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Trend Analysis of Historical Rainfall data comparison with Probabilistic Statistical Rainfall Surface and Bayesian Flood Phenomenon Investigation Using GIS Techniques in Huai Luang watershed, THAILAND.

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Abstract

Huai Luang River is a tributary of the Mekong River, located basin in Northeast Thailand, according to Udon Thani and Nongkai provinces. The trend analysis was applied to the time series of rainfall data for 32 years from 1982-2013. The probabilistic statistical surface of rainfall conducts with kriging surface technique. This study found different changing of spatial rainfall distribution. Flood Phenomenon investigates from Satellite data, analyse with Bayesian techniques for the pixels base scenario. Difference of changing rainfall, surface maps and flooding occurrence can be tested with correlation methodology.

Keywords: ***T****rend analysis****,*** *The probabilistic statistical surface****,*** *kriging surface technique, Pixels base scenario.*

1. INTRODUCTIONS

Flooding occurs most commonly from heavy rainfall when natural watercourses do not have the capacity to convey excess water. The phenomenon of El Niño and La Niña also influence the amount of rainfall in ASIAN countries. These events occur every three to eight years as a part of a natural cycle (Eso, et al., 2015). The impacts of El Niño and La Niña cause extreme droughts and floods and severe environment, social and economic damages across the country as it occurred in 2011 (extreme flood) and 2015 (extreme drought).

Thailand rainfall events are influenced by two monsoons. The southwest monsoon, which typically occurs from May to October, brings a stream of warm moist air from the Indian Ocean towards Thailand causing abundant rain over the country. Rainfall during this period is not only caused by the southwest monsoon, but also by the Inter Tropical Convergence Zone (ITCZ) and tropical cyclones which produce a large amount of rainfall. The northeast monsoon, which typically starts in October and ends in February, brings cold and dry air from the anticyclone in China mainland over major parts of Thailand, especially the Northern and Northeastern regions (Manisarn, 1995)

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2. STUDY AREA.

Our study area belongs to "Huai Luang watershed" which is the sub basin of Maekong river basin.This area covers Udon Thani, Nong Bua Lam Phu and Nong Kai Provinces. The elevation of the basin ranges from 631 to 153 m above mean sea level. The average monthly temperature for 30 years (1981 – 2010) varies from 16.3 to 36.3 °C. Annual rainfall over the watershed varies from 1,145-2,174 mm which an annual average of 1,564 mm. Based on the 2009 land use map from the Land Development Department, the watershed was dominated by agriculture (68%), while forest and urban area covered 14% and 6%, respectively, of the total area (Piman, et, al, 2016)

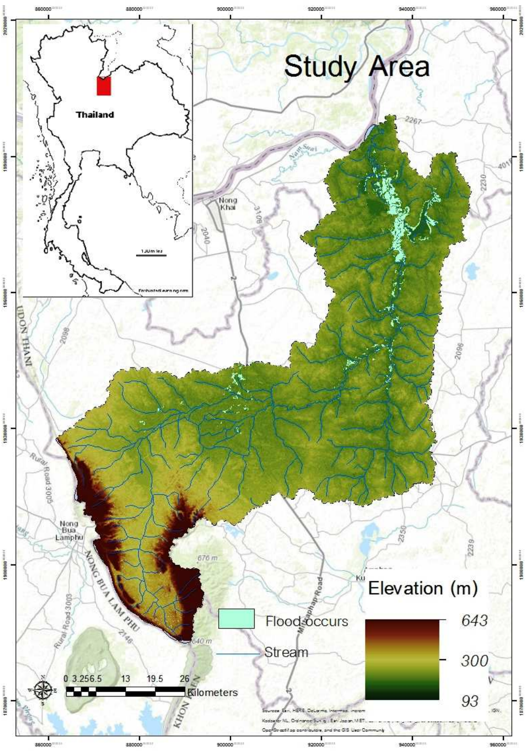
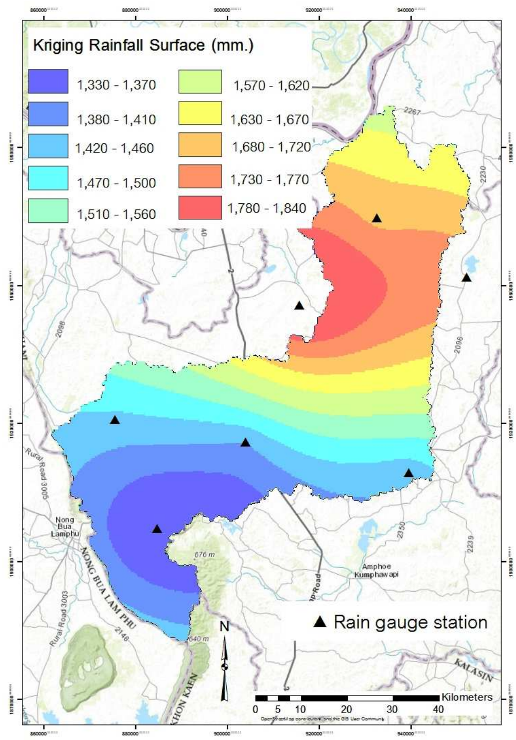


