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Studies on Seasonal variations of rainfall in java island at Indonesia

K. Aruna[1] , Dr. M. V. Subramanian*[1] (RTD), Dr. B. Jaya sudha[2] , Bharathidasan university[3]

[1]PG & Research Department of physics, H.H. The Rajah's College, Pudukkottai, Tamilnadu.

[2]PG & Research Department of physics, H.H. The Rajah's College, Pudukkottai, Tamilnadu.

[3]Affliated to Bharathidasan university, tiruchirappalli , Tamilnadu , India.

ABSTRACT

Rainfall is a key input in management of agriculture and irrigation projects and any change in this variable can influence on sustainable management of water resources, agriculture and ecosystems. Rainfall extremes motive big socioeconomic effects in Indonesia, as they're frequently followed with the aid of using disastrous events, including floods and landslides. Of precise hobby is Java Island, the most populated vicinity in Indonesia, that's susceptible to destructive flooding due to heavy rainfall. This study sought to determine the spatial and temporal variability of rainfall under past and future climate scenarios. The changes of water movement and distribution are influenced by extreme rainfall and land cover conversions. The rainfall becomes more extreme than before. The trends and patterns of extreme rainfall on Java Island, Indonesia, we were studied from 2009 to 2021 the rainy season from November to May, with January and February being the wettest months. The dry season begins from June and ends in October and also find the earthquakes and eruption days, month rainfalls.

Keywords: Rain fall, average, increase, climate effect, java island, eruption and earthquake.

INTRODUCTION:

Java is located between the Indonesian islands of Sumatra to the west and Bali to the east. To the north is Borneo, and to the south is Christmas Island. It is the world's thirteenth-largest island. Java is bounded to the north by the Java Sea, to the west by Sunda Strait, to the south by the Indian Ocean, and to the east by Bali Strait and Madura Strait. Java is almost entirely volcanic in origin, with thirty-eight mountains forming an east–west spine that have all been active volcanoes at some point. Mount Semeru, at 3,676 metres, is Java's tallest volcano (12,060 ft). Mount Merapi, at 2,930 metres, is the most active volcano in Java and Indonesia (9,610 ft). Java has over 150 mountains in total.

Silicic domes are high viscous extrusions of magma at the summit of dominantly dacitic-andesitic volcanoes. Silicic domes may destabilize and collapse, representing the source region for destructive pyroclastic flows (Calder et al., 2002). The growth and collapse of silicic domes are thought to be controlled by the extrusion dynamics (Hale et al., 2009a, 2009b), the underlying slope and surrounding morphology (Walter et al., 2013), the brittle (cooled) crust stabilizing the extrusive magma body and hence the exogenous and endogenous growth (Hale, 2008; Kaneko et al., 2002). Therefore, at growing domes a fragile balance exists between extrusion of viscous lava, cooling and degassing, erosion and the mechanical instability of the dome. At occasions, the stability of domes may be modified by external forcing, at Merapi possibly associated with heavy rain fall (Elsworth et al., 2007; Neuberg, 2000), or with large tectonic or regional earthquakes (Jousset et al., 2013; Voight et al., 2000; Walter et al., 2007, 2008). Rainfall extremes have been associated with environmental disasters, such as floods and landslides, that have significant impacts on society. The current thinking is that rainfall extremes (REs) are becoming more frequent, and intense (Westra et al., 2013), causing critical challenges to communities in dealing with climate changes(Data, 2009).

The presence of extreme rainfall and land conversion from forest to cultivation land influence changes in water flow and distribution. Precipitation becomes more severe than previously. The dry season has lengthened, while rainfall has increased during the rainy season. As a result, the heavy rains will cause flooding. The effect of climate change and land conversion led the discharge of water become extreme (change the character of flow) so that increased the threat of flooding and drought which affect on the degradation of water resources infrastructure functions.

Accurate temporal and spatial variability of global rainfall data has the potential to be used in the prediction of extreme weather conditions, climatology, hydrological simulation, agriculture, flood monitoring, drought monitoring, and water resource management (Ummenhofer and England, 2007; Hou et al., 2008; Kucera et al., 2013; Toté et al., 2015; Setiawati et al., 2016; Xu et al. The primary source of rainfall data obtained through direct measurement is rain gauges (Salio et al., 2015). The uneven distribution of rain gauges in remote areas, on the other hand, is a critical challenge to overcome for effective spatial coverage (Feidas et al., 2009).The wet season lasts from November to April.

