

**SUB-WEATHER ANALYSIS OF BA PHNOM,
KAMCHAY MEAR AND PEAR REANG DISTRICTS,
PREY VENG PROVINCE**



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Sub-Weather Analysis of Ba Phnom, Kamchay Mear and Pear Reang Districts, Prey Veng Province

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Abbreviations

CCSR	Centre for Climate Research Studies
CNMC	Cambodia National Mekong Committee
CSIRO	Commonwealth Scientific and Industrial Research Organization
DJF	December January and February
DS	Dry Season
ENSO	El-Nino Southern Oscillation
GCM	General Circulation Model
JJA	June July and August
MAFF	Ministry of Agriculture, Forestry and Fisheries
MAGICC	Model for the Assessment of Greenhouse-gas Induced Climate Change
MAM	March April and May
Max	Maximum
Min	Minimum
MoE	Ministry of Environment
MRC	Mekong River Commission
NAPA	National Adaptation Program of Action
NIES	National Institute for Environmental Studies
PDA	Provincial Department of Agriculture
PDWRAM	Provincial Department of Water Resource and Meteorology
PRECIS	Providing Regional Climates for Impacts Studies
RCM	Regional Climate Models
RUA	Royal University of Agriculture
SEASTART RC	Southeast Asia System for Analysis, Research and Training Regional Center
SCENGEN	A global and regional SCENario GENerator
SNC	Second National Communication
SON	September October and November
SRES	Special Report on Emissions Scenarios
SRESA2	Special Report on Emissions Scenarios as Reference
SRESB1	Special Report on Emission Scenarios as Policy
WS	Wet Season

CLIMATOLOGY OF PAST AND FUTURE CLIMATE CHANGE IN BA PHNOM, KAMCHAY MEAR AND PEAR REANG DISTRICTS, PREY VENG PROVINCE

1. Introduction

Cambodia's climate is principally categorized by two major seasons from mid-May to early October, strong prevailing winds from the southwest bring heavy rains and high humidity and from early November to mid-March, winds and humidity are low. The average annual rainfall is 1,400 mm in the central low land regions and may reach 5,000 mm in certain coastal zones or in highland areas. The average annual temperature is 28°C, with a maximum average of 38°C in April, and a minimum average of 17°C in January (MoE, 2002). Prey Veng's climate is divided into two seasons: the wet and dry seasons. The wet season generally starts in May and ends in October followed by dry season from November to April. The monsoon between March and November follows the same pattern as Phnom Penh (CNMC, 2011 and 2012).

The main findings of the analysis of observed climate are as follows: (i) Mean annual temperature anomaly has increased by 0.8°C since 1960, a rate of around 0.18°C per decade. The rate of increase is most rapid in the drier seasons (DJF and MAM) 0.20-0.23°C and slower in the wet seasons (JJA and SON); (ii) Mean observed rainfall does not show any consistent increase or decrease since 1960. The average time series of observed data for Cambodia is over the period 1960-2006, and projected future climate under three IPCC emission scenarios (A2, A1B and B1). However, the main findings for projected climate are: (i) The mean annual temperature is projected to increase by 0.7 to 2.7°C by the 2060s, and 1.4 to 4.3 degrees by the 2090s. The range of projections by the 2090s is around 1.0 to 1.5°C; (ii) All projections indicate substantial increases in the frequency of days and nights that are considered hot in current climate, and (iii) Projections of mean annual rainfall from broadly indicate increases in rainfall. This increase is mainly due to the projected increases in wet season rainfalls; partially offset by projected decreases in dry season rainfalls (McSweeney, New & Lizcano, 2008).

A number of studies indicated that under warming atmosphere Cambodian climate will be changed. Based on two GCM models CCSR and CSIRO from MAGICC-SCENGEN (NCSP, 2000), it was found that the mean deviation between observed rainfall and GCM outputs ranged from 16 to 794 mm. The deviations increased considerably in the wet season while decreasing in the dry season (MoE, 2002). The two GCM models also suggested that temperature in Cambodia would increase. However the increase in temperature between the two models was not the same. Under scenario SRESA2, the CCSR model suggested that the mean annual temperature would increase to about 0.60°C in 2025 and it will further increase to about 1.00°C and 2.50°C in 2050 and 2100 respectively. The CSIRO model suggested that the increase in temperature from the current year's temperature in 2025, 2050 and 2100 would be about 0.30, 0.70 and 2.00°C respectively. Similarly under SRESB1 scenario, the increase in mean annual temperature from the current temperature in 2025, 2050 and 2100 using CCSR would be about 0.60, 0.90 and 1.60°C respectively and using CSIRO would be about 0.45, 0.75 and 1.35°C respectively (Thoeun, Soben and Tara, 2012).

The significant is underestimate or overestimate current temperatures and precipitation in the many regions of GCMs in many regions. An additional disadvantage of GCM-based scenarios is that a single GCM, or even several GCMs, may not represent the full range of potential climate changes in a region. Therefore, many studies now are now use regional climate models (RCMs) which have higher resolution. In the Second National Communication, Cambodia adopted regional climate model (PRECIS) in combination with a number of GCM models run by Climate Risk Assessment Division, Center for Global Environmental

Research, National Institute for Environmental Studies (NIES) with resolution of 100x100 km (Masutomi, et al., 2009 and Drafted SNC, 2010). By using all data downscaled by PRECIS regional climate model for Mekong River Basin over the land area were averaged 30 years period of record started from 1960 to 2099. The result of analysis shows a clear increasing trend in mean temperature data. Rapid increase in temperature is expected to occur after 2030. Variation of mean temperature may also increase in the future. Based on the result of rescaling temperature data of all grids from PRECIS, it was found that the rate of mean monthly temperature increase ranged from 0.013 °C to 0.036°C per year depending on the location (Thoeun, Soben and Tara, 2012). The rate of temperature increase is high in low altitude areas such as in the central and in the North East of Cambodia (0.036°C per year) and low in the high altitude areas such as in South West region (0.013°C per year). However, by using all data downscaled by PRECIS regional climate model for Mekong River Basin over the land area were averaged 10 years period of record started from 1960 to 2099 (*SEASTART RC, 2009*). The result of analysis shows a clear increasing trend in average rainfall data. The change variance of monthly rainfall pattern in 1960-1979, rainfall pattern of Cambodia is dominated by Pattern. In 1980-1999, it change and is dominated by Pattern 5. In the period of 2000-2019, it will change again and it will be dominated by Pattern 2. In the period 2020-2039, some of region with Pattern 2 will be replaced by Pattern 1 and after that there will be no much change in rainfall pattern until 2079. In 2079-2099, there will be slight change in rainfall pattern where region with Pattern 2 in the period of 2020-2079 will change into Pattern 3. Rainfall variability of some regions may decrease and some other part may increase depends on the time horizons (Drafted SNC, 2010, and Thoeun, Soben and Tara, 2012). To cope with scarcity of historical climate data in evaluating the impact of current climate variability on sectors such as Agriculture and Water Resource as priority of government, long historical climate data was reconstructed using PRECIS for whole Cambodia and downscaling into region for target province.

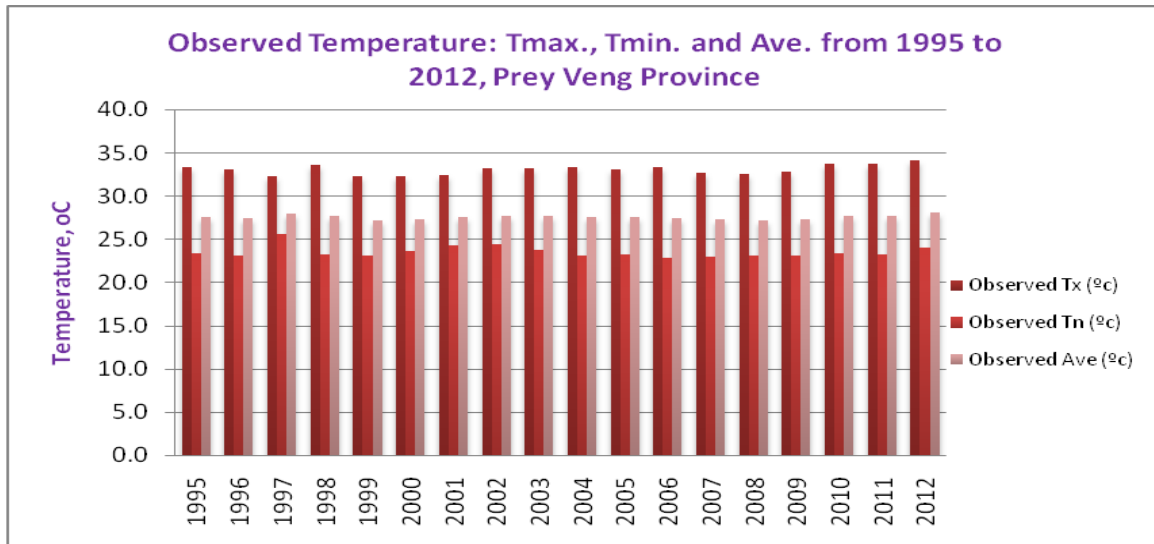
Study aimed to assess past and future climate change of Ba Phnom, Kamchay Mear and Pear Reang Districts, Prey Veng Province by using recorded and reconstructed data from sub-weather stations which has installed under target area. In particularly, analysis the cost structure and profitability of small farm households, incorporating observed climate meteorology such as temperature, humidity and rainfall and provide the output analysis of climate projection in the climate models, and as well as map showing; and determines the outreach programs targeted to policy makers and farmer groups to deliver information concerning adjustment principles.

2. Climatology in Prey Veng Province

A trend assessment of climate variability and climate change in Cambodia is documented and including Prey Veng province as target studied area, in which has identified and coordinated appropriate locations to install climate hardware (rain gauge, temperature and humidity) through technical supported from Provincial Department of Water Resource and Meteorology (PDWRM) in order to collect and analyze seasonal weather forecast information as such database of past and present of rainfall, temperature and humidity for climate analysis, farmer trained on how to collect weather data and analysis at farmer fields in the three districts of province.

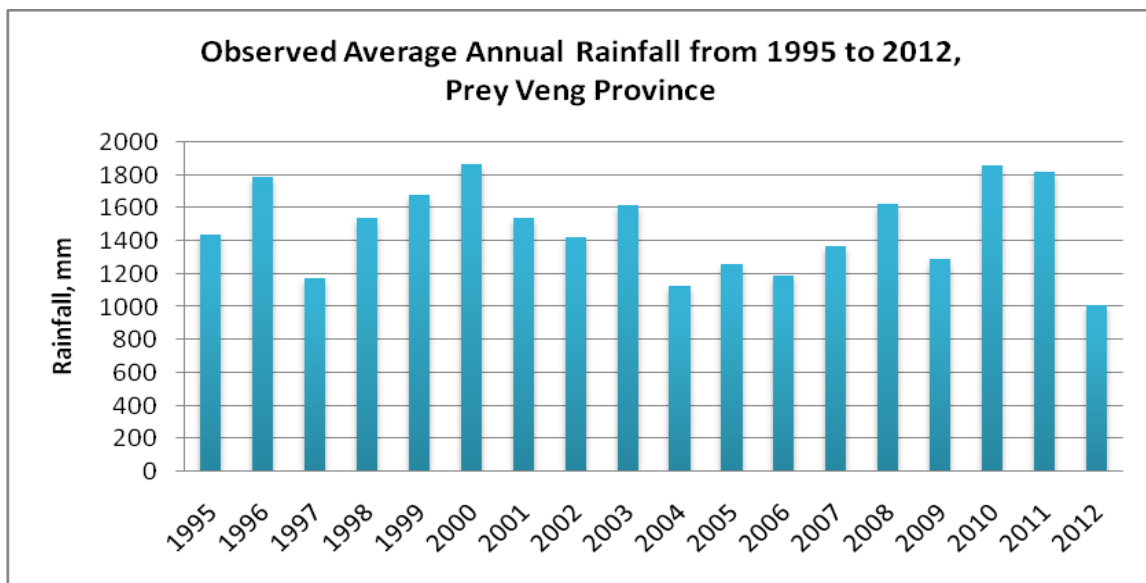
Prey Veng province's tropical monsoon climate is characterized by wet and dry seasons. During the wet season, which is the last from May to October, winds from the southwest and west carry heavy rains and account for 90% of annual precipitation cover for country wide. The dry season, from November to April, is associated with the northeast monsoon, which brings drier and cooler air from atmosphere from November to March and then hotter air in

April and early May. The average mean temperature in 18 year from 1995 to 2012 is about 27.6 °C, the minimum mean temperature about 23.5 °C and the maximum mean temperatures about 33.1 °C (Figure 2.1). The average annual rainfall as the same period from 1995 to 2012 has fluctuated between 1,009 mm and 1,867 mm (Figure 2.2). However, over the past decade, comparison to some inland provinces have experienced less than 600 mm of rainfall annually, and in coastal areas is about 3,800 mm.



Source: Data from PDWRAM, 2011 and Recorded 2012

Figure 2. 1: Observed Temperature, Tmax., Tmin, and Average from 1995 to 2012



Source: Data from PDWRAM, 2011 and Recorded 2012

Figure 2. 2: Observed Average Annual Rainfall from 1995-2012

The Impact of ENSO Events on Wet Season and Dry Season Rainfall is commonly occurring in the region. In this regard, the impact of El-Nino on wet and dry season rainfall was negative while the impact of La-Nina was positive in the low land regions were shown in Table 2.1 (MoE, 2002). In the upland and coastal regions, the impact of El-Nino on wet season rainfall for some months was positive and some were relatively normal, while on dry season rainfall, the impacts were commonly negative. In La-Nina years, most of the monthly rainfall in both seasons increased above normal. However, this pattern was more consistent in the low land regions than in the coastal or upland regions. In the coastal and upland regions

in some La-Nina years, rainfall decreased below normal. The upland and coastal regions are mostly situated in mountainous regions where the topographic effect is strong. In this case, inconsistency is due to the presence of local effects on rainfall. Therefore, along the coast and upland, a sea light wind effect also exists. Another important factor that affects the rainfall in the monsoon system is through all provinces in Cambodia included Prey Veng province.

Table 2. 1: Impact of ENSO Events on Wet Season and Dry Season Rainfall

Location	El Nino		La Nina		Description
	WS	DS	WS	DS	
Coastal	+/0	-	-/+	+/0	Based on Sihanoukville and Kampot rainfall stations
Low land	-/0	-	-/+	+	Based on Pochentong station
High land	0/+	-/0	0/+	+/0	Based on Kratie station

Source: MoE (2002) and Note: (+), (-) represent positive and negative impact, while 0-no impact.

3. Methods for Climatology Development

3.1 Approaches

The approach for climatology development as first step is to reconstruct long term historical climate data using analysis data from PRECIS downscaling. This analysis was performed to cope with data gap. The second step is to validate the reconstructed data using observation data. The third step to use the observation and reconstructed data to assess historical climate change. The fourth step is to develop climate change scenarios with two emission scenarios SRESA2 and SRESB2. The GCM mode was run by Southeast Asia System for Analysis, Research and Training Regional Center (SEA START RC) with resolution of 50 x50 km. The fifth step is to map spatial mapping change of historical and future climate using Geographical Information System (GIS).

The observed data recorded from appropriate locations where has been installed climate hardware of rain gauge, temperature and humidity through technical supported from Provincial Department of Water Resource and Meteorology (PDWRM) in order to collect and analyze seasonal weather forecast information as such database of past and present of rainfall, temperature and humidity for climate analysis of year 2012 in the three districts of province.

3.2 Data Analysis Process

The observed data and two historical and future climate data generated by RCM model PRECIS downscaling under the two emission scenarios SRESA2 and SRESB2. Data analysis has used an *Algorithm for Climate Model Data Adjustment*. The deviations of climate model outputs from the observed climate cannot be avoided and should not be neglected. To keep the outputs from baseline scenario using climate model data as inputs coincide with the outputs from the same scenario but using the observed climate data as inputs, the adjustment or correction needs to be employed. In this climate change study, the methodologies proposed by Hoanh et al. (2010) were adopted with slight modifications for adjusting the climate data synthesized by the PRECIS Regional Climate Model (RCM) system.

