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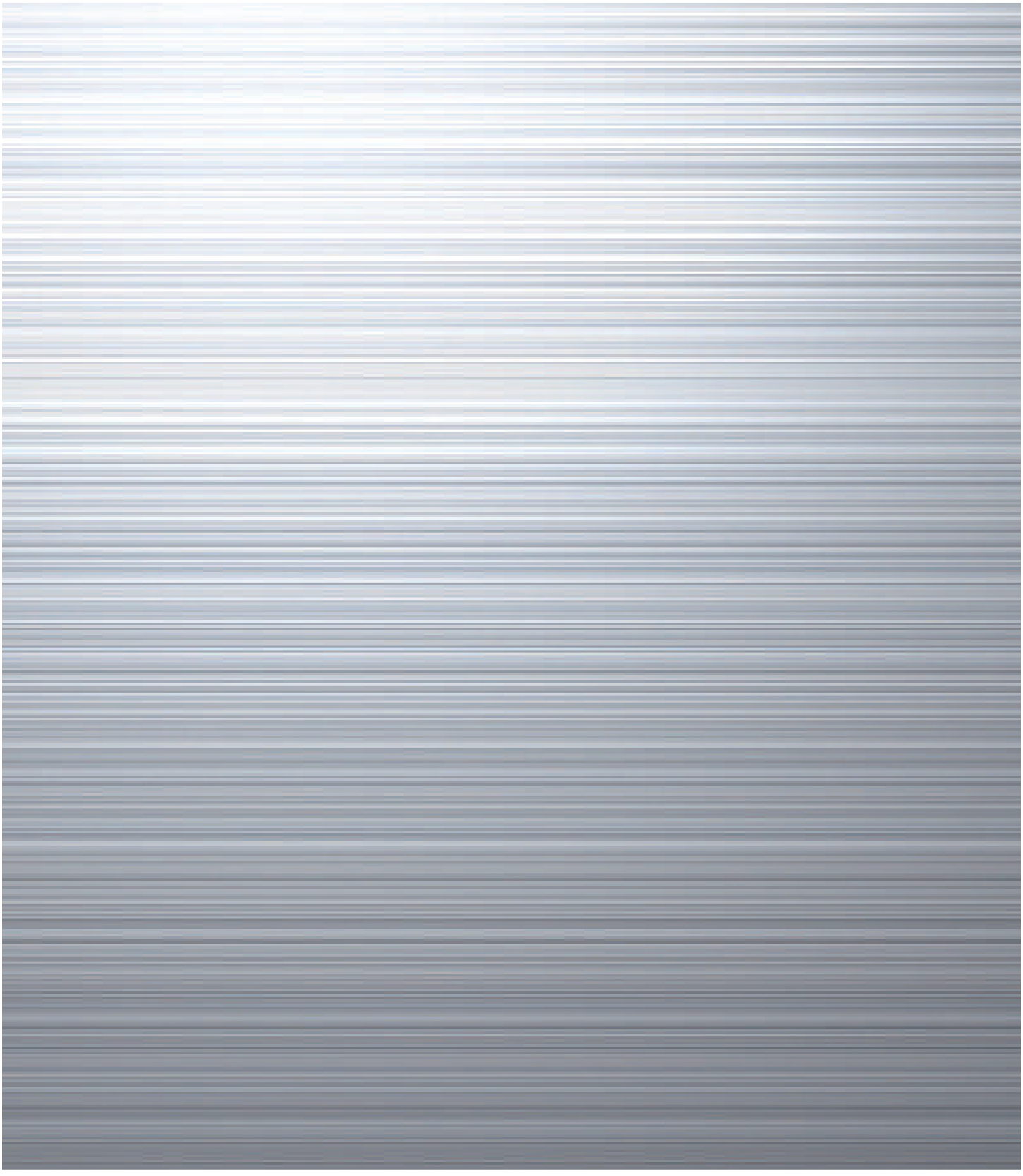

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Impacts of Dam Construction on the Livelihood of Villages in Thailand and Laos along the Lower Mekong Basin: From the Locals' Perspective

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Abstract:

This research presents the multi-dimensional impacts of dam construction, focusing on local people's narratives and general field observations using the Mekong River as a case-study.

In recent years, several cascade dams have been constructed in the Upper Mekong Basin, in Yunnan province of China. In the Lower Basin, Xayaburi Dam is the first of a further eleven dams planned for construction in the near future. Due to the lack of comprehensive environmental and social impact assessment studies for any of the projects, the livelihood and food security of a large population living along the transnational Mekong River have largely been neglected.

Using a qualitative approach, this research is a small step towards highlighting the significance of the locals' perspective as an important factor in the process of development planning. The way locals understand and analyze the socio-economic and environmental impacts of these dams on the rural livelihood is of interest to this research. The fieldwork was conducted at two rural sites along the Thai-Lao border near Vientiane and Nong Khai cities to comparatively analyze the perception of local communities on the environmental changes in the Lower Mekong Basin. A total of 25 interviews were conducted together with the observation of social life in both countries. The results show that Laotian villagers felt the changes in fishery and sediment much more than their counterparts in Thailand. Since they still rely on the traditional ways of fishery and fish is the primary source of food for many of them, they are more vulnerable than the Thai communities.

Moreover, the interviews indicate that while many of the Thai villagers blame the Chinese dams for the recent changes, Laotians believe that the construction of the Xayaburi Dam is the main reason. Moreover, it was observed that Laotians are less inclined to talk about the issue. This confirms the multidimensional nature of development planning when environmental observations alone should not be the only basis for decision making. Two environmentally similar but socio-politically different regions can be affected in dramatically different ways, as exemplified in this case study.

Keywords: dam construction impacts, Lower Mekong Basin, rural livelihood, social resistance

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Ⅰ. Introduction

This project portrays local perceptions of the multiple impacts of mainstream dam construction on the socio-economic and environmental situations. Against the background of a lack of independent and comprehensive feasibility studies, the primary objective of this research is to contribute, however small, to the development of strategies for the sustainable development of water resources including the locals' perspective in countries located in the Mekong Delta.

Having a social perspective, this project investigates how the local people's lives have been affected as a result of the environmental changes in the Lower Mekong Basin through assessing their awareness about the adverse impacts of dam construction and their strategies to cope with the consequences. In addition to the literature review, we adopted a qualitative approach by conducting semi-structured interviews mainly with the head of households whose income directly depends on the Mekong River, as well as with some officials, NGOs and community leaders. Two major cities along the Mekong River - Vientiane, the capital of Laos, and Nong Khai, the largest city across the Mekong in Thailand - were selected as the target cities for our research. The justification for selecting these cities was to compare the impacts in two countries under different political and social situations, but having the same environmental issues. The main research question of the project is as follows:

- What factors explain the main differences between the Thai and Lao people's approach regarding their perception about the recent environmental changes?

While economic and political interests seem to be the main factors driving countries to construct dams regardless of their impacts on the environment and communities, this project endeavors to show the adverse impacts of constructing cascade dams on the Mekong River prioritizing the locals' perception. While Xayaburi Dam in Laos is already under construction, three other large dams are to be constructed between Xayaburi Dam and the target cities of this project. Therefore, there is a vital need for the cooperation of social scientists, engineers and politicians to minimize possible negative impacts on the environment as well as the livelihood of the vulnerable population.

As a potential threat to the large population living in the Lower Mekong Basin in four different countries, this project aims to meet the objectives of the Global Resource Management Program at Doshisha University, by engaging researchers from different disciplines of social science and engineering. As no comprehensive research has been undertaken by major investors of the donors such as ADB, WB, UNDP or the Asia Foundation, we hope this research will add a different angle to the existing literature.

Following this introduction, the second chapter discusses the research methodology as well as the team's limitations in conducting fieldwork in different parts. The third chapter provides a general background required for this research. After an introduction to the significance of the Mekong River to the livelihood of the region and the upstream dams, the debates on the construction of Xayaburi Dam are discussed. Then, changes in the environment, sediments and the fish volume are discussed from an objective point of view in the literature review part. Next, the results of the fieldwork in assessing the transboundary impacts on the villagers in the Lower Mekong Basin along the Thai and Laos border are presented. In the concluding remarks, the differences in the perceptions of villagers in Thailand and Laos regarding the reasons for the recent changes are documented.

Ⅱ. Research Methodology

Taking an interdisciplinary qualitative approach, our team consists of three Ph.D. students from different academic backgrounds (one from Science and Engineering, two from Global Studies, with one of the latter having an Engineering background), and a supervisor who is an expert on earth system science.

Prior to the fieldwork, a literature review was conducted on the topic, primarily to gather information on the environmental changes from a scientific viewpoint. To that end, some scholars, representatives of major organizations and several active NGOs were contacted to gain insight into the environmental and socio-economic impact of the dams in the Mekong region. The organizations included the Mekong River Committee, International Rivers (HQ in the U.S., branch office in Bangkok), Department of Water Resource Engineering, Kasetsart University (Thailand) and Watch the Mekong (Japan and Thailand). No reply from the Mekong River Committee was received; however, an interview was held in Bangkok with the Southeast Asia Program Director of International Rivers. Moreover, meetings with Professors from Kasetsart University in Bangkok and some experts in different disciplines from Doshisha University, Kyoto, Japan, were held to acquire knowledge on the relevant fields.

Two areas around 400 kilometers downstream from the Xayaburi Dam were selected as the research field. The first was located in the suburban region of Nong Khai city, Thailand.

In addition to our observations of villagers' daily lives, the infrastructures in the region and ordinary talks with the locals, we conducted in total 11 individual interviews with the head of households and one group interview with three families in the villages on the Thai side. The questions included basic attributes of the interviewees and their families, such as age, year of schooling, number of households, the occupation of each family member, the source of income and food, their livelihood dependency on the Mekong River and their resistance strategies. Semi-structured interviews were conducted and open-ended questions were asked on the changes that had happened in the years since the construction of the Xayaburi Dam. The interviews were conducted in the Thai language and were translated into English by the Thai-speaking member of the team. All the interviews were recorded and carefully transcribed.

Furthermore, 13 interviews were conducted in the same way on the other side of the Mekong River bank in Vientiane, Laos. Following the local leaders, interviewees were selected randomly from fishermen who fished on the river bank, or whose house was close to the river. A very similar questionnaire was used to conduct the interviews.

To obtain official permission to conduct the research in Laos, an official request was submitted to the National University of Laos. The team obtained permission from the Lao government to conduct the research; however, a request for assistance from the National University of Laos was rejected as there was no academic cooperation between the universities. Thus, the interviews in Laos were all conducted with the help of some officials, with personal connections to the group, who asked that their identity be kept confidential.

As the political situation in Thailand and Laos is very different, restrictions on performing the fieldwork were distinct. Our contacts with a few NGOs in Laos failed to get any response. We asked the NGOs in Thailand to connect us with their counterparts in Laos; however, they rejected such request for political reasons. Few officials whom we met were not directly working on the focal issues of our research. Failure to get a response from the officials in charge, the small number of interviewees and the political restrictions were our main limitations in conducting the research.

Ⅲ. Background to the Study

In this part, first, we will present a general overview of the Mekong River in order to better understand the importance of the river to the people and countries in the region both from the environmental and socio-economic viewpoint. After that, information about several dams that have been operational, planned or under construction is reviewed. The dams are divided into two parts of the Upper Mekong Basin (in China) and the lower Mekong Basin (in Laos and Cambodia). The last part is dedicated to Xayaburi Dam, the first dam under construction in the Lower Mekong Basin. Since the fieldwork for this study was conducted close to this dam, understanding the operational and legal process of its construction was crucial for this research.

A. General Overview of the Mekong River

The Mekong River is one of the longest transboundary rivers in Asia. It is about 4,350 km long, servicing more than 810,000 km^2 of land. The upper reach of the Mekong River rises as the Zhaqu River on the Tibetan Plateau in Qinghai province, China and flows through the Tibetan Autonomous Region and then through Yunnan Province as the Lancang River until it arrives at the meeting point of the borders of Burma, Laos and China (1,955 km). The lower Mekong Basin downstream of the Chinese border comprises the majority of the land area of Lao PDR and Cambodia, the northern and northeast regions of Thailand and the Mekong Delta and Central Highland regions of Vietnam (2,390 km).

About 60 million people live in the Lower Mekong Basin, according to national population statistics of the four LMB countries, about 85% of which live in rural areas (Landscan data 2007). Most of them live near rivers, lakes and wetlands, with 25 million living within a 15 km corridor either side of the Mekong mainstream (Landscan data 2007). A total of 53% of the Lao population and 4% of the Thai population are distributed within this corridor and 79% of the 15 km corridor population live within 5 km of the mainstream.

The biodiversity of the Mekong River and its tributaries has supported water resource-based rural livelihoods in this region for generations (Mollot et al. 2003; Meusch et al. 2003). Farming, fishing and the collection of other

aquatic animals and plants comprise the main livelihood activities and sources of food and cash income. In Lao PDR, more than 70% of rural households depend on fishing to varying degrees for subsistence livelihoods and additional cash income.

The high degree of dependence of the population on water resources for livelihoods and food security implies a high vulnerability to declining availability, quality and diversity of the resources. The uneven distribution of the population and varied degree of dependence suggest a disparity in the distribution of impacts of changes in the resources across national, social and ecological boundaries and social groups.

At Siphandone, on the Lao mainstream, just under 40% of households receive some income from fish, far more than in Thailand or Vietnam, where less than 10% of households obtain income from this source. The way people engage in fishery differs according to their wealth: to fish in the main rivers often requires a considerable investment in boats, motors and nets, while in habitats like flooded forests, wetlands and streams, more impoverished people can use simple gear to collect fish and other aquatic organisms such as frogs, snails and insects (Mollot et al. 2003).

Figure1. Dams on the Mekong River
CGIARS / Internationalrivers.org

No.	Name	Installed capacity (MW)	Dam height (Meters)	Commissioning	Status
1	Gongguoqiao	750	130	2012	Operational
2	Xiaowan	4200	292	2009-2011	Operational
3	Manwan	1500	126	1993-1996	Operational
4	Dachaoshan	1350	118	2001-2004	Operational
5	Nuozhadu*	5850	261.5	2012-2014	Operational
6	Jinghong	1750	118	2008	Operational
7	Ganlanba**	195			Planned
8	Mengsong				Planned

Table 1. Mainstream Hydropower Schemes in the Upper Mekong Basin (Lancang River, YunnanProvince, China)

B. Dams on the Mainstream of the Mekong River

Scientists usually divide the study of environmental issues concerning the Mekong River into two parts of the Upper and Lower Basin. Following this tradition, we will present an overview of different operational and under-construction projects in both parts.

Since 1993, the projects of constructing cascade dams on the Upper Mekong Basin have commenced. With the last phase of the Nuozhadu Hydropower Plant commissioned in 2014, the installed capacity in Yunnan Province of China, i.e., the Upper Mekong Basin, totaled 15.4 GW for six dams (See Table 1). The Ganlanba project will be operated as a regulation reservoir to smooth the release of discharge to the downstream, which as of now is being performed by the Jinghong project. Detailed information about the installed capacity and commissioning of the Mengsong project is not available yet.

While Table 1 only includes the major hydroelectric projects in Yunnan Province, China has developed other in the upper reach of the Lancang River (upper half of the Mekong River). Moreover, seven projects in Yunnan Province are under construction with a total installed capacity of 960 MW. Another seven projects located in the Tibet Autonomous Region will add 630 MW to the Lancang hydropower when they are completed in 2030.

In the Lower Basin, since there are several countries directly or indirectly involved in the development process of the dams, some international cooperation has been initiated in the region. Cambodia, Laos, Thailand and Vietnam created the Mekong River Commission (MRC) to develop the Lower Mekong Basin in 1995. In addition to the Mekong River Commission, there are four major Mekong regional cooperation frameworks

launched and supported by an international organization and three great powers to strengthen regional cooperation, bring economic growth, social change and political stability in this region. The Greater Mekong Sub-region was created by the Asian Development Bank in 1992, the Lower Mekong Initiative was formed by the United States in July 2009; the Mekong-Japan Summit was organized by Japan in November 2009 and the Lancang-Mekong River Cooperation Mechanism was led by China in March 2016. A cooperative activity named Joint Research on the Hydrological Impacts of the Lancang Hydropower Cascade on Downstream Extreme Events has started between the MRC and the Lancang-Mekong Cooperation Mechanism (MRC, 2009).

Title of the report	Prepared by	Prepared for	Final draft
Strategic Environmental Assessment of Hydropower on The Mekong Mainstream	ICEM – International Centre for Environmental Management	MRC	Oct-10
Prior Consultation Project Review Report	Mekong River Commission Secretariat	Procedures for Notification, Prior Consultation and Agreement (PNPCA)	Mar-11
Compliance Report : Xayaburi Hydroelectric Power Project Run-of-River Plant	Pöyry Energy AG	Lao government (MRC)	Aug-11
Observations and Comments on The Pöyry Report on the Xayaburi Hydropower Project	Mekong River Commission Secretariat	MRC	Nov-11
Xayaburi Hydroelectric Power Project Peer Review of the Compliance Report made by Pöyry	CNR	Ministry of Energy and Mines, Laos	Mar-12

Table 3. Key studies on constructing the Xayaburi Dam

The hydropower development in the Lower Mekong Basin has just started. As Table 2 shows, there are at least 11 planned hydro-electric projects in the mainstream Mekong, nine in Lao PDR and two in Cambodia. The installed capacity will reach 11.335 GW after they are operational.

C. Construction of Xayaburi Dam

Xayaburi Dam is the first project in the Lower Mekong Basin, located approximately 30 km east of Xayaburi town in northern Laos and 80 km south of Luang Prabang city. The project was initiated in 2011 and is planned to be completed in 2019. As a run-of-river hydroelectric power plant, the total installed capacity is 1,285 MW, and annual energy production will be 7,370 GWh. A power purchase agreement has been signed between the Electricity Generating Authority of Thailand (EGAT) and Electricité du Laos (EdL).

The first plan to build a series of dams in the Lower Mekong Mainstream was first proposed in 1950. However, it took a long time until 1994 for the revival of the plans and the signing of the Mekong Agreement in 1995 to continue the process. After that, there was a longer delay in the progression until 2010 when the report by the Strategic Environmental Assessment of Hydropower in the Mekong Mainstream recommended a 10-year delay while further studies were carried out. This was the start of a series of arguments between a different independent organization to the Laotian government that have either slowed down or stopped the project (See Table 3).

