International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Factors Affecting the Occurrence of Floods and the Adaptation of People in Lahanam and Thakhamlian Villages, Songkhone District, Savannakhet Province

Keooudone Phetdavong[1], Somphone Inkhamseng. PhD[2], Keopheth Phoumphon[3]

[1]Master Program Student of Hydrology for Water Resources Management, Meteorology and Hydrology Department, Faculty of Water Resources

[2]Professor in Faculty of Water Resources, National University of Laos

[3]Lecturer in Faculty of Water Resources, National University of Laos

Abstract: ***The objectives of this study are to study the factors of the flood and the flood adaptation methods of villagers in Lahanam and Thakhamlian villages. The interview has been conducted with 86 samples from this study. This study investigated flooding factors, the relationship between location and house type, and the flood depth and time of flooding. The study found that the main factors contributing to flooding are strong storms with heavy rain and low plain land alongside the Xebanghieng River bank. Even though houses located near or far from the Xebanghieng river bank have the same flooded depth and time, villa houses or two - floor houses have the same flooded depth and time. The villagers have adapted to living with flooding in many ways, including agriculture, housing, and livelihood.***

Keywords: Storm, heavy rain, flood, adaptation, lowland

1. Introduction

Over the past decades, flood events have occurred continuously and continue to increase in frequency and intensity around the world. The exploitation and encroachment of natural resources and human activities have degraded the environment and the lack of balance causes climate change and global warming, storms, and high level of water flow causing a large amount of water to flood. The flood affected the people and swept away houses, fields, and livestock in many places, caused agricultural crops to be killed by floods, lack of food sources, etc., floods caused serious damage to life, property, socio - economic system and environment.

Savannakhet province is a province that lies in the central part of Laos and is a province with many large rivers such as Xebanghieng, Xechamphone, Xesangsoi, Xelanong, Xepon, Xebangnuan and Xebangfai. These rivers flow from the high mountains to the low plains along the Mekong River plain. According to statistics, the worst floods were in 2004, 2005, 2011 and 2018. Most of the causes of floods are caused by heavy rain storms for several days, average from 5 - 10 days, some areas 15 - 20 days "*Water Resources Department, 2014*". The amount of water from the various rivers is large and flows into the Mekong River at the same time. A large amount of water flooded the area below. Songkhone district is located in the area affected by such disaster, the flow of huge amount of water caused the water to flood the production area and people's houses because the location of Songkhone district is a low - lying area and it is supported by the sub - tributary river that flows into the Xebanghieng river. From the records of flood occurrences in the past, it is found that: there are 36 villages at risk of flooding, 27 villages are flooded every year (statistics of villages and families affected by floods, 2020).

Among them, Lahanam and Thakhamlian villages, which belong to Songkhone district, Savannakhet Province, are two of the villages that are flooded every year. For the above reasons, this research aims to study the important factors that cause flooding in Lahanam and Thakhamlian villages; and study how to adapt to the flood of the people of these two villages.

2. Material and Methods

This study interviewed a sample of 86 people (household representatives). The interviews started from November 25 to December 9, 2022. The sample size was determined by the Taro Yamane formula, and the sample size from each village was determined by the Cochran (1977) formula. The form covers the general information of the household, the type of house, the distance of the house from the Xebanghieng River, the depth of the house flood, the duration of the flood, comments on the factors that caused the flood, agricultural adaptation, housing adaptation, lifestyle adaptation, and flood coping. Data analysis was performed using descriptive statistics and statistical tests with the Chi - square.

3. Results

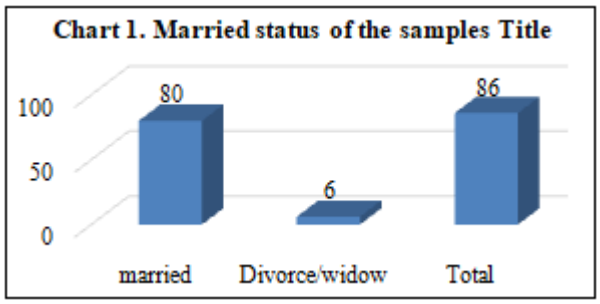
3.1 Background of the sample

The sample for this study is 86 people: 14 females, which cover 16.3% of the total; and 72 males, which cover 83.9%. The sample selected from Lahanam village is 63 people: 7 females, which covers 11.1%, and 56 males, which covers 88.9%; and the sample selected from Thakhamlian village is 23 people: 7 females, which covers 30.4%, and 16 males, which covers 69.6%.