3.2.1 Maximum and Minimum Temperature Adjustment

The Climate Model was used the maximum and minimum temperature period 1995-2012 also deviate from historical records, in order to keep those data close to those from using observed

temperature data, the maximum and minimum temperatures obtained from PRECIS Regional Climate Model need to be adjusted. To adjust maximum and minimum temperature, monthly values are adjusted against the observed ones and subsequently the monthly adjustment value for a specific month is used to adjust the daily temperature values in the month. The equations are applied to adjust maximum and minimum temperature in below.

$$T_{adj\ CM}(sub_i_month_j, day_k) = T_{CM}(sub_i_month_j, day_k) - T_{diff(sub_i_month_j)}$$

- $T_{adj\ CM}(sub_i_month_j, day_k)$: Adjusted daily Climate Model temperature for a particular cell i in month j and day k during the past period of 1995-2012
- $T_{CM}(sub_i_month_j, day_k)$: Daily Climate Model temperature for a particular cell i in month j and day k during the past period of 1995-2012
- $T_{diff(sub_i_month_j)}$: Monthly temperature adjustment value for a particular cell i in month j during the past period of 1995-2012

3.2.2 Rainfall Adjustment

The deviation of the rainfall data generated and run by the PRECIS system from the observed precipitation, to maintain those data as close as the observed at major monitoring points, the PRECIS precipitation needs to be adjusted. For the past period of 1995-2012, the monthly precipitation time series were adjusted against the observed rainfall data as input. The approach adopted here is similar with the method 3 proposed by Hoanh et al. (2010) and presented as below formula:

$$P_{adj\ CM}(sub_i_month_j) = P_{CM}(sub_i_month_j) - F \times (P_{Calib}(sub_i_month_j))$$

- $P_{adj\ CM}(sub_i_month_j)$: Adjusted Climate Model monthly rainfall for cell i in month j during the past period of 1995-2012
- $P_{CM}(sub_i_month_j)$: Simulated Climate Model monthly rainfall for cell i in month j during the past period of 1995-2012
- $P_{Calib}(sub_i_month_j)$: Monthly rainfall observed data (calibration data) cell i in month j during the past period of 1995-2012
- F : Adjustment factor (1.0 for complete adjustment)

The data were generated by dynamic downscaling methods from PRECIS program for the future period 2013-2030, the monthly PRECIS rainfall data for 18 years from current condition were adjusted using the monthly adjustment values obtained from 1995-2012 with observed rainfall data recorded and subsequently the monthly PRECIS precipitation data were adjusted using monthly data patterns.

3.2.3 Rescaling Factor and Climate Projection

Rescaling factor and projection value of climate data for Prey Veng province is generated historical data from PRECIS downscaling and validated by using observed data. Extracted outputs from this analysis process is a scaling factor for January until December for all grid of Prey Veng province grid and then, as known the simulation value of a certain grid. The scaling factor and projection value are presented in the formula below.

$$Scaling\ Factor = \frac{Observation\ Data}{Simulation\ Data}$$

$$Climate\ Projection = Simulation\ Data \times Scaling\ factor$$

4. Result Finding and Discussion

4.1 Reconstructed Climate Data

The result of reconstructed climate data by adjustment and monthly average observation rainfall for 18 year from 1995 to 2012 are not significantly different from the observation data. This indicate that the reconstructed data is to calculate the equation of $Y=0.665x+18.46$ and regression correlation of $R^2=0.574$, by calculation the observation data against to downscaling data from PRECIS model for both future climate change scenarios SRESA2 and SRESB2 was shown in Figure 4.1 below.

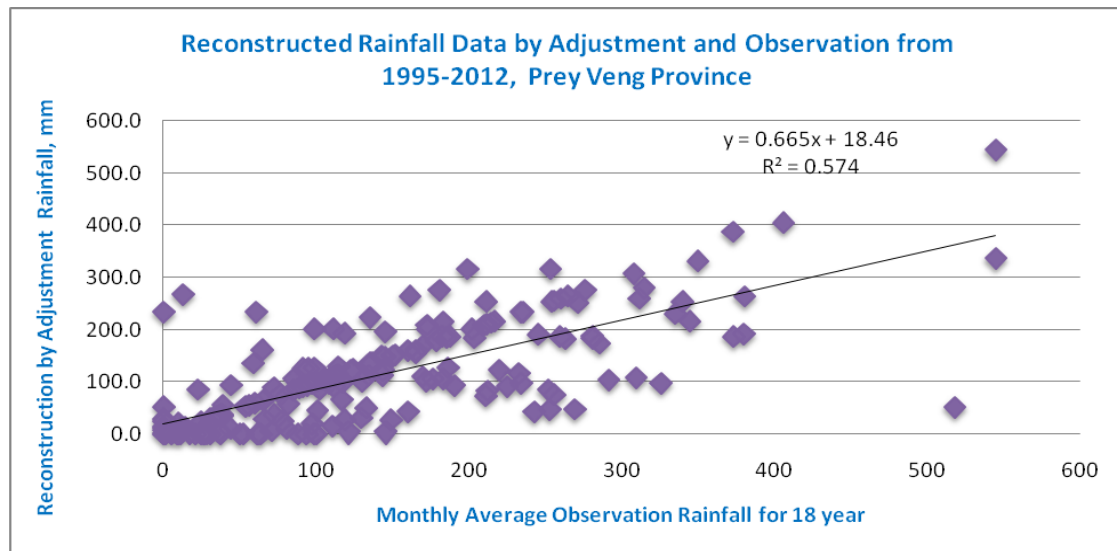


Figure 4. 1: Average Monthly Rainfall Reconstructed and Observed Data

4.2 Past and Future Climate Variability and Climate Change

The Past and Future Climate Variability and Climate Change concentrated on the temperature, rainfall and including humidity from a long historical data from PRECIS outputs and observed data recorded for Cambodia and Prey Veng province. The cost structure and profitability of small farm households, incorporating observed climate meteorology such as temperature, humidity and rainfall and provide the output analysis of climate projection in the climate models, and as well as map showing; and determines the outreach programs targeted to policy makers and farmer groups to deliver information concerning adjustment principles. However, this is a lesson learned and adaptation options initiative tested at farm-levels defined and scale out strategies captured for other appropriated district or target areas.

4.2.1 Temperature

The result of analysis was shown a clear increasing trend in mean temperature data and rapid increase in temperature is expected to occur after year 2030 by using all data over the land area of Cambodia were averaged using 30 years period of record started from 1960 to 2099 (Figure 4.2). Consequently, variation of mean temperature may also increase in the future (Drafted SNC, 2010, and Thoeun, Soben and Tara, 2012). Based on the result of rescaling temperature data of all grids from PRECIS is to assess the trend of mean monthly temperature change spatially. It was found that the rate of mean monthly temperature increase ranged from 0.013°C to 0.036°C per year. The rate of temperature increase is high in low altitude areas

such as in the central and low in the high altitude areas such as in South West and in the East including Low Mekong Basin coverage Prey Veng province, and North East region of Cambodia.

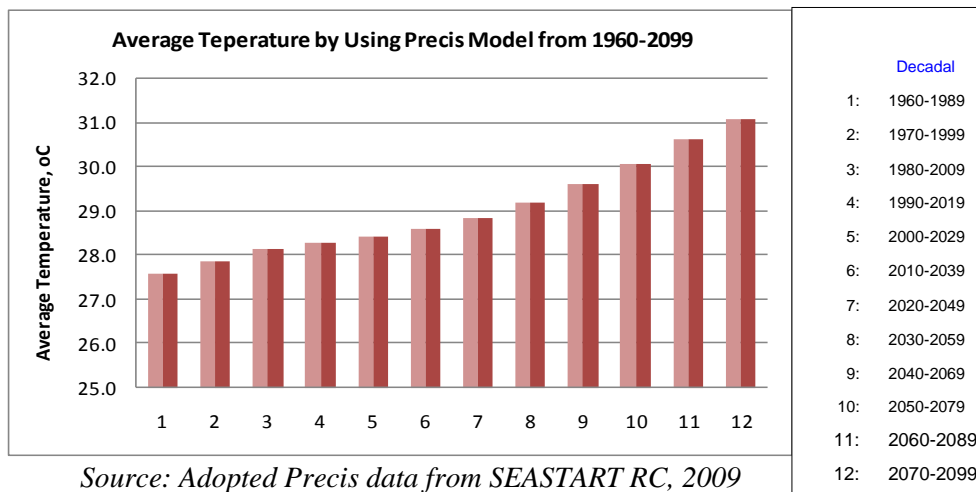


Figure 4. 2: Past and Future Average Temperature

Based on the result finding of the maximum and minimum temperature period 1995-2012 between observed data and output of PRECIS data need to be adjusted. An annual maximum and minimum temperature for Prey Veng province indicated that the degree is different of observed and output from PRECIS ranged from 33.1-35.7 °C (2.6°C) of the maximum was presented in Figure 4.3. However, the minimum as similarly of observed and output from PRECIS in maximum of Prey Veng province ranged from 23.5-26.1 °C (2.6°C) of the minimum was presented in Figure 4.4. Therefore, adjusted value for future temperature projection is the correction of scaling factor.

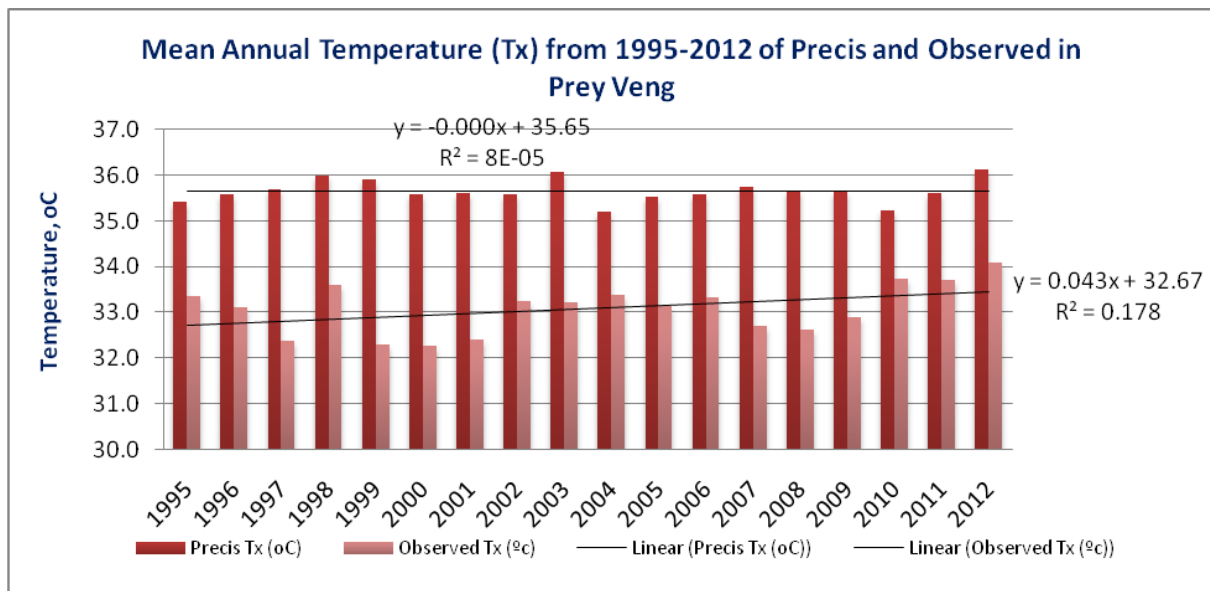


Figure 4. 3: Mean Annual Maximum Temperature of PRECIS and Observed, Prey Veng province

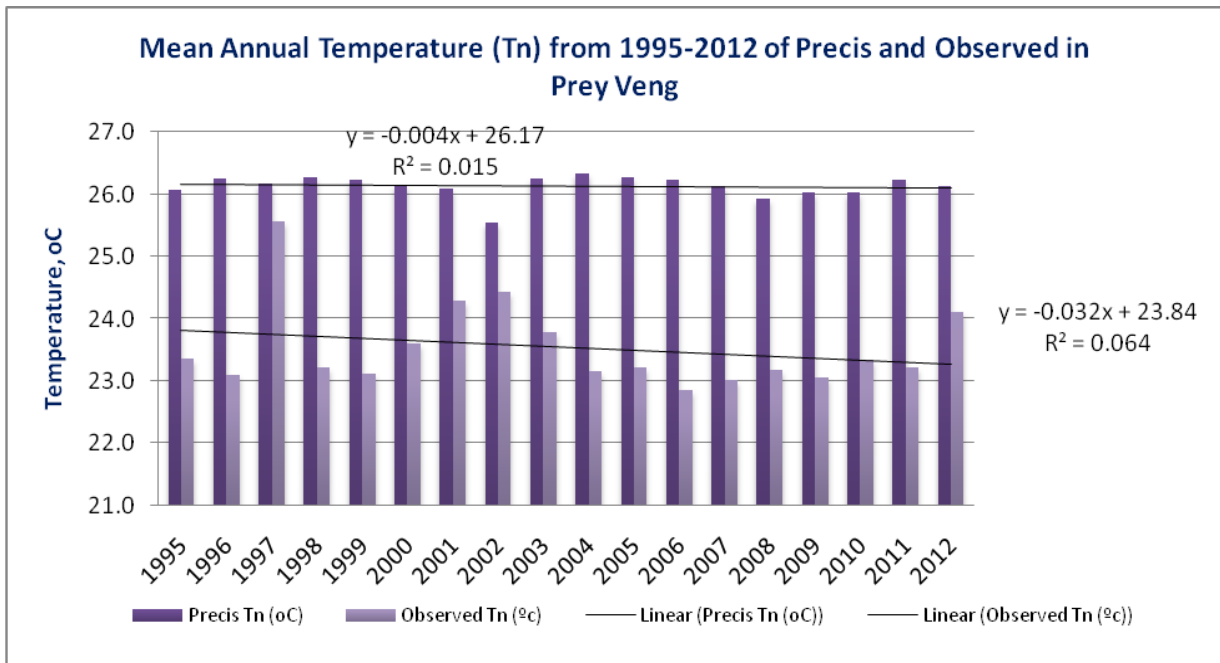


Figure 4. 4: Mean Annual Minimum Temperature of PRECIS and Observed, Prey Veng province

4.2.2 Temperature and Humidity by District

Based on results obtained in the activities of project, which has analyzed the climatic data recorded the sub-weather stations by the project team at sub-national level in the period from February 2012 to December 2012, map showing of Prey Veng province and climate projection and related to this information of agricultural sector for local community. As simplified guide was developed and disseminated to show how smallholder farmers can benefit from adaptation to climate change and associated climate variability. The temperature is cover three districts and shown in Figure 4.5 below.

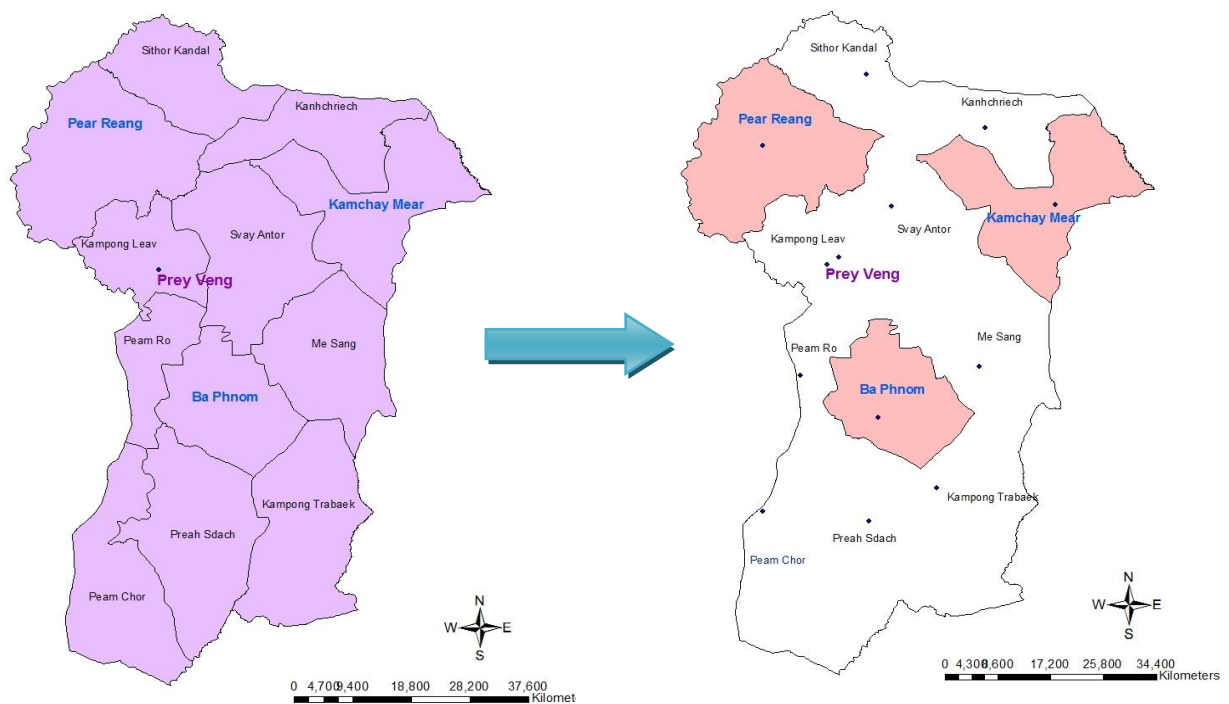


Figure 4. 5: Map of Prey Veng and Three Districts of the Sub-weather station

a. Temperature and Humidity in Ba Phnom District

The temperature and humidity in Ba Phnom district is covered 9 villages as such Angdong, Tra Baek, Graing, Ccher Triang, Ka Ley, Chan Ra, Kdey Dong, Khnuat and Tachhey in along with 9 communes as Chheng Phnom, Sday Koeung, They, Raik Chey, Spue Ko, Spue Kho, Reoung Domrey, Cchuer Kach and Beoung Prak. The key point of temperature is only Krang station representative for Ba Phnom district as Max., and Min. Temperature and Humidity (%) of Max. and Min. The maximum temperature in Ba Phnom district is ranged from 32.3-35.5 °C in September and April, and the minimum temperature is ranged from 22.2-24.9 °C in December and June, as well as the annual average temperature in this district is 28.8 °C, and was presented in Figure 4.6. In addition, the humidity is ranged from 90-97% of maximum and 66-89% of minimum, and the average of this annual average humidity is 83.7%., and was shown in Figure 4.7. For detail results were presented in Appendix 1.

