บทความวิชาการ

Characteristics of Spatial Rainfall Distribution in North-East Thailand

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Abstract

Daily Rainfall data is provided by 134 stations located in North-east Thailand courtesy of the Department of Meteorology of Thailand. The longest period of data records for the main station of each province dates from 1951. This paper presents the preliminary analysis of spatial rainfall distribution and long-term variability in this region. The annual mean rainfall within the period of records for each station were analysed . They varied from 777.4 mm. at Kaset Sombun (Chaiyaphum province) to 2808.4 mm. at Bungkan (Nong Khai province). These data were input to Geographic Information System and were manipulated to create contours of rainfall and classified to a surface of rainfall distribution. The results showed that the amount of rainfall in the West and South-west is 700-1200 mm. at Chaiyaphum, Nakhon Ratchasima , Khon Kaen ,and progressively increases to the North-east, and East, where the maximum rainfall is greater than 2000 mm. at Nong Khai, Nakkon Phanom. The long-term interannual variability of rainfall for the main stations of 13 provinces for the period 1951-1998 were analysed and it was found that the trends of rainfall mostly decrease in this region but increase for the areas of Loei and Sakon Nakhon provinces.

Introduction

The North-eastern Thailand is located between latitude $14^0 7'$ - $18^0 26'$ N and longitude $101^0 54'$ - $105^0 38'$ E. This area is approximately 167,845 km^2, one - third of the total area of Thailand. The region is commonly known as Khorat plateau with an undulating to rolling landscape. Western edges comprises Phetchabun and Dong Phayayen mountain ranges lying in a north-south direction with the level of 1300 meters above MSL. The border at the North and East follows along Mae Khong river which forms the common border with Laos. Southern is borded by Dongrak mountain range forming the border between Thailand and Cambodia. The middle of the northern part of the region is folded, forming Phu Phan mountain range in a North-West to South-West direction with the elevation of 600 meters above MSL.It separates the plateau into two basins. The smaller basin in the north is named Sakon Nakhon basin and the larger Korat basin is in the south. The surface of the region slightly slopes from the West and North to the Southeast. Most of the rivers flow across the region from the West marginal escarpment to the East, and Southeast and drain into Mae Khong river .

The climate of the region is classified according to Koppen's climatic classification as a tropical savanna. There are three seasons. The rainy season from May to September, the southwest monsoon bears warm and moist weather from Indian Ocean which causes heavy rainfall to the area. The winter season from November to February, the northeast monsoon brings cool and dry weather to the region. The summer season from March to April. Therefore these three seasons are influenced by the southwest and northeast monsoons.

The North-east region comprises 19 provinces and mostly covered by agricultural lands under rainfed condition. The major agricultural crops in this region are rice, cassava, sugarcane, corn, kenaf, soybean and orchards. Therefore, agricultural products depend very much on amount and distribution of rainfall and other factors such as soil properties, topography, water and crop management. The objective of this preliminary study is to analyse the spatial rainfall distribution and long-term interannual variability of rainfall of this region.

Rainfall data

Climatological data were recorded and provided by the department of Meteorology of Thailand. There are 134 available rainfall stations from different amphoes of 13 provinces in the North-east. These data were used to analyse for this study. These climatological stations have been established

and recorded in different years between 1951 to 1998. The periods of observations varie from 13 to 47 years. For each station, for every year of observation, daily rainfall was calculated to an annual rainlfall and then averaged to an annual mean rainfall. The initial stage of the analysis showed that at Kaset Sombun (Chaiyaphum province) received the least 777.4 mm. whereas Bung Kan (Nong Khai province) ranks highest received 2,808.4 mm annually. These annual mean rainfall for each station were presented in table 1.

Rainfall analysis and results

The analysis of spatial rainfall distribution

The annual means rainfall of all stations (as shown in table 1) were input into Geographic Information System with their geographical coordinates (latitude and longitude). The provinces and amphoes boundaries were digitized and geographically projected to the real world system. The location of the North-east region and the rainfall stations are given in Figure 1. Contours of rainfall or the isohyets for annual mean rainfall were created among these mean values with interval of 100 mm. (Figure 2) then analysed to a surface of rainfall distribution. The analysis implied that the average annual rainfall varies from less than 1,000 mm. in the West and South-west but increases to over 2,000 mm. along Mae Khong river in the North and North-east.

The region can be devided into four distinct rainfall regimes according to the average amount of rainfall received annually (figure 3)

1. The areas located in the West and the South-west, including Chaiyaphum, Nakhon Ratchasima, some parts in Khon kaen and Loei provinces are the driest. Theirs everage annual rainfall are less than 1,200 mm.
2. The areas located in the Southern part of Phu Phan range, including Udon Thanee, Karasin, Mahasarakham, Roi-et, Buri Ram, Surin, Srizaket provinces receive moderate amounts of rainfall ranging from 1,200 mm. to 1,400 mm.
3. The areas located in the North and the East of the region, including Sakon Nakhon, Mukdaharm, Amnart Charoen, Yasotorn and Ubon Ratchatanee provinces receive moderate to high amounts of rainfall from 1,400 mm. to 1,800 mm.
4. The areas in the extreme north of the region near Mae Khong river, including Nong Khai and Nakhon Phanom receive more than 1,800 mm. per annum.