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Table 3. Key studies on constructing the Xayaburi Dam

In March 2011, the prior consultation project review report was prepared by the Mekong River Commission to study significant gaps and concerns identified in Laos' documentation and recommended a further collection of baseline data and transboundary impact studies. However, discarding such studies, the government employed Pöyry Energy, a Finnish company, which later became the main contractor for the dam's construction, to conduct

the Compliance Report. Pöyry's report concluded that the project was "principally in compliance" with MRC standards despite identifying over 40 additional studies that were still required. The report, which obviously was not free of the conflict of interest, recommended that any additional studies could be conducted after construction was already under way. A few months later, in November 2011, the Mekong River Commission (MRC) objected to the Pöyry Report by preparing "Observations and Comments on the Xayaburi Hydropower Project." The review concluded that the Xayaburi Dam would not fully comply with MRC standards even if all of Pöyry's recommendations were followed. It also recommended that construction should be delayed to allow time for transboundary impact studies to take place. Although many scientists have criticized Pöyry's findings, no one has stepped up to support them. In January 2012, the Lao government hired French company Compagnie Nationale du Rhône (CNR) to review Pöyry's work after hearing the criticism from Cambodia and Vietnam. CNR focused on the issue of sediment flows and did not review Pöyry's work on fisheries. However, CNR itself acknowledged that the report was only a "desk study" and further studies were required.

Despite all these hot debates, international and regional criticism had no influential impact on the Lao Government to stop or slow down the project. As seen in Figure 2, the construction process is under way mainly through the involvement of the Thai companies that are the main investors in the project.

Figure 2. The Xayaburi Dam, as seen from above in early 2017 (Thien Y, The Mekong Eye)

IV. Literature Review

In this part, firstly, we will take a closer look at our two fields explaining how different they are when it comes to development planning and nation/state relations. Providing this information is important because socio-political differences between Laos and Thailand are the main variables of this research and the basis for building our arguments on. Later, due to the lack of reliable literature about the impacts on livelihood, we shall provide the reader with general information on the socio-economic impacts of dam construction in developing countries and the possible negative/positive impacts of these types of projects. This is to compensate for the lack of response by the government concerned as well as constructors who didn't give us any specific information on this particular project. Next, we will review some of the existing reports on the different impacts of dam construction in the Mekong region: the impacts on fishery and fish species which are closely connected to the livelihood of the rural population along the river, as well as the impacts of sediment trapping and water discharge of the dams. Most of the existing research has focused on the impact of the dams in the Upper Mekong Basin, partly because they are much bigger in size and were commissioned earlier, comparatively. (MRC 2015). In these reports, a wide range of relevant impacts has been discussed, including the change of water discharge, sediment load, fish species, water temperature, etc. According to the State of the Basin Report published by the Mekong River Commission in 2010, changes have taken place in water-related resources in the Lower Mekong Basin since 2005. Almost one in six households has members who have changed occupation because of declining productivity and services of the aquatic ecosystems. The data suggest that the impacts of changes in resources (caused by a wide variety of factors) have already been felt at all the study sites. Despite all these adverse impacts on the livelihood, especially in the poor rural areas, there is a scarcity of research about the socio-economic impacts in different countries. Most of the countries in the region have placed political restrictions on giving official permission to conduct independent research to access the social and economic impacts.

A. Development Planning and Nation/State Relations: Laos and Thailand

Divided by the great Mekong River, the people in both nations share linguistic and cultural similarities. In

fact, the Lao kingdom of Lan Xeng included all of northeastern Thailand as recently as the early 18th century (Ward 2016); however, nowadays, there is a huge difference between governance and nation/state relations in these two countries. Laos is a one-party state in which the ruling Lao People's Revolutionary Party (LPRP) dominates all aspects of politics and harshly restricts civil liberties. There is no organized opposition and no truly independent civil society. News coverage of the country is limited by the remoteness of some areas, repression of domestic media and the opaque nature of the regime. Economic development has led to a rising tide of disputes over land and environmental issues, which frequently lead to violence. Thailand, on the other hand, is governed by a constitutional monarchy. The King is the Chief of State and the Monarchy is hereditary, nevertheless, the political system benefits from enormous popular respect and moral authority. Therefore, although it is not ranked as a free or democratic country, the economy is booming and there is much more freedom of expression compared to Laos (House 2017). Interestingly, as will be shown later, these points were reflected in our interviews and group observations. In fact, it seems that the economic situation and civil rights practices are among the most important factors that have affected public opinion in the two separate communities located in environmentally similar regions

B. Dam Construction: Socio-economic Impacts

Large dams significantly impact humans worldwide. In this part, we provide a general picture of the social impacts brought by dam construction, especially in developing countries. Wang et al. (2013) have categorized these social impacts into agricultural, economic and local culture.

1- Impacts on Agriculture

The most direct and important impact of dam construction is the inundation of farmland. The conditions of the land along riverbanks are generally ideal for labor-intensive agriculture. For example, most of the highly productive paddy fields are along riversides. As a consequence of farmland inundation, new farmland needs to be cleared to compensate for the losses incurred by local farmers. These changes cause lower productivity, due to difficulties in irrigation, increased soil erosion and increased pollution due to the usage of synthetic fertilizer to counteract the poorer conditions (Wang et al. 2013).

2- Impacts on Local Livelihood

Large dam projects may cause thousands of people to be relocated, and therefore have substantial impacts on local livelihoods. According to the World Commission on Dams (World Commission 2000), around 40–80 million people were relocated worldwide between 1950 and 2000 because of large dam construction. The direct impacts of large dams on local people include the loss of housing, farms and other resources. The relocated people are sometimes given new houses and newly cleared farmland. Indirect impacts include losing their jobs and social network, plus the possibility of psychological problems which have occurred in some cases, including some communities along the Upper-Mekong River (Zhao et al. 2012). To sum up, we summarize the debates raised by the proponents/opponents of dam construction. Proponents of the dam construction believe that it will generate opportunities for economic and social development. Some of their arguments include:

1. Dam construction projects will increase the employment opportunities for local people and boost the economy of the region.

2. New roads and bridges will be built in the process of dam construction that will enhance the quality of life and work.

3. Hydropower dams generate cheaper and cleaner electricity. Cheap electricity could reduce the costs of many industries and stimulate the local economy. (Wang et al. 2013, p. 17)

However, the other side of the debate argues that many dams actually fail to achieve their economic goals and even cause secondary costs to the environment and local communities. Some of their arguments are listed below:

1. Many large dams that are considered economically feasible actually end up failing to recover their total costs due to underestimating the technical difficulties.

2. According to the WCD’s report (2000), most of the irrigation dams and water supply dams fail to achieve

their designed goals, while hydropower is more likely to fulfill their goals. However, even in the case of hydropower, undesirable results may occur: Nam Theun 2 Dam in Laos promoted by the World Bank, constructed for the development of hydropower projects, has displaced thousands of people and killed at least 40 (Boyle 2018).

3. Most large dam projects do not consider the externalized social and environmental costs when determining their total costs; For example, large dams could harm a downstream fishery that is not calculated as a cost.

4. There exist many alternatives to large dams, such as water-saving agricultural techniques that have great potential for reducing the agricultural water demand. If the use of renewable energy were increased greatly, the need to construct hydropower dams might decline substantially. (Wang 2013, p. 18)

C. Review of the Impacts on Fishery and Fish Species

The operation of hydroelectric power plants in the mainstream of the Mekong River has already changed the living conditions of fish by changing the water flow, sediment load and nutrients. Meanwhile, several dams have blocked the passage of migratory fish species affecting their reproduction processes, which will further affect the livelihood of residents along the river.

Several studies discuss the possible impact on the fish species and livelihood depends on it, but the lack of reliable data of the species composition of the catch in the Lower Mekong Basin has restricted the arguments. Barlow et al. (2008) mentioned that not all fish species caught in the basin are at risk from mainstream dams. They argue that those fish with only limited migrations over short ranges may not be affected. Some of the species are highly adaptable to habitat modification including impoundment. Moreover, they pointed out that species which "undertake significant passive and active migrations along the mainstream between critical spawning, feeding and refuge habitats as part of their life histories" are most likely to be affected. They continued to estimate the size of migratory fish resources in the Lower Mekong Basin by adopting a three-pronged approach. The first was a survey of 13 fisheries scientists from Laos, Cambodia and international organizations operating in the Lower Mekong Basin. The combined results from the group indicated that migratory fish resources comprise 71% of the fisheries yield in the Lower Basin. The first sale value of migratory fish at the time of the survey (2007) was estimated to be US$1.89 per kilogram. In the second step, they estimated the amount of highly migratory fish species in the basin by literature review. They divided the lower Basin into three major migration systems: the Lower Mekong Migration system (Vietnam to Khone Falls), the Middle Mekong Migration System (Khone Falls to Vientiane) and the Upper Mekong Migration System (Vientiane to China). By adding up the annual yield in each system based on the statistics of each country, the annual yield totaled 1,270,000 – 1,570,000 tons. The third step was to combine the information of fish migration with the catch survey data. As a result, 58 fish species were categorized as highly vulnerable groups, which comprised 38.5% of the total weight of all 233 species in a 2003/04 fishery catch survey.

By applying this proportion to the total fish yield of 1,860,000 tons in the Lower Mekong Basin (Hortle 2007), the annual yield of highly vulnerable migratory fish groups is approximately 744,000 tons, which will be equal to 1,400 million dollars if using the first-sale price estimated in the first step.

D. Review of the Sediment Concentration Impact

The studies on sediment decrease in the Mekong River are limited to the impacts on the Upper Mekong Basin. Although the sediment trapping impacts could be measurable after the construction of planned dams in the Lower Basin, the study of the current situation based on the impacts of the existing dams could be of help in predicting the impacts of the upcoming dams.

With the first four dams in operation, the downstream effects of the Lancang–Mekong cascade have become increasingly apparent. Water level fluctuations are now discernible in the dry season between Chang Saen city in Thailand and Luang Prabang in Lao PDR. Mekong River Commission modeling studies show that the primary effects on the flow regime in the lower mainstream include lower flood flows in the wet season and a shift in the time of the peak flood, and higher river flows in the dry season.

Apart from the issues associated with changes in flow regulation, the combined effect of sediment trapping in reservoirs in the Lancang–Mekong cascade and sediment trapping by the reservoirs of tributary dams in the lower basin requires careful assessment (MRC 2010, p. 72). It is estimated that the completed Yunnan cascade will trap some 90% of the upper Mekong sediment contribution to the lower basin (Kummu and Varis 2007).

MRC (2010) estimates that as much as 40–50% of the Mekong River's sediment originates in China. Analyses of sediment flux at various gauging stations on the Lower Mekong River have indicated a sharp decrease in the total suspended solids concentration (SSC) in the Mekong River in the post-dam period. Kummu et al. (2007) specified the period as after the closure of the Manwan Dam in China in 1993, the first one of a planned cascade of eight dams after its reservoir was infilled in 1992. Given that the estimation of sediment flux is challenging since the measurements of SSC were sporadic, Lu and Siew (2006) continue to state that the areas along the upper-middle and lowermost reaches of the Mekong have experienced a decline in sediment flux. However, it remains vague in their study whether that is the result of sedimentation in the Manwan Dam, or the decrease is only statistically significant at the nearest evaluating station below the Dam (i.e. Chiang Saen). At the same time, sediment fluxes in areas located in the mid-reach of the river have remained stable or even increased.

In another study, Fu et al. (2006) analyzed the sediment concentration at Jinghong, which is about 400km downstream of the Manwan Dam and 314km downstream of Dachaoshan Dam. They concluded that the "completion of the two dams had caused a significant and continuous reduction in annual sediment concentration by 50% since the late 1980s." The much larger Xiaowan Dam, located upstream of the Manwan Dam, has a predicted trap efficiency of 90% (Guo et al. 2007) and will reduce the sediment concentration to less than 10% of its natural value after passing the Dachaoshan Dam (Walling 2009). MRC (2010) forecasted that the sediment load would be reduced even further after the construction of the remaining dams of the cascade. Wang et al. (2011)'s findings are in line with MRC (2010) and they added that "usually, sediment load increases due to soil disturbance occur only during the construction period of dams, as observed from 1986 to 1992 during Manwan construction." The reduction in sediment concentration will likely have significant implications for the ecosystem of downstream countries.

E. The Impact of Water Discharge

The annual flood pulse is the key driver for the ecological productivity in the Mekong Basin (MRC 2010). It is shaped by the seasonal monsoon climate, with a distinct low flow season (dry season) in December-May and a high flow season (wet season) in June-November (MRC 2005).

Laos is the main water source of the Mekong. Regarding the Mekong's annual water discharge, 82% comes from four sources: "(1) the mountains of northern Laos through a number of tributaries; (2) the Southern Mountains via the San, Kong and Srepok; (3) the Mun Chi System, draining a large part of the Korat Upland; and (4) the drainage outflow from the Tonle Sap" (Gupta 2009). The rest originates in China (18% before any dams were built according to Gupta 2009, 16% according to Adamson et al. 2009) and Myanmar (2%, Adamson et al. 2009), although the runoff from China contributes to over 35% in April and May (Kummu et al. 2007).

Studies on the impact of the Upper Mekong Basin dams on the water discharge in the Lower Basin have been conducted since the 1990s, immediately after the first dam was constructed in China's Yunnan province. Kuenzer et al. (2013) did a comprehensive review of the existing literature on this issue. While most of the primitive studies have focused on the Manwan Dam (Lu et al. 2008; Lu et al. 2006), the recent ones (Räsänen et al. 2012; MRC 2010) examined the dam impacts of the Yunnan cascade. The results indicated that the discharge increases in the dry season and decreases in the wet season, though at different magnitudes. Kuenzer et al. (2013) summarized that "Independent of the source, all authors underline the occurrence of a shift in flood pulse and a decrease in its duration and amplitude, while dry season variability is likely to increase." Despite the numerous studies, it has to be noted that the lack of publicly available data on the reservoir operations and water releases from the hydropower reservoirs in the Upper Mekong Basin has made it difficult to assess the impacts more accurately and objectively.

The latest study on this topic has been conducted by Räsänen et al. (2017). Using the water level data and discharge conversions over the period of 1960–2014 provided by the Mekong River Commission Secretariat, the findings indicate that the hydropower operations have considerably modified the river discharges since 2011. The authors conclude that general changes in water discharge were characterized by an increase in dry season discharges and a decrease in wet season discharges, along with large and rapid discharge fluctuations in the dry season. The most significant changes were observed in 2014 after the completion of the Nuozhadu Dam, the most massive hydropower project in the entire Mekong Basin. The discharge impacts are expected to vary from year to year depending on hydropower operations, and the impact observed in the relatively lower reach of the downstream turned out to be weaker.

By reviewing the environmental consequences of building dams in the mainstream of Lancang-Mekong River, Chinese authorities from the Asian International Rivers Center argue that most of the impacts of the Upper Mekong Basin dams are limited to the Chinese border; they have only had small unfavorable effects on downstream environments and ecosystems outside of China (Fan, He and Wang 2015). Similarly, Li, He and Feng (2011) from the same organization state that significant downstream impacts of the two operating dams of Manwan and Dachaoshan are limited in scale to diurnal changes, primarily in the narrow channel north of Vientiane.

Despite their differing opinions, most independent researchers suggest that considering the potential environmental, socio-economic and humanity risks of the mainstream dams, transboundary cooperation for managing the downstream impacts is urgently required to ensure sustainable development in the Lancang-Mekong River Basin (Fan, He and Wang 2015).

V. Transboundary Impacts of the Dams on the Rural Livelihood

To assess the transboundary impacts of the dams on the lower basin, we focused on the rural areas near two large cities located about 400 kilometers away from the Xayaburi Dam across the Thai-Lao border. The main reason for selecting these regions was to have easier access to the villages considering the limitations of the current study.

Unless in the region close to the Thai-Lao Friendship Bridge, the economy of the villagers on either side is not dependent on the border trading. Villagers across the border speak the same language and historically maintain some family ties on the other side. On some occasions, illegal crossing of the river border to participate in events such as funeral and wedding ceremonies is a common occurrence.

Our target villages on the Thai side were located in the eastern suburbs of Nong Khai city as marked on the map (Figure 3 – Location No.1). On the Laos side, the fieldwork was conducted in two different regions, marked on the map as Location Nos. 2 and 3. Location No.3 refers to some small towns attached to Vientiane city and Location No.2 points to several villages close to Nong Khai city across the river.

Based on our fieldwork, the infrastructural developments on the two sides were completely different. The roads of all Thai villages in the site were paved, and long walking paths have been built along the river. All villages had access to electricity and piped water. The local economy relies on rice production and fish farms. Temples, schools and health centers were mostly well-distributed with new buildings, and local government activities to support the villagers were relatively satisfactory according to our interviews.

The villages on the Laos side, on the other hand, lack fundamental infrastructure and the villagers were impoverished, comparatively. Many families could not afford the schooling costs for their children beyond secondary school. They maintained their local culture and traditional lifestyle to a great extent.

The main criteria for selecting interviewees was their income's direct dependency on the Mekong River like fishermen, fish merchants, farmers, etc. From each occupation, we tried to maintain the balance of economic class. Eleven individual interviews in total were conducted with the head of households together with a group interview with three families in the villages on the Thai side. In Laos, we conducted six interviews at Location 3 and seven others at Location 2 were conducted. The surveys were conducted as open ended semi-structured interviews using a three-pronged approach:

First, we asked about the family life, income, social and economic class and their livelihood dependency on the Mekong River. Second, the recent changes in water level, sediments, fish species and fish volume were asked in detail. Third, they were asked about their perception on the reasons behind such changes, their information sources and their current and future strategies in confronting environmental changes of the Mekong.

Figure 3. Locations of the targeted villages in Thailand and Laos (Location 1 is on the Thai side and Locations 2 and 3 are in Laos)

A. Evaluating the Impacts on Villagers on the Thai Side

The income source of villagers on the Thailand side consists of a combination of fishery, rice plantation and keeping livestock such as cows and pigs. Investing in different income sources helps them to reduce the risk of income loss caused by environmental disasters. Villagers whose houses are located next to the river set up a certain number of caged fish farms to rear baby fish in the river. Moreover, there are plenty of rice fields in the region.