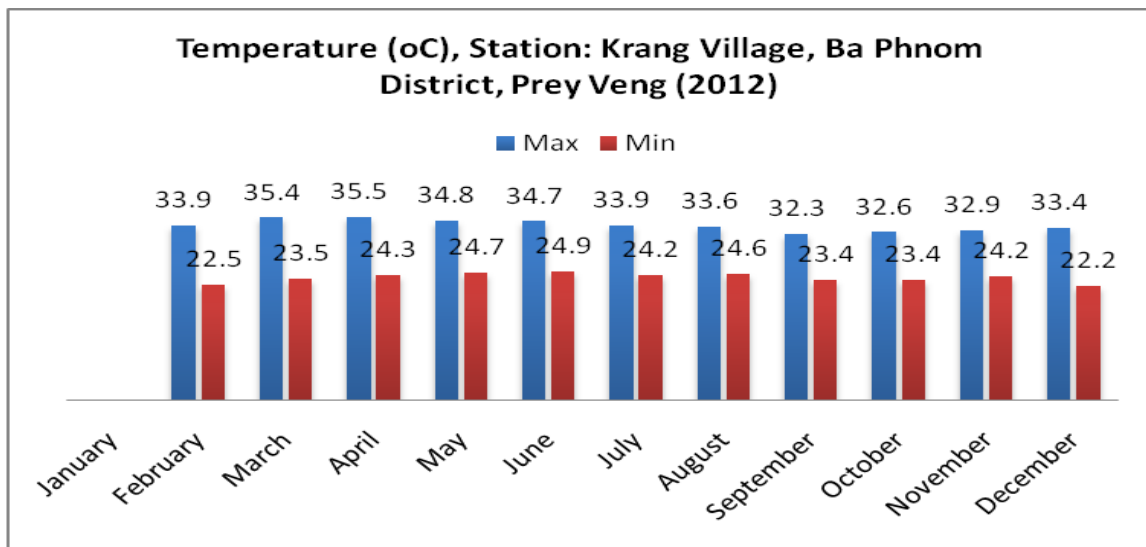


Figure 4. 6: Maximum and Minimum Temperature of Krang Station

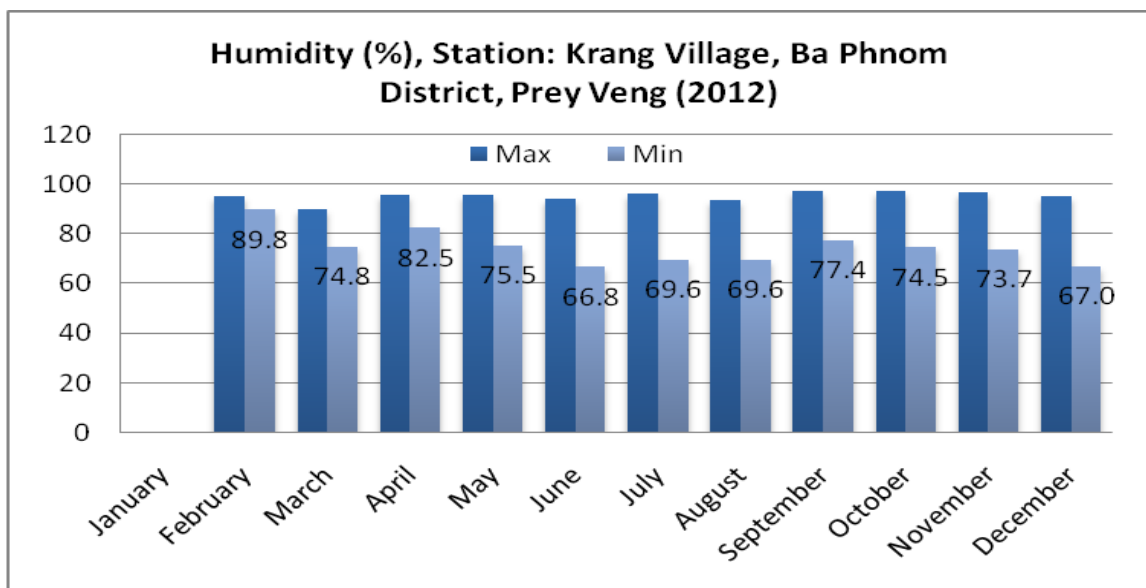


Figure 4. 7: Maximum and Minimum Humidity of Krang Station

b. Temperature and Humidity in Kamchay Mear District

The temperature and humidity in Kamchay Mear district is covered 8 villages as such Trapang Pry, Thnoat, Por Py, Cheach Khang Lech, Andong Saat, Sam Maki, Tean Pleung and Preak Sa1 in along with 8 communes as Tra Baek, Sang Kvang, Don Keoung, Cheach, Kror Bao, Kro Nguang, Smong Chheng, Smong Tbong. The key point of temperature is only Station: Pricksa 1 station representative for Kamchay Mear district as Max., and Min. Temperature and Humidity (%) of Max. and Min., Station: Pricksa1 Village, Kamchay Mear District. The maximum temperature in Kamchay Mear district is ranged from 32.7-35.6 °C in September and March, and the minimum temperature is ranged from 22.1-25.0 °C in December and August, as well as the annual average temperature in this district is 29.0 °C, and was presented in Figure 4.8. In addition, the humidity is ranged from 93-96% of maximum and 65-90% of minimum, and the average of this annual average humidity is 83.5%., and was shown in Figure 4.9. For detail results were presented in Appendix 2.

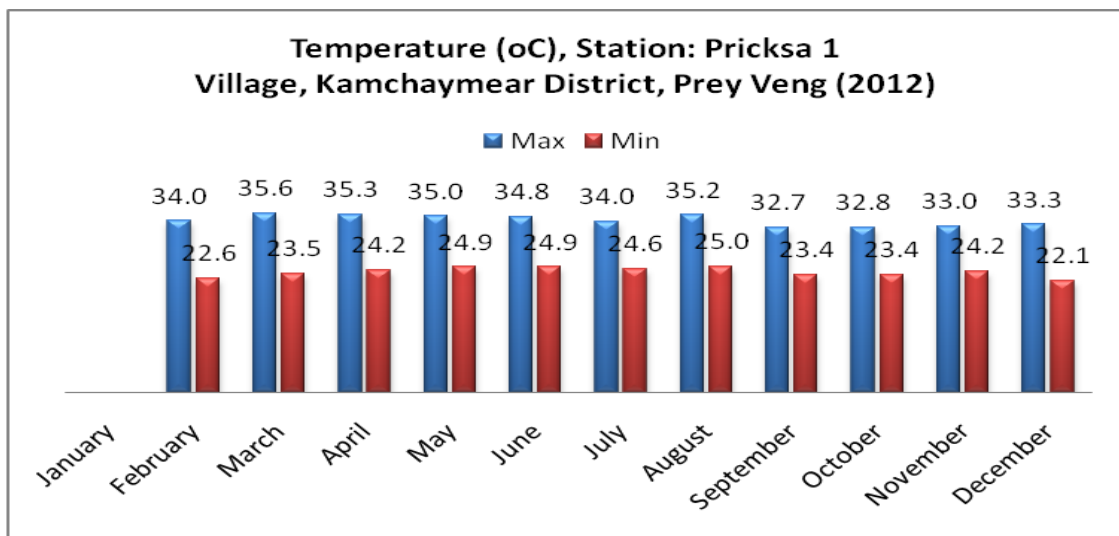


Figure 4. 8: Maximum and Minimum Temperature of Prichsa1 Station

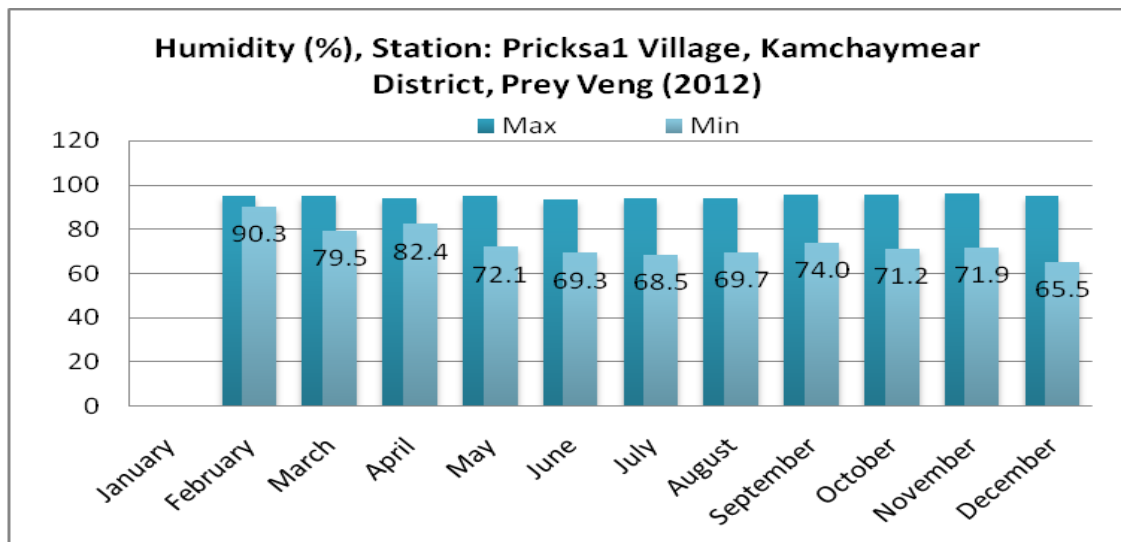


Figure 4. 9: Maximum and Minimum Humidity of Pricksa1 Station

c. Temperature and Humidity in Pear Reang District

The temperature and humidity in Pear Reang district is covered 8 villages as such Sam Rap, Prey Sneat, Pror Hut, Kampong Poppil, Trea, Snay Pol, Kampong Praing and Kampong Trear in along with 8 communes as Prey Pnov, Prey Sneat, Slor Let, Kampong Poppil, Kagn Chom, Ro Ka, Kampong Praing and Mesor Prochan. The key point of temperature is only Station: Trea station representative for Pear Reang district as Max., and Min. Temperature and Humidity (%) of Max. and Min., Station: Trea Village, Pear Reang District. The maximum temperature in Pear Reang district is ranged from 32.4-35.6 °C in September and March, and the minimum temperature is ranged from 22.1-26.2 oC in December and May, as well as the annual average temperature in this district is 29.4 °C, and was presented in Figure 4.10. In addition, the humidity is ranged from 93-96% of maximum and 66-90% of minimum, and the average of this annual average humidity is 83.4%. , and was shown in Figure 4.11. For detail results were presented in Appendix 3.

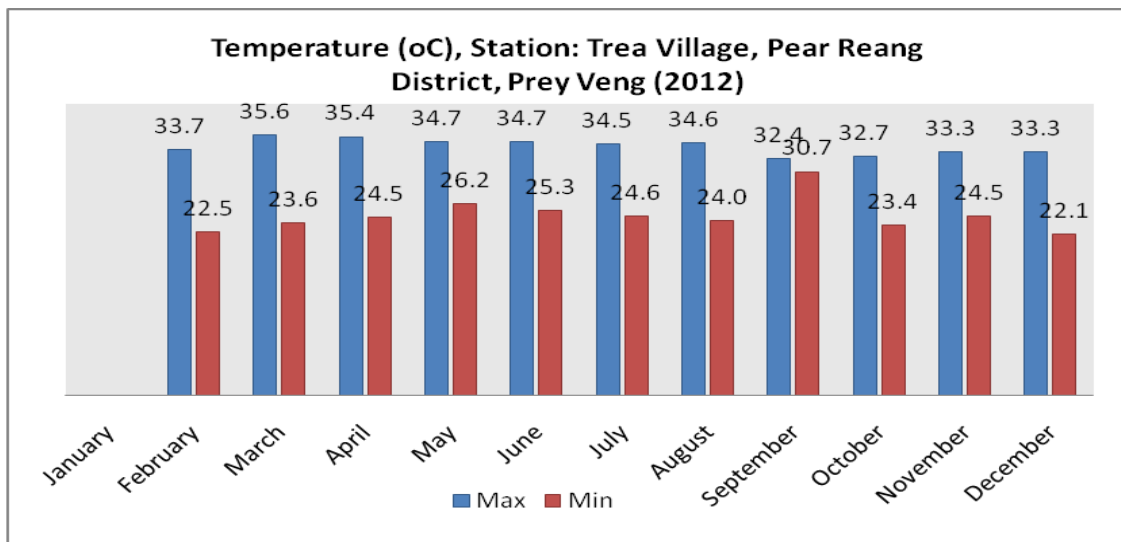


Figure 4. 10: Maximum and Minimum Temperature of Trea Station

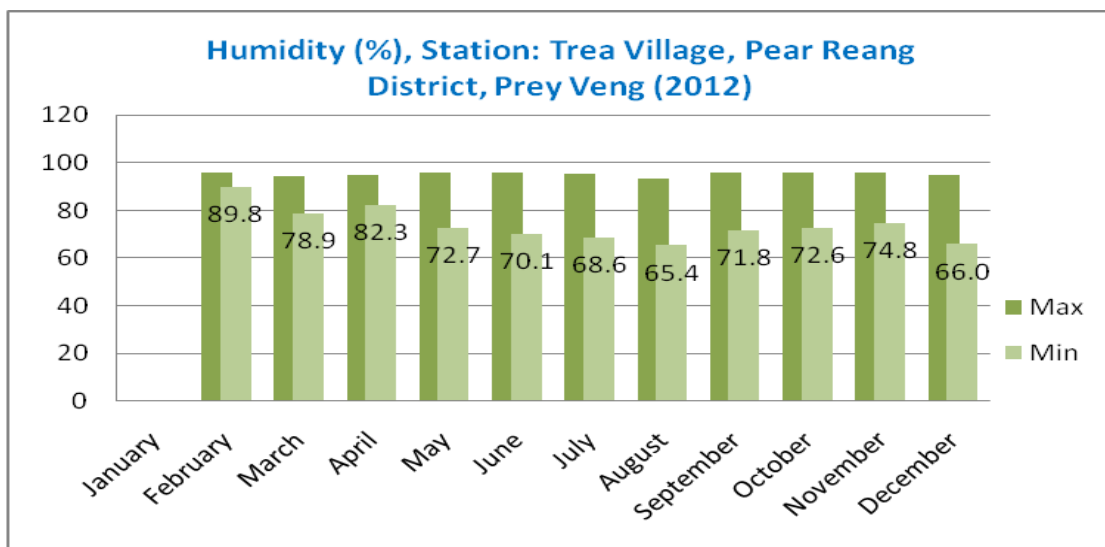


Figure 4. 11: Maximum and Minimum Humidity of Trea Station

4.2.3 Comparison to Temperature and Humidity

a. Comparison to Temperature by District

Comparison to Temperature Max., and Min. by month and district in Prey Veng province indicated that the maximum temperature is mainly high about 35.6 °C in March-April, and then go in slight down from May, June, July, August excepts Kamchay Mear and Pear Reang districts are increasing for the month of August about 34-35 °C. However, the minimum temperature is about 32.3 °C in September of Ba Phnom district, and these districts are slightly increasing from October to December of average 33 °C. Anyway, the minimum temperature of three districts is ranged from 22-26 °C for February to December, but except of Pear Reang district is highly increasing to 30.7 °C, and details were presented in Figure 4.12 below.