The lowest rainfall occurs in the western areas called "rain shadow zone" due to the high mountains range bar the south-west monsoon which brings the heavy rain to the region while in the northern and eastern parts near Mae Khong river receive a lots of rains because of the wind from Anam Mountain (in Laos).

Table 1
Mean Annual Rainfall of 134 Meteorological Stations.

Station Id.	Station Name	YEAR	Mean Annual Rainfall (mm.)	Station Id.	Station Name	YEAR	Mean Annual Rainfall (mm.)
352001	Tha Bo	1975 - 1998	1427.70	356003	Akat Amnuai	1975 - 1998	2020.20
352002	Phon Phisai	1975 - 1998	2050.60	356004	Kusuman	1975 - 1998	1599.90
352003	Si Chiang Mai	1975 - 1998	1546.90	356005	Ban Muang	1975 - 1998	1725.00
352004	Seka	1975 - 1998	2183.50	356006	Phang Khon	1977 - 1998	1193.90
352005	Sangkhom	1978 - 1998	1395.60	356007	Song Dao	1978 - 1998	1368.50
352006	So Phisai	1982 - 1998	2006.60	356008	Sawang Daen Din	1975 - 1998	1407.90
352007	Bung Kan	1975 - 1998	2808.40	356009	Waritchaphum	1975 - 1998	1271.60
352201	Nong Khai*	1975 - 1987	1577.30	356012	Kut Bak Highway Km.51	1975 - 1998	1596.00
353001	Wang Saphung	1975 - 1998	1116.40	356201	Sakon Nakhon*	1951 - 1998	1535.10
353002	Dan Sai	1975 - 1998	1037.80	356301	Sakon Nakhon Agromet	1967 - 1998	1494.60
353003	Chiang Khan	1975 - 1998	1218.80	357001	That Phanom	1975 - 1998	1404.70
353004	Tha Li	1975 - 1998	1097.40	357002	Tha Uthen	1975 - 1998	2311.80
353005	Phu Kradung	1975 - 1998	1213.10	357003	Renu Nakhon	1977 - 1998	1377.00
353006	Phu Rua	1976 - 1998	1167.80	357004	Si Songkhram	1975 - 1998	1958.50
353007	Na Haeo	1985 - 1998	1196.70	357005	Ban Phaeng	1975 - 1998	2612.50
353008	Pak Chom	1985 - 1998	1200.10	357006	Na Kae	1975 - 1998	1368.60
353201	Loei*	1955 - 1997	1218.40	357201	Nakhon Phanom*	1953 - 1998	2273.50
353301	Loei Agromet	1971 - 1997	1213.30	381001	Chonnabot	1971 - 1998	996.60
354001	Phen	1975 - 1998	1664.90	381002	Phon	1975 - 1998	990.00
354003	Kumphawapi	1975 - 1998	1165.50	381003	Chum Phae	1975 - 1998	1079.40
354004	Nong Han	1975 - 1998	1310.00	381004	Kranuan	1975 - 1998	1142.70
354005	Ban Dung	1975 - 1998	1462.50	381005	Mancha Khiri	1975 - 1998	967.60
354007	Non Sa-At	1975 - 1998	1061.40	381006	Ban Phai	1975 - 1998	1064.90
354008	Kut Chap	1975 - 1998	1091.70	381007	Si Chomphu	1975 - 1998	1075.70

Table 1 (continue)

