Spatial Analysis of Rainfall Variation in Dry Zone of Myanmar

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Abstract

The Dry Zone in Central Myanmar covers large parts of the 27 townships of Mandalay Region, 19 townships of Magway Region and 16 townships of lower Sagaing Region. The Dry Zone comprises the middle Ayeyarwady basin, centering at the Ayeyarwady- Chindwin confluence. The boundary of the Dry Zone is defined as the 40 inch-isohyet. The study is based on data collected from 34 rain guage stations during the period of 30 years (1986-20156). This paper aims to present the spatial distribution of seasonal rainfall in Dry Zone of Myanmar. Spatial databases were developed using UTM maps (Universal Transverse Mercator), and Google Earth downloaded maps as well as GPS field survey data for capturing point stations. The collected data has been proceeded and analyzed by using interpolation method with GIS software. In analyzing the long term average and annual rainfall, the annual rainfall of the region is 30.58 inches, of which the pre- monsoon , monsoon and post monsoon record 5.76 inches,17.93 inches and 6.49 inches respectively. Singu Township receives the highest rainfall of 37.3inches whereas Yenanchaung Township records the lowest rainfall of 22.55 inches. SintgaingTownship receives the highest variation in annual rainfall of 41.47 % and Meiktila records the lowest rainfall of 20.42%. It will be useful for determination of cropping pattern in general and the type of crop to be cultivated moreover it will be suggested for other economic activities.

Key words: Dry Zone, isohyet, seasonal rainfall, pre-monsoon, monsoon, post- monsoon

1. Introduction

The Dry Zone in Central Myanmar comprises some parts of the Magway Region, Mandalay Region and lower Sagaing Region. The Dry Zone covers large parts of the middle Ayeyarwady basin, centering at the Ayeyarwady - Chindwin confluence. In this region, the amount of rainfall is relatively small compared to other parts of country. The annual rainfall is usually less than 40 inches. The boundary of the Dry Zone is defined as the 40 inch-isohyet. Rainfall as the primary ecological parameter has created a variety of farming enterprises. Assessing the spatial distribution of rainfall is required for water resource management especially irrigation works for agriculture in Dry Zone. As the characteristics of rainfall variations affect agriculture as a whole, there is need to investigate them in detail.This paper aims to present the spatial distribution of seasonal rainfall, spatial variation of rainfall, township-wise and annual rainfall variability.

