A Study of an SMS-Based Flood Warning System for Flood Risk Areas in Laos

Saysoth Keoduangsine, Robert Goodwin, and Paul Gardner-Stephen

***Abstract*—Flooding is a regular major disaster in Laos and results in significant damage to the national socio-economic development and loss of life. The current flood warning systems of the country are received in real-time data from the hydrological stations to the data centres for flood forecasting and warnings. Most flood alerts are sent to the public by mass media and bulletins, yet people in flood risk areas remain affected by annual floods. The feasible study of using SMS message as a real-time flood warning system was investigated by collecting the primary data from the two groups of respondents, people in the flood risk areas and the flooding experts who work for the current flood warning systems in Laos. This paper presents the findings, concludes with a summary and suggests future work for the study.**

***Index Terms*—Mekong river basin, Laos, SMS-based flood warning system.**

I. Introduction

The Mekong River is one of the world's great rivers with a basin of 795,000 square kilometres. It traverses Laos from North to South; Laos covers 35% of its lower basin. Annual floods are a common disaster for Laos; many parts of the country are often subjected to flooding from both the Mekong River and its tributaries[1].

In 2008, an extreme flood along the Mekong River affected 32,610 households, 4 people died and total damage was more than US$56 million. The flash flood that hit the South of the country in 2009 caused by a typhoon, 180,000 people were directly affected, there were 28 deaths and the direct economic loss was estimated at US$58 million. During the 2010 flash flood, more than 80,000 people were affected, 7 died and the total property damage was more than US$20 million [2]

In Laos, there are two flood warning systems. The first system is operated by the Department of Meteorology and Hydrology (DMH)[3]and the second system is operated by the Mekong River Commission (MRC)[4]. To support flood forecasting and warnings, the both systems receive real time data from hydrological stations to the data centres.

In the first system, the flood forecasting bulletins are prepared twice a day during the monsoon season. If flooding Is detected, the flood forecast is sent to the national radio and television stations, which broadcast the warning during daily programmes to the public. In the case of the urgent warnings, the system's staff gives an interview for the mass media and sends the urgent warnings to the national disaster management committee (NDMC). The NDMC inform the flood status to the provincial, district and village levels through the traditional means of telephone and facsimile, two-way radio and emails [3]

The second system is a flood forecasting and river monitoring system. For forecasting a flood, the data is processed by flood forecasting model software to make real-time graphs of water levels and precipitation of the monitoring hydrology stations and then are sent to the web server to publish online. Users who have online access can view the real-time monitoring graphs by internet-enabled devices [5].

Even though the current systems receive real-time data from the remote hydrological stations to the data centres for forecasting and making warnings, there is not any option to alert the public as a real-time warning during floods.

However, mobile phone networks have been widely developed in Laos in parallel with the increasing number of mobile phone users. In 2011 mobile phone penetration reached over 87 mobile users per 100 inhabitants, this number has continued to increase and reached to 102 mobile phone subscribers per 100 inhabitants in the year 2012 [6]. As a result, using SMS messages for flood warnings through the existing mobile networks might be an appropriate method in flood risk areas of the country.

In this context, the feasibility of using SMS messages to issue real-time flood warnings in flood risk areas in Laos was investigated. The findings of the study are presented in this paper.

II. Aims of the Research

From the above issues it can be seen that the collection and processing of the data are effective and timely but there are problems with distributing the flood forecast to the people in flood risk areas during severe floods. The main aims of the research were to study the feasibility of using SMS as a real-time flood warning system for developing countries: the case of in Laos, particularly to answer the following questions

- How reliable is the mobile phone coverage in the flood risk areas?
- What is the mobile phone penetration rate in the flood risk areas?
- Can people afford using mobile phones?
- Are people in flood risk areas using SMS?
- Do people want an SMS-based flood warning provided for their flood risk areas?
- What do the flood management experts think about the possibility of using SMS messages as a flood warning?

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III. Research Methodology

A. Sample Scheme

This study is a quantitative research and the primary data used in the study are from two primary data sources.

The first primary data was conducted in Laos from March to May 2013, covering a period of two months; the researcher interviewed a total number of 569 respondents (18 years old and above) with questionnaire by random people from the selected villagers in the flood-prone areas.

During May and July, the second primary data was collected online using " The Survey Gizmo" as a tool of collecting data from the 24 flood forecasting experts who work in the two organisations, namely the MRC and the DMH in Laos.

The questionnaire used to collect the primary data covers a number of variables. The main variables are mobile phone network, penetration of mobile phone use, competence of using SMS and opinion toward an SMS-based flood warning.

