Correlation Analysis between Extreme Weather Event and Agricultural Damage Value in Northeast of Thailand

NIPAPORN CHUTIMAN, PIYAPATR BUSABABODHIN, PRAPAWAN SENAPENG,
TOSSAPOL PHOOPHIWFA AND MONCHAYA CHIANGPRADIT*
Statistics and Applied Statistics Research Unit, Department of Mathematics,
Faculty of Science, Mahasarakham University,
Khamrieng, Kantarawichai, Maha Sarakham, 44150
THAILAND
monchaya.c@msu.ac.th

Abstract: - In this study, the authors applied correlation analysis to investigate a relationship between extreme weather event and agricultural damage value in Northeast of Thailand. The results showed that two top-ranking provinces with the highest Pearson's correlation coefficient values; Buriram province with 0.714, followed by Udon Thani province with 0.597. We can conclude that the province in which the positive value of the Pearson's correlation coefficient implies the rainfall is high, the agricultural damage value will also high. The agricultural damage data after compensation from government agencies inconsistent with reality was found. Therefore the Government agencies should consider the compensation for agricultural damage concordant with the real situation.

Key-Words: - rainfall, correlation, extreme weather event, agricultural damage value

1 Introduction

Climate change will increase natural disaster magnitude and frequency. The disaster is not the only impact to the life and personal or public properties, but also impact directly and indirectly to all sectors including daily activities, agricultural activities, health, education, trade, investment, industry, communication [1]. Together the rainfall fluctuations and temperature variations in Thailand have been attributed to climate change and it may have economic impact and civil society impact of the country including ecosystems and future population [2].

Flooding in 1995 caused major damage from tropical cyclone "Garry Helen Luis" and "Nina". Moreover, in 2001, a deluge from tropical cyclone "Uzangi" in Roiet province especially Selaphum district was heavily damaged. Besides, the basin area also faced floods in many patterns such as flash flood, water overflow, huge water flowing and landslide. In 2009, Monsoon through lied across the northeast resulting in continuous rainfall causing a flood in many areas such as Nakhon Phanom province, Mukdahan province, Roiet province, and Ubon Ratchathani province. In September 2009, tropical cyclone "Ketsana" hit the northeast region of Thailand caused widespread flooding especially Ubon Ratchathani province and Sisaket province. At the end of July until the beginning of August, 2011 tropical cyclone "Nock-Ten" hit Thailand and caused heavy rain and therefore severe flooding in the upper northeast. In 2019, flooding occurred in many areas of the Northeast region caused by tropical cyclone "Podul" and "Kajiki" at the end of August continuously until the beginning of September in Roiet province, Yasothon province, Sisaket province and Ubon Ratchathani province were heavily affected especially in agriculture.

Thailand weather forecasting study have shown that an increasing amount of rainfall in each time than the past [3] and it will impact agricultural production. Thailand's government has the Royal Thai Government Gazette on government advances budget to help victims for emergency cases. The current version 2019 helps the victims in many aspects. One of these is agricultural assistance, which includes livestock and fishery support for victims. The disaster victim's assistance is intended to provide urgent assistance as needed and relief for immediate suffering. Therefore, we are interested in studying the relationship between annual cumulative rainfall and the agricultural damage value to be a guideline for related agencies to take immediately relief action plans.

2 Data Description

The area used for this research was the north eastern part of Thailand which is the widest region of the country, 168,855.5 square kilometers. It is the

highland where is obviously separated from the central part. It is located between 14 degrees north latitude to 18 degrees and 101 degrees east longitude to 105 degrees east longitude. There are 20 provinces, as shown in the Figure 1.

Fig. 1 Map of Northeast, Thailand

From: https://thethailandlife.com/wp-content/uploads/2012/03/isaan-map-.gif

This study used the data of the yearly rainfall and agricultural damage value from 2003 - 2018 in the north eastern part of Thailand in 16 provinces, the information from Meteorological Department and Department of Disaster Prevention and Mitigation. The data descriptive is shown in Table 1.

Table 1 shown that the first two provinces with the highest average agricultural damage value; Ubon Ratchathani province (143.9975 million baht), followed by Nakhon Ratchasima province (84.0285 million baht). In 2012, Ubon Ratchathani province has the highest agricultural damage for 823 million baht. There are two provinces with the highest average annual precipitation; Nakhon Phanom province reached 2,242.18 millimeters, followed by Ubon Ratchathani province reached 1,686.08 millimeters. In 2005, Nakhon Phanom province has the highest cumulative rainfall of 2,960.90 millimeters.