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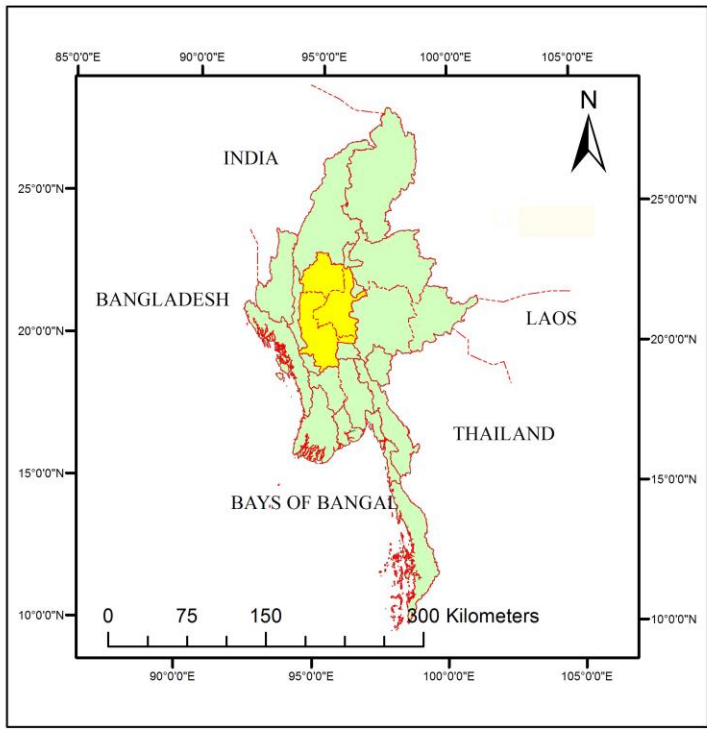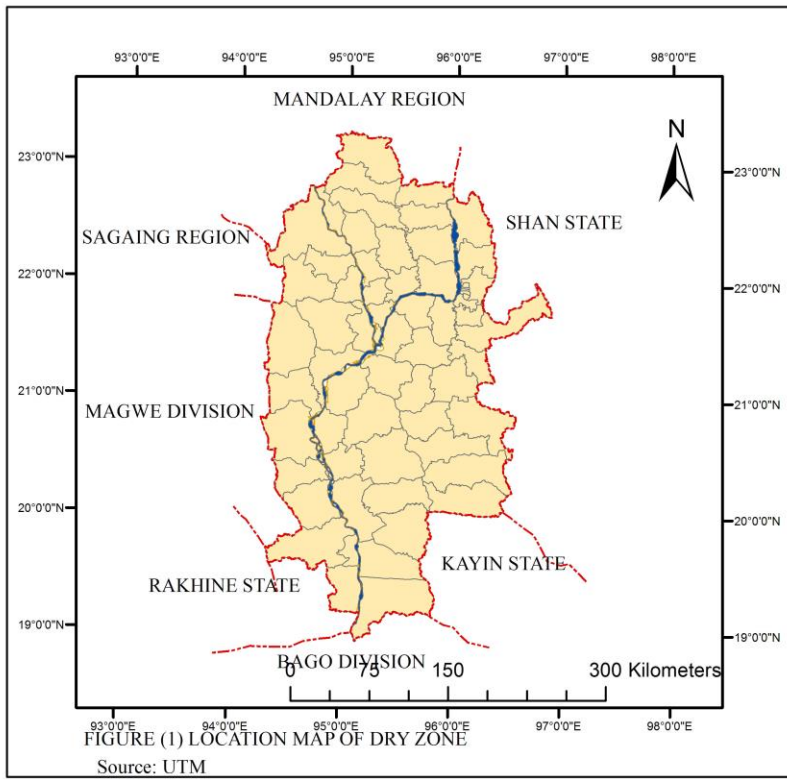
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FIGURE (1) LOCATION MAP OF DRY ZONE
Source: UTM

2.Study Area

The Dry Zone is situated between 19°North and 22° 36' North latitude and 94°18' East and 96°24' East longitude.There are 62 townships that are included in the Dry Zone. Administratively, this area comprises 27 townships of Mandalay Region, 16 townships of lower Sagaing Region and 19 townships of Magway Region. It is about 230 miles from north to south and about 115miles from east to west.The northern boundary of the Dry Zone is about 20 miles away from the Tropic of Cancer and the southern boundary is about 200 miles away from the Myanmar Sea.The Dry Zone has an area of about (19,000)square miles. The Dry Zone appears as a vast semi- arid lowland between two higher regions-the Shan Highlands on the east and the Rakhine Range and Chin Hills on the west. These higher regions provide the sharp climatic condition. The climate changes abruptly from dry to west types as one goes up the higher regions.The heavy rain occurs during the rainy season or the monsoon period (mid-May to September). April is the hottest month and January is the coldest month.Fig(1) & (2)
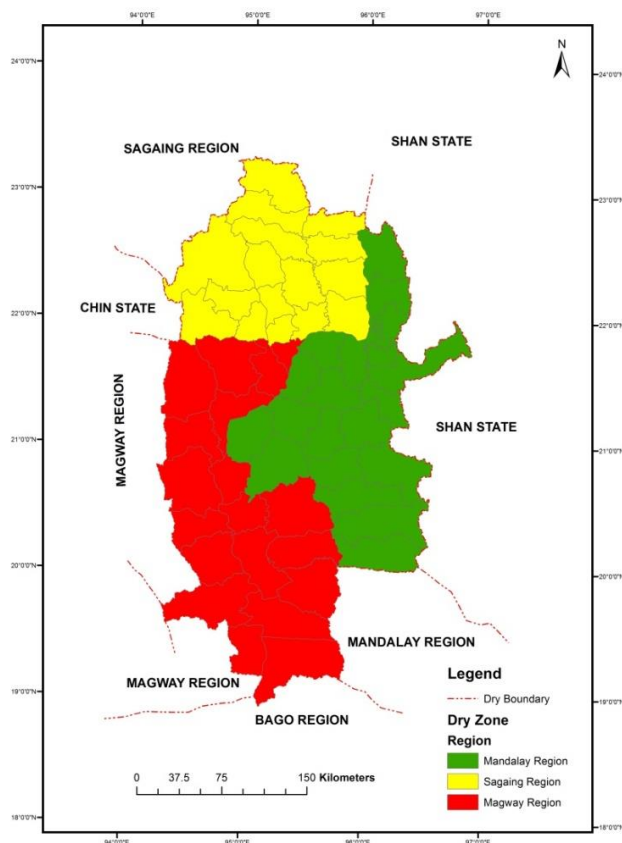

