THE PENINSULAR MALAYSIA FLOODING – A SPATIO-TEMPORAL ANALYSIS OF PRECIPITATION RECORDS

NURUL AFZAN BINTI MUSA HASNI

Thesis submitted in fulfilment of the requirements
for the award of the degree of
B. Eng (Hons.) of Civil Engineering

Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG

JANUARY 2014

ABSTRACT

Floods are regular natural disaster that frequently occurs in Peninsular Malaysia, which happens every year during the monsoon season. Especially second inter monsoon (October) to early North-East monsoon (November – December). During North-East monsoon, wind brings heavy rainfall to Peninsular Malaysia, which often results in flooding. The main study objective is to analysis spatial-temporal of precipitation records during flooding. The specific objectives of the study are as follow; to produce spatial-temporal rainfall distribution maps and to assess the depth, duration and intensity of the rainfall that can cause flooding. This study uses TMPA satellite-based rainfall, to map the spatial-temporal distribution of rainfall during flood events for period 2000-2013. From the maps, the assessment to identify the depth, duration and intensity of the rainfall that can cause flooding were performed. The results show that, the flooding occurs due to the variability of depth, duration and intensity of rainfall. However, at particular places the flooding that occurred at different periods, experiencing rainfall with the same intensity. In conclusion, floods can happen at a place with different rainfall characteristics (i.e. depth, duration, intensity). In addition, flooding able reoccurred at the same place with the same rainfall intensity.

ABSTRAK

Banjir adalah bencana alam yang sering berlaku di Semenanjung Malaysia, ia berlaku setiap tahun pada musim tengkujuh. Terutamanya monsun kedua antara (Oktober) hingga awal monsun Timur Laut (November - Disember). Semasa monsun Timur Laut, angin membawa hujan lebat ke Semenanjung Malaysia, yang sering menyebabkan banjir. Objektif kajian utama adalah untuk analisis spatial-temporal rekod hujan dalam banjir. Objektif khusus kajian ini adalah seperti berikut; untuk menghasilkan spatial-temporal peta taburan hujan dan untuk menilai kedalaman, tempoh dan keamatan hujan yang boleh menyebabkan banjir. Kajian ini menggunakan TMPA berasaskan satelit hujan, untuk memetakan spatial-temporal hujan semasa kejadian banjir bagi tempoh 2000-2013. Daripada peta-peta, penilaian untuk mengenal pasti kedalaman, tempoh dan keamatan hujan yang boleh menyebabkan banjir telah dijalankan. Keputusan menunjukkan bahawa, banjir yang berlaku disebabkan oleh kepelbagaian kedalaman, tempoh dan keamatan hujan. Walau bagaimanapun, pada tkawasan tertentu banjir yang berlaku pada tempoh yang berbeza, mengalami hujan dengan keamatan yang sama. Kesimpulannya, banjir boleh berlaku pada suatu tempat yang mempunyai ciri-ciri hujan yang berbeza (iaitu kedalaman, tempoh, keamatan hujan). Di samping itu, banjir dapat berulang di tempat yang sama dengan keamatan hujan yang sama.

TABLE OF CONTENTS

CHAPTER 5: CONCLUSION AND RECOMMENDATION

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Worldwide natural disasters are occurring every year and their impact and frequency seem to have increased in recent decades, mostly due to environmental degradation, brought on by human intervention to nature: deforestation, intensified and unplanned land use and increasing population (Vincent, 1997).

Flooding is a frequent natural disasters experienced around the world. Flooding occurs when an area, usually low-lying, flooded with water. Floods usually occur when water overflows from the banks of the river. Floods happen when soil and vegetation cannot absorb all the water. The water then flows over the land and cannot be accommodated by the natural flow of the river or pond or stored in man-made reservoirs. The flooding from the sea can cause overflow and flood the insulation will cause this natural fortress ruins. The area behind the coastal defences may be exposed to hazards. Floods from the sea can be caused by storms, high tides, tsunamis, or a combination of such elements. Because most communities' community located near the coast, the problem is a major threat worldwide.

