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THE PLANNING AND ENFORCEMENT OF EVACUATION AND SHELTER SYSTEM FOR DEBRIS FLOW DISASTER IN TAIWAN

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ABSTRACT

As a consequence of invasion by typhoon Herb (7/31/1996), Chichi earthquake (9/21/1999), and typhoon Toraji (7/30/2001), many catastrophic debris flow events caused severe damage to Taiwan. The debris flow disasters include breakage of embankments, collapse of bridges, failure of road foundation, and annihilation of buildings. As there are severe casualties, death and loss of valuable properties and facilities, the disaster mitigation has become a major issue in the current stage. Currently, the most crucial work is to establish a complete evacuation and sheltering system. The planning of the system was performed according to the potential hazardous area of debris flow in Taiwan. Through a systematic field investigation, visiting of local resident, mutual communication, mapping of evacuation shelters and disaster prevention training, the consciousness of crisis and the capability of disaster prevention from the local resident was then provoked and eventually the impact and damage caused by the catastrophic debris flow disaster.

Key Words: evacuation route, disaster mitigation, emergency management.

INTRODUCTION

In order to establish a sound disaster prevention regime and rescue system, and to ensure safety of lives and properties of the people as well as security of the national land, the government promulgated the Disaster Prevention and Response Act on July 19, 2000. Meanwhile, to reduce disaster events and losses of lives and properties, it is necessary to set the prevention and rescue work, countermeasures, community disaster prevention and rescue, evacuation and sheltering into action. Due to the debris flow disasters are unpredictable and also difficult to handle by the acquired knowledge accumulated from the past experiences, it appears that the modern engineering prevention work seems invalid to sustain the impact of disaster events. Currently, the most urgent demand for disaster prevention strategies is to set up a series of bottom-up, from residents to general public, (Residents have to save themselves before others can do.) disaster prevention concepts and disaster sheltering measures (Chen, 2001). In this study, plans for potential hazardous areas of debris flows around the island were made through site surveys and interviews with the local residents so that the general public can be aware of the importance of disaster prevention by themselves. It is also intended to assist the people to provoke a crisis consciousness as well as disaster prevention knowledge such as preparedness of emergency articles at usual times, familiarity with the symptom of

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disasters occurrence, withdraw along the evacuation route for sheltering and searching for assistance during the occurrence of disasters, etc. Through the discussion of disaster prevention and rescue system and the operation mechanism of the remedial regime with the local resident, it becomes possible to enhance the people’s self-protection awareness and the common senses of disaster prevention towards the environment they live in efficiently. According to the concept mentioned above, through the teamwork and mutual cooperation, a series of multi-function disaster prevention and sheltering maps related to the lives and properties of the people can be formulated simply and those maps are also easy to understand and use.

PLANNING PROCEDURES AND PRINCIPLES

Planning Procedures

Important items of planning for a map with evacuation routes and shelters are illustrated in the flow chart as shown in Fig.1. Based on the coadjutant neighborhood units a disaster prevention living circle can be established accordingly (Lee, 1999). The radius of evacuation and emergency promulgation, the space for disaster prevention and sheltering facilities and self-support units will be adjusted in accordance with the population of the neighborhood. Contents of such a disaster prevention map will include potential hazardous area of debris flows, evacuation routes and shelters, disaster promulgation organizations, police stations, fire stations, medical treatment institutes, disaster prevention articles and certain tips, etc., which will map out a “route chart of debris flow emergency evacuation for xxx village, xxx county” to serve as a reference for educating the residents and establishing a real time joint prevention system against regional disasters.

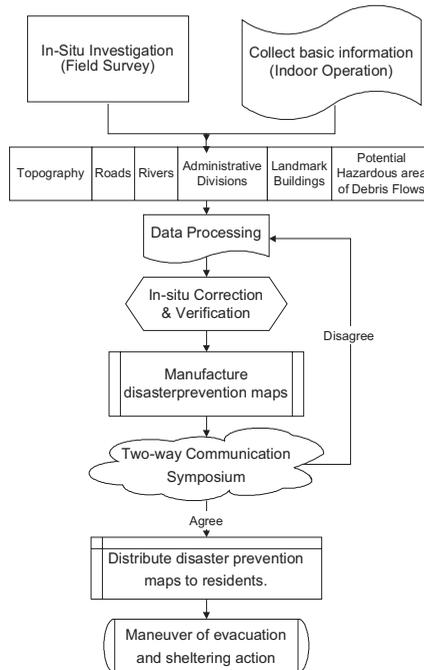


Fig. 1 Flow Chart of Planning Items

Principles of Planning

(1) Evacuation routes

- Do not pass through the potential torrent of debris flows; however, if it is not available, it is necessary to seek another sheltering asylum or to evacuate in advance.
- Use the existing roads as much as possible.
- Do not pass by dangerous road sections or steep slope area.
- Do not walk upward or downward along the debris flow valleys.
- Alternative roads should be considered for evacuation routes.