In this section, first, a general overview of the selected villages on the Thai side is given. Then, we focus on the impacts of the changes in water level on the caged fish farms. According to our fieldwork, one of the main reasons that villagers lose a lot of fish is the abrupt changes in water level and temperature. This happens a couple of times a year when Chinese dams are discharged. Finally, locals' perceptions on the possible impacts of upstream dams are investigated. The interview results show that the locals have not felt any significant changes since Xayaburi Dam has been under construction. They believe that the Chinese dams are responsible for their fish loss.

1. General Overview of the Field

The fieldwork on the Thai side was conducted in the villages along the Mekong on the eastern side of Nong Khai city. Some of the villages in which we conducted our interviews are Sala Kaew ku, Wat Pho Chai and Ban Phan. Based on the information from the residents, each village has an average of 300 families.

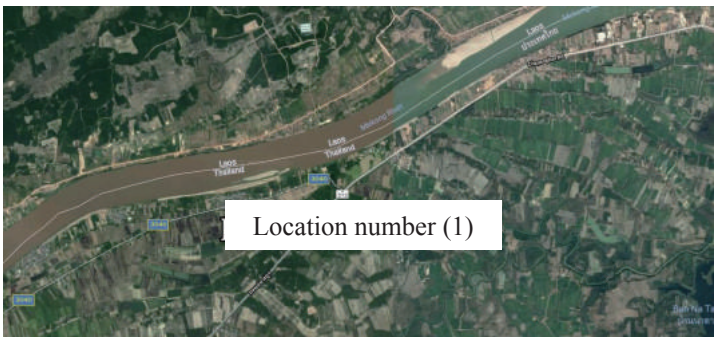

Figure 4. Villages on the east side of Nong Khai city

As Figure 4 shows, there are plenty of rice fields in the region. Rice plantation is performed twice a year in the dry and rainy seasons. During the dry season, they use Mekong water which is available through canals constructed by the government. The rice farmers rent the canal water from the government on an hourly basis. According to them, their production increases during the dry season as the Mekong water contains sediments that improve the rice fertility.

In recent years, the local government started a project to support local entrepreneurs from the villagers who engage in start-ups for community development. For instance, one of the interviewees, a 70-year-old woman, has just established a small fish drying unit by obtaining support from the local government. She was given land for her business beside the village's temple as well as some other necessary facilities to start her business. Such examples show the local government's endeavor to support villagers.

Figure 5. (1) Sun drying of the paddy on the walkway along the river. (2) Product basket of a local entrepreneur

2. Community Perceptions on the Reasons for Recent Changes

According to the interviewees, it has been several years since anyone on the Thai side relied on traditional

fishery as their main income source. While there are still a few people who do fish occasionally, it is neither considered as a significant portion of their income nor their daily food source. Instead, during the last ten years, the floating caged fish farming system has been initiated by some of the residents and later developed with the governmental and private sector's support.

The decrease in the number of fish in the lower Mekong Basin in recent years together with the economic development of the country caused many villagers to establish some floating caged fish farms along the river. According to the interviewees, fish farms are economically much more profitable than traditional fishery.

Floating cage fish farms are constructed using wooden or metal rods as the frame in various sizes of around 3(L) x 2(W) x 2(H) meters. As illustrated in Figure 4, the plastic water tanks keep the net cages floating on the water.

Figure 6. Caged floating fish farms

The owners need to put juvenile Nile tilapia fish inside each cage and feed them three times a day since there is little natural food available to the fish in the cage. While the initial construction cost for these cages is not very high, the feeding cost for the fish is considerably high. Moreover, the payback period of the invested capital is quite long. Therefore, not every family can afford the total cost by themselves. To overcome the shortage of capital, besides the availability of governmental loans, some chain companies offer wages for those who can rear fish for them.

While fish farming is far more profitable than traditional fishery on the Mekong, there are some risks for the farm owners. According to the fishermen, abrupt and unnatural changes in the water level and temperature cause the most significant fish loss in their fish farms. Such losses usually happen when some of the Chinese dams in the mainstream discharge water. Most of the fish cannot adapt to the rapid changes.

Since fish farming does not depend on the number of fish in the river, the villagers in Thailand did not express any changes in the volume of the fish or decrease in the species. On the other hand, all interviewees expressed their dissatisfaction about the Chinese dams already built in the Upper Basin's mainstream. When the Chinese dams are discharged in order to allow large commercial ships to cross the river, the most significant loss of fish happens in the lower basin. An experienced fisherman in Sala Kaew ku village expressed that:

> "When the Chinese discharge the dam, the water level reaches 20 meters. Fish cannot bear the abrupt change in the water temperature. Therefore, we lose almost half of our fish in each cage."

The news of the Chinese dam's discharge very quickly spreads around the villages, and the fishermen prepare themselves to sell the dead fish as soon as possible, of course for less than half the price of the large mature ones. According to the villagers, while they benefit from some governmental support during natural disasters such as the spread of disease among the fish or flooding, no form of governmental assistance is provided for the fish loss during the abrupt change of the water level.

In general, the middle-income fishermen were more aware of the adverse impacts of the mainstream dams on their life and income. Therefore, many of them blamed the Chinese for constructing the upstream dams and expressed their disagreement with the new dams planned for construction in the Lower Basin too. There were also a few low-income families among our interviewees who had never heard about the Xayaburi or other dams planned. An old woman from Wat Pho Chai village who owns a few fish farms expressed that:

> "… Chinese dams are already constructed and we have experienced the impact, I do not think that anything worse is going to happen in the future with more dams… so I do not care if they are building more and more…"

The information flow on the dam construction on the Thai side was mainly formed by the Thai governmental media. While freedom of the press in Thailand is not guaranteed by the government, the media broadcasted the construction of Xayaburi Dam as a case of international aid and foreign investment in Laos (Reuters 2014). On the other hand, NGOs tried to form some campaigns among the local villagers; however, because of their political and budget restrictions, they were not very successful. None of the families whom we interviewed engaged in any social action against the construction of the Xayaburi Dam. Many of them had not even heard about such campaigns. This situation was quite shocking for us as there are many online reports about some large campaigns in cities and villages along the river.

B. Evaluating the Impacts on Villages on the Lao PDR Side

For centuries, the exceptional biodiversity of the Mekong River, directly or indirectly, has been the primary source of income for millions of locals that live on the river bank. However, the direct dependency on traditional fishery varies according to the countries' development. Laos, as one of the lowest-income countries in the region, economically depends on the river, comparatively.

Among the communities living along the river, at least one member from each family goes to the river every day to catch some fish for their daily meal. Based on our interviews, the local people mentioned two significant changes in the recent year that have affected their economy: Significant decrease in their catchment amount and the changes in the sediments. In this part, after a general introduction of the field, we will explain the impact of the decrease in fish catchment on the villagers' life. Then we will discuss the community's awareness of the impacts of dam construction and their perceptions on the reason for the recent changes.

1. General Overview of the Field

The fieldwork on the Laos side of the riverbank was conducted in two different locations as marked in Figure 3. Location 3 (See Figure 7), Oumong neighborhood, is a suburb of Vientiane city close to the international airport, where there used to be a small village which has since been attached to the city by its expansion.

Figure 7. Suburbs of Vientiane city, near the international airport.

The rapid growth in the tourism industry has heavily influenced the economy of the surrounding villages in this region. Although the access roads on the river bank have not been paved and there are many potholes along the way, the hotel industries have been expanding rapidly along the river. (See Figure 8).

Figure 8. Unpaved roads and the growth of the tourism industry in suburbs of Vientiane.

These rapid changes in the city together with the decrease in fish catchment have shifted the economy of these suburb residents gradually from being directly dependent on fishery or growing rice to a labor force involved in the emerging tourism industry such as that of the construction or service sectors.

The next location to conduct fieldwork for this study was some villages along the river from the Thai-Laos friendship bridge to the East (See Figure 9). Our initial aim was to focus on the villages facing those we studied

on the Thai side. However, the unpaved roads restricted our access to those areas. Instead, we managed to conduct the fieldwork in villages facing Nong-Khai city. Generally, the area on the Laos side is less populated compared to Thailand and the villagers who are living beside the river usually do not own the rice fields. As this area is quite far from Vientiane city (about 30 kilometers of unpaved road) and daily commuting is difficult, a large number of families still rely on fishery as the primary and only income source.

Figure 9. Villages facing Nong Khai city on the side of the border in Laos

The main income source for other villagers far from the river bank is rice cultivation. The government has built some large water canals to carry the water from the river to the rice fields, and the villagers pay for the local government to use this canal water, especially during the dry season.


Figure 10. 1- Unpaved roads, the dust and difficulties of access to the villages
2- A local grocery shop in Thadeua village

2. Community Perceptions on the Reasons for Recent Changes

Unlike the Thai side, the governmental media in Laos does not hold much attraction for Laotians. They mainly watch the entertainment TV channels from the Thai side. However, for the news, they follow both the Laotian and Thai side channels. As in Laos, there was large propaganda in governmental discourse about the importance of the Xayaburi Dam for their development, people were well-aware of the construction process.

Many Laotian villagers still use traditional catchment methods for the fishery, whether as an income source or for their daily food. For this reason, unlike the Thai side, Laotian villagers felt a significant decrease in fish volume in recent years.

According to them, the government prohibited setting up the fish farms along the river several years ago. For this reason, some families moved to the other tributaries nearby where fish farming is still allowed. We could not obtain any official reason for this prohibition.

The economic dependency on fishery was quite different for the villagers in Locations 2 and 3. Located in the suburb of Vientiane city, villages in Location 3 were less dependent on fishery as their income source. Instead, they are generally engaged in the tourism industry or being considered as the labor force for the rapidly growing economy of the capital city. On the other hand, in Location 2, there are still many families whose only income source is fishery.

In Oumong village (Location 3), about 30 out of 200 families still engage in traditional fishery as their main income source. They own boats and can use the fish nets as the catchment tool. On the other hand, other families go fishing for a few hours every day to catch a small number of fish for their daily food.

All of the interviews at both sites did mention that the number of fish has significantly decreased especially in the last few years. They stated that nowadays it is very difficult to make a living just with fishery like they had been doing previously for many years. A 56-year-old man in Oumong village (Location 3) stated that:

> "I used to be a fisherman for more than 30 years. However, nowadays I cannot make enough to feed my family by fishery alone. I used to catch about 20-30 kilograms a day and it has been reduced to less than 3 kilograms. That is why now I have shifted to making and selling fish nets for those who own the boats and can go fishing on the river. My wife is also working as a beer delivery service with a motorcycle to the hotels and restaurants."

According to the interviewees' claim, the decrease in the catchment amount is about 80% to 90% only in the last few years. Because of this decrease in number, many fishermen on boats, taking the risk, cross the Laotian border into Thailand's territory to increase their chance of catchment.

Figure 11. (1) Professional fisherman catches a large Mekong catfish. (2) The common usage of square fish nets to catch the daily food.

Moreover, another significant reason for the decrease in the catchment amount is the contraction in sediment level in some locations. This change has been felt differently by the fishermen in distinct locations according to the river flow speed and its depth. While interviewees in Location 3 reported on the decrease in sediment level, others in Location 2 did not feel any impact. The reason could be explained with the difference in the river depth. In Location 3, the river width is wider and the flow speed is slower. Therefore, the decrease in sediment level causes the fish nets to get snagged on the large rocks. This has made it very difficult for the fishermen to manage their fish nets in such locations.

As discussed in the previous parts, all the fishermen and community members claimed that the fish numbers had significantly decreased in the last 3-4 years; however, the answers to the question of the reasons behind it vary among different people. Some locals also reported that the water level fluctuation is no longer normal. When the level is high, they cannot go fishing.

Some of the interviewees in the remote villages were not aware of the construction of the Xayaburi Dam in the upper stream. They either have no idea about the reason behind the recent changes in the river or some claim that this phenomenon is because of the overfishing. On the other hand, those who live closer to the city or follow the news did know about the dams in China. Since the impact has only started to be felt by lower basin residents in recent years, many people have blamed the Xayaburi Dam as being the main reason behind the changes. A middle-aged man from Thadeua Village who used to be a fisherman but now runs a small grocery shop said that:

> "The water level changed 3 to 4 years ago because of the Xayaburi Dam. The Chinese dams did not affect our lives that much. The main impact started once they started to construct the Xayaburi Dam."

Even though some of them are well aware that Thai companies are the main investors of the project declaring that they are the victims of these rapid environmental changes, no collective action has been reported from the Laos side so far. While we were concerned about the political restrictions against any forms of social resistance, Laotians preferred not to express any personal objection to our group. A young man who owns a restaurant and three boats close to the Thai-Laos friendship bridge stated that:

> "Because of the Xayaburi Dam, the environment changed, everybody knows about it, but they cannot do anything. We follow the news on Thai TV, so we know about it. Nevertheless, the government is making the decision. Our position is neither positive nor negative."

This position of remaining neutral was seen among almost all of the interviewees. While a few villagers stated that they are happy about the dam, most of them mentioned that they are powerless and their voice cannot be heard for decision making. One interviewee who is a rice farmer and inherited a large rice field talked about how he was witnessing the demonstrations in Nong Khai city:

> "It was a couple of years ago when I crossed the border to Nong Khai and saw some protesters against the Xayaburi Dam construction. Some groups were supporting the dam construction, while others were objecting to it; there were two groups wearing shirts in different colors: white and red. I think the locals did not inspire the movement, but there were some political parties that organized the people, bringing them onto the street."

Many interviewees heard about the adverse impacts of dam construction on the environment and their life from Thai TV channels. The Laotian media, on the other hand, advertises the dam as a symbol of the start of rapid economic development and the starting phase of the country becoming the battery of south-east Asia.

All in all, there is a strong tendency among the locals to blame the Xayaburi Dam, not the Chinese dams, as the main reason for the changes of the fish volume in recent years. They, however, did not show open disagreement to stopping the construction process. In general, the contradiction of blaming the dam construction as the main reason for the problem and not expressing their ideas openly might be understood when considering the political restrictions on freedom of speech in Laos.

VI. Conclusion

There are few studies that focus on the environmental and socio-economic impact produced by the cascade dams on the Lower Mekong Basin. Most of the arguments rely on NGO / NPO information, which turned out to be lacking in empirical evidence, or sometimes biased to a different extent. Against the background of the scarcity of academic objective research, this project attempted to comparatively clarify some of the environmental and socio-economic basic facts based on fieldwork in the rural areas of Thailand and Laos.

The impact on the population living in the Lower Mekong Basin varies significantly among different regions. In the case of this study, fishermen in Nong Khai who manage the caged floating fish farms along the river bank are more vulnerable to the sudden change in water level caused by discharges from Chinese dams in the Upper Mekong basin. On the other hand, using this fishery method frees them from worrying about the reduction of sediment in the riverbed. Across the river, however, fishermen in the suburbs of Vientiane city are still using traditional methods of fishery in the Mekong River. They are more sensitive to the change in sediment and fish amount, many of them declaring a significant decrease in both.

Moreover, the socio-economic and livelihood impact in each country differs as well. For instance, while on the Thai side only about 10% of the population were involved in fishery, in Laos, this proportion rose to nearly 40%. Furthermore, for many Laotian villagers, fish is the only source of protein in their daily meal. Therefore, such dependency on the river as the primary source of income and food security for many villagers in Laos shows how vulnerable the people are to any environmental changes in the Mekong.

While on the Thai side, people's perception indicates no impact from the Xayaburi Dam, but from Chinese dams, Laotians blame the Xayaburi for being the main source of recent changes. From an objective viewpoint, as Xayaburi Dam is not operating yet, it cannot be the only reason for the recent changes. This shows that the perception of the locals profoundly depends on the local discourse. At the same time, any social movement is being carried out based on such perceptions rather than scientific research. This indicates the importance of studying the locals' perception of environmental changes in addition to having a positivist and scientific viewpoint.

Considering people's perception of the recent changes, the research shows that the Laotian villagers were

more conservative in participating in any collective actions against the construction of the Xayaburi Dam. The Thai communities were more expressive, although they did not feel the impact in their daily life as much as the others across the border did. Although this difference is considerably important, the role of NGOs and other international organizations seems to be far more vital in putting international and political pressure on authorities by mobilizing the local communities.

The governmental discourse in both countries was to support the construction of dams. While in Laos, the focus is on the need to expedite the development process by using the countries' potential to become the "Battery of Asia" by transporting energy to the neighboring countries, the focus on Thai media is on the importance of foreign investment. In fact, becoming the "Battery of Asia" could be a good way of expediting the economic development; however, the social and environmental impacts should be carefully assessed and minimized before initiating any project.

While the environmental impact is almost the same for the targeted areas of this research, it seems that the economic situation and civil rights practices are among the most important factors that have affected public opinion in the two separate communities located in environmentally similar regions.

At least two limitations exist in this part of the research. First, the environmental impact could not be investigated thoroughly. Change of factors such as sediment has been widely discussed in the published literature, but most of that focused on the impact of Chinese dams in the upper stream of the Mekong River. This research encountered the same restriction as the previous studies did, i.e., the monitoring data along the Mekong River can hardly be accessed by the public. Meanwhile, people are taking sand from the river to sell as construction materials. Thus the decrease in sediment cannot be attributed merely to dam construction. Also, the Xayaburi Dam is still under construction, so probably some of the impacts can only be observed over time.

The second limitation is that the change in fish amount could not be discussed adequately. Similar to the sediment decreasing, it is reported in the field that the number of fishermen has increased in recent years. In this report, the responses of the fishermen have been discussed without comparing the statistics of total fish yield amount; attention has to be paid to the one-sided approach when interpreting the results.

As empirical research that covers the major aspects and takes the entire Mekong region into consideration, this project is a small step towards facilitating the countries involved to build a sustainable development strategic framework while sharing the prosperity. Since many other dams are still in line for construction, this project could be used in the pre-consultation studies for upcoming projects to mitigate the environmental as well as social problems. On the other hand, as the public needs a comprehensive understanding of what's going on and what should be done to help to improve the situation, results from social investigations in this project might be used by some social and political intellectuals to measure the need for strengthening the civil society in the region.

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Using the Information Dissemination to Improve the Response of Earthquake through the First Days of Disaster

Case study: The 2015 Nepal earthquake

Mohammed Hajjaj

Abstract

The using of the information dissemination has been considered to improve the response of the earthquake through the first days of the disaster in the 2015 Nepal. Communication Technologies such as social media, mapping systems, and image sharing sites have created wormholes through which we can watch as earthquakes hit, fires spread, or waters rise in any part of the world.