Station Id.	Station Name	YEAR	Mean Annual Rainfall (mm.)	Station Id.	Station Name	YEAR	Mean Annual Rainfall (mm.)
354009	Nong Wua So	1975 - 1998	1172.80	381008	Phu Wiang	1975 - 1998	1194.60
354010	Nam Som	1975 - 1998	1312.70	381009	Nong Song Hong	1975 - 1998	1164.70
354013	Ban Phu	1975 - 1998	1342.20	381010	Nam Phong	1975 - 1998	1053.00
354201	Udon Thani*	1951-1998	1360.40	381011	Ubol Ratana	1975 - 1998	995.70
356001	Phanna Nikhom	1975 - 1998	1438.90	381201	Khon Kaen*	1951 - 1998	1194.40
356002	Wanon Niwat	1975 - 1998	1366.60	381301	Tha Phra Agromet	1967 - 1998	1137.40
383001	Khamcha-I	1975 - 1998	1473.70	405011	Pho Chai	1975 - 1998	1181.20
383201	Mukdahan*	1951 - 1998	1508.80	405012	Muang Suang	1981 - 1998	1143.90
387001	Maha Sarakham	1975 - 1998	1145.50	405201	Roi Et*	1951 - 1998	1337.10
387002	Borabu	1975 - 1998	1145.00	405301	Roi Et Agromet	1984 - 1998	1248.30
387003	Kantharawichai	1975 - 1998	1066.40	407001	Warin Chamrap	1975 - 1998	1388.50
387004	Na Chuak	1975 - 1998	1144.70	407002	Det Udom	1975 - 1998	1562.30
387005	Wapi Pathum	1975 - 1998	1122.10	407004	Si Muang Mai	1975 - 1998	1744.50
387006	Chiang Yun	1975 - 1998	1042.70	407005	Muang Samsip	1975 - 1998	1601.90
387007	Na Dun	1985 - 1998	1107.00	407006	Trakan Phutphon	1975 - 1998	1743.30
387008	Phayakkhaphum Phisai	1975 - 1998	1275.90	407007	Khong Chiam	1975 - 1998	1837.00
387401	Kosum Phisai*	1970 - 1998	1200.50	407008	Khuang Nai	1975 - 1998	1643.60
403001	Chatturat	1970 - 1998	1013.20	407009	Phibun Mangsahan	1975 - 1998	1761.20
403002	Phu Khieo	1975 - 1998	1013.80	407012	Nam Yun	1981 - 1998	1457.30
403003	Kaset Sombun	1975 - 1998	777.40	407013	Buntharik	1975 - 1998	1715.30
403004	Ban Khwao	1975 - 1998	997.00	407015	Khemarat	1975 - 1998	1607.10
403005	Ban Thaen	1975 - 1998	933.10	407301	Ubon Ratchathani Agroment	1970 - 1998	1615.10
403006	Nong Bua Daeng	1975 - 1998	1013.50	407501	Ubon Ratchathani*	1951 - 1998	1567.80
403007	Bamnet Narong	1975 - 1998	864.60	431001	Phimai	1975 - 1998	963.60
403008	Khon Sawan	1975 - 1998	1103.70	431002	Bua Yai	1975 - 1998	966.30
403201	Chaiyaphum*	1957 - 1998	1161.50	431003	Dan Khun Thot	1975 - 1998	931.40
405001	Selaphum	1975 - 1998	1283.60	431004	Sung Noen	1975 - 1998	903.00
405002	Suwannaphum	1975 - 1998	1234.90	431005	Pak Thong Chai	1975 - 1998	955.70

Table 1 (continue)

Station Id.	Station Name	YEAR	Mean Annual Rainfall (mm.)	Station Id.	Station Name	YEAR	Mean Annual Rainfall (mm.)
405003	Thawatchaburi	1975 - 1998	1167.40	431006	Khon Buri	1975 - 1998	849.10
405004	Pathum Rat	1975 - 1998	1147.20	431007	Chakkarat	1975 - 1998	1038.00
405005	Nong Phok	1975 - 1998	1078.04	431008	Khong	1975 - 1998	1150.90
405006	At Samat	1978 - 1998	1166.00	431009	Huai Thalaeng	1976 - 1998	1170.10
405007	Phon Thong	1975 - 1998	1244.30	431010	Chum Phuang	1975 - 1998	1073.50
405008	Phanom Phrai	1975 - 1998	1226.70	431011	Prathai	1975 - 1998	1087.90
405009	Kaset Wisai	1975 - 1998	1226.70	431012	Kham Sakae Saeng	1975 - 1998	895.70
405010	Chaturaphak Phiman	1975 - 1998	1170.30	431014	Non Thai	1975 - 1998	1057.80
431015	Sikhiu	1975 - 1998	914.30	436004	Satuk	1975 - 1998	1183.60
431201	Nakhon Ratchasima	1951 - 1998	1096.30	436005	Krasang	1975 - 1998	1285.90
431301	Pak Chong Agromet	1971 - 1998	1048.00	436006	Prakhon Chai	1975 - 1998	1360.70
431401	Chok Chai*	1970 - 1998	1095.70	436007	Khu Muang	1975 - 1998	1167.00
436001	Buri Ram	1975 - 1998	1187.80	436008	Nong Ki	1978 - 1998	1163.50
436002	Lahan Sai	1970 - 1998	1127.60	436009	Ban Kruat	1982 - 1998	1205.10
436003	Lam Plai Mat	1975 - 1998	1205.40	436401	Nang Rong*	1970 - 1998	1163.60

