Extreme Rainfall Analysis on the December 2014 Flood, Terengganu

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Keywords: Rainfall, Kriging method, Inverse Distance Weighting (IDW)

Abstract. In December 2014, Terengganu was hit by the worst floods in three decades. Rainfall was one of the factors that influence this catastrophic event. The findings of this study show the pattern of distribution in the extreme rainfall events that occurred in Terengganu during December 2014. The information of the rainfall distribution can help in identifying the characteristic of the rainfall which could be the significant cause of the Terengganu December 2014 flood. Moreover, the study was centered on looking at two interpolation methods for assessing the rainfall in Terengganu. This study aims to analyze the extreme rainfall event occurred during December 2014 using reliable and sufficient amount of rain gauge data. The analysis includes various cumulative rainfall periods of 1-day, 2-day, 3-day, 5-day, 7-day, 9-day, 11-day, 13-day and 15-day. In this research there are two type method of interpolation used for plotting spatial rainfall distribution. The method assessed here are deterministic interpolation methods of Inverse Distance Weighting (IDW) and the geostatistical method of Kriging. The analysis is conducted by using ArcGIS software. The analyses show that 7 rainfall station (Jambatan Air Putih, Jambatan Tebak, Rumah Pam Pasir Raja, Kg Embong Sekayu Ulu Terengganu, Sungai Gawi, Kampung Bukit Berangan Setiu and Kampung La) have received extreme rainfall and exceed historical data in the past 25 years from 1985 to 2013. Spatial rainfall distribution patterns show high amounts of rainfall accumulated at the worst-hit district in Kemaman, Dungun, Kuala Terengganu, Hulu Terengganu, Besut and Marang.

Introduction

Recent increases in the frequency and intensity of extreme rainfall events have raised concern that human activity might have resulted in an alteration of the climate system. It is believed that rise in both frequency and intensity of extreme rainfall events are the major impacts of global warming [1,2]. Intense rainfall occurrences in short temporal scales or persistent rainfall over long period of time often lead to massive floods resulting in hazardous situations. The increase in massive flood cases, including flash flood and landslides in the last decade, is due to the increase in rainfall intensities. Several factors such as urban heat island (UHI) effect and local temperature changes contribute to the extreme rainfall [3].

Peninsular Malaysia is located near the equatorial line with its latitude between 1°0 0’’N to 7°0’00’’N and 100°0’0’’E to 105°0’0’’E. Because of its location near the equatorial and surrounded by seas (South China Sea on the East and Malacca Straits on the West), Malaysia Peninsular is exposed to climate with uniform temperature and high humidity every year. In general Malaysia is exposed to the Northeast Monsoon Season from November to March and Southwest Monsoon between May to September every year. Usually during Northeast Monsoon, weather conditions will become humid especially to states in east coast Peninsular Malaysia. Combination of cold surges from China Continents and easterly winds from Pacific Ocean have formed convective clouds that bring continuous heavy rain and caused massive flooding to a number of areas in Kelantan, Terengganu and Pahang [4].

From historical overview several major flood events experienced in the east coast area back to year 1926 and 1967 where disastrous floods surged across Terengganu, Kelantan and Perak. A few years later in 1971, another flood occur where Pahang severely affected. Generally, floods in Peninsular Malaysia are caused by heavy rainfalls due to monsoonal and convectional rainstorms and surface factors such as low lying topography, poor drainage system and design, coastal areas located below high tide level and the loss of natural retention areas resulting from urbanization [5, 6]. Massive flood happened from December 17 to December 31, 2014.

On December 2014, states in Peninsular and Sabah received rainfall distributions above normal. Kelantan, Terengganu and Pahang recorded monthly total rainfall amount exceeded 1200 mm. As part of the northeast monsoon, heavy rains since 15 December forced 3,390 people in Kelantan and 4,209 people in Terengganu to flee their homes. By 23 December, most rivers in Kelantan, Pahang, Perak and Terengganu had reached dangerous levels. The situation continues to worsen in Kelantan and Terengganu, due to heavy rain. Most roads in Kelantan have been closed. The worst-hit district in Terengganu is Kemaman, followed by Dungun, Kuala Terengganu, Hulu Terengganu, Besut and Marang. In Pahang, the worst-hit areas are Kuantan, Maran, Jerantut, Lipis and Pekan [7].

Terengganu received heavy rainfall during the North east monsoon that occurs between October and March and leads to severe floods almost every year at all over the state. Terengganu is located at the east coast of Peninsular Malaysia that has never missed a flooding event especially during the months of November and December during the north east monsoon period. The floods that occur at Dungun area of Terengganu state was due to the combination of physical factors such as elevation and also its close proximity to the sea apart from heavy rainfall received during the monsoon period. Hence, a flood that affects the Terengganu area and other location along the eastern coast is termed as a coastal flooding [8].

Objectives

The objectives of this study are:

1. To create rainfall spatial distribution using Inverse Distance Weighted Average (IDW) and Kriging technique based on rain gauge data.
2. To assess the spatial cumulated rainfall depth during the rainfall events on December 2014 in Terengganu.
3. To compare historical rainfall against rainfall event on December 2014 flood.

Literature Review

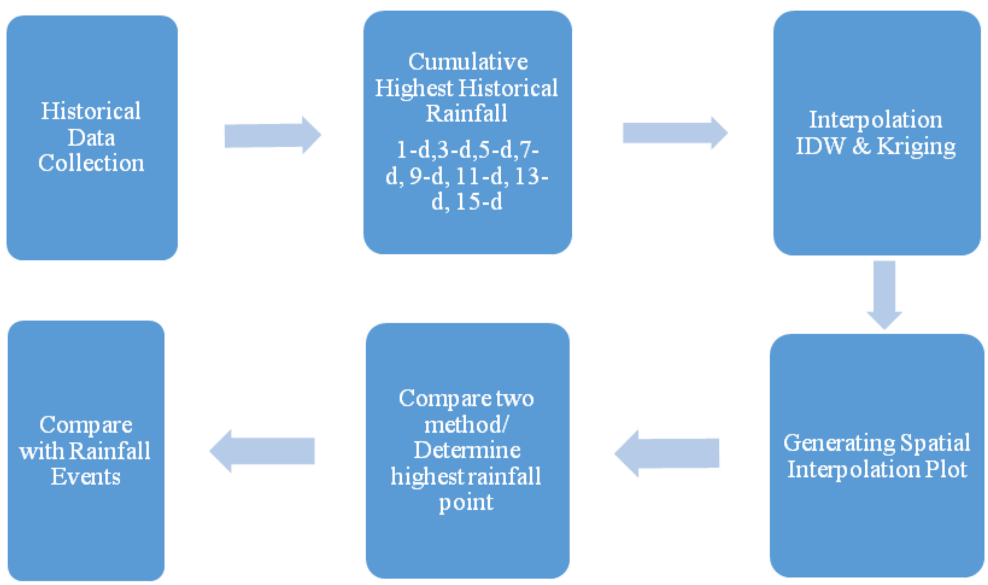
In Malaysia several extreme and drought events have been reported in recent years. For example, an extreme rainfall event from 9 to 11 December 2004 caused severe floods over the eastcoast of Peninsula Malaysia and the effect was worst in Terengganu state. These events are mostly occurred between November and January due to heavy rainfall caused by cold surges of the north-east monsoon [9].

