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Using Drone As a Map to Draw Landslide Hazard Areas in the Application of Community Environmental Education

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Abstract. Besides used the data from topography, geology, soil, landuse, history disaster records to definite to dangerous areas with heavy rain in typhoon on communities on the river valley and foot of mountain. The government also need to organize local residents living in these landslide disaster potential areas to evacuate efficiently. In this research, drone is used as an image background and then overlay drawing potential hazard households, evaluation routes, shelters and surround hazard environment factors. The result shows local residents is more easily to understand hazard boundary comparing to other traditional maps such as google maps for the undertakers in villages and towns in environmental education.

1. Introduction

Located in the eastern part of Taiwan, Hualien is very vulnerable to typhoons during the summer. With adverse inferior geographical environment, plus typhoons and heavy rainfall over the years, landfalls, landslides, or debris flows cause severe damage to people and property. At the time of releasing the typhoon warning, people living in potentially dangerous areas of debris flows (e.g. people living at the piedmont and mouth of the valley) must take mandatory measures to evacuate before heavy rains or traffic interruption in remote areas. The evacuation order comes from the forecast of rainfall in each county and city after the release of the onshore typhoon warning, as well as whether the estimated rainfall is expected to cause damage to the dangerous area of debris flows. The object of the evacuation order is the households for preservation in the corresponding dangerous area of debris flows.

According to the regulations, the disaster prevention operation undertaker of the township office is responsible for the households for preservation in the area affected by debris flows. Every April, the construction of the system must be completed before the start of the flood season, and reported to the county/city government and the central government as the basis and object of disaster response. How to define the dangerous areas where debris flows may occur, even the dangerous areas where landfalls or landslides may occur at the piedmont and mouth of the valley, and how many residents actually live in this type of dangerous area, involve environmental geology and topographic surveys, as well as positioning of the geographic information system, which requires real-time and comprehensive on-the-spot investigation and other professional work to be completed. This study has used the long-term risk survey of Hualien County residents on slope disasters for different townships from 2003 to the present.

It is the data source for determining the potentially dangerous areas of disasters. In addition, through the unmanned aerial vehicle, it uses orthophotos or lateral photos as the base map of settlements or the communities, and uses the method of covering transparent drawings onto the photo to mark the local environmental information and households for preservation to create a set of security images. It can effectively provide the basis for undertakers of the township office to carry out preventive evacuation, and establish the independent disaster prevention planning and response capability of the township office.

2. Settlement Safety Survey

Hualien County is about 137.5km long from north to south. It is narrow in east and west, with an average width of about 43km. What's more, it is limited by mountains and rivers. There are many remote and mountainous villages in its living environment, which are the marginal land with high sensitivity to slope disasters in Hualien County. Under natural forces such as landfalls, landslides and debris flows, it often threatens the living safety of communities or tribes. In order to find out residents with highly potential and dangerous slope disasters in the county, Hualien County Government has been conducting field investigations since 2003 to complete the survey of potential debris flow torrents (Lin, 2013; Lin, 2014) [1-2]. What's more, it also has evaluated and investigated landfalls, landslides and debris flows for areas of slope land, piedmont and mouth of the valley. It consists of 4 main stages. The first stage is 2003-2006: It investigated the residential settlements with the same topography, geology or soil for different townships by year, and identified the cases with "high risk" or "medium risk" and their disaster types through the general survey. The second phase is 2007-2009: For the disaster response centres of various counties and cities during the typhoon, it is necessary to let decision-makers understand the situation of the disaster-prone areas in real time, which is conducive to the effective distribution of disaster prevention resources, the establishment of the real-time mobile surveillance network, and the database query of the Internet geographic information system. The third stage is 2010-2014: The object is the high-potential debris flow torrents or the medium-potential debris flow torrents with large scope of influence in each township. It progressed from the general survey of the settlement to the household survey, and began to use the UAV to take aerial photos to facilitate the comparison of the pre- and post-period of the disaster to find out the cause of the disaster. The fourth stage is from 2015 to the present: It began to take slope settlements as the object, set the scope in the tribes or communities subject to the influence of landfalls, landslides or debris flows, and assist local governments in the proper use of survey data and potential hazard maps. It reviews and reports the households for preservation before the flood season in each year. Moreover, it records the topographical features and spatial location information of the area with aerial photographs by UAV, and checks the appropriateness of local evacuation shelters and evacuation routes.

3. Estimation of Potentially Dangerous Areas of Slope Disasters and Delineation and Visualization of Dangerous Residents

3.1. Simplified deterministic method and environmental risk initial judgment

Research methods for assessing the influence scope of flood or debris flow commonly use the GIS numerical terrain databases, utilize numerical equations and finite difference methods to conduct numerical simulation, calculate and plot fluid flow velocity and depth (O'Brien et al., 1993; Han et al., 2016) [3-4]. Such disaster simulation software is limited by the accuracy of numerical data and the calculation method. In practice, the estimated submerged area is not possible to replace the field investigation method. Therefore, this study has adopted the field investigation method, and taken the "simplified deterministic method of the evaluation model" of the "Technical Specification for Soil and Water Conservation" stipulated in Article 8 of the "Water and Soil Conservation Law" of Taiwan and the "environmental risk calculation method" stipulated in Article 147 (Chang, 1984; Chang, 1987) [5-6]as the methods for investigating the potential influence scope of disasters in slope settlements.