Fig. 1. (a) Study area



(b) Kriging rainfall surface

3. DATA REQUIREMENT AND METHODS.

3.1 Data requirement

Our study uses rainfall data for 32 years (1982-2013), for applying with the trend analysis and kriging surface technique. Flooding occurs are investigated from satellite data, as according to GISTDA 2014.

3.2 Methods

a) Trend analysis uses daily rainfall data from 1982-2013 (32 years) of seven stations were selected for analysis in this study. The data were obtained from the Thai Meteorological Department. The trend analysis application was an attempt to fit the linear models for the time series of average annual rainfall for 32 years. The standard deviation was used to represent the spatial variability of annual rainfall among the selected seven rainfall stations.

b) Kriging surface of rainfall, also use same rainfall data of trend analysis, then analyze with geostatistical method to find rainfall prediction space and rainfall probabilistic space in the study area.

c) Flood phenomenon data has analyze with information value (IFV), based on the "Bayesian algorithm" according to frequency data, similar to maximum likelihood classification. IFV for each variable, selected for the present study and stored as thematic layers in a GIS database, are computed using various map analysis techniques such as map crossing; the parameter values, which are required to calculate the IFV are obtained by crossing the mudslide map with a certain parameter map (Vansarochana, 2009)

$$IFV = \log \frac{p[M / A]}{p[M]},$$

where IFV is information value, $p[M/A_j]$ is the conditional probability flood in the class A_j, and p[M] is the probability of mudslide (M) occurrence irrespective of any class in the study area.

$$IFV = \log \frac{Class\ Density}{Map\ Density}$$

$$Class\ Density = \frac{nmclass}{nclass}$$

$$Map\ Density = \frac{Sum\,(nmclass)}{Sum\,(nclass)} = \frac{nmmap}{nmap},$$

where *nmclass* depicts the number of flood pixels in a particular class and *nclass* depicts the total number of pixels in that class. nmmap represents the number of pixels from the whole map with flood, and *nmap* represents the total number of pixels in the entire map.

Table 1. IFV range for Flood occurs.

Condition	Hazard	IFV Range
Stable	Low	<-0.75 to -0.38
Unstable	Moderate	-0.38 to 0.75
Highly Unstable	High	0.75 to >1.5

4. RESULTS AND DISCUSSION.

4.1 Trend analysis of rainfall

The average monthly rainfall of the seven rainfall stations during 1982-1997 and 1998-2013 are changed in temporal rainfall distribution. Difference in temporal rainfall distribution between those two periods is found in the wet season during May to October. There are two peaks of average monthly rainfall distribution in Jun and

August during 1982-1997 but the average monthly rainfall distribution has changed to one peak in August during 1997-2013. The amount of rainfall in July-Sep during 1998-2013 increased considerably compared to the amount of rainfall during 1982-1997. All these results, affect our team to experiment kriging technique to see any probability rainfall space.

