalence of agricultural plantation area may be viewed as one of the development indicators especially for the agricultural sector. The percentage area being higher in villages with better road connectivity suggests that agriculture development is higher in these villages.

Third, percentage of forest cover area is higher in villages not connected with AWR and villages above 15 km from AWR than their counterparts while it is lower for villages with road density below 7.5 km and for villages outside main route. This, again, may be due to the presence of sanctuaries like Ngengpui Wildlife Sanctuary and Blue Mountain Sanctuary in villages along main route. The possibility of these sanctuaries raising the average percentage of forest area for these villages cannot be ruled out.

Fourth, the average Jhum area per household per village is lower in villages with better road connectivity. In other words, the practice of Jhumming is being undertaken more extensively in villages with poor road connectivity. Lastly, in most cases, the average area of the village is larger in villages with better road connectivity. Moreover, the area of the village within 1 km from motorable land also shows a favourable situation for villages with better road connectivity. Therefore, it may be concluded that village area and road network are influenced by their connectivity status while the reverse may also hold true to that effect.

Analytical Results

To supplement the observations given in the previous section, it is an academic interest to undertake further empirical analysis. Table 3 shows the result of t-test for difference in land use data of villages having different connectivity status. The test statistic is significant at all levels for agriculture plantation area, average Jhum area per household and area within 1 km from motorable road for the 'AWR connectivity' and 'Main Route' classifications, while for the 'Road Density' classification, it is significant at the same level for agriculture plantation area and total area of the village. This denotes that the classifications according to whether or not villages are connected with AWR and whether

they lie along the main route shows results of significant differences across their respective categories for plantation area, Jhum area, and area of village within 1 km from motorable road. Thus, the condition that it is being connected with AWR and/or that it lies along the main transport route result in a favourable state for the village which can be interpreted as agriculture development because a larger area of agriculture plantation and a smaller area of Jhum cover was observed in the analysis undertaken in the previous section.

Villages with better road connectivity also have larger area within motorable road which can translate into higher opportunities for agriculture marketing. It may also be noted that a higher agriculture plantation area can be observed in villages with higher road density. The highly significant difference in average Jhum size per household shows a more extensive practice of traditional Jhum system in the villages with poor connectivity. We can therefore conclude that average performance of the villages having better connectivity conditions is significantly higher with respect to agriculture development which is a consequence of how land is being utilised. However, the classification of villages according to their distance from the nearest AWR does not show any significant difference between its categories thus showing that the distance of the village from AWR do not have noteworthy impact on agriculture development, so also for land use. Table 4 shows results of the estimated regression of agricultural land use on the three connectivity

Table 3. Difference in the Indicators of Rural Land-use

Sl. No.	Variable	t-value for difference of means			
		AWR Connectivity	Main Route	Distance	Road Density
1	Percentage of WRC Area	0.09	-0.70	1.45	-1.71
2	Percentage of Agriculture Plantation Area	4.79***	5.56***	-0.48	4.86***
3	Percentage of Forest Area	-2.36*	0.57	-1.61	0.65
4	Average Jhum Area per Household (ha)	-4.81***	-5.97***	-0.62	0.299
5	Geographical Area of the Village	0.61	1.43	-2.10*	6.98***
6	Area within 1km from motorable road	11.44***	8.71***	2.70**	27.23***

*** - significant at all levels, ** - significant at 1%, * - significant at 5%
Source: MIRSAC, 2014

measures. Here, it can be observed that the estimated regression is significant for all cases except the percentage of WRC area. Thus, one may state that road connectivity has significant contribution in the change in agricultural land use, directly or indirectly.

The coefficient of AWR Connectivity for agricultural plantation is 0.16 which is significant at 1 percent level. The coefficients for average Jhum size per household and village area are -1.34 and -6.81 which are also significant at 1 percent level. This result shows the practice of agricultural plantation at a more intense level in the villages connected by AWR and the increase in Jhum size per household for villages not connected with AWR which have relatively lower geographical area. Thus, there is a higher level of practice of settled cultivation in AWR-connected villages while shifting cultivation is more extensive in the non-connected villages.

Table 4 also shows the significant relationship of road density and land use as its estimated coefficients are significant for plantation, Jhum size and also for total geographical area of the village. The results indicate the coming up of agricultural plantation with the increase in road density and also for Jhum size, surprisingly. At the same time, the coefficient with respect to distance is significant for total geographical area of village only.

Conclusion

To conclude, the following points

Table 4. Estimated Regression of the Agricultural Land-use on Road Connectivity

Figure in bracket indicates significance level

Sl. No.	Dependent Variable	Constant	Coefficient of Independent Variables			R-square	F- Statistic
			AWR Connectivity	Road Density	Distance from AWR		
1	Percentage of WRC Area	1.14 (0.000)	-0.05 (0.882)	-0.02 (0.142)	-0.01 (0.226)	0.007	1.12 (0.339)
2	Percentage of Agriculture Plantation Area	0.07 (0.173)	0.16 (0.018)	0.01 (0.010)	0.00 (0.805)	0.056	10.06 (0.000)
3	Percentage of Forest Area	73.27 (0.000)	-0.04 (0.977)	0.06 (0.340)	0.15 (0.001)	0.032	5.66 (0.001)
4	Average Jhum Area per Household (ha)	4.42 (0.000)	-1.34 (0.000)	0.03 (0.002)	0.00 (0.948)	0.071	13.04 (0.000)
5	Geographical Area of the Village	24.01 (0.000)	-6.81 (0.010)	1.76 (0.000)	0.37 (0.000)	0.340	88.18 (0.000)

Source: MIRSAC, 2014

may be noted. Firstly, the area of wet rice cultivation is higher in villages with better road connectivity. Secondly, there are larger areas of land coming under agriculture plantation in the villages with better access to road connectivity. Thirdly, the Jhum size per family is higher in villages with poor road connectivity which points to the fact that Jhumming is practiced at a more extensive level in these villages which again is positively correlated with low intensity of agricultural plantation. Lastly, the sign of significant estimated regression coefficients suggest the increasing trends of plantation areas with connectivity improvement, while it also shows the increasing Jhum size with poor connectivity.

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Spatio-Temporal Analysis of Population Growth in Aizawl City

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Abstract: The rapid growth of urban population in Mizoram has been questioned often. In this paper, we argue that the phenomenal growth of urban population in Mizoram is largely due to the exceptional high growth rate of Aizawl city which contains about half of the urban population of Mizoram and more than one-fourth of the entire population of the state. The growth rate of the city's population has been traced and analyzed from 1901 and different stages of growth have been observed. The paper also analyzed spatial patterns of population growth at municipal ward level since 1981.

Introduction

Urbanization in Mizoram has been much discussed and frequently debated (Agarwal, 1995, Guhathakurta, 1999). The rapid growth rate of urban population in the state has been attributed to the increasing declaration of number of towns by the state government (Agarwal, 1995). These towns were notified out of socio-political considerations and characterized by improper rural-urban base and feeble urban commercialization and economic growth (Kumar, 1998). These government-notified towns were subsequently declared by the Registrar General of India as Notified Towns (NT) or Statutory Towns (ST) unlike Census Towns (CT) that conforms to the Census of India definition of urban centres. However, some of them have not attained the 5000 population benchmark till 2011. The rapid growth of urbanization is not only due to the mere increasing number of towns but also the rampant growth of Aizawl city in the post-Independence period. In 2011, Aizawl city population consisted of 26.89 per cent of the entire population of Mizoram while the total percentage of urban population in the state was 52 per cent. The rapid growth of Aizawl city has prompted us to analyze the patterns and processes of spatio-temporal growth of the city.

Objectives of the Study

The main objectives of the study are-

(1) to study the temporal growth of Aizawl city during 1901-2011.
(2) to analyze the spatial growth of Aizawl city since 1981 at municipal ward level.
(3) to formulate proper population policy for healthy growth of the city.

Methodology

Data is mainly obtained from the District Census Handbook published by the Census of India for each census year.

To calculate population growth rate, both decadal growth rates and exponential growth rates were

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employed. Decadal growth rate is given as

$$DGR = \left(\frac{P_n - P_o}{P_o} \right) * 100$$

where DGR = Decadal Growth Rate, Pn= Present population, Po= Initial Population.

Exponential growth rate is also calculated as follows:

