International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 05 | May 2022 www.irjet.net p-ISSN: 2395-0072

The impact of the floods in the Kuzhur panchayat and the depth of the floods in the area as the spillway of Peringalkuth were opened.

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Abstract - *Floods are one of the strongest forces on earth. Floods arise when water surges the land that is already dry. Floods are one of the major causes of natural disasters change to the economy, environmental damage, destruction of human settlements, and public-private services there for the floods are the most devastating disasters. River floods are the most frequent and often devastating. It is mainly due to excessive rain, ruptured dam or levee, tides or cyclonic surges, rapid melting of snow, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions, deposition of materials in stream channels during flood recession, the rise of groundwater coincident with increased streamflow and other geo-environmental influences. India is a developing country and floods have been a regular phenomenon in the country from time immemorial. Almost every year floods of varying magnitude affect some parts of the country or others. Different regions of the country have different climates and rainfall patterns and so some parts face devastating floods and other parts may experience drought conditions at the same time. In recent years, many flood events were reported in the country which has caused damage to life and property. Kerala is a south-western state of India and its population is 3.46 crore (2018) with a total area of 38,863km2. The state is divided into 14 districts within 941 panchayats. Usually, Kerala receives rainfall of about 3000mm annually. In 2018, the intensity of the southwest monsoon was very high which resulted in severe flooding. This flood was recorded as the highest flood that the Kerala state has ever experienced. Earlier the "Great flood of 99" was reported as the highest flood in Kerala in the year 1924 where the rain continued for about 3 weeks and many districts of present Kerala were submerged in the water. The 2018 flood inundated 13 out of 14 districts in the state. The study was conducted in the Kuzhur panchayat which is one of the best panchayats in the Thrissur district. Kuzhur panchayat is a panchayat that was completely submerged in the 2018 floods. It is located in the Mala block of Mukunthapuram taluk and the panchayat is bordered by Mala, Annamada Panchayats in the north, Poyya, and Puthanvelikara panchayats in the west, Chalakudy river in the south, Annamada and Parakadavu panchayats in the east. Kuzhur is 37.6 km far from its District Main City, Thrissur.*

***Key Words*: Landslide, GIS, Kuzhur, Flood, LULC, etc.**

1. INTRODUCTION

Earth has many powerful forces and we say natural disasters are one among them. A flood is a natural disaster that causes harm to the people, and environment and also disturbs the economic development of the place. Human societies worldwide have lived and died with floods from the very beginning, spawning a prominent role of floods within legends, religions, and history (Jim E. O'Connor and John E. Costa 2004). Most floods take hours or even days to develop giving residents time to prepare or evacuate. Murray and Ebi, (2012) stated that flash floods are caused by an excessive amount of rain falling within a short period of time or the massive amount of water suddenly released from rivers or dams. Flash floods are difficult to predict because they are characterized by quick and intense runoff generation that leads to a rapid rise of water levels and discharges reaching to peak within less than one hour to a few hours after the onset of the generating storm (Borga et al., 2011).

Floods have been a regular phenomenon in the Indian subcontinent from time immemorial. The flash floods of Uttarakhand in June 2013, Jammu & Kashmir in 2014, Chennai Flood in 2015, etc. are the major flood events reported in the country. The 'Great flood of 99' was a severe flood reported in Kerala in 1924 which plunged many districts in water. Kerala Flood of 2018 was the highest flood that the Kerala state has ever experienced. This flood inundated 13 out of 14 districts in the state. As the rainfall data of IMD, Kerala received about 2346.6 mm of rainfall from June 1st, 2018 to August 19th, 2018 in contrast to an expected 1649.5 mm. Kerala authorities opened the shutters of 35 of the state's 39 dams, which had reached dangerously high water levels. Floods were so severe that the entire state was brought to a standstill for many days. Kerala flood caused the death of more than 483 people and economic damage exceeding $3 billion. More than 1 million people were displaced and 3,274 relief camps were opened. The crops of 54,000 hectares were destroyed and 537 landslides were reported. The roads and bridges were damaged which covered 16000 km and 221 bridges respectively. This study analyses the flood impact on Kuzhur Panchayat, Thrissur District where more than 60% of the panchayat was affected by the flood of 2018. The study was carried out using Remote Sensing and GIS.