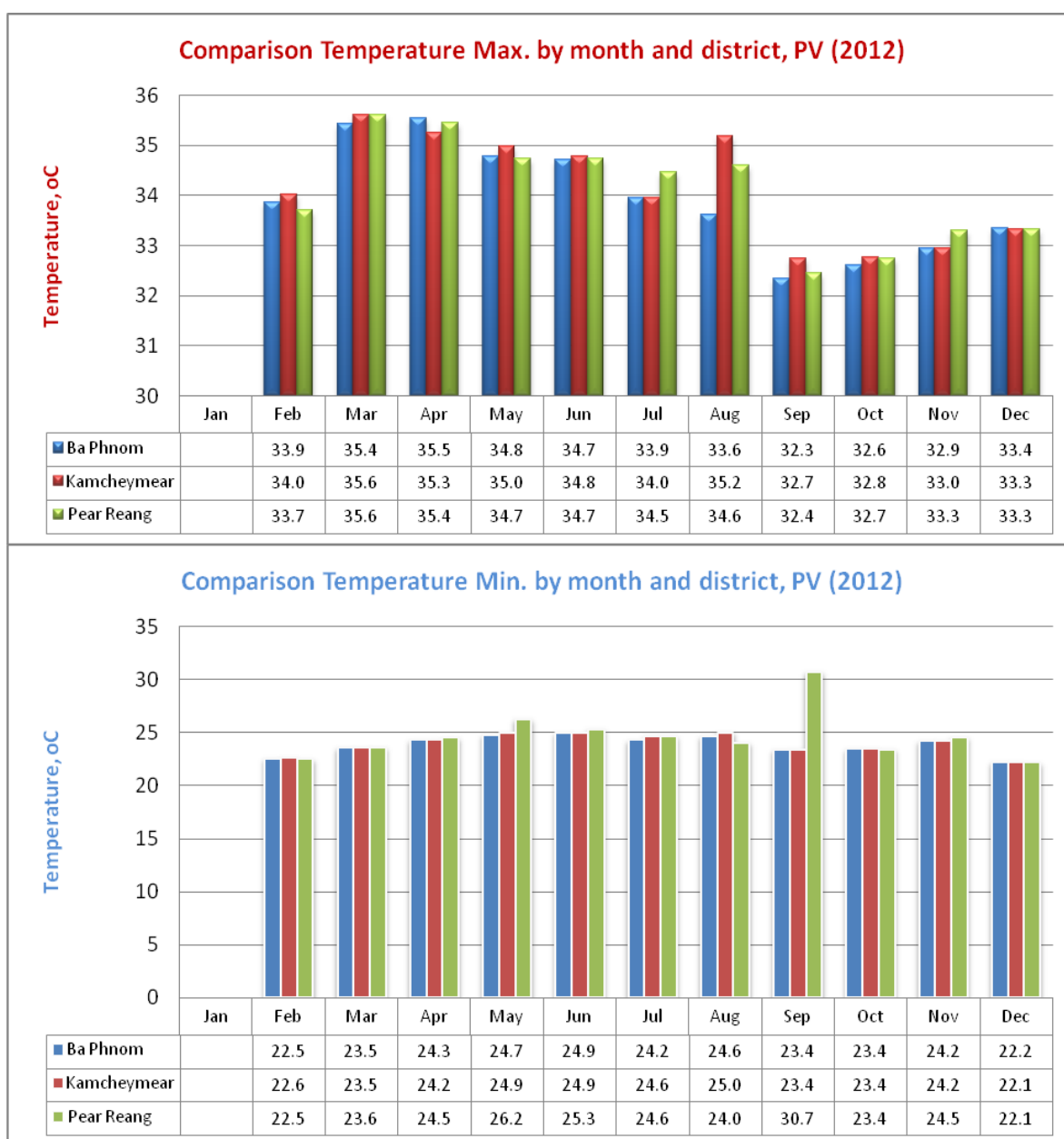


Figure 4. 12: Comparison Maximum and Minimum Temperature by District

b. Comparison to Humidity by District

Comparison to Humidity Maximum and Minimum by month and district in Prey Veng province indicated that the maximum humidity is mainly high ranged from 95.5-97.3% in September, October and November of three districts, and Ba Phnom District only is highest humidity. For average maximum humidity is ranged from 93-96% of February, April, May, June, July, August and December. However, humidity is ranged 90-95% in March; the lowest humidity is Ba Phnom district. In addition, the minimum humidity is ranged from 65.5-90.3% from February through December indicated that three districts is similar humidity, and details were presented in Figure 4.13 below.

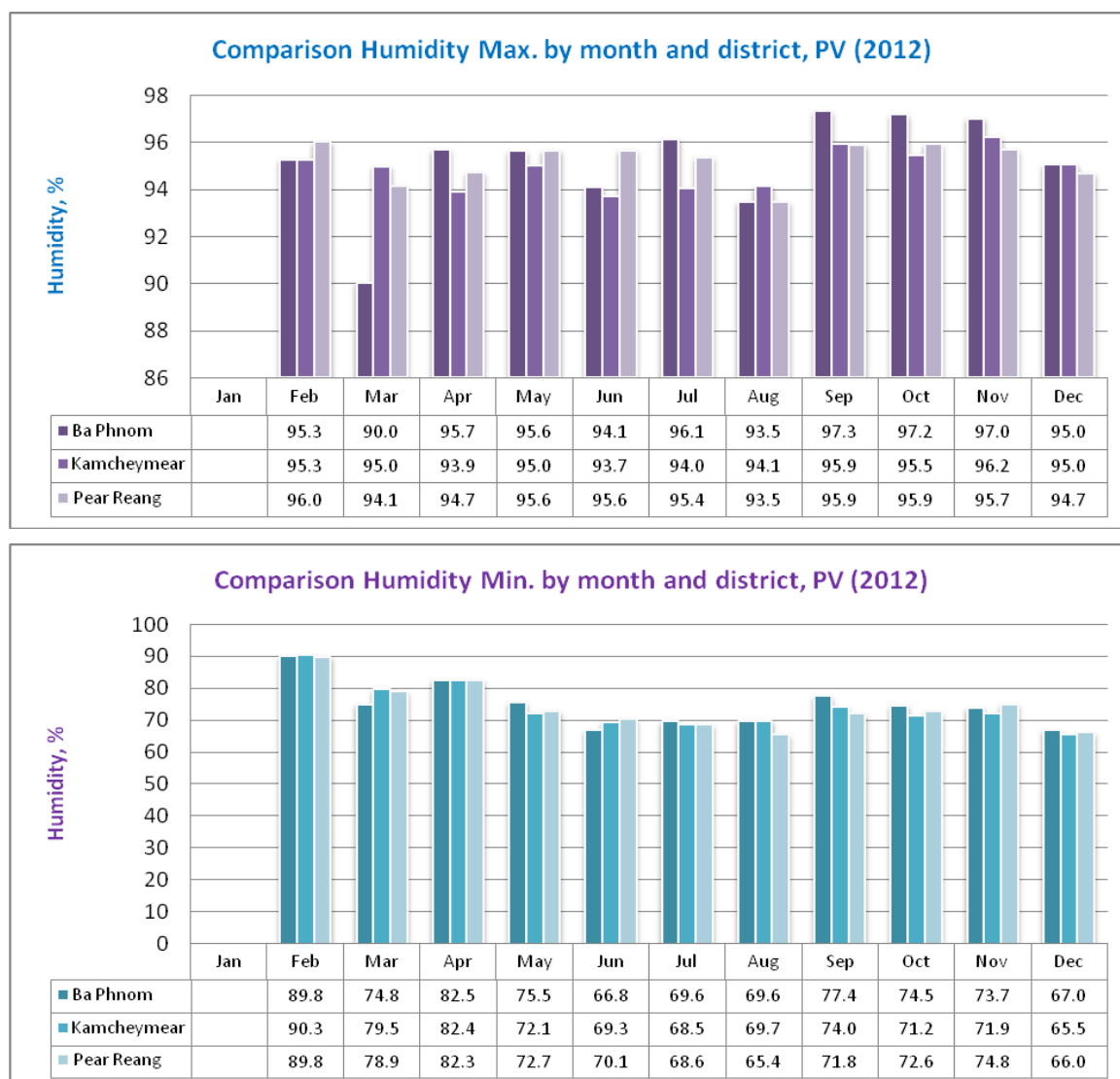
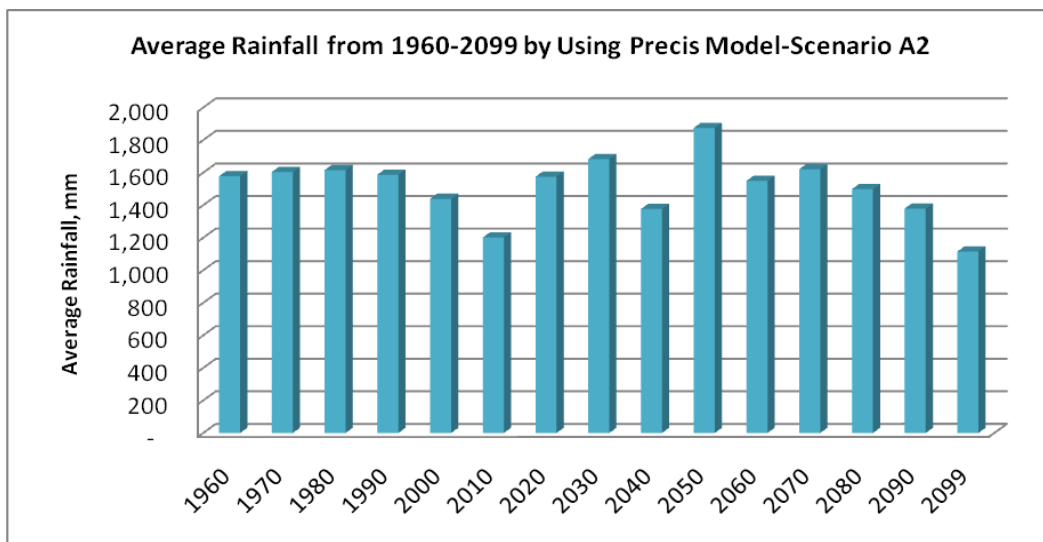


Figure 4. 13: Comparison Maximum and Minimum Humidity by District

4.2.4 Rainfall

The output from downscaled rainfall of PRECIS regional climate model for Mekong River Basin over the land area were averaged 10 years period of record started from 1960 to 2099 (SEASTART RC, 2009, and Thoeun, Soben and Tara, 2012). The result of analysis shows a clear increasing trend in average rainfall data. Rapid increase in rainfall is expected to occur after 2010 and will be continually increasing in year 2050, and slightly decreasing from 2070 to 2099 was shown in Figure 4.14 below.



Source: Adopted Precis data from SEASTART RC, 2009
 Figure 4. 14: Average Rainfall from 1960-2099 by Using Precis Model

The result analysis of observed precipitation data for period from 1995-2012, the monthly precipitation time series were adjusted against to the observed rainfall data as input and PRECIS outputs downscaling. The annual average precipitation of Precis model of Prey Veng province indicated that output is different average ranged from 1,200-1,800mm (600mm) , and the annual average precipitation of observed ranged from 1,000-1,800 mm (800mm) was presented in Figure 4.15. Therefore, adjustment value for future precipitation projection is the correction of scaling factor.

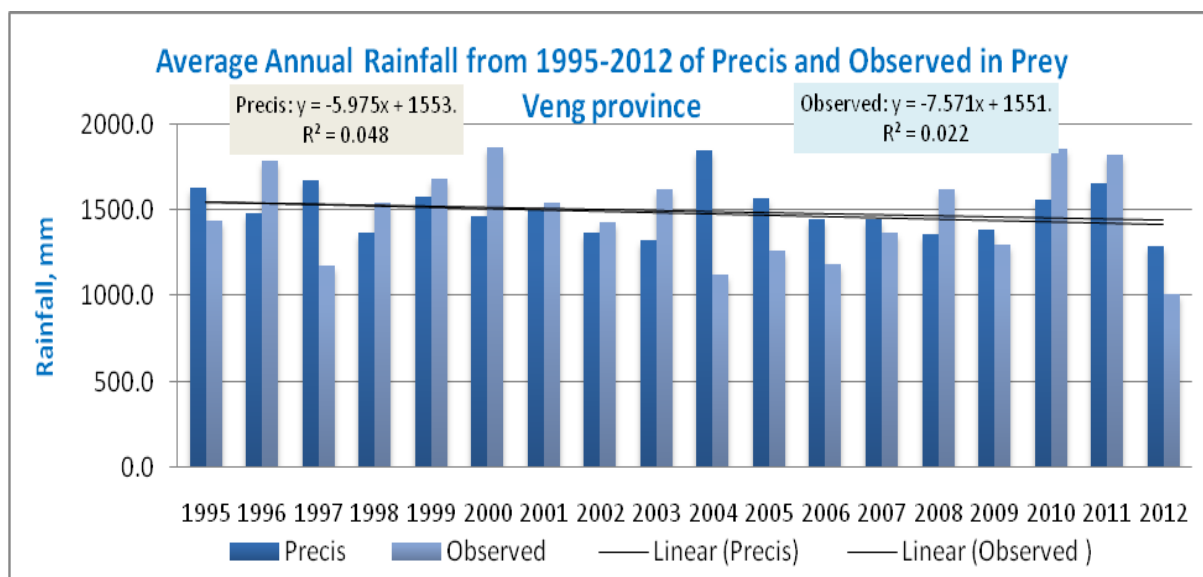


Figure 4. 15: Annual Average Precipitation of PRECIS and Observed, Prey Veng province

4.2.5 Rainfall by District

a. Rainfall in Ba Phnom District

The monthly rainfall in Ba Phnom district is covered 9 villages as such Angdong, Tra Baek, Graing, Ccher Triang, Ka Ley, Chan Ra, Kdey Dong, Khnuat and Tachhey in along with 9

communes as Chheng Phnom, Sday Koeung, They, Raik Chey, Spue Ko, Spue Kho, Reoung Domrey, Cchuer Kach and Beoung Prak, and details output by village and commune was presented in Figure 4.16 below.

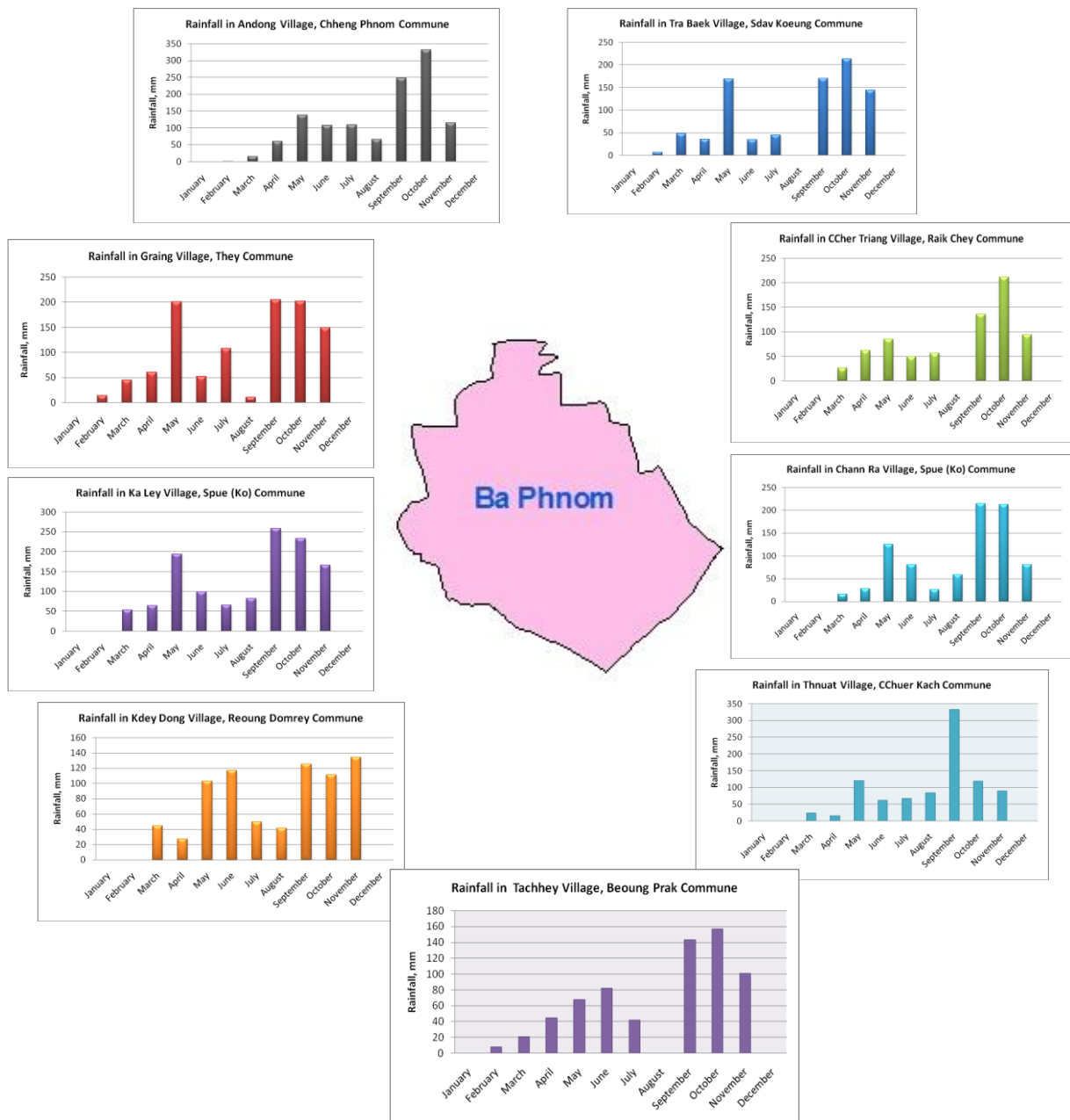


Figure 4. 16: Monthly Rainfall by Village and Commune, Ba Phnom District

Annual rainfall by village and commune in Ba Phnom district indicate that the high rainfall ranged from 1000-1200 mm refer to Andong, Grang and Ka Ley villages; rainfall ranged from 800-1000 mm refer to Tra Back, Chan Ra and Thnuat villages; the less rainfall ranged from 600-800 mm refer to Chher, Kdet Dong and Tachhey villages, and detail was presented in Figure 4.17 and see in Appendix4.

