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Rainfall Dynamics , People's Perception about Flood and Indigenous Adaptation Practices : A study from Sarlahi and Rautahat, Nepal

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Abstract

Flood is seriously affecting local people in Terai, Nepal. Local people have perceived and adapted indigenous practices to protect from flood due to rainfall. Limited research is carried out to analyze rainfall and flood impact where people have adapted indigenous practices. Thus, this study was conducted to assess the trend of rainfall, people's perception about flood and indigenous practices against flood. Bagmati Corridor of Rautahat and Sarlahi district of Nepal was selected for this study. Primary data were collected through house hold survey using random sampling technique with 25% (182 HHs in total) sample size, focus group discussion (6) and key informant interview (15) carried out to collect the data about effect of flood and indigenous practices in Rautahat and Sarlahi districts. The secondary data were collected from published and unpublished documents. Rainfall data from 1990 to 2019 were collected nearby three meteorological stations namely Karmaiya, Ramoli and Gaur and these data were analyzed descriptively to link with flood and indigenous practices. The result showed that, there was about 7.68 mm decrease in annual rainfall based on record of Karmaiya meteorological station and similar result was about 6.69 mm rainfall decreased based on Ramoli meteorological station but this was high rate with 15.51 mm decline based on Gaur meteorological station. The high rainfall was recorded in 2004, 2007 and 2017 at all meteorological stations. The respondents were opined that the flood is serious problem in these areas which was very shocking in 2004, 2007 and 2017. The flood in 2004 was very worst destructive, never seen before. The indigenous practices and adaptation strategies were explored based on the people's opinion. This includes the predicting flood, protecting physical structures, storing crops, saving livestock, emergency materials and saving life. Each category was explored for pre-flood stage, during flood stage and post-flood stage. This also indicates that communities have well perception and indigenous practices adapted to protect themselves from flood. This study helps scientific community to understand differential effect of flood due to rainfall and how people have perceived it and adapted indigenous practices to cope it. This research will be useful to design the policy level strategies to find the key solution on flood effect.

Key word: Severity, flood, rainfall, risk, indigenous, adaptation, poor

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1. Introduction:

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as “all evolution of the climate in the time that is due to the natural variability or to the human activities”. But for the United Nation Framework Convention on Climate Change (UNFCCC), climate change means “all change in climate, directly or indirectly attributed to human activity that alters the composition of global atmosphere and which is in addition to natural climate variability observed over comparable time period” (UNFCCC, 1992, p4). Anthropogenic climate change poses serious risks to societies through its impacts on species, natural resources, economies, socio-political institutions, and structures, cultural traditions, and human health (Intergovernmental Panel on Climate Change (IPCC), 2018; USGCRP, 2018).

The impact of global warming is already being felt by the most vulnerable- the world's poorest people and countries and its impact is severe in Nepal because of the geographical and climatic conditions, high dependence on natural resources and lack of resources to cope with the changing climate. This is results of greenhouse gas emissions mainly done by the developed countries. However, climate change is a common issue, and therefore, the entire global community needs to work together to address this major problem (CEN, 2003).

Flood is one of the major disaster in Terai region of Nepal. The high velocity narrow and deep channel river of hilly region flows forming braided in Terai region covering the wide section of land with relatively shallow speed. These braided river in rainy season (June to September), gets uncontrolled due to heavy rainfall in upstream or vicinity arising the Flood havoc in Terai region. Bagmati is one of the braided river of terai bordering the Rautahat and Sarlahi District. According to the fact of Nepal Flood 2017: Post Flood Recovery Needs Assessment, Rautahat and Sarlahi are among the most vulnerable districts in terms of flood. These districts had also the most casualty and injuries in 2017 due to flood. The recurrence of flood in Bagmati corridor is common every year during monsoon. The area suffers from inundation and flooding due to lack of embankments or poorly constructed embankments that swept away by the flood. The area has high water table and is composed of silty clay- loam soil having slow infiltration rate. The rainfall occurring locally in the area cannot infiltrate into the ground and so creates large surface runoff. The area being flat, and drains being congested, the runoff water cannot get out of the area quickly and thus starts spreading (APFM, 2004). The communities of this region are highly populated with poor economic status and believe flood as their part of life. With the increase in population, the landholding is decreasing implying a greater number of persons to feed from the plot of land (Paudel et al 2018). In the settlement near the Bagmati River, flood erodes the bank permanently washing away the agricultural land and making people landless. At high floods the water spills over the bank and the village gets inundated. However there is limited research regarding these issues. Thus, this study was objectively conducted to assess the trend of rainfall, people’s perception about flood and indigenous adaptation strategies.

2. Materials and Methods

The research study was done on vulnerable communities of Bagmati River corridor of Terai region, covering Rautahat and Sarlahi districts. Sarlahi district is situated at between 270 03' 01.80" to 270 03' 20.68"N latitude and 850 38' 34.97" to 850 37' 27.81" E and altitude of this district ranges from 150 to 1350 m . Rautahat district is located at 26.9547° N, 85.3136° and the Elevation ranges from 122 to 244 meters above sea level.

The study area was divided into three zones namely up-stream, mid-stream and down-stream. The up-stream covers the foothill of Chure range (Karmaiya area: where the Bagmati Irrigation Dam is constructed). As Bagmati River is the boundary of Sarlahi and Rautahat districts. This zone consists of ward no. 1 of Chandrapur Municipality of Rautahat district while ward no. 11 of Bagmati Municipality of Sarlahi District. Mid-stream covers ward no 3 of Gadhimai Municipality of Rautahat district and ward no 2 of Basbariya Rural Municipality of Sarlahi district. The Down-stream covers ward no 2 and 5 of Durga Bhagwati Rural Municipality of Rautahat district close to the Indian border as well.

2.1 Field visit: The preliminary visit was conducted for household survey using a pretested questionnaire to find socio-economic and house hold level information while the final field visit and interaction with community and relevant stakeholders were done by using KII. The duration of research study includes issue identification of the research site, preliminary field visit, formulating questionnaires and final visit for data collection carried out between June 2019 and December, 2020.