Rain falls mostly in the afternoons and intermittently throughout the rest of the year. January and February are the wettest months. West Java is wetter than East Java, and mountainous areas receive significantly more rain. West Java's Parahyangan highlands receive over 4,000 millimeters (160 in) of rain per year, while East Java's north coast receives only 900 millimeters (35 in).

RESULT AND DISSCUSSION :

We have analyzed java island rainfall variation data's from the years 2009 to 2014. The maximum and minimum variation drawn in graph. Rainfall can increased and decreased some years .Total averages can found in this study area.

AVERAGE RAINFALL VARIATIONS IN ALL MONTHS : (2009 – 2021)

JANUARY

Maximum rainfall variations in the years 2009 is 10.0322 in (mm), 2021 is 10.0161 in (mm) and Minimum rainfall variations in the years 2013 is 2.6645 in (mm) and 2016 in 1.500 (mm). average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in January month is 4.8161 (mm).

FEBRUARY

Maximum rainfall variations in the years 2009 is 7.1107 in (mm), 2012 is 5.4785 in (mm) , 2017 is 5.7857 in (mm) and Minimum rainfall variations in the years 2011 is 3.7535 in (mm), 2019 is 2.1357 in (mm), 2019 is 2.3428 in (mm). average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in February month is 4.6252 (mm).

MARCH

Maximum rainfall variations in the years 2009 is 7.7064 in (mm), 2010 is 7.1838 in (mm) , 2021 is 11.8548 in (mm) and Minimum rainfall variations in the years 2012 is 2.6838 in (mm), 2014 is 2.8967 in (mm), 2019 is 1.5354 in (mm). average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in march month is 4.6975 in (mm).

APRIL

Maximum rainfall variations in the years 2010 is 10.2733 in (mm), 2008 is 14.7266 in (mm) , 2021 is 18.7700 in (mm) and Minimum rainfall variations in the years 2011 is 2.1933 in (mm), 2015 is 2.9933 in (mm), 2014 is 3.1433 in (mm). average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in march month is 7.4487 in (mm).

MAY

Maximum rainfall variations in the years 2010 is 22.0812 in (mm), 2019 is 19.9000 in (mm) , and Minimum rainfall variations in the years 2009 is 5.3709 in (mm), 2014 is 3.9322 in (mm) .average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in may month is 11.0662 in (mm).

JUNE

Maximum rainfall variations in the years 2011 is 11.9300 in (mm), 2018 is 13.9833 in (mm) , 2019 is 15.2900 in (mm), and Minimum rainfall variations in the years 2014 is 3.9466 in (mm), 2016 is 4.9000 in (mm) ,2012 is 4.8266 in (mm),average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in may month is 9.2315 in (mm).

JULY

Maximum rainfall variations in the years 2010 is 10.6451 in (mm), 2018 is 11.4677 in (mm) , 2021 is 7.5032 in (mm), and Minimum rainfall variations in the years 2014 is 3.3483 in (mm), 2016 is 3.9258 in (mm) , average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in July month is 6.6458 in (mm).