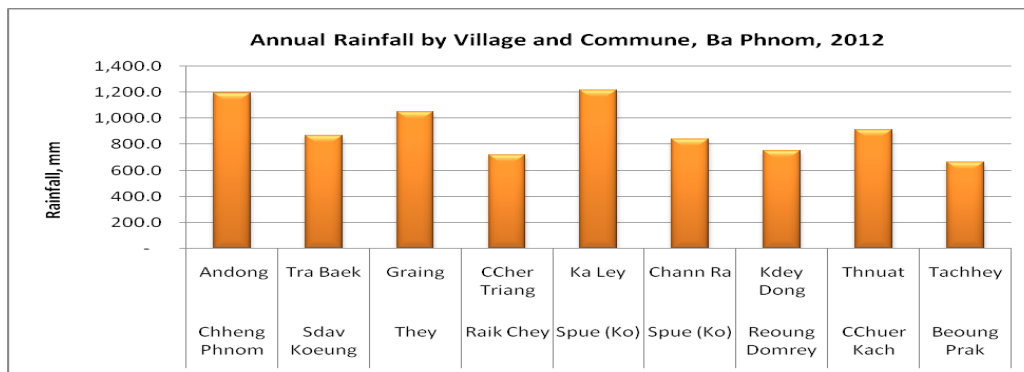


Figure 4. 17: Annual Rainfall by Village and Commune in Ba Phnom District

b. Rainfall in Kamchay Mear District

The monthly rainfall in Kamchay Mear district is covered 8 villages as such Trapang Pry, Thnoat, Por Py, Cheach Khang Lech, Andong Saat, Sam Maki, Tean Pleung and Preak Sa1 in along with 8 communes as Tra Baek, Sang Kvang, Don Keoung, Cheach, Kror Bao, Kro Nguang, Smong Chheng, Smong Tbong, and details output by village and commune was presented in Figure 4.18 below.

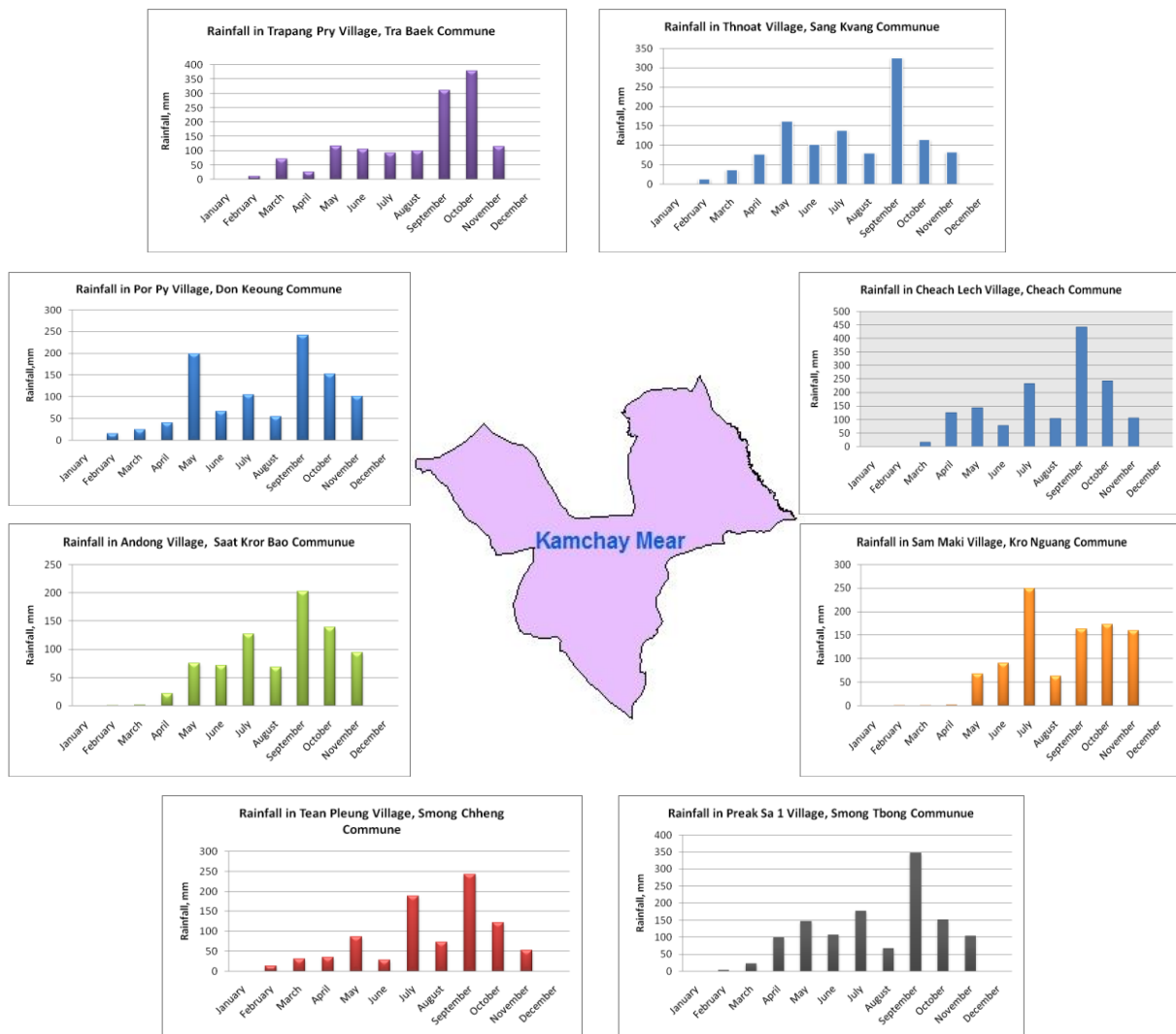


Figure 4. 18: Monthly Rainfall by Village and Commune, Kamchay Mear District

Annual rainfall by village and commune in Kamchay Mear district indicate that the high rainfall ranged from 1000-1200 mm refer to Trapang Pry, Thnoat, Cheach Khang Lech and Preak Sa1 villages; medium rainfall ranged from 800-1000 mm refer to Por Py, Andong Saat, Sam Maki, and Tean Pleung villages, and detail was presented in Figure 4.19 and see in Appendix4.

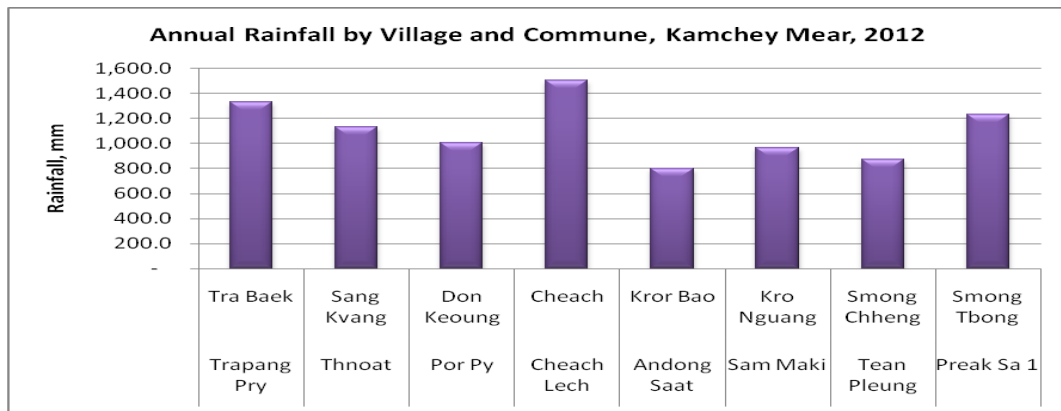


Figure 4. 19: Annual Rainfall by Village and Commune, Kamchay Mear District

c. Rainfall in Pear Reang District

The monthly rainfall in Pear Reang district is covered 8 villages as such Sam Rap, Prey Sneat, Pror Hut, Kampong Poppil, Trea, Snay Pol, Kampong Praing and Kampong Trear in along with 8 communes as Prey Pnov, Prey Sneat, Slor Let, Kampong Poppil, Kagn Chom, Ro Ka, Kampong Praing and Mesor Prochan, and details output by village and commune was presented in Figure 4.20 below.

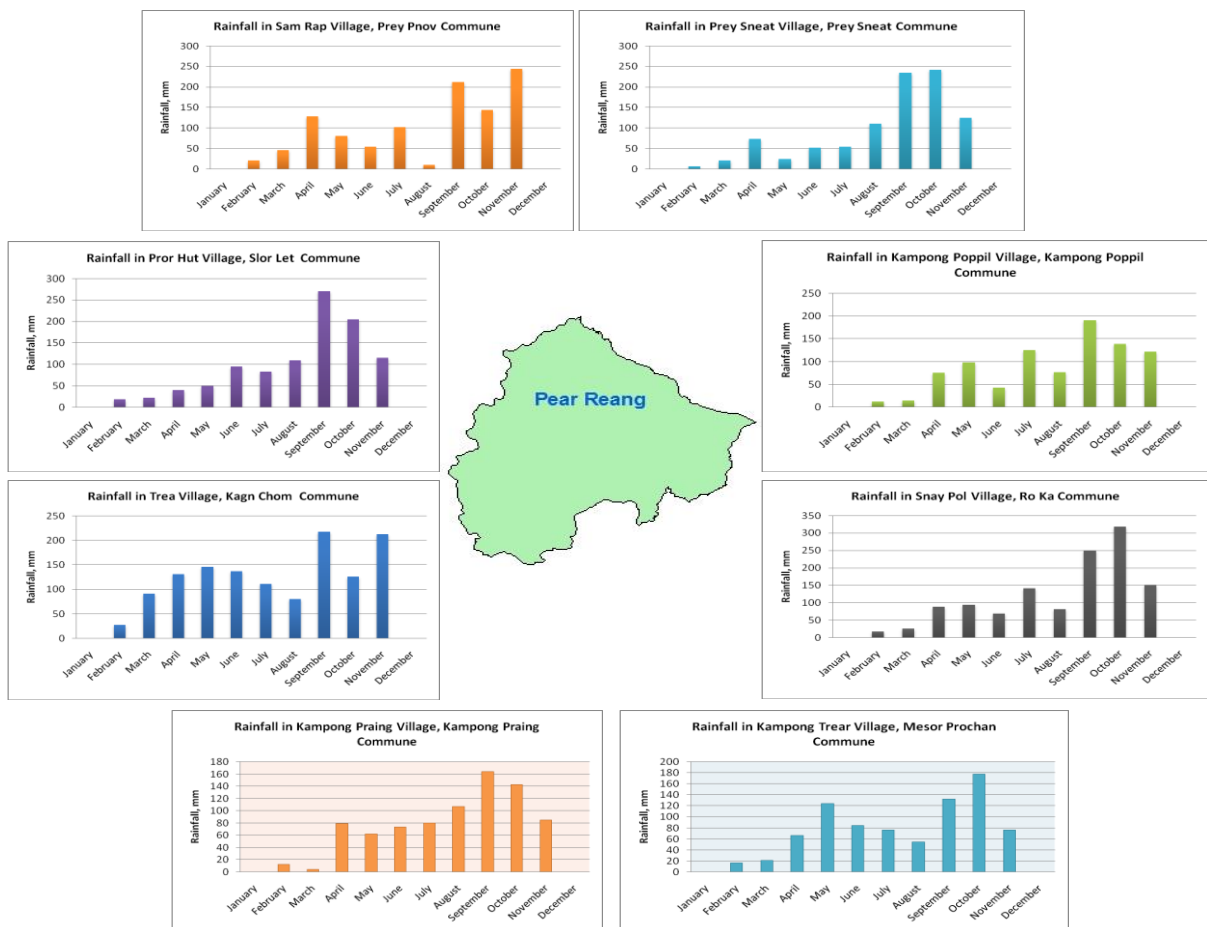


Figure 4. 20: Monthly Rainfall by Village and Commune, Pear Reang District

Annual rainfall by village and commune in Pear Reang district indicate that the high rainfall ranged from 1000-1200 mm refer to Sam Rap, Pror Hut, Trea and Snay Pol villages; medium rainfall ranged from 800-1000 mm refer to Prey Sneat, Kampong Poppil, Kampong Praing and Kampong Trear villages, and detail was presented in Figure 4.21 and see in Appendix4.

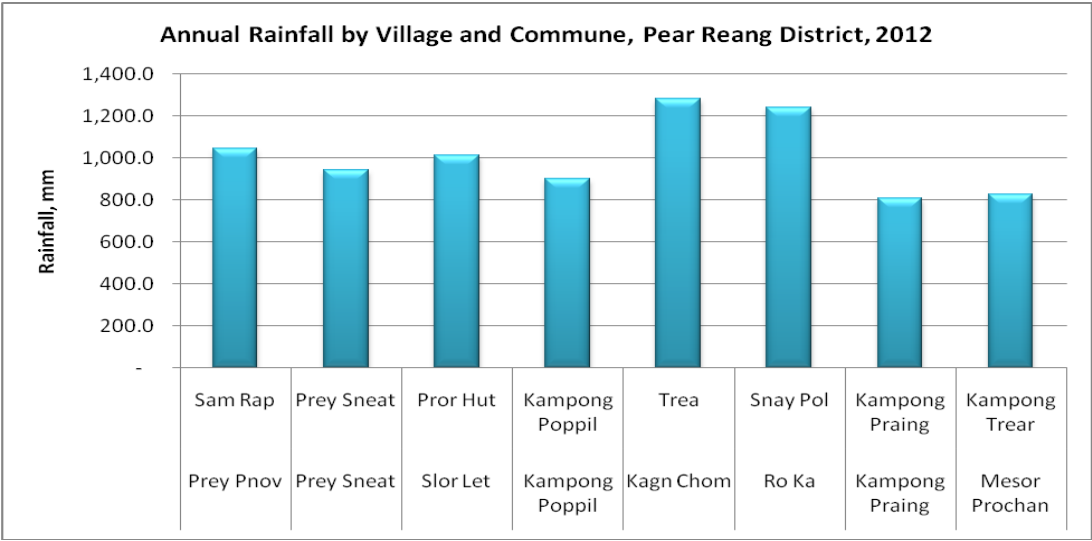


Figure 4. 21: Annual Rainfall by Village and Commune, Pear Reang District

4.2.6 Comparison to Annual Rainfall by District

Comparison to annual rainfall by village in Ba Phnom, Kamchay Mear and Pear Reang districts indicated that the high rainfall ranged from 1000-1200 mm refer to Andong, Graing and Kaley villages in Ba Phnom district. For Kamchay Mear district, a high annual rainfall refers to Trapang Pry, Thnoat, Cheach Khang Lech and Preak Sa 1 villages. However, for Pear Reang district a high rainfall refers to Sam Rap, Pror Hut, Trea and Snay Pol villages. For the rest of villages are medium and low annual rainfall ranged from 600-1000 mm. As for the highest of annual rainfall refers to Cheach Khang Lech village and the lowest annual rainfall refers to Tachhey village was presented in Figure 4.22 and details annual rainfall by commune of three districts was shown in Appendix5.