Malaysian floods occur when storm overflows that exceed the ability of the soil or water reservoirs like rivers, or lakes to absorb rainwater, meet landmass. Malaysian floods often occur at the end of the Northeast monsoon which is taking place from November to March. The weather in Malaysia is characterised by two monsoon regimes, namely, the Southwest Monsoon from late May to September, and the Northeast Monsoon from November to March. The Northeast Monsoon brings heavy rainfall, particularly to the east coast states of Peninsular Malaysia and western Sarawak, whereas the Southwest Monsoon normally signifies relatively drier weather. The transition period in between the monsoons is known as the inter-monsoon period.

Monsoon is caused by land-sea temperature differences due to heating by the sun's radiation. In winter, the continental landmass cools rapidly resulting in extremely low temperatures over central Asia. As temperature drops, atmospheric pressure rises and an intense high pressure system (anticyclone) develops over Siberia. Cold air flows out of Siberia as northwester lies and turns into northeaster lies on reaching the coastal waters of China before heading towards Southeast Asia.

From time to time, strong outbursts of cold air (termed as monsoon surges) interact with low pressure atmospheric systems and cyclonic vortices are formed near the equator resulting in strong winds and high seas in the South China Sea and heavy rainfall to east coast states of Peninsular Malaysia as well as the west coast of Sarawak in East Malaysia.

In summer, intense solar heating leads to scorching temperatures over the Asian landmass. As hot air expands and rises upwards, a semi-permanent low-pressure area develops. Moist south easterlies originating from the southern Indian Ocean and the Indonesian-Australian region transforms into southwester lies on crossing the equator and flow across Southeast Asia before converging towards Indochina, China and Northwest Pacific.

The northeast monsoon is the major rainy season in the country. Monsoon weather systems which develop in conjunction with cold air outbreaks from Siberia produce heavy rains which often cause severe floods along the east coast states of

Kelantan, Terengganu, Pahang and East Johore in Peninsular Malaysia, and in the state of Sarawak in East Malaysia.

1.2 SOURCE OF FLOODING

According to Høybye (2009), there are three identified main sources of flooding in the basin:

1) Heavy Local Rainfall

   Because of two monsoon winds which are blowing moist air from different directions depending on the season and local convective rainfall at the low-lands, the basin receives large amount of rainfall causing flash flood in different parts of the basin.

2) Extreme Increase in River Discharge

   During the monsoon seasons the mountains surrounding the basin receives substantial amount of rainfall. Because of the steepness of slope on the mountain and the intensity rainfall, the mountains send more runoff into the river which increases the river discharge and may lead to flooding.

3) Sea Wave from South China Sea

   The third source of flooding which is most common at the southeast coast of the basin is the sea wave from South China Sea. The broken wave at the surf zone increases the water level in the river column. This phenomenon is called the wave setup and the effect will propagate over a certain distance to upstream by increasing the water level in the river column gradually. As the water level rises above the river bank level, the water will spill out and flood the areas along the river.

1.3 PROBLEM STATEMENT

Flood in Peninsular Malaysia are regular natural disaster that frequently occurs in Malaysia which happens every year during the monsoon season. Especially second inter monsoon (October) to early North-East monsoon (November – December).

The study will attempt to answer the following research questions: how can rainfall characteristics (i.e. depth, duration and the intensity) that can cause flooding are quantified.

1.4 OBJECTIVE OF STUDY

The main study objective is to analysis spatial-temporal of precipitation records during flooding incidents in Peninsular Malaysia. The specific objectives of the study are as follow;

1. To produced spatial-temporal rainfall distribution maps.
2. To quantify the depth, duration and intensity of the rainfall that can cause flooding.

1.5 SCOPE OF STUDY

Series of Tropical Rainfall Measuring Mission Multi-satellite Analysis (TMPA) satellite-based rainfalls (i.e. 3B42 version 6) for period of year 2000 to year 2013 were used as rainfall sources.

The study was conducted at Peninsular Malaysia is part of Malaysia. Peninsular Malaysia is located at Latitude 1°-7° N and 100°- 104.5°E Longititud. Area is 131,798.35 km2, divided into 11 states and two federal territories. Gujarat has an area

of 35,965 km² is the largest state in Peninsular Malaysia while Perlis of 795 square miles is the smallest state Figure 1.1.