An exceptional rainstorm affected the eastern coast of Peninsular Malaysia during 9–11 December 2004 as a result of a westward propagating tropical disturbance known as the Borneo vortex. Rainfall totals near the storm center exceeded 600mm and led to flash floods, loss of life and severe damage in the area. Results of a numerical simulation of this event using the fifth generation of the Penn State – NCAR Mesoscale Model (MM5) has successfully simulated a synoptic circulationand reproduced the episode with comparable spatial patterns and total accumulated amount of precipitation. Various sensitivity experiments showed that the local topography is decisive in shaping the rainfall distribution during the storm episode. Based on the studies also showed that the role of the terrain elevation appears to block the westward progression of the system and inhibit excessive rainfall in the inland areas of Peninsular Malaysia. Other than that, to the north of the storm center where coastal terrain elevation is relatively high, orography plays an important role in the rainfall by providing an additional forcing for moist air lifting [10].

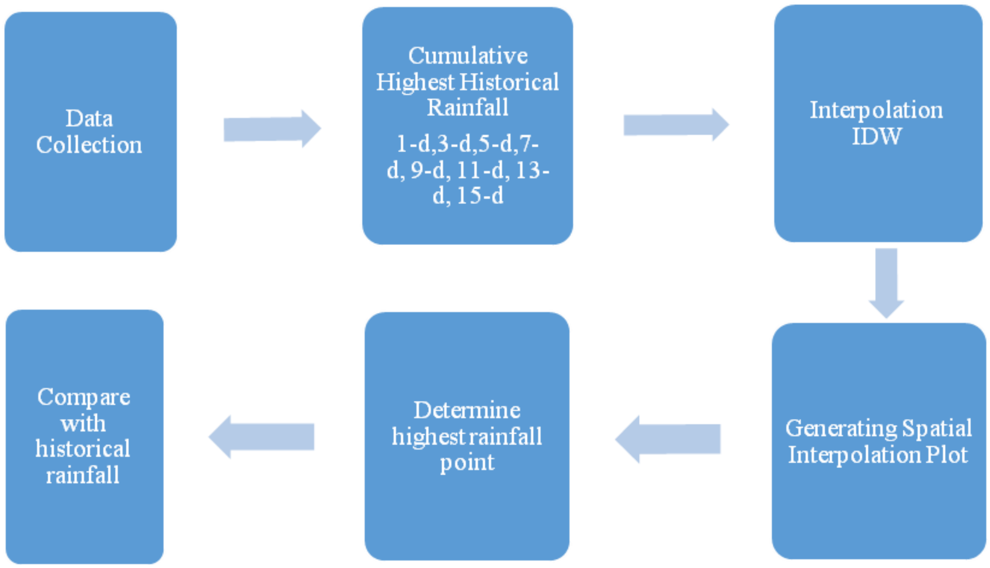
Inverse Distance Weighting (IDW) is the deterministic method, which are based on the location of the measured stations and on measured value [11]. Kriging is an example of a group of geostatistical method. Geostatistical method has capability of producing a prediction surface but also provide some measures of the certainty and accuracy of the predictions. However, geostatistical method can estimate the rainfall values for areas where no rainfall stations exist [12].

Methodology

The analysis uses the rainfall data that was obtained from the Department of Irrigation and Drainage (DID) Malaysia. In order to assess the spatial distribution of the rainfall, 95 rainfall stations consisting of station in Terengganu (52), Pahang (35) and Kelantan (7) were used. The stations chosen are the stations that have rainfall data during December 2014. While for the historical rainfall data, the selected rainfall station chosen was based on two criteria: 1) contain rainfall data for more than 25 years 2) no data error or missing years. For analyzing the historical data, 27 rainfall stations in Terengganu were used. In this research there are two type of interpolation method used for plotting spatial rainfall distribution. The method assessed here are deterministic interpolation methods of Inverse Distance Weighting (IDW) and the geostatistical method of Kriging. Each method uses the same rainfall data sets. The analysis was conducted by using ArcGIS software.



(a) Workflow for historical



(b) Workflow for rainfall event

Figure 1: Work flow of methodology

Data Processing

December 2014 rainfall data that was in hourly was converted to daily data. Then, the data was processed using Microsoft Excel to make it in maximum 1-day and cumulative maximum 3-day, 5-day, 7-day, 9-day, 11-day, 13-day and 15-day. The historical data was sorted out using MATLAB programming software to find the highest maximum 1-day and cumulative maximum 3-day, 5-day, 7-day, 9-day, 11-day, 13-day and 15-day for every year from 1985 until 2013.

Results and Discussion

Highest Historical Rainfall Distribution

Based on the analysis conducted, the selected historical rainfall station plots are shown in (Figure 2). 27 number of rainfall station were selected and the data was interpolated based on more than 25 year historical record. No data error in every rainfall station using Kriging and IDW interpolation method. Figure 3 (a) and (b) show the highest receiving rainfall for the maximum 1-day historical rainfall are Kg. Hulu Seladang Setiu rain station (1340 mm), Pusat Kesihatan Paka rain station (1216 mm) and Klinik Kg. Raja Besut rain station (1189 mm) which rainfall exceed more than 1000 mm.