B. Data analysis

The responses to the questionnaire have been summarized using five points (Likert scale), where 1= Strongly disagreed, 2= Disagreed, 3=Neither disagreed/agreed, 4= agreed and 5= Strongly agree. The data collected was tabulated, analysed and finally used for the study purpose. For the analysis of data, the statistic tools and techniques are applied like proportion, descriptive statistics analysis using SPSS and spreadsheets.

IV. Analysis and Results

The primary data for analysis have been collected from the two sources, the first primary data were collected from the 569 residents living in the selected villages of the flood prone areas, and the second primary data are collected online from the 24 flooding experts who work for the flood warnings systems. The data analysis and results are compared to the two groups of the respondents

TABLE I: Demographic Profile of the Respondents in Flood Risk Areas

Categories	Respondents	Percentage (%)
Gender		
Male	311	54.66
Female	245	43.06
Ages		
18-20	35	6.15
21-30	119	20.91
31-40	156	27.42
41-50	135	23.73
51-60	74	13.01
Above 60	21	3.69
Profession		
Employees(govt./private)	104	18.28
Businessperson	45	7.91
Farmer	360	63.27
Student	36	6.33
Other	24	4.22
Total respondents	**569**	

A. Demography of the Respondents

The demographic profiles of the two respondent groups are summarized in Table I and Table II.

Table I shows the demographic profile of respondents in the flood-prone areas. More than a half of the respondents in flood risk areas (54.66%) were male and the majority of the respondents surveyed were in the age group of 21 to 50. The majority of the respondents from residents were farmers (63.27%) and second highest category was the employee (18.28%), whereas the smallest percentage of the respondents were unspecified (other), it was just 4.22%.

TABLE II: Demographic Profile of the Respondents of the Flooding Experts

Categories	Respondents	Percentage (%)
Gender		
Male	21	87.50
Female	3	12.50
Ages		0.00
18-20	0	0.00
21-30	0	0.00
31-40	5	20.83
41-50	12	50.00
51-60	7	29.17
Above 60	0	0.00
Profession		
Environment special	5	20.83
Flooding modeler	3	12.50
Hydrologist	8	33.33
Flood forecaster	5	20.83
Meteorologist	3	12.50
Total respondents	**24**	

The demography of respondents from the 24 flood experts shows in Table II.The 87.5% of the respondents were male of the age between 41 and 50; the majority of occupation was the hydrologists and the flood forecasters.

B. Literacy Level of Respondents by Profession

In this survey assuming that the flooding experts have high education, only respondents of the flood risk area have been assessed for their competence of knowing their own language (Lao) and basic English.

TABLE III: Knowledge of Mother Tongue by Profession

Profession	Can read and write mother tongue(Lao)					Total
	Don't know	Basic level	Fair	Fluent	Very fluent	
Employed(govt./private)				0.9%	17.4%	18.3%
Businessperson			0.4%	1.4%	6.2%	7.9%
Farmer	10.2%	14.1%	27.2%	9.7%	2.1%	63.3%
Student					6.3%	6.3%
Other			0.5%	1.2%	2.5%	4.2%
Total	**10.2%**	**14.1%**	**28.1%**	**13.2%**	**34.4%**	**100.0%**

Table III indicates the percentage of literacy level of respondents from the flood risk areas who can read and write their own mother tongue (Lao) by profession. Most respondents can read and write their own language (34.4% and 13.2% for very fluent and fluent respectively, followed

by 28.1 % of fair). However, farmers were majority of the respondents who cannot read and write their own languages representing 10.2% of the respondents in the flood risk areas.

The Table IV also illustrates basic English for the respondents surveyed in the flood risk areas; it was quite low compared to that of mother tongue. More half of the respondents (51.1%) don't know basic English, especially 49.7% out of the respondents who don't know English at all were farmers. It is suggested that if an SMS-base flood warning uses English to communicate, the majority of farmers will not understand the message.

TABLE IV: BASIC ENGLISH LEVEL BY PROFESSION

Profession	Can read and write a basic English					Total
	Don't know	Poor	Fair	Good	Excellent	
Employed(govt./private)		0.2%	1.9%	6.3%	9.8%	18.3%
Businessperson	0.4%	0.2%	2.1%	2.8%	2.5%	7.9%
Farmer	49.7%	9.3%	1.9%	1.8%	0.5%	63.3%
Student			0.4%	1.9%	4.0%	6.3%
Other	1.1%	0.7%	1.4%	0.7%	0.4%	4.2%
Total	**51.1%**	**10.4%**	**7.7%**	**13.5%**	**17.2%**	**100.0%**

C. How is Reliable the Mobile Phone Coverage in the Flood Risk Areas

Under this study, the two groups of respondents have been asked whether reliable or not is mobile phone signal in the flood-prone areas. The response against this question is very satisfactory (Fig. 1).