In the most ways to improving the responding during the disaster, all the relief groups and emergency teams or any stakeholders who can play a main role in the land, have a big challenge to do an immediate responding for people and proceed their plans. One of the challenges is the availability of the information during the disaster. Using the information and sharing the data for all groups could help for responding to give the first aid for people. Powering the terminal devices and access points for citizens and emergency responders to use the Internet for communication was the main hindrance.

The International Federation of Red Cross and Red Crescent Societies stated that information is as important as food, water, and shelter as a form of aid. This report argues the case study of the 2015 Nepal earthquake using the sharing of information to improve the response of the disaster.

Index Items: Information Dissemination, Disaster, Emergency Plan,

Introduction

Earthquakes is one of the natural disasters which are the major adverse event resulting from natural processes of the earth. Earthquakes cause great damage to properties and human beings, so that the people cannot know how to protect themselves during or after the earthquakes.

The International Federation of Red Cross and Red Crescent Societies (IFRC) as a largest international organization work on the humanitarian issues define the disaster as a sudden accident or a natural catastrophe that causes great damage or loss of the life of people, as well it a calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources (IFRC, 2018). Whatever, IFRC said also that the human can have making a disaster due to the controlling in the resources in the world (IFRC, 2018).

Whatever to the reasons of disaster, though often caused by nature, or human origins, the responding during or after the disaster is the purpose for all the emergency groups or responding teams. The stakeholders who work in the land like the government and the public organizations are expecting and thinking in different ways to help people to give them the first aid, or protect them from any unexpected effect even before the disaster. Many plans are set, and used to process the responding of the disaster.

Nepal have a lot of previous natural disasters before the earthquake in 2015 and they have many challenges after the event. Earthquake cause great damage to properties and human beings. During the earthquakes the people do not know how to protect themselves. All civil societies and organizations have many challenges to work in Nepal after the event. Other aspects of the institutional organizations have been a standard institutional response to ensure effective and efficient recovery and reconstruction for the damage. As well, some of commitments are carried out for many organizations in an inclusive and transparent manner and that interventions integrate risk reduction for all people and the infrastructure, so as to withstand the impact of future disasters.

The earthquake of Nepal is measuring 7.9 to the scale at the depth of 15 kilometers, according to the US Geological Survey. The earthquake struck 77 kilometers northwest of Kathmandu in Nepal in close to Barbark town located in Gorkha district and 68 kilometers from Pokhara. The quake struck also in New Delhi and in northern India. It is the worst earthquake which hit Nepal during the last 80 years and the largest in the world since 2014 which hit Chile with 8.2 magnitude in the scale (C. Welton-Mitchell, 2017).

However, a series of aftershocks emerged after the Nepal earthquake causing more deaths and injuries, and exacerbating the feeling of fear and tension among the affected the people (Nepal Earthquake Clearinghouse, 2018). The highest of the next day of the earthquake with 6.7 in scale. However, two weeks after the quake, the second Nepalese earthquake and its neighboring countries struck by 7.3 degrees, followed by third one with a 6.3 in scale. The earthquake struck Mount Everest in all sides in 30 seconds to 2 minutes. It has a hug big effect in the communities around the event, and killed many people.

Seismicity in the Himalaya dominantly results from the continental collision of the India and Eurasia plates, which are converging at a relative rate of 40-50 mm a year. Northward under thrusting of India beneath Eurasia generates numerous earthquakes and consequently makes this area one of the most seismically hazardous regions on Earth (Nepal: Earthquake 2015 Situation, 2015).

NGO, and international NGO sectors play some main roles in Nepal after disaster, so many policy objectives are set for the organization and coordination between all teams to retrofit, reconstruct the partially and completely damaged residential, community and heritage sites using local technologies as needed. Therefore, the sector plays a role in building the resilience among the community and people at risk in the earthquake affected area which help in reconstructing the damaged cities or villages to original structures. Thus, new opportunities are developed by recovering the economic growth and livelihoods.

However, the health system in Nepal is not strong. The hospitals during the earthquake were unable to serve a huge number of patients in need of medical care. Some Nepalese have complained that aid takes too long to reach them.

The deadliest earthquake in the country in 81 years has led to avalanches that killed 81 people at the Everest summit in the worst disaster to hit the world's largest summit in history. More than 200 people were trapped on top of the mountain, but helicopters are rescuing them, with 60 people being rescued, Monday, the Tourism Ministry said.

Therefore, the monsoon rains cause soil erosion on the slopes of the mountains, while dense forests cover much of the earth, which quickly blocks seismic cracks.

Rapid assessment team from WHO and Ministry of Health found hospitals in worst hit area of earthquake in Sindhupalchowk, Nuwakot, Rasuawa and Ramechhap districts severely damaged or completely destroyed.

Another team (C. Welton-Mitchell, 2017) of several academic and practitioner experts in earthquake engineering, community resilience, and risk reduction, spent a week in Nepal to document the impact the earthquake had in Bhaktapur and surrounding districts. Strategic goals of the reconnaissance team included investigating recovery and resilience related issues, along with the more traditional pursuits. Results from this rapid assessment highlight community perspective on the following topics: culturally specific disaster attributions, psychological distress, preferred means of coping, social support, community conflicts, livelihood implications and other economic impacts, and concerns with governance and corruption - providing a snapshot of the situation in the early aftermath of the earthquake (Nepal: Earthquake 2015 Situation, 2015).

In rural areas (Information & Communication Technologies and the 2015 Nepal Earthquake, 2017), mobile phones were considered a lifeline for many, particularly to contact family members who had migrated to Kathmandu or overseas for work. When mobile networks were down,

radio stations were a point of contact for the dispersed workers to find out about the impact of the disaster on the family members they had left at home.

Social media was more commonly mentioned in urban areas, where many volunteers used Facebook and other platforms for networking and coordinating emergency help, acting as mouthpieces for rural communities' needs.

The complex problems of access and capability remain major barriers to communication technology use in Nepal, particularly in rural areas, as is also the case in other low-income countries. The need to communicate and the idea that information is a form of assistance is increasingly acknowledged as an urgent but under-supported aspect of disaster response.

Background

The map of perceived shaking of the earthquake as shown in the Figure 12 below Nepal experienced a 7.8 magnitude earthquake, followed by countless aftershocks, including one of 7.3 magnitude. The earthquake affected 14 out of the 75 districts of the country, with just under 9,000 people dead and over 600,000 homes destroyed. Geographical isolation and lack of infrastructure further compound the risk of loss to life and property in the event of natural disasters (C. Welton-Mitchell, 2017).

Figure 12: The map of perceived shaking of the earthquake.

At least 8,669 people killed, 384 missing, 17,866 injured, 500,717 houses destroyed and 269,190 damaged in Nepal in this earthquake and the M 7.3 aftershock on May 12 morning. Included in the casualties are 180 people killed from the collapse of Nepal's historic Dharahara Tower and 20 people killed and 120 injured from an avalanche at the Mount Everest Base Camp. Landslides occurred and roads and power lines damaged in Nepal. Felt (VIII) at Bhimeshwar, Kathmandu and Kirtipur; (VII) at Bhaktapur, Bharatpur, Bidur, Ghorahi, Lalitpur and Pokhara. Damage estimates exceed 5 billion US dollars. At least 78 people killed and 560 injured in India. Felt (VII) at Nautanwa and (VI) at Patna and Shiliguri. At least 25 people killed, 4 missing, 383 injured, 2,500 houses destroyed and 24,700 damaged in China. Four people killed, 200 injured and 17 buildings damaged in Bangladesh. Felt (V) at Bhaluka and (IV) at Dhaka, Rajshahi, Sylhet, Tangail and Tungi. Felt (IV) at Thimphu, Bhutan. Felt in much of western Bangladesh, northern India, central Nepal and parts of Bhutan. Felt as far as Kahuta, Pakistan. The effect of the earthquake based on the intensity as shown in Figure 13.

The Government reports that 130,033 houses were destroyed and 85,856 houses partially damaged. Over 30,000 houses are destroyed in Nuwakot District alone (Nepal: Earthquake 2015 Situation, 2015).

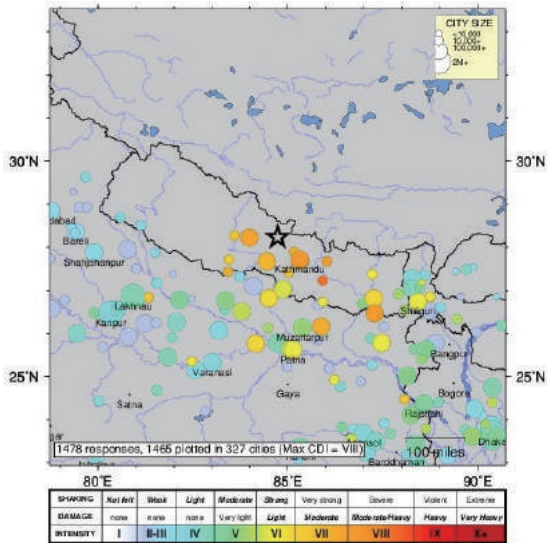

Figure 13: The effect of the earthquake based on the intensity.

The Problem Statement and Objectives

The problem statement of report is considered for using the information dissemination to improve the emergency responding during the disaster especially the 2015 earthquake in Nepal. The objective the of the report is to find a plan or framework for using ot sharing the information during the disaster which could help in the emergency cases in the event.

The Significance of Report

The significance impact of report is becoming in propose a proper solution of using the information dissemination to improve the response during the disaster. It is arguing about the points which help in using a framework of the information dissemination for the resilience during the event. However, all of the emergency plans are set in the different ways as the players or stakeholders are expected before any disaster, so the framework in this report could increase the awareness for different people during natural disasters, and it will be helpful as a guide lines for designing the policies and the standard practice within the community.

The Related Cases

The 2015 earthquake in Nepal killed over 8000 people, injured more than 21,000 and displaced a further 2 million. Nepal is one of the most seismically active regions of the world; it has a long record of earthquakes. The earliest earthquake event in the country dates back to 7 June 1255. The earthquake, measuring 7.8 on the Richter scale, took the life of Nepal's king and wiped out a third of Kathmandu's then population. Nepal has witnessed at least one major earthquake per century ever since.

The following table is a list of earthquakes occurred in Nepal. It includes only major seismic events with their epicenter in the country, and those that occurred outside the country that resulted in a significant loss of life and property in the country.

Table 1: The history of the earthquake in Nepal.

Date	Time	Place	Longitude	Deaths	Magnitude
7/6/1255		Kathmandu	85.3	2200	7.8
1260		Sagarmatha	86.8	100	7.1
1344		Mechi	87.5	100	7.9
8/1408		Near Nepal-Tibet Border, Bagmati zone	86.0	2500	8.2
6/6/1505		Near Saldang, Karnali zone	83.0	6000	8.7
1/1681		Northern Kosi zone	87.1	4500	8.0
7/1767		Northern Bagmati zone	85.5	4000	7.9
26/8/1833		Kathmandu/Bihar	85.5	6500	8.0
7/7/1869		Kathmandu	85.3	750	6.5
28/8/1916	06:39	Nepal/Tibet	81.0	3500	7.7
15/1/1934	08:43	Nepal/India/Tibet	86.762	8519	8.0
27/6/1966	10:41	Nepal/India border	80.854	80	6.3
29/7/1980	14:58	Nepal/Pithoragarh	81.092	200	6.5
20/8/1988	23:09	Kathmandu/Bihar	86.616	1091	6.6
18/9/2011	18:29	Sikkim, India	88.62	111	6.9
24/4/2015	11:56	Kathmandu/India/Tibet	84.708	8,922	8,922

The Methodology and Design

In this report, the current situation as a case study has been considered in Nepal during the 2105 earthquake. The reset of report is arguing about the current situations of the related plans following with some strategies and tactics, responding process, proposed solutions and conclusion.

The Information Dissemination and the Current Situation in Nepal

In the first time after the earthquake, everybody wanted to communicate for each other and wanted to make sure for all family's people and friends were in safe area, or to know the level of damage in properties or loss of lives and the situation (Bustanul, Bisria, & Beniya, 2016). The government apparatus had to be mobilized and that required communication. The entire public communication had almost crashed for hours after the quake directly, as well there is no electricity, and no telephone working for over a week in remote areas. In addition, mobiles were useless for the first few days (Nepal: Earthquake 2015 Situation, 2015).

However, the National Emergency Operation Center does not provide information systems to support crisis response and management (Waidyanatha, 2016), as well, the District Emergency Operation Center do not have access to an incident management system to coordinate the information with relevant emergency services and to communicate with government. It is all manually processed on paper and communicated by phone or FAX (Nepal needs better communication infrastructure to respond to disaster, 2015).

The Nepal Telecommunications Authority (NTA) estimated 40% of the damaged telecommunications to have been restored by the 2nd day, and Telecom Engineers, in Nepal, and the Telecom emergency operation centers worked around the clock to restore services (Waidyanatha, 2016).

The government of Nepal used Radio for the first media of communicating people after the earthquake in some reasons (Waidyanatha, 2016): the building of Radio was constructed well and had a sturdy building; as well some media and broadcasts start interacting people after few hours, and others shut or collapsed during earthquake like TV as it was stopped and not accessible for people because of the damage in electricity and people had to stay inside houses to watch, so people use radio as the first media all the time outside of building.

After the second earthquake, the communications became more complicated and difficult in special remote areas for international aid works flocked in, and all relief teams and also people need more specific, clear and accurate information (Waidyanatha, 2016). Communication for relief in remote areas were completely damage as well difficult to travel, so all people started distributing relief by using different ways to reach each people.

There are many people use the social media in the mobile as well they have the radio media in Nepal, so one of the strategies to improve the connection with the people in two ways, the first one uses some application to connect them by social media even the infrastructure of mobile is not being well by connecting peer to peep technology or from people to each other. Another way in the other side is using the most effective way by radio channel to send all important or urgent messages by one channel that easy for everyone to use it in case the mobiles are useless for the first few days (Waidyanatha, 2016).

The government apparatus had to be mobilized and that required communication. However, the government of Nepal used the Radio for the first media of communicating people after the earthquake in some reasons: the building of Radio was constructed well and had a sturdy building; as well some media and broadcasts start interacting people after few hours, and others shut or collapsed during the quake like TV as it was stopped and not accessible for people because of the damage in electricity and people had to stay inside the houses to watch, so people use the radio as the first media all the time outside of building (Waidyanatha, 2016).

Some reports have been shown by government about the damage of earthquake. Kathmandu and Gorkha are one of the districts with the highest number of damaged in houses and communication infrastructure. The only thing everybody wanted to do was communicate for each other and wanted to make sure for all family's people and friends were in safe area, or to know the level of damage in properties or loss of lives and the situation. The government apparatus had to be mobilized and that required communication.

Humanitarian partners in the most affected areas identified as the most critical needs and assistance. Partners also have delivered food to affected people in Gorkha and Dhading. The entire public communication had almost crashed for hours after the quake directly, as well there is no electricity, and no telephone working for over a week in remote areas. In addition, mobiles were useless for the first few days. Helicopters are used transport and reach to remote area due to the lack of communication infrastructure. Poor communication and security concerns, remain the main challenges in providing for those most at need.

In another case (Nepal needs better communication infrastructure to respond to disaster, 2015), the Radio of Nepal was the only mass media functioning after the earthquake as the building of Radio was constructed well and had a sturdy building. As well some broadcasts continued intact people after few hours, and others shut down and many others collapsed during the quake. Television was stope and not accessible for people because of the damage in the electricity and people had to stay inside the houses to watch, so people use the radio as the main media all the time outside of building.

Overall, the communications system is more stable in comparison to the early days of the emergency, when remote areas were out of reach with only mobile text messaging functioning in Kathmandu Valley. Communications has been reinforced by the private sector which has donated cash and free telecommunication services in Nepal (Communication and Information, 2015).

The main Radio of Nepal had played a main role to communicate with people and also in communicating rescue and relief needs to the Home Ministry from across all affected areas, as well the crucial announcements which notices from the Government's disaster response authority.

Communication (Nepal needs better communication infrastructure to respond to disaster, 2015) for relief in remote areas were completely damage as well difficult to travel, so all people started distributing relief by using different ways to reach each people. However, communication on disaster should be harmonized to avoid mixed messages to the public, avoid confusion, and maximize impact, as well use it to control the awareness between people, and distribute the right information between all people as needed exactly of the relief which avoid the duplication or violence, and reduce the dispelling rumors between people, and making the mass media communicate the right message (Communication and Information, 2015).

Communication to handle public fury during disaster, and work in social media like twitter or Facebook and resource mobilization are also other strategies after the earthquake (Nepal needs better communication infrastructure to respond to disaster, 2015). All of these tools are used to reduce the gap in communication between people and government after the shock of earthquake. Local radio was very helpful in making communication possible during the disaster to realize the importance of taking extra care in setting up public buildings, including communication hubs.

Eighty five percent of the people use television. Therefore, solar cells should be arranged in the municipalities of each region, which should communicate with central government instead of using direct means of communication with people.

In the case of uninterrupted power supply, municipalities can communicate with the people through the use of the Internet and cellular communications, but the problem is that the percentage of Internet users in the country does not exceed 17.2 % of the people, while the proportion of mobile users up to 50% only (One in two Nepalis use internet: NTA report, 2018).

Strategies and Tactics for Using the Information Dissemination

The best way to protect against earthquakes is to prepare the public and the civil administration. It is important to make all lifeline buildings, such as hospitals, fire and police stations, and schools' earthquake resistant. What's more, human should stress and highlight the importance of educating school children on a routine basis about the earthquakes and how to live with them.

Other mechanisms: The Prime Minister's Disaster Relief Fund which used for rescue, treatment, relief, rehabilitation of victims and restoration of physical infrastructure damaged by natural disasters. It is managed through a Committee, made up of eight secretaries from key Ministries (Nepal: Earthquake 2015 Situation, 2015).