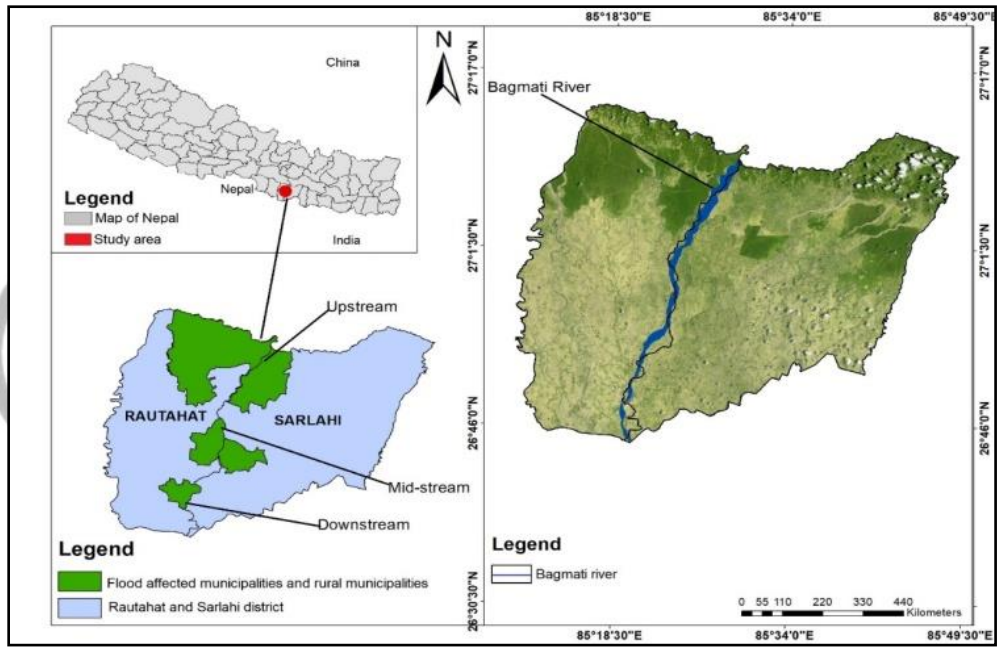


Figure 1: Location map of the Study area

2.2 Primary Data collection : The primary data were collected through household survey, conducted on the basis of random stratified sampling, by using 25% sample size (i.e. 182 sampled HHs out of total 922 HHs in all 3 belts (upstream, mid-stream and downstream) of flood prone zone within the Bagmati Corridor of Rautahat and Sarlahi districts of Nepal.

The sample size for household survey was calculated using following formula.

$n = (NZ^2PQ)/ (Ne^2+ Z^2PQ)$,
Where, N= total no. of households (547)
Z= the value of standard variant at 95% confidence level (1.96)
e=Acceptable error (± 0.05)

P=the expected rate of occurrence of the attributes (95%, that is 0.95)
Q=the expected rate of non-occurrence of the attributes (100-95%=5%, that is 0.05)
Substituting the values in the above formula, we get sample size. (Arkin & Colton, 1963).

Six FGDs (Focused Group Discussions) were conducted in study areas while 15 KII (Key Informants Interview) and personal interview were conducted with key stakeholders, civil societies, representatives of Governmental and Non-governmental Organizations working in flood risk, preparedness, adaptation and disaster management sector, to collect the data. The check list was prepared emphasizing on collecting the data regarding the effect of flood and adaptation indigenous practices pre-flood, during flood and post-flood phases. While conducting KII and FGD, both male and female were chosen who represented farmers, communities, teachers, government officer and representatives, health worker, housewife, students, etc.

Table 1: Study Area and number of Households and Sample Size

S.N.	Study Section	Study Area			Households	Total Households	Total Samples
		Settlement	Existing Administrative Division	Previous Administrative Division			
1	Northern Belt	Gopalkuti	Chandrapur M– 1, Rautahat	Paurai VDC -1	255	498	67
		South Bagmati	Bagmati M -12, Sarlahi	Karmaiya VDC -4	243		
2	Middle Belt	Laxmipur	Gadhimai M -3, Rautahat	Gamhariya VDC - 8	85	208	57
		Manpur	Basbariya RM -2, Sarlahi	Manpur VDC -9	123		
3	Southern Belt	Badarwa	Durgabhagwati RM – 2, Rautahat	Badarwa VDC -3	82	216	58
		Badarwa	Durgabhagwati RM – 5, Rautahat	Badarwa VDC -5	134		

(Source : Govt. of Nepal, Central Bureau of Statistics / CBS, 2011)

2.3 Secondary data collection : The rainfall data of 1990 to 2019 were collected from three weather stations namely Karmaiya, Gaur and Ramoli meteorological stations (DHM, 2020). The secondary data were collected from published and unpublished documents like article, reports, socio-economic information from district profile, record of district administration office.

2.4 Data Analysis : The rainfall data were analyzed using trend and descriptive analysis was applied to show the phase wise prediction of flood and adaptation indigenous practices.The climatic data was analyzed based on five main seasons in Nepal. The rainfall was categorized according to season and the trend analysis was performed to show the dynamics. The trend analysis was done to analyze the total annual rainfall and seasonal rainfall and its impact. The Kruskal Wallis and Mann Whitney test were applied to evaluate the people's perception about the rainfall trend and link this with the effect of flood. Data were analyzed by descriptive as well as inferential statistics (ANOVA) through SPSS, Excel software.

3. Results

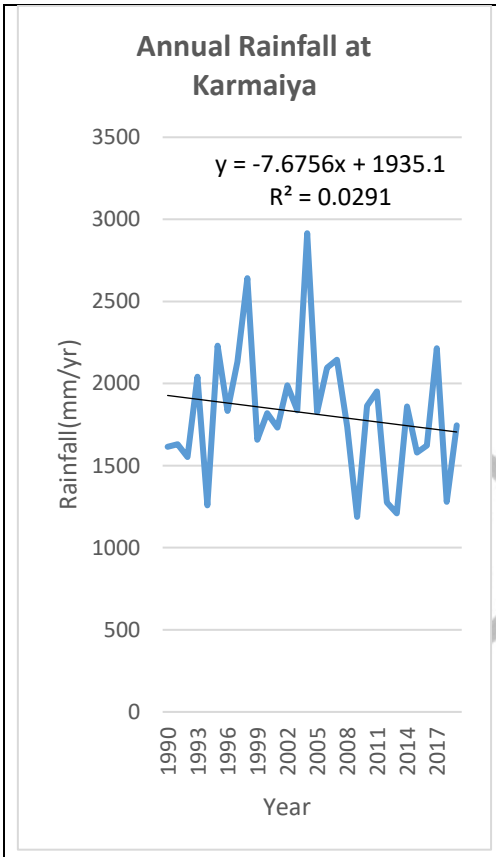
Variation on rainfall and temperature: The data related climatic variable mainly temperatures and rainfall of thirty years (1990 to 2019) data showed there was variation in temperature and rainfall.