Figure (2) Townships of the Dry Zone

3.Data Source and Methodology

Monthly rainfall and temperature data for the period of (30) years (from 1986 to 2015) were collected from Meteorology and Hydrology Department of Mandalay Region. There were 34 in and around rain gauge stations which were taken into consideration for analyzing long- term mean monthly, seasonal and annual rainfall patterns were calculated for each station by using Microsoft Excel. Calculation of standardized rainfall anomaly index of regions was done through Oliver's methods. Spatial databases were developed using UTM maps (Universal Transverse Mecator), and Google Earth downloaded map as well as GPS field survey data for capturing point stations.The collected data were proceeded and analyzed by using interpolation method, spatial analyst with GIS software.

4. Results and Discussion

4.1   Mean Monthly Rainfall

One of the peculiar features of the rainfall of the Dry Zone is the presence of double maximum rainfall pattern. The average monthly rainfall of 30 years (1986 to 2015) for 34 rain gauge stations of the Dry Zone inferred that the first maximum occurred in the month of May. The second maximum occurred in the month of September. However, Tatkon, Minhla and Minbu receive second maximum rainfall in the month of June.Fig(3)
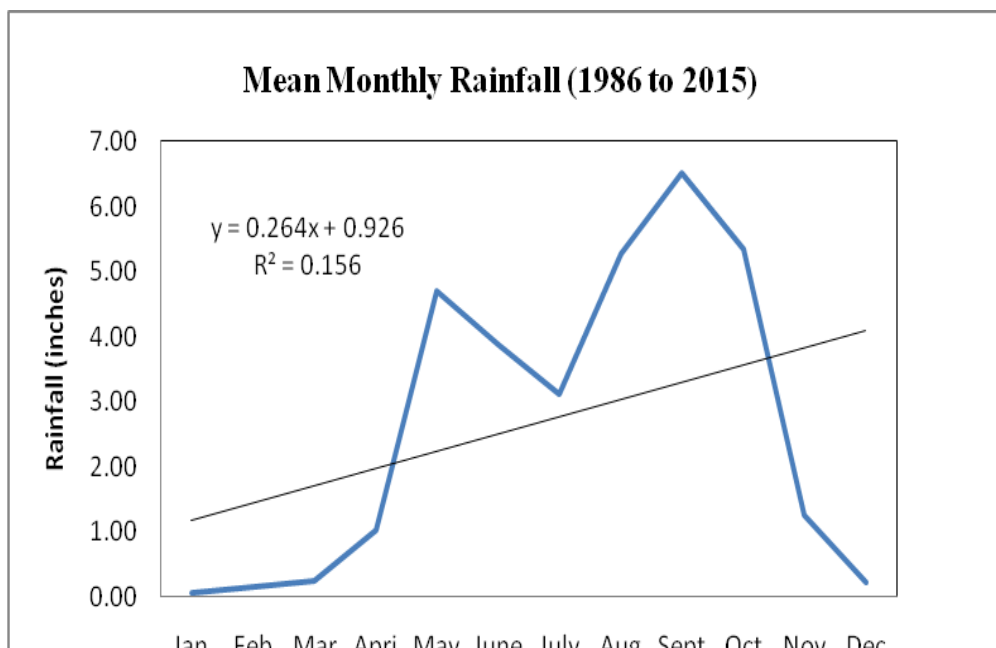

Mean Monthly Rainfall (1986 to 2015)