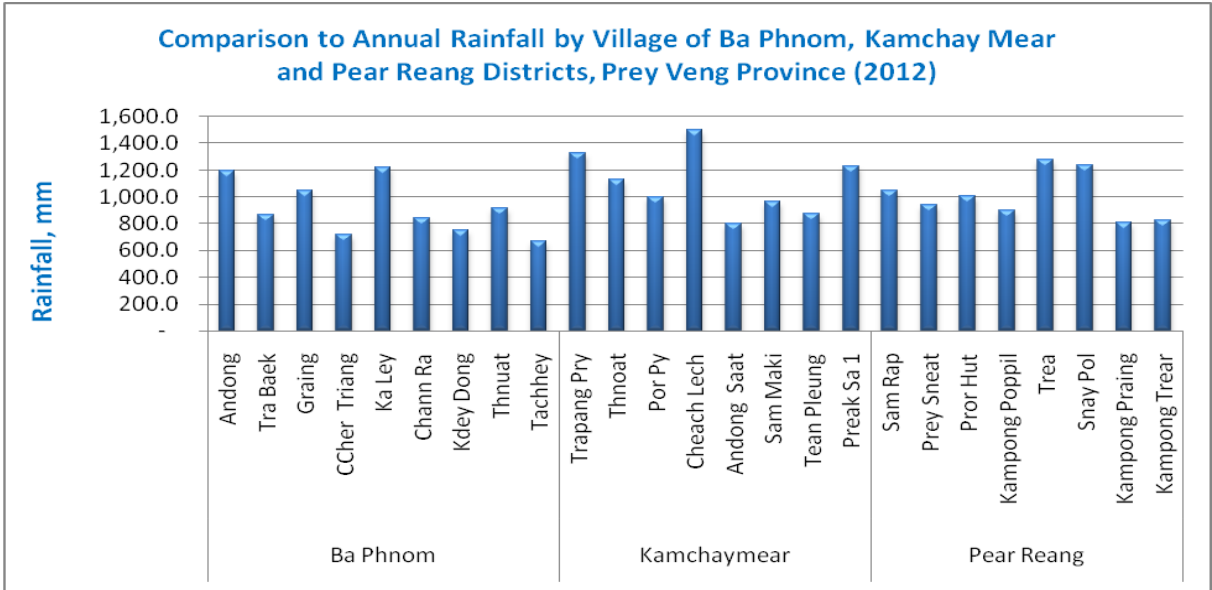


Figure 4. 22: Comparison Annual Rainfall by Village and District

4.3 Projection Climate Variability and Climate Change

4.3.1 Temperature Projection by District

a. Temperature Projection in Ba Phnom District

The result analysis for projection climate variability and climate change for Ba Phnom district will predict for long term period up to 2030 of temperature, which depended on the Mean Annual Temperature (Tx.) and (Tn.) from 1995-2012 of Precipitation and Observed in Prey Veng and then Projection Mean Temperature Max., from 2013 to 2030, and Projection Mean Temperature Min. from 2013 to 2030 for Ba Phnom District. The maximum temperature will be ranged from 34.0-35.0 °C refers to 2017, 2018, 2022, 2025 and 2029, and the highest temperature is 34.4 °C in 2027 and lowest temperature is 33.2 °C in 2013. In addition, the minimum temperature will be ranged from 23.5-25.0 °C refer to 2014, 2017, 2018, 2022, 2024, 2025, 2026, 2027, 2028, 2029 and 2030, in this case indicated that is similar level, but excepted the lowest temperature is 23.1 °C refer to 2013 and 2014, more detail was presented in Figure 4.23 below.

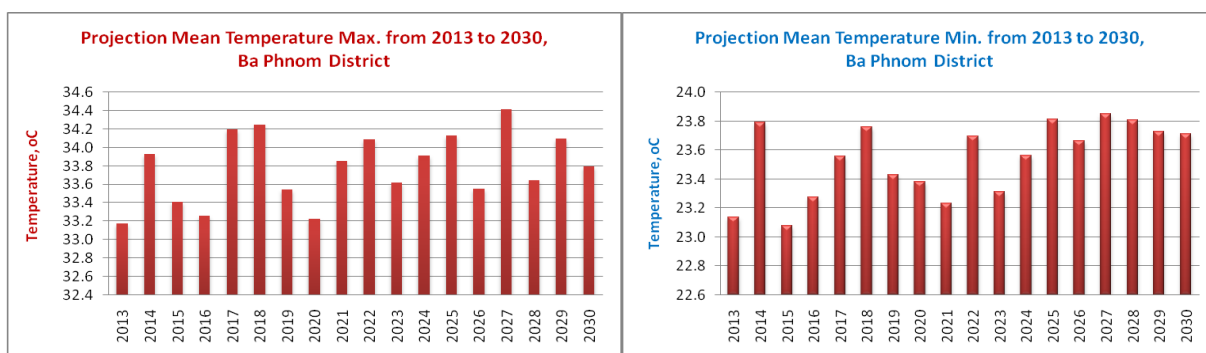


Figure 4. 23: Projection Mean Temperature Max., and Min. from 2013 to 2030, Ba Phnom District

b. Temperature Projection in Kamchay Mear District

The result analysis for projection climate variability and climate change for Kamchay Mear district will predict for long term period up to 2030 of temperature, which depended on the Mean Annual Temperature (Tx.) and (Tn.) from 1995-2012 of Precipitation and Observed in Prey Veng and then Projection Mean Temperature Max., from 2013 to 2030, and Projection Mean Temperature Min. from 2013 to 2030 for Kamchay Mear District. This district is similar maximum temperature in Ba Phnom district. The highest temperature is 34.6 °C refer to 2027 and the lowest temperature is 23.1 °C refer to 2015, was presented in Figure 4.24 below.

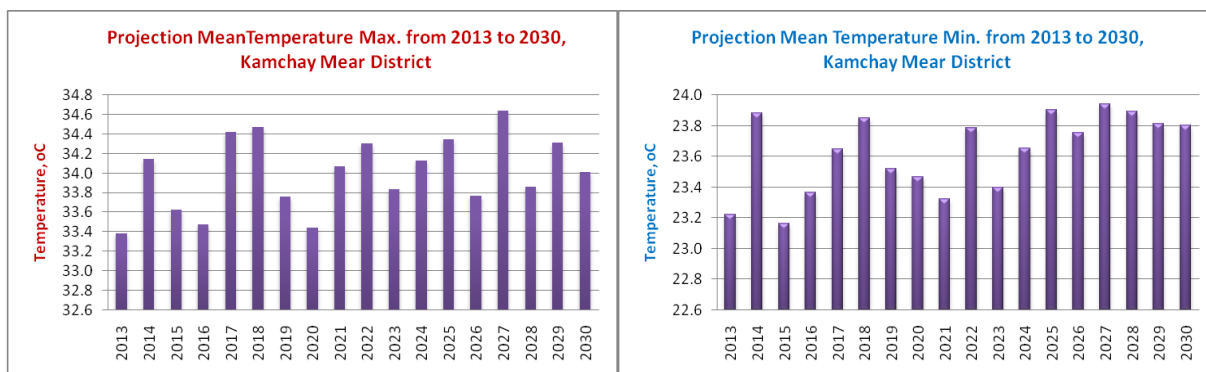


Figure 4. 24: Projection Mean Temperature Max., and Min. from 2013 to 2030, Kamchay Mear District

c. Temperature Projection in Pear Reang District

The result analysis for projection climate variability and climate change for Pear Reang district will predict for long term period up to 2030 of temperature, which depended on the Mean Annual Temperature (Tx.) and (Tn.) from 1995-2012 of Precipitation and Observed in Prey Veng and then Projection Mean Temperature Max., from 2013 to 2030, and Projection Mean Temperature Min. from 2013 to 2030 for Pear Reang District. This district is similar maximum temperature in Ba Phnom and Kamchay Mear districts. The highest temperature is 34.6 °C refer to 2027 and the lowest temperature is 23.9 °C refer to 2015, was presented in Figure 4.25 below.

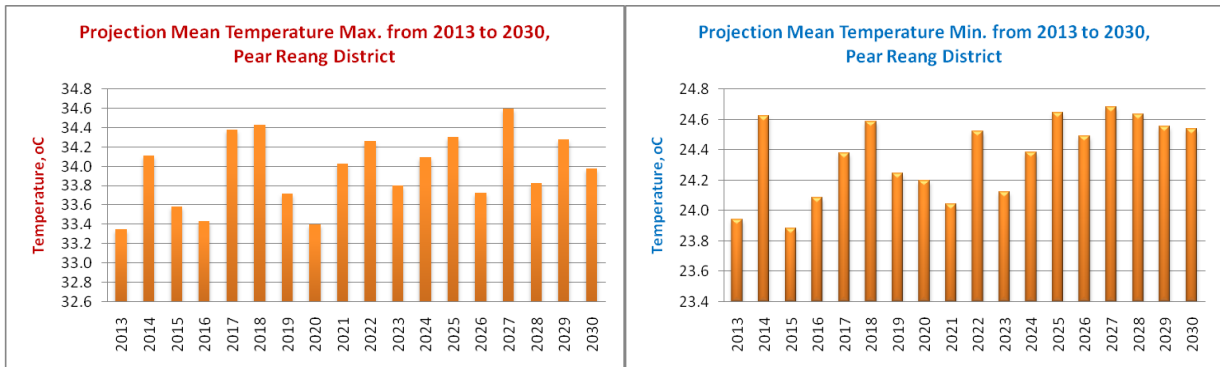


Figure 4. 25: Projection Mean Temperature Max., and Min. from 2013 to 2030, Pear Reang District

4.3.2 Comparison to Temperature Projection by District

Comparison to Average Temperature Projection by three districts of Ba Phnom, Kamchay Mear and Pear Reang from 2013 to 2030 in Prey Veng Province. Average of temperature ranged from 28.0-29.5 °C indicated that Pear Reang district is higher about 0.5 °C than Ba Phnom and Kamchay Mear districts refer to 2014, 2017, 2018, 2024, 2025, 2027, 2028, 2029 and 2030, and was presented in Figure 4.26. For detail results of maximum and minimum projection were presented in Appendix 6.

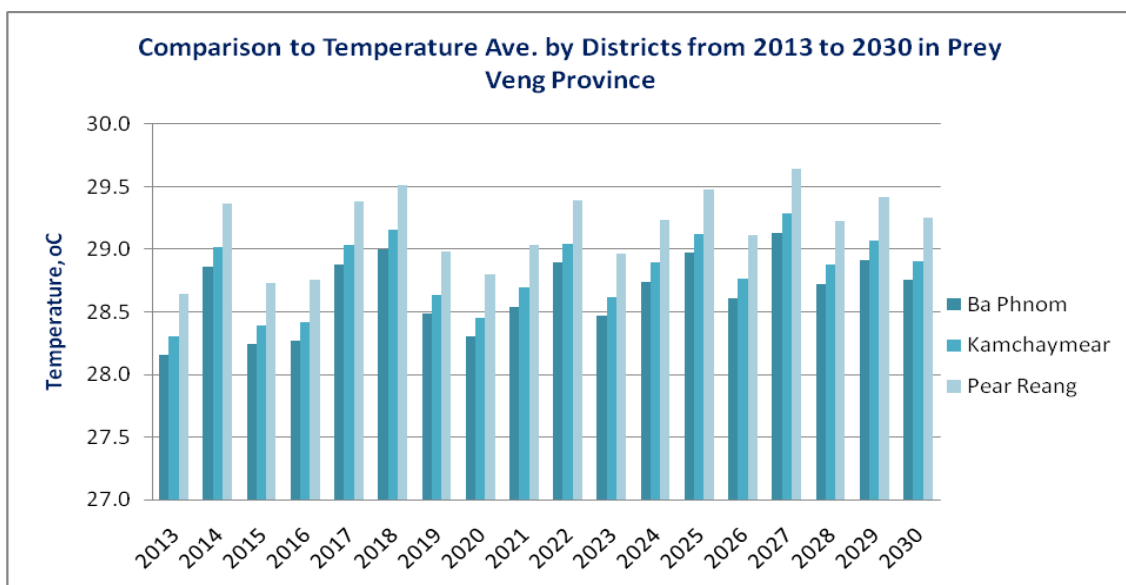


Figure 4. 26: Comparison to Mean Temperature Projection from 2013 to 2030 by District

4.3.3 Rainfall Projection by District

a. Rainfall Projection in Ba Phnom District

Based on the result analysis for projection climate variability and climate change for Ba Phnom district will predict of rainfall depended on the Average Annual Rainfall from 1995-2012 of Precip and Observed in Prey Veng province. Average Annual Rainfall Projection from 2013 to 2030 in Ba Phnom District indicated that the higher rainfall from 1200-1500 mm refer to 2018, 2020, and 2026, and the lower rainfall is ranged from 800-1000 mm refer to 2014, 2017, 2021, 2027 and 2029, and was presented in Figure 4.27 below.

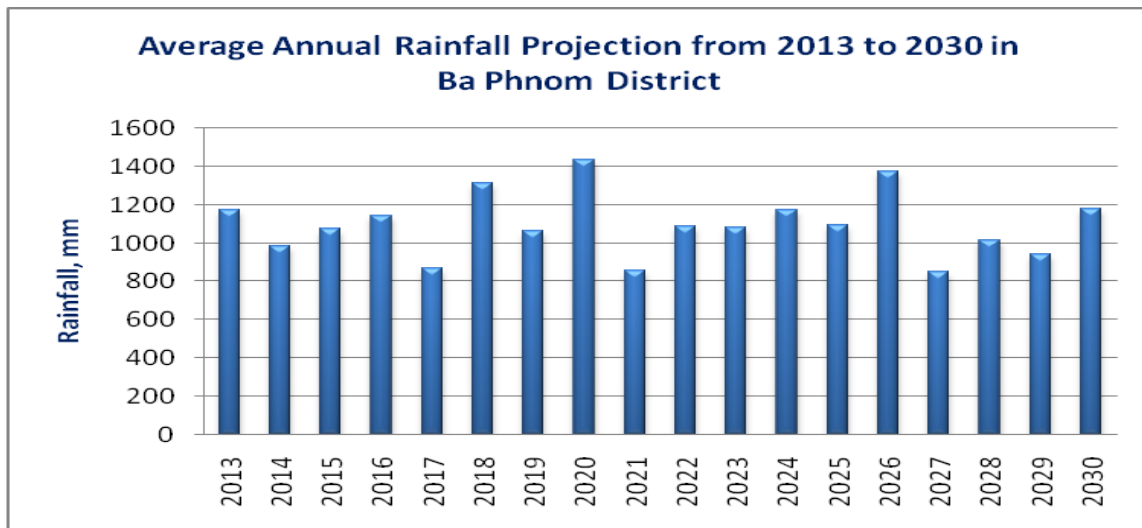


Figure 4. 27: Projection Ave. Annual Rainfall from 2013 to 2030, Ba Phnom District

b. Rainfall Projection in Kamchay Mear District

The result analysis for projection climate variability and climate change for Kamchay Mear district will predict of rainfall depended on the Average Annual Rainfall from 1995-2012 of Precip and Observed in Prey Veng province. Average Annual Rainfall Projection from 2013 to 2030 in Kamchay Mear District indicated that the higher rainfall from 1400-1800 mm refer to 2013, 2018, 2020, and 2026, and the lower rainfall is ranged from 1000-1200 mm refer to 2014, 2017, 2021, 2027 and 2029, and was presented in Figure 4.28 below.

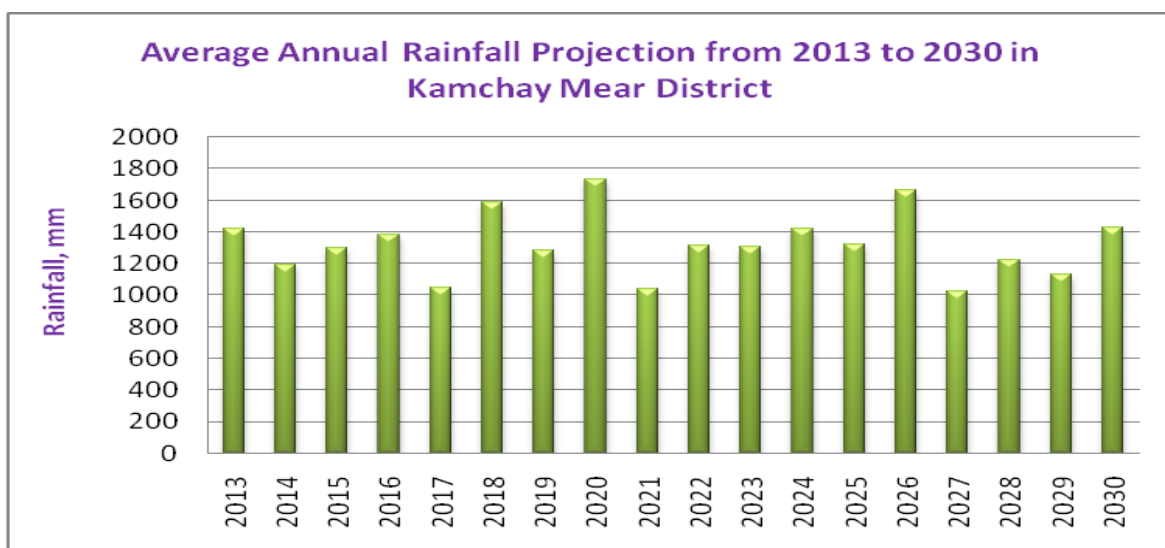


Figure 4. 28: Projection Ave. Annual Rainfall from 2013 to 2030, Kamchay Mear District

c. Rainfall Projection in Pear Reang District

The result analysis for projection climate variability and climate change for Pear Reang district will predict of rainfall depended on the Average Annual Rainfall from 1995-2012 of Precip and Observed in Prey Veng province. Average Annual Rainfall Projection from 2013 to 2030 in Pear Reang District indicated that the higher rainfall from 1200-1600 mm refer to 2013, 2016, 2018, 2020, 2024, 2026 and 2030, and the lower rainfall is ranged from 800-1000 mm refer to 2017, 2021, and 2027, and was presented in Figure 4.29 below.