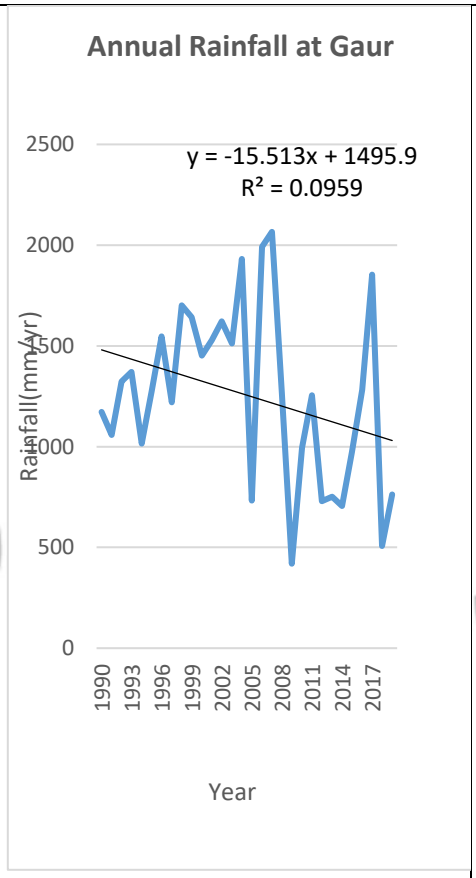
3.1. Variation in rainfall based on record of Karmaiya, Ramoli and Gaur meteorological stations

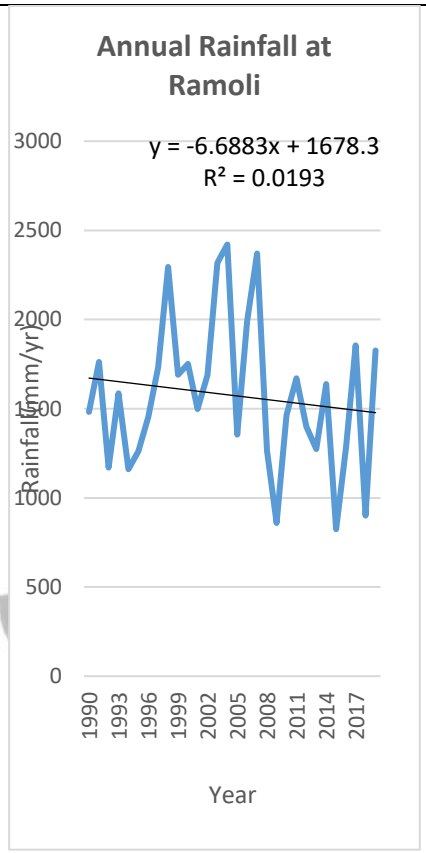
It is essential to describe the variation in rainfall. Annual rainfall from 1990 to 2019 indicated variation in the value based on record of Karmaiya, Gaur and Ramoli meteorological stations.

3.1.1 Variation in Annual rainfall based on Karmaiya, Gaur and Ramoli station

The annual rainfall was decreasing based on the record of rainfall of Karmaiya, Gaur and Ramoli meteorological station. It was about 7.68 mm decrease in annual of rainfall based on record of Karmaiya meteorological station similar result was about 6.69 mm rainfall decreased based on Ramoli meteorological station, but this was high rate with 15.51 mm decline based on Gaur meteorological station. The high rainfall was recorded in 2004, 2007 and 2017 at all meteorological stations.