$P(t)=P_0 e^{rt}$

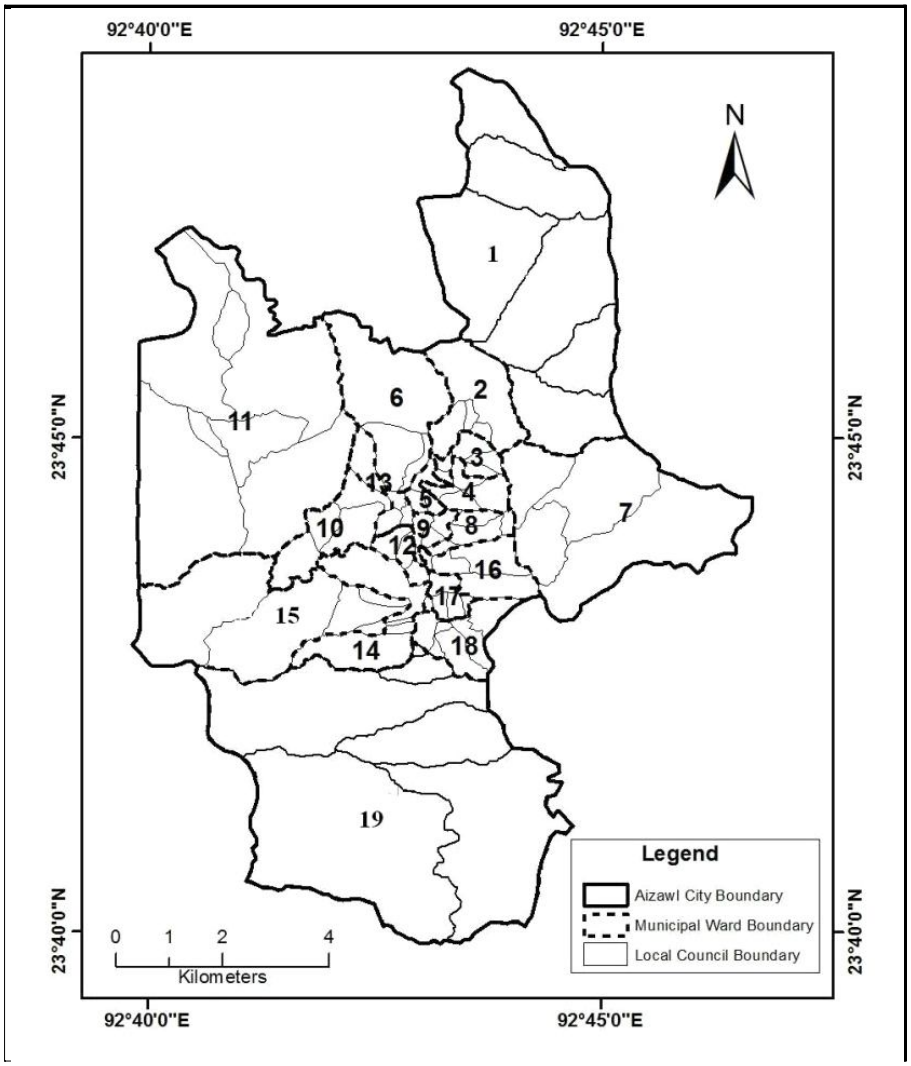

Figure 1. Aizawl City - Administrative Division

The Study Area

Situated between 23°39'52"-23°48'43"N latitudes and 92°39'49"-92°46'39"E longitudes at the northern part of the Mizoram, Aizawl is the administrative capital and primate city of Mizoram. In 2011, the population of Aizawl was 293,416 and classified as a Class I city as per the Census of India classification of urban centres. The city is administered by Aizawl Municipal Corporation (AMC). The AMC comprises of 19 Municipal wards which altogether comprises 82 Local Councils (LCs). However, there were only 75 census wards corresponding to the existing Local Councils as per the Census of India 2011. These Local Councils, previously known as Village Councils (VCs) are the lowest administrative units.

Temporal Growth Pattern of Aizawl City

'Fort Aijal' was established in 1890 as a military station by the colonial Britishers who invaded or 'pacified' in colonial parlance the Mizos and subsequently occupied their homeland. The invasion has brought in a new kind of social, political and economic systems that transformed the Mizo society in a rapid manner. The consolidation of colonial empire took place from certain geographically favourable locations like Aizawl (Fort Aijal), Lunglei (Fort Lungleh) which became the headquarters of North Lushai Hills and South Lushai Hills respectively. These two sites of power became centres of socio-economic transformation and diffusion of social change. One of the many spheres in which the societal transformation pronouncedly manifested was urbanization which has far reaching socio-economic impact in the making of modern Mizo society. The

Table 1. Growth of Population, Aizawl City, 1901-2011

Census year	Population	Stage	Inter-censal year	Decadal Growth Rate (%)	Average Annual Exponential Growth Rate
1901	325	Initial Surge	-	-	-
1911	2890		1901-1911	789.23	21.85
1921	3034	Period of Stagnation	1911-1921	4.98	0.48
1931	3250		1921-1931	7.12	0.68
1941	4780		1931-1941	47.07	3.85
1951	6950		1941-1951	45.39	3.74
1961	14,275	Rapid Growth Stage	1951-1961	105.40	7.19
1971	31,740		1961-1971	122.35	7.99
1981	74,493		1971-1981	134.69	8.53
1991	1,55,240	Declining Growth Stage	1981-1991	108.39	7.34
2001	2,28,280		1991-2001	47.05	3.85
2011	2,93,416		2001-2011	28.56	2.51

Source: District Census Handbook, Aizawl District, 1961-2011, Directorate of Census Operation, Mizoram.

following Table 1 presents the actual population and its growth rate since 1901.

Initial Surge (1901-1911)

In the initial years of British occupation, the Aizawl outpost consists of a military barrack and a few bungalows only. The newly established outpost was fortified to accommodate around 200 military personnel only. However, many local population were attracted to the new settlement. The outpost was gradually surrounded by civilian residential areas through increasing migration from the surrounding areas. Therefore, the population of Aizawl increased rapidly after the British occupation from 325 persons to 2890 during 1901-1911.

Period of Stagnation (1911-1951)

The colonial administrators, however, perceived the Aizawl outpost as an enclave. To restraint the increasing native people around the fortified outposts, the colonial administrators imposed two methods of exclusion - restrictions on number of houses for each locality and imposition of a new kind of tax known as 'Personal Residence Surcharge' (PRS). The number of houses was fixed for each locality. The following Table 2 gives the number of houses permitted in each locality amounting to a total 722 houses within the settlement. Thakthing veng which is presently a small locality was permitted the highest number of houses while Maubawk was permitted only 20 houses. Although there were a few government quarters at Babutlang, Zarkawt, the area was not considered as residential area at the time. Apart from these localities, there were residential areas like Sriman Tilla (Present Zotlang), Dokhama veng (present Bungkawn), Survey Tilla (present Dinthar), Vaivakawn, Rangvamual, Zemabawk and Chanmari veng which consists of Hmarkaii Nu Veng and Suklala Veng at the present Chanmari West. No Mizo house was found in the first four localities but occupied by the immigrant Gorkhalis and the other localities were expected to be "discontinued by natural process" (McCall, 1980:101). As such, number of permitted house was not earmarked for these localities. By this time, the population of Aizawl was a little higher than 3000 only.

The personal residence surcharge (PRS) was introduced only in Aizawl (Fort Aijal) and Lunglei (Fort Lungleh) - the headquarters

Table 2. Number of Houses Permitted in Various Localities of Aizawl, 1932.

Sl. No.	Name of locality	No. of Houses permitted
1	Venghlui	30
2	Tlangnuam	50
3	Thakthing	150
4	Kulikawn	50
5	Khatla	10
6	Maubawk	20
7	Mission veng	82
8	Dawrpui	30
9	Chhinga veng	25
10	Chaltlang	75
11	Luangmual	50
12	Hlimen	50
13	Durtlang	100

Source: McCall (1980:101).

of North Lushai Hills and South Lushai Hills respectively. The main objective of the system was "to control and discourage settlement around Aijal and Lungleh" (McCall, 1980:78). The colonial administrators justified the enactment of this tax by maintaining that increasing migration to these two settlements would increase reduction of forest through shifting cultivation and consequent decline of rainfall and accelerated denudation. The tax was not levied to government employees. The government also exempted the permanent staff of the Welsh Mission at Mission Veng from payment of PRS although the number of houses was fixed at 82 by mutual agreement between the two parties.

Secondly, this is a period of hardship due to certain reasons. II World Wars were witnessed. Many mizo men were also involved and fought the wars. this may also be reflected in the low growth rate.

Rapid Growth Stage (1951-1981)

The post-independence era has witnessed unprecedented growth of Aizawl population. During 1951-1991, the decadal growth rates of Aizawl had continuously exceeded 3 digits which may be unparalleled in the history of urban growth. A number of factors may be attributed to the high growth rates witnessed during this period.

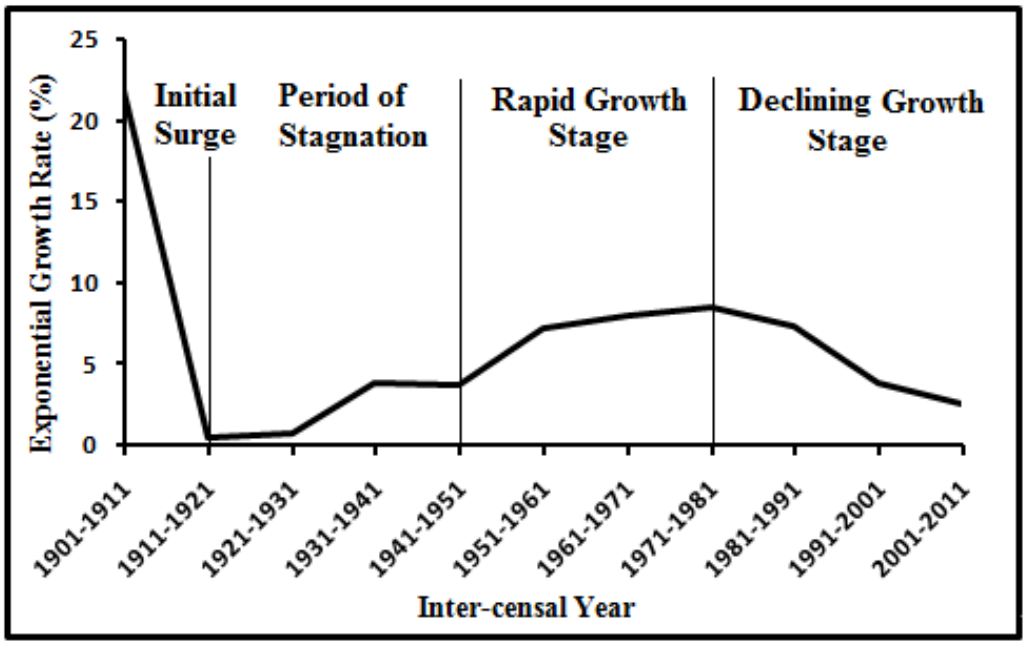

Figure 2. Stages of Population Growth of Aizawl City

Firstly, with the Independence of India in 1945, the strict migration control policy imposed by the Colonial Raj came to an end. This resulted in uncontrolled migration to Aizawl from various corners of Mizoram due to various socio-economic push-pull factors.

Secondly, a state-wide insurgency happened between 1966 and 1986. During the 20 years of insurgency, Aizawl received a large number of 'war refugees'. This resulted in large-scale migration to the relatively safer Aizawl town out of fear of violence, better economic opportunities and quality of life in the growing city. Thirdly, the upgradation of Mizo Hills District Council into Union Territory in 1972 was highly significant in the process of urbanization. With the attainment of Union Territory, the power and functions of the local government increased manifold which resulted in large-scale opening of government jobs and concomitant increase in employment opportunities in other sectors. The growth of population during 1961-1981 was spectacular. The decadal growth rates were 122.35 per cent and 134.70 per cent during 1961-1971 and 1971-1981 respectively. Apart from these, outlying villages were subsequently incorporated within the city proper. In 1982, the number of localities was only 26 and it has increased to 82 in 2011.