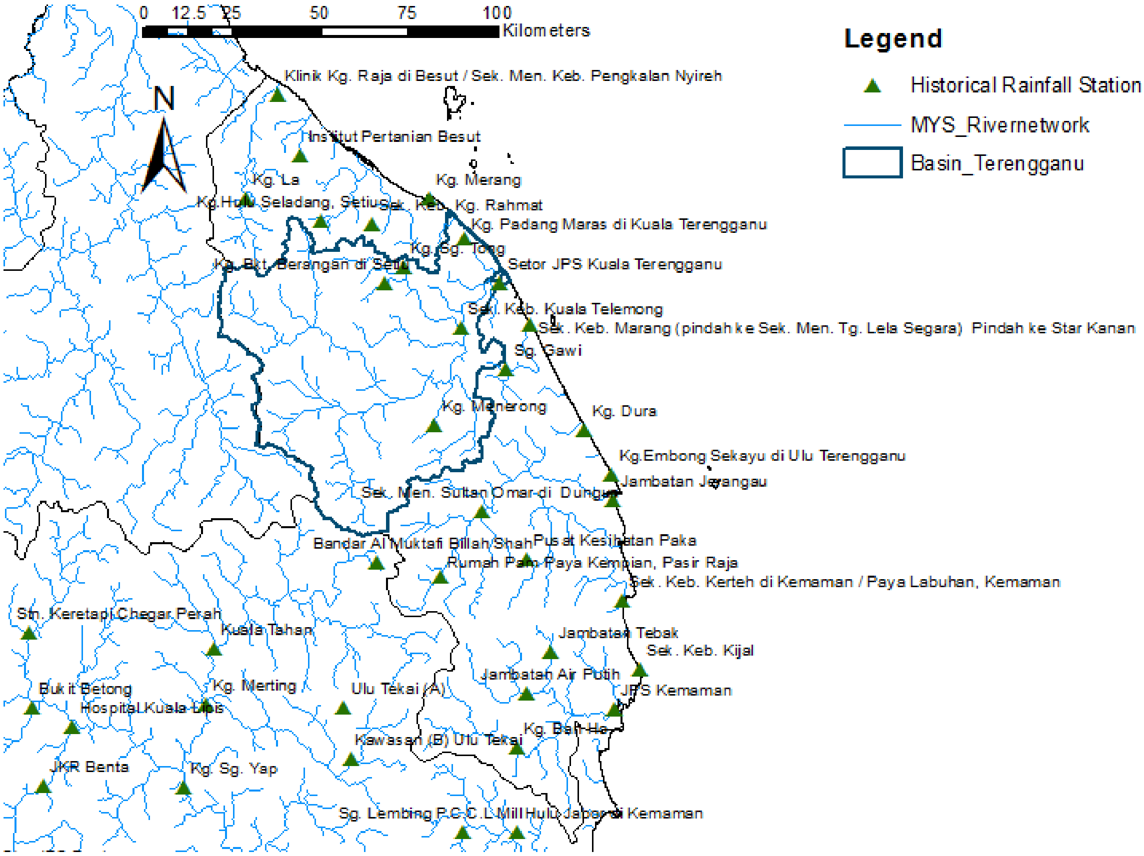
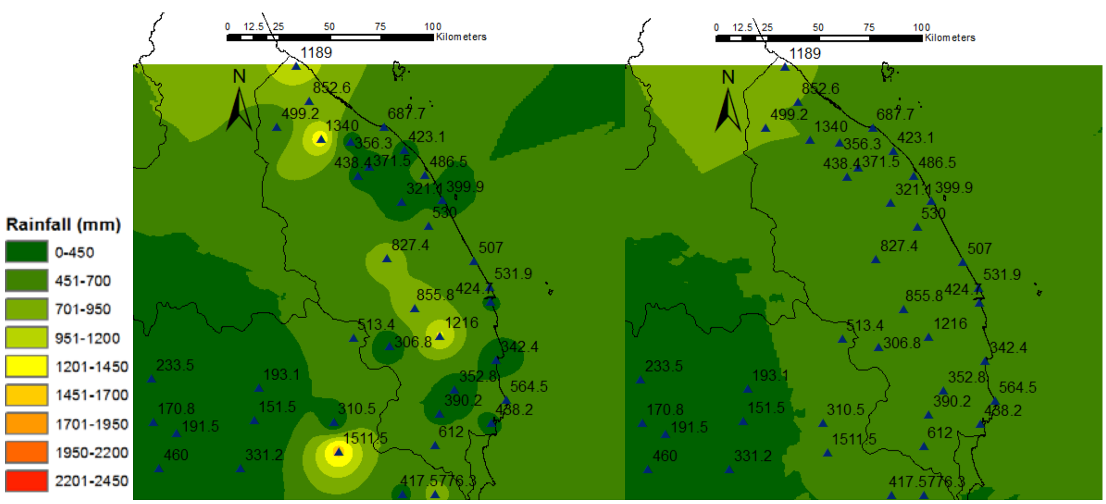
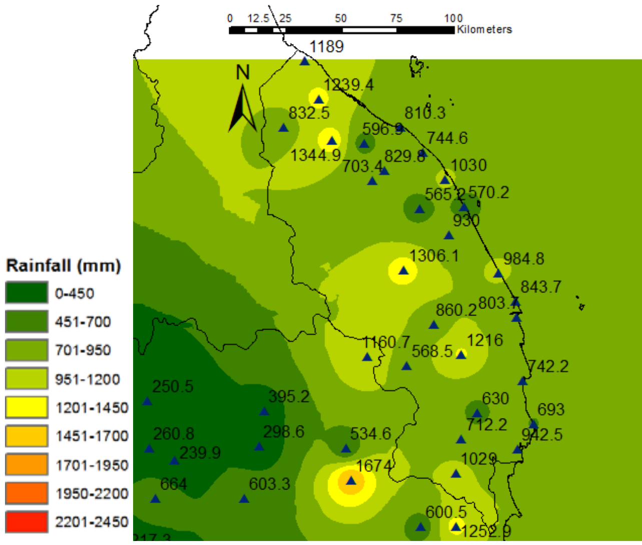


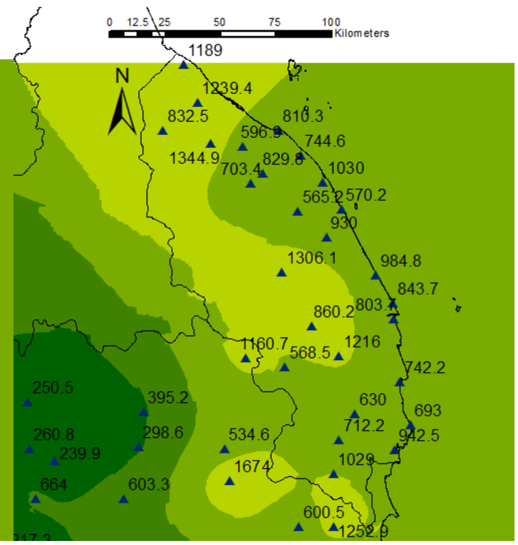
Figure 2: Selected historical rainfall station