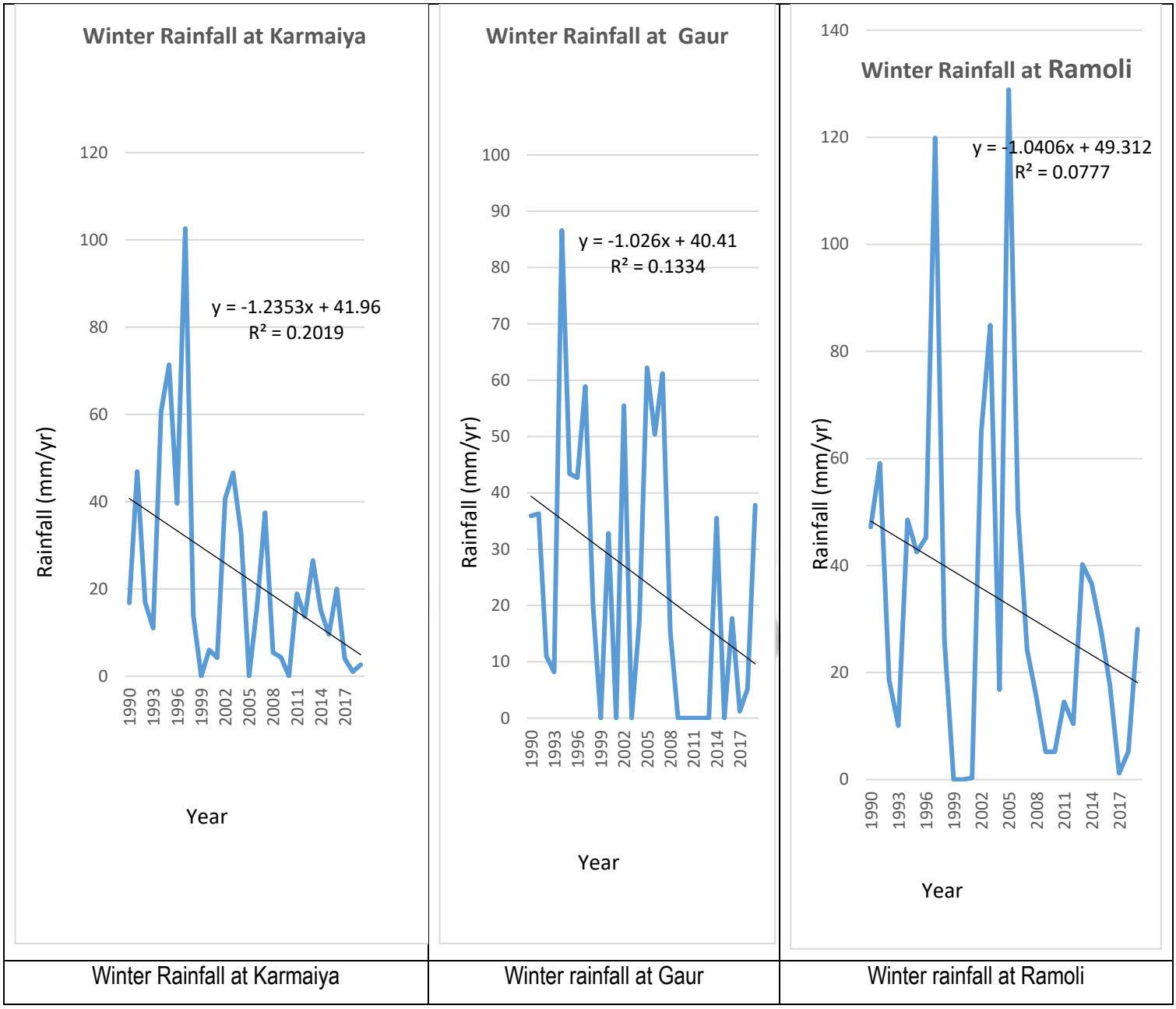




Annual Rainfall at Karmaiya	Annual rainfall at Gaur	Annual rainfall at Ramoli

Figure 2: Annual Rainfall Variation showed in Graphics at three Metrological Stations

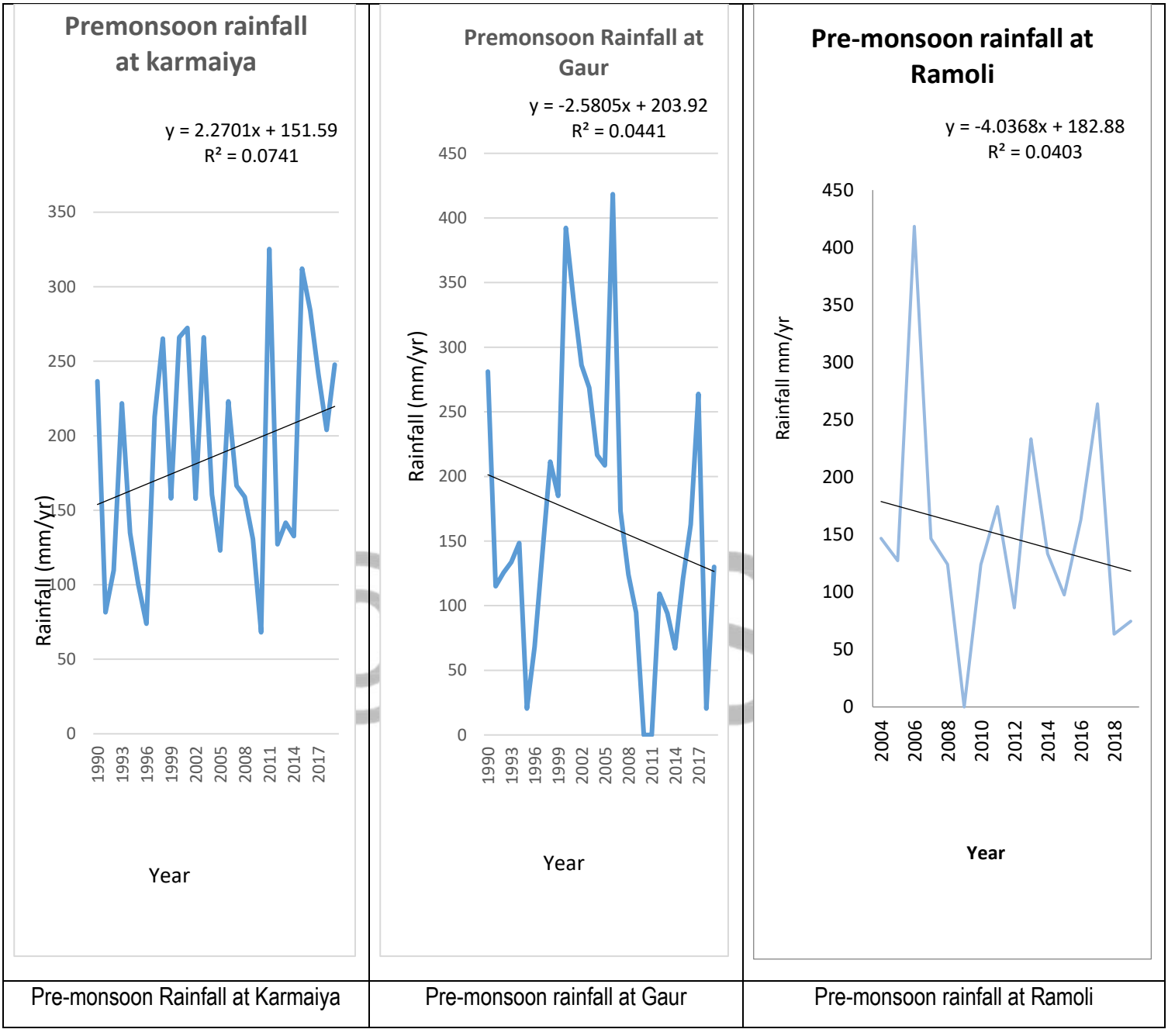
3.1.2 Variation of Winter Rainfall at Karmaiya, Gaur and Ramoli: The winter rainfall was also decreasing based on the record of rainfall of Karmaiya, Gaur and Ramoli meteorological stations. It was about similar values of decrease in annual rainfall based on the record of Karmaiya, Gaur and Ramoli meteorological stations like 1.23, 1.02 and 1.04 mm respectively.