"Environmental risk rate" means dividing the areas into a number of "land units" based on topographical homogeneous areas in the survey with the simplified deterministic method, and according to the environmental status survey values of the five factors of the slope, slope erosion degree, rock engineering properties, rock structure and soil depth of each land unit, in contrast with the grading evaluation criteria that have been determined a forehand based on the actual experience, converting it into the ordinal number that can be added to impact factors in different degrees. For example, a certain land unit has a slope of 15%-30%, a slope rank of 2; the abrasively degree of the slope surface is erosion, and the slope surface erosion rank is 2; the combination of slope rank and slope surface erosion rank comes to the topography rank of 4. Its rock engineering properties belong to the pyroclastic rock, the rock structure is unstratified, the soil depth is less than one meter, and the geology rank of the geological combination of soft rock, unstratified and shallow lay is 2. The environmental risk rate after the addition of the topography and geology rank is 6, and the environmental sensitivity of slope disasters is "low".

In the above-mentioned "land unit" division method, the largest river watershed area in the survey area is selected first, and the slopes, gaps, valleys, and flat areas with a slope of less than 5% in the survey area are divided into different areas. Then, taking the bed of the river as the boundary, the side banks are divided into two areas and become independent units. Among them, large valley units can be further divided into its tributaries. For each individual land unit, its slope aspect, slope and slope erosion are "homogeneous" until it can no longer be divided as a separate unit.

3.2. Field investigation review method

In addition to using the above-mentioned UAV and simplified deterministic methods to conduct initial judgment on the division information of the potential dangerous areas in communities and tribes, the undertakers of the township office also use the track recorder and camera records to locate and record (including the river bed reinforce project, roadside collapses, potentially dangerous residents of falling rocks or landslides, whether it is located in the red area near the potential debris flow torrents), and divide the households for preservation of the potential debris flow torrents, and review the information related to resident safety.

3.3. Visualization of the surrounding environment by aerial photos

All along, Japan has been known for its relatively advanced urban and rural construction and awareness of disaster prevention. In July 2018, heavy rains in western Japan caused major disasters and casualties. It is widely believed that the major reason it that people do not read the disaster risk maps (Chinese Network of Japan Sankei Shimbun, 2018) [7]. In 2012, the Executive Yuan, R.O.C, conducted the "Telephone Survey of Households for Preservation in the Potential Disaster Areas", and interviewed the people over 20 years old of the households for preservation in the affected area of potential debris flow torrents in Taiwan. It was also found that 38.1% of the respondents had not read the disaster prevention maps marked with evacuation sites provided by the government (Disasters Prevention and Protection Office of the Executive Yuan, 2012) [8]. Therefore, attracting people to actively read the disaster prevention maps distributed to them and using the visual design close to the community and tribe is a necessary measure to implement the disaster prevention education. At present, the debris flow map environment information used in Taiwan the debris flow location map of the 1/25000 scale, the basic environment map produced by the Soil and Water Conservation Bureau, COA (Soil and Water Conservation Bureau, COA ,2016) [9], and the evacuation map with GoogleMap as the base map promoted by the National Fire Agency, MOI (National Fire Agency, MOI, 2016) [10], cannot close to the real-life experience of residents.

Therefore, this study has used the highly popular and cheap, convenient UAV to take aerial photos of the entire community or tribe landscape, and used them to replace the topographic map or GoogleMap as the base map closer to the residents' life experience. The transparent tracing paper has also been used to mark the geographical overview of the surrounding area of the community, the distribution of disaster prevention resources and shelters, the places where potential disasters may occur, and the areas that need special attention or rescue. It uses the way of overlay to achieve better visualization and communication effects "Figure 1", latitude 23.14303 and longitude 121.26985.