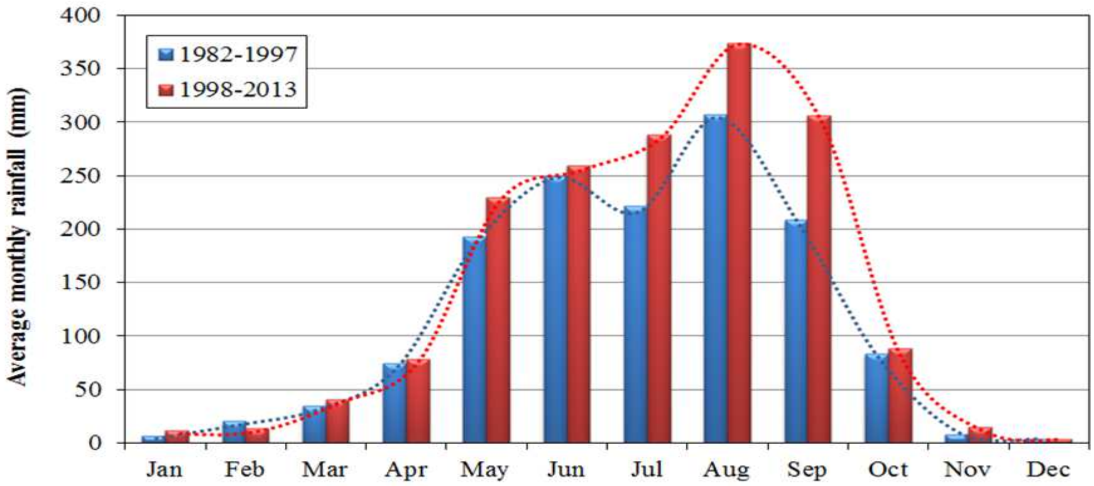


Fig. 2. Monthly rainfall distribution between 1982-1997 and 1998-2013

4.2 Kriging surface of rainfall

Kriging is a probabilistic method for spatial interpolation, kriging assumes that the spatial variation of an attribute such as changes in grade within an ore body or elevations of the land surface is neither totally random nor deterministic. According to variogram and cokriging technique to find the predicted highly rainfall area (Fig. 3a.) and the probability of high rainfall area (Fig 3b.). The probability rainfall has been shown according to the heavy flood occurrence map (Fig 1a.).