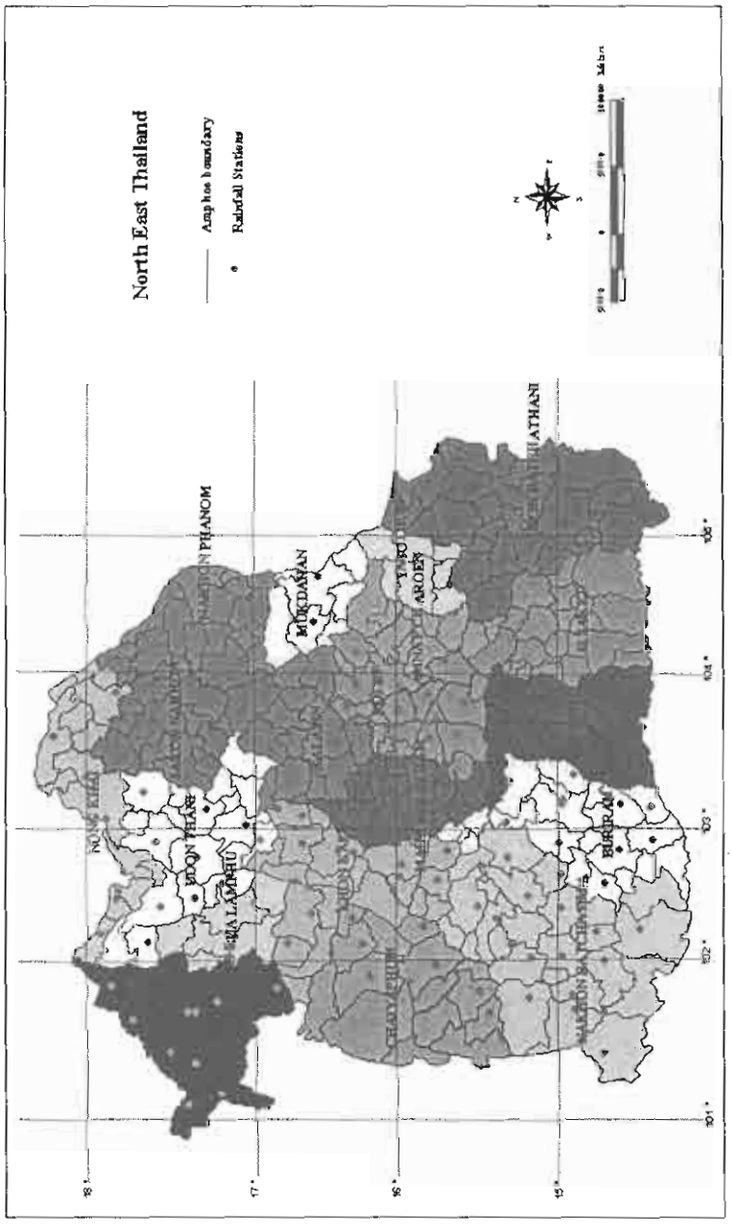

Figure 1 Location of rainfall stations in provinces of North-East Thailand.