Of the respondents of the flood risk areas, 42% and 23% have experienced that the mobile phone coverage in their areas is reliable and very reliable respectively. Only 2% of them are not happy with the mobile signal (Fig. 1a).

Similarly, the flooding experts who work in the current flood warning systems have given their opinion that the mobile phone coverage in flood risk areas is reliable (64%), but just 11% of them have some doubts that mobile phone coverage is somewhat unreliable(Fig. 1b).

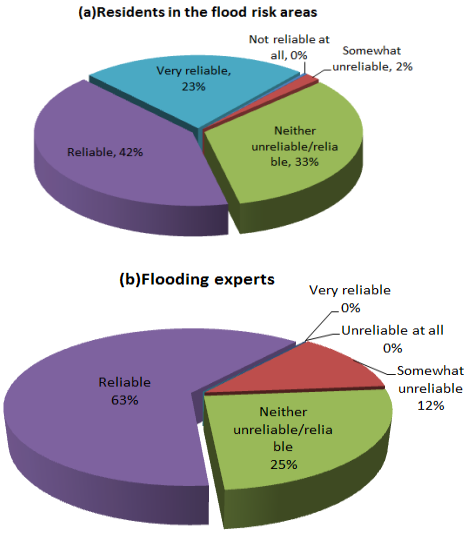

Fig. 1. Mobile phone coverage in the flood risk areas.

To conclude both residents and the flood management experts have experienced that mobile phone signal in the flood risk areas is reliable, and the results support the notion of using SMS-based alerts to reach majority of people living n flood risk areas.

D. Penetration of Mobile Phone User in the Flood Risk Areas

In this section, the respondents of the flood-prone areas have been asked whether they have a mobile phone or not. Table V illustrates the mobile phone penetration in the research area. Of the respondents, 96.8% have mobile phones, only few from farmer population don't use mobile phones which represent 2.6% of total respondents in flood-prone areas.

TABLE V: MOBILE PHONE PENETRATION IN THE FLOOD RISK AREAS

Profession	Mobile phone users		Total
	Don't have mobile phone	Have own mobile phone	
Employed(govt./private)		18.3%	18.3%
Businessperson	0.2%	7.7%	7.9%
Farmer	2.6%	60.6%	63.3%
Student	0.4%	6.0%	6.3%
Other		4.2%	4.2%
Total	**3.2%**	**96.8%**	**100.0%**

E. Can People in the Flood Risk Areas Afford Using Mobile Phones

The response against affordability of using mobile phones for people in flood risk areas, both respondents of two groups have been given their opinion that people in the flood risk areas can afford their mobile phone use.

Although, 57% of the respondents of the flood-prone areas fell they neither can afford and cannot afford, but 25% and 13% of them can afford and always afford respectively(Fig. 2a).

The 39 % of the respondents of the flooding experts have given their opinions that residents in the flood risk areas can afford on mobile phone top up and 35% of them have given that they can always afford (Fig. 2b).

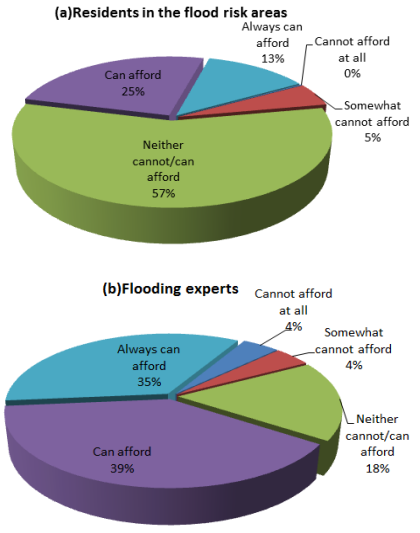

Fig. 2. Affordability of using mobile phones for people in the flood risk areas.

F. Are People in Flood Risk Areas Using SMS?

Fig. 3 shows the proportion of respondents of the

flood-prone areas who use SMS. 37% of them never use SMS, followed by 28% of respondent use SMS sometimes, but 24% of them are very often and always using it.

It is interesting to note that even though residents have their own mobile phones, there are some barriers to prevent them to use SMS among these people the barriers might associate with language problems or mother tongue is not available on their mobile phones.