Government Cluster Mechanism establishes the coordination between domestic clusters of ministries and international agencies in structuring the emergency response and drafting DRR (Disaster Reduction and Recovery) policies on short- and long-term bases. The clusters are: Health; Water, Sanitation and Hygiene; Shelter;

Food Security; Logistics, Education; Protection; Telecommunication; Nutrition; Early Recovery Network; Camp Coordination and Camp Management. In another side the logistical causes:

- complex geographical conditions of Nepal as a mountainous and earthquake-hit area.
- A poor transportation network and the loss of power and telephone connections
- shortage of helicopters, supply trucks and drivers.
- Institutional and Procedural Imperfections

In current framework, damage estimates must be made locally and transmitted to the central authorities, while instruction for responders and the population must be disseminated from the central authorities, but after the earthquake, Nepal's communication infrastructure crumbled. This also meant that international responders entered the country blind, without knowing where their assistance was most needed. The coordination and management of the many aid agencies as well the communication and access difficulties between urban 'command centers' and rural villages.

Response Process

The purpose of response process is to provide urgently needed medical supplies, including all emergency agencies health kits including basic health needs for about 460,000 people for three months, for all camps of refugees or people who have been evacuated to camps in collaborating with the Ministry of Health and Population WHO and continues to work closely with the Ministry of Health and Population in coordinating the relief efforts of the Group's health stakeholders at the national and provincial levels, and in coordinating the deployment with foreign medical teams. As well, working together with UNICEF and the Ministry of Health and Population to vaccinate children against measles in all the official camps and in many informal camps, and cover the worst affected districts.

In close collaboration with the Government of Nepal, the Emergency Telecommunication Cluster group (ETC, 2015) hosted the Communication Emergency Response workshop together with the Ministry of Information and Communications in Kathmandu with many stakeholders participating to enhance the emergency response plan for Nepal.

According to National Disaster Response Framework, public service announcement by radio, TV, SMS for factual EWS (Nepal: Earthquake 2015 Situation, 2015), emergency warning, ongoing rescue operations and public announcement. In 2015 earthquake, emergency response activities that were implemented timely include the District Disaster Relief Committee meeting, Central Natural Disaster Relief Committee meeting, appeal for international support, activation of search and rescue operation, coordination setup for receiving international support at the Tribhuvan International Airport, as well as the processes that requires communication with the UN/HC and IASC humanitarian clusters. These activities have pre-established standard operating procedure at National Emergency Operation Center, which understood across ministries (Sigdel, 2016).

After the earthquake, The National and International telecommunications community responded to the earthquake to restore emergency communications. There were several projects that were hosted to crowd-source disaster information and exchange information using new media, like:

1. Using the social media to connect people.
2. SMS and hot-line to receive reports and to notify various groups of each other's response efforts.
3. Some online software for the map, and street geography, as well for the humanity roads.
4. Radio Broadcasters FM Radio broadcaster comprise Nepal Radio. These radio stations serve as the only mean of education for some remote communities.

The silence that emanates from areas cut off from communication, especially in the areas near the epicenter, is a profoundly ominous indicator, and communication will only become more important in the days to come, and some of the worst affected areas take days to reach even in normal times.

Nepal is showing just how much digitization is changing communications in disasters. Many people have used the platform to criticize the government, contact the authorities directly and share requests for help. In another side, Nepalis overseas are joining online volunteer efforts to translate information and map affected areas. Local newspapers continue to publish online, even while they struggle to print and distribute their traditional hard copies.

Proposed Solutions for Using the Data during the Earthquake

In this section, the solutions of using the information dissemination during the earthquake especially in Nepal case has been proposed. At first, collecting data is the most significant which the public orientation of plan will be, followed with the distribution the information and the authorities for all stakeholders.

This part also argues the significance of information during the disaster and earthquake in Nepal starting from the collecting data from people or resources, sharing the information between all main players and strategies to help in sharing the information.

There is a need to build the technology and communication applications that can be used every day and make the public aware of those to utilize during any emergency. Establish a multi-agency situational-awareness platform to integrate all alerting authorities and emergency response organizations, at national and local layers, with a common operating picture to improve institutional responsiveness. Thus, establish a multi-agency first response platform including the management system to integrate all emergency response organizations, at national and local layers, with situational reporting procedures for improving response coordination and management, then establish interoperability standards to integrate all crisis and emergency groups with national and international systems.

However, the availability of data is the most important to people who work in the road, and collecting data and share the information between all stakeholder for the response processes are in the first priority to be on the road for the first aid for people.

Collecting the Data

One of the most important responsibility during the disaster is the data collection and gathering the information on targeted area. Simply collecting data and information during the disaster often presents a set of barriers. Many types of data need to be collected after earthquakes which will be used for different purposes: decision makers and emergency responders. Among the types of data that need to be collected:

-Geologic data like landslides, liquefaction, and fault rupture or displacement.
-Data on damage to lifelines and infrastructure systems in example: water, power outages, sewer and pipelines, telecommunications, and transportation.
-Data on building damage, and people in and out of the area, specific types of building losses like commercial building losses, stores, shelters, and for business or economic usage.
-Data on injuries and deaths to provide the health care for them.
-Data on emergency response procedures, resources needed for response, effectiveness and rescue procedures, or responses to warnings and predictions.
-Data on the political context like for development, land use regulation, historic preservation, and commercial redevelopment.

Distributing the Information

On another side, sharing the information between all people and distributing it might help people to protect themselves during or after the earthquake as well might reduce the effect in the injuries people and protect them to be in life for any effect could become from the building damage or infrastructure damage. The information would be like below:

-Share the emergency information among people such as the phone numbers of the nearest emergency center to quake-hit areas.
-Describe how people can stay safe when the earthquake threatens.
-Describe how people can check themselves for injury and how can they provide the help for others.
-Guide people to safe places in their surroundings.
-Describe to people how to make an emergency groups to make a communication plan to avoid the out-of-state contact among the people in the quake-hit areas to facilitate the process of assistance from international institutions and local government.
-Describe what kind of food should be eaten after the earthquake, for

example avoiding foods that cause thirst especially contain salts and trying eat some foods have more liquid inside them.

-Give preliminary information about places affected by earthquakes and warn people to get close to them or return to their homes.

-Give people preliminary information on how to get water and the nearest place where water is available for each affected area.

Strategies and Authorities

In order to respond for the authorities and mobilize the community level actors, the strategy is to rely on the capacity of informal authorities (e.g. the head of a local community or a village) in a close collaboration with the local official government, especially when it comes to post-disaster challenges such as:

-Collecting fast and reliable information from the villagers,

-Prioritizing the villages when central government and international NGOs are concerned with big cities or simply do not have easy access to these villages,

-Providing the villagers with specific information on their village or their problem through local radio channels based on collected information

For example, below is a probable scenario in collecting the information from the villagers in far-flung areas like Barpak, some resilient buildings have to keep equipped tricycles inside. This building should be considered as a main hub close to several villages.

The local government manages these facilities but the actual work of driving these tricycles to the villages, collecting the information, and help them to restore the communication devices, should be done by trained and trusted people from the local communities working under the supervision of the community leaders and the local government. This information can later be used to prepare the necessary guidelines for the villagers. In the communication hub carried by motor-tricycle, few equipment will be put on the vehicles like (Internet Live Stats, 2018):

-Wi-Fi router, and there is no regulation for it, considering it is just a medium to provide wireless access point.

-Cellular signal base station, which include 2/3G and 4G, it is regulated by Nepal Telecommunications Authority (NTA).

-radio emitter and receiver, and there has no regulation for it. For radio emitter, it is regulated by the Ministry of Information and Communications.

Conclusion and Summary

The best way to protect against earthquakes is to prepare the public and the civil administration. It is important to make all lifeline buildings such as hospitals, fire and police stations, and schools. What more, human should stress and highlight the importance of educating school children on a routine basis about the earthquakes and how to live with them.

The potential of providing the communication system in facilitating disaster management is huge and has begun to be realized in the way they are used for fundraising, finding missing people, and to strengthen feelings of solidarity between dispersed communities.

Starting in rural central Nepal where multiple devastating aftershocks struck after the earthquake killing many people, the people used different technologies for different reasons and in different ways. Access to the technologies and the internet connection for using were common barriers, as were capability like read in English, the predominant Internet-language, or to read at all.

Overall, the technologies and communication technology are facilitating resilience of individuals in the face of a disaster, there is some way to go for this to be applied to the evacuation and health care system after the disaster as a whole.

There is scope for increased connectedness and collaboration between all responding of the disasters, although they have the same overarching goal of saving the lives of people. Innovative use of technologies could help bridge that gap in future.

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Improve the Response of the Earthquake through the first 48 hours Case Study of Barpak Village, Nepal

Zhang Wenyu

Table of Contents

1. Introduction

1.1 Earthquake and Nepal

We focus on earthquake problem and to which the disaster response is based on several factors: (i) earthquake can happen anywhere. Earthquakes occur all the time all over the world, both along plate edges and along faults. Most earthquakes occur along the edge of the oceanic and continental plates. The earth's crust (the outer layer of the planet) is made up of several pieces, called plates. The plates under the oceans are called oceanic plates and the rest are continental plates. The plates are moved around by the motion of a deeper part of the earth (the mantle) that lies underneath the crust. These plates are always bumping into each other, pulling away from each other, or past each other. The plates usually move at about the same speed that your fingernails grow. Earthquakes usually occur where two plates are running into each other or sliding past each other. Earthquakes can also occur far from the edges of plates, along faults. Faults are cracks in the earth where sections of a plate (or two plates) are moving in different directions. Faults are caused by all that bumping and sliding the plates do. They are more common near the edges of the plates. (ii) Earthquake happened without warning.

There is no way to predict earthquake so far. (iii) Earthquake can cause huge disaster to humankind's life, such as causing fires and damage roads, or causing tsunamis, landslides and avalanches. To study how to improve the disaster response of earthquake can improve our lives.

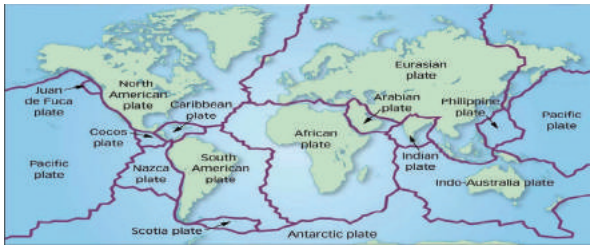

FIGURE 1 AN IMAGE OF THE WORLD'S PLATES AND THEIR BOUNDARIES.

We chose Nepal as our target site. For the geological factor, our focus will be on An active earthquake zone represented by unstable earth which an earthquake is expected to occur at. Himalayas Mountains are chosen to be the zone of the study where the Indian and Eurasian continents are converging at the rate of ~1850 mm/year. It is quite well known that the present day structure of the Himalaya has resulted from the progressive under thrusting of the Indian plate, leading to a stack of thrust sheets that get progressively younger, southward. In this geometry, the oldest and the northernmost is the Main Central Thrust (MCT), followed by the Main Boundary Thrust (MBT) and the Main Frontal Thrust (MFT), all of which sole into the Main Himalayan Thrust (MHT). The thicker part of the MHT is believed to be creeping smoothly while the shallower parts slip episodically which cause great earthquakes. So our study case will focus on one cities near the Nepali Himalaya. This mountains cover the north of India, Tibet, and Nepal. As shown in the following figure.

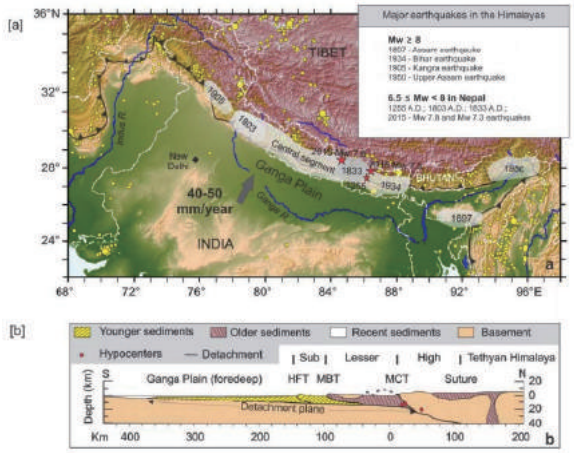

FIGURE 2 THE GENERAL LOCATION OF THE HIMALAYAS MOUNTAIN RANGE

1.2 Research Objectives and Limitations

Our research objectives is to propose ideas to improve one-way and two-way communications in post-earthquake. We want to (i) improve the guidance system for people and international organization through the first 48 hours after the earthquake, (ii) facilitate information dissemination to rural/remote areas through national media, and (iii) facilitate people to Search and Rescue (SAR) groups and SAR to people communications.

We have two limitations in this study. We did not have the chance to do fieldwork and had little access to detailed fieldwork based studies in rural areas of Nepal. We are not taking into account the possible discriminations caused by Caste system or Gender inequality in Nepal.

2. Current Situation

2.1 Current National Disaster Response Framework

The Ministry of Home Affairs (MOHA) completed and enacted the aforementioned NDRF. It states that in the Nepali context, a national disaster response means "actions taken immediately before, during and after the disasters, or directly to save lives and property; maintain law and order; care for sick, injured and vulnerable people; provide essential services (lifeline utilities, food, shelter, public information and media); and protect public property". The framework has eight sections with main components that regulate the national system for disaster response, arrangements for international assistance, the coordination structure of national and international assistance, special operation arrangements for national disaster response, the national framework for disaster response, and necessary future courses of actions for emergency preparedness. Firgure 3 and 4 show the NDRF of the first 48 hours after disaster occurred.

Time frame	Activities	Responsible Leading Agency
0-1hr	Information about earthquake	National Seismologic Center
	Household fire & instruction of response to fire	DDC/VDC/Municipal offices
	Instruction for search & rescue and deployment security forces	DDRC & security forces
	Authentic info of disaster & public announcement of rescue efforts	MoHA/NEOC
	Establish and transmit automatic emergency message via electronic media	MoIC/MoHA
0-7hrs	Information about weather induced disaster	Department of Hydro & Meteorology
	Information collection and flow	CDO/DDRC
	DDRC meeting	CDO/DDRC
	Emergency meeting of relevant officers at HoHA	MoHA/NEOC
	Activate NEOC and operationalize as per SOP	HoHA/NEOC
	Public service announcement by radio.TV, SMS for factual EWS, emergency warning, ongoing rescue operations & public announcement. If needed, communicate to abroad, timely transmitting of such info	National, Regional, District and local emergency operation centers
0-24hrs	In case of epidemic, info to public and response	Department of health Service/Epidemic & Disease Control Division
	Instruction and coordination for epidemic of livestock	Department of livestock
	Information flow about atomic, bio and chemical hazards and rescue the affected people	Ministry of Science, Technology and Environment
	Coordination for possible national international assistance	NDRC
	Operationalize the NEOC for cooperation center for disaster response	NEOC
	Deployment of search and rescue teams	NEOC and security forces
	Provide first aid service to the injured on the spot	NRCS/hospitals
	Ambulance service, emergency first aid & immediate transportation of injured	MoHP
	Transportation and treatment of severely injured people immediately	MoHA and hospitals
	Fire control	Municipalities & fire brigades
	Emergency declaration (defining basis and process) based on recommendation of NDRC	Cabinet
	Carrying out initial rapid assessment	NEOC
	Activate UN cluster system	UN humanitarian coordinator
	Appeal for national and international assistance	Cabinet
	Assigning National, Regional, district level operation centers for information management focal point	NEOC/REOC/DEOC
	Airport safety and Civil Aviation Traffic management	Civil Aviation Authority

FIGURE 3 NATIONAL DISASTER RESPONSE FRAMEWORK OF THE FIRST 48 HOURS PART 1 OF 2

		Nepal
0-24hrs	Road maintenance for minimum service	Department of road
	Crowd management for open spaces and guide affected people to nearest camp site	Search and rescue teams/ security forces
	Handover of dead body of tourist, diplomats & foreigners and communicate to other affected areas	MoFA
24-48hrs	Transportation arrangement for search, rescue and relief items	Department of Transportation Management
	Provide and insure food items for affected and IDPs	MoCS
	Registration and facilitation for International Relief items providers, transporters and international humanitarian workers	MoFA/Department of Immigration
	Arrangement for visa fee and custom exemption for international humanitarian assistance community at entry point, coming by air or road.	Department of Custom/Immigration
	Coordination for easy implementation of acquisition and transportation of relief items	NEOC/DEOC
	Electricity supply to the basic services such as hospitals, health centers, IDP camps, and schools	Nepal Electricity Authority
	Establishment of temporary hospitals at affected areas	Division of diseases control
	Water supply, hygiene and health promotion to the hospitals, health centers, IDP camps, schools and settlement areas.	Department of Water Supply and Sewerage
	Management of biological, solid waste and debris management	Garbage Management Center
	Protect and maintain law and orders at warehouses, IDP camps, personal residences, humanitarian service providers and assets	MoHA
	Registration of affected families, provide ID card and maintain records Manage emergency communication system and repair the regular communication system earliest possible.	DAO/DEOC MoIC
48-72hrs	Detail assessment of infrastructure and services such as hospitals, schools, health care providers, road, bridge	MoHA
	Debris management	Municipalities/VDC
	Collection and management of dead body of livestock	Municipalities/VDC
	Carry out search and rescue, provide food and nonfood items and approved relief money to meet immediate need	DAO/DDRC
72hrs-7days	Dead body management according DBM Guidelines, provide economic support and issues death certificate	DDRC
	Special attention towards possible gender based violence at different places such as affected areas, IDP camps, relief distribution sites, during search and rescue. Arrange special protection for the elderly, children and disables	MoWCSW
	Initiate multi-sector initial rapid assessment	UN humanitarian coordinator
	Distribution of utensils, fuel, clothes, blanket, health hygiene kit for family, women and children	NRCS

FIGURE 4 NATIONAL DISASTER RESPONSE FRAMEWORK OF THE FIRST 48 HOURS PART 2 OF 2

To be noted, it is mentioned in the NDRF that (i) transportation and treatment of severely injured people immediately by MoHA and hospitals; (ii) carrying out initial rapid assessment by NEOC; (iii) road maintenance for minimum service by Department of road and (iv) transportation arrangement for search, rescue and relief by Department of Transportation.

2.2 Case Study: Barpak village, Gorkha District

Barpak village is located in the northern part of the Gorkha district of Nepal. This village is about 1900 meters above sea level. It is epicenter and lodged on a steep hillside. On April, 2015, a M8 earthquake hit Gorkha area, which also seriously hit Barpak village. 16 houses out of 1400 remained only in Barpak. Study shows that an NGO was able to provide some electricity to Barpak after two weeks post-earthquake. During the blackout, men, women and children must carry solar panels up the steep paths of the Himalayan mountains to power a generator, which in turn charged cell phones and allow them to communicate with outside world. In terms of communication, we found out that many village people have never used social media, like facebook, twitter, due to the illiteracy or lack of access. However, most of them owned the basic cell phones. Majority of village people listen to the radio on their mobile phones, which were safe in their pockets during the earthquake, while TV, PC and radios were damaged. Earthquake had also damaged most of the roads. Village people must walk or drive motorbike to travel.