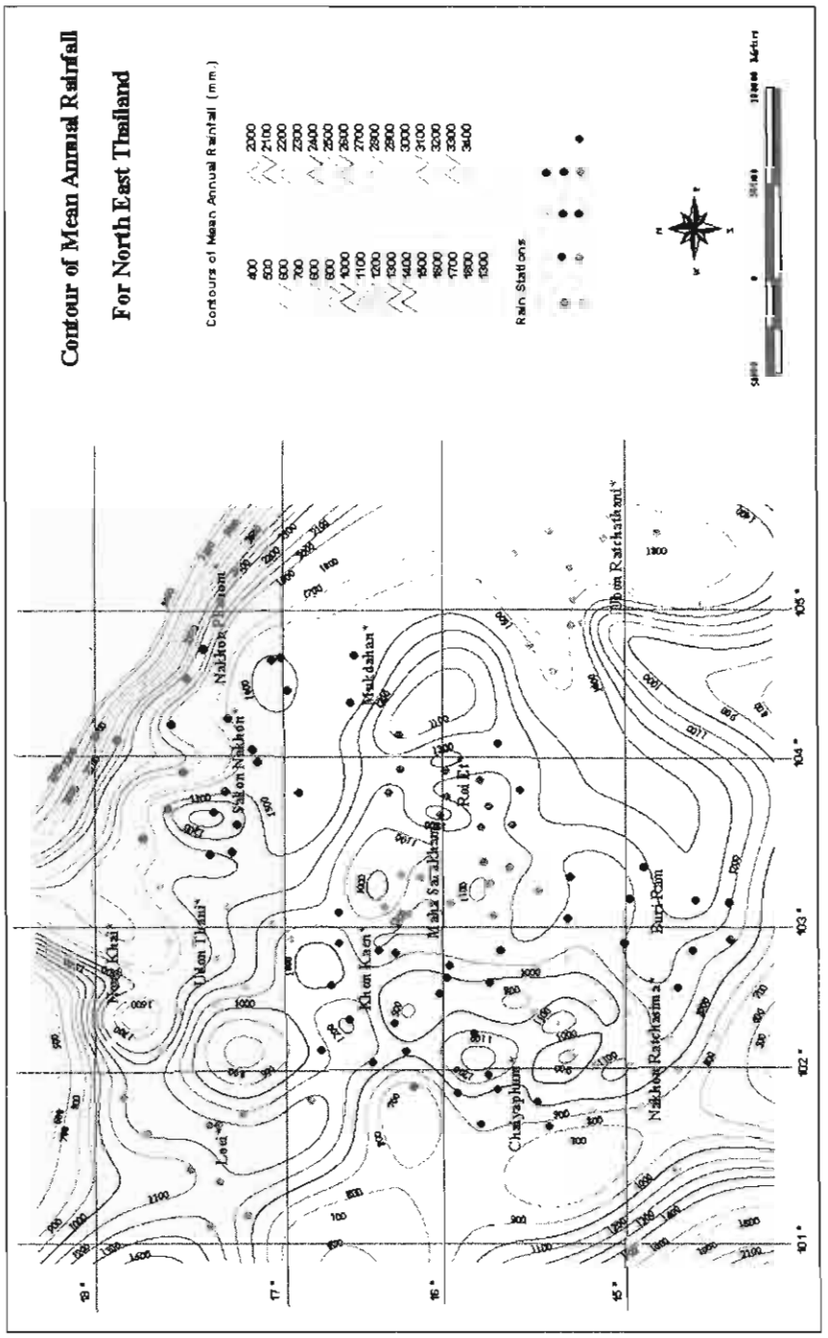

Figure 2 Contours of mean annual rainfall for North-East Thailand.

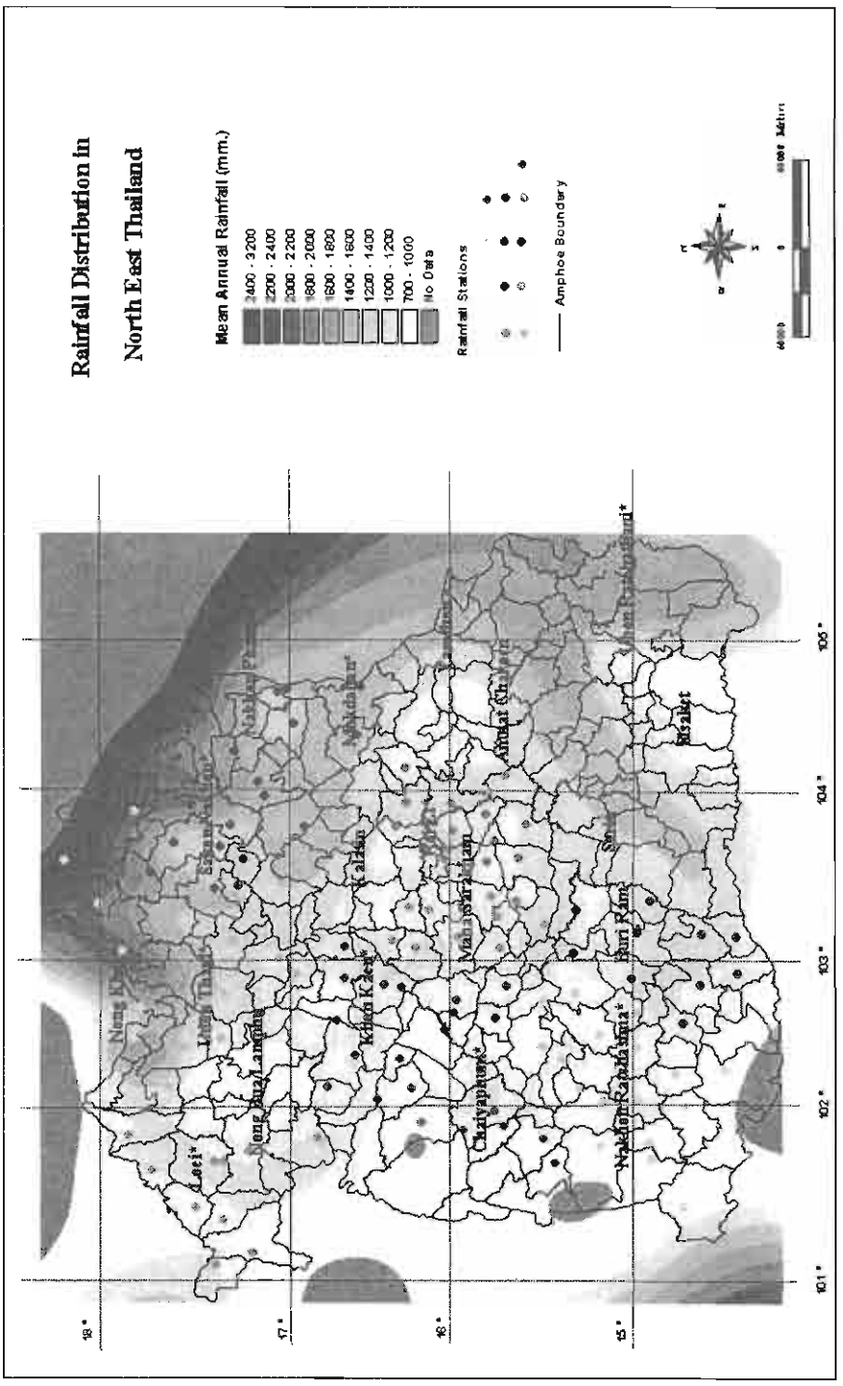

Figure 3 Spatial rainfall distribution in North-East Thailand.