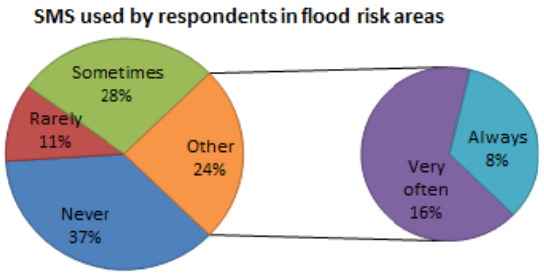

Fig. 3. SMS used by respondents in the flood-prone areas.

G. Do People Want an SMS-Based Flood Warning System Provided for Their Areas (the Flood Risk Areas)

Residents of the flood risk areas have been found to be very keen to have the SMS-based flood warning to save their properties and life. Fig. 4a illustrates response of resident respondents in favour of SMS-based flood system, 51% and 32% of them respectively agree and strong agree to have the SMS-based flood warning.

The respondents from the flooding experts also have been assessed that whether possible or not the SMS –based flood warning can be used in the flood risk areas. The response against this question(Fig. 4b), more than haft (54%) of the flooding experts have agreed with being possible to apply SMS as a flood warning for people in flood risk areas, and 17% of them have given that it is highly possible to use this proposed system.

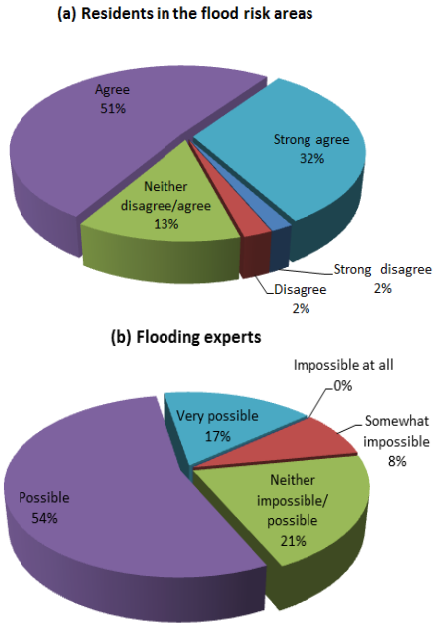

Fig. 4. Respondents' opinions to an SMS-based flood warning system.

V. Combustion and Future Work

The aim of this paper was to survey the feasibility of SMS-based flood warning system in flood risk areas in Laos. The main conclusion of the study as following:

- There were two groups of the respondents surveyed in this study, residents in the flood risk areas and the flood experts who work in the organisations associated with flood forecasting and dissemination. The majority of the respondents surveyed were farmers.
- In this research study, more than haft of the respondents in the flood risk areas able to read and write their own language, but famers were the majority of the respondents who cannot read and write their mother tongue.
- More than haft of the respondents surveyed in the flood risk areas don't understand Basic English, and most of them were farmers.
- The findings of this study indicate that the mobile phone coverage is reliable in the flood risk areas given opinion by the both groups of the respondents.
- Budget spent on mobile phones use among residents in flood risk areas is relatively affordable.
- For SMS use, of 37 % of respondent in the flood-prone areas doesn't know SMS, but 24% of them often and always use it. Interesting to note is that the respondents do know how to use SMS, but it is seemed that they aren't interested in using it which represents 11% for rarely use and 28% for use sometimes.
- In overall, the study shows that a feasibility of using SMS as a flood warning system in the flood risk areas of Laos can be described as high potential given by both respondent groups.

Future work aims to analyse the primary collected data more specifically, particularly to identify the factors associated with SMS usage among groups respondents interviewed. Moreover, the data transmission over the existing mobile phone networks in study case areas will be analysed. A survey on how reliable data for SMS-based flood warning system as well will be conducted.

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References

[1] (2011). Mekong River Commission: Basin Development Strategy. [Online]. Available: http://www.mrcmekong.org/assets/Publications/strategies-workprog/BDP-Strategic-Plan-2011.pdf

[2] S. Keoduangsine and R. Goodwin, "A GPRS-Based data collection and transmission for flood warning system: The case of the mekong river basin," *International Journal of Innovation Management*, vol. 3, no. 3, pp. 217-220, 2012.

[3] (2013). Department of Meteorology Hydrology, Mekong Water Level Bulletins, [Online]. Available: http://dmhlao.etllao.com/English/Mekong%20forecast%20.html

[4] (2013). Mekong River Commission. [Online]. Available: http://www.mrcmekong.org/

[5] (2013). Mekong River Commission, Real-Time Water Levels Monitoring. [Online]. Available: http://monitoring.mrcmekong.org/

[6] (2013). The International Communications Unions. [Online]. Available: http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

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