$y = 0.264x + 0.926$
$R^2 = 0.156$

Figure (3) Mean Monthly Rainfall Pattern

4.2   Mean Annual Rainfall

        The long-term mean annual rainfall of the Dry Zone is 31.73 inches. Singu Township receives the highest rainfall of 37. 3 inches whereas Yenanchaung Township records the lowest rainfall of 22.55 inches. The Dry Zone falls under following zones experience in low rainfall. Fig (4)

1.Zone of below 25 inches: There are three groups with very low annual rainfall (below 25inches) in Dry Zone. These are (i)Chaung –U, Myinmu, Monywa , Ayadaw group, (ii) Myingyan, Taungtha, Pakokku, Nyaung–U, Kyaukpadaung, Chauk, Yenanchaung group and (iii)Taungdwingyi, Sinbaungwe, Aunglan group. Most of them are located in inner core of the Dry Zone.

2. Zone of between 25 and 30 inches : This zone can be found mostly in the northern part of the Dry Zone.Pyawbwe ,Myothit, Minhla,and Aunglan also comprise partly in this zone.

3. Zone of between 30 and 35 inches: Ye-U,Khin-U, Madaya,Mandalay.Meiktila ,Natmouk, Magway andMinbu belong to this zone. Especially, most of the marginal area of Dry Zone fall in this zone.

4.Zone of above 35 inches : Rrainfall above 35 inches occursseparately in three sub-groups. These are (i) eastern part of Tatkon, Yamethin, Thazi (ii) eastern part of Kyaukse, Madaya, Singu and (iii) Taze townships. They are at the eastern and northern tips of the Dry Zone.

Figure (4) MEAN ANNUAL RAINFALL OF DRY ZONE
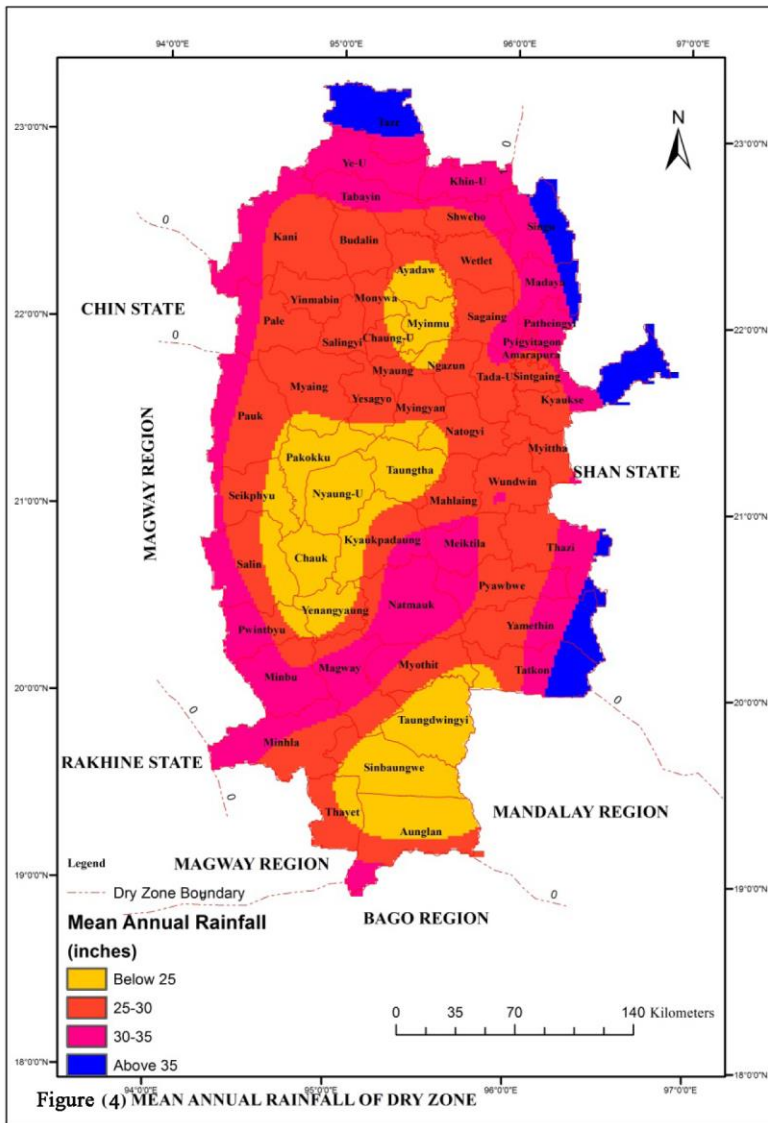
4.3. Distribution of Seasonal Rainfall