Winter Rainfall at Karmaiya	Winter rainfall at Gaur	Winter rainfall at Ramoli

Figure 3: Winter Rainfall Variation showed in Graphics at three Metrological Stations

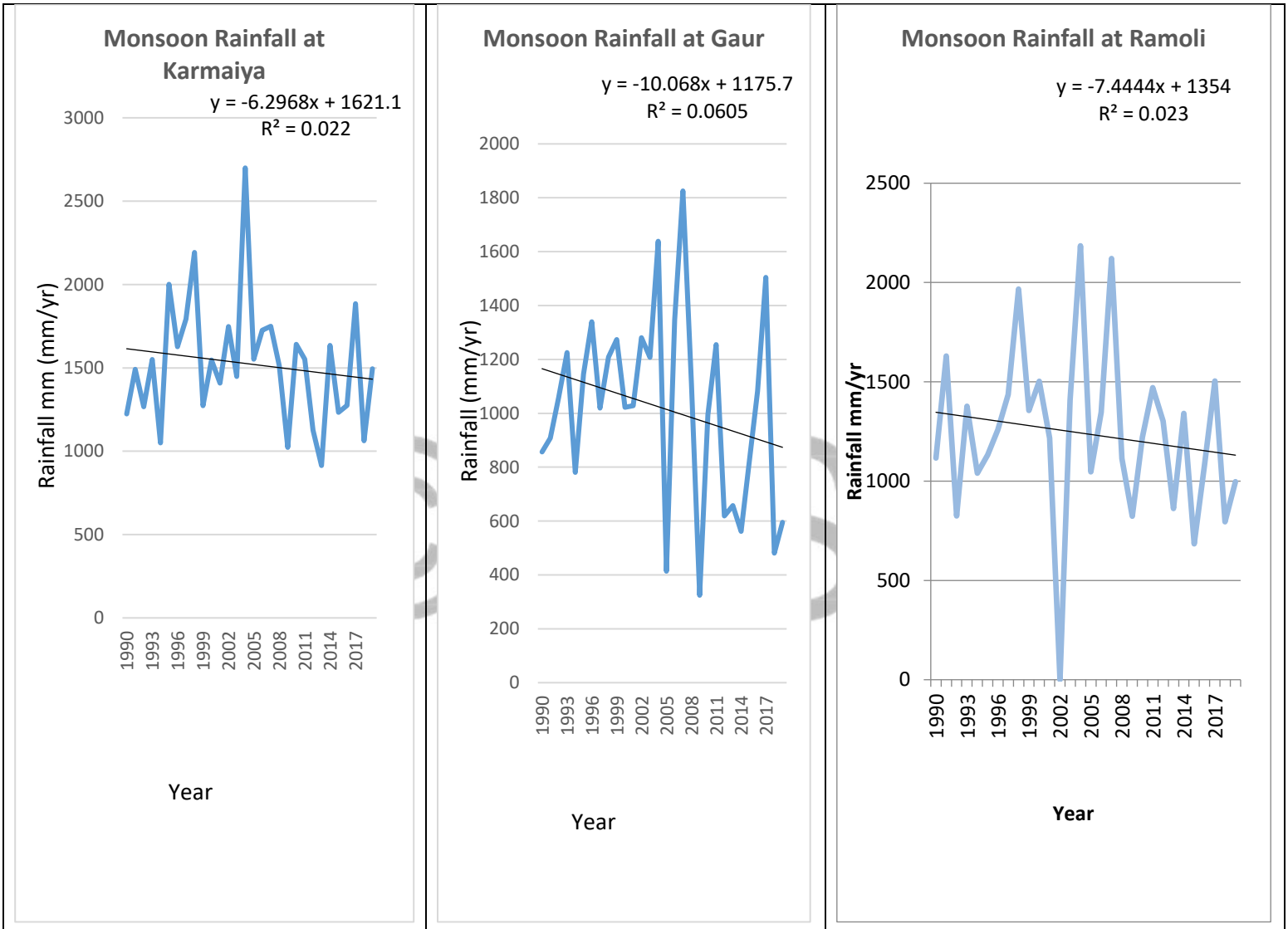
3.1.3 Variation of Pre-monsoon Rainfall at Karmaiya, Gaur and Ramoli : The trend of pre-monsoon rainfall was also decreasing with very low rate. The annual rate of decrease in rainfall has been shown here based on the record of rainfall of Karmaiya and Ramoli meteorological stations. The rate of annual rainfall decrease was 2.27 and 4.03 mm but it was lightly increasing at Gaur meteorological stations with 2.58 mm.



Pre-monsoon Rainfall at Karmaiya | Pre-monsoon rainfall at Gaur | Pre-monsoon rainfall at Ramoli

Figure 4: Pre-Monsoon Rainfall Variation showed in Graphics at three Metrological Stations

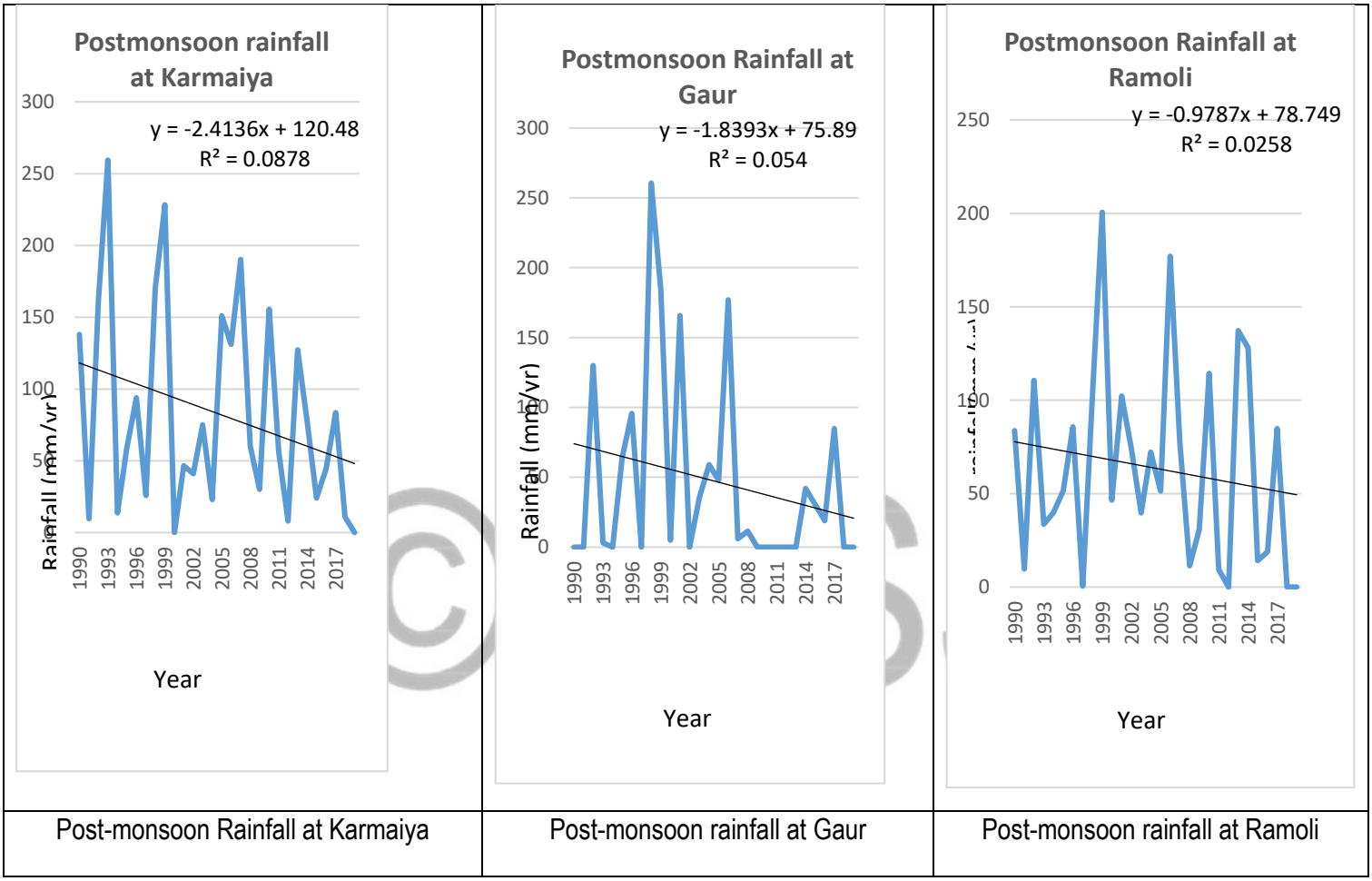
3.1.4 Variation of monsoon Rainfall at Karmaiya, Gaur and Ramoli : The trend of monsoon rainfall was also decreasing but the rate was very low. The annually, it was 6.29, 10.07 and 7.44 mm rainfall decline based on the record of rainfall of Karmaiya, Gaur and Ramoli meteorological stations respectively.



