

# RAINFALL CLIMATOLOGY OF THE PHILIPPINES IN HIGH-RESOLUTION GRIDS

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**Abstract** This study characterizes the rainfall climatology of the Philippines based on the newly developed high-resolution gridded climate data, which were obtained by combining *in situ* and satellite-derived rainfall observations. Analyses revealed that the eastern coast of the country and the mountainous region of western Luzon receive the highest amount of annual rainfall exceeding 4000 mm/year. In contrast, the driest areas in the country are located over the southern section of Mindanao, central portions of Visayas, the plains and valley of Luzon receiving <1000 mm annual-averaged amount of rainfall. The study has further shown that the country is characterized with three regions of distinct rainfall seasonality. Most parts of the western coasts of the country experience rainy season during the months of May to October and relatively drier condition during the rest of the year. The eastern coasts of the country, on the other hand, have no dry periods and experience the rainiest months from October to March. The remaining parts of the country, mostly of the central location (longitudinally), has no distinct rainy and dry season, making it the third of the three distinct rainfall types of the country. These findings could be useful in various planning and disaster mitigation efforts of the country.

**Keywords:** high-resolution gridded climate data, climate classification, cluster analysis, the Philippines

## 1. Introduction

Rainfall is primarily used to characterize the climate of the Philippines (e.g., Coronas 1920; Kintanar 1984; Villafuerte *et al.* 2017). This is mainly because seasonal variations in temperature are minimal in the country (Villafuerte *et al.* 2020). The country's climate classification based on Coronas (1920), as well as its modified form (Kintanar 1984) and the recently updated version derived by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) as provided in <https://www.pagasa.dost.gov.ph/information/climate-philippines>, describes the country's rainfall characteristics into four types. The first type is characterized with two pronounced seasons — dry from November to April and wet from May to October. The second type has no dry season and with discernible maximum rain period during the months of December, January, and February. The third type follows closely the characteristics of the first type, but with shorter dry season lasting from one to three months only, while the fourth climate type has almost the same features as the second climate type, which has no dry season and has an almost evenly distributed rainfall throughout the year.

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However, the methods used in earlier studies to define such climate types are mainly based on a limited number of meteorological stations where rainfall observations were taken; thus, poses subjectivity in characterizing the climate of a particular location in the country. Initial attempts in addressing such issue include the use of gauge-based gridded rainfall data (Bagtasa 2017) and satellite-based gridded precipitation data (Corporal-Lodangco and Leslie 2017). The current study aims to extend the aforementioned studies addressing the known data gap and the subjectivity in characterizing the country's climate by utilizing the newly developed high-resolution rainfall data, which are derived from the merged *in situ* rainfall observations and satellite rainfall estimates. This paper is organized as follows. The dataset and methods employed in this study are briefly described in Section 2 followed by the results of analyses in Section 3. The main findings and obtained conclusions are presented in Section 4.

## 2. Data and Methods

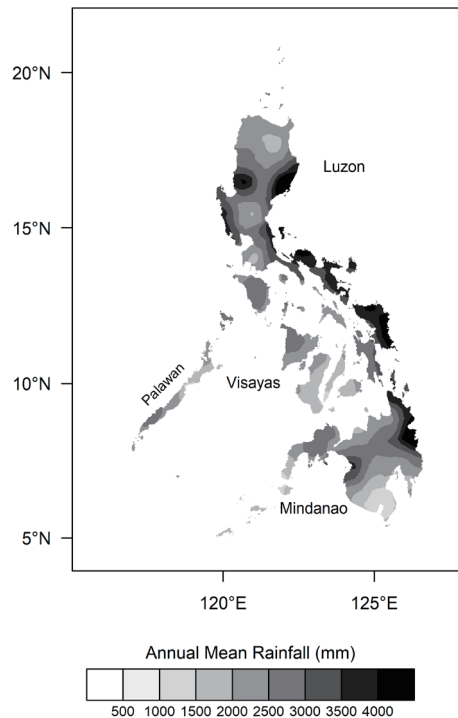
In this study, the newly developed high-resolution gridded rainfall data of the Philippines, known as the ClimGridPh-RR (Saligo *et al.* 2022) is used. The ClimGridPh-RR was developed by merging the daily rainfall observations and satellite rainfall estimates provided at  $0.01^\circ \times 0.01^\circ$  spatial resolution covering the period from 2008 to 2020. All-in-all, the dataset comprises a total of 232,750 pixels (land-only datapoints) at daily timescale covering the entire archipelago. Such huge number of pixels is sufficient to describe the rainfall characteristics of almost every kilometer distance across the country, the first of its kind. To describe the rainfall characteristics, the climatological monthly mean rainfall and annual-means were obtained from the daily rainfall in each pixel. Then, similar climate zones were identified from the climatological annual cycle of rainfall using the *K*-means clustering method described in Hartigan and Wong (1979). The optimal number of clusters to define climate zones was selected following the method suggested by Pham *et al.* (2005).