4.3.1.The Hot Season or Pre-monsoon Period

During the pre-monsoon period from March to mid- May, the Dry Zone receives low rainfall. Its average seasonal rainfall is 5.76 inches, this season contributes 18.84% to mean annual rainfall. The highest seasonal rainfall recorded at Amarapura, which is 7.84 inches and minimum 3.06 inches at Yenanchaung. The main cause of less rain during this period in the Dry Zone is the absence of uplifting the moisture air. Fig(5)
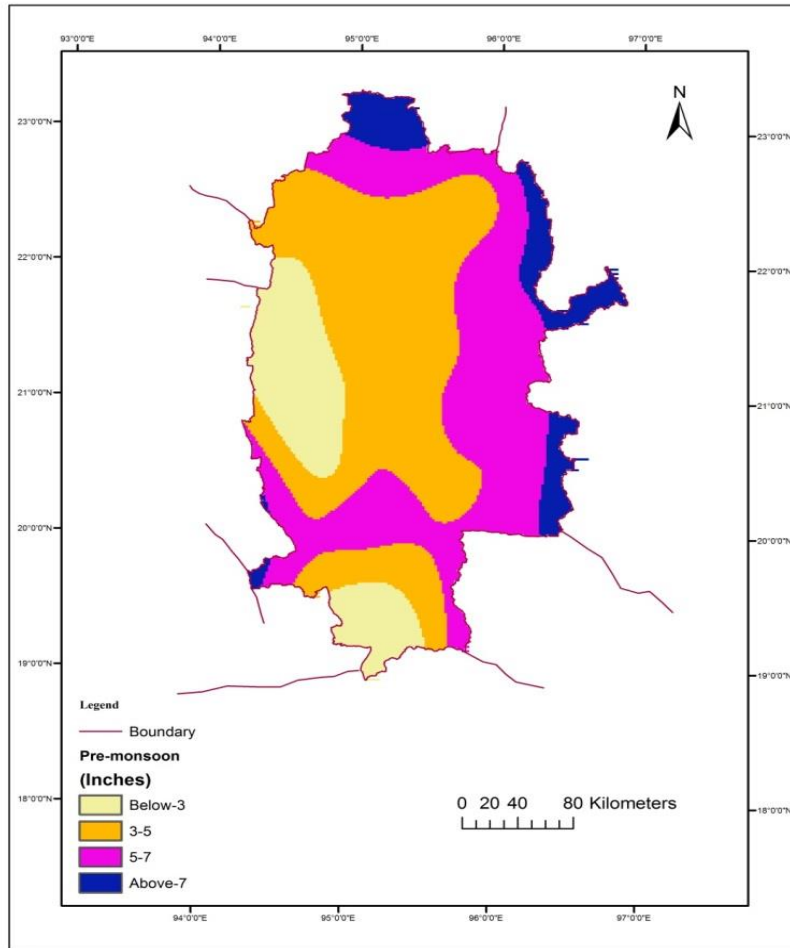
Figure (5) **PRE-MONSSON RAINFALL**