FIGURE 5 MAP OF GORKHA PROVINCE WHERE BARPAK IS LOCATED

2.3 ICT service

2.3.1 Background Information on ICT in Nepal during emergency

In Nepal, international Connectivity is considered 'weak' and its fixed and mobile infrastructure 'limited'.

The NETP (National emergency Telecommunication Plan) provides a detailed description of the Nepali emergency communications and disaster management:

1. Governance and Leadership

The Ministry of Home Affairs (MoHA) and the Ministry of Information and Communication Technology (MoICT) are working together to contribute to improving emergency communications in Nepal. They developed NETP which adopts some of the Nepal Emergency Telecommunication Continuity Management System (NETCOMS).

2. Operational Coordination

MoHA coordinates the SAR and Relief operations in Nepal. The National Emergency Operation Center (NEOC) supports MoHA with the laborious work of collecting, processing, and presenting the ground information. The Chief District Officer, appointed by the MoHA, leads the District Emergency Operation Center (DEOC). Through the DOEC the MoHA administers SAR and relief operations. Other response organizations such as police, military, and NGOs are debriefed at the DEOC.

Issue1: At present NEOC does not provides information systems to support crisis response and management.

Issue2: The DEOCs do not have access to an incident management system to coordinate the information with relevant emergency services and to communicate with the MoHA. It is all manually processed on paper and communicated via phone or FAX.

3. Plans and Procedures

The Nepal Five Year Plan is setting the action plans for utilizing the Rural Telecommunications Development Fund (RTDF), namely the Universal Service Fund (USF). This will allow Nepal to extend the fiber networks and connectivity in rural areas. Emergency Services will also benefit from this expansion. The initial intention of the RTDF project is that of sharing the network with health, education, and e-Government services. One objective of the design is to develop broadband services in the fourteen most earthquake affected districts. The GoNP has established a "telecommunications cluster", which could potentially serve as Nepal's Emergency Communications Charter.

2.3.2 Impact of Nepal's 2015 Earthquake on ICT sector

After the earthquake, The National and International telecommunications community responded to the earthquake to restore emergency communications. There were several projects that were hosted to crowdsourced disaster information and exchange information using new media.

Below those initiatives that made an impact are listed below:

1. Police Social Media: Nepal police introduced twitter account (@ nepalpolicepq) had been helpful to keep citizens informed. One instance, in Dolakha, citizens used Facebook to report a landslide and request for SAR. Nepal Police exercised an framework that involved interactions between police crisis communication practices, institutional elements, and convergence

2. QuakeMap: QuakeMap was used as one of the key information sources in Nepal's earthquake response and relief work. They set up a SMS hotline to receive reports as well as to notify various groups of each other's response efforts. Approximately ten percent of the records were received through SMS but most of it was through the data communication channels, including social media and an online form.

3. OpenStreetMapKLL: was instrumental to developing several useful OpenStreetMaps (OSMs) to assist the humanitarian response. Some OSM work was carried out a couple of years prior to the earthquake. However, there were no maps for the 14 affected districts at the time of the earthquake. Organizations, the Military, and Government were some of the avid users of the KLL generated maps.

4. Humanity Road:Humanity Road's overall disaster response activities for Nepal spanned 49 days. The organization activated its disaster desk on April 25th and stood down on June 12th. Humanity Road helped to collect, verify, and process reports coming to the QuakeMap repository.

5. Micromappers:Micromappers provides a platform for Digital Humanitarians, termed as Digital Jedis, to support disaster responders with a simple click.

6. Mass Displacement of People:Outputs from the WorldPop project mapping team rapidly produced updates of static population density maps with a resolution of 100x100 m, including gender and age distribution for Nepal. This data were used by the UN Organization for the Coordination of Humanitarian Affairs (OCHA) and other key relief agencies to estimate the number of people affected and the needs which had to be met.

7. Disaster Management Software:Members from the Indian IT community approached Sahana Software Foundation (SSF) requesting to assist them with configuring the Sahana software for supporting the Nepal earthquake relief operations. United Nations Development Program (UNDP) and IBM had also hosted instances of the Sahana Software13.

8. Story Cycle Story:Cycle15, similar to MySpace, is a social media platform for humanitarian communities of practice to collaborate. The intent of the developers was to offer a the communities to build their own cyber presence, predominantly with a functionality built in to support the recovery phase and rebuilding.

9. Emergency Communications Cluster During the earthquake the International ETC, MoICT, MOHA, Ministry of Defense (MoD), and the WFP established the Nepal ETC16. Many other Organizations, immediately, joined the group. This working group was most useful in coordinating the restoration of telecommunications and providing a satisfactory service in support of the humanitarian response. The International ETC setup VSATs and communications hubs (or Kiosks) to support the humanitarian operations. Their services include providing Internet, ICT help desks, radio programming, and training. While some services were accessible to the public, ETC objectives were to provide communications to the humanitarian response organizations. International ETC decommissioned its operations in October of 2015. However, some of the founding members of Nepal ETC are now part of a working group that is assisting NTA to revise the NETP.

10. Radio Broadcasters FM Radio broadcaster comprise Nepal Radio (the National Radio) and the 500+ Community Radio Stations covering the country. These radio stations serve as the only mean of education for some remote communities.

3. Purpose Solution

We can see that during earthquake, Nepal people relied on radio to receive information via radio receiver or their mobile phone which has the radio function. What's more, Nepali people have to travel on foot or on small vehicle due to bad road condition, to find ways to charge their phones to communicate. To these problems we propose two solution.

3.1 Radio

We found out that radio signals reach every possible corner of any geography, ensuring successful objectives of communicating. In 1995, the Frequency Modulation [FM] technology was introduced in this country. After years of development, there are about 85 registered FM stations in Nepal. According to Nepal Telecommunications Authority, mobile phone ownership was widespread and around 96% of people lived within the coverage area of mobile tower. The internet penetration is reportedly at about 44% nationally.

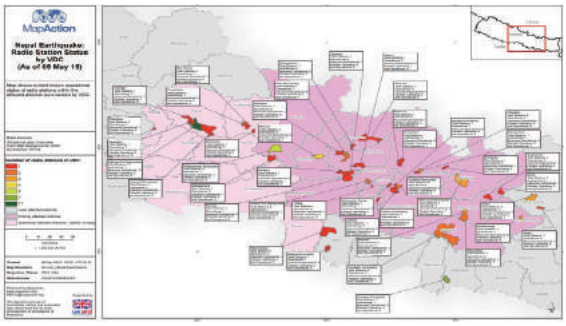

FIGURE 6 THE CURRENT SITUATION OF NEPAL RADIO NETWORK, INFRASTRUCTURE

Therefore, we proposed to distribute emergency information by radio. The distributed information contains notes of how to stay safe. After earthquake happened, the Nepal radio in kathmandu will be used as the main transmitter, and other radio channel will be transformed into repeater tower of the main radio during the first hours of the earth quake. What's more, the main radio transmit important information for 15 minutes every 2 hours. In additions, set new extension towers in rural areas.

3.2 Motor-tricycles and Drones

3.2.1 Introduction

We also considered to provide a information hub for Nepali people to use during earthquake. TOYOTA company proposed that to use vehicles as information hub/physical shelter/electric power source for SAR. In their proposal, vehicles will be equipped with gas fuel, electric generator and electric battery for power source purposes, and it will carry WiFi router, white space for TV signal, 3G/4G base station for mobile phone signals. The cost of such vehicles are not expensive, compared to building infrastructure. The infrastructure including cellular operations, might get disrupted either locally or in very wide areas due to a myriad of reasons ranging from base station power outages to equipment failures, from collapsed antennas to operator level call prioritization policies. Moreover, WiFi hotspot and access point connectivity might be lost due to similar causes. This, in turn, instantly renders expensive and multifunctional gadgets such as smart phones, tablets, personal computers and countless other communication devices useless. However, using vehicles as information hub was not practical in our consideration. However, in the case of Nepal, roads were reported damaged during the earthquake. Citizens had to walk on foot, or use motorbike if possible, to go to save place.

In this case, we need a vehicles with agility that can travel on a narrow road, but also can carry certain amount of generator, base station for mobile phone and internet machine. Therefore, we propose a motor-tricycle. it can carry some of the equipments, while having the agility to move around. Also we can use Drone. such technology exist in China already. We think motor-tricycle has a few merits compared to vehicles: (i) it is cheap, a brand new motor-tricycle only cost 800 USD; (ii) it has medium capacity and medium durability, so it can carry some of the equipments such as base station and Wi-Fi router for people; (iii) it is mobile even with bad road condition. Drones are helpful despite its expensive price. We found out that there are some commercial drones in the market that integrated with cellular signal base station and Wi-Fi router already. What's more, drones can travel around regardless of road condition.

3.2.2 Timing and Protocol

Therefore, we propose to use motor-tricycle and drones. When should the motor-tricycle be distributed? First, we think it can be used as mobile radio station, to broadcast emergency information from the government. Secondly, according to Telecommunication Technology Center (TTC) JAPAN the time period from 24hrs to 48hrs is crucial. Yet the number of people rescued decreased due to limited info collected to command center, which means command center should be determined

during this time period. As we all know, details of disaster are important to command center.

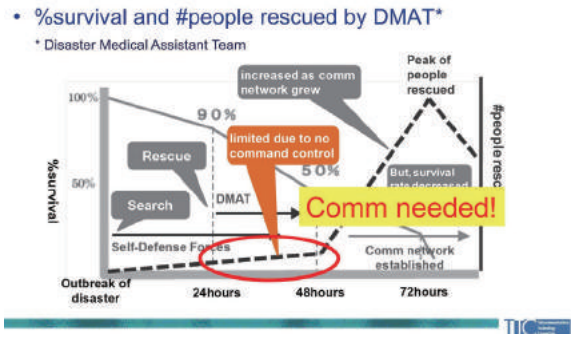

FIGURE 7 PERCENTAGE OF SURVIVAL AND NUMBER OF PEOPLE RESCUED BY DMAT

Therefore, the protocol of distributing motor-tricycle is as follows:

(i) 07 hours after earthquake, motor-tricycle with radio receiver and speaker will be distributed from each communities in Nepal. Its goal is to broadcast emergency information, and collect information of earthquake damage, such as road condition and infrastructure collapse.

(ii) 724 hours after earthquake, motor-tricycle will upload the collected information to command center (set by government). So the command center can have the first hand information about disaster damage, and create the assessment and rescue plan.

(iii) 2448 hours after earthquake, motor-tricycle will carry electric generator and drones to disaster center, or roadblock area according to the command center plan. Its goal is to provide information communication hub for the people without communication access. Drones will be sent out for surveillance.

3.2.3 Cost and Replenish

We estimate each motor-tricycle unit cost 1150 USD, which contains motor-tricycle

800 USD, Wi-Fi router 50 USD, cellular signal base station 100 USD, electric generator 200 USD. Drone cost around 5000 USD. Each community in Nepal will have one unit. There are 3157 communities. In total this plan will cost around 20 million USD. We can acquire funds from UN and private sectors.

The investment can be replenished. In nonemergency time, Nepal can provide service to mountain climber. Provide surveillance and wifi/ cellular service by drones.

4. A Simulation of Post Earthquake

Figure 8 shows the information flow of these two new methods activated.

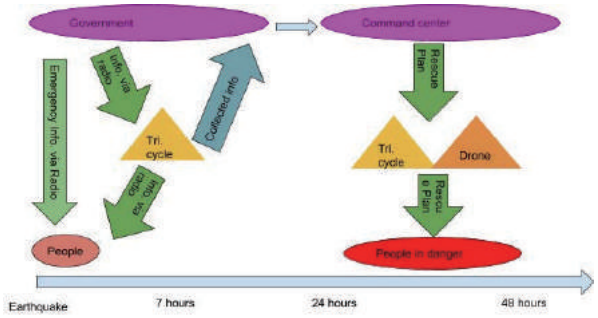

FIGURE 8 INFORMATION FLOW IN THE FIRST 48 HOURS OF EARTHQUAKE

Let's simulate a post earthquake scenario:

Earthquake happened, NDRF become active, at the same time

(i) 02 hours radio will broadcast emergency information to teach people how to be safe. Motor-tricycle in each community will be distributed with radio receiver and speak to broadcast the same information.

(ii) 27 hours while the motor-tricycle is distributing emergency information, it will also collect information, such as road condition and infrastructure collapse.

(iii)724 hours the collected information will be uploaded to government. Nepal government will create a command center, and base on the collected information, the command center will have a rapid assessment of disaster. A search and rescue plan will be constructed.

(iv)2448 hours motor-tricycle will be distributed again, but this time its target is disaster center, or road-blocked area. Drones with cellular base station, Wi-Fi router will fly to midair in these area, providing communication access for people in-need.

5. Conclusion

In this study, we have one case study about Barpak village in Nepal during the 2015 Nepal earthquake. We found that radio is the main information collecting method for village people, and roads were damaged during the earthquake. Barpak people have to travel on foot to find safe place with power source so they can have access to radio. Therefore we proposed two methods to improve this situation. First method is to broadcast emergency information in the first 2 hours of earthquake. The information include teaching people how to stay safe. Other than this oneway communication method, we also proposed a second method, which is creating information hub. This information hub is in the form of motor-tricycle and drone. A protocol is created based on these two new methods, and it should be carried out at the same time as the NDRF.

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Improving Post-Earthquake People-SAR Communication Strategies during the first 48 hours Case Study of Barpak Village, Nepal

Elham Hosnieh

1. Introduction

Nepal is one of the most seismically active regions of the world; it has a long record of earthquakes. The 2015 earthquake in Nepal killed over 8000 people, injured more than 21,000 and displaced a further 2 million (Hall, 2015). This major earthquake of 7.6 ML with the epicentre in Gorkha District caused devastation in Nepal. Thousands of people died, injured, and a large number of buildings was either completely destroyed or severely damaged. The 2015 Gorkha earthquake caused considerable damage to the infrastructure sector of Nepal. A significant number of information and communications systems, transportation networks, roads,…were destroyed or damaged (Parajuli, 2016).

Telecommunications on the other hand, are the backbone of search and rescue operations. Both infrastructural-wise and management-wise, Nepal showed serious shortcomings in handling the first 28 hours of emergency response. Therefore, the purpose of this paper is to propose solutions to improve post-earthquake one way and two ways communications in rural areas of Nepal.

Section 2 provides some background information on earthquakes with the focus on Barpak village in Nepal. Thereafter, Section 3 examines our recommendation to facilitate communication and their implementation costs.

Date	Time	Place	Longitude	Deaths	Magnitude	Sources
1255, 7 June		Kathmandu	85.3	2200	7.8	2
1260		Sagarmatha	86.8	100	7.1	3
1344		Mechi	87.5	100	7.9	3
1408 August		Near Nepal-Tibet Border, Bagmati zone	86.0	2500	8.2	3
6/6/1505		Near Saldang, Karnali zone	83.0	6000	8.7	3
1681 January		Northern Kosi zone	87.1	4500	8.0	3
1767 July		Northern Bagmati zone	85.5	4000	7.9	3
26/8/1833		Kathmandu/Bihar	85.5	6500	8.0	4
7/7						
/1869		Kathmandu	85.3	750	6.5	5
28/8/1916	06:39	Nepal/Tibet	81.0	3500	7.7	6
15/1/1934	08:43	Nepal/India/Tibet	86.762	8519	8.0	7
27/6/1966	10:41	Nepal/India border	80.854	80	6.3	8
29/7/1980	14:58	Nepal/Pithoragarh	81.092	200	6.5	9
20/8/1988	23:09	Kathmandu/Bihar	86.616	1091	6.6	10
18/9/2011	18:29	Sikkim, India	88.62	111	6.9	11
24/4/2015	11:56:26	Kathmandu/India/Tibet	84.708	8,922	8,922	12, 13

earthquakes in Nepal. Source: https://earthquake.usgs.gov/

2. Research Background

2.1. Background Information on ICT in Nepal during emergency

In Nepal, international Connectivity is considered 'weak' and its fixed and mobile infrastructure 'limited'. The NETP (National emergency Telecommunication Plan) provides a detailed description of the Nepali emergency communications and disaster management:

• Governance and Leadership

The Ministry of Home Affairs (MoHA) and the Ministry of Information and Communication Technology (MoICT) are working together to contribute to improving emergency communications in Nepal. They developed NETP which adopts some of the Nepal Emergency Telecommunication Continuity Management System (NETCOMS).

•Operational Coordination

MoHA coordinates the SAR and Relief operations in Nepal. The National Emergency Operation Center (NEOC) supports MoHA with the laborious work of collecting, processing, and presenting the ground information. The Chief District Officer, appointed by the MoHA, leads the District Emergency Operation Center (DEOC). Through the DOEC the MoHA administers SAR and relief operations.

Other response organizations such as police, military, and NGOs are debriefed at the DEOC. (Waidyanatha, 2015).

Issue1: At present NEOC does not provides information systems to support crisis response and management.

Issue2: The DEOCs do not have access to an incident management system to coordinate the information with relevant emergency services and to communicate with the MoHA. It is all manually processed on paper and communicated via phone or FAX.

2.2. Impact of Nepal`s 2015 Earthquake on ICT sector

After the earthquake, The National and International telecommunications community responded to the earthquake to restore emergency communications. There were several projects that were hosted to crowd-source disaster information and exchange information using new media.

Below few of the initiatives that made an impact, are listed (Waidyanatha, 2015)

1. Police Social Media: Nepal police introduced twitter account (@ nepalpolicepq) had been helpful to keep citizens informed. One instance, in Dolakha, citizens used Facebook to report a landslide and request for SAR. Nepal Police exercised an framework that involved interactions between police crisis communication practices, institutional elements, and convergence

2. QuakeMap: QuakeMap was used as one of the key information sources in Nepal's earthquake response and relief work. They set up a SMS hot-line to receive reports as well as to notify various groups of each other's response efforts.

3. OpenStreetMapKLL: was instrumental to developing several useful OpenStreetMaps (OSMs) to assist the humanitarian response. Some OSM work was carried out a couple of years prior to the earthquake. However, there were no maps for the 14 affected districts at the time of the earthquake. Organizations, the Military, and Government were some of the avid users of the KLL generated maps.