1.1 Study Area

Kuzhur Panchayat has a geographical area of 19.11 sq. km and lies between 10º10'24" and 10º13'23.98" N latitude and 76º15'53.7" and 76º18'45.33" E longitude. It has a total population of 19956 of which 9737 are males and 10219 females. The panchayat has 5603 households. (Kerala state land use board, 2007). This panchayat has an agricultural-based economy and lies at an elevation of 16m above MSL. It has the lateritic type of soil. The Chalakudy River runs along the area. This area experiences a tropical wet climate with a strong monsoon.

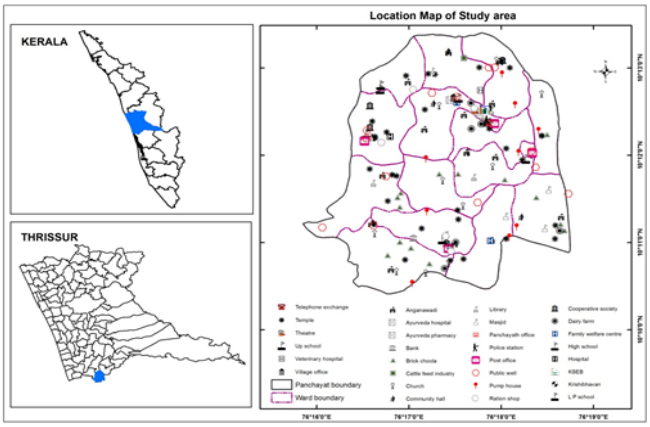

Fig -1: Location map

Table -1: Census Data

Year	Total Population	Household
1991	16626	3202
2001	18569	3578
2007	19456	4457
2011	19916	5060
2019	-	5603

2. MATERIALS AND METHODS

For the study, all analysis was done by ArcGIS and Qgis software. Survey of India (SOI) Toposheet on 1:50,00 scales used for drawing drainage patterns. And GPS Garmin is used for field location for selective location and measure water level. Quick map service plugin Google satellite image 2018 for Land use land cover.

2.1 Area detection

The study area Kuzhur was selected based on the flood intensity reported in the area during the 2018 flood of Kerala.

2.2 Collection of Secondary Data

The secondary data such as census data, climate, population, area, wards, boundaries, geography, soil types, major crops, and location map details were collected from the Mala block report 2007 of Kerala Land Use Board.

2.3 Field Survey

The field survey conducted in the month of April lasted for 15 days. The questionnaires were prepared to interview the people of the panchayat to record the details of the flood, its intensity, and its impacts.

2.3 Land Use and Land Cover Map Creation

The LULC map creation for the study area was carried out based on the census data. The hike in the population density brought changes in the LULC. The base map was digitized from the topo sheet. The LULC map of 2018 was also digitized using the Google Satellite data.

2.3 Flood Map Preparation

The flood map was created based on the details collected during the Field survey. The flood Intensity, Flood Zone, LULC Maps of Flood Zones, 3D view Flood map, and also the Map regarding the 'Impact of Spillway Opening of Peringalkuthu Reservoir on Kuzhur Flood Levels' were created.

3. RESULT AND DISCUSSION

3.1 Base map – 1968

The base map was created using the Toposheet (58B/8) on a 1:50,000 scale. The base map was prepared as historical reference data.

Table -2: Category details of the base map

Sl.No	Category	Area(Ha.)	Percentage of total area
1	River	39.06	2.04
2	Water body	35.7	1.87
3	Paddy	901.13	47.15
4	Cultural landscape & Homestead with Mixed cultivation	890.05	48.93
Total		**1911.09**	**100.00**

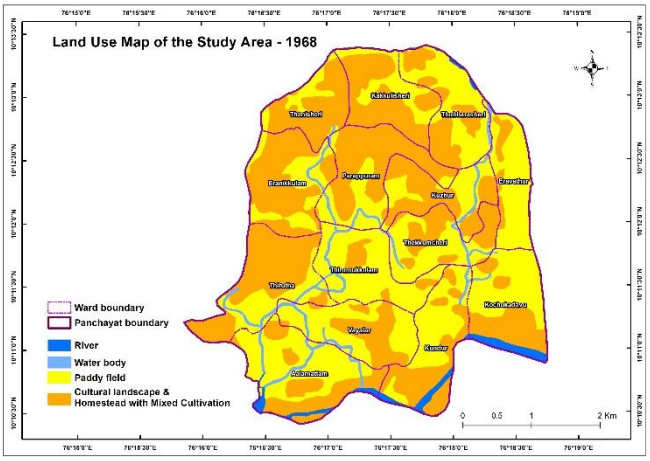

Fig -2: Base map (1986)

3.2 LULC map – 2018

The LULC map of 2018 was digitized from the Quick map service plugin in Qgis using Google satellite and Google map.