(2) Sheltering asylum

- The sheltering asylum can be reached within 20 to 30 minutes by walk.
- The space of sheltering asylum should be large enough to accommodate the residents in the vicinity of potential hazardous area for daily living.
- Sheltering asylum should be kept away from the potential hazardous area of slope collapse.
- It is not allowed to have an isolated area where is difficult to reach or contact with.
- It needs a secure passage to connect with outside (e.g. a helicopter apron).

(3) Investigations

- Location description: include geographical locations and disaster records, etc. (Status of damage and destruction suffered from debris flows in each village can be analyzed through newspapers, magazines and related information provided by the government.).
- In-situ investigations: Investigations consist of geology, hydrology, populations, distribution of potential hazardous area of debris flows and relevant prevention engineering measures, etc.
- Planning of evacuation and sheltering: Include lists of the personnel to be secured, organizations to announce (or manage) disaster situations and emergency rescue systems (police, fire stations and medical institutes), disaster prevention and rescue teams in the communities (e.g. teams of neighborhood rescue and neighborhood watch) and the scale of sheltering asylum, etc.
- Popularization through illustrated explanations: Organize informal discussion meetings with the residents face to face to popularize the concept of disaster prevention against debris flows and collect and integrate opinions of the general public.

Results of planning

Currently, route charts of emergency evacuation against debris flows have been finished in 128 villages around the island, Taiwan. Details of various tasks are described as follows:

In-Situ Investigations

Investigations were performed by a manner of teamwork, which consisted of three members. Each term employed drawing pencil, digital cameras, tape recorders, GPS positioning instruments and laser rangefinders, etc. Through the interviews with local residents about their lives and memories of disasters as well as taking pictures and site surveys using photos (scale: 1/5,000 or 1/10,000), the planning was then conducted on the basic drawings. The investigation was performed from short sight views to long sight views as shown in Figs. 2-3. The short sight view provides a close observation on the local failure by debris flow torrent while the long sight view reveals the main causes led to overall catastrophic disaster. According to the field investigation, it was found that some deviation exists between the map and the actual site conditions. This was partly resulted from the

change of natural landforms and partly by man-made excavation during the development of economic activities. Therefore, to newly debris flow torrent or road construction, the modification should be made immediately on site and the factor safety as well as evacuation routes, shelters and aprons for emergency rescue helicopters, etc. need to be determined as presented in Fig. 4. A comprehensive understanding of the field situation of disasters in advance may help the interviews with the residents become easier. The best way to prepare various maps and forms is to print regional maps of a proper size from computer files. It should be noted that the content of the relevant blank forms should be made in accordance with the field investigations and it eventually can make the form easy to fill in. Besides, make sure to contact the administration officer of the village, relevant organizations and guidance personnel before taking field trip for a successful survey. For the selection of evacuation routes and shelters, opinions of local residents should be taken into consideration in addition to professional judgments.



Fig. 2: In-Situ Investigation [long sight view (left) & short sight view (right) of Ching Fu Li, Dong Shi]



Fig. 3 In-Situ Investigation [interview (left) and planning before trip (right)]



Fig. 4: In-Situ Investigation [shelter (left) and apron (right)]

Manufacture of Evacuation Route Charts

Items of debris flow emergency evacuation route charts for each village consist of the following:

- (1) Information for communicating with administrator of the villages, police stations, fire stations, medical institutes and disaster control organizations: As shown in Fig. 5, an emergency communication and promulgation system should be established for local residents in order to obtain the necessary supports from the rescue units in case of emergencies.
- (2) Instruments and articles prepared for disaster prevention (as shown in Fig. 6 for details.): As shown in Fig. 6, These photos are intended to remind the general public to get disaster prevention objects ready at any time as well as basic disaster prevention articles required for evacuation shelters (e.g. communication and lifesaving appliances, etc.).
- (3) Map of village location: It is used to understand the location where a dangerous village is situated. Manufacture of a 1/5,000 evacuation route chart should be based on simplicity and readability in such manner the general public can easily follow up.
- (4) Evacuation shelters, evacuation routes, aprons for helicopters and locations of potential hazardous area of debris flows need to be specified on the evacuation route charts clearly.