4. Humanity Road: Humanity Road's overall disaster response activities for Nepal spanned 49 days. The organization activated its disaster desk on April 25th and stood down on June 12th. Humanity Road helped to collect, verify, and process reports coming to the QuakeMap repository.

5. Micromappers: Micromappers provides a platform for Digital Humanitarians, termed as Digital Jedis, to support disaster responders with a simple click.

6. Mass Displacement of People: Outputs from the WorldPop project mapping team rapidly produced updates of static population density maps with a resolution of 100x100 m, including gender and age distribution for Nepal. This data were used by the UN Organization for the Coordination of Humanitarian Affairs (OCHA) and other key relief agencies to estimate the number of people affected and the needs which had to be met.

7. Disaster Management Software: Members from the Indian IT community approached Sahana Software Foundation (SSF) requesting to assist them with configuring the Sahana software for supporting the Nepal earthquake relief operations. United Nations Development Program (UNDP) and IBM had also hosted instances of the Sahana Software13.

8. Story Cycle Story: Cycle15, similar to MySpace, is a social media platform for humanitarian communities of practice to collaborate. The intent of the developers was to offer a the communities to build their own cyber presence, predominantly with a functionality built in to support the recovery phase and rebuilding.

9. Emergency Communications Cluster During the earthquake the International ETC, MoICT, MOHA, Ministry of Defense (MoD), and the WFP established the Nepal ETC16. Many other Organizations, immediately, joined the group. This working group was most useful in coordinating the restoration of telecommunications and providing a satisfactory service in support of the humanitarian response.

10. Radio Broadcasters FM Radio broadcaster comprise Nepal Radio (the National Radio) and the 500+ Community Radio Stations covering the country. These radio stations serve as the only mean of education for

some remote communities.

(Summary of the point s made in Waidyanatha, 2015)

2.3. Major Communication-based Shortcomings

Here are three main shortcomings to ICT-based emergency communication plans in Nepal. Firstly, RadioBroadcasters FM Radio Station has been the ONLY source of Information provided for remote communities, and secondly, necessary measures hasn't been taken to collect reliable information from those communities within the first 48 hours after the earthquake to facilitate SAR operations and broadcast customized information through local radio channels based on their needs. Moreover, some challenges occurred using the Radio channels during the earthquake which need to be addressed: FM Radio broadcaster comprise Nepal Radio (the National Radio) and the 500+ Community Radio Stations covering the country. These radio stations serve as the only mean of education for some remote communities. Radio stations were important in disseminating SAR and relief/rehabilitation specific information to the earthquake affected communities. Community Radio, including Radio Sindu, which the research team visited, **did not have** any BC-DRP with necessary SOP to react to emergencies. *None of it is formal, planned, and rehearsed. There is a need for a National Community Radio Policy. Also a need for the allocation of a Community Radio Emergency Band (frequency) that all stations can harmonize on.* (Waidyanatha, 2016). Therefore, We aim to propose solutions to improve post-earthquake one way and two ways communications in rural areas of Nepal. For doing so, we have chosen Barpak village as a case study. To be more specific, we aim to firstly, facilitate information dissemination to rural remote areas through Radio and secondly, enhance communication between villagers and Search and Rescue groups. We have chosen Radio and Mobile communication because they are two mediums that the most people, even in rural areas of Nepal have access to.

2.4. Background of our Case-Study : Barpak Village

As explained in the last section, the focus of response protocols was largely limited to the urban (high-population) areas. Detailed plans for rural settings were not specifically addressed even though the recent earthquake affected non-urban districts.

We have focused on the post-earthquake one-way and two-ways communication in farflung villages with our case-study being a rural village closest to the epicenter of the earthquake named "Barpak".

3. Our Proposed Solutions

We aim to propose solutions to improve post-earthquake one way and two ways communications in rural areas of Nepal. For doing so, we have chosen Barpak village as a case study. To be more specific, we aim to firstly, facilitate information dissemination to rural remote areas through Radio and secondly, enhance communication between villagers and Search and Rescue groups. We have chosen Radio and Mobile communication because they are two mediums that the most people, even in rural areas of Nepal have access to. Our original contribution is to propose using a combination of them considering the situation of our site.

Main objectives are listed below:

- To improve the guidance system for people and international organization during the first 48 hours after the earthquake.
- To facilitate people to SAR groups and SAR to people communications.
- To facilitate "customized" Information dissemination to rural remote areas through National and Local Radio Channels.

Our plan is decided into three parts:

A. Distribution of safety information at the first 2 hours after the earthquake:

This information speaks about how they can check if something damaged, how to check themselves and then how to help the others to be safety and will be distributed by using Radio. Radio Broadcasting has been proved to be the cheapest and the quickest means of mass communication in Nepal. Hills and mountains cover about 87 percent of the country's area. And only 17 remains as flatlands. This geographical formation and fluctuating altitudes bring barriers to other communication methods. Radio signals reach every possible corner of any geography, ensuring successful objectives of communicating. In 1995, the Frequency Modulation [FM] Technology was introduced in the country, and Nepal Radio station did not remain the only one, anymore. Today, there are about 85 registered FM stations around the zone of the last earthquake; about 71 of them were still in operational mode while the others are not operated during the earthquake. This huge number of the radio channels can be easily controlled to be used like a one way communication to guide people in Nepal during the first 48 hours of the earthquake. This is one of the proposed of using the various radio stations as extension towers for the central Radio station in the Kathmandu capital may help to unify guidance and facilitate the process of guiding people to safe areas and safety of earthquake.

B. Collect information during the period 2 hours to 24 hours after the earthquake.

B-1: Overview of the solution

We will focus on two kinds of information to be collected the first one about what is the areas and building were damaged by the earthquake, and about the injured and killed people in these areas. This information will be collected by using the motor-tricycle, few pieces of equipment will be put on the vehicles. They are Wi-Fi router, cellular signal base station, radio emitter and receiver. This information should be analyzed and checked by using another type of collecting information which will be using Helicopters. Distribution guidance information to people after collecting information about the damaged area such as what is the dangerous area which people should not return back to them, what is the most safety area, what is the nearest national or international help centers or camps.

B-2: Authority in charge

Regarding the authority in charge of these operations, we realized that In many reports related to 2015 Gorkha earthquake, a great emphasis has been put on the huge role that "community level responses" have played during the Gurkha earthquake. The question is: how can we mobilize the community level actors and give them some authorities to act. In order to response to that, our strategy is to rely on the capacity of **informal authorities (e.g. the head of a local community or a village)** in a close collaboration with the **local official government**, especially when it comes to post-disaster challenges such as :

- collecting fast and reliable information from the villagers
- Prioritizing the villages when central government and international NGOs are concerned with big cities or simply do not have easy access to these villages
- Providing the villagers with specific information on their village or their problem through local radio channels based on collected information

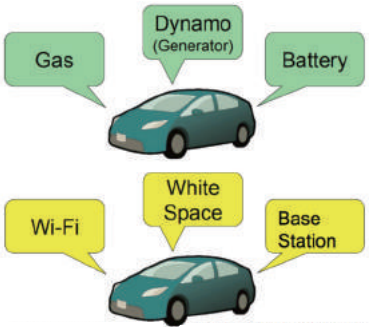
For example, below is a probable scenario:

For collecting the Information from the villagers in far-flung areas like Barpak, we need to have some resilient buildings to keep those equipped tricycles inside. This building should be considered as a main hub close to several villages. The local government manages these facilities but the actual work of driving these tricycle to the villages, collecting the information, and help them to restore their communication devices, should be done by trained and trusted people from the local communities working under the supervision of the community leaders and the local government. These information can later be used to prepare the necessary guidelines for the villagers.

B-3: Technological explanations:

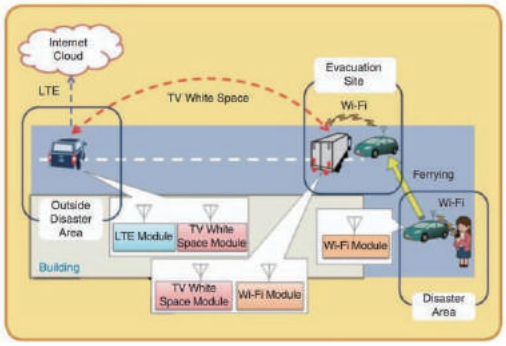
We proposed that to use vehicles as information/communication hub during the disasters. Vehicles are multi-function, not only does it provide transportation, also it can be a physical shelter, electric power source, and radio communication.

In the case of vehicles in japan, these communication hubs have gas for fuel, electric generator, electric battery, Wi-Fi emitter, base station for mobile phone signal and White space antenna for tv. the cost of such vehicles are not expensive, compared to building infrastructure. The infrastructure including cellular operations, might get disrupted either locally or in very wide areas due to a myriad of reasons ranging from base station power outages to equipment failures, from collapsed antennas to operator level call prioritization policies. Moreover, Wi-Fi hotspot and access point connectivity might be lost due to similar causes. This, in turn, instantly renders expensive and multi-functional gadgets such as smart phones, tablets, personal computers and countless other communication devices useless.



https://www.itu.int/en/ITU-T/extcoop/cits/Documents/Workshop-201607-Tokyo/PPT/S3P3_VHUB_TTC.pdf

The usage of such vehicles is easy: deploy the vehicles to disaster area. People in need can acquire aids (electricity, interne) from it. at the same time the car can collect information of the disaster area. After a certain time, return to the evacuation site, upload information of damaged area to emergency response.

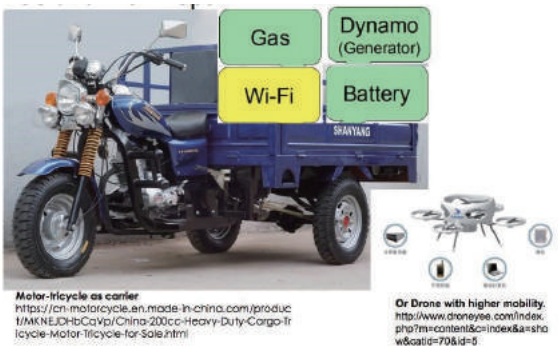


https://ieeexplore.ieee.org/stamp.jsptp=&amumber=6717123

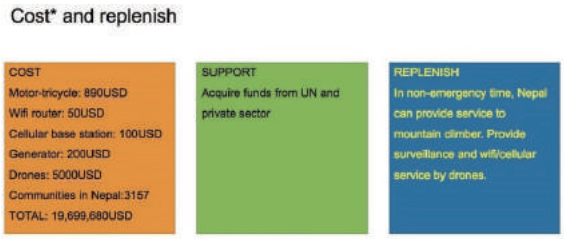
In the case of Barpak Village in Nepal, roads were reported damaged during the earthquake. citizens had to walk on foot for hours, or use motorbikes in order to disseminate information or carry necessary items back to the village. According to the current National Disaster Response Framework, in the first 24 hrs, transportation is important for disaster relief. The initial road inspecting and severely injured people transporting should be carried out immediately.

Another important is the rescue time. According to Telecommunication Technology Center (TTC) JAPAN the time period from 24hrs to 48hrs is crucial. Yet the number of people rescued decreased due to limited info collected to command center.

Based on all the given information above, we need a vehicles with agility that can travel on a narrow road, but also can carry certain amount of generator, base station for mobile phone and internet machine. Therefore, we propose a motor-tricycle. it can carry some of the equipments, while having the agility to move around. Also we can use Drone. such technology exist in China already.



B-4: Implementation and Cost



price from https://www.made-in-china.com/
https://en.wikipedia.org/wiki/Village_development_committee_(Nepal)

We decide to give one information hub to each community in Nepal. In the following, you can see a demonstration of calculated cost for the use of Motor-tricycles, routers, base stations, generators, drones for each rural community in Nepal.

Other than that, Radio Broadcasting has been proved to be the cheapest and the quickest means of mass communication in Nepal. Hills and mountains cover about 87 percent of the country's area. And only 17 remains as flatlands. Therefore, due to the existing infrastructure and their relative resistance, the cost of choosing radio channels as our main tool for information dissemination can be justified.

B-5 : Summary of the points mentioned above:

- Collect information during the period 2 hours to 24 hours after the earthquake.
- We will focus on 2 kinds of information to be collected the first one about what is the areas and building were damaged by the earthquake, and about the injured and killed people in these areas.
- This information will be collected by using the motor-tricycle, few pieces of equipment will be put on the vehicles. They are Wi-Fi router, cellular signal base station, radio emitter and receiver.
- This information should be analyzed and checked by using another type of collecting information which will be using Helicopters.
- Distribution guidance information to people after collecting information about the damaged area such as what is the dangerous area which people should not return back to them, what is the most safety area, what is the nearest national or international help centers or camps.

4. Conclusion

In the conclusion, we propose solutions to improve post-earthquake one way and two ways communications in rural areas of Nepal. In the first 2 hours of earthquake, information about "how to be safe" will be broadcasted via radio, because radio frequency covers almost 90% of Nepal. Information dissemination via mobile will also be considered because 95% of Nepali possess cell-phone. Motor-tricycle will be distributed in the first 7 hours of earthquake to collect information about road damage and severity of damage in each area in Nepal. Information will be uploaded to commend center for initial assessment. Motor-tricycle will be distributed again in the first 24-48 hours, following the assessment plan. Helicopter will be used for surveillance.

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Exploring the Possibility of Autonomous Vehicle Service in Rural Area Preferences of Local Residents: Concerns and Positive Feedback

Mohammed Hajjaj

Abstract

In order to understand the knowledge, preferences and attitudes of local residents in Iinan town for exploring the possibility of autonomous vehicle service in the rural area, methods must be performed to survey and collect data through interactions with all relevant local stakeholders. In the most recent autonomous vehicle service experiment in Iinan town, a very small number of residents were surveyed, leaving space for better and more comprehensive information gathering to be performed in the city of Iinan town, or any other site with autonomous vehicle service testing. A more representative survey will gauge public opinion more accurately.

All references and resources which have been used in the report based on the local government and previous survey which has been conducted in Iinan town, as well the onsite training and filed work to the town.

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Overview

The onsite training program at Iinan town was considered for exploring the possibility of using the autonomous vehicle service in a rural area. Akan area is a part of Iinan town which has a problem of the depopulation and also the increase in elderly people.

Japanese rural areas are facing two big problems: depopulation and aging society. With those problems, it would be difficult for the local government to maintain the local people in the rural in term of transportation, and other basic infrastructures.

Autonomous vehicles (AV) technology has been one of the top topics recently which will be used in Akana area by the government of Japan (Discover Autonomous Driving Potential in Japan, December 2016). Autonomous vehicles technology is one of the mature technologies as well as it one of new paradigms expands the range of modes, objectives, impacts, and options considered in transport planning which can be ready to implement in the real world, but as shown in many news articles, it is not fully reliable yet. Enormous expectations are present towards autonomous vehicles technology in many different places in the world. Many experiments of autonomous vehicles technology in Japan have been conducted by the government including multi models of simulations in a different area.

Autonomous vehicles in rural Akana area might be able to provide a new service which can help the elderly people for trips to the hospitals, shopping, and improved safety, so the local residents are aware of the benefits of autonomous vehicles in terms of safety and are positive towards the future. As well, the local government is looking for using the autonomous vehicles technology to activate the tourism in the town.

Many stakeholders are interested in using autonomous vehicles technology in the town beginning from the national and local government, tourism association, Japan agricultural cooperatives (JA), and local residents. Japan agricultural cooperatives is going to use autonomous vehicles for shipping, and they want to utilize it to improve production of crops by elderly farmers. Tourism association will use the autonomous vehicles technology for activating the tourism in this area, but the local bus companies have clearly expressed the opposition towards the implementation of autonomous vehicles technology in the area by providing drivers within the company which will play a big role in terms of communication among the residents.

The official government of Shimane prefecture, and the local office of Iinan town are afraid to loss the services in the rural communities or being ignored (Fieldwork, 2018). Declining population reduces small businesses while house prices are inflated beyond the reach of young people by the dormitory effect.

Declining population, and activate the rural areas are considered the causes and negative impact on rural areas and highlights best initiatives to recover the community through introducing the new services of using the autonomous vehicles technology to help people and activate the tourism in the rural area.

Background

Iinan or Iinan-cho is a small town in Shimane prefecture, Japan. It is located in the central and southern part of Shimane in close to Hiroshima prefecture (Introduction of Iinan Town, 2018). The town has around 240 square kilometers, and also about 90% is occupied by forests and wilderness.

It is surrounded by Mt. Koto and Mt. Omaki in the area. There is a river originates from another mountain which located in the southern part of the town, flows to the north, as well as there is another one flows to the south part of town. Figure 14 show the geographical map of the town.

Figure 14: Iinan-cho, Shimane-ken, Japan.

Akana area is one of the subdivisions of Iinan town which the autonomous vehicles will be in the service for people in this area.

Census Data of Iinan Town

The total population (Number of households and population of Iinan Town, 2018) of Iinan town is estimated to 4929 residents as of 2018 in 2292 for males and 2648 for females. The number of households is estimated to 2056, and the population density in the town is 20 persons per square kilometers according to the statistic report of the town for 2018, as shown in Figure 15 for the number of households and population in the town:

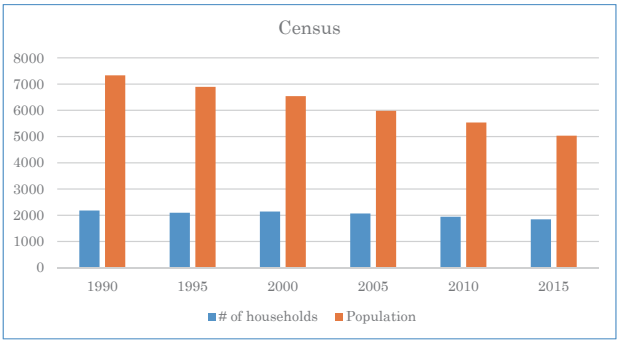

Figure 15: The number of households and population in Iinan town.