Table 1: Number of sample by villages and sex

No	Village	Male		Female		Total	
		No.	%	No.	%	No.	%
1	Lahanam	56	88.9	7	11.1	63	100.0
2	Thakhamlian	16	69.6	7	30.4	23	100.0
	Total	72	83.7	14	16.3	86	100.0

There is 80 people or 93.0% were married, other 8 people or 7.0% were divorce or widow.



The sample has an average build - up area of 1, 156.1 m^2, the minimum build - up area is 100 m2, and the maximum build - up area is 7000 m2, with a standard division of 1, 462 m^2. The majority of the sample has no garden land; the average garden land area is 0.1422 ha. The largest garden land area is 3 ha, with a standard division of 0.45 ha. Some of the samples have no paddy land; the average paddy land area owned is 2 ha; the largest owned paddy land area is 9.5 ha; and the standard division is 2.1 ha.

Other assets owned by the sample households are cars, motorbikes, hand tractors, boat machines, rice mills, refrigerators, televisions, washing machines, and others. All households have assets differently, which means some households have certain assets while others have others. For livestock, they prefer to raise cattle and poultry, followed by goats and buffalo.

The sample has a similar portion of house types: 30 samples, or 34.9%, own villa houses; 28 samples, or 32.8%, own two - floor houses with free brick or block laying in the first floor; and 27 samples, or 31.4%, own a two - floor house with brick or block laying in the first floor. A hut is owned by one sample, or 1.2 percent (Chart 2).

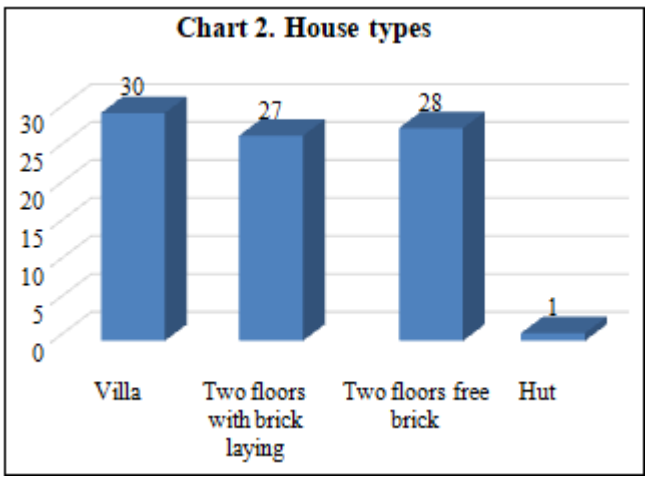


Table 2 shows the distance of the house location of the samples from the Xebanghieng river bank. Figures show that 21 samples, or 24.4 percent, have their houses located less than 100 meters from the Xebanghieng river bank; 35 samples, or 40.7%, have their houses located between 100 and 200 meters from the Xebanghieng river bank; and 30 samples, or 34.9%, have their houses located more than 200 meters from the Xebanghieng river bank.

Table 2: Shows distance of house location of the sample from the Xebanghieng river bank

No.	Villages	House location from the Sebanghieng river bank							
		< 100 m		100-200 m		> 200 m		Total	
		No.	%	No.	%	No.	%	No.	%
1	Lahanam	16	25.4	23	36.5	24	38.1	63	100.0
2	Thakhamlian	5	21.7	12	52.2	6	26.1	23	100.0
	Total	21	24.4	35	40.7	30	34.9	86	100.0

3.2 Factors Influencing the flood

When talking about the influencing factors leading to the flood, some of the samples provided many factors influencing the flood in their village areas. The 68 samples, or 79.1%, reported that storms are the main factor leading to flooding; other 37 samples, or 43%, give their reasons for thinking heavy rain is the important factor leading to flooding; and other 23 samples, or 26.9%, cite that their village's location in a low area causes flooding to occur. Other factors include a lack of a flood protection dike, a lack of drainage or a lower drainage canal, and deforestation, all of which are present in less than 5% of each of the samples.