Table -3: LULC categories of 2018

Sl.No	Category	Area (Ha.)	Total area (%)
1	Coconut	71.64	3.75
2	Grassland	23.89	1.25
3	Ground	1.23	0.06
4	Water-body	134.20	7.02
5	Wetland	243.60	12.75
6	Open-scrub	35.75	1.87
7	Paddy field	158.47	8.29
8	Plantain field	13.12	0.69
9	Riparian vegetation	5.86	0.31
10	River	51.62	2.70
11	Major roads	43.04	2.25
12	Rubber plantation	9.22	0.48
13	Uncultivated paddy	24.43	1.28
14	Mixed cultivation	518.22	27.12
15	Homestead with Mixed cultivation	576.81	30.18
Total		**1911.09**	**100.00**

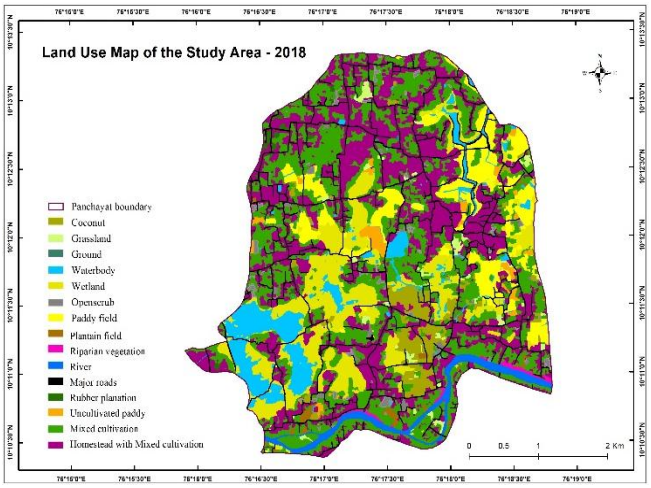

Fig - 3: LULC map (2018)

3.3 Flood analysis

On 15th August 2018, the Kuzhur panchayat experienced the first episode of the flood. The flood remained for about 7 to 10 days at a dangerous level. The houses near the wetlands, riverbanks, and paddy fields were inundated with high water levels which had risen more than 15 feet.

The panchayat has an area of 19.11 sq. Km. in which 13.9 Sq. Km. was affected by the flood. The flood zones were marked based on the flood intensity as unflooded zone, high flooded zone, medium, and low flooded zones. These flood zones were differentiated using the range of water levels. Table 4 displays the flood zones with their respective Water level and Area, followed by the flood intensity map and flood zone map. The LULC Maps and tables of different flood zones are also displayed below. The flood zone map describes the safe zones of the panchayat of a future flood event.

Table -4: Flood zone with their water level and area

Sl.No	Zone Class	Range of Water level (m)	Area (Ha.)	Total area (%)
1	Unflooded area	0 - 0.69	520.54	27.24
2	Low flood	0.69 - 1.38	139.7	7.31
3	Medium flood	1.38 - 2.07	176.46	9.23
4	High flood	2.07 - 6.13	1074.39	56.22
Total			**1911.09**	**100**