Long term of rainfall interannual variability

The main rainfall station of each provincial was selected, annual rainfall were analysed and used to correlate with the years corresponding. These results were presented in figure 4. The variation of annual rainfall is clearly distinguished. The irregularity of amount of rainfall might result in the occurrence of droughts and floods over both time and area. The long-term trend was investigated for the period 1951-1998 and showed that the declining of rainfall mostly appeared in every part of this region. The statistical analysis with about a 10 year period has been reported, the amount of annual rainfall of Nakhon Ratchasima, Chaiyaphum, Buri Ram, Maha sarakharm, Roi-et, Udon Thanee and Nong Khai decreased variably from 40 mm to 80 mm.for decade. The others meterological stations, the amounts of rainfall have been decreased but less than the stations mentioned above while only in Loei and Sakon Nakhon provinces area the amounts of rainfall increased. It is remarkable, the areas in rain shadow the annual rainfall is the least but with high decreasing trend of rainfall. Nong Khai area is the most receiving rainfall of this region, unfortunately the trend in annual rainfall decreases.

Conclusions and discussions

Rainfall distribution in North-east Thailand is less from the West and South-west and progressively increases to the North-East and East of this region. The analysis of annual rainfall showed an interannual variation. On the long-term timescale, a decreasing trend in rainfall is remarkable. The future work is needed for more analysis in number of rainy days, growing season and monthly rainfall in order to better understand for seasonal changed and for water shortage management in this region. However, weather hazards and number of storms should be considered. This can be helped in long-term climatic prediction and therefore help to mitigate some of the socioeconomical impacts as droughts and floods over this region.

Acknowledgement

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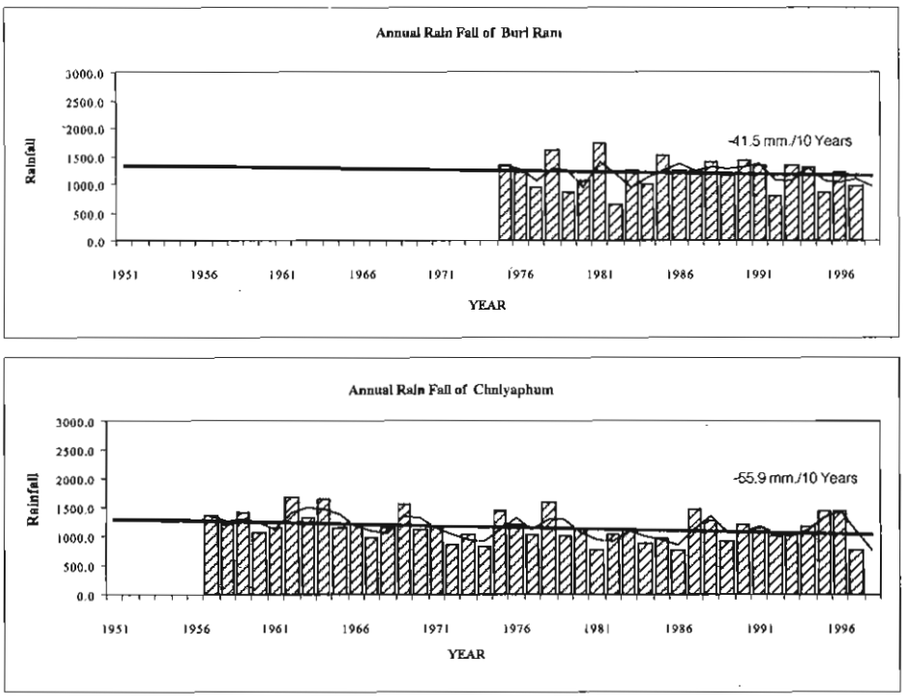
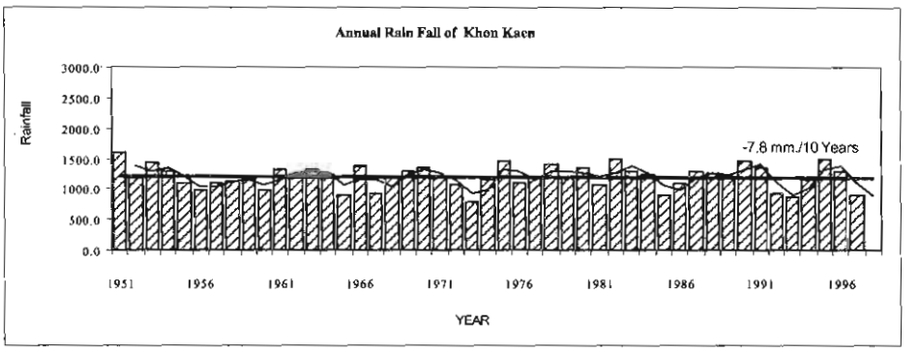
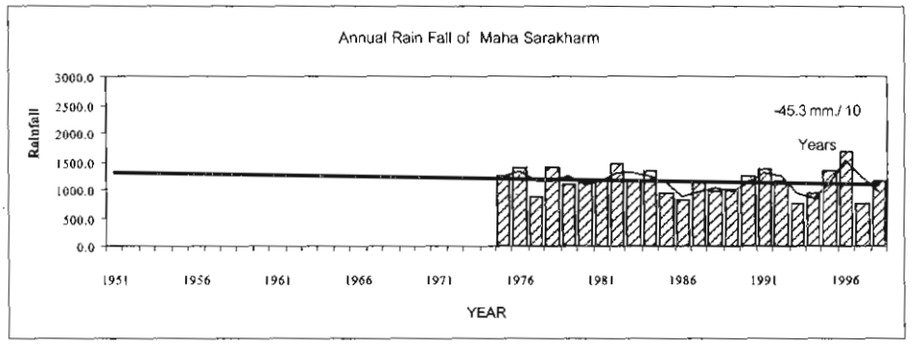
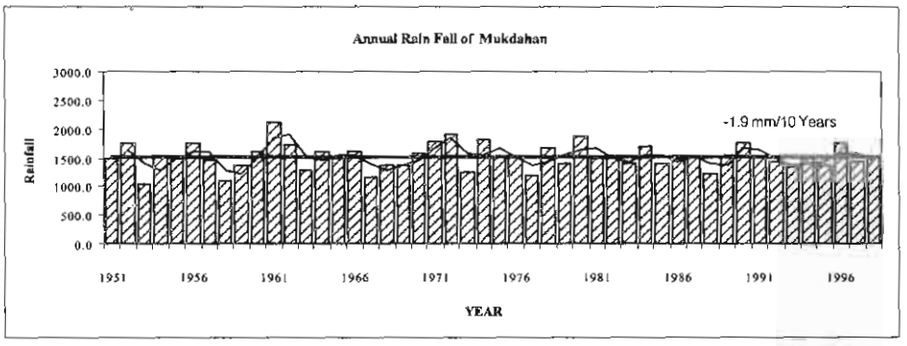
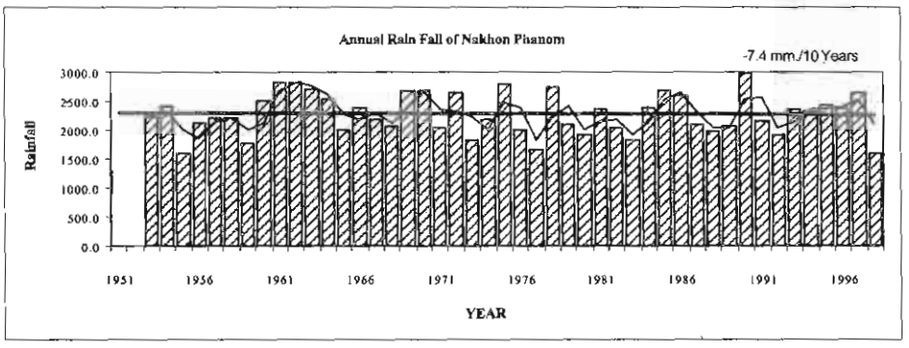


