氏　　名	Lyndon Mark P. Olaguera（りんどん まーく おらげら）
所　　属	都市環境科学研究科　都市環境科学専攻　地理環境科学域
学位の種類	博士（理学）
学位記番号	都市環境博　第 263 号
学位授与の日付	令和元年 9 月 30 日
課程・論文の別	学位規則第 4 条第 1 項該当
学位論文題名	A Climatological Study of the Rainfall Variability in the Philippines: from Synoptic to Decadal-Scale Aspects (フィリピンにおける総観スケールから十年スケールまでの降雨変動に関する気候学的研究)
論文審査委員	主査　教　授　松本　淳
	委員　教　授　高橋　日出男
	委員　教　授　松山　洋

【論文の内容の要旨】

The variability of rainfall in the Philippines occurs over a wide range of spatial and temporal scales. While the interannual, seasonal, and long-term trends in rainfall have been extensively examined in previous studies, very little attention has been given to the variabilities at the sub-seasonal and decadal-to-interdecadal time scales. In addition, different synoptic-scale convective processes have yet to be identified and examined in detail. Identifying these synoptic-scale processes and understanding the mechanisms inducing the sub-seasonal and interdecadal variabilities in rainfall have important ramifications for improved management of water resources in the country. To address these issues, first, the different synoptic-scale convective processes were identified and examined during the pre-summer, summer, and winter monsoon seasons. Then, the decadal-to-interdecadal variability of the summer and winter monsoon seasons are examined.

Intermittent wet events, which accounts for about 24 % of the total pre-summer monsoon days from 1979–2012, were identified from April 1 to the monsoon onset defined by the Philippine Atmospheric, Geophysical and

Astronomical Services Administration (PAGASA). The results show that these intermittent wet events are associated with mid-latitude disturbances besides the prevailing easterlies along the southern flank of the western North Pacific Subtropical High (WNPSH). This is the first attempt to clarify such phenomenon and document the role of deformation zones, where the cold front interacts with the easterlies, as another rain-bearing system during the pre-summer monsoon season.

The zonal wedging of the WNPSH was also found to induce a monsoon break over the Philippines during the early summer monsoon season. Using the rainfall data from PAGASA, the climatology of the first post-onset monsoon break was examined. The results show that this break is very clear in stations located over the north and central Luzon, and occurs climatologically in early June. Composite analysis of the synoptic conditions during the monsoon break period reveals that the westward intrusion of the WNPSH is initiated through a cloud-radiation feedback process by the enhanced rainfall and cloudiness during the onset period. The enhanced rainfall during the onset leads to the cooling of the atmosphere, while the enhanced cloudiness leads to a decrease in the incoming solar radiation. These changes favor the increase of sea level pressure and the westward intrusion of the WNPSH. Furthermore, the impact of deformation zones is more common during the winter monsoon season. In fact, the shearline along the confluence region of these deformation zones induces winter heavy rainfall/flooding events (HRF) over the southern Philippines. Using the flood reports archived by the Dartmouth Flood Observatory from 1979–2017, it was found that about 74 % of such HRF events occur over Mindanao Island that are associated with the interaction of the shearline and a westward propagating cyclonic circulation.

As for the decadal variability, using the rainfall data of the stations located on the western coast of the Philippines from 1979–2008, a robust climate shift was found around 1993/1994 during the mature phase of the summer monsoon season. Compared with 1979–1993 (ES1), the rainfall during 1994–2008 (ES2) is suppressed, which is accompanied by weakened monsoon westerlies, enhanced moisture flux divergence, mid-tropospheric descent, enhanced vertical zonal wind shear, and decreased relative humidity. These changes are unfavorable for synoptic-scale activities during ES2. Finally, for

the winter monsoon season, two robust and significant interdecadal shifts that are most remarkable during December, were found around 1976/1977 and 1992/1993. Hence, the analysis period was divided into three epochs: 1961–1976 (EW1), 1977–1992 (EW2), and 1993–2008 (EW3). The mean and interannual variability of rainfall during EW2 is suppressed compared with the two adjoining epochs. The shift around 1976/1977 is related to an El Niño-like sea surface temperature (SST) change over the Pacific basin, while that around 1992/1993 is related to a La Niña-like SST change. A weakened low-level easterly wind, decreased moisture transport, and decreased synoptic-scale activities contributed to the decrease in the mean rainfall during EW2, while the El Niño-like SST change and the weakening of the East Asian winter monsoon during EW2, partly contributed in suppressing the interannual variability of December rainfall in the Philippines.