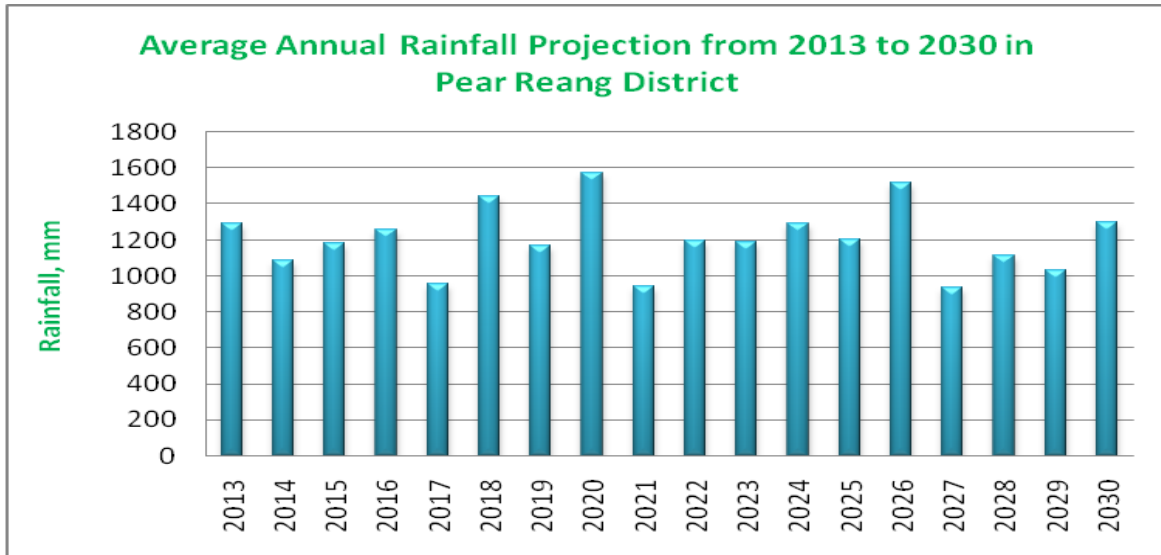


Figure 4. 29: Projection Ave. Annual Rainfall from 2013 to 2030, Pear Reang District

4.3.4 Comparison to Rainfall Projection by District

Comparison to Average annual Rainfall Projection by three districts of Ba Phnom, Kamchay Mear and Pear Reang from 2013 to 2030 in Prey Veng Province. This result indicated that Kamchay Mear district is higher rainfall than the other two districts by ranged from 1400-1700 mm per year refers to 2013, 2018, 2020, 2024, 2026 and 2030. However, the highest rainfall 2020, and see detail was presented in Figure 4.30.

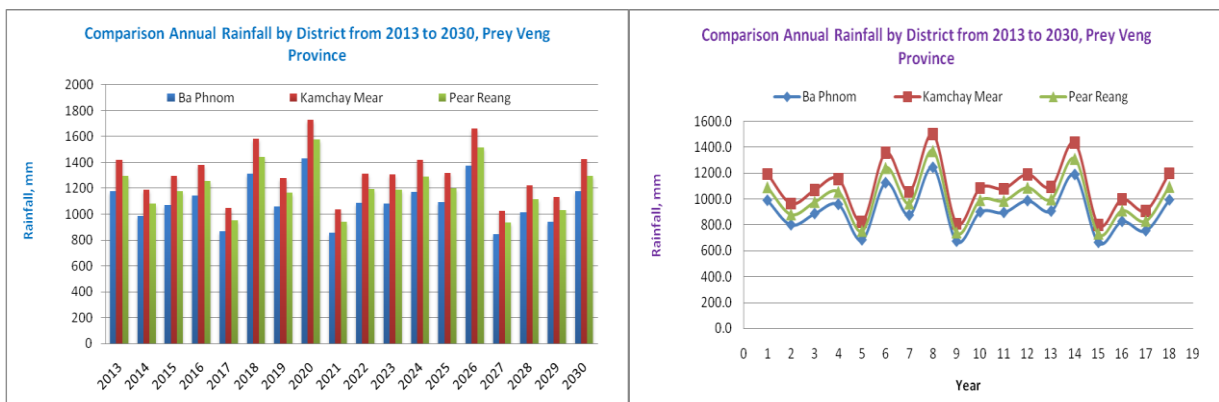


Figure 4. 30: Comparison to Ave. Annual Rainfall from 2013 to 2030 by District

5. Conclusion and Recommendation

The outputs of PRECIS and observed climatic data suggest the Prey Veng province climate of Cambodia is changing. Prey Veng province as target studied area, in which has identified and coordinated appropriate locations to install climate hardware of rain gauge, temperature and humidity. The average mean temperature in 18 year from 1995 to 2012 is about 27.6 °C, the minimum mean temperature about 23.5 °C and the maximum mean temperatures about 33.1 °C. The average annual rainfall as the same period from 1995 to 2012 has fluctuated between 1,009 mm and 1,867 mm.

The result finding of the maximum and minimum temperature period 1995-2012 between observed data and output of PRECIS data need to be adjusted. An annual maximum and minimum temperature for Prey Veng province indicated that the degree is different of observed and output from PRECIS ranged from 33.1-35.7 °C (2.6°C) of the maximum. However, the minimum as similarly of observed and output from PRECIS in maximum of Prey Veng province ranged from 23.5-26.1 °C (2.6°C) of the minimum. As for, observed precipitation data for period from 1995-2012, the monthly precipitation time series were adjusted against to the observed rainfall data as input and PRECIS outputs downscaling. The annual average precipitation of Precis model of Prey Veng province indicated that output is different average ranged from 1,200-1,800mm (600mm), and the annual average precipitation of observed ranged from 1,000-1,800 mm (800mm).

Maximum and Minimum Temperature by month and district in Prey Veng province indicated that the maximum temperature is mainly high about 35.6 °C in March-April, and then go in slight down from May, June, July, August excepts Kamchay Mear and Pear Reang districts are increasing for the month of August about 34-35 °C. However, the minimum temperature is about 32.3 °C in September of Ba Phnom district, and these districts are slightly increasing from October to December of average 33 °C. Anyway, the minimum temperature of three districts is ranged from 22-26 °C for February to December, but except of Pear Reang district is highly increasing to 30.7 °C. In addition, annual rainfall by village in Ba Phnom, Kamchay Mear and Pear Reang districts indicated that the high rainfall ranged from 1000-1200 mm refer to Andong, Graing and Kaley villages in Ba Phnom district. For Kamchay Mear district, a high annual rainfall refers to Trapang Pry, Thnoat, Cheach Khang Lech and Preak Sa1 villages. However, for Pear Reang district a high rainfall refers to Sam Rap, Pror Hut, Trea and Snay Pol villages. For the rest of villages are medium and low annual rainfall ranged from 600-1000 mm. Therefore, the highest annual rainfall output refers to Cheach Khang Lech village and the lowest annual rainfall refers to Tachhey village.

The projection climate variability and climate change for Pear Reang district will predict for long term period up to 2030 of temperature. Average Temperature Projection by three districts of Ba Phnom, Kamchay Mear and Pear Reang are projected from 2013 to 2030 in Prey Veng Province. Average of temperature ranged from 28.0-29.5 °C indicated that Pear Reang district is higher about 0.5 °C than Ba Phnom and Kamchay Mear districts refer to 2014, 2017, 2018, 2024, 2025, 2027, 2028, 2029 and 2030. However, Average annual Rainfall Projection by three districts of Ba Phnom, Kamchay Mear and Pear Reang from 2013 to 2030 in Prey Veng Province. This result indicated that Kamchay Mear district is higher rainfall than the other two districts by ranged from 1400-1700 mm per year refers to 2013, 2018, 2020, 2024, 2026 and 2030. Therefore, the highest rainfall was in 2020.

The cost structure and profitability of small farm households, incorporating observed climate meteorology such as temperature, humidity and rainfall and provide the output analysis of climate projection in the climate models, and as well as map showing; and determines the

outreach programs targeted to policy makers and farmer groups to deliver information concerning adjustment principles. However, this is a lesson learned and adaptation options initiative tested at farm-levels defined and scale out strategies captured for other appropriated district or target areas.

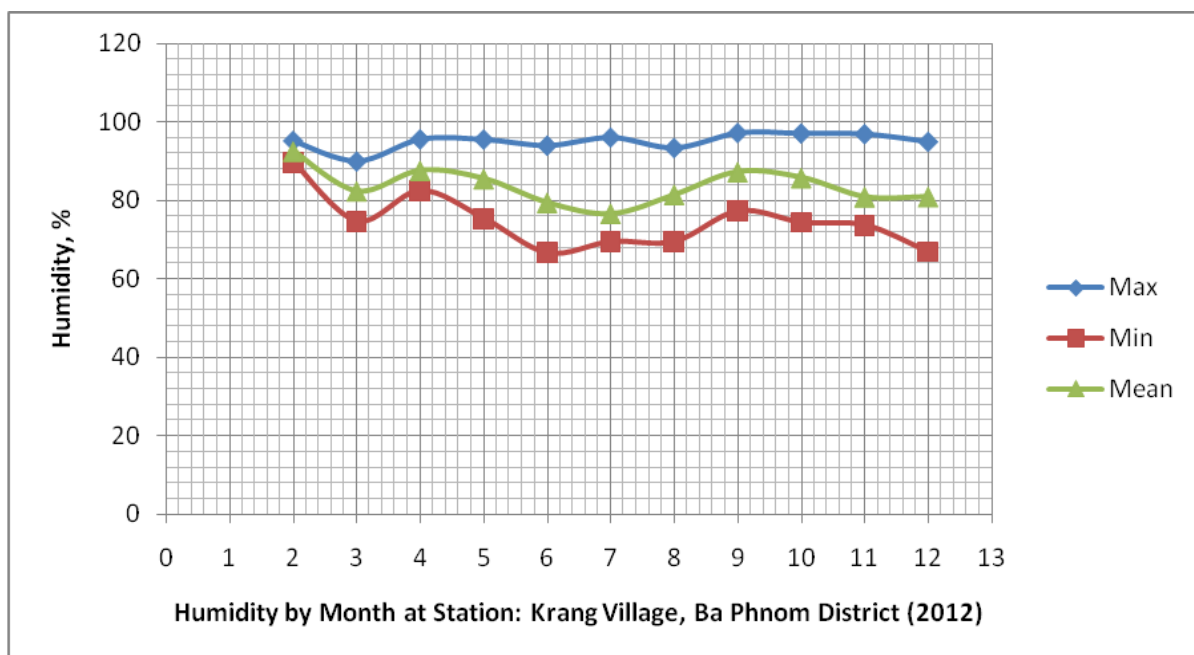
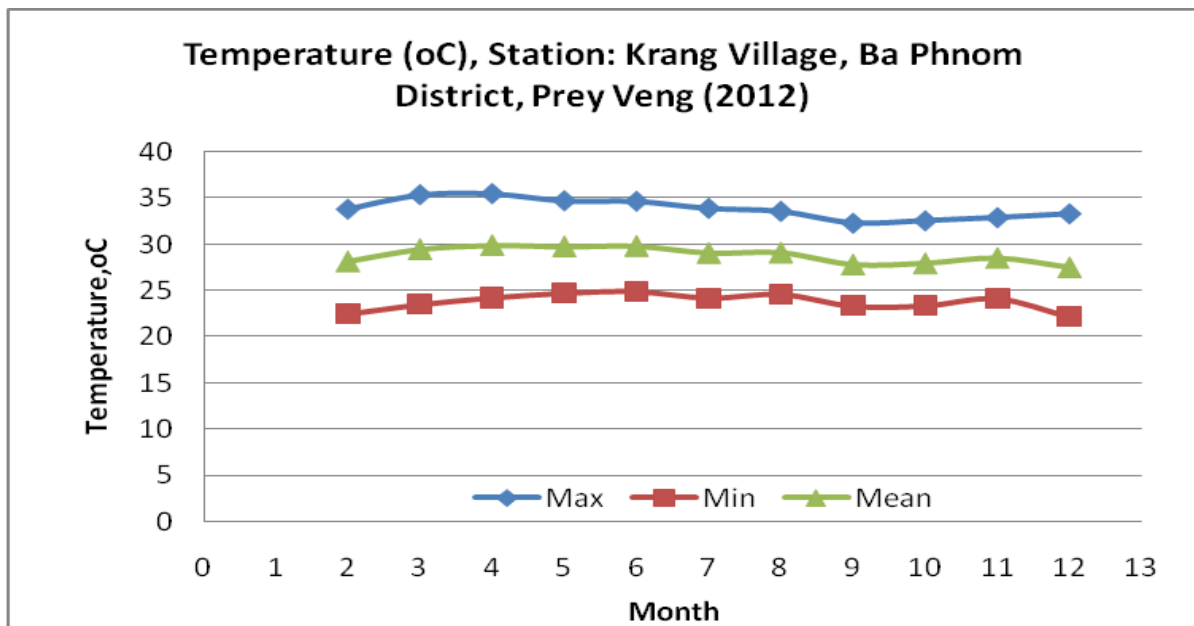
The GCM output is monthly basis and observed climatic data recorded of temperature, rainfall and humidity. In some cases, daily data required to perform vulnerability and adaptation assessment. Therefore, for further study, techniques to generate daily climatic data from monthly data for recorded should be explored and assessed. It will facilitate and recorded many years for specific target areas of province to use more sophisticated methods and appropriate using stochastic method.