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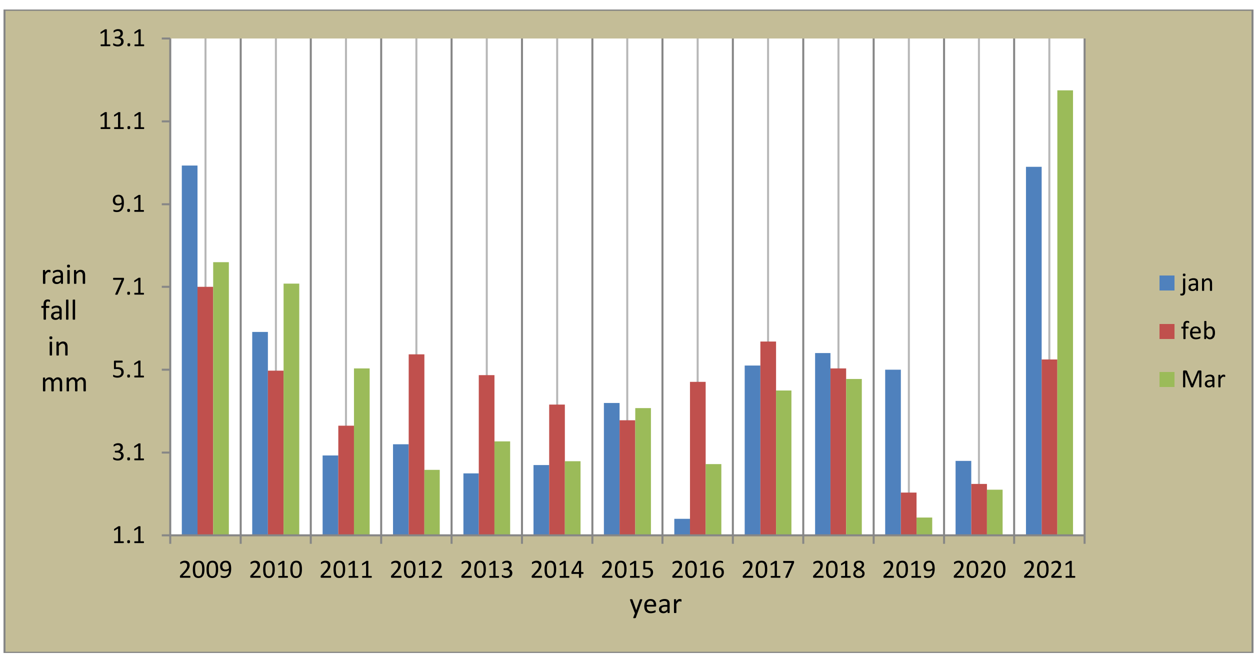
AUGUST
Maximum rainfall variations in the years 2010 is 6.7166 in (mm), 2015 is 5.7833 in (mm) , 2019 is 7.2300 in (mm), and Minimum rainfall variations in the years 2009 is 2.9133 in (mm), 2012 is 2.5567 in (mm) , 2020 is 3 in (mm) average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in august month is 4.6335 in (mm).

SEPTEMBER
Maximum rainfall variations in the years 2010 is 6.8133 in (mm), 2018 is 5.76 in (mm) , and Minimum rainfall variations in the years 2012 is 1.04 in (mm), 2015 is 1.2633 in (mm) , 2019 is 2.1 in (mm) average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in august month is 3.1051 in (mm).

OCTOBER
Maximum rainfall variations in the years 2011 is 6.0392 in (mm), 2013 is 3.65 in (mm) , 2021 is 5.8857 in (mm), and Minimum rainfall variations in the years 2010 is 2.5571 in (mm), 2012is 1.4142 in (mm) , 2015 is 1.075 in (mm) average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in October month is 3.0477 in (mm).

NOVEMBER
Maximum rainfall variations in the years 2017 is 10.07 in (mm), 2020 is 8.1166 in (mm) , and Minimum rainfall variations in the years 2009 is 3.1333 in (mm), 2014 is 2.3556 in (mm) , average rainfall variations gradually increased from 2009 to 2021 and the average mean rainfall in November month is 4.705 in (mm).

DECEMBER
Maximum rainfall variations in the years 2009 is 7.8354 in (mm), 2017 is 15.1935 in (mm) , 2020 is 9.1258 in (mm) and Minimum rainfall variations in the years 2014 is 0.7106 in (mm), 2013 is 3.3387 in (mm) , average rainfall variations gradually decreased from 2009 to 2021 and the average mean rainfall in December month is 5.9207 in (mm).



a) January , February and march Rainfall variations in millimeter in java island from the year 2009 to 2021.

