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Feedback analysis of an expert opinion survey for flood management

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ABSTRACT
Flood is a serious physical phenomenon which is now a day becomes a common scenario around the world. The flood management planning is essential for decreasing the damages that occurred due to flood like situations. There are several flood management techniques and methods but the problem still persists. Hence in order to have better understanding about floods and flood management strategies, a survey was conducted in three parts. First part of survey is for an Expert people and other parts of surveys are for PG and UG students of Civil engineering department respectively. The main objective of the paper is to determine the Expert people's opinion, their perception and understanding about flood phenomena. And based on their experience, identify the critical parameters involved in causing flood and steps involved in flood management. The feedbacks from the surveys are then analyzed thoroughly which shows that the green canopy covers should be increased; deforestation and urbanization should be controlled to some extent to manage floods effectively.
Keywords – Expert opinion survey, flood, flood management, feedback analysis, green cover.

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I. INTRODUCTION

Flood is a serious natural disaster, which damages everything that comes in between its way. To tackle flood disaster, the understanding of its nature, causes, and parameters involved, their aftermaths are to be considered in flood management planning for any area. The expert people and the inhabitants are the main source of information in preparing the flood management plan for any country.

The analysis of social research data plays an essential role in developing strategies, self precautions and warning systems for the people by the people [3]. The development of public education, coordination, communication and emergency strategies are the outcomes of public opinions. The public survey sometimes revealed the serious threat in the eyes of the inhabitants. The surveys also highlight the need of insurance against floods, measures to prevent floods etc [4].

In modern flood risk management the knowledge of public perception is considered crucial as it steers the development of effective and efficient mitigation strategies against flood [5]. The Delphi method is now a day's effective in getting the results from the survey. However multi-step Delphi method proved to reduce the deviation of answers thereby enabling consensual results and also enhanced the quality by modifying group answers in the direction of experience based answers [6].

The key to developing a successful disaster management plan is to find a balance between technocratic and social aspects of interventions so that public's perception reflects the real risk and they are prepared to deal with uncertainties that may arise in emergency [2]. The public opinion always varies fundamentally with the expert people opinion. This underlines the fact of having the flood management plan but with social accountability before any crucial decision [1].

The management of flood involves multiple researches based on the flood control structures, growing urbanization, deforestation, population growth etc. The flood seems dangerous before attacking any area and after it the rehabilitation phase takes place for people survived. Hence, in this paper we have carried out surveys for understanding the floods, categorizing the key parameters involved in critical situations and how to manage logically.

II. OBJECTIVES OF THE STUDY

The main objective of the paper is to determine the expert people's opinion, their perception and understanding about flood phenomena. And also to identify the critical parameters involved in causing flood and steps involved in flood management. The paper also

focuses on views about the green cover and impervious nature of urban cities and protective decision making in response to floods. In this paper the main focus is to identify the hierarchy of events occurring during flood like situation and to determine the best structural and non-structural measures used in floods.

III. METHODOLOGY

The methodology consists of the following steps: 1) first of all the three online questionnaire surveys are created in the Google forms (One for expert people, second for PG students and third for UG students respectively). 2) Then the three questionnaire surveys were mailed to expert people, PG and UG students respectively. 3) Then the feedbacks of the surveys were downloaded in a new folder on the desktop. 4) Then the feedback analyses were performed based on responses. 5) Identify the critical parameters involved in causing flood and steps involved in flood management. 6) Finally based on survey flood management solutions were recommended.

IV. DATA COLLECTION AND ANALYSIS

A questionnaire consisting of 20 questions regarding flood management was prepared first. Then online survey form was created using Google forms. The survey form was sent to Expert people, PG students and UG students of civil engineering branch via emails for getting their feedback. It is made available for Expert people between June 2016 to May 2017 (1 Year) and for PG- UG students of civil engineering branch between April to October 2017 (6 months). Total responses recorded were 339 (130 expert people, 23 PG students and 186 UG students). After closing the forms, the datasets were downloaded in excel format from Google forms for feedback analysis. This dataset is useful for understanding the nature of floods, causes of floods, key parameters which influence the flood situation etc.

Table 1: Self reported experiences of expert people

Experience in years	Percentage responses
0-5	38
6-10	18
11-15	9
16-20	5
21-25	12
26-30	10
31-35	6
36-40	2
41-45	2

Table 2: Responses for Question 6 from expert people, PG students and UG students

"Floods are natural phenomena" do you agree?	Expert people (% response)	PG students (% response)	UG students (% response)
Strongly agree	21	22	23
Agree	51	61	53
Neutral	16	17	18
Disagree	11	0	5
Strongly disagree	2	0	1

Total responses for expert people, PG students and UG students are 130, 23 and 186. As per the above table, maximum numbers of responses of expert people (72%), PG students (83%) and UG students (76%) are towards agreement that floods are natural phenomena.