There are several mountain ranges running parallel from north to south. Major mountain range (Main Range) has divided the two peninsular on the west coast (facing the Straits of Malacca and the Indian Ocean) and east coast (facing the South China Sea), make it a maritime country with a long coastline and gentle. Onshore area covered by tropical rainforest. Since 1960, the forest area has much to be explored for the expansion of plantation areas and settlements to enhance the economic activities of the population. This has changed the landscape of the river basin area to cover and land-use diversity (LULC).

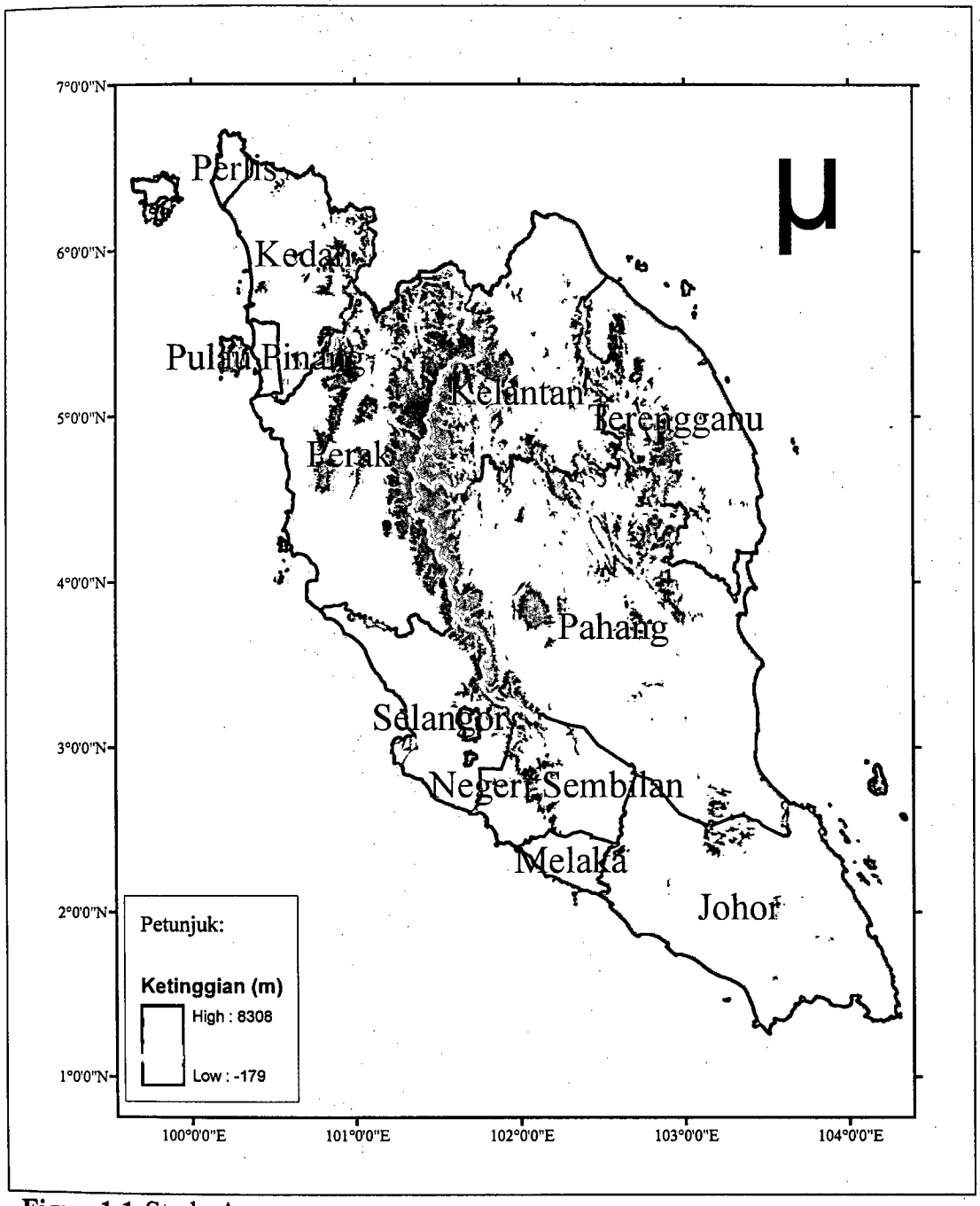


Figure1.1: Study Area

1.6 THESIS STRUCTURE

In this structure, there are five chapters namely introduction, review, methodology, results and conclusions. For introduction it explains the flood is a natural disaster-prone in the country of Malaysia. For chapter two, it is the purpose of flood, flood and others. In addition, it describes the method used in this study. For chapter three it is explains the methodology of the study of water products consist of four (4) levels, namely: a) the collection of data, b) pre-processing of data, c) processing and d) the results of research and analyses. For chapter four, it is describes the analysis and discussion of the results obtained. Lastly in chapter five it explain overall about conclusion for all chapters.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

A flood is an overflow of water that submerges land which is usually dry The European Union (EU) Floods Directive defines a flood as a covering by water of land not normally covered by water. In the sense of "flowing water", the word may also be applied to the inflow of the tide. Flooding may occur as an overflow of water from water bodies, such as a river or lake, in which the water overtops or breaks levees, resulting in some of that water escaping its usual boundaries, or it may occur due to an accumulation of rainwater on saturated ground in an area flood. While the size of a lake or other body of water will vary with seasonal changes in precipitation and snow melt, these changes in size are unlikely to be considered significant unless they flood property or drown domestic animals.

Floods can also occur in rivers when the flow rate exceeds the capacity of the river channel, particularly at bends or meanders in the waterway. Floods often cause damage to homes and businesses if they are in the natural flood plains of rivers. While reverie flood damage can be eliminated by moving away from rivers and other bodies of water, people have traditionally lived and worked by rivers because the land is usually flat and fertile and because rivers provide easy travel and access to commerce and industry.