4.3.2.The Rainy Season or Monsoon Period

The monsoon period is important rainy season .This season extends from the middle of May to the end of September. The average rainfall of this season is 17.93 inches and it is 58.62% of mean annual rainfall. The highest seasonal rainfall recorded at Singu, which is 24.52 inches and the lowest seasonal rainfall recorded in Chauk, 13.07 inches. Fig (6)
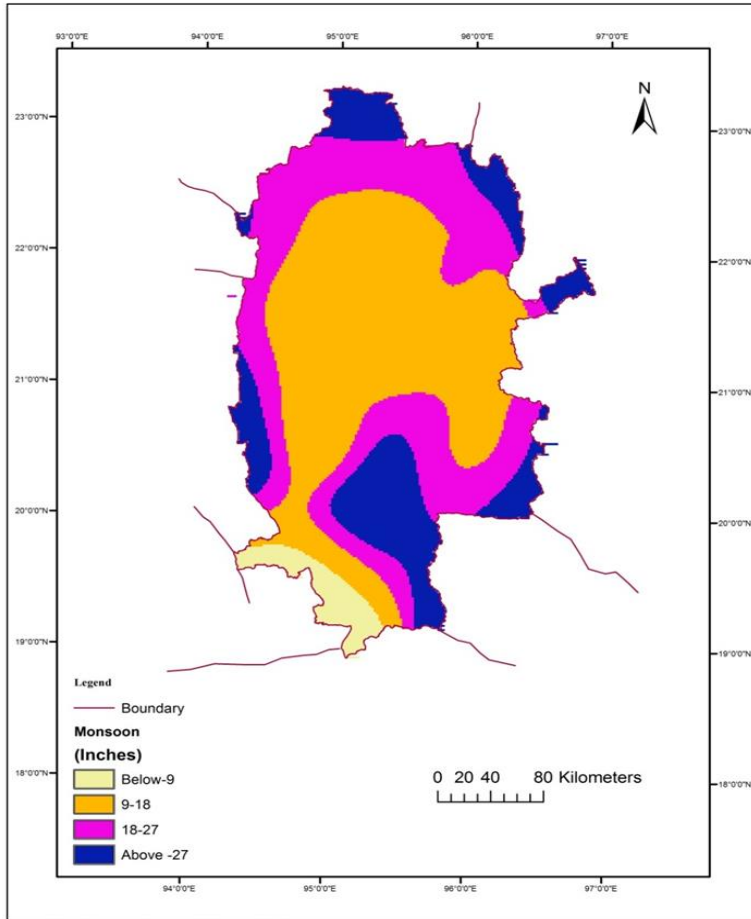
Figure (6) MONSOON RAINFALL

4.3.3. The Post-monsoon Period

The period of two months (October to November) is the post-monsoon season. The average seasonal rainfall is 6.49 inches, it is 21.23% of mean annual rainfall. Patheingyi receives highest seasonal rainfall, 8.46 inches and Yenanchaung is the lowest rainfall ,4.09 inches. Fig (7)
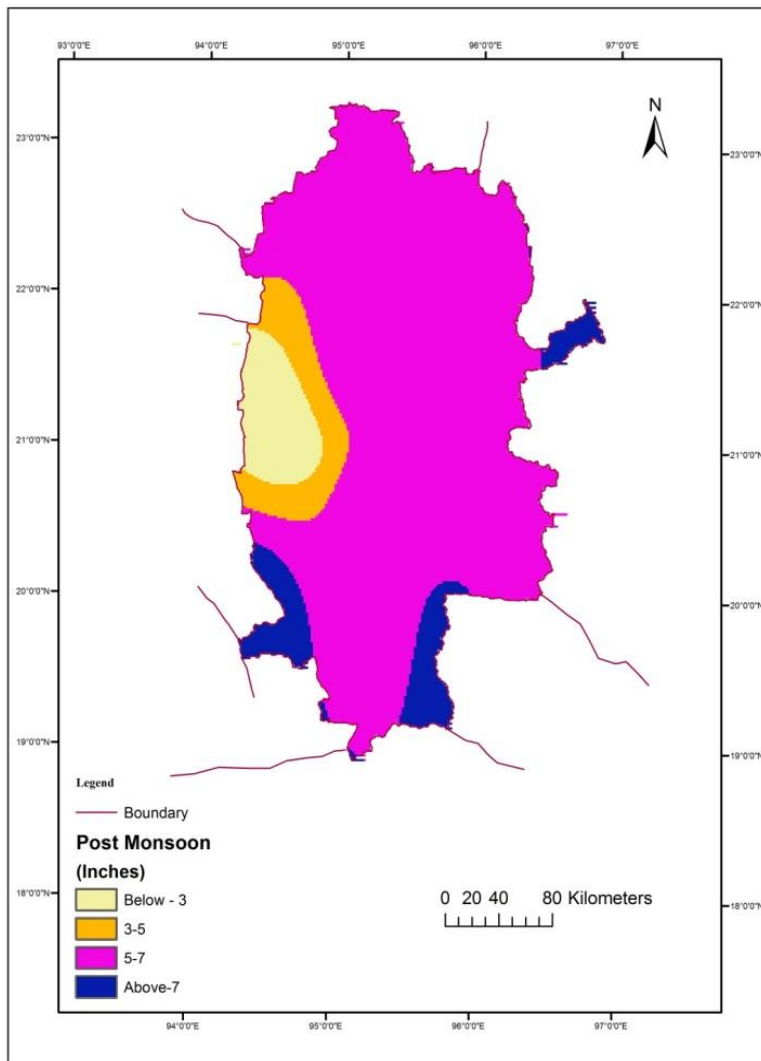
Figure (7) POST-MONSOON RAINFALL