Figure 4 International variability and long-term trend of rainfall in North-East Thailand.









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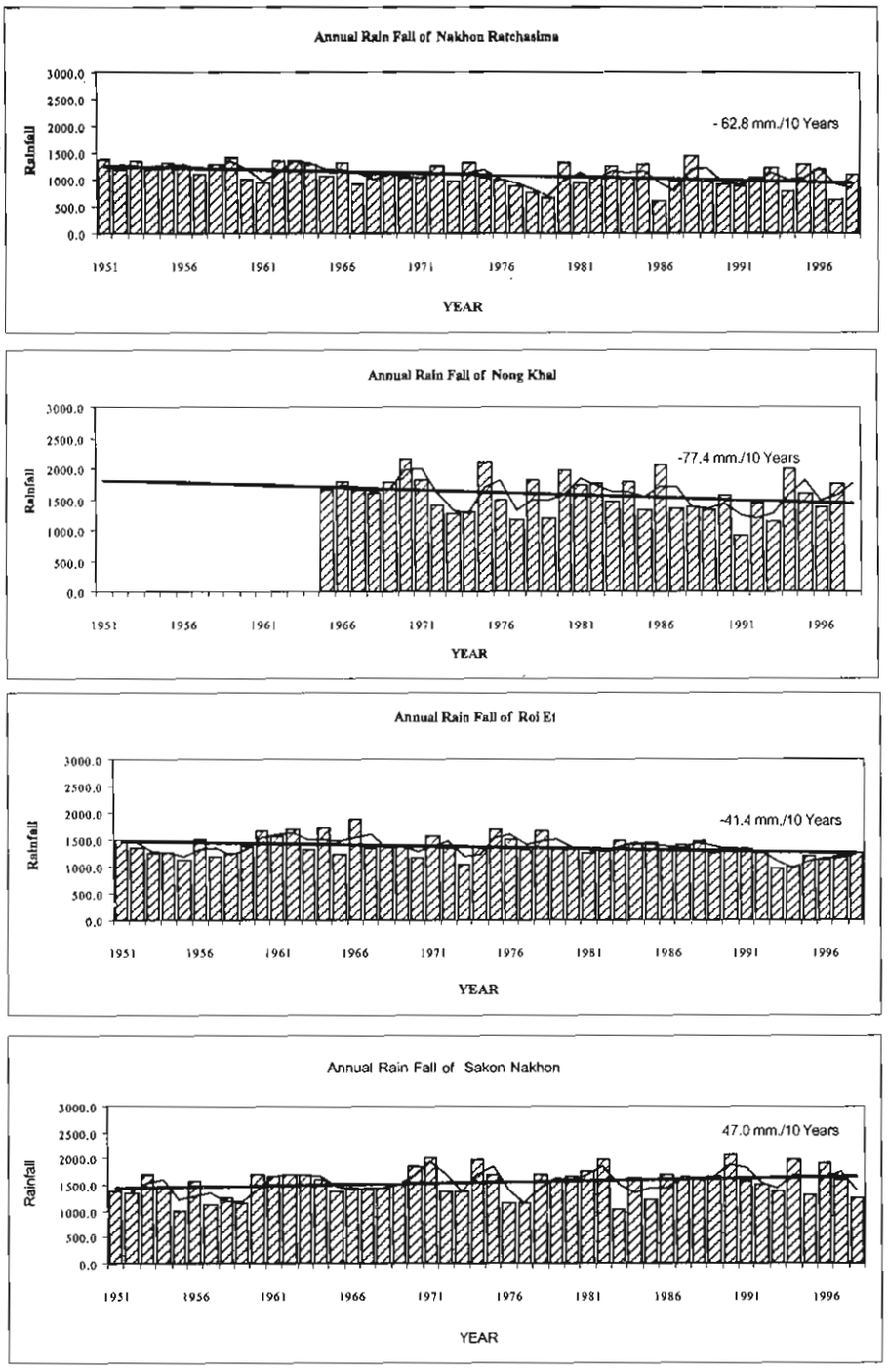