Declining Growth Stage (1981-2011)

Interestingly, a sudden decline in population growth rate has happened after the 1980s. During 1981-1991, the decadal growth rate was reduced to 108.39 from 134.69 in the preceding decade. After the 1990s, the growth rate has declined abruptly to 47.05 during 1991-2001. The growth rate went down further to 28.56 during 2001-2011. It seems that the pull factors of the city has been waning with increasing population as a result of decreasing employment opportunities in the post-statehood era, deterioration of physical infrastructures etc that diseconomies of scale started to operate. Moreover, the official declaration of 22 bigger settlements during 1981-1991 as well as the creation of 5 new districts in 1998 may also contributed in reduction of inflow of internal migrants from other places.

Spatial Growth Pattern of Aizawl City

The present section is an analysis of spatial pattern of population growth of Aizawl city. The annual average exponential growth rates of various municipal wards during 1981-2011 have been calculated from Census of India data.

During 1981-2011, as many as 2, 18,923 persons have been added to the population of Aizawl. The number of localities has also increased by 43. In 1981, the num-

ber of localities was 32 only. It has increased to 54 in 1991 after inclusion of certain outlying localities like Durtlang and division of existing localities into multiple localities by forming separate Local Councils (the then Village Councils). During 1991-2001, another new 15 localities were either added or created. Presently, there are 82 localities although the 2011 Census of India recognized only 75 localities since certain localities were not existed at the time of the survey.

The following Table 3 gives the growth rates of various municipal wards of Aizawl city from 1981-

Table 3. Average Annual exponential Growth Rate, Municipal Wards of Aizawl City, 1981-2011

Ward No.	No. of Local Councils	Main Area	Location*	Expo Gr. Rate (%)		
				1981-1991	1991-2001	2001-2011
1	6	Durtlang	OP	NA#	6.49	3.03
2	2	Chaltlang	OC & IP	7.96	2.82	3.98
3	5	Ramhlun North	IP	4.90	5.66	2.58
4	4	Ramhlun South	IP	12.98	4.55	3.14
5	3	Chanmari	IC	1.86	2.55	0.42
6	3	Chanmari West	IP & OP	NA#	4.59	3.09
7	4	Zemabawk	OP	7.15	3.00	4.76
8	4	Armed veng	OP	8.40	2.73	2.02
9	3	Dawrpui	IC & IP	1.96	4.74	0.74
10	4	Zotlang	IP	12.88	8.24	2.62
11	5	Luangmual	OP	13.97	2.81	3.37
12	3	Tuikual	IP	6.28	2.59	1.68
13	3	Vaivakawn	OC	2.83	4.76	1.72
14	3	Khatla	IP	7.16	3.59	2.65
15	5	Bungkawn	IP	6.46	3.60	2.33
16	3	Bethlehem	OP	10.84	3.45	2.64
17	4	Republic	IP	2.00	3.53	1.28
18	6	Mission Veng	OC, IP & OP	7.32	3.76	2.06
19	5	Kulikawn	OC, IP & OP	2.80	5.79	2.55

* OP=Outer Periphery, IP=Inner Periphery, OC=Outer Core, IC=Inner Core

\# Municipal Ward Nos. 1 and 6 were neither included nor existed in 1981 Census.

2011. Municipal wards were classified arbitrarily into outer periphery, inner periphery, outer core and inner core on the basis of their relative location from Bara Bazar - the central business district (CBD) of Aizawl city with the exception that all local councils covered by the most important route of the city i.e. Bawngkawn-Kulikawn (B-K Route) have been put under either inner core or outer core.

The growth rates of inner core localities have been relatively low in comparison to their counterparts in outer and inner peripheries and outer core areas. Municipal Ward No. 5 comprising of 3 localities including Chanmari, Zarkawt and Electric veng has been showing the lowest growth rates since 1981-1991 to 2001-2011. This residential cum commercial area is a very high density zone and seems to be already congested in 1981. In spite of the increasing verticalization of residential buildings, the scope of increase in population is highly limited. Another inner core area includes Dawrpui locality of Ward No. 9. This ward also comprises Saron veng and Chhinga veng which may, however, be included under inner periphery due to their outward growth towards the eastern slope. This ward has also witnessed slower growth during the observed period.

The highest growth rates have been observed in the outer peripheral areas including Municipal ward Nos. 11, 7 and 16. These mu-

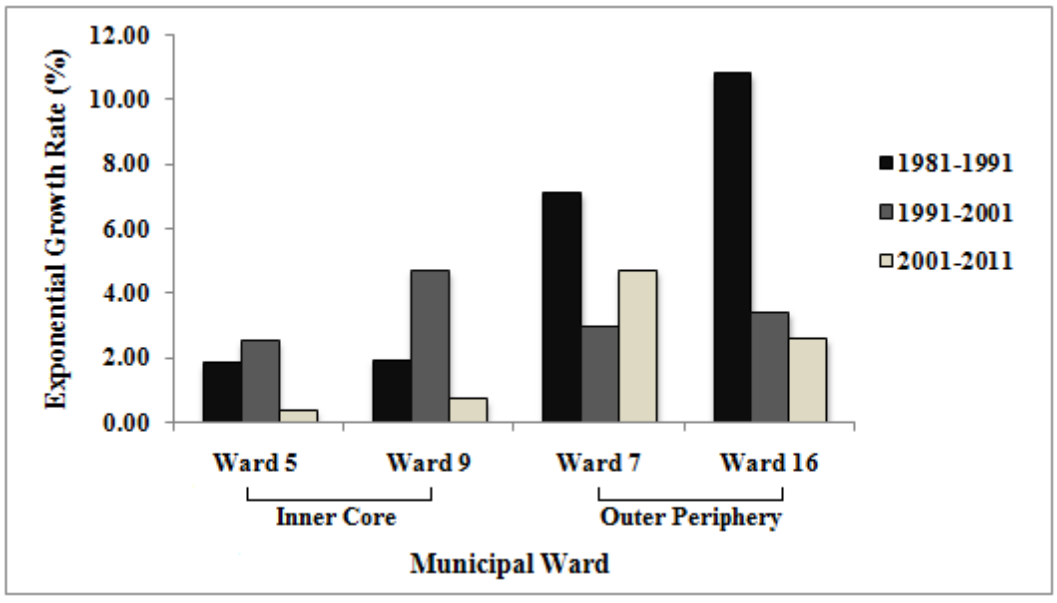

Figure 3. Growth Rates in Inner Core and Outer Periphery, Aizawl City

nicipal wards include Luangmual and its adjoining areas, Zemabawk and its adjoining areas and Bethlehem and its adjoining areas respectively. These peripheral localities are preferred destinations of newer migrants. Relatively lower land value and house rent, more available spaces for construction of housing and easy accessibility are some important determining factors of higher growth rates of these wards.

An observation into the spatial growth of Aizawl city suggested that the process of exurbanization (Champion, 2000) has been taking place in the city. The peripheral, low-density, semi-rural settlements located beyond the city proper are growing faster in comparison to the centrally located, high-density core areas of the city. The process of exurbanization in a less-developed city like Aizawl, however, seems to be different from those in developed cities due to differences in level of socio-economic and infrastructural development. Majority of the residents of the peripheral areas are poorer people while the inner areas are inhabited by more affluent people. Yet, it has been noticed that there is a tendency among the affluent people to move to more favourable locations in the peripheral areas where they already acquired properties.

Conclusion and Policy Matters

The growth rate of Aizawl city had been fluctuating much during the late 20th century. After a brief spell of very high growth rate, the pre-Independence period was characterized by slow growth rate mainly due to strict anti-immigration policy enforced and maintained by the colonial power. The growth rate dramatically increased after the independence of India until 1981 after which it slowed down in a rapid manner. It may be expected that the growth rate will continue to decline for some decades until it reaches stability.

Analysis of spatial pattern of population distribution in Aizawl city presents that, after the 1980's the peripheral areas are growing faster in comparison to the core areas. The core areas are highly crowded and this led to the proliferation of housing units at pre-uninhabited low lying or steep sloping surfaces as well as at more favourable sites in the peripheral areas of the city. Moreover, outlying settlements were incorporated into the city while existing localities were divided into multiple localities when uninhabited sites in these existing localities were occupied. Inside the core and inner peripheries, multi-storey buildings started to dominate the skyline in order to accommodate the increasing population.

The relatively rapid growth of Aizawl city with respect to other settlements in Mizoram has implications in the processes of intra-urban, inter-urban and re-

gional economic development. The core area has been highly congested due to concentration of all economic activities. Due to absence of dispersal of economic activities away from the core areas mainly due to problems of internal linkages, the city is becoming monocentric and highly inaccessible. Secondly, the relatively higher growth rate of Aizawl city has cause serious discontentment among other towns. Disproportionate allocation of growth inducing resources with the sustained favouratism given to Aizawl city has been shaking the integrity of the state and separatist tendencies have been germinated in the multi-ethnic and multi-religious state. Lastly, the trickle-down effect of the city has been obliterated by the more powerful backwash effect through sucking and pulling in the most productive human and physical resources from its hinterland. The seepage of growth from Aizawl city, if any, failed to reach the neediest and most impoverished areas. The 'parasitic city' thesis (Hoselitz, 1955; Bairoch, 1988) seems to have relevance in the present context due to the unsatisfactory impact of the city on the regional economy of the state. However, it seems that urbanization is unavoidable for the growth and development of a region in the long run even if it is not accompanied by rapid and steady growth in the initial period.

We are also convinced that re-distribution of population towards the peripheral areas has to be maintained for healthy growth of the city. The negligence of fringe areas has to be corrected and investments should be made in order to develop various infrastructures like road, water supply, and banking as well as social institutions to attract the more affluent population and growth inducing agents. Presently, they are devoid of important offices, institutions, basic infrastructures and services. Most of the inhabitants are engaged in primary activities due to absence of diversification of economy. Decentralization of important offices and relocation of certain activities would be an ideal starting process to develop these places keeping in mind the present level of development.