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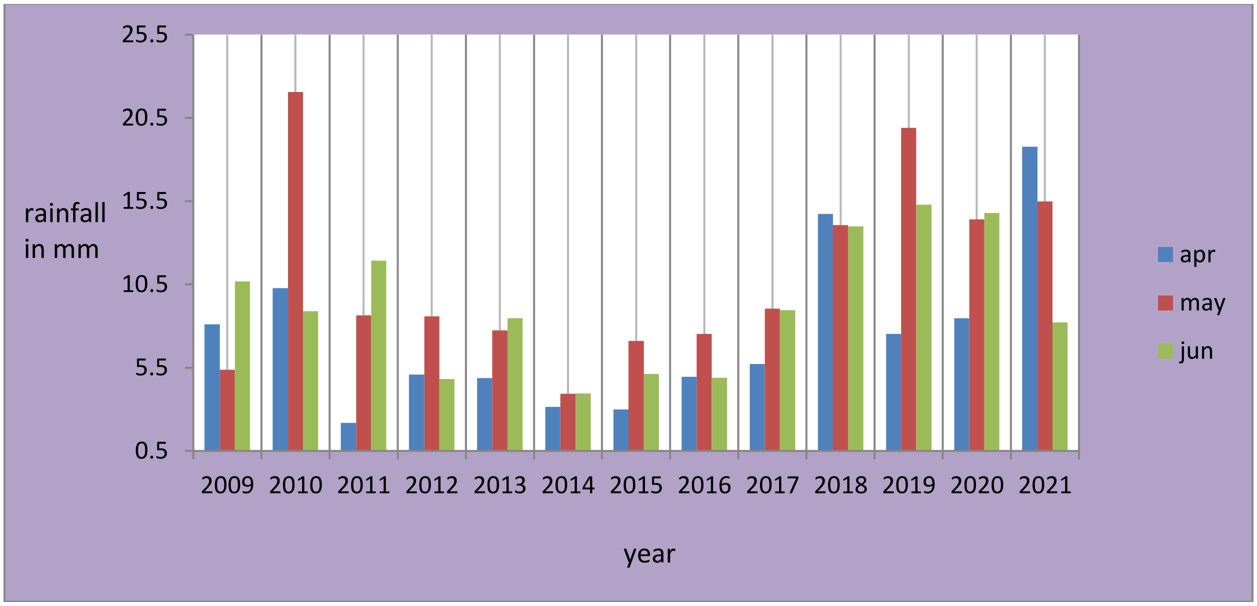
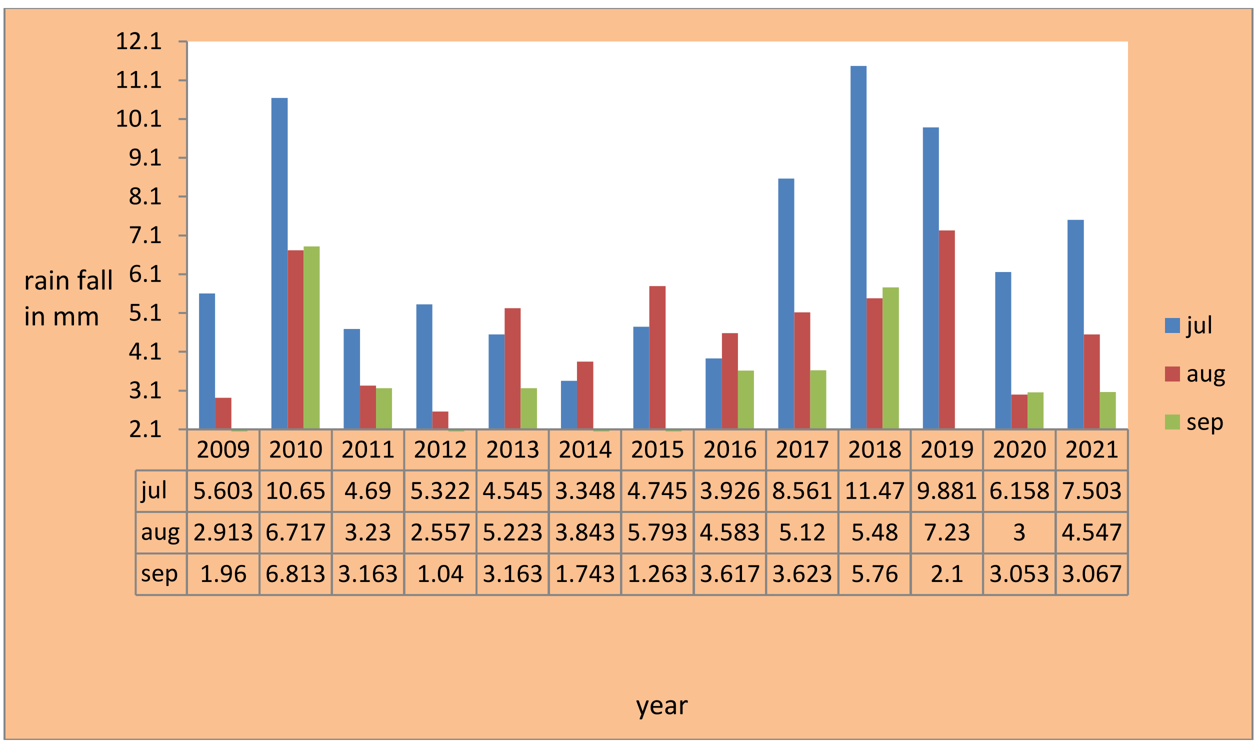