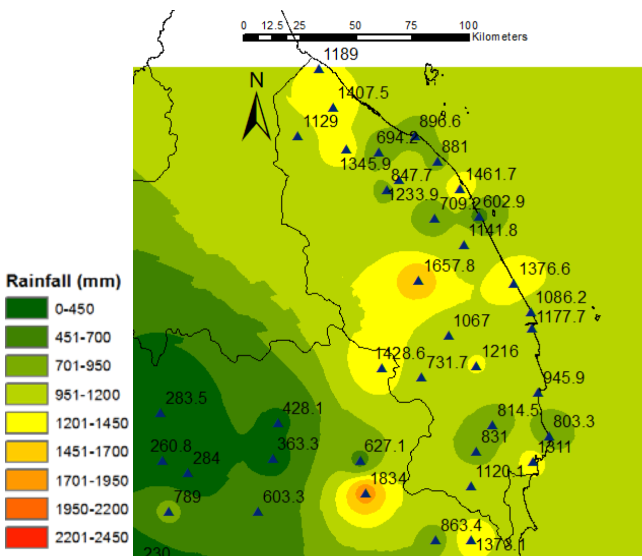
(a) Max 1-day IDW (b) Max 1-day Kriging



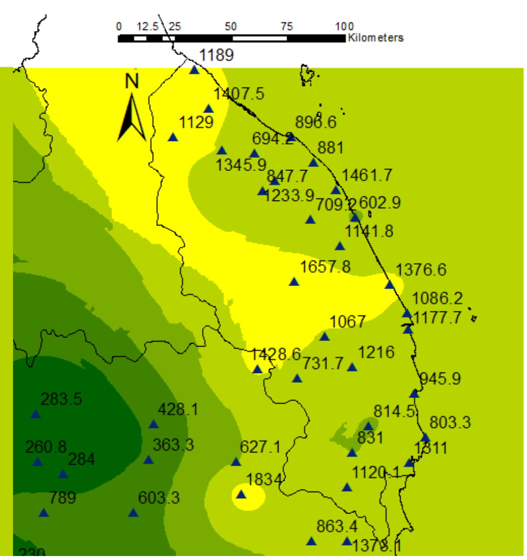
(c) Max 3-day IDW



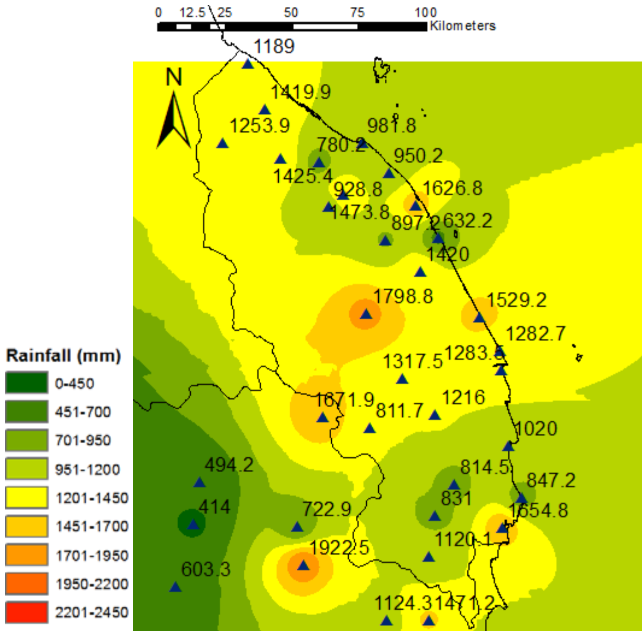
(d) Max 3-day Kriging



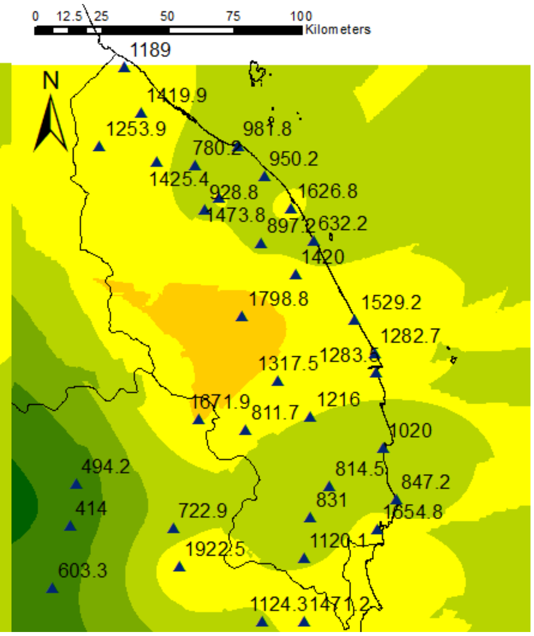
(e) Max 5-day IDW



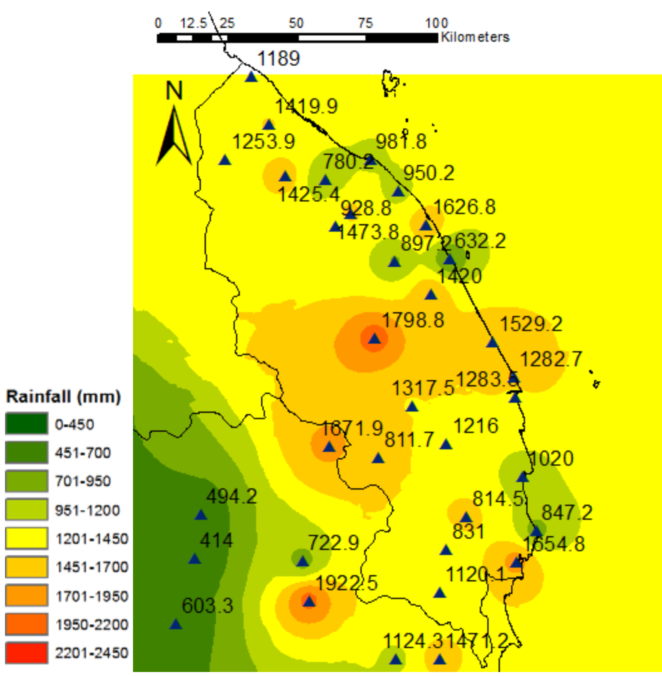
(f) Max 5-day Kriging



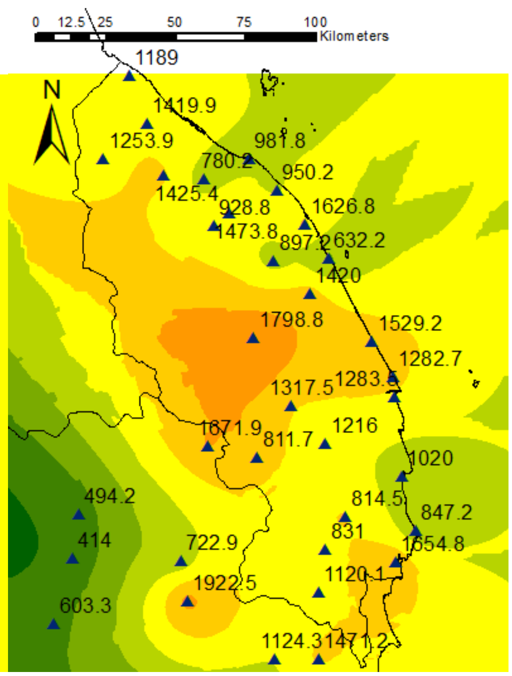
(g) Max 7-day IDW



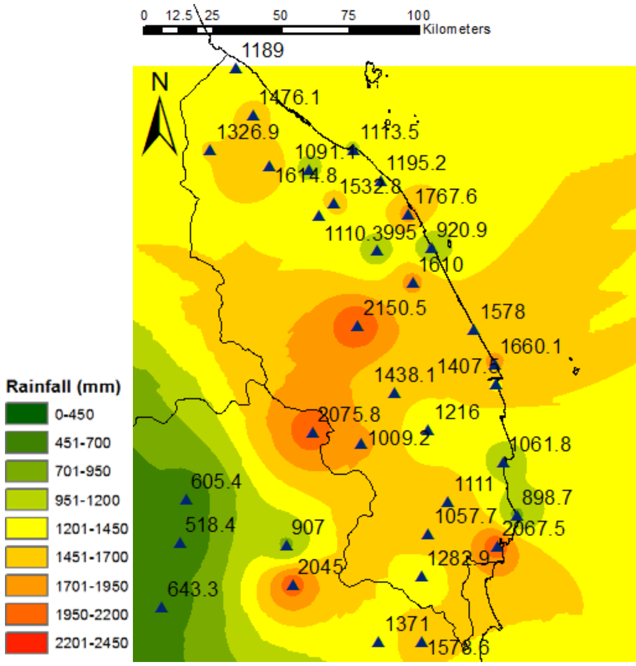
(h) Max 7-day Kriging



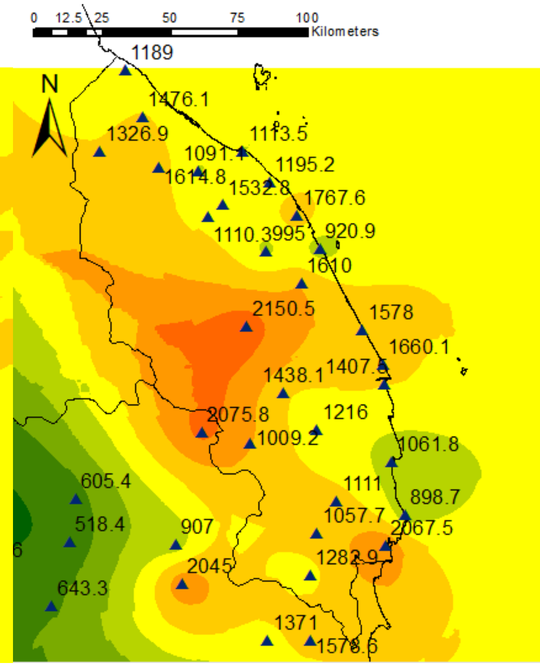
(i) Max 9-day IDW



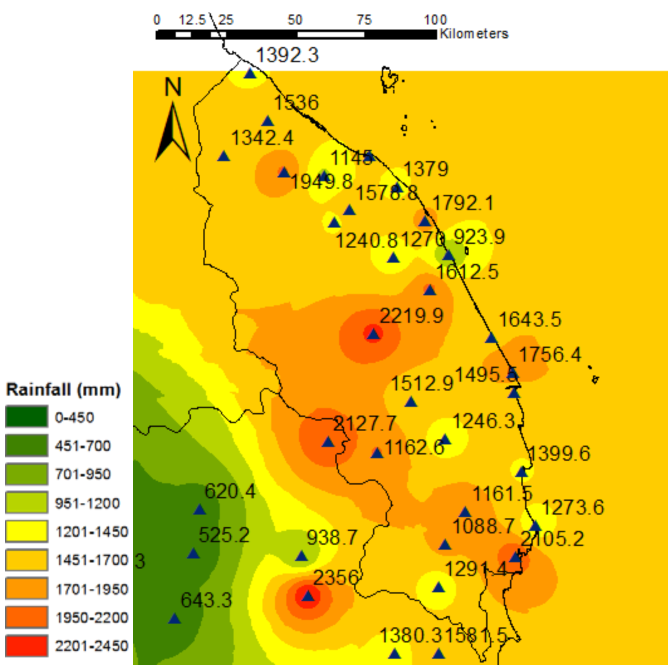
(j) Max 9-day Kriging



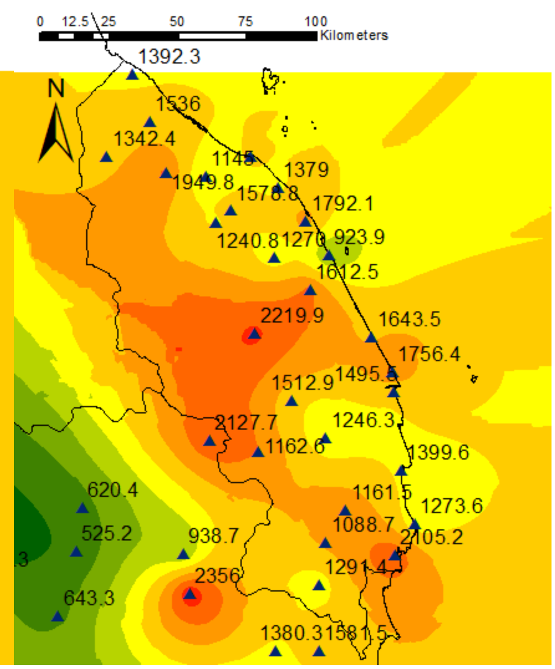
(k) Max 11-day IDW



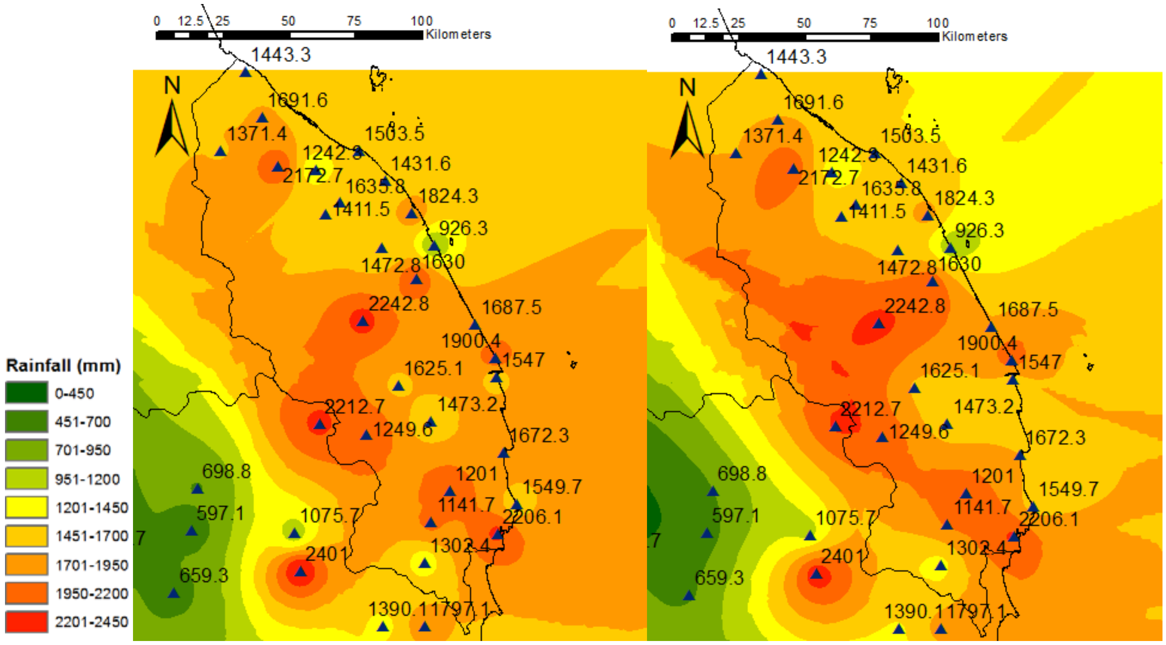
(l) Max 11-day Kriging



(m) Max 13-day IDW



(n) Max 13-day Kriging



(o) Max 15-day IDW (p) Max 15-day Kriging

Figure 3: (a) – (p) Distribution of historical rainfall

The distribution based on IDW shows a high historical of rainfall depth distributionon the North and Central of Terengganu for the 1-day rainfall. When rainfall data were cumulated from 1-day to 5-day,the historical high cumulated rainfall depth are observed on North-West and Central of Terengganu. From cumulative 7-day to 15-day, the high rainfall distribution were more concentrated more on North, Central and South-East. Meanwhile in distribution based on Kriging interpolation, the spatial distribution of high rainfall show a concentrated rainfall in north area for 1-day. From cumulative 3-day to 5-day the high rainfall concentrated area was from North,West and Central area of Terengganu. Starting from cumulative of 7-day to 15-day, the concentrated high rainfall were more focused on Central and South-East area of Terengganu. From this we can clearly see that in IDW, the dispersion of interpolated rainfall depths are much more focus and concentrated on the rainfall station. That is why the concentration of rainfall depths focusing on certain point of rain station while Kriging interpolation of rainfall depth is more towards dispersing around the area. From the result of interpolation by ArcGIS, we can see there are differences of spatial distribution between IDW and Kriging. In term of the spatial distribution pattern, IDW interpolation is much more look like a circular while Kriging is not. There is a difference because of the method Kriging weights for the surrounding measured points are more sophisticated and complex using a mathematical function than those of IDW that used directly based on the surrounding rainfall station to measure the interpolated rainfall depth.