After completing the analysis, integration and overlapping of various field surveys and indoor information, on-site correction and verification of the evacuation routes and evacuation shelters on the plan charts are required as presented in Fig. 7. Upon checking and verifying with the administrator of villages, manufacture of regional emergency evacuation route charts can be completed as Fig. 8.

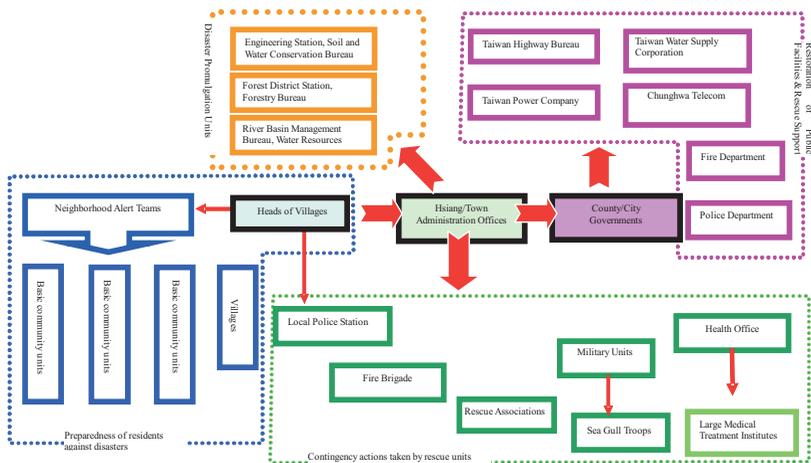


Fig. 5 Framework of Emergency Communication & Promulgation System

Illustrated Popularization and Two-way Communication

As prevention and emergency measures against debris flow disasters are related to many aspects, not only geology, hydrology, and soil and water conservation experts are required to work out preventive and management methods together, but local residents need to work hand in hand to perform soil and water conservation tasks so that debris flow disasters might be mitigated or reduced. Illustrated popularization and mutual communication are implemented through conducting disaster control and prevention education face to face with a mutual communication discussion approach and written materials. Contents of important tasks and implementation procedures are shown as the flow chart in Fig. 9.

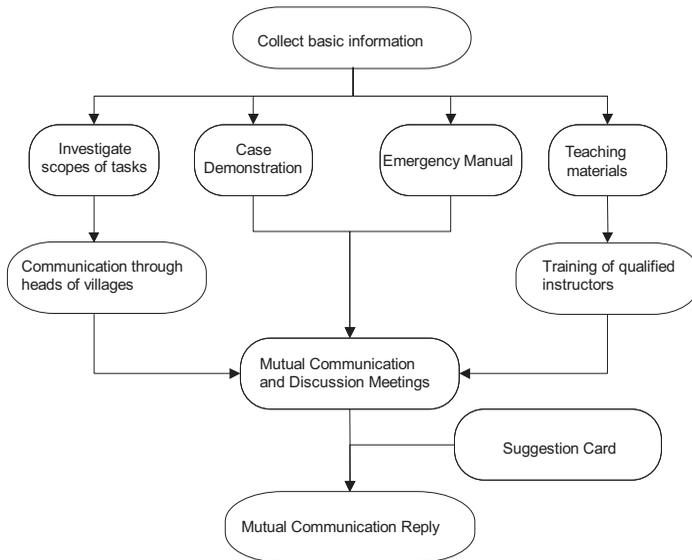


Fig. 9 Flow Chart of Communication and Discussion Meeting

Major objectives of mutual communication are:

- (1) Local residents might have an understanding of debris flow disaster prevention and emergency measures through popularization of debris flow control and prevention.
- (2) Efficiency of slope-land management might be increased through reinforcing communication, exchanging experiences and popularizing legal regulations related to slope-land.
- (3) Crisis awareness of the general public can be enhanced and losses caused by disasters might be reduced through popularization of debris flow disaster prevention and control.
- (4) Explain debris flow disaster prevention, control and slope-land management measures through the simple and clear illustrations of the debris flow disaster emergency manual.
- (5) Fill in the checklist (questionnaire) by residents to serve as a reference for disaster prevention, evacuation, management and planning.
- (6) Provide books and documents related to debris flow prevention work as a reference for discussion meetings and short-term training courses as well as to enhance the effects of popularization.