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Distribution of Landslide Hazard Zones in Aizawl City

- Bobby Beingachhi
- HL. Lawmzuala

Abstract : *Generalized hazard zone map of Aizawl city depicts the distribution of different prone areas of landslides in the city. Very low hazard zone covers the second smallest areas and distributed over the outskirts of the city. Low hazard zones are scatter but large areas are lying periphery of the city. Human activities and developmental works should be undertaken within these zones in consultation with experts. Moderate hazard zones extend over the largest areas of the city. The present condition of these zones may change to high hazard zones due to anthropogenic action. 'High hazard zones' are also dispersed in various parts of the city and several places of human settlement come under this zone. The 'very high hazard zones' cover the smallest areas and these zones are found at many places within the settlement areas. It is a constant treats of landslides especially during rainy season. The extent of landslides prone areas depends on the steepness of the slope, the bedding plane of the rocks, the amount of vegetation cover and the extent of folding and faulting of the rocks. It is the rocks that break and carry with the soil debris. Removal of the vegetation cover, developmental activities, poor ground conditions, geomorphic phenomena, and long spell of heavy rainfall are the main responsibility of soil erosion, destabilization of slope and landslides.*

Introduction

Landslide is considered as one of the major natural environmental hazards in almost all parts of the world more especially in the mountainous regions. Due to the sudden and unpredictable occurrence of this disaster causes loss of a large number of precious life and property every year in different parts of the world. About 80% of all the landslides in different parts of the world are the result of anthropogenic factor. This phenomenon is a major environmental issue as a result of which it is essential to study the causes, impact, precaution and the mitigation measures for further occurrence.

Landslide is a major problem faced every year in Mizoram. The main causes of landslide are geological immature topography, high degree of slope, long spell of rainfall during monsoon season and human activities. The extent of landslides depends on the steepness of the slope. The steep bedding plane of stratified sedimentary rocks, the amount of vegetation cover, the weight of overlying materials, the water content of the soil and the removal of lateral support are another causes of landslide.

Rapid pace of urbanization in Aizawl result in a number of developmental works being taken up along the hill slope which reduces the stability of areas. These unplanned and unscientific development activities cause massive and micro landslides at many places. The anthropogenic action without consideration of

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geomorphic condition of the area brought various parts of the city highly prone to landslides. Therefore, a number of landslides in and around the city are caused by nature and induced by human activities.

Rating for Landslide Criterions

Mizoram Remote Sensing Application Centre (MIRSAC) has given weightage to various criterions according to their assumed importance which brought about landslides based on the theoretical knowledge of the connoisseurs. They prepared landslides ratings for parameters on a scale of 1 to 10 while making micro-landslide hazard zone maps of Aizawl city. According to them, there are five major parameters viz lithology; slope morphometry (in degrees); structure (faults and lineaments); geomorphology and; land cover with vegetation. All these five major parameters consist more than four sub-categories except structure.

The lithology has been divided into five groups. One of the categories of lithology is crumpled shale which is the highest rating of this group and its weightage is assumed as 10 and shale sandstone unit is 9 on this scale which is the second highest ranking in the criterion of lithology. The siltstone-sandstone and sandstone are sixth and fourth position respectively. Regarding the parameter of structure, it is presumed as eighth although the rating scale depends on the length of buffer distance on either side of faults and lineaments.

In connection with geomorphology the highest weight of landslides is only four which has been found in the high structural hill. The second highest rating of landslide in geomorphic condition is established at three which is commonly lies in the medium structural hill. The low structural hill of geomorphology has been estimated as only three based on the above mentioned scale of landslide parameters.

In regard to slope degrees chance of possibility of landslides are predominantly increasing as the slope degrees ever more up to forty degrees and its weight has reached to six on this scale. Rating for landslide parameter in between 40 - 60 slope degrees are calculated roughly as eight weight but evaluated only five weight above 60 slope degrees category. Moreover, there are other relevant criterions are old occurrences of landslides, condition of vegetation cover, the vicinity of road cutting or excavation of materials, dip-slope relation and the drainage texture are predisposed and vulnerable areas to landslides.

Landslide Hazard Zones in Aizawl City

Mizoram Remote Sensing Application Centre (MIRSAC) take up a major study of preparing micro

landslide hazard zone maps on 1: 5,000 scale using Remote Sensing data. A number of thematic maps were procreated using Remote Sensing Technology and Geographical Information System (GIS) and minor landslide vulnerable area maps of Aizawl City depicting various groups of landslide endangered areas has been produced. The following interpretation of landslide vulnerable areas of the city were based on this thematic map.

(a) Very High Hazard Zone

Very high hazard areas of landslide are generally located at many places where road passing through the slope of the land, excavation of materials for building construction, human activities are actively undertaken for developmental work and places loss the strength to resist the landslip down. Landslide is commonly found in the city where highly unstable condition of soil, scanty vegetation covers, steep slope with unconsolidated materials and weathered rocks. Soil debris covering sharply slope are incessantly taken away by the action of exogenetic forces. The rocks exposes to the surface has distinctive features of bedding and joint planes which provides the possibility of downward movement of a mass of soil and rock materials along the slope.

Very high hazard spread out widely over the entire area of Aizawl city. Within $92^0$44'00'' to $92^0$46'00''E and $23^0$48'00'' to $23^0$50'00''N very high hazard zone has been identified along Chhimluang lui and around Selekawn, Remand Home (Durtlang north), western side of MC Hall Durtlang, western areas of Presbyterian Hospital. Inside the degrees of $92^0$44'00'' to $92^0$45'00''E and $23^0$46'00'' to $23^0$48'00''N very high hazard zones are marked near Agape Camping Center, Central Store PHE Department. Very high hazard zone has also been located at PWD Complex, northern facing steep slope between Vaivakawn and Ropaiabawk saddle and this area is not only steep slope but loose sediments, unconsolidated rocks and terrific speed of the sources of Tuikhur lui. Between $92^0$42'00'' to $92^0$44'00''E and $23^0$44'00'' to $23^0$46'00''N very high hazard zones are found around Dinthar saddle, from Lalsangliana petrol pump via Lalboi filling station, Singson servicing station extending from north-west along Sairang road up to Rangvamual, north and south of Electric veng, Ramhlun sport complex, western side of Hauva petrol pump.

Very high hazard areas are spatially distributed within $92^0$44'00'' to $92^0$46'00''E $23^0$44'00'' to $23^0$46'00''N around Aizawl Building Center, LAD; Gov't Godown Zuangtui, eastward facing steep slope between north Durtlang and Hermon Children Home. It also

scattered on TNT, DOEACC, PWD Godown, south facing slope of Bawngkawn to Thuampui especially on all sides of Hauva Petrol Pump, in and around Power and Electricity power station, wayside slope between Thuampui and Zuangtui, vicinity of Gov't Primary School Thuampui and Primary School-1 Zemabawk. Another very high hazard zones are found close to High Court, southern area between Maubawk and Lawipu localities. Major patches of very high hazard areas are located near Dintharkawn, Bethlehem north, below AR Play Ground including Saron veng, eastern facing steep slope of soft sediments in Venghlui locality, western side slope of Maternity Hospital ITI and Tlangnuam play ground, eastward facing steep slope extending from Kulikawn to Melthum.

Very high landslide hazard zones are commonly found at the steep slopes with soft nature of rocks and unconsolidated materials, stone quarries, toe-erosion like road cutting and excavation of material for building construction, depth and lateral erosion of stream current on the hill slope and anthropogenic interferences. Some very high hazard areas are situated near faults and tectonically weak zones which are manifested on the surface by subsidence of lands. As calculated and recorded by Mizoram Remote Sensing Application centre this zones may occupies about an area of 6,44 km^2 and forms 44.99% of the total study area.

(b) High Hazard Zone

High hazard zone are found at various places on all sides of very high hazard zone. High hazard zone includes areas where probability of sliding debris is at a high risk due to the weathered rocks and soil debris covering steep slope. Several lineaments, fracture zones and fault planes also traverse the high hazard zones. High hazard zones covered and are of 33.33 km^2 which is 24.29% of the city as computed by Mizoram Remote Sensing Application Center, Science and technology.

High hazard zones scattered inside the degrees of $92^0$44'00" to $92^0$46'00''E and $23^0$48'00'' to $23^0$50'00''N. This zone spread out from Selekawn to Sihphir vengthar play ground, western side of Agriculture Cold Storage, along the stream of Darlui and Kawmliam lui, eastern side of Gov't Sihphir High School, close to Twin Market in Sihphir. High hazard zone also extend from Thangrahbi saddle to Remand Home and small pocket of this zone has been marked along the western side of Sairang road, high hazard zone has been spread out from Hindi Training College following Huahlam lui, around the areas of Durtlang dawrkawn and way to Women Polytechnics. It also includes the surrounding areas of Sihphir lui, Sailum lui, Midum lui

and Leitan lui.

Between the degrees of 92^{0}44'00'' to 92^{0}46'00'' E and 23^{0}46'00'' to 23^{0}48'00''N, high hazard zones covers an area around Sele lui, Doodarshan Kendra and Gospel Thunder Team Camping Center. Various dimensions of high hazard zones extend from Bawngkawn along the Sairang road including Vaivakawn, sothern facing slope of Bawngkawn, around Social Welfare Department, Ramhlun Indore Stadium, eastern side of Laipuitlang reservoir, southern side of Chandmari saddle and the entire areas of the tributary sources of Theihai lui. High hazard zone covers almost half of the entire area of Lungding lui, Kudam lui, near Zemabawk play ground, close to Gov't High School Zemabawk, southern side of Central Water Commission, northern side of Ramri lui and around the area of Mizoram Science Center.

High hazard zones and vulnerable to landslide are found in the south western facing slope of Khatla, Nursery, Bungkawn localities and also north east facing slope of Bungkawn and Maubawk localities. A part from these, high hazard zones are located near Dinthar saddle, Bethlehem north, Venghlui, Republic veng, Kulikawn and Tlangnuam. These zones are also found along the streams of Mualpui lui, Sihpui lui, Saisih lui, Vailui and Tuikual lui. Another prominent high hazard zones are found near RIPAN, TB Hospital Zemabawk, Beraw tlang and along the stream of Beraw lui. Highly vulnerable areas to landslides are identified at the western side of Chite lui up to Kangthelh lui. The entire eastern facing steep slope between Ngaizel and Hualnghmun are high hazard zone. These zones has been identified between Beraw lui and Tuikhur lui, Melthum locality to MST Workshop and also found around Hlimen playground.