Based on the previous figure, the population of Iinan town is going down by year, and the people in the town move out in different situations to business areas as the Iinan town one of the rural areas in Shimane Prefecture. The distribution of age by gender in Iinan town is as shown in Figure 16 below:

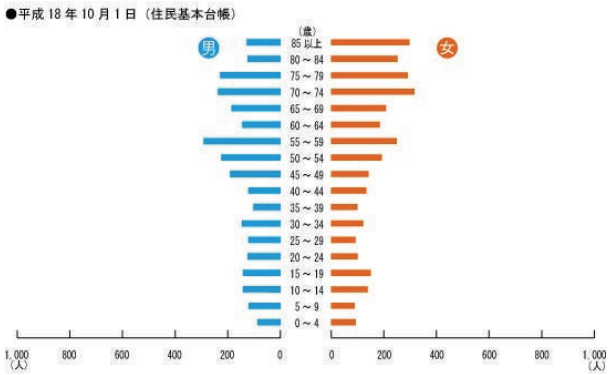

Figure 16: The distribution of age in Iinan town by gender.

The Activities of Iinan Town

Iinan town has a role to play in the sustainable economies of Shimane prefecture (Introduction of Iinan Town, 2018). There are some ways to be sought to empower the rural community to play a part in addressing vital policy areas such as job creation for people who are living in the area in special elderly people, farmers and also the transportation fields.

The domestic and local government of Iinan town are afraid for reducing the services due to the declining population in the town as shown in Figure 15, which affect to the small business in the area. The agriculture sector is the main activity in the town, and there are many farmers export their products and crops to many residents in the prefecture by Japan agricultural cooperatives.

Japan agricultural cooperative is regional cooperatives to support the production, transportation and sales of agricultural products in Japan. It is a voluntary organization as membership of every farmer in Japan. However, it is founded by the central government to have a control over Japanese agricultural industry to improve production of crops by farmers.

Whatever, in the town, there are two private bus companies for the transportation, and they provide the local transportation in the town by using different types of vehicles. The bus companies are supported by local government to continue the service in the town. As well, there is Iinan tourism association which is another organization related to the town officials. The association is working to activate the tourism in the town. Iinan town has been affected by lowering the importance of its main road by opening a new highway which does not trespass the town. There are two national highways which are 54, and 184, and also there is no railroad access to Iinan town.

Roadside stations all over the country are designed by the national government in terms of basic facilities such as parking space and rest areas, however, the roadside stations are playing an important role in tourism which is often connected with other facilities such as restaurants, souvenir shops, but also shopping areas managed by different shops.

People in the town should commit to a sense of community that encourages integrate with each other from within. The elderly people in the town is around the half of the population, and the population is going down due to other factors in the town.

Iinan town needs empowering with greater powers from the local and domestic government and access to financial resources to lead and support residents which could help the town to be more active in life. Therefore, the domestic government is going to introduce the technology of the autonomous vehicle in service for people to be in the town.

The government of Japan has decided to use the technology of autonomous vehicle in the Iinan town, Akana area by the 2020 Olympic and Paralympic Games. The purpose of using the new technology is to provide away to have a car in the road without driver, and to put self-driving taxis into practical use by 2020. However, the main challenge for using this technology is to apply the full insurance system, and to ensure the safety of not only the consumers, but also the safety of other vehicles in the roads and pedestrians.

Autonomous Vehicle Experiments

Many experiments and verifications have been conducted in different areas of Japan using multi models of autonomous vehicle (Demonstration experiment report, 2017). As well (Government-report, 2017), some of business model of using the autonomous vehicle technology are in plan to introduce and conduct with more functions in future as shown in Figure 17 below.

The smart car is equipped with technology and radar on a route that included a roadside rest area and a hospital. The new technology including sensors, and GPS is to identify the routes and traffic signs in the roads, as well as to detect other vehicles in the route.

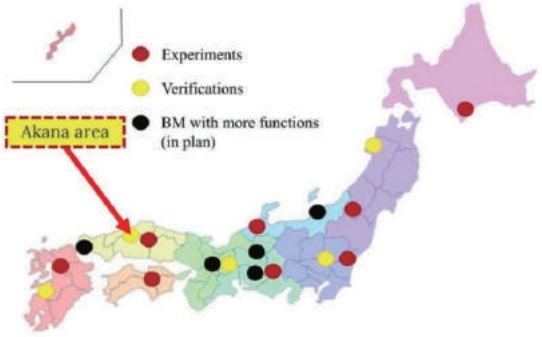

Figure 17: The simulations of autonomous vehicle technology in Japan.

As well, four types (Government-report, 2017) of vehicles are used to conduct the experiments and the verification in Japan including bus, car, and trucks. The Table 2 shows the models of autonomous vehicles technology in Japan.

Table 2: The models of autonomous vehicles technology.

Bus Model	Car Model
1- D Corporation  -Level: 4 -No of Passengers: 6 people. -Speed: 10km/h ~ 40km/h - Include: (1) GPS to identify the routes, and (2) IMU for detecting everything in the route.	3- Yamaha Motor Co., Ltd.  -Level: 4 (private route), 2 (public route) -No of Passengers: 7 people -Speed: 12km/h without driver, up to 20km/h with driver Include: (1) Detecting system for the route and (2) Sensor to detect the traffic signs in the roads.
2- Advanced Mobility Corporation  -Level: 4 (private route), 2 (public route) -No of Passengers: 20 people -Speed: 35km/h ~ 40km/h Include: (1) GPS to identify the routes, (2) sensors to detect the positions for vehicles in the road.	4- Eisan Technology Co., Ltd.  -Level: 4 (private route), 2 (public route) -No of Passengers: 4 people -Speed: 40km/h ~ 50km/h Include: (1) LiDAR technology to detect the vehicles in the road, and (2) 3D map. Note: this model is used for the experiment in Akana area, Iinan town.

There are two models of bus, as well as there are two models of car models. The bus model which has been used in Hokkaido is mini bus, but the model of car from Eisan Technology company which have been used in Akana area in Iinan town. All models are including sensors to detect the vehicles in the road, as well there is camera also and GPS to identify the routes. All models have been used in different level depending in the route, as it is used the level 4 which fully without driver for the private route, and level 2 with driver in the public route (NHK, 2017).

The experiment of autonomous vehicles technology in Akana area as shown in Figure 18 was in two parts, the first part, the autonomous vehicle is used without driver which level 4 is applied in 0.6 km, and the automatic change in driving was based on the road structure and the slope of the rout, as well in this route, there is an agent besides the passenger for emergency response. The second part of the experiment using driver in level 2 with distance 3.9 km in public route, and the road was normal with vehicles, cars, and pedestrians too.

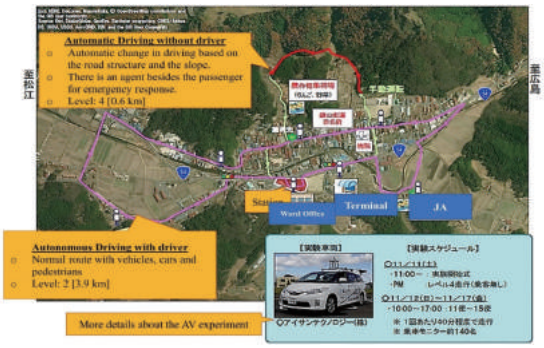

Figure 18: The experiment of autonomous vehicles technology in Akana area, Iinan town.

As shown in Figure 19 below: the route of using the autonomous vehicles technology in Akana area was in private and public route.

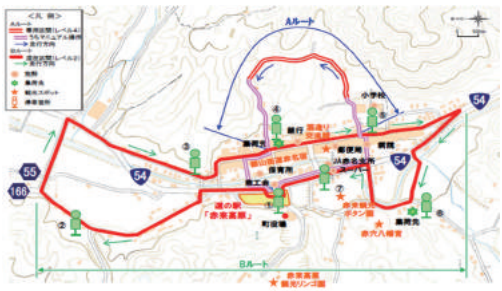

Figure 19: The routes of the experiment for using the autonomous vehicles technology in Akana area.

The goal of the experiment is to using a limited, and defined the track as well to check and verify the using of vehicle in the route. However, the using of autonomous vehicle was also to check the safety in less crashes in the town.

Autonomous Vehicle Analysis

Using the autonomous vehicle technology have many benefits for the people as more safety with fewer crashes (Tomodachi, 2018), and also increased access to the transportation of people without driver's license or live far from existing bus route. However, the using of autonomous vehicle technology will increase the efficiency due to the ability to perform tasks other than driving, and activate or increase the tourism in Iinan town.

In another side, there are some concerns of using the autonomous vehicle technology as the maximum speed of the vehicle will be 30 km per hour which be too slow in comparing with normal vehicles, as well as the sudden stopping or braking of the vehicle, so it can unable to drive in area with zero obstacles.

Therefore, the autonomous vehicle technology is supported by the government using subsidies (NHK, 2017), but it is still in high competition by private companies, as well as the cost of producing the autonomous vehicle is high and depend on the government subsidy. Also, the autonomous will increase the unemployment in the town as it will be used without drivers, so the new technology will not support the employment for bus drivers in the town.

Stakeholders Analysis

Within the city of Iinan, multiple groups of people will be affected by the use of autonomous vehicle technology within the city through both private and public services. The stakeholders of Iinan town have been in different fields. One is the domestic national and local government of Shimane prefecture and Iinan town will use the autonomous vehicle technology.

As well the Japan agricultural cooperatives, and the tourism association are expected to use the technology in the town. However, the main stakeholders will use the technology is the local residents in the town, in special elderly people. Whatever, the private bus company might not use the technology and it be one of their concerns to continue the business in the town.

The Current Situation

Japan is likely to be one of the main drivers of development in a rapidly growing autonomous driving market (Discover Autonomous Driving Potential in Japan, December 2016). The market size for self-driving car technologies in Japan is expected to grow rapidly over the coming years. The global market for self-driving car technologies follows the same growth trend as in Japan.

A previous survey (Demonstration experiment report, 2017) was conducted in Iinan town to study the attitude of local people in Iinan town. One of the questions which is asked for people about the satisfaction of the experiments which have been conducted in the town as shown in Figure 20, and it is found that 45% are strongly satisfied with the experiment in Akana area, but there are still 35% are normally satisfied with the experiment, so 80% of people are satisfied with the experiment of autonomous vehicle in the area.

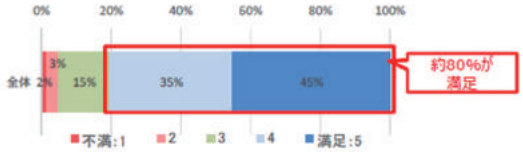

Figure 20: The satisfaction of the experiments in Akana area, Iinan town.

However, the local people were asked also about the satisfaction of bus frequency in the town as shown in Figure 21, and it is found around 30% are strongly satisfied, and 37% are satisfied which around 70% of people are satisfied about the bus frequency in Iinan town.

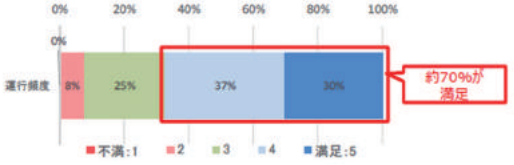

Figure 21: The satisfaction of bus frequency in Akana area, Iinan town

As well, the satisfaction about the bus schedule was in the same values in the town as shown in Figure 22.

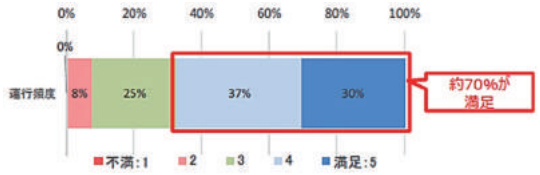

Figure 22: The satisfaction of bus schedule in Akana area, Iinan town

In another side as shown in Figure 23, around 71% of people are feeling with a non-safety for using the autonomous vehicle technology while the percentage of people who feel something strange more than conventional vehicle when stopping at stop sign for using the autonomous vehicle technology are 31%, and 36% in the same as vehicle, but 33% are feeling less that the conventional vehicle as shown in Figure 24.

Figure 23: The percentage of people who feel with the danger in using the autonomous vehicle technology.

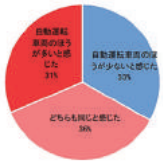

Figure 24: The percentage of people who feel something strange when stopping at stop sign for using the autonomous vehicle technology.

Therefore, the percentage of people who agree of using autonomous vehicle technology is high and it is more than 50% while around 40% of people will use the autonomous vehicle technology when the government introduce the technology in the town as shown in Figure 24 and Figure 25.

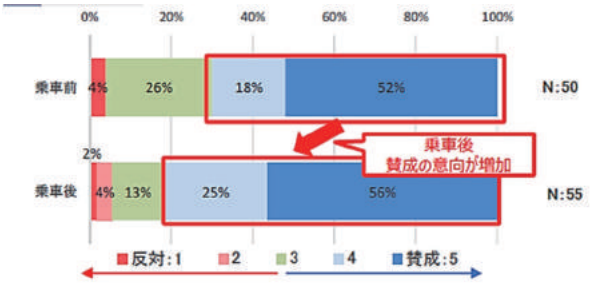

Figure 25: The percentage of people who agree of using autonomous vehicle technology.

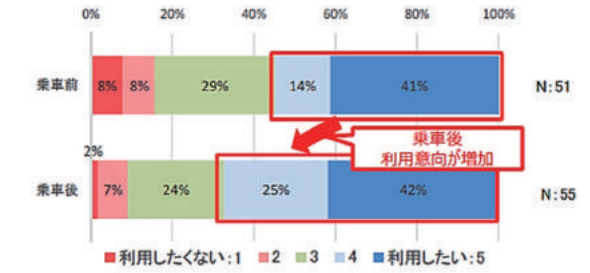

Figure 26: The percentage of people who will use the autonomous vehicle technology.

Preferences of Local Residents

The local residents of Iinan town are aware of the benefits of using the technology of the autonomous vehicle in terms of safety and are positive towards the future (Fieldwork, 2018). The main hopes of people in the town are visits to the hospital, shopping and improved safety.

The new service which will provide by the government for using the technology of autonomous vehicles is important especially for elderly people as the Japanese government has been calling for its residents over that age cap to return voluntarily their driving license as according to various research they are much more likely to be involved in fatal accidents on roads (Fieldwork, 2018). However private car functions as the only way of moving around in a depopulated area such as Iinan town in case there is no public transportation like trains or more private bus company to use it all the time. If local residents give up their driving license their everyday life becomes much more difficult and challenging, however, the risk of car accidents will be demonstrated.

The local residents of Iinan town are considering the using of autonomous vehicle technology in the town. Some concerns from some people but there are positive feedbacks to use the technology in the future for different purposes (Fieldwork, 2018).

The domestic national government (Fieldwork, 2018) is looking forward to increasing the accessibility of using the autonomous vehicle technology and improve the transportation in the town with improving the mobility for non-drivers and for people who don't have a license to drive the car. Therefore, the government is looking to reduce the parking space in the rural area, and use all spaces for urban effectively in the town. As well, reducing the cost of the drivers and create domestic markets are also one of the hops for the government.

The local government is going to make a time saving to provide and get the services in the town with more safety in transport the goods and increase the mobility for all people, so all residents in the town can have the accessibility to move comfortable even if they don't have licenses or private car.

In contrary, the domestic and local government are concerned about using the technology of autonomous vehicle in the town. One concern is to increase the vehicle costs in the town which will affect in the employment issues and social equity in the town.

Japan agricultural cooperative (Fieldwork, 2018) represent a different view on the utilizing the new technology to improve production of crops by farmers. They are going to find a way for reducing the cost of transportation by using the autonomous vehicle technology what in consequence will make the farmers save time as they will not be required to transport their produce every day to the premises of Japan agricultural in Iinan and safety of elderly farmer will be in control.

The Japan agricultural cooperative has clearly expressed the positive views regarding the autonomous vehicle technology which is going to improve the efficiency of the farming activities and the revenue of products. However, the positive views of Japan agricultural as an organization is not truly expressing the voice of farmers or residents of Iinan as it is an official part of the government.

The tourism association of Iinan (Fieldwork, 2018) is another organization related to the town officials and the government. They have an optimistic view of the coming implementation of using the new technology in the town. They are looking for providing the service for all people and residents in the town, as well, they want for all to reach easily for all services in the town.

The association is looking also by using the new technology to activate the tourism in the town which will help to implement more projects and open new services in the town like more restaurants, markets, and more shopping. The diversification of bodies in charge of different sections gives a wide space for creating a unique image to improve its potential in tourism.

The only local bus companies have clearly expressed the opposition towards implementation of autonomous vehicles technology in the area. They are concerned about the employment issue in the town and considered that the drivers play a big role in the community in terms of communication among the residents.

They are only two bus companies (Fieldwork, 2018) and have integrated into different services in the town in schools, hospitals, shipping and also local people. The companies have made a good relationship between the drivers and residents in special elderly people of farmers by sharing the products as a sign of appreciation for providing transport services which cannot be in using the technology of the autonomous vehicle as there is no driver and tie up the sociality between the people.

The residents of Iinan town are going to use the technology of service in special the farmers in increasing the productivity and make more revenue in using transport the product and crops to different destinations.

The positive feedback from the people in the town (Fieldwork, 2018) was not able to have a deeper look at all the significant interest groups among the residents specifically: firefighters, hospital workers, and the police due to the cultural uniqueness present in Japan.

Summary

The people in Iinan town are aware about the autonomous vehicle technology. The awareness could be attributed to the fact that the local town government has taken a lot of initiatives to make local people aware about autonomous vehicle technology, but some farmers seem

excited to use autonomous vehicle to transport the products from the farm to the market which could be a successful testing of autonomous vehicle service in Iinan town.

Iinan is a depopulating city with 44% elderly people and the primary occupation of the town being farming, it poses a challenge to transport the crops. Due to the incapability of driving in special for elderly people, it makes the transportation really inconvenient which explore the possibility of using autonomous vehicle service for transportation needs.

However, there is a previous survey was conducted in Iinan town by the local government to know the interest of local people towards autonomous vehicle service. The survey concluded that the local people seemed really excited during the testing of autonomous vehicle service in Iinan town.

Overall, the survey response rate was approximately in high. Since the survey was answered by such a small number of people and in approximately 55 residents, self-selection bias is a strong factor in the results, making the data questionable. Residents who responded to the survey were likely previously aware of and interested in autonomous vehicle technology, creating strong bias in the results. Additionally, the data represents only about 10 percent of the town's residents.

For a future survey of Iinan town residents, an in-person survey or interview would be preferable to ensure a high response rate. Therefore, a survey conducted door-to-door or when residents shop at the market or visit other town centers would be much more inclusive of town residents. Incentives also could be offered to increase the survey response rate.

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