Explanations and popularization of debris flow disaster prevention were performed with completed Route Charts of emergency evacuation under the guideline of mutual communication and planning and will be finalized and distributed to residents of each region after being signed by the heads of villages as shown in Figs.10-11. Explanation meetings made it easy to realize how deep the residents involved in the matter concerning evacuation and sheltering. For example, some villages were so enthusiastic in participation that the whole village even had a barbecue party on this occasion. However, reactions to such meetings in certain villages were not very zealous. Generally speaking, this kind of meets should be able to proceed smoothly and recognized by the village people if proper surveys and communication were performed in advance.



Fig. 10 Illustrated Popularization and Mutual Communication (1)



Fig. 11 Illustrated Popularization and Mutual Communication (2)

Maneuver of Evacuation Action

Finish map-making of debris flow disaster prevention evacuation charts; assist the communities to maneuver the evacuation actions; make efforts in regional disaster prevention, evasion and mitigation measures and promote the capability of the general public to mitigate the disaster. Bottom-up disaster prevention concepts and evasion measures should be established through a sound regional disaster prevention system. A complete disaster prevention system with reinforced preventive and rescue functions can be achieved via a specific division of labor organization and efficient mobilization. The purpose of maneuvering evacuation action is to set up a disaster management center that can cooperate, communicate and integrate among private groups and government organizations and put various resources

and equipment into efficient, mobile, prompt and skillful usage as well as for a reference of correcting and verifying the disaster control system. In this way, emergencies will be handled appropriately and losses resulted from disasters can be largely reduced as presented in Figs. 12-15.

A maneuver of evacuation action can be divided into two stages, which are measures taken before and at the occurrence of debris flow disaster. Five groups are categorized accordingly as the pre-warning monitoring group, the evacuation acceptance group, the rescue group, the first aid group and the logistics group. Important procedures of a maneuver of evacuation action are described as Table 1.

Table 1 Procedures of A Maneuver of Evacuation Action

Procedures of Situation Maneuver	Item of Maneuver	Unit of Maneuver
1	Chairman address and introduce superiors and guests.	County (Town) Administration Office
2	Briefing	County (Town) Administration Office
Live Drill		
3	Disaster alarm and prevention popularization	Fire squad, Neighborhood rescue self-defense team
4	Disaster Management Center established	Member of Disaster Management Center, Taiwan Power Company, Telecom, Taiwan Water Supply Corporation and health offices
5	Evacuation Self-defense Team mobilized urgently	Neighborhood rescue self-defense team
6	Advance command posts set up.	Member of Disaster Management Center Taiwan Power Company, Telecom, Taiwan Water Supply Corporation and health offices
7	Force to evacuate.	Police station, fire brigade, neighborhood rescue self-defense team
8	Traffic control and public order maintenance	Police station, fire squad, neighborhood rescue self-defense team
9	Medical treatment, first aid and rescue of victims	Police station, fire brigade, neighborhood rescue self-defense team, health office
10	Urgent repair on roads, power, water supply and phone lines.	County (Town) Administration Office, Taiwan Power Company, Telecom, Taiwan Water Supply Corporation
11	Victims accepted and relieved	County (Town) Administration Office, neighborhood rescue self-defense team
12	Integrate situations of disasters.	County (Town) Administration Office



Fig. 12 Establishment of Disaster



Fig. 13: Emergency Mobilization

Management Center



Fig. 14 Compulsory Evacuation



Fig. 15 Rescue Victims

CONCLUSIONS

Debris flow is a natural leveling process activated by sediment and flood, which should be paid close attention because of its catastrophic damage and hazards to the safety of environment. From now on, management of disaster evasion and precaution should be strengthened and the concept of 'evacuation for sheltering in advance' needs to be promoted through the debris flow disaster prevention and evacuation plan made after demonstrations performed in county administration offices. Heads of villages, enthusiastic people or volunteer can be trained through education and mutual communication so as to assist in teaching the local residents to be more aware of debris flows. As 'precautions speak louder than remedies,' disasters may be reduced to the minimum extent by moving away from the dangerous zones, planning for evacuation routes and establishing a general disaster control system. For ultimate perspectives, hazardous areas ought to be delimited in compliance with features of debris flow; specified the potential hazardous area, set up efficient control facilities, observation techniques and assessment methods for management. Precise calculation of the flow concentration, velocity, volume, distribution of particle size and impact force enable a more accurate forecasting and warnings of debris flow disaster. All of countermeasures mentioned above, can be effectively adopted to mitigate the debris flow disaster. Other approaches to maintain the stability and balance of soil and water resources include the maintenance of the configuration of mountains and forests, limitations on illegal cultivation, deforestation and excessive constructions on hillside and prohibitions against excessive utilization, etc.

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