Monsoon Rainfall at Karmaiya	Monsoon rainfall at Gaur	Monsoon rainfall at Ramoli

Figure 5: Monsoon Rainfall Variation showed in Graphics at three Metrological Stations

3.1.5 Variation of post-monsoon Rainfall at Karmaiya, Gaur and Ramoli : The trend of post-monsoon rainfall was also decreasing but the rate was very low. The annually, it was 2.41, 1.84 and 0.98 mm rainfall decline based on the record of rainfall of Karmaiya, Gaur and Ramoli meteorological stations respectively.



Post-monsoon Rainfall at Karmaiya	Post-monsoon rainfall at Gaur	Post-monsoon rainfall at Ramoli

Figure 6: Post Monsoon Rainfall Variation showed in Graphics at three Metrological Stations

3.2 People perception about the flood in Nepal

The people perception was matching the trend of rainfall between 1990. As per their memory recall, the respondents were opined that the flood is serious problem in Terai. However, the flood in 2004, 2007 and 2017 was very shocking. The 95% respondents opined that flood in 2004 was very worst, never seen before. Whole Nepal was affected and Sarlahi as well as Rautahat district.

Table 2: People's perception about flood in different belts

Perception about flood	Year 2004			Year 2007			Year 2017		
	Damage & casualty	Yes/no	Not known	Damage & casualty	Yes/no	Not known	Damage & casualty	Yes/no	Not known
Perception of Karmaiya Sarlahi &Gaur and Ramoli	12 July, 2004 Torrential rains was continued for six days (7-12 July, 2004) have killed 47 people. tens of thousands of families were displaced and thousands of ha of paddy submerged.Jhapa, Morang, Sunsari, Saptari, Udayapur, Siraha, Sarlahi, Mahattari, Rautahat and Bara districts are severely inundated (MOHA, 2009).	About 95% respondents answered, it was heavy rainfall for 4/5 hours	About 5% people answered, not known about the flood	Total 333500 people were affected by flooding and landslide in Nepal from 23 to 27 July including Dhanusha, Mahottari, Sindhuli, Sarlahi and Ramechhap. Eighty-four people were killed and 9,700 families were displaced by the floods and landslides. Twenty-eight districts including Sarlahi and Rautahat. (MOHA, 2009).	About 97% agreed about this statement.	Only 3% people are unknown about it.	Total 3 people dead and 1 missing and 50 houses damaged in Sarlahi district and 4 people died and 1 was missing and over 100 houses were damaged in Rautahat district (Willitts-King and Ghimire, 2019)	About 98.0% people agreed on this statement	Only 2.0 % respondents were unknown about it
Perception of of Gaur	Similar statement	About 92% respondent said yes	About 8% people are unknown about the flood	Similar reaction	About 97.5% people agreed on this statement	Only 2.5% respondents were unknown about it	Similar reaction	About 98.5% people agreed on this statement	Only 1.5% respondents were unknown about it
Perception of Ramoli	Similar statement	93% percent said yes	Only 3% said unknown about it	Similar reaction	About 96.5% people agreed on this statement	Only 4.0% respondents were unknown about it	Similar reaction	About 97.5% people agreed on this statement	Only 2.5% respondents were unknown about it

The Kruskal Wallis test showed that people's perception about flood in 2004 was significantly differed at 95% confidence level within the Karmaiya, Gaur and Ramoli (p=0.000) similarly, Mann-Whitney U test showed there was significance difference between people's perception of Karmaiya and Gaur (p= 0.000) and similar result was found the people perception of Karmaiya and Ramoli (p=0.000), but it was not significant differed people perception of Gaur and Ramoli (p=1.90) in 2004.

However, people's perception within the Karmaiya, Gaur and Ramoli (p=0.000) about the flood in 2007 was not so significant difference at 95% confidence level applying Kruskal Wallis test (p= 0.089). The, Mann-Whitney U test showed there was no significance difference in about the flood between people's perception of Gaur and Ramoli (p=0.038) but it was not significant difference between people's perception of Karmaiya and Gaur (p= 0.17) and similar result of people's perception between Karmaiya and Ramoli (p=0.332) in 2007.

3.3. Local adaptation practices against the flood at upstream, mid-stream and down stream

The indigenous practices and adaptation strategies were explored based on the people's opinion. These practices were categorized into pre-flood stage, during flood stage and post-flood stage.

3.3.1 Adaptation practices Pre-flood stages

3.3.1.1 Predicting Flood

The local people are using several types of practice to predict the flood. The first practice (97.8% to 100% respondents) is understanding about the weather phenomenon like intensity of rainfall, color of cloud, wind direction and water flow to forecast the flood. Second one (75.6% respondent) is magnitude of hotness which is to forecast the future flood (refer table no 3).