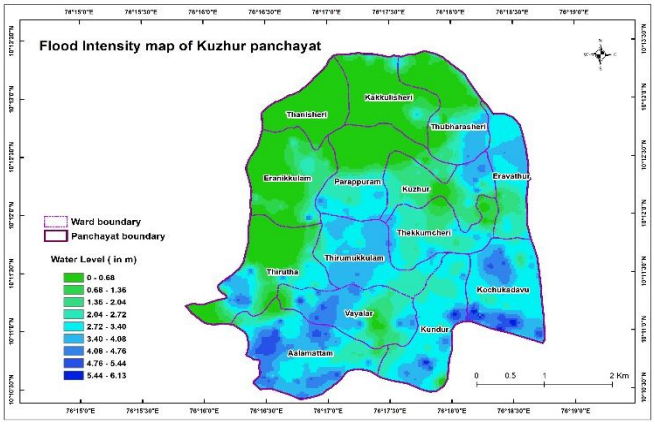

Fig - 4: Flood intensity map

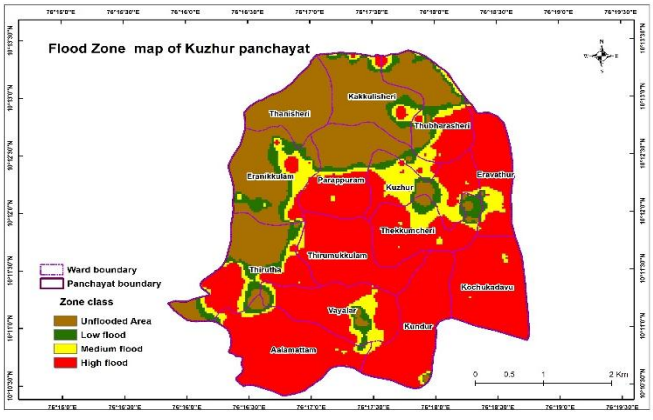

Fig - 4: Flood zone map

3.3.1 LULC maps of unflood zones

Table -5: LULC categories of unflooded zone

Sl.No	Category	Area (Ha.)	Total area (%)
1	Coconut	2.46	0.48
2	Grassland	4.87	0.96
3	Ground	0.95	0.19
4	Water body	6.38	1.26
5	Wetland	16.56	3.26
6	Open scrub	11.94	2.35
7	Paddy field	6.8	1.34
8	Plantain field	0.83	0.16
9	Major roads	14.21	2.80
10	Rubber plantation	7.72	1.52
11	Uncultivated paddy	3.27	0.64
12	Mixed cultivation	179.02	35.26
13	Homestead with Mixed cultivation	252.65	49.77
	Total	507.66	100.00

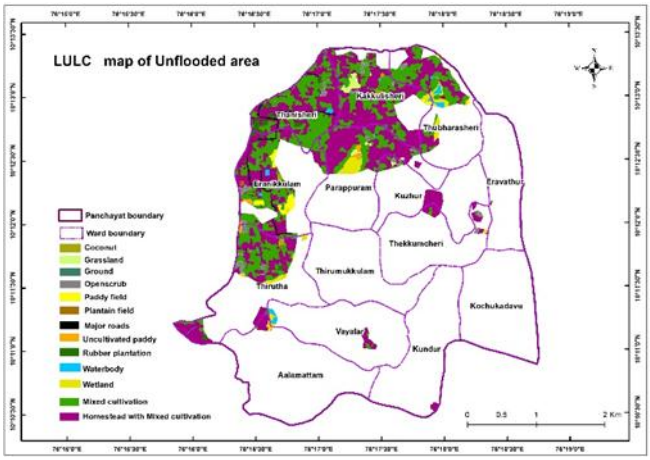

Fig - 5: LULC map of the unflood zone

3.3.2 LULC maps of medium flood zones

Table -6: LULC categories of medium flooded zone

Sl.No	Category	Area (Ha.)	Total area (%)
1	Coconut	0.83	0.51
2	Grassland	4.07	2.48
3	Water body	12.14	7.40
4	Wetland	27	16.46
5	Open scrub	2.9	1.77
6	Paddy field	24.16	14.73
7	Plantain field	0.53	0.32
8	Riparian vegetation	0.11	0.07
9	River	0.21	0.13
10	Major roads	4.16	2.54
11	Rubber plantation	0.73	0.45
12	Uncultivated paddy	1.12	0.68
13	Mixed cultivation	30.83	18.80
14	Homestead with Mixed cultivation	55.21	33.66
	Total	164	100.00