b) April, may and June Rainfall variations in millimeter in java island from the year 2009 to 2021.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
jul	5.603	10.65	4.69	5.322	4.545	3.348	4.745	3.926	8.561	11.47	9.881	6.158	7.503
aug	2.913	6.717	3.23	2.557	5.223	3.843	5.793	4.583	5.12	5.48	7.23	3	4.547
sep	1.96	6.813	3.163	1.04	3.163	1.743	1.263	3.617	3.623	5.76	2.1	3.053	3.067

c) July , august and September Rainfall variations in millimeter in java island from the year 2009 to 2021.

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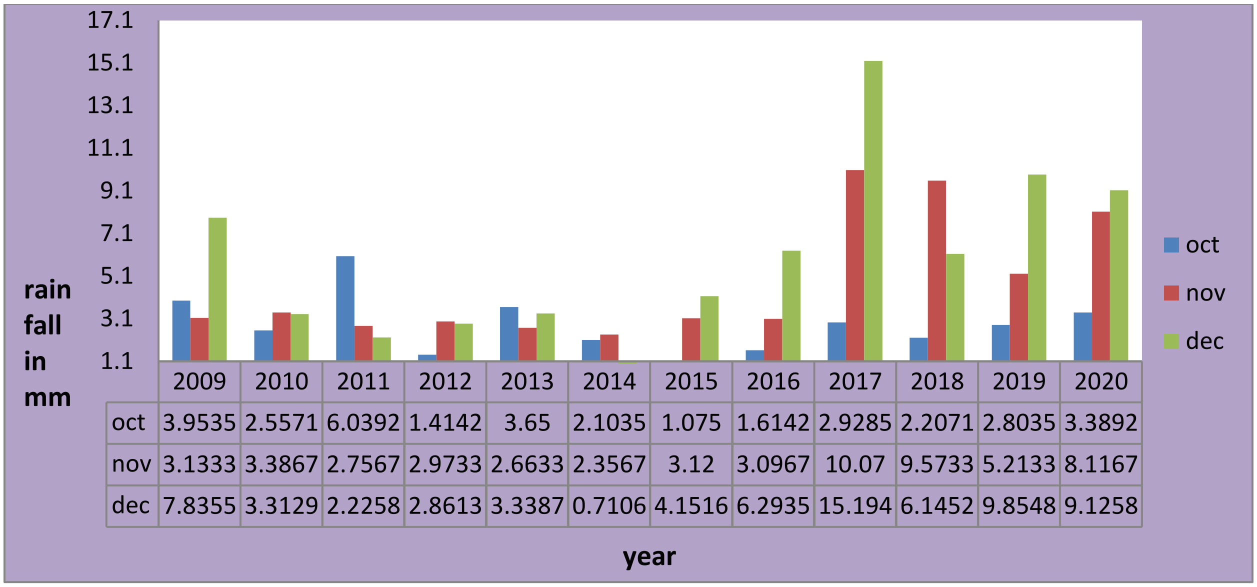
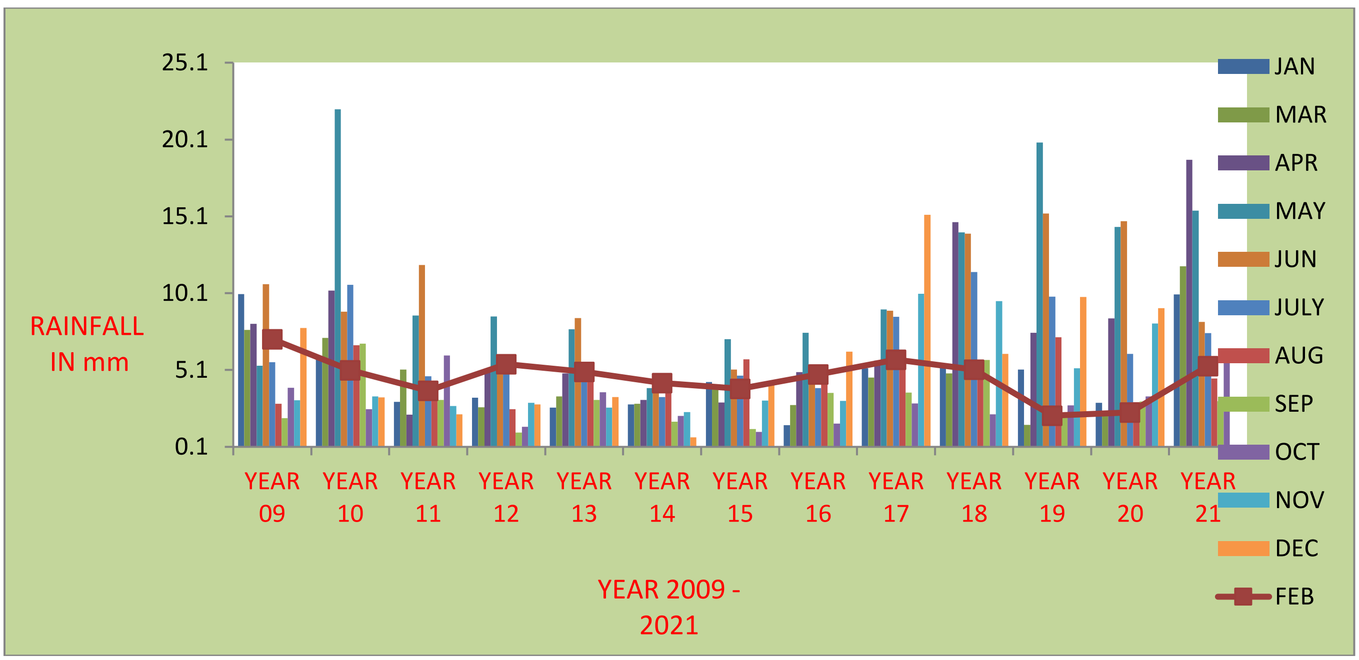