Spatial Rainfall Distribution

Table 1: List of 95 rainfall stations used

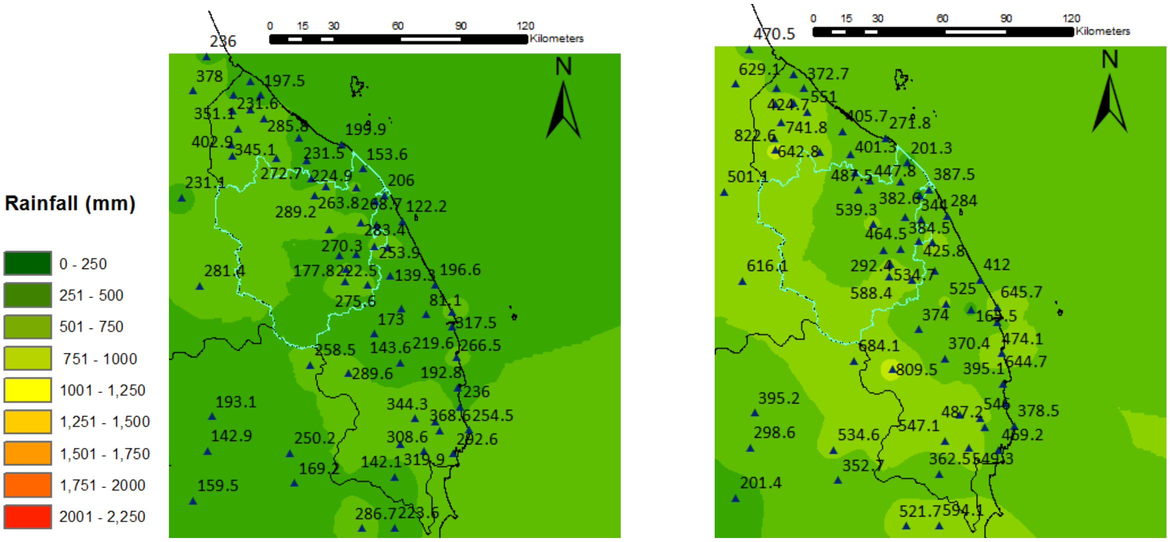
Station no.	Station name	State	Latitude	Longitude
2630001	Sg. Pukim	Pahang	2.603	103.057
2634193	Sg. Anak endau kg. Mok	Pahang	2.617	103.458
2828173	Kg. Gambir	Pahang	2.850	102.839
2829001	Ulu sg. Chanis	Pahang	2.813	102.938
2831179	Kg. Kedaik	Pahang	2.889	103.186
2834001	Stn. Pertanian rompin-endau	Pahang	2.813	103.450
2841001	Takek,pulau tioman	Pahang	2.818	104.165
3026156	Pos iskandar	Pahang	3.027	102.658
3028001	Sg. Kepasing	Pahang	3.020	102.832
3030178	Pecah batu bkt. Raidan	Pahang	3.065	103.081
3032167	Temeris	Pahang	3.016	103.199
3121143	Simpang pelangai	Pahang	3.175	102.197
3129177	Bkt. Ibam	Pahang	3.168	102.976
3134165	Dispensari nenasi di pekan	Pahang	3.137	103.442
3221001	Jkr kg. Manchis	Pahang	3.202	102.163
3228174	Sg. Cabang kanan	Pahang	3.298	102.822
3231163	Kg. Unchang	Pahang	3.287	103.189
3330109	Kampong batu gong	Pahang	3.390	103.026
3424081	Jps temerloh	Pahang	3.438	102.426
3429096	Kg. Salong	Pahang	3.486	102.933
3519125	Kuala marong di bentong	Pahang	3.512	101.915
3533102	Rumah pam pahang tua di pekan	Pahang	3.561	103.357
3628001	Pintu kawalan paya kertam	Pahang	3.633	102.856
3818054	Stor jps raub	Pahang	3.805	101.847
3930012	Sg. Lembing p.c.c.l mill	Pahang	3.916	103.036
4019001	Jkr benta	Pahang	4.033	101.967
4023001	Kg. Sg. Yap	Pahang	4.031	102.325
4120064	Hospital kuala lipis	Pahang	4.186	102.043
4127001	Kawasan (b) ulu tekai	Pahang	4.105	102.753
4219001	Bukit betong	Pahang	4.233	101.940
4223115	Kg. Merting	Pahang	4.243	102.383

4227001	Ulu tekai (a)	Pahang	4.233	102.733
4324001	Kuala tahan	Pahang	4.386	102.403
4419047	Stn. Keretapi chegar perah	Pahang	4.425	101.933
4513033	G. Brinchang di c.highlands	Pahang	4.516	101.383
3933001	Hulu jabor di kemaman	Terengganu	3.918	103.175
4131001	Kg. Ban ho	Terengganu	4.133	103.175
4232002	Jambatan air putih	Terengganu	4.270	103.199
4232104	Sek. Keb. Pasir gajah	Terengganu	4.238	103.297
4234109	Jps kemaman	Terengganu	4.231	103.422
4332001	Jambatan tebak	Terengganu	4.377	103.263
4333001	Seri bandi	Terengganu	4.362	103.347
4333096	Klinik bidan di kg. Ibok	Terengganu	4.327	103.368
4334094	Sek. Keb. Kijal	Terengganu	4.331	103.488
4434093	Sek. Men. Keb. Badrul alam shah	Terengganu	4.427	103.451
4529001	Rumah pam paya kempian, pasir raja	Terengganu	4.568	102.979
4534092	Sek. Keb. Kerteh di kemaman	Terengganu	4.508	103.444
4631001	Bandar al muktafi billah shah	Terengganu	4.603	102.819
4634085	Pusat kesihatan paka	Terengganu	4.613	103.199
4730002	Kg. Surau di kuala jengai	Terengganu	4.636	103.438
4734079	Sek. Men. Sultan omar di dungun	Terengganu	4.734	103.087
4832011	Jambatan jerangau	Terengganu	4.762	103.419
4833078	Rumah pam delong, dungun	Terengganu	4.843	103.204
4834001	Klinik bidan di kuala abang	Terengganu	4.816	103.309
4929001	Kg.embong sekayu	Terengganu	4.827	103.416
4930038	Kg. Menerong	Terengganu	4.952	102.966
4931061	Ldg. Koko jerangau	Terengganu	4.938	103.061
4933001	Sek men keb jambu bongkok	Terengganu	4.977	103.158
5029034	Kg. Dura	Terengganu	4.943	103.348
5029035	Sek. Keb. Kg. Dusun	Terengganu	5.066	102.941
5030039	Jps.hulu trg	Terengganu	5.008	102.969
5031062	Kg. Bukit diman ulu terengganu	Terengganu	5.070	103.013
5128001	Sg. Gawi	Terengganu	5.098	103.147
5129040	Rumah pam paya rapat	Terengganu	5.172	102.901
5130063	Stn. Pertanian ajil	Terengganu	5.102	103.090
5131064	Sek. Men. Bkt. Sawa	Terengganu	5.191	103.100

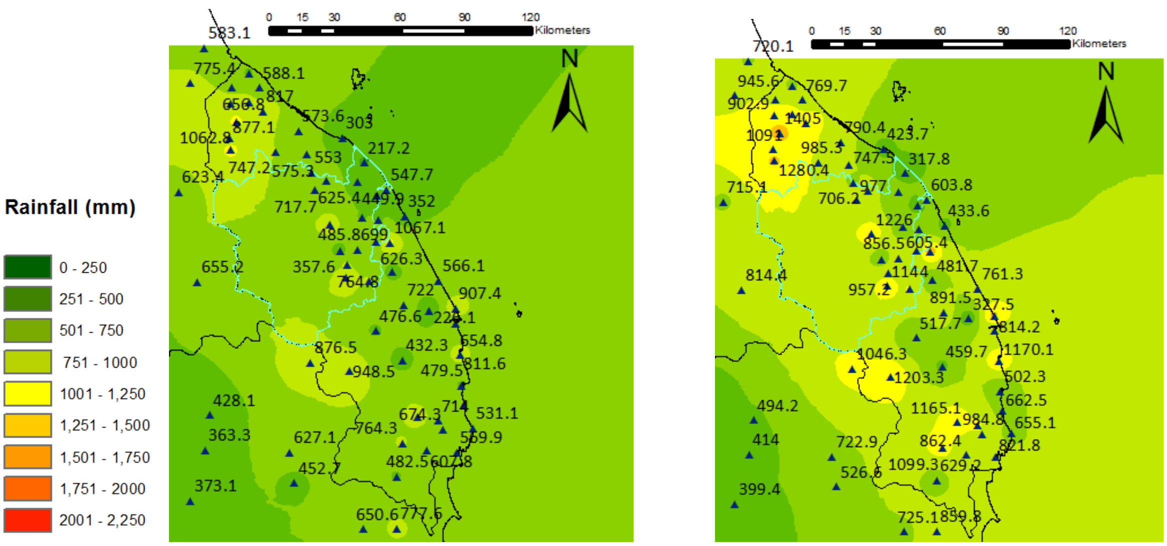
5230041	Sek. Keb. Kuala telemong	Terengganu	5.202	103.031
5230042	Rumah pam pulau musang	Terengganu	5.294	103.095
5232065	Star kanan	Terengganu	5.208	103.206
5328002	Bkt. Durian di chalok-site 3	Terengganu	5.390	102.823
5328043	Kg. Bkt. Berangan di setiu	Terengganu	5.316	102.838
5328044	Kg. Sg. Tong	Terengganu	5.355	102.886
5330046	Sek. Keb. Kg. Gemuroh	Terengganu	5.350	103.013
5331048	Setor jps kuala terengganu	Terengganu	5.318	103.133
5424001	Kg. Keruak di ulu besut	Terengganu	5.483	102.491
5426001	Kg.hulu seladang, setiu	Terengganu	5.476	102.675
5428025	Sek. Keb. Kg. Rahmat	Terengganu	5.465	102.805
5430049	Kg. Padang maras	Terengganu	5.429	103.040
5524001	Kg. La	Terengganu	5.530	102.483
5527024	Stesen kg banggol	Terengganu	5.561	102.772
5529027	Kg. Merang	Terengganu	5.531	102.951
5624001	Empangan jajar	Terengganu	5.674	102.490
5625003	Ibu bekalan sg. Angga, ulu besut	Terengganu	5.600	102.515
5625011	Sek. Keb. Kg. Jabi	Terengganu	5.679	102.563
5626001	Institut pertanian besut	Terengganu	5.643	102.622
5724003	Jambatan jertih	Terengganu	5.739	102.493
5725006	Klinik kg. Raja di besut	Terengganu	5.797	102.565
5726013	Sek. Keb. Kg. Tembila di besut	Terengganu	5.740	102.608
4614001	Brook	Kelantan	4.676	101.484
4717001	Blau	Kelantan	4.600	101.400
4819027	Gua musang	Kelantan	4.879	101.969
4923001	Kg. Aring	Kelantan	4.938	102.353
5322044	Kg. Laloh	Kelantan	5.308	102.275
5723056	Telusan	Kelantan	5.758	102.322
5923081	Tok ajam	Kelantan	5.904	102.381