References

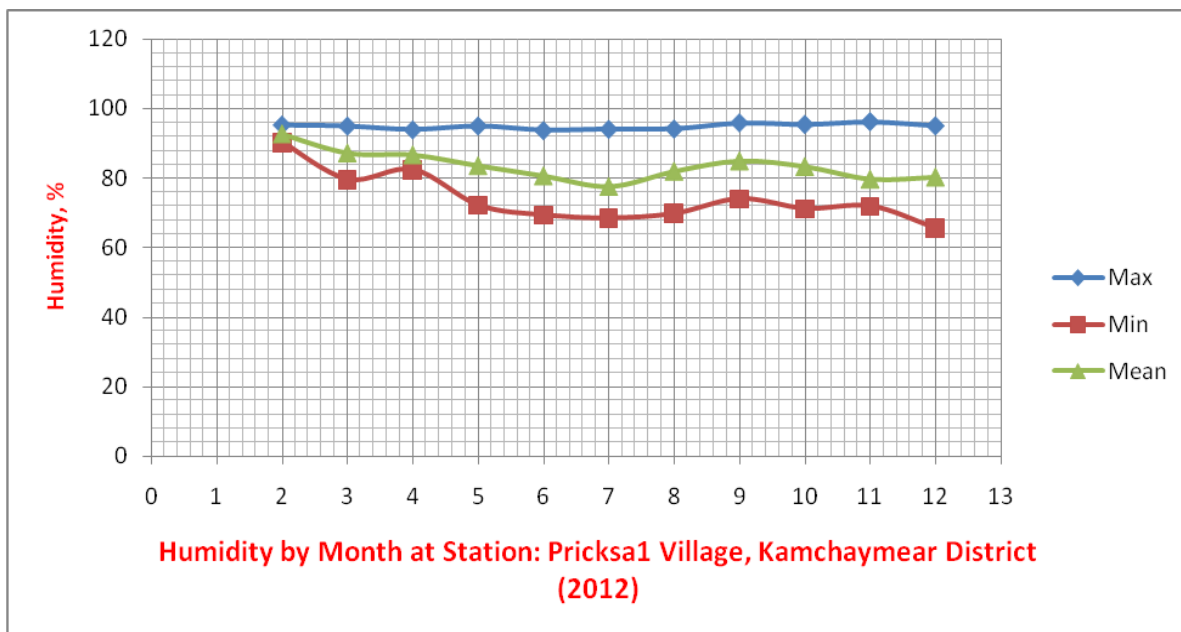
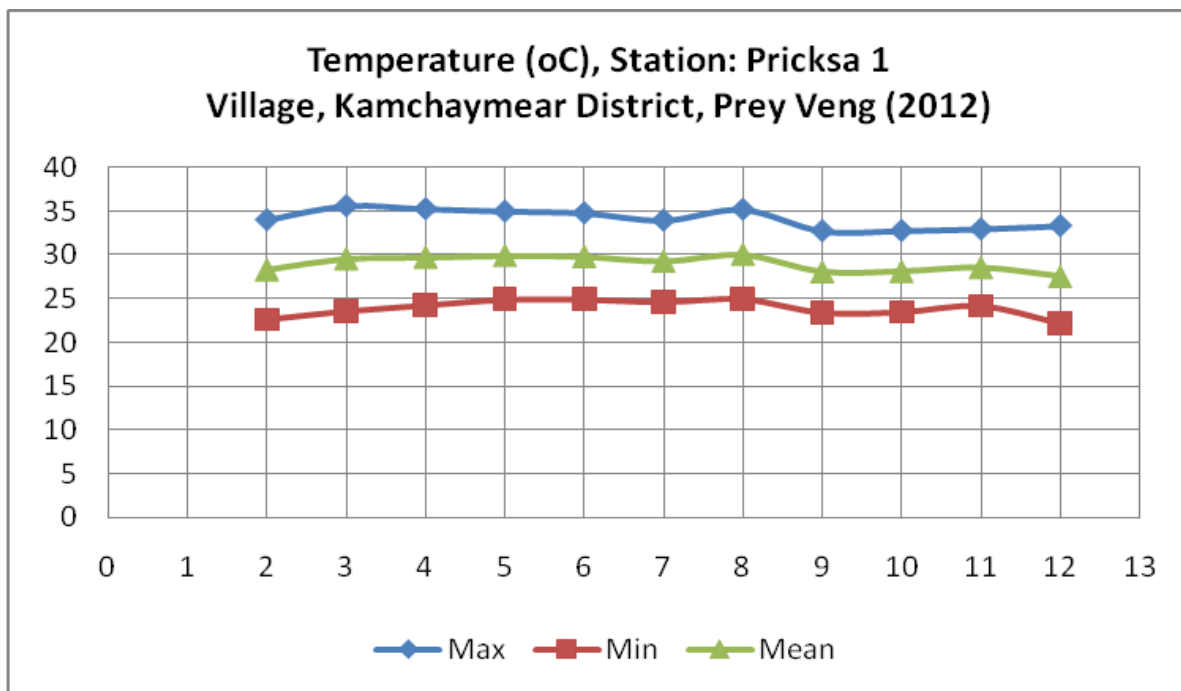
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Appendix

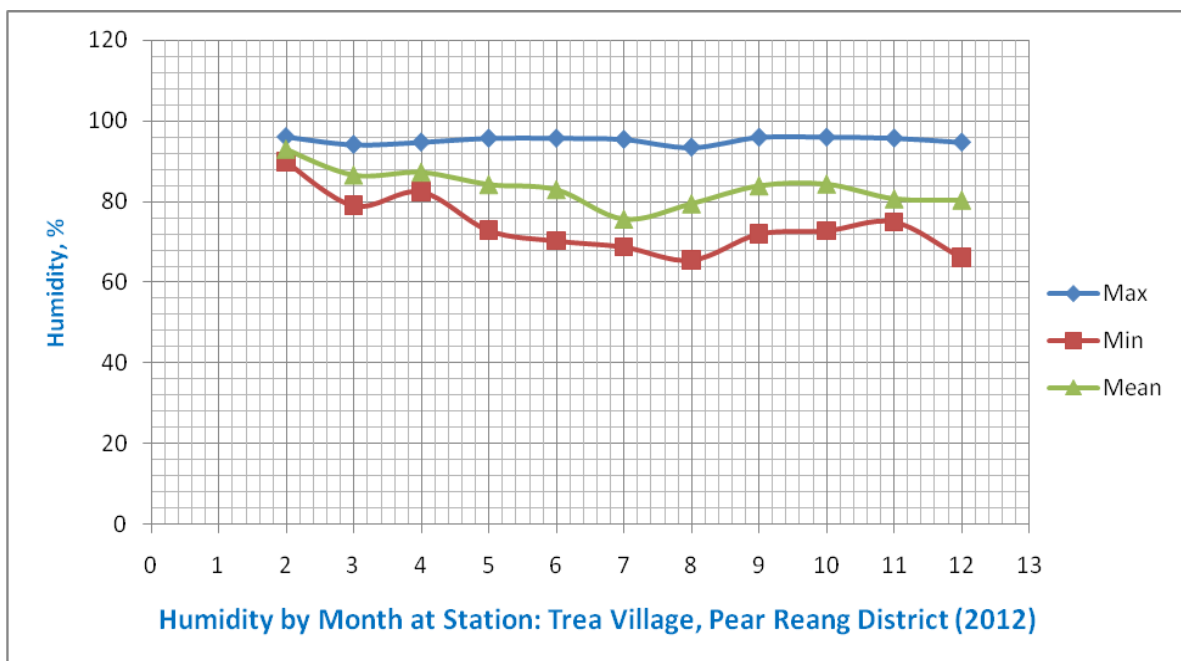
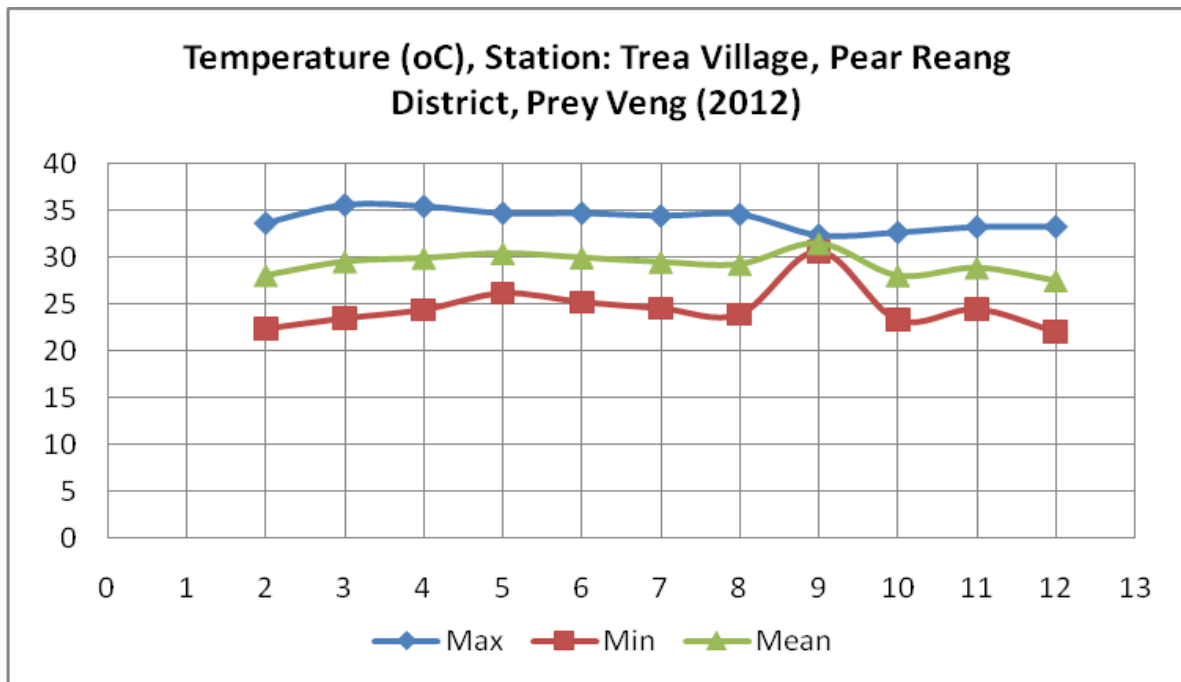
Appendix1: Max. and Min. Temperature and Humidity of Krang Station, Ba Phnom district



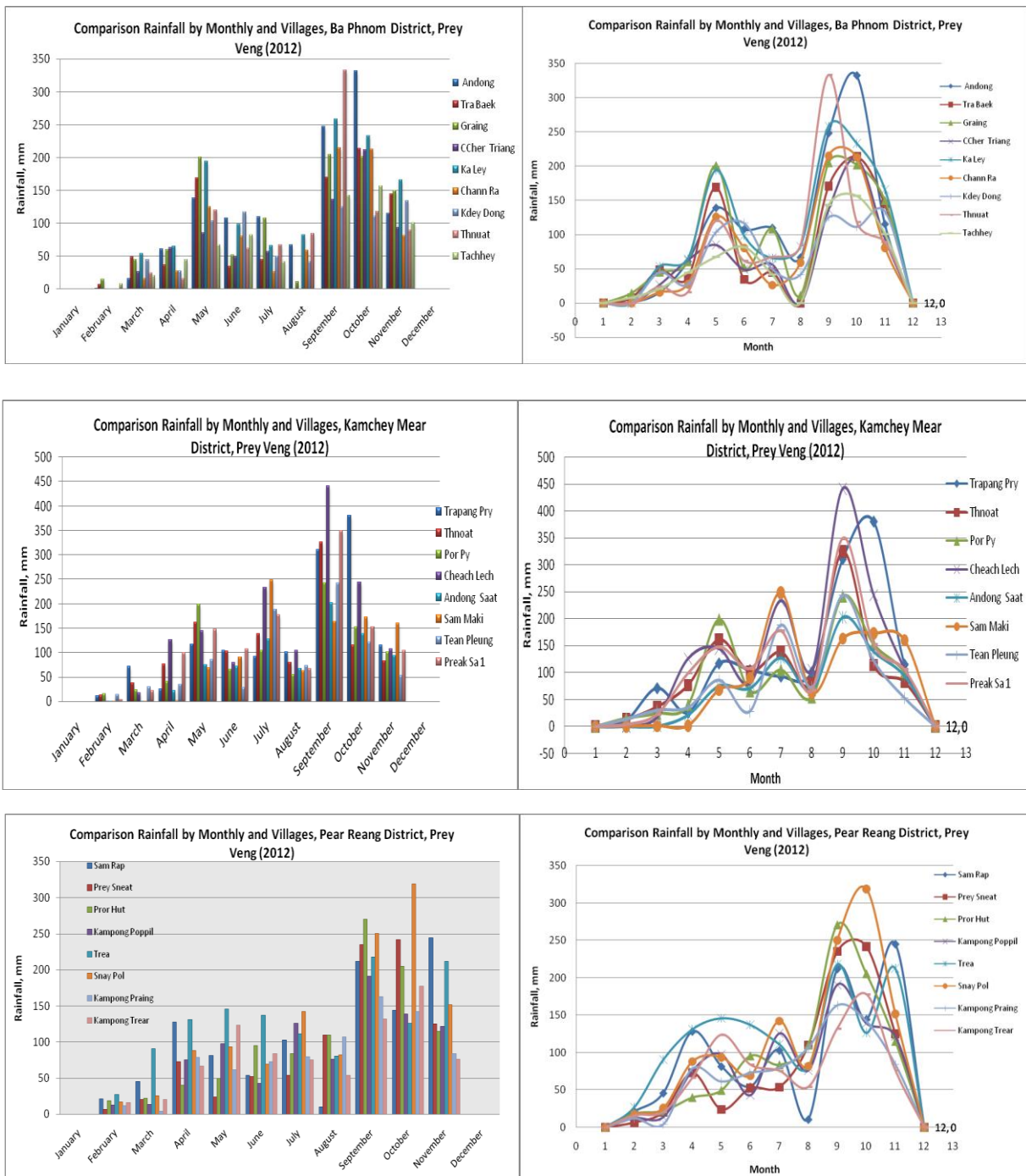
Appendix2: Max. and Min. Temperature and Humidity of Pricksa1 Station, Kamchay Mear district



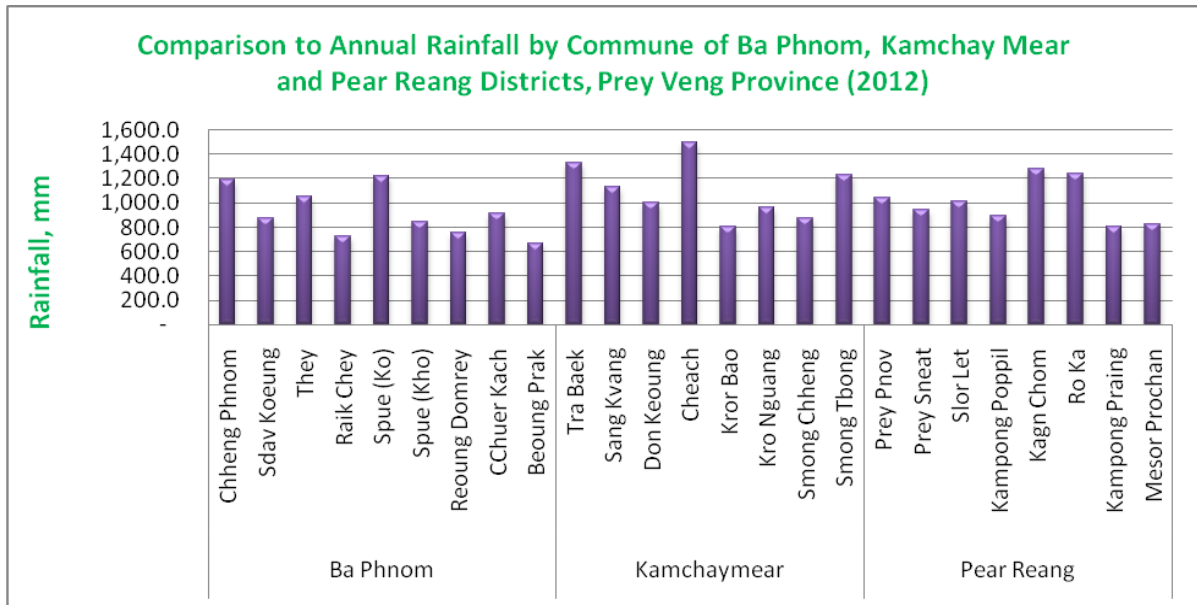
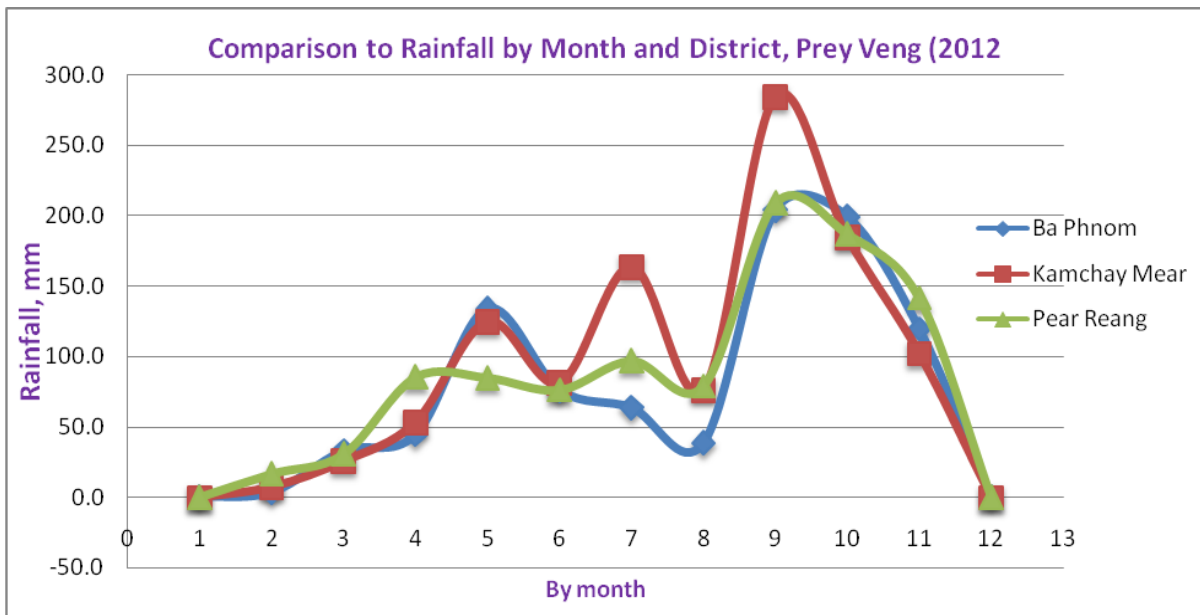
Appendix3: Max. and Min. Temperature and Humidity of Trea Station, Pear Reang district



Appendix4: Monthly Rainfall by Village in Ba Phnom, Kamchay Mear and Pear Reang Districts



Appendix5: Comparison to Rainfall by Month and District and Annual Rainfall by Commune



Appendix6: Comparison to Temperature Max. and Min. by District from 2013-2030