Table 3: Responses for Question 7 from expert people, PG students and UG students

"Floods are extremely difficult to manage" do you agree?	Expert people (% response)	PG students (% response)	UG students (% response)
Strongly agree	5	0	11
Agree	40	43	41
Neutral	15	22	18
Disagree	36	35	28
Strongly disagree	5	0	1

The table represents that maximum percentage of responses from expert people (40%), PG students (43%) and UG students (41%) are in agreement that floods are extremely difficult to manage.

Table 4: Responses for Question 8 from expert people, PG students and UG students

In your opinion do you think, the green cover (canopy cover) plays a vital role in managing the floods?	Expert people (% response)	PG students (% response)	UG students (% response)
Strongly agree	32	17	15
Agree	52	52	56
Neutral	14	30	22
Disagree	2	0	4
Strongly disagree	0	0	3

The table represents that maximum percentage of responses from expert people (52%), PG students (52%) and UG students (56%) are in agreement that green cover plays a vital role in managing floods.

Table 5: Responses for Question 9 from expert people, PG students and UG students

Do you think that the urban cities land cover become more impermeable for water to infiltrate into the ground surface?	Expert people (% response)	PG students (% response)	UG students (% response)
Strongly agree	52	26	23
Agree	43	65	54
Neutral	4	9	17
Disagree	1	0	5
Strongly disagree	1	0	1

The table represents that maximum percentage of responses from expert people (52% & 43%), PG students (65%) and UG students (54%) are in complete agreement that the urban cities land cover becomes more impermeable for water to penetrate into the ground.

Table 6: Responses for Question 10 from expert people, PG students and UG students

	Expert opinion (% responses)		PG student (% responses)		UG student (% responses)	
Responses in Yes or No	Yes	No	Yes	No	Yes	No
1. Climate changes due to environmental degradation	94	6	96	4	95	5
2. Decrease in vegetation cover due to deforestation	93	7	96	4	86	14
3. Change in land use pattern due to fast urbanization	94	6	91	9	88	12
4. Human mistakes in handling hydrological structures	86	14	74	26	92	8

Table 7: Responses for Question 11 from expert people

	Responses from Expert people	Order of significance in percentage							
Sr. No.	Reasons	1	2	3	4	5	6	7	8
1	Heavy rainfall	53	22	8	6	5	3	1	2
2	Improper management of hydraulic structures (human error)	22	22	17	12	8	8	6	4

3	Decrease in vegetation cover (deforestation)	22	30	18	13	8	5	2	2
4	Increase in concrete cover (urbanization)	20	26	20	8	11	7	3	5
5	Increase in temperature (global warming)	17	27	18	11	5	6	9	6
6	Change in climatic conditions (environmental pollution)	18	24	11	11	12	9	8	8
7	Increase in confinement of natural rivers	25	22	18	14	5	7	6	3
8	Increase in construction activities in flood plain areas	29	23	13	6	5	9	6	8

From the table, according to expert people's responses, the hierarchies of reasons of floods in the order of their significance are:

1. Heavy rainfall
2. Decrease in vegetation cover (deforestation)
3. Increase in construction activities in flood plain areas
4. Increase in temperature (global warming)
5. Increase in concrete cover (urbanization)
6. Increase in confinement of natural rivers
7. Change in climatic conditions (environmental pollution)
8. Improper management of hydraulic structures (human error)

Table 8: Responses for Question 11 from PG students

	Responses from PG students	Order of significance in percentage							
Sr. No.	Reasons	1	2	3	4	5	6	7	8
1	Heavy rainfall	70	13	0	4	4	4	4	0
2	Decrease in vegetation cover (deforestation)	13	48	13	4	4	4	13	0
3	Increase in concrete cover (urbanization)	26	35	9	13	13	0	0	4
4	Increase in temperature (global warming)	26	26	22	9	9	4	4	0
5	Change in climatic conditions (environmental pollution)	30	17	17	4	13	4	4	9
6	Increase in confinement of natural rivers	13	22	22	17	0	13	9	4
7	Increase in construction activities in flood plain areas	30	13	9	13	4	17	13	0
8	Improper management of hydraulic structures (human error)	22	26	4	22	0	0	4	22

From the table, according to PG student's responses the hierarchies of reasons of floods in the order of their significance are:

1. Heavy rainfall
2. Decrease in vegetation cover (deforestation)
3. Increase in concrete cover (urbanization)
4. Change in climatic conditions (environmental pollution)
5. Increase in construction activities in flood plain areas
6. Increase in temperature (global warming)
7. Improper management of hydraulic structures (human error)
8. Increase in confinement of natural rivers

Table 9: Responses for Question 11 from UG students

	Responses from UG students	Order of significance in percentage							
Sr. No.	Reasons	1	2	3	4	5	6	7	8
1	Heavy rainfall	64	7	4	4	3	6	2	10

2	Decrease in vegetation cover (deforestation)	24	26	13	9	4	9	9	5
3	Increase in concrete cover (urbanization)	22	17	13	10	8	9	10	11
4	Increase in temperature (global warming)	27	23	13	14	8	5	6	4
5	Change in climatic conditions (environmental pollution)	33	24	11	10	12	3	3	4
6	Increase in confinement of natural rivers	20	22	9	11	13	10	8	6
7	Increase in constrution activities in flood plain areas	20	18	9	6	13	9	14	12
8	Improper management of hydraulic structures (human error)	29	18	10	11	3	8	6	15

From the table, according to UG student's responses the hierarchies of reasons of floods in the order of their significance are:

1. Heavy rainfall
2. Change in climatic conditions (environmental pollution)
3. Improper management of hydraulic structures (human error)
4. Increase in temperature (global warming)
5. Decrease in vegetation cover (deforestation)
6. Increase in concrete cover (urbanization)
7. Increase in confinement of natural rivers
8. Increase in construction activities in flood plain areas

Table 10: Responses for Question 12 from expert people, PG students and UG students

Sr. No.	In your opinion which one is the best possible solution by structural measures (please tick any one)	Expert people (% response)	PG students (% response)	UG students (% response)
1	Increasing the size of the channel by removing sediment load	20	4	12
2	Embankment/ levees	15	9	4
3	Dam/ weir construction	35	57	52
4	Floodways	19	13	13
5	Floodwalls	5	9	6
6	Any other new construction	5	4	8
7	Blank (None)	1	4	5

From the table, the one best possible solution by structural measures by expert people (35%), PG students (57%) and UG students (52%) is dam/ weir construction.

Table 11: Responses for Question 13 from expert people, PG students and UG students

Sr. No.	In your opinion which one is the best possible solution by non-structural measures (please tick any one)	Expert people (% response)	PG students (% response)	UG students (% response)
1	Flood forecasting	35	35	20
2	Hydrological modeling	38	30	29
3	Flood proofing of nearby structures	10	17	15
4	Flood warnings	10	4	13
5	Evacuation of people before floods to a safer placer	7	9	17

7	Blank (None)	0	4	5

From the table, the one best possible solution by non-structural measures by expert people is hydrological modeling (38%), PG students is flood forecasting (35%) and UG students is also hydrological modeling (29%).

Table 12: Responses for Question 14 from expert people

Responses from Expert people	Score in percentage										
Conditions of flood	1	2	3	4	5	6	7	8	9	10	Blanks
Pre-flood condition	29	16	15	8	12	5	2	4	0	2	7
During flood	8	11	8	5	11	3	7	13	10	18	7
Post-flood condition	8	6	15	4	6	3	8	15	12	15	8

The table represents the most normal condition is pre-flood condition, than during flood condition and worse condition is post-flood condition according to expert people responses.

Table 13: Responses for Question 14 from PG students

Responses from PG students	Score in percentage										
Conditions of flood	1	2	3	4	5	6	7	8	9	10	Blanks
Pre-flood condition	35	13	17	13	17	0	4	0	0	0	0
During flood	9	22	13	9	4	4	0	30	4	4	0
Post-flood condition	9	17	13	4	4	0	9	9	13	22	0

The table represents the most normal condition is pre-flood condition, than during flood condition and worse condition is post-flood condition according to PG student's responses.

Table 14: Responses for Question 14 from UG students

Responses from UG students	Score in percentage										
Conditions of flood	1	2	3	4	5	6	7	8	9	10	Blanks
Pre-flood condition	38	13	14	6	8	3	1	4	3	3	8
During flood	12	16	5	3	9	3	5	9	8	22	9
Post-flood condition	17	5	13	3	4	5	4	7	10	21	11

The table represents the most normal condition is pre-flood condition, than post- flood condition and worse condition is during flood condition according to UG student's responses.