Based from the result of IDW spatial interpolation, comparisons can be made to see whether the event rainfall on December 2014 exceed the historical maximum. The analysis was made from 15-29 December 2014 based on 1-days, 3-days, 5-days, 7-days, 9-days, 11-days,13-days and 15-days. In the 1-day event, heavy rainfall was pouring on two separated location which are the North-West of Terengganu (e.g Kg. Keruak Ulu Besut, 402.9 mm and Kg. La, 345.1 mm) and South-East of Terengganu (e.g Seri Bandi, 384.8 mm and Klinik Bidan Kg. Ibok, 368.6 mm) but none of them are exceeding the value of historical rainfall. Following 3-day event Rumah Pam Paya Kempian, Pasir Raja are the highest station receiving heavy rainfall with a cumulative rainfall depth of 809.5 mm almost near the historical rainfall 825.5 mm.

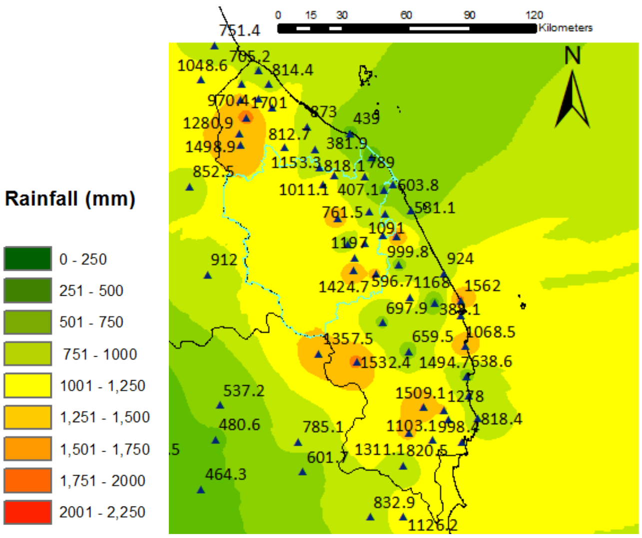
As for 5-day event until 15-days event, the area that have a higher cumulative rainfall are on North-West, Central,South and East Coast of Terengganu.



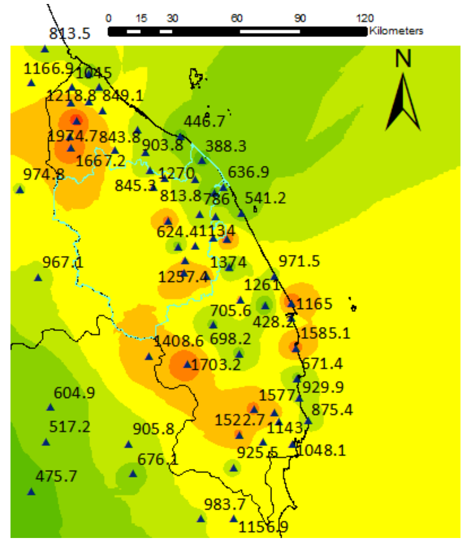
(a) Max 1-day IDW (b) Max 3-day IDW



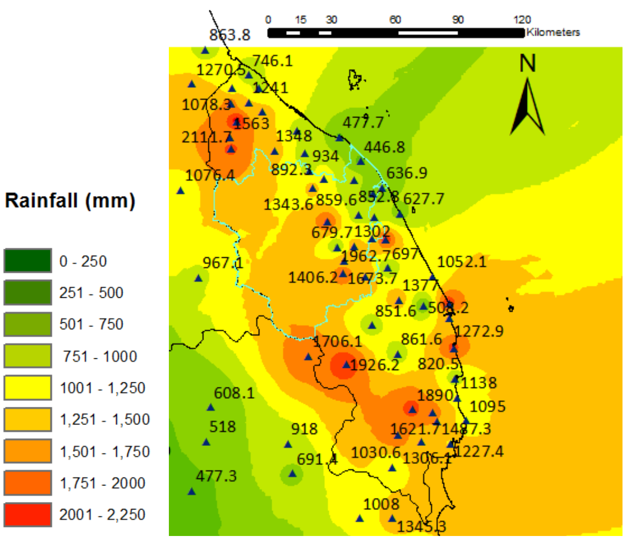
(c) Max 5-day IDW (d) Max 7-day IDW



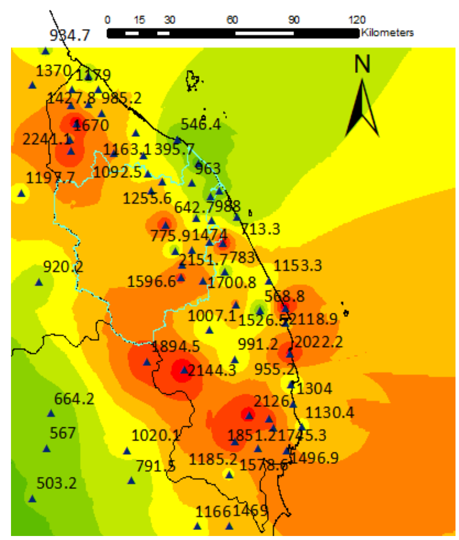
(e) Max 9-day IDW



(f) Max 11-day IDW



(g) Max 13-day IDW



(h) Max 15-day IDW

Figure 4: (a) – (h) Distribution of December 2014 rainfall

Comparison of Highest Historical Rainfall and Rainfall Events

The comparison between historical rainfall with event rainfall can be made. 7 areas of rainfall stations were identified. The 7 areas that received extreme rainfall and exceeded historical data in the past 25 years is Jambatan Air Putih, Jambatan Tebak, Rumah Pam Pasir Raja, Kg Embong Sekayu Ulu Terengganu, Sungai Gawi, Kampung Bukit Berangan Setiu and Kampung La. Table 2 show the comparison between highest historical rainfall and December 2014 rainfall events. The highlighted area in the Table 2 shows the value of rainfall that exceed the historical rainfall data. Thus, this show rainfall events that occur could have significant contribution to the cause of flood in December 2014.