Table 1 Descriptive statistics of annual rainfall and agricultural damage value

province	agricultural damage value (million baht)				annual rainfall (mm.)			
	mean	max	min	sd	mean	max	min	sd
Nongkhai	10.3403	26	0.3165	7.6202	1,643.74	2,408.80	341.00	490.21
Loei	30.5153	191	0.0574	50.3756	1,226.44	1,972.20	183.40	384.30
Udon Thani	19.8717	78.6	0.0316	28.1567	1,447.08	1,860.20	888.50	268.56
Sakon Nakhon	40.1409	103	0.0308	36.9911	1,655.41	2,422.90	314.30	458.17
Nakhon Panom	27.1488	86.2	0.0300	27.0742	2,242.18	2,960.90	459.40	607.31
Khon Kaen	43.4916	86.2	0.0300	27.0742	1,148.05	1,780.60	373.90	314.72
Mukdahan	58.2563	527	0.0008	138.7703	1,412.05	2,056.80	283.40	428.38
Maha Sarakham	76.3999	389	0.0180	121.8673	1,365.61	1,890.80	883.80	296.28
Kalasin	18.4654	101	0.0819	26.4922	1,303.45	1,713.90	246.30	366.46
Chaiyaphum	54.1478	326	0.0518	93.9028	1,154.07	1,695.20	306.60	355.03
Roiet	54.4781	353	0.1014	97.2727	1,318.12	1,759.10	278.30	359.46
Ubon Ratchathani	143.9975	823	0.0130	259.1747	1,686.08	2,035.50	1,323.00	235.37
Srisaket	49.4167	284	0.0790	77.9021	1,344.01	1,788.70	364.80	351.69
Nakhon Ratchasima	84.0285	720	0.5950	192.1010	1,142.51	1,652.80	188.40	324.18
Surin	8.1787	28.6	0.0618	10.2101	1,434.71	1,804.80	1,009.10	211.70
Buriram	14.7199	79.7	0.0158	21.5721	1,340.08	1,873.80	831.60	264.23

3 Methodology

Correlation analysis is a method of statistical evaluation used to study a relationship between two continuous variables. This particular type of analysis is useful when a researcher wants to establish if there are possible connections between variables. It is often misunderstood that correlation analysis determines cause and effect; however, this is not the case because other variables that are not present in the research may have impacted on the results.

The following formula is used to calculate the Pearson r correlation:

$$r_{xy} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - \left(\sum x_i\right)^2}\sqrt{n\sum y_i^2 - \left(\sum y_i\right)^2}},$$

where r_{xy} is Pearson correlation coefficient between x and y, n is number of observations, x_i is value of x for ith observation and y_i is value of y for ith observation.

If correlation is found between two variables it means that when there is a systematic change in one variable, there is also a systematic change in the other; the variables alter together over a certain period of time. If there is correlation found, depending upon the numerical values measured, this can be either positive or negative.

Positive correlation exists if one variable increases simultaneously with the other, i.e. the high numerical values of one variable relate to the high numerical values of the other.

Negative correlation exists if one variable decreases when the other increases, i.e. the high numerical values of one variable relate to the low numerical values of the other.

Pearson's product-moment coefficient is the measurement of correlation and ranges (depending on the correlation) between +1 and -1. +1 indicates the strongest positive correlation possible, and -1 indicates the strongest negative correlation possible. Therefore the closer the coefficient to either of these numbers the stronger the correlation of the data it represents. On this scale 0 indicates no correlation, hence values closer to zero highlight weaker/poorer correlation than those closer to +1/-1.

4 Result

The result of the correlation analysis between extreme weather event and agricultural damage value in Northeast of Thailand is shown in Table 2.

According to the Table 2, it found that the first three provinces with the highest Pearson's Correlation coefficient are Buriram province (0.714), followed by Udon Thani province (0.597), and Loei province (0.552), respectively.

5 Conclusion

The Correlation Analysis between Extreme Weather Event and agricultural damage value in the Northeast of Thailand was studied. The annual cumulative rainfall data and agricultural damage values from 2003 to 2018 shows two top-ranking provinces with the highest Pearson's correlation coefficient values; Buriram province (0.714), followed by Udon Thani province (0.597). We can conclude that the province in which the positive value of the Pearson's correlation coefficient implies the rainfall is high, the agricultural damage value will also high. However there are three provinces with a negative value of Pearson's correlation coefficient implies the rainfall is high, but the agricultural damage value will be decreased. This might be a conflict from the actual situation. The agricultural damage data after compensation from government agencies inconsistent with reality was found. Therefore the Government agencies should consider the compensation for agricultural damage concordant with the real situation.

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Table 2 Correlation coefficient between average annual rainfall and agricultural damage value

province	r	province	r
Nongkhai	0.139	Kalasin	0.294
Loei	0.552	Chaiyaphum	0.019
Udon Thani	0.597	Roiet	0.092
Sakon Nakhon	0.332	Ubon Ratchathani	0.085
Nakhon Panom	0.349	Srisaket	0.312
Khon Kaen	0.242	Nakhon Ratchasima	0.107
Mukdahan	-0.074	Surin	-0.182
Maha Sarakham	-0.013	Buriram	0.714