Table 3: Shows factors leading the flood (Multiples choice)

No.	Factors leading to a flood	Lahanam		Thakhamlian		Total	
		No.	%	No.	%	No.	%
1	Storm	48	76.2	20	87.0	68	79.1
2	Heavy rain	20	31.7	17	73.9	37	43.0
3	Low land area	22	34.9	1	4.3	23	26.7
4	Have no flood protection dike	4	6.3	0	0.0	4	4.7
5	Low drainage /have no drainage	1	1.6	3	13.0	4	4.7
6	Deforestation	2	3.2	0	0.0	2	2.3
	Total	63	100.0	23	100.0	86	100.0

The big flood year is 2019, and all houses in the samples are flooded. The house of 61 samples, or 70.9%, flooded for more than 2 weeks; the house of 22 samples, or 25.6%, flooded for 1 - 2 weeks. For the houses of three samples, or 3.5% flooded in less than one week (table 4),

Table 4: Shows the duration of houses flooded in the big flooding year (2019).

No.	Flood duration	Lahanam		Thakhamlian		Total	
		No.	%	No.	%	No.	%
1	<1 week	3	4.8	0	0.0	3	3.5
2	1 - 2 weeks	13	20.6	9	39.1	22	25.6
3	> 2 weeks	47	74.6	14	60.9	61	70.9
	Total	**63**	**100.0**	**23**	**100.0**	**86**	**100.0**

During the big flood year, all houses in the sample are flooded. The house of 81 samples, or 94.2%, were flooded

more than 2 meters deep; the other 5 samples, or 5.8%, were flooded between 1 - 2 meters deep (table 5).

Table 5: Shows house flood depths during the big flood year (2019).

No.	Depth flood level	Lahanam		Thakhamlian		Total	
		No.	%	No.	%	No.	%
1	< 1 m	0	0.0	0	0.0	0	0.0
2	1 - 2 m	4	6.3	1	4.3	5	5.8
3	>2 m	59	93.7	22	95.7	81	94.2
	Total	63	100.0	23	100.0	86	100.0

3.3. Flood adaptation

Chart 3 shows the impact on people during the flood. There are 80 samples, or 96.5%, citing that they have no personal impact from floods, such as loss of life or injury; only 3 samples, or 3.5%, say that floods impact their health, especially when they become injured after moving their assets from their home to other upland places.

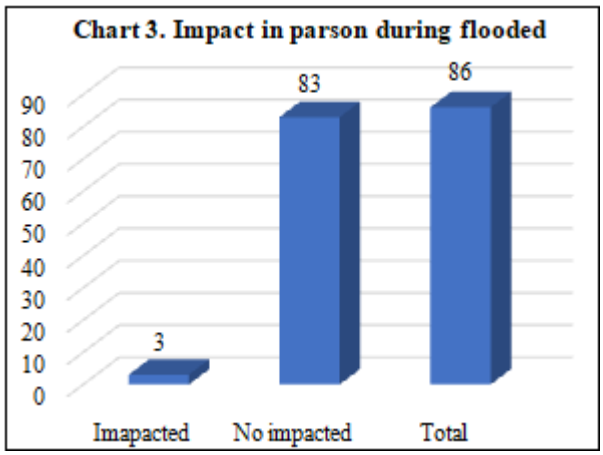


Table 6 shows the flood adaptation of the samples in two sample villages. They used many methods together to adapt to floods. The 37 samples, or 43.0%, moved their livestock to stay in higher land areas with no flooding; the 28 samples, or 32.6%, each used flood - tolerant rice seed and early warning information monitoring; the other 27 samples, or 31.4%, cultivated crops to avoid flooding periods.