Table 15: Comparison of feedback from expert people, PG students and UG students

	Expert people		PG students		UG students	
Conditions of flood	Normal (score 1 to 5) %	Worst (score 6 to 10) %	Normal (score 1 to 5) %	Worst (score 6 to 10) %	Normal (score 1 to 5) %	Worst (score 6 to 10) %
Pre-flood condition	81	12	96	4	79	13
During flood	42	51	57	43	45	46
Post-flood condition	38	54	48	52	42	47

Table 16: Responses for Question 15 from expert people

Responses from Expert people		Score in percentage						
Sr. No.	Stages of watershed under floods	1	2	3	4	5	6	Blanks
1	Heavy flood condition	18	13	18	8	12	20	12
2	Flood warning	10	32	15	25	6	1	12
3	Flood forecasting	29	18	26	8	4	5	10
4	Structural measures	19	15	19	22	8	5	11
5	Non-structural measures	6	25	19	9	25	5	11
6	Evacuation of people to safer places	13	9	8	12	17	28	12

From the table, according to expert people's responses, the hierarchies of stages or conditions for any watershed/ basin under floods in ascending order: -

1. Flood forecasting
2. Flood warning
3. Non-structural measures
4. Structural measures
5. Heavy flood condition
6. Evacuation of people to safer places

Table 17: Responses for Question 15 from PG students

Responses from PG students		Score in percentage						
Sr. No.	Stages of watershed under floods	1	2	3	4	5	6	Blanks
1	Heavy flood condition	35	13	4	4	26	17	0
2	Flood warning	17	43	4	22	13	0	0
3	Flood forecasting	30	9	48	4	9	0	0
4	Structural measures	22	26	17	22	0	13	0
5	Non-structural measures	22	22	13	22	17	4	0
6	Evacuation of people to safer places	13	30	13	4	17	22	0

From the table, according to PG student's responses, the hierarchies of stages or conditions for any watershed/ basin under floods in ascending order: -

1. Heavy flood condition
2. Flood forecasting
3. Flood warning
4. Structural measures
5. Non-structural measures
6. Evacuation of people to safer places

Table 18: Responses for Question 16 from expert people and PG students

Hydrological model plays a vital role in preventing floods and flood risk?	Expert people %	PG students %
Yes	93	100
No	2	0
Blanks	5	0

The table represents that hydrological model will play a vital role in preventing floods and flood risk to certain level according to expert people (93%) and PG students (100%) respectively.

Table 19: Responses for Question 17 from expert people

Expert people responses (%)	>85%	>65%	>50%	<50%	Blanks
Flood inundation mapping	54	25	14	2	5
Flood forecasting situations	45	38	9	2	5
Mitigation of floods	25	31	28	11	5
Evacuation of people	27	25	18	25	5

The table represents that in a hydrological modeling, flood inundation mapping (>85%), flood forecasting situations (>65%), mitigation of floods (>50%) and evacuation of people (<50%) plays significant role respectively according to expert people's opinion.

Table 20: Responses for Question 17 from PG students

PG student's responses (%)	>85%	>65%	>50%	<50%	Blanks
Flood inundation mapping	30	30	35	4	0
Flood forecasting situations	26	48	26	0	0
Mitigation of floods	30	30	30	9	0
Evacuation of people	26	35	22	17	0

The table represents that in a hydrological modeling, Flood inundation mapping (>85%), flood forecasting situations (>65%), mitigation of floods (>50%) and evacuation of people (<50%) plays significant role respectively according to PG student's opinion.

Table 21: Responses for Question 18 from expert people and PG students

SWAT model is helpful in managing floods?	Expert people %	PG students %
Yes	52	39
Sometimes	39	43
No	7	4
Blanks	2	13

The table represents that SWAT model is helpful in managing flood to some extent according to expert people's (52%) and PG student's (39%) respectively.

V. CONCLUSION

The flood management plan involves the opinion of expert people, students; inhabitant's etc. The flood has to be understood properly before developing the management plan. In order to achieve the objectives, the questionnaire surveys were conducted and feedbacks were recorded from the expert people, PG and UG students. The survey results indicate that the critical parameters involved in causing floods are heavy rainfall followed by deforestation, construction in flood plain areas, global warming, rapid urbanization, confinement of natural rivers, changes in climatic conditions and improper management of hydraulic structures. And

from the feedback the best structural and non-structural measure is dam/weir construction and hydrological modeling respectively. And the results also show that the SWAT model is helpful model in managing floods. Hence in order to management floods effectively, the green cover should be increased, deforestation should be stopped and the urbanization should be controlled to some extent which in turn will help in managing floods effectively.

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