The elderly people predict the weather through intensity of rainfall, color of cloud, wind direction and water flow. They expressed that the high wind speed from east to west and high wave in the Bagmati River cross the foreshore indicates high chance of flooding. They said that unbearable hotness brings the rainfall which cause flooding. The subterranean animals like field mouse, moles, ants, and snake are more visible in pre-flood periods as they leave their habitats for safer places. The people's perception of Laxmipur village expressed that home rats become more active in this period while snakes were also mostly found in roofs made up of clay roof tile. The domestic animals deny going nearby the rivers and starts to graze in the safe lands. The feeding behavior of cattle also decreases during the pre-flood stages.

3. 3.1.2 Protecting Building Structures and Physical Properties

Most of the households are unable to raise their house platform as they used to construct drainage around their houses and used to construct divergent using sacks for flood. About 57% households were raising RCC house whereas 91.6% used to construct drainage around properties. About 35.2% household move their properties to safer place. About 80% landless people of Badharwa, Gaur, used to construct temporary house. The few of the respondents shift their valuable properties to safer places like of neighborhood and relatives. The dam along river side was also constructed with the help of government. In the FGD, they replied that construction of the drainage and building the barriers were not so effective. The native plants like bamboo, white fur and riverine tree, grass species etc. were used to build the dam of Bagmati corridor (Table 3).

3.3.1.3 Storing Crops: *Bhakari* (Mud build crop store) is one of the traditional ways of storing and protecting the crop in Terai region of Nepal. About 30.6% households use *Bhakari* to store paddy and rice but remaining households have limited agricultural land no more crops to store. Local people store maize hanging it at ceiling of house. They put millet and pulses in cloth at roof of house. The 21.8% households were storing crops in attic of house.

3.3.1.4 Saving Livestock: Cow, buffalo, goat, chicken, duck, pigs are major source of income of local community. The dependency on livestock is higher in this region as they sell to minimize their loans during pre-flood and post flood time. Most of them (70.1%) heighten their shelters to save livestock or keep them in higher places (29.4%). About 32.6% households sent livestock like pregnant one and those which give milk to their relatives. They store dry fodder like dry husk (local name: *paral*) and *bhusaa* to feed livestock during flooding season.

3.3.1.5 Saving Live: Most of households in this region were heavily dependent on livestock. Around 56.6% households used to sell livestock to buy dry foods, tents and cloths. About 69.8% households were depend on loan to meet their expenditures. Poor people used about 77.5% expenditure to buy dry foods selling cattle during flood season. Around 46.7% communities shifted to embankment of river during pre-flood while 22.5% used to go to roof of neighboring RCC houses to safe their life. Around 20.3% households shifted to next villages or to relatives to safe their life. About 22% households stay at home if there house is made up of RCC. About 89.6% households were using mobile Chulo (mud stove).

Table 3: Indigenous Adaptation Practices in Pre-Flood Stage

Stage	Indigenous Practices	Up-stream Belt	Mid-stream Belt	Downstream Belt	Total	Percentages (%)
Pre-Flood Stages	**Predicting Flood**					
	Intensity of rainfall, color of cloud, wind direction and water flow analysis	65	53	58	176	97.8
	Understanding the weather of upstream	67	57	58	182	100
	Magnitude of hotness	35	47	54	136	75.6
	Behavior of subterranean	31	44	49	124	68.9
	Change in Behavior of Domestic Animals	21	38	44	103	57.2
	Protecting Building Structures and Physical Properties					
	Raising the house platform	48	24	30	102	57
	Moving properties to safe locations	6	24	33	63	35.2
	Construction of Drainage around the properties	50	58	56	164	91.6
	Building divergent for flood	3	52	48	103	57.5
	Planting indigenous vegetation	5	3	0	8	4.5
	Storing Crops					
	Building Mud crop store (Bhakari)	13	32	14	59	33.9
	Storing in top of the house	25	10	3	38	21.8
	No Storing	32	20	44	96	55.2
	Saving Livestock					
	Sending to relatives and high-altitude location	0	35	24	59	32.6
	Heightening the Shelters	14	32	32	78	43.1
	Keeping with self	39	45	44	128	70.7
	Saving Live					
	Selling of livestock to buy necessities	32	50	45	127	69.8
	Loan to meet expenditures	9	53	41	103	56.6

	Living in the roof of neighbors RCC houses	0	21	20	41	22.5
	Shifting to next villages	2	12	23	37	20.3
	Staying home	33	3	4	40	22
	Shifting to embankment of river	5	31	49	85	46.7
	Dry Food Collection	29	56	56	141	77.5
	Mobile Chulo	50	57	56	163	89.6

The 4 categories namely predicting flood duration, storing food, saving livestock and saving lives had their own indigenous practices and strategies to cope with existing flood duration.

3.3.2 Adaptation practices during flood

3.3.2.1 Saving Crops during flood: There is high probability of spoiling of food during the flood. Local communities were kept their food grains in the plastic or steel bucket (91.5%) to protect from flood or they rap food in polythene (61%). (Table 4)

3.3.2.2 Saving Livestock: The livestock are unleashed like cow, buffalo etc. move to the safe land such as higher places like roads and embankment during flood. About 98.9% households keep livestock nearby area so that they can return after the flood. About 46.6% households keep cattle like goats, hen, duck with themselves. The pregnant cattle were kept safely during the flooding period.

3.3.2.3 Saving Live: About 72.5% respondents stated that they were capable to swim to reach in safe place. Their swimming skill saves and rescues people from flood. About 82% households shared that they use rope which is tightened with trees or pillar to move from one place to another with the help of rope. About 43.3% stated that they use tubes to float to reach in safe place.

The children, elderly and persons with disabilities are mostly shifted to top of RCC house, road or embankment during flood to save their life.

Table 4: Indigenous Adaptation Practices during Flood Stage

Stage	Indigenous Practices	Up-stream Belt	Mid-stream Belt	Downstream Belt	Total	Percentages (%)
During Flood Stage	Intensity of Rainfall, water flow analysis	67	57	58	182	100
	Understanding weather of eastern belt	59	57	58	174	95.5
	Saving Crops					
	Raping in Polythene	2	52	54	108	61
	Keeping in closed Bucket	47	57	58	162	91.5
	Saving Livestock					
	Unleashing the livestock	57	57	58	172	98.9
	Keeping with self	52	19	10	81	46.6

	Saving Life					
	Swimming	32	45	52	129	72.5
	Walking with the help of tighten rope in trees or pillars	42	52	52	146	82
	Floating with the help of empty plastic bottles and tubes	0	34	43	77	43.3
	Eating habit changes	16	52	56	124	69.7

The community as per their own traditional judgment moved away to seek safe places like schools, roads, and other embankments when water level rises above risk level.