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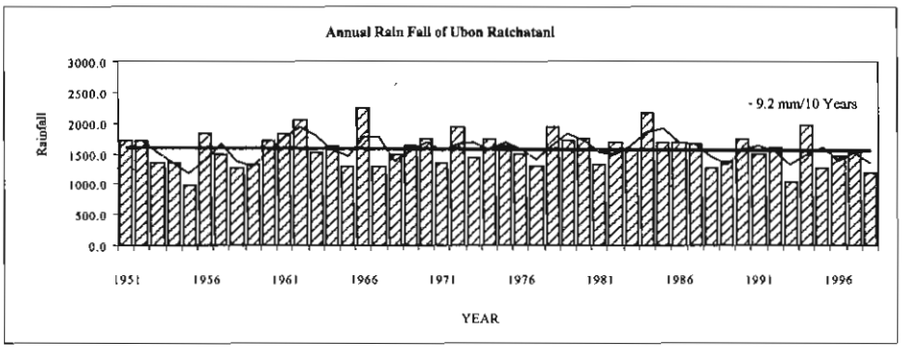

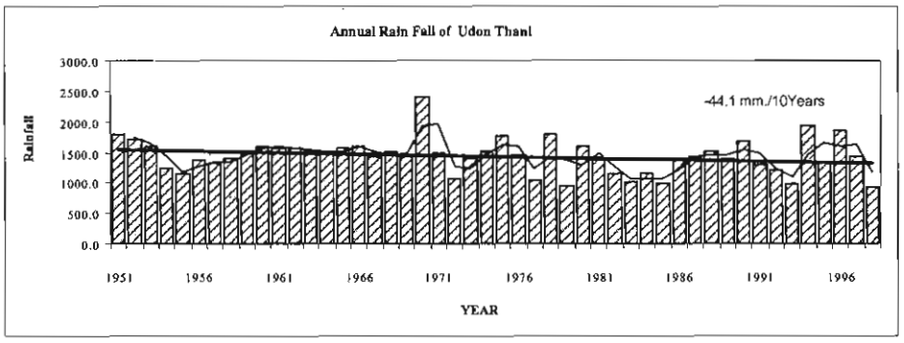

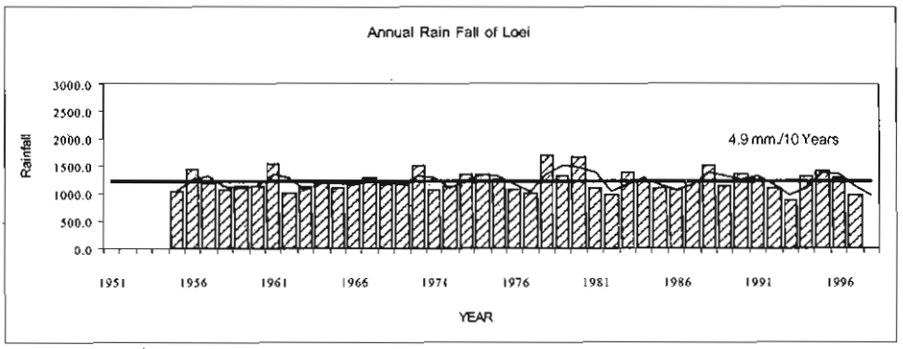

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