d) October , November and December Rainfall variations in millimeter in java island from the year 2009 to 2020.



e) Rainfall variations in millimeter in java island from the year 2009 to 20

TABLE 1 : year 2009 – 2021 java island rainfalls

Year	jan	feb	Mar	apr	may	jun	jul	aug	sep	oct
2009	10.03226	7.110714	7.706452	8.11	5.370968	10.68	5.60322	2.913333	1.96	3.9535

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2010	**6.016129**	**5.089286**	**7.183871**	**10.27333**	**22.06129**	**8.886667**	**10.6451**	**6.716667**	**6.813333**	**2.5571**
2011	**3.03871**	**3.753571**	**5.132258**	**2.193333**	**8.648387**	**11.93**	**4.6903**	**3.23**	**3.163333**	**6.0392**
2012	**3.303226**	**5.478571**	**2.683871**	**5.086667**	**8.577419**	**4.826667**	**5.3225**	**2.5567**	**1.04**	**1.4142**
2013	**2.664516**	**4.978571**	**3.377419**	**4.876667**	**7.741935**	**8.473333**	**4.5451**	**5.223333**	**3.163333**	**3.65**
2014	**2.864516**	**4.264286**	**2.896774**	**3.143333**	**3.932258**	**3.946667**	**3.3483**	**3.843333**	**1.743333**	**2.1035**
2015	**4.322581**	**3.882143**	**4.177419**	**2.993333**	**7.112903**	**5.12**	**4.7451**	**5.793333**	**1.263333**	**1.075**
2016	**1.5**	**4.817857**	**2.822581**	**4.956667**	**7.522581**	**4.9**	**3.9258**	**4.583333**	**3.616667**	**1.6142**
2017	**5.206452**	**5.785714**	**4.6**	**5.716667**	**9.041935**	**8.96**	**8.5612**	**5.12**	**3.623333**	**2.9285**
2018	**5.532258**	**5.132143**	**4.887097**	**14.72667**	**14.06452**	**13.98333**	**11.4677**	**5.48**	**5.76**	**2.2071**
2019	**5.13871**	**2.135714**	**1.535484**	**7.52**	**19.9**	**15.29**	**9.8806**	**7.23**	**2.1**	**2.8035**
2020	**2.974194**	**2.342857**	**2.209677**	**8.466667**	**14.40645**	**14.79**	**6.158**	**3**	**3.053333**	**3.3892**
2021	**10.01613**	**5.357143**	**11.85484**	**18.77**	**15.48065**	**8.223333**	**7.50322**	**4.546667**	**3.066667**	**5.8857**