Table 6: Shows agricultural adaptation to flood of samples households (multiple choices)

No.	Adaptation types	Lahanam		Thakhamlian		Total	
		No.	%	No.	%	No.	%
1	Used flood - tolerant rice seed	19	30.2	9	39.1	28	32.6
2	Crops cultivation avoids flood periods	27	42.9	0	0.0	27	31.4
3	Moved livestock to higher land area	31	49.2	6	26.1	37	43.0
4	Monitor the information from early warning system	19	30.2	9	39.1	28	32.6

There are many methods for shelter adaptation to a flood in the sample households in the two sample villages. The majority of the samples (35 people) uplift their house floors to a higher normal flood level, followed by 33 people, or 38.4%, who build resilience in their houses to floods, and the other 9 people, or 10.5%, do nothing with their houses. Minority of sample, for example, 4 people or 4.7% improved the house wall to protect water infiltration or flow into their houses; other 4 samples, or 4.7%, did not build their houses in normally flood - prone areas; and 1 sample, or 1.2%, brought sandbags to make a flood protection dikes around the house, especially during normal flooding (table 7).

Table 7: Shows the shelter flood adaptation of the samples.

No.	Adaptation types	Lahanam		Thakhamlian		Total	
		No.	%	No.	%	No.	%
1	Uplift their house floor	30	47.6	5	21.7	35	40.7
2	Build resilience house	21	33.3	12	52.2	33	38.4
3	Do nothing	5	7.9	4	17.4	9	10.5
4	Construction wall the protect water infiltration	3	4.8	1	4.3	4	4.7
5	Do not build houses in flood - prone areas	4	6.3	0	0.0	4	4.7
6	Used sand bags to make flood protection dike	0	0.0	1	4.3	1	1.2
	Total	63	100.0	23	100.0	86	100.0

The majority of the samples (74 people) represent 86.0% of those who temporarily migrated to live in other places when flooding occurred; 15 samples, or 17.4%, were fishing for their daily livelihood. Some of the samples coping with floods do so by using boats for transportation, eating less food, and relying on relatives for assistance.

Table 8: Livelihood adaptation to flood (multiple choices)

No.	Adaptation types	Lahanam		Thakhamlian		Total	
		No.	%	No.	%	No.	%
1	Temporary migrated to live other places	51	81.0	23	100.0	74	86.0
2	Fishing for their daily livelihood	15	23.8	0	0.0	15	17.4
3	Live with flood and use boat for transportation	6	9.5	0	0.0	6	7.0
4	Less amount of food consume	4	6.3	0	0.0	4	4.7
5	Depanding on assistance from relatives	3	4.8	0	0.0	3	3.5
6	Fish fishing for processing	1	1.6	0	0.0	1	1.2

The flood problem solving of the respondent when flooding shows that the majority of the respondents (48 people) moved their assets to upper land areas; the 37 respondents, or 43.0%, monitor information from the early warning system; and the 11 respondents, or 12.8%, consumed food and used the money saved to spend. Some of the respondents, such as 9 respondents, or 10.5%, try to contact their relatives and request help from the government, and the 5 respondents, or 5.8%, change their behavior when it floods.

	Value	df	Asymptotic Significance (2 - sided)
Pearson Chi - Square	8.602[a]	4	.072
Likelihood Ratio	9.387	4	.052
Linear - by - Linear Association	3.411	1	.065
N of Valid Cases	86		
a.3 cells (33.3%) have expected count less than 5. The minimum expected count is.73.			