3.3.3 Adaptation practices post flood stage

The post flood stage is the period of escaping havoc and preparing for the livelihood for next year. Due to unavoidable circumstances people became socially, mentally and physically offset. They have to arrange things like clothing, shelter and food, which is very difficult. Similarly, when water level starts subsiding epidemics like diarrhea, cholera, dysentery, pneumonia etc. might cause heavy damage to human and animal life and need money to save lives.

3.3.3.1 Saving Live

The people return to their houses when the water level decreases but they have to face big challenges. Most of houses were completely or partially damaged. About 91.8% of the households owning livestock sell to fulfill their needs in this period. They take loans (78%) to manage the situation before migrating to get jobs (31.3%). It was also found that there is good collaboration (72%) between the neighbors and relatives in construction of their houses. Most of the respondents had more faith towards the non-governmental organizations (54.4%) than governmental organizations (50%). Around 28% of respondents had changes the cropping patterns leaving the indigenous plants like rice, sugarcane to vegetables, peanuts, mustard etc. (Table 5).

Table 5: Indigenous Adaptation Practices in Post Flood Stage

Stage	Indigenous Practices	Up-stream Belt	Mid-stream Belt	Downstream Belt	Total	Percentages (%)
Post Flood Stage	Loan to meet expenditures	46	48	48	142	78
	Selling livestock to meet expenditure	57	54	56	167	91.8
	Utilize the savings	19	7	12	38	20.9
	Seeking help from neighbors and relatives	38	40	53	131	72
	Seeking help from governmental organizations	4	33	54	91	50

	Seeking help from non-governmental organizations	4	41	54	99	54.4
	Migrating for occupations	4	23	30	57	31.3
	Changing the cropping patterns	2	32	17	51	28

4. Discussion

Analysis of the rainfall data showed that trend of rainfall is decreasing but the intensity is highly increasing. The duration of rainfall is very serious so the damage is extremely high. The human casualty, loss and damage of wealth and crops are continuously recorded in these areas. There are several causes of flood. One of the important cause is heavy rainfall within a short period of time. Similarly, the areas are vulnerable from floods due to many small streams mix in river like Hardi (Banke), the Lakhandei, Jhim and Bagmati (Boarder between Sarlahi and Rautahat). Similarly, many stream mix in the rivers like Lalbakaiya, Bagmati River. Most of the streams are originated from Chure, which is very fragile and youngest mountain in Nepal. Theses stream carry boulders, stones and sands during the monsoon season which cause serious damage in southern belt including Sarlahi and Rautahat district.

Many researches support this finding that flood causes serious damage in southern part of Nepal. The Terai region is considered as the bowl of the agriculture but the devastating flood results serious damage the crop yield (Adhakari, 2013, Dewan, 2015, Dingle at al., 2020). The reason behind this is the entire Siwalik is so degraded that it can erode easily (Ghimire , 2011, Ghimire et al., 2013). At the same time the high intensity of rainfall functions as catalyst of erosion which is the prime and reliable reason of flood in southern part of Nepal including India (Kumar, 2004, Pandey, 2015). Therefore, the problem of flood and emundation and its damage to wealth and health of the people are obvious in Nepal, India and Bangladesh (Michel et al., 2021).

The rainfall record showed decreasing trend based on analysis of record of Sarlahi, Rautahat and Ramoli metrological stations. Similar result was found in Chitwan and Makwanpur district and some part of Himalayan area(Vedwan, 2006, Chaudhary and Bawa, 2011, Piya et al., 2012). The findings of these researches were matching with the finding of our research. It was the highest record in 2004, 2007 and 2017. The people perception on this fact was completely matching with the value of record of rainfall based on Sarlahi, Rautahat and Ramoli metrological stations. People's perception also showed that the heavy flood was experienced in 2004, 2007 and 2017 which damage a lot (Devkota, Gyawali, 2015). Several researches support the finding of this research. The extreme flood in 2017 was so devastating millions of people were died and they lost millions of wealth and flood damaged the crop as well. These effect was recorded in Nepal India and Bangladesh (Palash et al., 2020). The flood caused by monsoon rainfall affected thousands of people living near the Koshi river. Thousand's people were migrated from their home, they became homeless (Sharma et al., 2019, Zhang & Fang, 2020). The people perception was analyzed to show the rainfall pattern in Mid-hill showed that the rainfall is decreasing (Piya et al., 2012) this result is similar with this finding.

The pre-stage flood, during flood and post flood stage prediction and indigenous practices save the health and wealth of the local people. The indigenous adaptation practices against the flood in different stages in Sarlahi and Rautahat showed a good examples of saving the health and wealth as well as recovery in post flood as well. Resilience capacity development in response to the different stage of flood cane save health

and wealth of the flood affected people as well to recover and reinstate to the original situation (Sattaru et al, 2021, Ntontis et al., 2021). The indigenous adaptation practices against the flood is good and useful solution for the flood affected local people (Fabiyi & Oloukoi, 2013, Islam et al., 2014). The resilient capacity of the local people and their indigenous practice contribute significantly to recover from effect of flood (Mavhura et al., 2013, Al Mamun and Al Pavel, 2014). The flood affected people in Bangladesh have recovered from the damage of agriculture crops and other wealth, as well as applying the indigenous practicing (Colding et al., 2003, Ahmmed, 2015). Application of indigenous practices are very useful to enhance the resilience capacity of the flood affected people. These solutions are similar with our research findings. The reason behind this is local people use the local knowledge and skill to enhance the resilience capacity of the people and get recovery soon and reinstate at original situation.

5. Conclusion

The rainfall trend was decreasing for Karmaiya, Gaur and Ramoli meteorological stations. The seasonal rainfall was also decreasing for these meteorological stations. The rainfall record was very high in 2004, 2007 and 2017 at all meteorological stations. The respondents were opined that the flood impact was intense in Terai in 2004, 2007 and 2017. The indigenous practices and adaptation strategies are effective to adapt to flood readiness, community response as well as rapid recovery after flood. This research will be useful to design the policy level strategies to find the key solutions on the effect of the flood. It is recommended that similar research is undertaken to influence the design of national policy to manage floods and minimize the impact on flood affected people.

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