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TABLE 2: year 2009 – 2021 java island maximum rainfalls

YEAR	MONTH	MAXIMUM RAINFALL (mm)
2009	JUNE	10.6800
2010	MAY	22.0612
2011	JUNE	11.9300
2012	MAY	8.5777
2013	JUNE	8.4733
2014	FEBRUARY	4.2642
2015	JUNE	5.1200
2016	DECEMBER	6.2935
2017	NOVEMBER	10.0700
2018	JULY	11.4677
2019	MAY	19.9000
2020	MAY	14.4064
2021	APRIL	18.7700

TABLE 3: year 2009 – 2021 minimum rainfall in java island

YEAR	MONTH	MINIMUM RAINFALL (mm)
2009	SEPTEMBER	1.9600
2010	OCTOBER	2.5571
2011	APRIL	2.1933
2012	SEPTEMBER	1.0400
2013	JANUARY	2.6645
2014	DECEMBER	0.7106
2015	OCTOBER	1.0750
2016	JANUARY	1.5000
2017	OCTOBER	2.9285
2018	OCTOBER	2.2071
2019	SEPTEMBER	2.1000
2020	FEBRUARY	2.2096
2021	SEPTEMBER	3.0666

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TABLE 4 : Earthquake Vs Rainfall variations in java island

year	Earthquake region	Mw	Rainfall increased in (mm)	Rainfall decreased in (mm)
2009/ 09/02	java	7.3	---------	1.9600 (September)
2010/05/09	Sumatra	7.2	22.0612 (may)	-----------
2010/10/25	Sumatra	7.8	----------	2.5571 (October)
2012/04/11	Wharton basin	8.6	8.5777 (may)	------------
2015/07/28	Papua	7.0	--------------	1.0750 (October)
2016/12/07	Sumatra	6.5	6.2935 (December)	--------------
2017/10/31	Ambon	6.3	10.0700 (November)	2.9285 (October)
2018/07/21	Sumatra	5.2	-------------	-----------------
2018/07/29	Lombok	6.4	11.4677 (july)	-----------------
2018/10/10	java	6.0	-----------	2.2071 (October)
2019/05/12	Sulawesi	6.8	19.9000 (may)	------------
2019/08/02	java	6.9	-----------	2.1000 (September)
2021/04/11	java	6.0	18.7700 (April)	---------------

TABLE 5 : years 2009 – 2021 earthquake in java island

Year	Region	Magnitude	MMI	Fatalities	Injuries	Comments
2009/09/02	Java	7.3	VII	79	1250	Tsunami
2012/04/11	Wharton Basin	8.6 & 8.2	VII &VI	10	12	Doublet
2015/07/28	Papua	7.0	VII	1	---	Buildings damage and destroyed
2016/12/07	Sumatra	6.5	IX	104	1273	Heavy damage in Aceh region

2018/07/29	**Lombok**	**6.4**	**VIII**	**20**	**401**	**Foreshock**
2021/04/11	**Java**	**6.0**	**V**	**10**	**104**	**--------**

CONCLUSION:

The island of Java has a hot and humid equatorial climate with stable temperatures throughout the year and small temperature fluctuations. Most of the earthquakes are created in may month from the year 2009 to 2021. Mount merapi volcano erupt in java island in september and october month from the year 2009 to 2021. The dry season begins in June and ends in October. Volcanic eruption and earthquakes are created the rainy season maximum in may , November and December month in java island and dry season begins September and ends in October with January and February being the wettest months in java island. This state of affairs can reason disasters, inclusive of floods and landslides, that could harm many parties. Rainfall in Indonesia, specifically at the island of Java itself, is intently associated to the worldwide phenomenon of Niño 3.four. In the duration from January 2009–November 2021, the rainfall and Niño 3.four confirmed a few excessive values. The Niño3.four index is predicted to be below -0.5°C and regularly growth to 0°C via the forecast period. Based at the going for walks 3-month imply Niño3.four index, the state-of-the-art APCC ENSO outlook indicates an round 59% risk of La Niña situations with vulnerable depth for March - May 2022, which regularly decreases. Meanwhile, ENSO-impartial situations are probably to be regularly growing after which dominant (~56%) at some point of June - August 2022.

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