Table 9: Shows flood problem solving when flooding (multiple choices)

No.	Problem solving methods	Lahanam		Thakhamlian		Total	
		No.	%	No.	%	No.	%
1	Moved assets to higher land areas	34	54.0	14	60.9	48	55.8
2	Monitor information from early warning system	30	47.6	7	30.4	37	43.0
3	Consume food and spend money saved	11	17.5	0	0.0	11	12.8
4	Contract to relatives and request for help from government	7	11.1	2	8.7	9	10.5
5	Behavior change on food diet	5	7.9	0	0.0	5	5.8

4. Statistics Testing

4.1. Relationship test of house location and flooding duration

This study has tested statistically whether the house location is far from the Xebanghieng river bank is related to the duration of the floods or not. The Pearson Chi - Square test results show that Pearson Chi - Square has a significant (2 - sided) value of 0.072, which value > 0.05. We can conclude from the test that the house location from the Xebanghieng River bank has no relation to the duration of the flooding at 95% confidence (table 11).

Table 10: Compare house location from Xebanhhieng River bank and duration of flood

Distance	Flooded duration			
	<one week	1 - 2 weeks	> 2weeks	Total
<100 m	0	3	18	21
100 - 200 m	0	12	23	35
>200 m	3	7	20	30
Total	3	22	61	86

4.2. Relationship test of house location and flood depth

Table 11: Test results on the relationship of house location from River bank and duration of floods by Chi - Square

	Value	df	Asymptotic Significance (2 - sided)
Pearson Chi - Square	8.278a	6	.218
Likelihood Ratio	8.812	6	.184
Linear - by - Linear Association	.220	1	.639
N of Valid Cases	86		
a.6 cells (50.0%) have expected count less than 5. The minimum expected count is.03.			

This study has tested statistically whether the house location is far from the Xebanghieng river bank is related to the flooded depth or not. The Pearson Chi - Square test results show that Pearson Chi - Square has a significant (2 - sided) value of 0.959, which value > 0.05. We can conclude from the test that the house location from the Xebanghieng River bank has no relation to the flooded depth at 95% confidence (table 13).

Table 12: Compare house location from Sebanhhieng River bank and flooded depth of houses

Distance	Flooded depth level		
	1 - 2 m	> 2m	Total
<100 m	1	20	21
100 - 200 m	2	33	35
>200 m	2	28	30
Total	5	81	86

Table 13: Test results on the relationship of house location from River bank and flooded depth level by Pearson Chi - Square

	Value	df	Asymptotic Significance (2 - sided)
Pearson Chi - Square	.083[a]	2	.959
Likelihood Ratio	.084	2	.959
Linear - by - Linear Association	.082	1	.775
N of Valid Cases	86		
a.3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.22.			

4.3. Relationship test of house types and flooded duration

This study has tested statistically whether the house types are related to the flooded duration or not. The Pearson Chi - Square test results show that Pearson Chi - Square has a significant (2 - sided) value of 0.218, which is a value > 0.05. We can conclude from the test that the house types have no relation to the flooded duration at 95% confidence (table 15).

Table 14: Compare house types and flooded duration

House types	Flooded duration			
	<a week	1 - 2 weeks	> 2 weeks	Total
Villa	0	11	19	30
Two floors with free first flood	2	5	20	27
Two floors with brick - laying construction on the first floor	1	5	22	28
Hut	0	1	0	1
Total	**3**	**22**	**61**	**86**

Table 15: Test results on the relationship of house types and flooded duration by Pearson Chi - Square

4.4. Relationship test of house types and house flooded depth

The research has been tested statistically whether the house types are related to the house flooded depth or not. The Pearson Chi - Square test results show that Pearson Chi - Square has a significant (2 - sided) value of 0.122 which is a value > 0.05. We can conclude from the test that the house types have no relate to the house flooded depth at 95% confidence (table 17).

Table 16: Compare house types and house flooded depth

House types	House flooded depth		
	1- 2 m	> 2m	Total
Villa	0	30	30
Two floors with free first flood	1	26	27
Two floors with brick - laying construction on the first floor	4	24	28
Hut	0	1	1
Total	5	81	86

Table 17: Test results on the relationship of house types and house flooded depth by Pearson Chi - Square

	Value	df	Asymptotic Significance (2 - sided)
Pearson Chi - Square	5.803a	3	.122
Likelihood Ratio	6.632	3	.085
Linear - by - Linear Association	4.658	1	.031
N of Valid Cases	86		
a.5 cells (62.5%) have an expected count of less than 5. The minimum expected count is.06.			