Some floods develop slowly, while others such as flash floods, can develop in just a few minutes and without visible signs of rain. Additionally, floods can be local, impacting a neighborhood or community, or very large, affecting entire river basins. The types of flooding in Peninsular Malaysia; monsoon flood and flash flood.

The information on natural disasters presented here is taken from EM-DAT: The OFDA/CRED International Disaster Database. In order for a disaster to be entered into the database at least one of the following criteria has to be fulfilled:

- 10 or more people reported killed
- 100 people reported affected
- A call for international assistance
- Declaration of a state of emergency

2.1.1 Monsoon Flood

Monsoon is derived from the Arabic word "mausim" which means season. Traders plying the Indian Ocean and the Arabian Sea to use this word to describe the wind system alternates from the Northeast during winter in the Northern hemisphere and in the Southwest during the summer in the Southern Hemisphere.

In Malaysia, there are two known types of monsoon Southwest monsoon and the northeast monsoon. Southwest Monsoon occurred late May to September and the Northeast monsoon also occurs in November to March. Northeast monsoon usually brings heavy rains, especially to the states on the East coast of Peninsular Malaysia and Western Sarawak, whereas the Southwest monsoon is relatively dry. The transition period monsoons are also known as transition periods.

Northeast monsoon floods usually occur in the states of the East coast of peninsular Malaysia. This season, the rain is very heavy and many days. It is also known as the monsoon season, where the sea was rough and dangerous. Northeast Monsoon occurs when cold air moves out of the plains of Siberia as a result of increased atmospheric pressure and high pressure system forming very strong. The explosion of strong cold air (monsoon surges) interact with low pressure systems or cyclones that form near the equator , thus producing strong winds and rough seas in the South China Sea and heavy rains on the east coast of Peninsular Malaysia and Sarawak on the west coast .

In Malaysia, normally the east coast states of Kelantan, Terengganu and Pahang is the state that will be faced by the northeast monsoon floods. Usually it happens in November to March. At this point, the fishermen and rubber tappers have to stop their jobs because of rough seas and heavy rain. For these states is quite common flooding that occurred during the year. The floods usually take three days to a week. However, it depends on the rainfall rate. If heavy rains and flooding continue to occurs over time.