4.3.4..The Cool Dry Season

During the cool dry season (winter season) heavily experiences low rainfall.This season extends from December to February. The average rainfall is not more than 0.5 inches. The received rainfall is 1.31% of the mean annual rainfall.

**Table (1) Annual and Seasonal Rainfall (inches) of Dry Zone (1986-2015)**

No	Station	Annual	Pre-monsoon March-May	Monsoon June-Sept	Post-monsoon Oct-Nov	Cool Dry Season
1	Amarapura	33.88	7.84	18.55	7.16	0.34
2	Chauk	22.88	4.10	13.07	5.48	0.22
3	Kani	30.19	4.84	18.98	6.12	0.25
4	Kyaukpadaung	31.09	4.73	19.53	6.58	0.25
5	Kyaukse	29.68	7.41	14.57	7.35	0.36
6	Madaya	35.53	7.10	20.57	7.49	0.36
7	Magway	35.68	6.30	22.37	6.66	0.35
8	Mahaling	30.10	5.63	16.89	7.22	0.36
9	Mandalay	33.91	7.66	19.10	6.72	0.43
10	Meiktila	32.50	6.56	18.48	6.95	0.52
11	Minbu	32.55	5.45	18.69	7.09	1.32
12	Minhla	35.15	6.11	22.95	5.85	0.24
13	Monywa	28.33	4.75	16.99	6.35	0.24
14	Myingyan	26.53	4.43	16.16	5.63	0.30
15	Myittha	28.26	7.00	13.66	7.20	0.40
16	Natogyi	27.54	5.07	16.20	5.98	0.30
17	Ngazun	29.40	5.55	18.39	5.12	0.35
18	Nyaung_U	24.98	4.42	14.37	5.89	0.31
19	Pakokku	24.16	4.35	13.30	6.35	0.16
20	Patheingyi	35.52	7.73	18.88	8.46	0.45
21	Pwintbyu	31.50	4.33	20.30	6.58	0.28
22	Pyawbwe	30.84	6.02	17.05	7.33	0.44
23	Shwebo	32.38	5.05	20.66	6.36	0.31
24	Singu	37.30	5.77	24.52	6.78	0.23
25	Sintgaing	29.99	7.36	15.72	6.50	0.41
26	Tada-U	32.80	7.22	18.37	6.83	0.38
27	Tatkon	34.51	5.59	21.39	7.26	0.27
28	Taungtha	23.16	4.05	13.79	5.12	0.20
29	Thazi	30.51	6.43	17.38	6.24	0.46
30	Wundwin	29.00	6.06	16.36	6.12	0.45
31	Yamethin	33.58	6.60	19.45	6.87	0.66
32	Yenanchaung	22.55	3.06	12.78	4.09	0.62
33	Ye-U	36.72	6.96	22.55	6.82	0.39
34	Yinmabin	29.18	4.43	17.53	6.17	1.05
Average		30.58	5.76	17.93	6.49	0.40
Percentage			18.84	58.62	21.23	1.31

Source: Meteorology and Hydrology Department, Mandalay Region

4.4.Variability of Rainfall

"Variability is defined as the deviation from the mean" or "ratio of the standard deviation to the mean rainfall" and in other words co-efficient of variation. The study of rainfall variability is especially important for the crop season. A variability in excess of 20% implies a great risk to farming(Williamson, 1925).This is usually a determining factor of the

crop pattern over the Dry Zone. Annual rainfall variability of Dry Zone ranges between 18.71 % and 37.27 %. The highest variability recorded in the central part of the Dry Zone is Madaya Township and the lowest is Yemethin Township. Most of the townships experience high rainfall variability above 20%. Fig (8)

