CHAPTER 6

CONCLUSIONS

To investigate the impact of global warming on future climate changes in regards to intensity, frequency, and duration of extreme rainfall and temperature over Thailand for the future period 2020-2029 relative to the reference period 1990 - 1999 under the IPCC SRES A1B emission scenarios. MM5-RCM forced with CCSM3 outputs were used in the calculations of the following extreme rainfall and temperature indices: SDII (simple daily precipitation intensity index), Rnn (the number of heavy rainfall days), Rx1day (maximum 1-day rainfall amount), Rx5day (the monthly maximum consecutive 5-day rainfall amount), CDD (the annual maximum of consecutive dry days), CWD (the annual maximum of consecutive wet days), SUnn (the number of summer days), TxX (maximum daytime temperature), TnX (maximum nighttime temperature), Tx90P (frequency of hot days), Tn90P (frequency of warm nights), and DTR (monthly mean difference between maximum and minimum temperature).

The validation of average annual total rainfall archived from Adj-MM5-RCM output against that from the station data for the reference period 1990-1999 demonstrates that the total annual rainfall are reproduced reasonably by Adj-MM5-RCM. There is no significant difference in the distribution between the observed data and bias-corrected simulated outputs. Several large rainfall areas observed in 1990-1999 are well represented, including those over Trad and Chanthaburi provinces, and the west-southern region during the cool season as well as the stations over the south during the rainy season. The total rainfall was overestimated in the wet season more so than in the dry season. The biases of rainfall are within -0.95 to 1.36 mm/day and -1.72 to 4.5 during the dry and wet seasons. Overall, rainfall was slightly overestimated. The comparison between the simulated and observed annual cycle of rainfall in the reference period shows an agreement in all stations. Most bias comes from an overestimation of rainfall.

The Adj-MM5-RCM temperatures are in overall agreement with the observations. Bias-correction of the minimum temperature yields a better result than that of the maximum temperature. The Adj-MM5-RCM temperatures were slightly lower than the observed temperatures. The main features in the spatial distribution of both temperatures were represented well. The bias-corrected simulations are in good agreement with the observations with correlation coefficients of 0.62-0.93 and 0.60-0.97 for maximum and minimum temperatures, respectively. On the annual basis, the Adj-MM5-RCM temperatures tend to be underestimated in most stations over the country. The slightly larger negative biases are found during the warm season. The Adj-MM5-RCM reproduces the higher minimum temperatures than the observed ones in most stations over the north, east, west, and lower-south. The overestimated maximum temperature is mainly noticed in most stations during the rainy season.

The changes of extreme rainfall are mostly insignificant. The changes of the SDII, Rnn, Rx1day, and Rx5day indices are in the same way. An increase of SDII, Rnn, Rx1day, Rx5day, CWD, and a slightly decrease of CDD in the stations over most areas of northern, western, and northeastern Thailand in the wet season indicates more intense and heavy frequent rainfall with a longer wet spell. During the dry season, it is the opposite; the decreases of SDII, Rnn , Rx1day, Rx5day, CWD indicates less intense and heavy frequent rainfall with a shorter wet spell. From this, it can be concluded that in the future these areas will likely become wetter in the wet season and drier in the dry season. When considered in conjunction with the annual changes, in the stations over lower-northern and western part of Thailand, increases in mean annual SDII and Rnn indicates that these areas may be vulnerable to flooding in the future, in particular, the areas that have experienced flooding in the past (reference period). Likewise a decrease in mean annual SDII and Rnn suggest that the risk of dryness is likely to increase in northeastern and upper-northern Thailand, especially, the areas that have experienced these problems in the past.

In central and eastern Thailand, a decrease in SDII, Rnn , Rx1day, Rx5day, CWD, and a slightly decrease of CDD indicate less intense and heavy frequent rainfall with shorter consecutive wet days in wet season, which suggests that in the future these areas will become drier during the wet season. In the dry season, an increase in SDII , Rx1day, Rx5day and Rnn along with the decrease of both CDD and CWD suggest that rainfall may become more intense; heavy rainy days will be more frequent but not continual, which is why CDD is decreased. Conclusion can be drawn that in the future, central and eastern Thailand will become drier in the wet season while in the dry season, rainfall become more intense, and rainy days become more scattered with a higher number of heavy rainy days.

In southern Thailand, extreme rainfall changes are both positive and negative. The magnitude of change varies spatially and seasonally. On an annual basis, an increase of SDII and Rnn indicates wetter conditions (more intense and frequent heavy rainfall with a longer wet spell) in most stations. The wet spell will be decreased in the Southern Andaman Sea and increased in the East-Southern Region. The dry spell will be shorter in the whole region during the entire seasons.

The projected changes of SUnn indicate that the number of hot summer days will occur more frequently in the future during all seasons throughout the country. The magnitude of change varies by season and location. The number of hot summer days is expected to increase by 14.50-36.50 days in the future. The daytime maximum temperatures will possibly increase approximately 0.46-1.68, 0.30-0.93, and 0.28-0.98 °C during the cool, warm, and rainy seasons, respectively. An insignificant decrease in this index is also presented in the simulations during the warm and rainy seasons where the increase in SUnn is comparatively small. Generally, the changes in TnX increase faster than those of TxX. The nighttime maximum temperature will likely increase approximately in 0.60-1.97, 0.49-1.01, and 0.64-1.06 °C during the cool, warm, and rainy seasons, respectively. The frequency of hot days and warm nights will likely increase throughout the country during all seasons. The annual average increases of Tx90P and Tn90P are 3.73-7.67% (13.60-28.01 days) and 2.25-9.17% (8.22-33.48 days). The faster changes in the TnX than those in TxX cause an decrease of the DTR throughout the country during the cool and rainy seasons. During the warm season that faster changes in the TnX cause a decrease of the DTR at most stations in the north, west, and south as well as some stations in the east while the faster changes of TxX (compared with TnX) also cause an increase of the DTR in the stations in the remaining areas.

All indices projections in this research suggest that, in the future, the frequency and intensity of extreme temperature events are expected to increase significantly in most areas of Thailand. The annual averages of minimum-related indices tend to increase more than those related to maximum temperatures. The changes of the indices are most obvious during the cool season except for the Tn90P and DTR index, where the greatest changes are expected during the rainy season. The warming of these extreme temperature indices will have serious impacts on human living in many ways. The increase of daytime temperature possibly intensifies heat stress on humans. Increases in all warming indices indicate the hotter conditions that may shift the time or increase the duration of the warm season, which might affect human adaptation in the future.

In the cumulus parameterizations analysis from this study, it is reasonable to assert that the BMJ is the optimal parameterization to be used in Thailand.