2.1.2 Flash Flood

Means a flood flash flood happened possible for the immediate or possible for unexpectedly. Flash floods occur quickly for a few minutes to half an hour after it was raining heavily. However, storm water quickly ended the run of his life is half an hour to a day.

In Malaysia, a serious flood occurred in the vicinity of major cities like Kuala Lumpur, Georgetown, Selangor, Ipoh and others. Flash flood occurs because the density of population and densely built-up and paved roads. Rain for two hours is sufficient for the occurrence of flash floods. Flash floods occur because of the water has no place to drain because the rivers were in landfills and replaced with drains or smaller drains. As a result the quantity of water cannot drain or drain support by provided.

Additionally, flash floods in Malaysia also occur as a result of changes in land use. Changes in land use occurs when the population of the area from the compact. Where are the land and it is began to be paved initially gripped by trees replaced by high-rise buildings and dense. The effected of impervious surface. Thus, rain water has no place to be absorbed. As a result of impervious soil, flash floods in towns rapid happen faster because the water cannot be filtered properly. Different flood are monsoon floods. As we know, the flash flood happened so fast, and sometimes it happens unexpectedly. The monsoon floods, it occurs in a longer time. For monsoon flooding, flood victims are better prepared and have signs in advance, otherwise, flash floods occur rapidly and flood victims do not get an indication that the flash floods will occur.

2.2 THE EFFECT OF FLOOD

Floods give some bad effect on all living things which can lead to death. Among the effects that arise due to flooding are:

1) Death

   Deaths from diseases of the worst affected by the floods are brought to human health. The floods will cause sewage overflows out with water. This shit scattered all over the place, resulting in a variety of diseases such as cholera and malaria. Other diseases are dengue, disease leprosy (rat urine disease) much spread in the flood season. Flooding can also result in loss of life due to drowning, especially in areas of low and close to the river.

2) Property destruction Population

   Great flood can submerge homes, sweep products, and other destructive items such as electrical goods, cars and so on. This brought huge losses to the population.

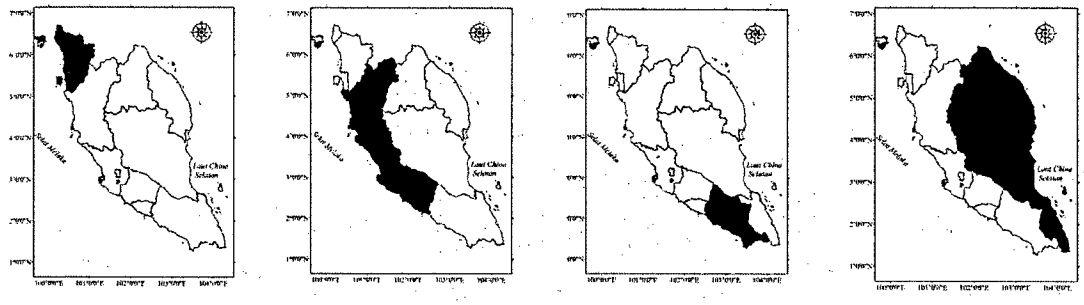
3) Caused a lot of losses in agriculture.

Destruction of crops and livestock due to the stagnant flood water too long in agricultural areas cause dead plants. Among the dead crops are rubber, cocoa, palm oil and rice. The destruction of these crops is to the detriment of the farmers.