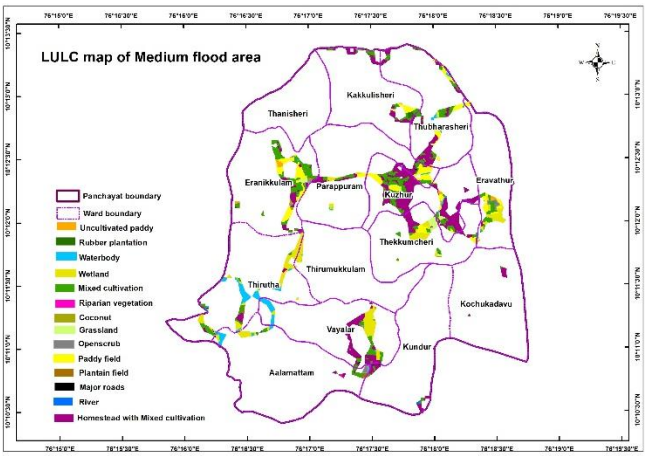

Fig - 5: LULC map of the medium flood zone

3.3.3 LULC maps of high flood zones

Table -7: LULC categories of high flooded zone

Sl.No	Category	Area (Ha.)	Total area (%)
1	Coconut	67.05	6.10
2	Grassland	14.62	1.33
3	Ground	0.28	0.03
4	Water body	106.39	9.68
5	Wetland	183.25	16.67
6	Open scrub	18.22	1.66
7	Paddy field	115.13	10.47
8	Plantain field	11.24	1.02
9	Riparian vegetation	5.71	0.52
10	River	51.35	4.67
11	Major roads	21.01	1.91
12	Rubber planation	0.53	0.05
13	Uncultivated paddy	19.31	1.76
14	Mixed cultivation	262.57	23.88
15	Homestead with Mixed cultivation	222.71	20.26
	Total	1099.37	100.00

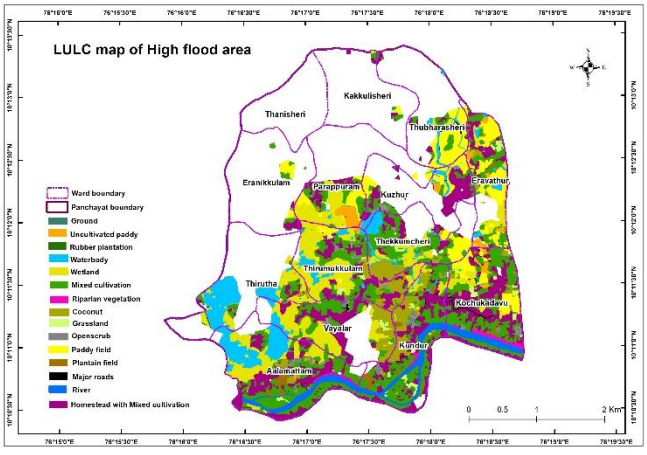

Fig - 5: LULC map of the high flood zone

3.3 Impact analysis

The severe flood interrupted the routine of the panchayat for a prolonged period. The interviews taken with the local

people opened our eyes to the difficulties they faced in the months following the flood. In most cases, the ground floor was submerged and in some cases, the water level was up to the first floor. The major impacts of the flood were the changes in the water quality, agricultural changes, soil fertility changes, damages caused to the built-ups, etc.

Most of the wells had contaminated water, evident from a yellowish tint. After the floods, the villagers of the Alamattaom ward tested about 100 samples of the well water, of which only 10 were potable. The rest of the wells were cleaned twice or thrice, but it was found that the recharge time had also increased, even though the wetlands were nearby. The choking of the pore spaces prevented the recharge of some wells.

Another major impact was the severe damage to the built-ups, affecting up to 3723 structures. Some of the built-ups had collapsed and most of the households were found with long cracks. These cracks were formed within a few weeks or months after the flood. The houses near the wetland region were destroyed due to high discharge. Most of the belongings were damaged making them unfit for further use. Documents from several offices were lost during this flood.

Table -8: Households of different flood zones

Sl.No	Zone Class	Area (Ha.)	Number of Household	Household (%)
1	Unflooded area	520.54	2330	42
2	Low flood	139.7	564	10
3	Medium flood	176.46	558	10
4	High flood	1074.39	2151	38
Total		**1911.09**	**5603**	**100**