(c) Moderate Hazard Zone

The moderate hazard zone has been distributed over several parts of the city. The sedimentary rocks which lies in the moderate zone hazard zone are usually hard and compact but its stability may bring down due to chemical reaction and mechanical action and toe-erosion or excavation of materials coupled with long heavy rainfall during monsoon season. As mentioned by the Mizoram Remote Sensing Application Center moderate hazard zone may include areas that have steep slope more than forty five degrees and this zone are covers with moderate dense vegetation. The orientation of the rock beds or the absence of overlying loose debris and human activity may make these zones less hazardous.

Generally, moderate hazard zone are stable rocks structure, firm and secure but it may contains pouches of precarious areas in certain places. For which reason this zone

is needed spot verification and authentic investigation due to rapid growth of urbanization to take up precaution measures. Various development works and human activities should be taken up within the sphere of moderate zone cautiously so as to avoid wreak havoc in the area.

Moderate hazard zone covers an area of about 56.66 km^2 and occupies 43.93% of the total study area1. It spread over the largest areas of landslide hazard zone in Aizawl city. Three landslide hazard zones like very high hazard zone, high hazard zone and moderate hazard zone occupies not less than

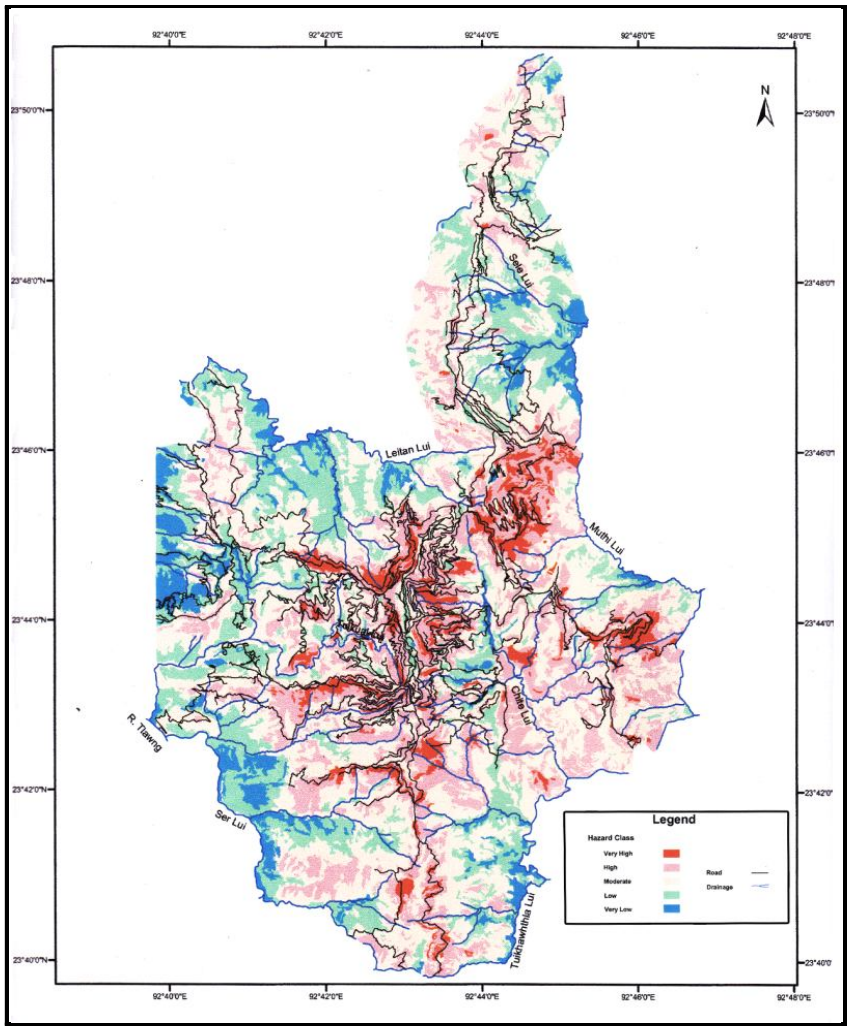

Figure 1. Landslide Hazard Zones Map of Aizawl City

94.43 km^2 (73.21%) of the entire area which indicates that most of the places are insecure for human settlement in Aizawl city. As such, it is vitally important to take step any developmental works in consultation with subject expert like engineers, geologists and geomorphologists etc. The government or authority should strongly propose to pass by-laws not to disturb or destroy natural drainage, vegetation or plants and undermine the slope etc within moderate hazard zone.

(d) Low Hazard Zone

Low hazard zone is normally considered stable and it has been located on the peripheral areas of the city. A work on 'Micro landslide hazard zonation map of Aizawl city' prepared by Mizoram Remote Sensing Application Centre, showing different categories of landslide hazard zones, with the help of Quick bird Satellite data, and the Indian Remote Sensing Satellite (IRS-P5) stereo-paired Cartosat-1 data depicted that a few small pockets of stable areas in the central part of the study area.

The slopes are gentle in low hazard zone where the chance of possibility of slope failure and landslide down are narrow. Normally, low hazard zone is located at the lower level of the investigated area where the various controlling factors of landslide having forceful impact on the stability of the slope are fall off or declining.

Low hazard zone is found in the western area of the city, south eastern part and also north eastern side of the study areas. The dimensions of the low hazard zone extend over an area of 26.58 km^2 and forms 26.61% of the total study area. Low hazard zones are suitable for human settlement and eager to take up developmental works due to less chance of landslide if it is not big changes take place in this zone. Anthropogenic activities should be done in consultation with experts in case it may include small areas of unstable condition at various places.

Most of the low hazard zones are distributed at the outskirt of the city normally along the vicinity of the river valleys, low hazard zone are found at places of higher level of altitude. So, the nature of this zone is stable, hard, compact and having power to remain unchanged until big surgery by human interference and toe-erosion occur at any places. These areas are covered with vegetation but some places are bare plant, human activities for development are slowly come up as it was lying peripheral areas of the city.

As it was sedimentary formation the nature of soils are same to other places of Aizawl city but its stability to landslide are high and more secure for human settlement because the degree of slope, where the degree of slope are not more

than thirty degrees which is not vulnerable to landslides. Flat and low level lands, stable and compact landscapes, low degrees of sedimentary stratified layers fall under the categories of low hazard zone.

(e) Very Low Hazard Zone

Very Low Hazard Zone has been identified and distributed at various places mainly in the lower level of the study area. Very low hazard zone covers an area of about 7.97 km2 and forms 6.18% of the total area of the city (MIRSAC, 2015). The areas of very low hazard zone has been found along the western side of Tuikhawhthla lui in south eastern corner of the city, along the western bank of Ramri lui, alongside the river valleys of Ramri lui and Sele lui and also present at and around the confluence of Chhuahlam lui and Zotuimawng lui in the north eastern part of the city.

Another very low hazard zones were located in the direction of the left bank Muthi lui and the surrounding area of the flowing together of Muthi lui, Pangen lui and Vainam lui. Small pocket of very low hazard zone has been marked in the central area of Aizawl city alongside Chite lui and also found on every side of LAD picnic spot. This zone is suitable for carrying out developmental works and secure for allocation of human settlement.

Very low hazard zone are spread out widely in the western and north western peripheral areas of Aizawl city. These zones are lying on the southern side of Sairang lui, Leitan lui including the entire area of Maumual. This low hazard zone has been found by the side of Kurung lui, some area of Tanhril local council come under this category and other very low hazard zone is situated on the eastern area of river Tlawng around the joining place of Tuikum lui and Tlawng lui. Low hazard zone is scattered to several places on every side of Aizawl Greater Water Supply Scheme phase-11 complex, between Serlui to Tuikum lui and Mizoram University campus to Blessing Home.

By and large, very low hazard zones are located at low level of land which includes valley fill and flat lands and is not much utilizing for human settlement despite very low hazard zone because its location are outskirts of the city. As recorded by the MIRSAC, the areas of very low hazard zones are nearly free from landslide for the present and future to come because it has been covers with dense vegetation and the dip direction of the rocks and slope angles are fairly low which kept the chance of slope failure is minimized in spite of soft nature of sediments and unconsolidated structure of rocks.

Conclusion

Mizoram being a hilly and soft nature of topography has come

across a number of disasters especially with repetition of landslides at several parts of the areas. Every year, problem of landslides have been reported from various places during rainy season. Landslides in the state and also in the city brought about serious damage to private properties, terrible threat to public and loss of precious life. Due to landslide communication network remained closed for many days in many areas which caused severe privation to the people who get their foodstuffs and edible things from other places.

This has been a matter of the state as well as the study area is concern it is necessary to take appropriate mitigation measures. Landslide cannot be avoided totally in this area because it is hilly area of steep relief, receive seasonal heavy rainfall every year and geologically immature topography. Notwithstanding this landslides and its adverse effects can be mitigated by adopting certain remedial measures as under.

Hazard mapping : It locates areas prone to slope failure. This hazard mapping will give reliable information to the concerned department and NGO to plan execute and adopting preventive measures for landslide inside their respective areas. It can also help in identifying areas vulnerable to landslides and avoidance of areas for settlements, building construction and any other developmental works.

Engineered structures : Any construction works within and around the landslide prone area should be done in consultation with engineers, geologists, geomorphologists and experts. Buildings and other engineered structures with strong foundations are in a better position to withstand the ground movement forces. Underground installations such as pipes and cables should be made flexible to move in order to withstand forces caused by landslides.

Land use/terracing : Land use and terracing pertains to preservation of soil erosion caused by external forces and human activities. Denuded path slopes provoke landslides and must be protected through land use like tracing. Due care must be taken in order to avoid increasing pressure of human, animal needs, rapid denudation and biotic interference etc have further aggravated the problem of landslides.

Check dam : Terrific speed of running water on the slope and storm water causing lateral and vertical corrosion and erosion. The rock fragments, pebbles, debris and waste materials roll down along the bottom of the stream widen and deepening the cause of the streams year by year which hampered

stability of the soil and its adjoining areas. The landslide took place due to the complete removal of materials which support upper part of the rock mass. In this situation, mitigation measure to be taken in construction of check dam across the streamlet.