FIGURE (8) ANNUAL RAINFALLVARIABILITY
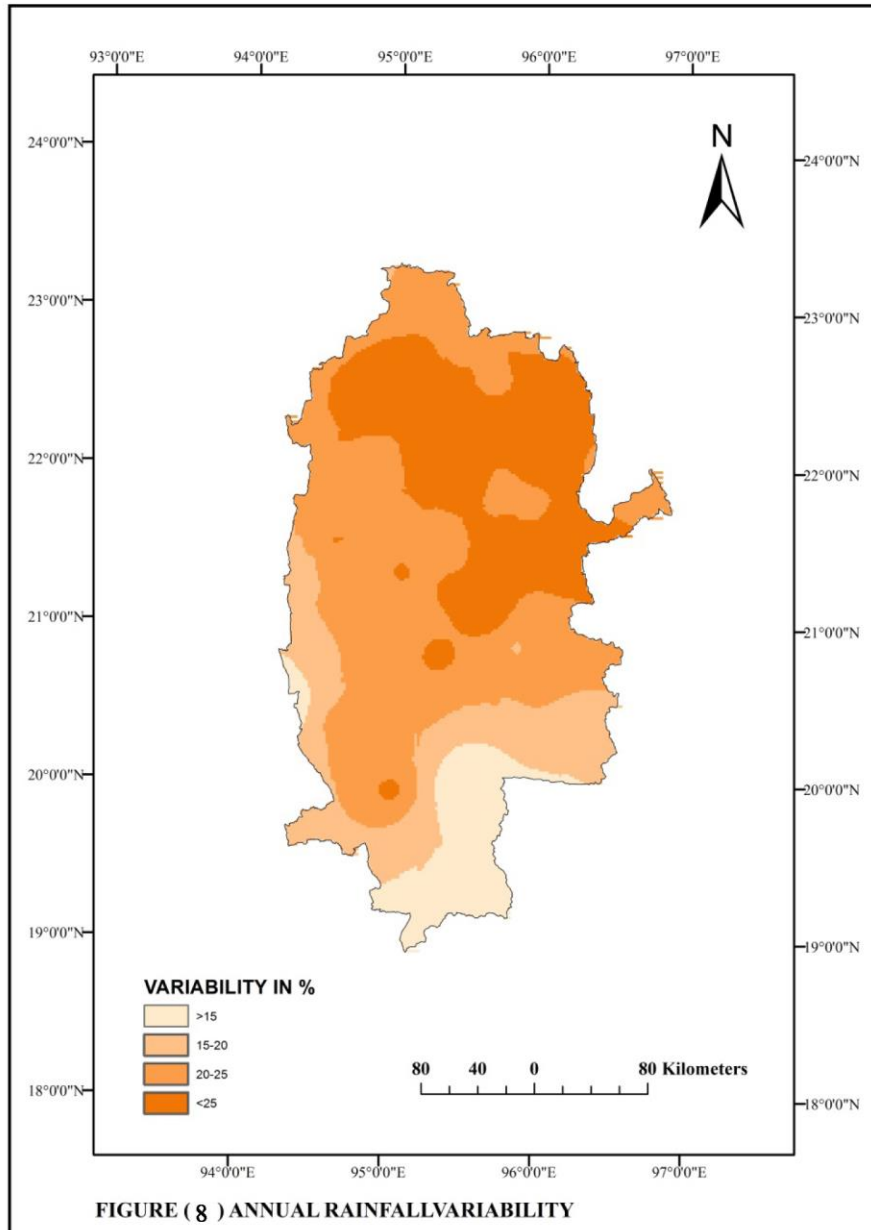
Conclusion

Rainfall data recorded at the 34 rain gauges stations over the period from 1986 to 2015 were used. Dry Zone received double maximum rainfall pattern. Inner core area of the Dry Zone received very low rainfall because of their location. The highest percentage of rainfall variation was observed in core area. This is usually a determining factor of the crop pattern over the Dry Zone. The southern tip area of the Dry Zone experiences low rainfall variation. The variation of rainfall influences not merely crop yields, but, especially in marginal areas, the economic and possibilities of agricultural expansion and development.

Acknowledgements

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