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Spatial and temporal Teleconnections of Sea Surface Temperature and Ocean Indices to regional Climate Variations across Thailand - a Pathway to understanding the Impact of Climate Change on Water Resources

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Thailand has a long coastline with the Pacific Ocean, as part of the Gulf of Thailand, as well as with the Indian Ocean, as part of the Andaman Sea. Because of this peculiar location, Thailand's local climate and, in particular, its water resources are strongly influenced by the mix of tropical wet, tropical dry and tropical monsoon seasons. Because of the large seasonal and interannual variations and irregularities of these, mainly ocean-driven weather patterns, particularly in recent times, large-scale water storage in huge river-fed reservoirs has a long tradition in Thailand, providing water for urban, industrial and agricultural use during long dry seasonal periods. These reservoirs which are located all over Thailand gather water primarily from monsoon-driven rainfall during the wet season which, usually, lasts from May to October. During the dry season, November to April, when the monsoon winds move northward, the air masses are drier in central and northern Thailand, with rain falling here only a few days in a month. Southern Thailand, on the other hand, which is constituted mostly by the isthmus between the two oceans, stays even hot and humid during that time period. Because of this tropical climate pattern, the surface water resources in most of Thailand strongly hinge on the monsoon movements which, in turn, depend themselves upon the thermal states of the Pacific and Indian Oceans. Therefore, the understanding of the recent strong seasonal and interannual climate variations with their detrimental effects on the availability of hydrological water resources in most parts of Thailand, must include the analysis of changes of various sea-state indices in the adjacent oceans and of their possible teleconnections with regional climate indices across this country. With the modern coupled atmospheric-ocean models being able to predict the variations of many ocean indices over a period of several months, namely, those driven by El Nino- Southern Oscillations (ENSO) events in the Pacific Ocean, if such teleconnections exist, one would have would have a powerful tool at hand to forecast extreme seasonal climate pattern across Thailand over a limited time period. Eventually, such a predictive tool would help to better manage the availability and adequate supply of surface water resources to the various water users in this country.

In the present study the spatial and temporal relationships between the global climate circulation system and the regional weather in Thailand are assessed by various techniques of stochastic time series analysis. More specifically, the time series of the sea surface temperature (SST) and various ocean indices of the Pacific and the Indian Oceans, as well as the time series of 121 meteorological stations from 5 regions across Thailand which include humidity, evaporation, temperature and rainfall during 1950-2007 are examined using autocorrelation, ARIMA, Wavelet Transform methods. Possible teleconnections between the behaviour of the ocean states and the climate variations at meteorological stations in eastern Thailand which frequently suffers from water shortage problems are analyzed using regression, cross-correlation and the Wavelet cross-correlation method. In addition to the time series of the observed ocean and meteorological variables, 1961-2000 CGCM3 predictors of the macro-scale regional climate variations for this study area are analyzed by the methods above and correlated with the ocean indices as well. Rainfall and temperatures at selected stations are forecasted up to year 2007 using the teleconnection- relationships found by multiple linear regression with the CGCM3 predictors. In addition, autoregressive integrated moving average (ARIMA) models of these climate variable are set up that are eventually extended to include the ocean indices as external regressors.

The results of these various statistical techniques show that the El-Niño 1.2 SST anomaly indice of the Pacific Ocean, which refers to the most eastern section of the Pacific, correlates the strongest with the Thai local climate. Through cross-correlation, the most sensitive parameters to the ocean indices are the minimum temperature at

stations in the northern and northeastern, inland regions of Thailand and the number of rainy days in the eastern, central and southern, coastal regions. In the southern region the amount of rainfall at the coast of Gulf of Thailand varies positively with El-Niño, but negatively for stations along the Andaman Sea coast in the west of the isthmus, with maximal correlation lag.-times of 4 months. Surprisingly the corresponding connections of the local climate variables with the Indian Ocean indices are less well established, with an optimal lag-time of only 3 months. Using the results of the teleconnection regression relationships, the forecast of the local climate variables could be improved significantly, as indicated by the Nash–Sutcliffe-coefficient of the prediction model's which increased from originally 0.30, 0.72 and 0.26 to 0.51, 0.82 and 0.46 for the rainfall, minimum and maximum temperatures, respectively. The results of our analysis indicate the possibility of a better forecast of extreme seasonal climate variations across some regions of Thailand over a limited time period by using short-term expected variations of the Pacific and Indian ocean indices.