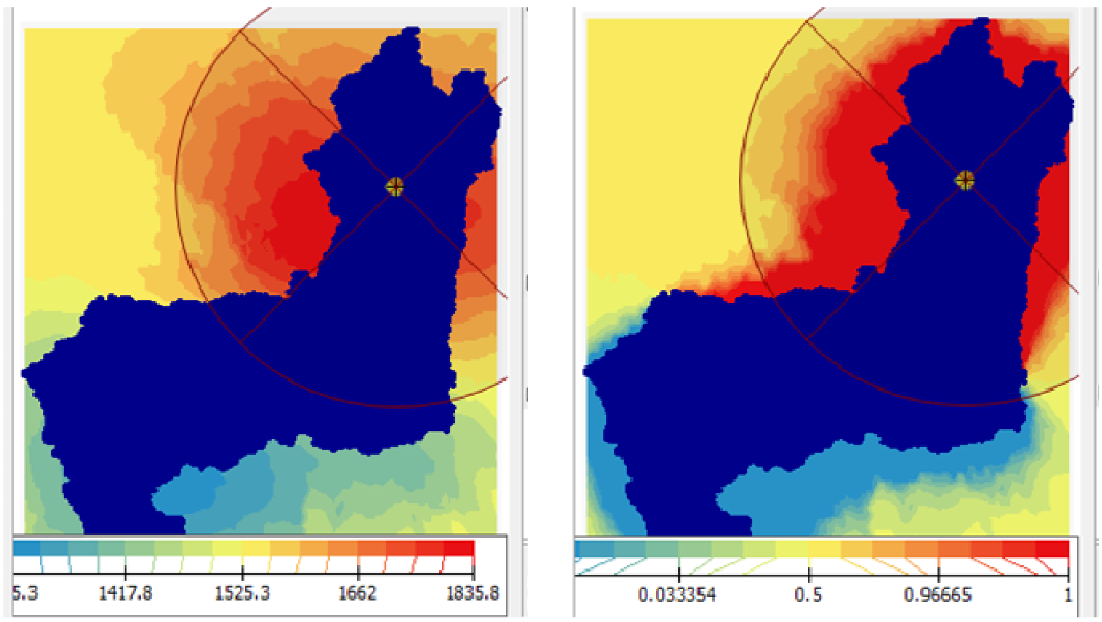


Fig. 3 a. Predicted highly rainfall area

(b.) the probability of high rainfall area

4.3 IFV of Flood occurs

With “Bayesian algorithm”, we analyze flood phenomenon accompany with the kriging rainfall surface. Unstable of flood occurs is related to rainfall section 1730-1770 mm., 1630-1670 mm., and 1570- 1620 mm. The highly unstable flood area belongs to rainfall 1680-1720 mm., while highest rainfall section 1780-1840 mm., found in the stable flood area. Therefore, we use correlation technique to evaluate the relationship between flood occurs and the kriging rainfall surface, as found r = 0.338, that mean not fairly significance.

Rain	nclass	nmsclass	nmap	nmsmap	classden	mapden	cl_map	ivalue
1780 - 1840	281870	121	4600973	74630	0.00043	0.016	0.027	-3.63
1730 - 1770	537712	16446	4600973	74630	0.03059	0.016	1.886	0.63
1680 - 1720	493879	41490	4600973	74630	0.08401	0.016	5.179	1.64
1630 - 1670	449148	9526	4600973	74630	0.02121	0.016	1.308	0.27
1570 - 1620	295333	3664	4600973	74630	0.01241	0.016	0.765	-0.27
1510 - 1560	375522	1481	4600973	74630	0.00394	0.016	0.243	-1.41
1460 - 1500	428935	1191	4600973	74630	0.00278	0.016	0.171	-1.76
1420 - 1450	610302	711	4600973	74630	0.00116	0.016	0.072	-2.63
1380 - 1410	611337	0	4600973	74630	0.00000	0.016	0.000	0
1330 - 1370	517819	0	4600973	74630	0.00000	0.016	0.000	0

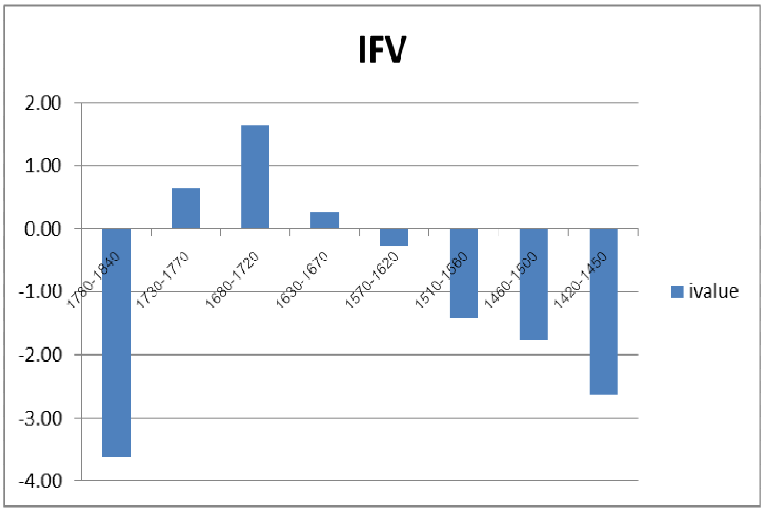


Fig. 4. IFV results

5. CONCLUSIONS.

The trend analysis can show the tendency of rainfall phenomenon, which inspire the idea for the experiment rainfall of the same data with kriging surface, as belong to GIS techniques in term of probabilistic surface, and also can signify probability space and predicted space of rainfall. Depend on the correlation coefficient, rainfall surface didn’t absolutely predict flood occurs in any area. Although, kriging rainfall surface can symbolize more flood occurs in the river basin area, thus more heavy rainfall could impact to more flood occurrence. Belong to our results, any researcher would use our GIS techniques, but also attach any topographic factors for analyzes more obviously results.

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