## 3. Results and Discussion

The spatial map of climatological annual-mean rainfall over the Philippines is shown in Fig. 1. Figure 1 reveals that the eastern coast of the country and the mountainous region of western Luzon receive the highest amount of annual rainfall exceeding 4000 mm/year. The central plains of Luzon and its valley receive the smallest portion of annual rainfall over the mainland of the biggest island. Meanwhile, the central sections of Visayas receive the least amount of rainfall ranging from about 1000 mm to <2000mm over the central part of the country. The western section of Visayas receive an annual rainfall higher than the central section, but is lower than the eastern section of the Visayas islands. Over the southern region of the country, the eastern and western sections of Mindanao receive the highest amount of rainfall, which gradually decreases over the central part of the island and with the lowest amount of annual rainfall (<500 mm/year) receive in the southernmost part of the island.

Based on the *K*-means clustering method applied to the climatological annual cycle of rainfall, three distinct climate zones were identified in the country (Fig. 2). The first cluster, which comprises most of the western section of the country (excluding most of Palawan), is characterized with a wet season starting from May to October coinciding to the southwest

monsoon season (e.g., Akasaka *et al.* 2007; Cruz *et al.* 2013; Matsumoto *et al.* 2020) and a dry season during the remaining half of the year. The central portions of Luzon, most of Visayas (except its eastern coasts), Palawan, and most of Mindanao (except its eastern coasts) comprises the Cluster II, which is characterized of an evenly distributed rainfall throughout the year. The eastern sections of the country belong to the cluster III, where the highest rainy period starts around October lasting until March coinciding to the northeast monsoon (e.g., Matsumoto *et al.* 2020). The lowest amount of rainfall received in areas belonging to Cluster III is in April, but the average amount of rainfall is still relatively high (~200 mm), which is comparable to the wettest months of areas belonging to Cluster II and the start of rainy months in Cluster I. This can probably be attributed to the influence of tropical cyclones contributing significant amount of rainfall over the country (e.g., Kubota and Wang 2009; Cayan *et al.* 2011; Cinco *et al.* 2016; Bagtasa 2017).

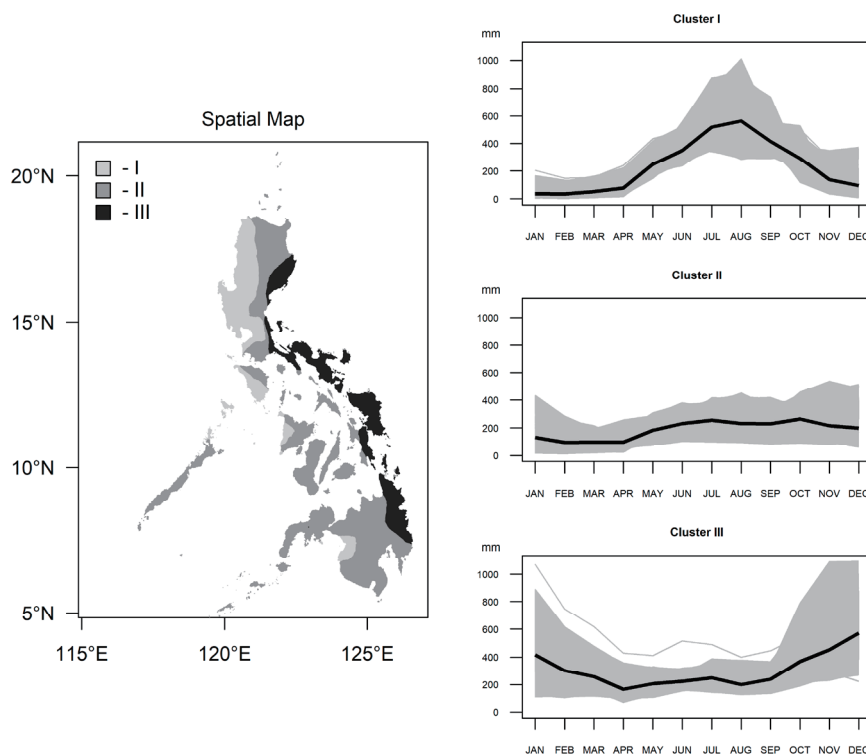


**Fig. 1** Spatial map of climatological annual-mean rainfall of the Philippines derived from the ClimGridPh-RR.

#### 4. Conclusion

This study has characterized the spatial and temporal variations of rainfall in the Philippines utilizing the high-resolution (approximately 1 km × 1 km) gridded daily rainfall data known as the ClimGridPh-RR. It has been shown that the country's driest area can be found over the southern most portion of Mindanao (<500 mm/year) and over the central plains and valley of Luzon. The

mountainous area in western Luzon and the eastern coasts of the country receive the highest amount of rainfall every year (>4000 mm), on average. Three distinct climate zones with similar annual cycle of rainfall were identified by the *K*-means clustering technique. The first cluster, comprising most of the western section of the country excluding Palawan, demonstrates a wet (from May to October) and a dry season during the remaining half of the year. The second cluster, which comprises most of the central (longitudinally), Palawan, and southern main island of the country, is characterized of an evenly distributed rainfall throughout the year. The eastern sections of the country belonging to the third cluster have no dry period and have the highest rainy period starting around October lasting until March. These findings provide an updated information on climate characteristics of the country that could be useful in various applications.



**Fig. 2** The three climate zones identified by the *K*-means clustering technique from the climatological annual cycle of rainfall in the Philippines.

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