No human activity : No human activity be undertaken in the landslide prone areas and past occurrences of landslide. The vulnerable area to landslide has to be entirely avoided for settlement and other construction works. It should be left out for re-generation of vegetation to attain stability during the course of time through the physical processes active in the areas. It should be checked human interference in the hazard zone of landslides as far as possible.

Proper drainage : Proper drainage should not be neglected. The side drain and culvert passages should be put under stick vigilance to escape accidental blockage during heavy rain, constructing roads and building etc. Gutter water and rain water from the roof of the house also should be kept away to the nearest drainage, properly and carefully.

Increasing vegetation cover : Whenever possible plant trees and increasing vegetation on the slope with grasses, shrubs and trees should be implemented in the landslide prone areas. This is the cheapest and the most effective away of mitigation of landslides. Plantation of those species helps in binding the top layer of the soil with layer below while preventing excessive run off and soil erosion.

Retaining walls : It is apparent that landslides may occur when either shearing forces increase or shearing resistance of material decreases. Construction of retaining wall along the road side is very helpful to increase resistance to check debris slide down. Removal of slide debris to reduce the weight of material is imperative need in order to avoid landslide at many places.

Developmental works : Due to rapid pace of urbanization in the city a number of developmental works are being taken up at various places without considering geomorphic condition. Removal of underlying support and toe-erosion weakened the resistance of material which affect the land stability. The human activities coupled with heavy rainfall caused landslides at several places during rainy season. The allocation of major structure should be permitted only in local safe areas.

Excavation of materials : The avoidance of excavation of the materials for building and road construction in and around the areas of steep slopes, old slides or recognizable landslides and hazard

areas is important to escape to landslide. It is estimated that the construction of just one kilometre long road required removal of 40,000-80,000 cubic metres of debris, which slide down slopes, killing vegetation and choking mountain streams.

By law : As a consequence of fast growing of Aizawl city and increasing in population result in more human activities along the hill side enhanced the instability of the area at various places. The areas vulnerable to landslide should be identified to declare certain areas are totally prohibited, some areas are restricted and other places are free areas as its condition of stability. For that, it is necessary to have by law to resist the encroachment of the prohibited areas.

It is expected that these mitigation strategies will give valuable information to concerned persons, various organization and disaster management etc to apply and to execute at the vulnerable areas to landslide within their respective spectrum of operation.

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Attitude towards Pre-marital Sex among Students of Regional Institute of Paramedical and Nursing (RIPAN), Aizawl, Mizoram

- K.C. Lalmalsawmzauva

Abstract : *The present study is an attempt to understand students' attitudes toward pre-marital sex, virginity and its interlinkages with internet exposure and awareness about these issues. Students of Regional Institute of Para Medical and Nursing (RIPAN) has been selected for this study to compare students of different culture, ethnic groups and religion. Out of 360 students in the institute 111(31%) students has been asked questions on their view about pre-marital sex and virginity. Study covered students' background and if they are educated by parents on pre-marital sex as well as internet exposure with the expectation that current technology might somewhat linked with their attitude towards pre-marital sex.*

Introduction

Study on pre-marital sex is more prevalent in more develop countries compared with less develop countries as the study require more liberal outlook and open society. Since India and Mizoram belong to less developed world it is unlikely that we can conduct successful study onpre-marital sex as it is. Considering less openness of the society that is generally related with development level, we rather opted only 'attitude towards pre-marital sex'. It is expected that the time will come to study the actual happening and its related issues. Intermixing culture seems to create a chance to intermingle and leads to liberal world view. When students of different ages, nationalities, ethnic and religious backgrounds and status are brought together in a higher institutions environment, opportunities exist for sexual relationship. RIPAN is the lone institute of such kind in Mizoram having youth cohort teens sharing ideas and culture. It is expected that their outlook would be more liberal than many institutes in Mizoram, which is why present study has been carried out.

As far as Mizo culture and society is concerned it can be broadly divided into pre-christianity and post-christianity. Before christian missionaries came into Mizoram in 1894, it can be said that pre-marital sex is prohibited for girls and promoted for boys. Sexual intercourse before marriage became a disaster for girls and an honour for boys. The society however, considered sex too sacred and holy as it relates with religious and belief system. It is used to said in Mizo traditional beliefs that "a boy who had intercourse with girls in their life time were great achievement as a result of which he could avoid punishment of Pu Pawla(who was the gate keeper of the land of death people), who used to flung by his catapult to those boy who was a virgin. If Pu Pawla punished in such a way, it was so hurt and the

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wound would not heal even up to three years. However, in the case of girls virginity was extremely important that if she was not a virgin Pu Pawla would detect and punish and vice-versa. As a result of those contradictions in the traditional Mizo society, women tried their best to prevent their virginity while men put their best effort to indulge in sex with virgin women. It can be said that, in Mizo society pre-marital sex is neither accepted as nor condemned as severely sinful. Pre-marital sex seems existed in every Mizocommunity throughout history.

However, after Christian missionaries landed in Mizoram (post-christianity) during 1890s, Mizo society has been transformed and exceedingly large proportion of Mizo are embracing Christianity as their religion and as a result, pre-marital sex attitudes has been transformed enormously. Therefore, today it is unaccepted to have pre-marital sex from Christian belief system and condemned in the society too. The big question however, is that, do the society truly and honestly condemned pre-marital sex?

Regarding the meaning and definition of pre-marital sex, it can be vary from one to another. Pre-marital sexuality is any sexual activity with an opposite sex partner or with a same sex partner before he/she has started a married life. The term is usually used to refer the intercourse before the legal age of a marriage. Adults who presumably marry eventually also fall under this definition. Pre-marital sex is sexual activity practiced by persons who are unmarried. The prevalence of pre-marital sex has increased in both developed and developing countries (http:/en.wikipedia.org/wiki/premarital_sex#cite_note-1).

It refers to all sexual relations a person has prior to marriage; this removes emphasis on the relationship between two promising marriage couples. Some people confused on the definition of pre-marital sex as it can be confusing with increasing modernity in which we experience many unknown things of the past day. Two prominent confusing situations are that: One is sexual intercourse that is engaged between a man and a woman who are never been married. Second, a sexual intercourse done by a married person with someone else who is not his/her legitimate spouse. The later is adultery and prohibited by laws across the countries. Because of ambiguity of the definition of pre-marital sex with the passage of time alternative terms have been suggested, including non-marital sex, youthful sex, adolescent sex, and young-adult sex. Still these terms also suffer from a degree of ambiguity, as the definition of having sex differs from person to person.

Objectives

1. To study the general attitude towards pre-marital sex among students of RIPAN where majority are below 20 years
2. To investigate how far it is true to the general opinion that 'today's generations are more liberal and open on the issues of pre-marital sex and virginity.
3. To study whether or not if there any background influence of the students on their attitude towards pre-marital sex and on virginity issue
4. To compare male-female attitudes towards pre-marital sex and virginity to find out if there any influence of sex-education on students perspective towards pre-marital sex.
5. To examine whether access of internet and watching porn film are related with attitude on pre-marital sex or not

Review of Literatures

The literature opining in different aspects of pre-marital sex is highly controversial, touching upon such fundamental issues as: What is holiness and how we value virginity? What is the function of marriage? What is the purpose of sex? What is a meaningful sexual relationship, and many question to be asked? With time passes society's acceptance on pre-marital sex seems increasing in almost all society. Here are some literatures dealing with pre-marital sex.

Robertson (I989) observes that societies of the West have shrouded sexual behavior in myth, taboo and ignorance. Research interest into the field of sex began in the late I940s to early 1950s. It was Kinsey (1948) who first carried out elaborated investigation on sexual behavior, tie faced condemnation from many religious organizations and media. In Africa, most of our traditional leaders and parents still find it difficult to publicly speak on sexual practices, despite its seeming implications to youths. This attitude has led our children to acquire sexual knowledge from the media and peers, particularly in a learning environment.

The last one hundred years have witnessed a revolution in sexual behavior. In1900, only 6% of US women had engaged in pre-marital sex by age 19; The number is now 75%. Public acceptance of this practice reacted with delay. Only 15% of women in 1968 had a permissive attitude toward pre-marital sex (Aiyagari et al., 2000). The number with a permissive attitude had jumped to 45% by 1983, a time when 73% of 19-year-old women had experienced pre-marital sex. Beyond the evolution and acceptance of sexual behavior over time, there are relevant cross-sectional differences across women (Fern´andez-Villaverde et al.,2014)

In Vietnam, Ghuman et al., (2005) reported that pre-marital sex

has risen perceptibly among individuals who married between 1992 and 2000 compared to those married during earlier periods. The evidence showed that in recent years, important socio-economic, cultural and attitudinal changes arising in part from economic liberalization have contributed to rising sexual activity before marriage.

Lalmalsawmzauva (2014) conducted pre-marital attitude among students of Mizoram University which showed that a little over one-fourth (29.8%) of Mizoram University students agreed upon lovers' indulgence in pre-marital sex based on certain grounds whereas a fairly high proportion i.e 70 % still are conservative on the issue of pre-marital sex. More than 48% students of both sexes cherished the inherent value of virginity by reporting their wife/husband should be a virgin whereas more than 51 % are liberal about virginity by saying that 'their partners should not necessarily a virgin or love is enough'. More than 56% students of Mizoram University preferred 'love marriage' while over 23% preferred 'both-arrange and love marriage' while only 4 % can accepted 'arrange marriage'.

Research Questions

(1) Is it true the belief of many people that pre-marital sex is currently more common than yesteryears in today's globalised world?
(2) Is there any variation of attitude towards pre-marital sex based on background among students of RIPAN?
(3) Is there any sex education to students from parents? If so, is there any impact on pre-marital sex and virginity.

Methodology and Data Base

There are 360 students in RIPAN during survey period-2014-2015, out of which 111 (30.8%) students are interviewed to answer the above research question.Questions have been asked to students of various departments randomly. Interviews were conducted to students across ages, married and unmarried so as to understand attitudes towards pre-marital sex of different age groups, different background and different belief system. Students are of different ages ranging from 17 years to 24 years.