Table 2: December 2014 rainfall station that exceed historical data

STATION NAME	1-day Historical (mm)	15 Dec 2014 Events (mm)	3-day Historical (mm)	15-17 Dec 2014 Events (mm)	5-day Historical (mm)	15-19 Dec 2014 Events (mm)	7-day Historical (mm)	15-21 Dec 2014 Events (mm)
Jambatan Air Putih	390.2	319.9	712.2	547.1	831	764.3	831	1099.3
Jambatan Tebak	352.8	344.3	630	641.3	814.5	843.1	814.5	1165.1
Rumah Pam Paya Kempian, Pasir Raja	306.8	289.6	568.5	809.5	731.7	948.5	811.7	1203.3
Kg.Embong Sekayu di Ulu Terengganu	531.9	317.5	843.7	645.7	1086.2	907.4	1282.7	1292.3
Sg. Gawi	530	336.6	930	717.4	1141.8	1067.1	1420	1412.4
Kg. Bkt. Berangan di Setiu	438.4	289.2	703.4	487.5	847.7	717.7	928.8	977
Kg. La	499.2	345.1	832.5	642.8	1129	877.1	1253.9	1091

Station name	9-day historical (mm)	15-23 dec 2014 events (mm)	11-day historical (mm)	15-25 dec 2014 events (mm)	13-day historical (mm)	15-27 dec 2014 events (mm)	15-day historical (mm)	15-29 dec 2014 events (mm)
Jambatan Air Putih	1019.5	1311.1	1057.7	1522.7	1088.7	1728.2	1141.7	1963.2
Jambatan Tebak	1065.5	1509.1	1111	1577	1161.5	1890	1201	2126
Rumah Pam Paya Kempian, Pasir Raja	900	1532.4	1009.2	1703.2	1162.6	1926.2	1249.6	2144.3
Kg.Embong Sekayu di Ulu Terengganu	1381.3	1562	1660.1	1739.2	1756.4	1897.7	1900.4	2118.9
Sg. Gawi	1545	1651.2	1610	1751.7	1612.5	1962.7	1630	2151.7
Kg. Bkt. Berangan di Setiu	1054.7	1214.5	1110.3	1270	1240.8	1343.6	1411.5	1495.6
Kg. La	1323.9	1280.9	1326.9	1426.5	1342.4	1563	1371.4	1670

Factor Contributing December 2014 Flood

Rain and River

During December 2014, non-stop rain poured for eight days and on 19 December, heavy rainfall occurred for more than 6 hours. High intensity rainfall and continuously is one of the possible reason the flood occurred. When this matter happen, the underground drainage system were saturated with the rainfall water and lead to its failure. Underground drainage system cannot contain the rainfall water anymore thus flowing out on the earth surface and flooding the area. Most of the rainfall station that exceed the historical rainfall data is located near the river so this is the reason why the area is flooded. The rainfall stations are as mentioned in section 4.3.

The rainfall stations located near the main river are Sungai Besut (Kg. La), Sungai Terengganu (Kg Bukit Berangan,Kg. Embong Sekayu), Sungai Dungun (Rumah Pam Pasir Raja, Sg. Gawi) and Sungai Kemaman (Jambatan Air Putih, Jambatan Tebak).

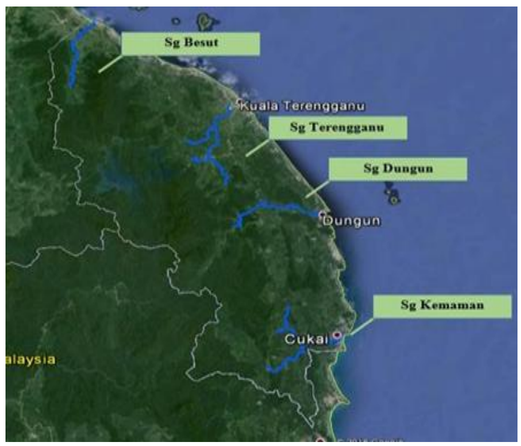


Figure 5: Location of main river in Terengganu

The level of river water reaches its maximum and overflow. By the end of 2014, most of the rivers in Terengganu had reached dangerous level. The Terengganu Department of Irrigation and Drainage (DID) Hydrology Division Flood Operations Room reported that on 20 December 2014, the water level at Sungai Dungun in Kuala Jengai exceeded the danger level with 21.6 metres (danger level is 21 metres) while Sungai Dungun at Jerangau Bridge recorded 13.42 metres (danger level is 12.5 metres).

Topography of Area

Topography of the area have an influence in causing the flood. Based from the topography of Terengganu state area (Figure 6) most of flooded areas are located in low level areas. The areas that were affected by flood are Besut, Dungun, Hulu Terengganu, Kemaman, Kuala Terengganu and Marang. Most of the flooded areas on the list is located near the coastal area except the Hulu Terengganu area that located at the center on Terengganu River basin. Most of the low-lying areas along the coast is formed from a series of sand ridges or gong formed parallel to the beach. Among these sand ridges or grooves formed area of regional lower than gong [13].

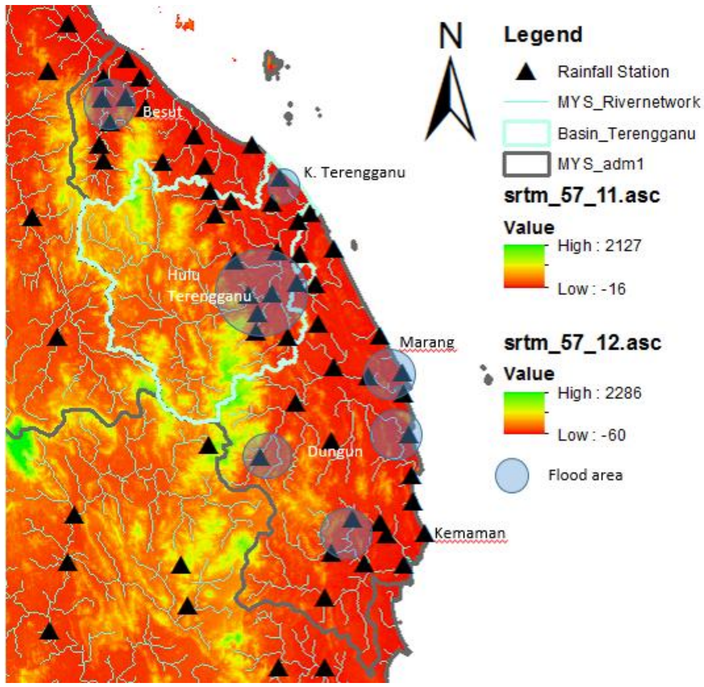


Figure 6: Terengganu topography map and location of December 2014 flood

Conclusion

Extreme rainfall is one of the factor that can lead to natural disaster such as flood that occur in Terengganu on December 2014. The objective of this study is to analyze the rainfall distribution pattern based on extreme rainfall events in Terengganu from 15- 29 December 2014 using rain gauge stations. 95 rainfall stations have been used to analyze the distribution rainfall depth pattern using Inverse Distance Weighted (IDW) spatial interpolation techniques in this study. With the application of geographic information system software ArcGIS 10.2.1, spatial analysis of the computed extreme rainfall able to conduct. Next, with the help of programming software, it is easily to sort out of much more detail rainfall data to simple data in accordingly.

The comparison of rainfall event of December 2014 with historical rainfall of more than 25 years record was carried out and 7 areas were identified have rainfall events exceeding the value of historical events. Consequently this area was flooded as a result of extreme rainfall occurred in that area. Other than this, another factor also caused the flood such as river and geographical factor in term of topography of area.

Therefore, we can summarize the analysis on the extreme rainfall events as follows. In comparison with other spatial interpolation, IDW spatial interpolation method is a good tool for those who want to study, understand and analyze rainfall event. Meanwhile the result from this study can be used for future reference or something that related with flood. In addition, the study about frequency analysis can also be conducted to estimate the return period of the rainfall events.

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