2.3 KEY FEATURES OF PHYSICAL AND CLIMATE STUDY AREA

Peninsular Malaysia climatic information can be found on the website of the Malaysian Meteorological Department (www.met.gov.my). Here is a summary of that information. The entire study area is located in the equatorial zone doldrums. The climate is equatorial but for some places in Malaysia, especially in the northern part of Peninsular Malaysia has a tropical monsoon climate. Subjects to the influence of climate change in the ocean and the wind system of the Indian Ocean and the South China Sea. Usually, the climate here is divided into the southwest monsoon season (April-September), northeast monsoon (November to March) and the monsoon months between April and October. Seasonal wind patterns coupled with the local topography to determine the pattern of rainfall in the study area. Peninsular Malaysia has an average annual precipitation (MAP) 2490mm (NWRS, 2011). However, for the states on the east coast, with maximum rainfall during November to January, the minimum rainfalls are in June and July. Patterns of rainfall over the west coast of Peninsular Malaysia showed two periods of maximum rainfall separated by two periods of minimum rainfall. The main maximum usually occurs in October and November, while the second maximum occurs in April to May. In the northwest, the primary minimum occurs in January and February, while the second minimum occurs in June and July. In other places, the primary minimum occurs in June and July, while the second minimum occurs in February. Rainfall patterns in the south-west coast of Peninsular Malaysia are characterized by the creation of "Sumatra" from May to August, and the minimum and maximum pattern of multiple non-existents. October and November are the months with maximum rainfall while February is the month with minimum rainfall. Maximum in March to May and a minimum in June and July were absent or indistinct.

Dale (1959) has divided the study area into five (5) rainfall regions, with its different monthly rainfall, the North-West Malaya (NWM), West Malaya (WM), Port Dicksons and Muar Coast (PDMC) South-West Malaya (SWM) and East Malaya (EM). However, for the purposes of this study, the MMD rain gauge stations are divided into four (4) regions, namely North-West Peninsular Malaysia (NWM) overlap with NWM, West Peninsular Malaysia (WM) overlap with WM and PDMC, South-West Peninsula Malaysia (SWM) overlap with SWM, and East Malaysia (EM) overlap with EM (Figure 2.1).



(a) (b) (c) (d)

Figure 2.1: Region of the study area, a) North-West of Peninsular Malaysia (NWM), b) West Peninsular Malaysia (WM), c) South-West Peninsular Malaysia (SWM), and d) East Malaysia (EM).

Winds generally light Peninsular Malaysia. The gust is also variable, based on the monsoon and the monsoon. During the southwest monsoon, the prevailing winds are generally southwesterly and light, below 15 knots. Whereas, during the northeast monsoon, is the prevailing winds are from the east or northeast at a speed between 10 and 20 knots. East coast states of Peninsular Malaysia are more affected by the wind that can reach speeds of 30 knots or more during a strong surge of cold air from Siberia (wind surges in winter). During the monsoon, winds are generally light and variable.

The study area lies close to the equator, having an almost uniform temperature throughout the year. The annual variation is less than 2°C except for the east coast of the study area is often affected by surges of winter wind from Siberia during the northeast monsoon which occurs in the Northern Hemisphere winter. Daily temperature ranges are large, for the stations near the coast is between 5°C to 10°C, while for inland stations is between 8°C to 12°C. However, the study area has never had a high daily temperature as found in the tropics. Although the days are usually hot, cold night everywhere except during the southwest monsoon, which at night was quite warm.

Peninsular Malaysia has high moisture content. Mean monthly relative humidity is between 10% to 90%, and varies with location and month. Minimum humidity is usually available in January and February, except for the east coast states, namely Kelantan and Terengganu, where the relative humidity is minimums in March. The maximum is however usually is in November. As in the case of temperature, the diurnal variation of relative humidity is greater than the annual changes. The mean daily minimum can reach as low as 42% during the dry months and as high as 70% during humid months. However, the mean daily maximum, not much has changed from one place to another, which is more than 94% and may reach as high as 100%. The states in the northwest, the Kedah and Perlis have the largest daily humidity changes.

As a country surrounded by the sea and close to the equator, Peninsular Malaysia is naturally receive a lot of sunlight and thus solar radiation. However, it is rare for a full day with clear sky except during drought. Cloud cover reduces the amount of sunshine and the next the sun. On average, it received a total of 6 hours of sunlight a day. However, there is a difference in the amount of sunlight received by season and location. Alor Setar and Kota Bharu receive about 7 hours of sunshine a day. Moreover, Alor Setar received the maximum of 8.7 hours per day on average in the same month. Solar radiation is closely related to the sun. Seasonal and spatial variations are more or less similar to sunlight.