Questions covered age, sex, marital status, rural or urban background of student, religion, regularity on internet, watching porn film, whether they received pre-marital sex education from parents and under which situation lovers agree to indulge in pre-marital sex and degree of liberty on virginity. After collecting all informations data has been enter and tabulated in excel for further calculations. A simple mathematical technique of percentage calculation and

variations of opinion on pre-marital sex based on backgrounds of the students is done.

Discussion:

General Information of the Interviewees

This section highlights the general information of students of Regional Institute of Paramedical and Nursing (RIPAN) on sex, marital status, religion and background. As many as 111 students of different sexes, married and unmarried, various religious faiths and of different backgrounds were interviewed. As shown in Table 1, out of 111 students 54 (48.6%) were male and 57 (51.4%) were female. Majority of the students interviewed were unmarried (108 or 97.3%) while merely 3 or 2.7% were married students.

Regarding religion, as many as 85 or 76.6% students embraced Christianity whereas 20 or 18% belongs to Hindu religion and there was 1 Muslim and 5 of them belongs to 'other' group. Table 1 displays that majority of the students (78 or 70.3%) were having urban background while 20 or 18% students coming from rural areas and 12 or 10.8% reported having

Table 1. General Information of Interviewees

		Total	%
Sex	Male	54	48.6
	Female	57	51.4
Marital Status	Married	3	2.7
	Unmarried	108	97.3
Religion	Christian	85	76.6
	Hindu	20	18.0
	Muslim	1	0.9
	Other	5	4.5
Background	Rural	20	18.0
	Urban	78	70.3
	Both	12	10.8
	Total	111	100
In RIPAN there are 360 students, of which 121 are male and 239 are female			

Source: Survey conducted by the author during 2014-2015

both rural and urban backgrounds

General Attitude towards Pre-marital Sex

This section examines the general attitudes of both sexes of different backgrounds on pre-marital sex. This is an attempt to understand the degree of liberty and openness of educated RIPAN students pertaining to pre-marital sex.

As shown in Table 2, out of 111 odd students, a few of them(22 or 19.8%) agreed that pre-marital sex is acceptable 'if lovers' are willing while as many as 89 or 80.2% disagreed at all. The number of students slightly increased when asked on 'if lovers really love each other' pre-marital sex is acceptable with 24 or 21.6% agreed on it while a large chunk of 87 or 78.4% students remain conservative by disagreeing even if lovers are really love each other. It is interesting to note number of respondents and their willingness on pre-marital sex is similar on 'if lovers are willing' and on the questions of 'if lovers are going to marry' (Table 2).

Number of student who accepted pre-marital sex on the ground of 'if lovers are mature' falls down to 11 or 9.9% while 100 or 90.1% disagreed on the same. Again, the proportion of students agree upon pre-marital sex on the ground of 'if women can prevent from pregnancy' decreased to 12 or 10.8% whereas as many as 98 or 88.3% disagreed on it.

Thus, it can be concluded that only a little over 16% of RIPAN students agreed upon lovers' indulgence in pre-marital sex based on certain grounds whereas a fairly high proportion of over 83% still conservative on the issue of pre-marital sex. This clearly clarify the general perception of 'today's generations are more liberal on pre-marital sex' is not completely true.

Attitude towards Virginity

Table 3 reveals different attitudes of male and female students of the degree of liberty

Table 2. Under What Conditions Pre-Marital Sex is Condoned

Attitude on Pre-marital Sex	Agree	%	Not agree	%
If lover willing	22	19.8	89	80.2
If they really love each other	24	21.6	87	78.4
If they are going to marry	22	19.8	89	80.2
If they are mature	11	9.9	100	90.1
If women can prevent from pregnancy	12	10.8	98	88.3
Average	18.2	16.38	92.6	83.44

Source: Survey conducted by the author during 2014-2015

pertaining to virginity. It is pretty clear from Table3 that male students are more lenient and liberal than female students on virginity. While 37 (68.%%) male students reported that their spouses should be a virgin whereas as many as 49 or 86% female students responded for the same.

Among male students 8 or 14.8% said that their wife should not necessarily be a virgin and 9 or 16.7 % reported that 'Love is enough' whereas only 2 or 3.7% and 6.10.5 % of their female counter part reported that their husband should 'not necessarily be a virgin' and 'Love is enough' respectively

Therefore, it can be concluded that majority of RIPAN students still cherished to the so called traditional value of 'virginity' proving the wrong notion of 'liberal generation of today'.

Difference between Men and Women on Choice of Marriage System

Practice of marriage system differed from place to place and from one culture to another. Present section briefly highlighted the value and choice on the type of marriage for among RIPAN students based on sex. Table 4, clearly exposed that only few students of RIPAN preferred arrange marriage i.e3.7 % for boys and 1.75% for girls while as many as 57.4% boys and 47.4% girls preferred 'love marriage' and 38.89 boys and 50.9% girls students

Table 3. Attitude towards Virginity

		No	%
Male	My wife should be a virgin	37	68.5
	Not necessarily	8	14.8
	Love is enough	9	16.7
Female	My Husband should be a virgin	49	86.0
	Not necessarily	2	3.7
	Love is enough	6	10.5

Source: Survey conducted by the author during 2014-2015

Table 4. Male-Female Differentiation Towards Marriage System

	Marriage choice	Arrange	%	Love	%	Both	%	Total
Sex	Male	2	3.70	31	57.4	21	38.89	54
	Female	1	1.75	27	47.4	29	50.9	57
	Total	3	2.70	58	52.3	50	45.0	111

Source: Survey conducted by the author during 2014-2015

reported of accepting both arrange or love marriage.

It is interesting to note from Table 4 that 'Love marriage' is cherished more among boys than girls while both 'love and arrange' is preferable for girl students. Taken together of boys and girls choice on marriage shows that 'Love marriage' became the most preferred with 52.3%, followed by 'Both' with 45% and arrange shared minimal with 2.70%.

Influence of Background on the Attitude of Pre-marital Sex

Background characteristics of people and their environment have great impact on attitude formation and considering this, present section focus on influence of background of students on their attitude towards pre-marital sex. There is a general opinion that people living in urban areas are more liberal, open and broad minded in their world view. In light of this, common attitude test has been conducted here to prove or disprove the statement. Table 5 to 9 shows the opinion of students having different backgrounds like student who are coming from rural, from urban and those who are having a both rural and urban background.

Table 5 reveals that out of 79 students having urban background 13 or 16.46 % reported that pre-marital sex is acceptable 'if lovers are willing' while majority i.e. 66 or 83.54% disagreed on the same. Students having rural background comprised of only 20, and out of which 3 or 15% reported of agreeing pre-marital sex 'if lovers are willing' while a good number of 17 or 85% do not agree at all. Among those students having both 'rural and urban background' half of the (6 or 50%) agreed on pre-marital sex 'if lovers are willing while another half do not agree for the same.

Taking together of rural, urban and both backgrounds 22 or 19.82 % agreed pre-marital sex 'if lovers are willing' whereas a huge majority of 89 or 80.18 % disagreed for the same.

Table 6 shows that out of 79 students coming from urban areas 12 or 15.19% reported to agreed pre-marital sex 'if lovers are really love each other' but more number of students i.e. 67 or 84.81% disagree on the same condition.

Out of 20 students coming

Table 5. Under What Condition Pre-Marital Sex Is Condoned

If lovers are willing		Agree	%	Disagree	%	Total
Background	Urban	13	16.46	66	83.54	79
	Rural	3	15	17	85	20
	Both	6	50	6	50	12
	Total	22	19.82	89	80.18	111

Source: Survey conducted by the author during 2014-2015

Table 6. **Under What Condition Pre-Marital Sex Is Condoned**

If they really love each other		Agree	%	Disagree	%	Total
Background	Urban	12	15.19	67	84.81	79
	Rural	5	25.00	15	75.00	20
	Both	7	58.33	5	41.67	12
	Total	24	27.59	87	78.38	111

Source: Survey conducted by the author during 2014-2015

from rural areas 5 or 25% agreed pre-marital sex between lovers 'if they really love each other'. It is interesting to note that those students attaining both rural and urban background are the most liberal as 7 or 58.33% of them agreed on pre-marital sex 'if lovers are really love each other' while another 5 or 41.57 % disagree on the same.

Table 7 shows the result of another criteria test on students based on their backgrounds. 11 or 13.92% urban students can condone pre-marital sex 'if lovers are going to get married' whereas majority of them i.e. 68 or 86.08% disagreed on the same.

Comparatively lesser number of students coming from rural areas i.e.4 or 20% agreed on pre-marital sex 'if lovers are going to get married' while 16 or 80% of them are not approved pre-marital sex even if lovers are going to get married. Another interesting finding is that students having both rural and urban background are most liberal once again as 7 or58.82% of them agreed pre-marital sex 'if lovers are going to get married' while a good number i.e.5 or 41.67% of them still conservative on the same.

Another criteria set forth to test impact of background on attitude towards pre-marital sex is 'if lovers are mature'. Out of 79

Table 7. Under what Condition Pre-Marital Sex is Condoned

If they are going to marry		Agree	%	Disagree	%	Total
Background	Urban	11	13.92	68	86.08	79
	Rural	4	20.00	16	80.00	20
	Both	7	58.33	5	41.67	12
	Total	22	19.82	89	80.18	111

Source: Survey conducted by authors during 2014-2015

urban students 5 or 6.33% agreed pre-marital sex 'if lovers are mature' whereas as many as 74 or 93.69% students disagreed on the same (Table 8).

Out of 20 students having rural background 2 or10% reported to agreed pre-marital sex 'if lovers are mature' while majority i.e.18 or 90% disagreed on the same. Out of 12 students having both rural and urban background,3 or 25% agreed that pre-marital sex is acceptable 'if lovers are mature' while 9 or 75% disagreed on it (Table 8).

Table 9 reveals that 8 or 10.13% students coming from urban areas agreed on pre-marital sex 'if women can prevent from pregnant' whereas a huge proportion of 71 or 89.87% reported disagreed on the same condition.

Out of 20 students of rural origin merely 1 or 5% agreed pre-marital sex 'if women can prevent from pregnancy' while an overwhelming number of 19 or 95% disagreed on the same condition. Students who have 'both' urban and rural backgrounds reported that out of 12 of them 4 or 33.3% agreed on pre-marital sex 'if women can prevent from pregnancy'.