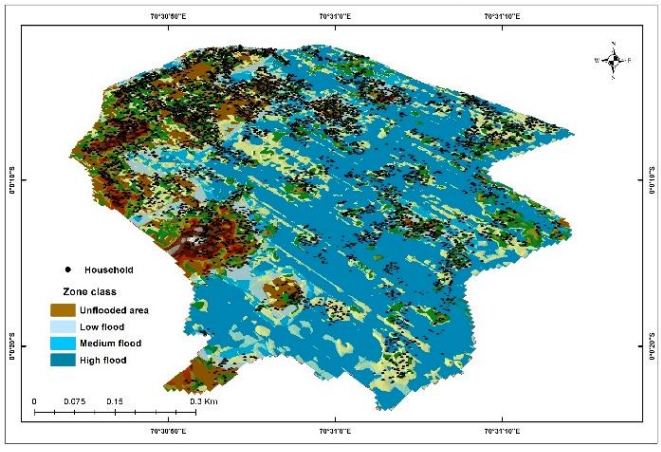

Fig - 6: 3D view flood map

Changes observed in the agricultural fields are, the reduced production, disease and pest attack in vegetable crops, yellowing of leaves, formation of lesions, drying of nutmeg trees and plantains, etc. caused due to the fertility changes in the soil. Soil tests indicated a lack of macro and micronutrients. Places showing potassium deficiency also showed the failure of Plantains. The places with increased fertility had higher crop yields. The time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

3.4 Impact of spillway opening of perigalkuthu reservoir on kuzhur flood level analysis

Chalakudy river, the fifth-longest river in Kerala, originates from the Western Ghats. The Peringalkuthu reservoir had a major role in the flood levels of the kuzhur panchayat and its surrounding areas. The reservoir was opened unexpectedly on August 14th, 2018 raising the water level in all drainages. The unexpected opening of the Peringalkuthu reservoir made evacuation difficult. The water flow did not follow the meandering path of the river and was diverted resulting in flash floods.

On August 14, the water level in the dam peaked at its maximum storage capacity of 424 meters. All seven shutters were then raised by 3.6 m, and the two sluice gates by 5.1 m. The Peringalkuthu reservoir is having a free catchment area of about 529 Sq.km. and its live storage capacity is about 30 MCM. Its FRL is at EL 424 m and the crest level of the spillway is at EL 419.4 m. The discharging capacity of the spillway is 2265 cu mec. Apart from its free catchment this reservoir also receives the spills from Parambikulam, Sholayar, and Tunakadavu dams. The unexpected release of water from Sholayar and Parambikulam worsened the already vulnerable Chalakudy river system.

The State government also failed miserably in coordinating with the Tamil Nadu government on the release of water from Upper Sholayar, despite the State heading the joint water regulatory board. The dam overflowed for more than 3 meters, submerging Chalakudy town on August 4th. The dam has been severely damaged with its structural stability is under serious threat.

The Kuzhur Panchayat lies 63km away from the Peringalkuthu reservoir. The water reached the Panchayat by the morning of 15th August. The drainage flow between the Vynthala and Parakkadavu was westward instead of south, flooding the nearby regions such as Mala, Vynthala, Annamanada, Poovathussery, Kuzhur, Puthenvelikkara, Kuthiyathodu, Parakkadavu, etc. As these regions have many wetlands, paddy fields, water bodies, and several low-lying areas; the water runoff was severe and these places appeared like a sea during the flood. The merging of the Chalakudy and Periyar rivers at Elanthikkara intensified the flood in this region.

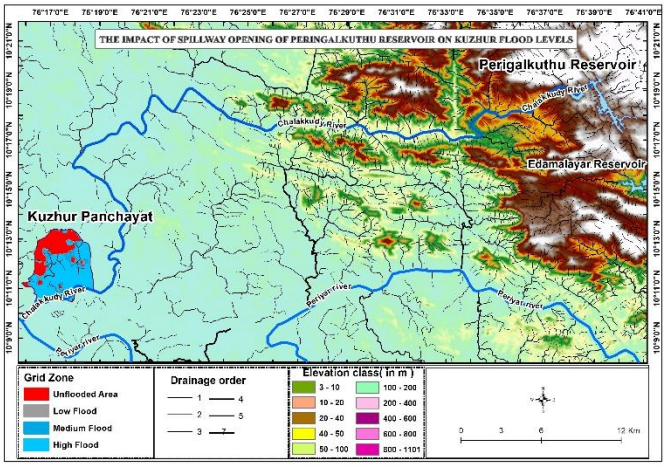

Fig - 7: Area map showing Perigalkuthu reservoir and Kuzhur panchayat

4. CONCLUSIONS

The unflooded zone (507.66 Ha) of this Panchayat is considered the safest area. As the Peringalkuthu reservoir is 63 Km away from the study area, the water may take several hours to a day to reach the panchayat and the people have enough time to vacate from the flood-prone areas to unflooded areas in a future flood event. Further study is required for reducing the flood intensity since most of the area of this Panchayat is covered by the Low lands, Paddy fields, wetlands, etc.

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