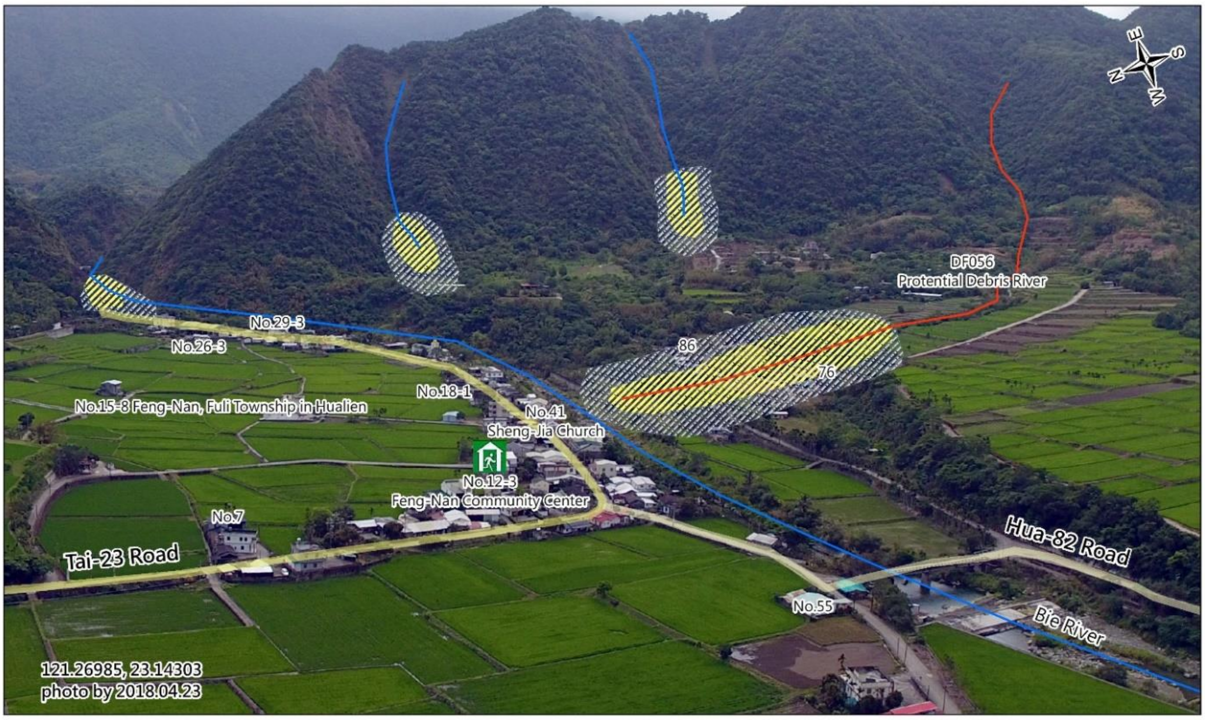

Figure 1 Overlay the transparent tracing paper and the aerial photo result.

Safeguarding the lives and property of the people is the basic responsibility of the government. Maps for potentially dangerous areas prone to flooding, landslides and debris flows can be handed over to local governments for plotting disaster prevention maps, so as to examine which area has high potential of flooding, landslides and debris flows, which household is more dangerous, where are the evacuation shelters and routes in the vicinity. However, communication is the most important key to the success of disaster prevention maps. Which house on the mountain are warehouses? Which house has people living in it? Which people are inconvenient that needs to be evacuated in the first place? Where is most prone to flooding in the past two years? Which road is most prone to landslides? These questions need local residents to provide independent disaster prevention advice, and they cannot be answered through the topographic map or GoogleMap in the research room. The aerial photo of the entire community landscape visualizes the surrounding environment as the base map of the disaster prevention map, and it can make the community achieve the effect of independent disaster prevention.

4. Applications of Preventive Evacuation

In recent years, when the typhoon warning is issued, if the estimated rainfall exceeds the warning value, local governments in Taiwan may actively evacuate the residents in areas with high disaster potential to safe positions before the catastrophic rain. It brings forward the evacuation of households for preservation against disasters from "during the disaster" to the "pre-disaster" stage, reducing human life losses, avoiding the island effect, reducing the dilemma of government's need to invest huge costs to mobilize helicopters to evacuate the people in the air, which is to actively execute the "preventive evacuation" for ensuring the safety of the potential disaster areas (Central Emergency Operation Center, 2018)[11]. Therefore, in the short-term limited manpower range, understanding

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different levels of danger and arranging the priority of evacuation according to the distance required for evacuation is the key factor for the success of evacuation missions.

The related researches on spatial distribution and evacuation time have also attracted many scientific and technological operators in recent years. For example, RiChi Technology's "Smart Analysis of Disaster Sanctuary" is calculated based on spatial data, and the service area for each evacuation shelter is calculated for a 10-minute walk in the densely populated area of the six municipalities directly under the central government. It is hoped that suggestions for additional disaster sanctuary locations may be provided for areas with insufficient service (RiChi Technology, 2018)[12]. Through further analysis of the environmental information for potential disasters, this study has used the aerial photos to visualize the surrounding environment, so as to analyze the route of the evacuation shelter, consider the disaster risk degree and time factor, and estimate the execution priority of evacuation, as well as the feasibility of large-scale promotion of preventive evacuation.

5. Conclusion

This study reviewed the environment of communities and tribes in the areas of piedmont and mouth of the valley through the simplified deterministic method and household field surveys to determine potentially dangerous areas for landfalls, landslides or debris flows. In addition, this study also used UAV to take lateral photos of the settlement or community panorama, and marked the above-mentioned households for preservation against disasters, evacuation routes and places, potentially dangerous areas of the surrounding environment as the stackable disaster prevention information. It used the settlement safety image close to the residents' life experience, which is conducive to the priority of evacuation arrangement according to different danger levels and evacuation time in large-scale evacuation during the disaster prevention work in communities and tribes. It can be applied to the independent disaster prevention by households for preservation against debris flows, so as to establish the independent disaster prevention planning and response capability of the township office.

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