It can be concluded that among the three categories of students' backgrounds i.e. students having both urban and rural backgrounds are the most liberal followed by students coming from rural areas and urban areas. This clearly disproved the assumption of urban students having more liberal attitudes than rural areas and at the same time we can also concluded that rural origin students are not necessarily conservative or

Table 8. Under what Condition Pre-Marital Sex is Condoned

If they are mature		**Agree**	**%**	**Disagree**	**%**	**Total**
Background	Urban	5	6.33	74	93.67	79
	Rural	2	10	18	90.00	20
	Both	3	25.00	9	75.00	12
	Total	10	9.01	101	90.99	111

Source: Survey conducted by authors during 2014-2015

Table 9. Under what Condition Pre-Marital Sex is Condoned

If women can prevent from pregnant		Agree	%	Disagree	%	Total
Background	Urban	8	10.13	71	89.87	79
	Rural	1	5	19	95.00	20
	Both	4	33.33	8	66.67	12
	Total	13	11.71	98	88.29	111

Source: Survey conducted by authors during 2014-2015

liberal.

Impact of Sex Education on Pre-marital Sex Attitude

In our research question it is asked whether there is any sex education among students of RIPANS from parents and if so, what the impact is.Table11 clearly reveals that YES, sex education has positive impacts among students. There are 32 students who are getting sex education from parents while a larger number of 79 students are not receiving any sex education from parents.

Taking the average questionnaires, students who agreed on pre-marital sex are comparatively lesser among those who received sex education (12.5%) than those who never receive sex education from parents (29.1%). In all categories of questions shown in Table 11, who agreed on pre-marital sex are exceedingly lesser among those who get sex education than those who do not get sex education except in the case of 'if women can prevent from pregnancy'.

We can say that students who received sex education from parents are generally stern and more conservative than those who do not received sex education. In all categories sex educated students disagreed with a high degree of over

Table10. Ranking based on Background of the Students who are Liberal on Pre-marital Sex

Attitude on Pre-marital Sex	**Agreed based on %**		
Conditions	**Urban Rank**	**Rural Rank**	**Both Rank**
If lovers are willing	2	3	1
If they really love each other	3	2	1
If they are going to marry	3	2	1
If they are mature	3	2	1
If women can prevent from pregnancy	2	3	1
Rank	Conservative	Liberal	Most liberal

Source: Survey conducted by the author during 2014-2015

Table 11. Comparison between who received Sex Education and Who do not Received from Parents (%)

	Received Sex Education		**Not Received Sex Education**	
Questions	Agree	Not agree	Agree	Not Agree
If lovers are willing	12.5	87.5	19	81
If they really love each other	18.8	81.3	22.8	77.2
If they are going to marry	9.4	90.6	24.1	75.9
If they are mature	9.4	90.6	10.1	89.9
If women can prevent from pregnancy	12.5	87.5	11.4	88.6
Average	12.5	87.5	29.1	82.5

Source: Survey conducted by the author during 2014-2015

80 %t and in some cases as high as 90 % whereas students who are not getting sex education disagreed level are comparatively lesser ranging from 75-89 %.

However, we can generalize that students of RIPANS are generally conservative may be much lower than many people thought of, which is clear from Table 11 where level of disagreed on pre-marital sex reached as high as 82 %and 87 %.

Impact of Sex Education on Attitude of Virginity

This section is for answering one of our research questions on the attitude of virginity among student who received sex education and who do not received it. As stated in the previous section there are 32 students who received sex education from parents whereas there as many as 79 students who do not received sex education from parents.

Table 12 shows that among 32 students who received sex education as many as 84.4 % opined that his wife or her husband should be a virgin whereas in the case of those who do not received sex education a relatively lesser number of 74.7 % opined for the same.

The percentage of students who answered their husband or wife should 'not necessarily a virgin or Love is enough' are comparatively lesser among students who received sex education than those who do not received sex education with 15.6% and 25.3 % respectively.

From Table12, it can be concluded that sex education surely have positive impact on the attitude of students on virginity. Students receiving sex education cherish and valued the sanctity of virginity and conservative than those who do not received sex education.

Relationship between Internet Use and Watching Porn

Exposure to internet becoming increases due to easy access from mobile, laptop and computer, which are assumed here becoming one factor influencing people, indulge in pre-marital sex. What we see and what we think are important for attitude formation and which is why watching porn and pre-marital sex has been directly or indirectly related. Out of 111 respondents, 52 (46.85%) students are using

Table 12. Comparison between who received Sex Education and who do not Received from Parents (%)

My wife/ Husband should be a	Received Sex Education	Not Received Sex Education
Virgin	84.4	74.7
Not Necessarily or Love is enough	15.6	25.3

Source: Survey conducted by the author during 2014-2015

internet 'regularly', 55 (49.55%) of them uses internet 'sometimes' and merely 4 (3.6%) of them 'never' use internet.

There exist a positive correlation between internet use and watching porn. Out of 52 students who used internet 'regularly' 41 or 78.5% used to watch 'porn' and only 11or 21.15% never watch porn. Out of 55 students who used internet 'sometimes' as many as 39 or 70.91% students used to watch 'porn' and 16 or 29.09% never watch internet. Interestingly however, it is reported that even who never use internet, all of them i.e 4 or 100% used to watch 'porn'.

Relationship between Watching Porn and Pre-marital Sex Attitude

In the previous section it was clearly shown that there exist a relationship between internet uses and watching porn. Present study is an attempt to confirm the relationship of internet users, watching porn and pre-marital sex attitude among RIPANS students.

As shown in Table14, there are only 3 or 2.70% students who 'regularly' watch porn out of 111 respondents. Among this total respondents, as many as 81 or 72.97% of them used to watch porn

Table 13 . Relation between Internet Used and Watching Porn

	Internet Uses		Watch Porn		Never watch Porn	
	Total	**%**	**Total**	**%**	**Total**	**%**
Regularly	52	46.85	41	78.85	11	21.15
Sometimes	55	49.55	39	70.91	16	29.09
Never	4	3.6	4	100	0	0
	100	100				

Source: Survey conducted by the author during 2014-2015

Table 14. Relationship between Watching Porn and who Agreed on Pre-Marital Sex

	Watching Porn		
	Regularly	**Sometimes**	**Never**
	3 (2.70%)	81(72.97%)	27(24.32%)
If lover willing	2 (66.67%)	20 (24.69%)	0(0%)
If they really love each other	3(100%)	21 (25.93%)	0(0%)
If they are mature	1 (33.33%)	8 (9.88%)	2 (7.41%)
If women can prevent from pregnant	1 (33.33%)	10 (12.35%)	2(7.41%)

Source: Survey conducted by the author during 2014-2015

'sometimes' and a good portion of 27 or 24.32% 'never' watch porn.

Among students who watch porn 'regularly' more than half of the students (2 or 66.70%) agreed pre-marital sex 'if lovers are willing' while a good number of 20 or 24.69% students agreed on pre-marital sex 'if lovers are willing. Out of 3 students who 'regularly' watch porn all of the students (3 or 100%) agreed on pre-marital sex 'if lovers are really love each other' and a fairly high number of 21 or 25.93 % who 'sometimes' watch porn are agreed on 'if lovers are really love each other'. Among the 'regularly' watch porn student 1 or 33.33 % reported of agreeing pre-marital sex 'if lovers are mature' and a proportion of 8 or 9.88% who 'sometimes' watch porn agreed on pre-marital sex on the same case and out of 27 students who 'never' watch porn 2 or 7.41% of them agreed on pre-marital sex 'if lovers are mature'. It is also reported that 33.33% of student belongs to 'regular watchers of porn agreed pre-marital sex on the ground that 'if women can prevent from pregnancy'. A good proportion of 10 or 12.35% students who 'sometimes' watches porn agreed pre-marital sex 'if women can prevent from pregnant' while 2 or 7.41% students who never watch porn still agreed on pre-marital sex on the same ground.

It can be summarized of the fact that there exist a positive relationship between watching porn and attitude towards pre-marital sex. Whoever watching porn regularly or even 'sometimes' are leading to more liberal attitude towards pre-marital sex.

Results

Taking together of all the discussion, it can be concluded that only a little over 16% of RIPAN students agreed upon lovers' indulgence in pre-marital sex based on certain grounds whereas a fairly high proportion of over 83% still conservative on the issue of pre-marital sex. This clearly clarify the general perception of 'today's generations are more liberal on pre-marital sex' is not completely true.

It is also reveals that majority of RIPAN students still cherish the so called traditional value of 'virginity' proving the wrong notion of 'liberal generation of today'. Interestingly, Love marriage' is cherished more among boys than girls while both 'love and arrange' is preferable for girl students. Taken together of boys and girls choices on marriage 'Love Marriage' became the most preferred with 52.3%, followed by 'Both' with 45% and 'Arrange Marriage' shared minimal with 2.70%.

It can be concluded that among the three categories of students' backgrounds - students having both urban and rural backgrounds are the most liberal group, followed by students coming

from rural areas and urban areas. This clearly disproved the assumption of urban students having more liberal attitudes than rural areas and at the same time we can also concluded that rural origin students are not necessarily conservative or liberal.

However, we can generalize that students of RIPANS are generally conservative may be much lower than many people thought of, as level of disagreed on pre-marital sex reached a fairly high percentage of 82 and 87.

Study also explored that sex education surely have positive impacts on the attitude of students on virginity. Students receiving sex education cherish and valued more of the sanctity of virginity and conservative than those who do not received sex education

It can be summarized of the fact that there exist a positive relationship between watching porn and attitude towards pre-marital sex too. Whoever watching porn 'regularly' or even 'sometimes' are leading to more liberal attitude towards pre-marital sex.

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To

The Secretary
Geography Association of Mizoram
Department of Geography & RM
Mizoram University
Aizawl - 796004

Sub : Life Membership

Sir,

I am seeking a Life Membership to the Geography Association of Mizoram with immediately effect.

☐ I am sending Cash Amount/Demand Draft/Bank Cheque of Rs. 1000/- (Rupees One Thousand Only) in favour of Secretary, GAM, Aizawl.

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I promised to abide with the constitution of the Association.

Yours faithfully,

Place :

Date :

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