5. Discussion

The most important factor influencing floods is storms, which together with heavy rain are the main cause of floods. The built - up area is flat and low - lying, contributing to flooding in two of the sample villages. Other factors, such as the lack of a flood protection dike, the lack of a drainage system or shallow drainage, and deforestation, are considered not to be important factors in the two sample villages.

The different house locations from the Xebanghieng river bank with different distances cause the same flood duration and flood depth, and the different house types (one - floor and two - floor houses) have the same flood duration and flood depth.

Even though flooding regularly occurs, villagers can adapt to floods for their livelihoods. The villagers try to use rice seed tolerant to flooding, cultivate crops to avoid flooding season, move livestock to stay in higher land areas, and monitor the information from the early warning system for agriculture adaptation. Uplifting house floors to higher than normal flooding levels and building strong, resilient houses are the shelter adaptation methods of the respondents. The temporary migration, fishing for daily livelihood, living with a flood, consuming less food, and being dependent on assistance from relatives are adaptation methods for livelihood.

6. Conclusion

This study on the important factors leading to flooding and flooded adaptation can conclude that the important factors leading to flooding are storms with heavy rain, continuous rain for several days, and lowland areas along the Xebanghieng river bank. The house location, either near or far from the Xebanghieng river bank, is not related to flooded depth and flooded duration, which means the flooded depth and flooded duration are not different, and the villa houses or two - floor houses flooded depth and flooded duration are the same when big floods occur. Villagers in the study areas have more experience with adaptation to flooding, including in agriculture, shelter, and livelihoods affected by flooding in their villages.

Acknowledgement
I would like to thank the district natural resources and environment office, village administration authority, and sample households in Lahanam and Thakhamlian villages, Songkhone district, for their good coordination and facilitation in this study.

References

[1] **Asian Disaster Preparedness Center, 2556.** Training manual on Integrated flood risk management,
[2] **ADPC and USAID, 2006**. Training manual on Provincial and District Flood Preparedness Planning and implementation
[3] **ADPC, LNMC, and NDMO, 2010**. Flood planning and implementation, Manual for development of flood preparedness program.
[4] **Associate Professor Dr. Vorlavouth Vouthvanoth.1996**. Applied hydrology, Water Resources Engineering department, Faculty of Engineering, Kasetsart University (Thailand).
[5] **Associate Professor Dr. Youth Kaivone**, 2009. Step by Step data analysis by SPSS, 315/43 Economic village road (Phetkasem 102), Bangkeanue, Bangkea region, Bangkok10106
[6] **Bounpasong Norlaphim, 2019**. Bachelor thesis, peak water flow analysis in Xebangfai watershed, case study: Xebanhfai watershed of Khammouane province. Faculty of Water Resources, National University of Laos.
[7] **Curriculum research and training division, Infermation service department, National statistics Center**, 2012. Applied statisticd handbook.
[8] **Dr. Vilaphanh Themsombath, 1988**. Applied hydrology, Water resources department, Faculty of engineering, Kasetsart University (Thailand).
[9] **KhenPhimathat, 2019**. Master thesis onrainfall and surface water flow analysis for Namlik watershed, Vientiane Province, Faculty of Water Resources, National University of Laos.
[10] **Natural Resources and Environment Department of Savannakhet province, 2022.** Environment, water and meteorology and hydrology division annual report, 2022
[11] **Professor Bountham Kitpedaborlisout, 2540**. Social Researcg methodology, 789/2 Suanphou road 1, Thongkhamem, Sathone region, Bangkok, 10121
[12] **VirothXaytham.1993**. Hydrology, Civil engineering department, Faculty of engineering, Khonkean University (Thailand).
[13] **Vilakone Kasioudome, 2009.** Meteorology, Faculty of Water Resources, National University of Laos. Vientiane Capital.
[14] **https: //www.statisticssolutions. com/w. Using Chi - Square Statistic in Research**
[15] **https: //www.scribbr. com/statistics/chi - square - tests**