Transfer of knowledge and technology from the flood simulation system for the people of Tha Wang Pha District, Nan Province

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Abstract:

Lots of area in Tha Wang Pha District, Nan Province, is a basin in the north of Nan Province that supports the whole Nan River flowing downwards and into the Chao Phraya River. Therefore, Tha Wang Pha District is the first lowland area at risk of flooding from the Nan River. Recurring flooding problems in Tha Wang Pha District directly and indirectly effect 50,519 people. This project employed knowledge to build and technology to integrate the flood simulation system of Tha Wang Pha District, Nan Province, which was the product of the cooperation between Defence Technology Institute and Chiang Mai University. The objectives were to transfer knowledge and technology from the flood simulation system to local administrative organizations in 7 sub-districts, to encourage children and youth, communities and local administrative organizations in Tha Wang Pha districts to adopt the flood simulation system as part of formulating guidelines for coping with flood situations.

Target groups for the knowledge and technology transfer activities consisted of the Nan Provincial Disaster Prevention and Mitigation Office at Chiang Klang branch, local government organizations in 7 sub-districts of Tha Wang Pha district, government agencies in Tha Wang Pha district office and Tha Wang Pha Pittayakom School. Participation in the knowledge sharing activities, technical workshops for collaboration and value-added workshop of the flood simulation system for executives of government agencies in Tha Wang Pha district was assessed with questionnaires for academic results in disaster relief and mitigation. They also looked for possible social benefits within local communities with regard to self-preparedness for flood situations. Officers at Chiang Klang branch, local Administrative organizations, teachers and students of Tha Wang Pha Pittayakom School, and head of government agencies in Tha Wang Pha District were seen to have embraced this tool to help themselves and their subjects to cope with flood situations.

Keywords: knowledge transfer, technology transfer, flood simulation system, flood preparedness

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1. Recurring Problems and Effected People

Tha Wang Pha District is in Nan Province of Northern Thailand. It is the first lowland area at risk of frequent flooding from the Nan River. To make the matter even worse, there is also water overflowing the banks from Thung Chang District, Pua District, and Chiang Klang District. These areas are flooded in a short period of time with the water remaining stagnant for approximately 6-12 hours. Recurring flooding problems in Tha Wang Pha District directly and indirectly effect 50,519 people. For example, the Kon Son Tropical Storm in 2010 causing heavy rains with mud left 2,437 people in 5 villages of the District stranded and unable to lift electrical appliances, vehicles and agricultural equipment to higher ground. There were also land-slides and fallen trees blocking the road in Ban Sop Khun - Doi Tiw and Ban San Charoen, making other villagers of more than 6 villages unable to pass through. Flood aftermath also impacted the teaching and learning of teachers and students at Tha Wang Pha Pittayakom School.

The situation can sometimes be severe, causing the school to be closed for a long time. On August 8, 2023, at Ban Nong Bua, Pa Kha Subdistrict, and Ban Don Tan, Sri Phum Subdistrict, Tha Wang Pha District, there was a flood that inundated agricultural areas, travel routes, and houses in low-lying areas near the river. The Governor of Nan Province, President of the Red Cross Society of Nan Province, President of the Nan Provincial Administrative Organization,

Tha Wang Pha District Chief, head of the Nan Provincial Disaster Prevention and Mitigation Office and related agencies joined in the area to monitor the situation and help the affected people, see figure 1. The flood simulation system was invented with a combination of geospatial data, real-time analytics, and advanced mapping to provide a precise and comprehensive understanding of flooding situations as shown on figure 1 left to viewers without or before having to be on site as shown on figure 1 right.

Figure 1. Villagers and governments during flood situation.

2. Geo-Intelligence for Situational Awareness

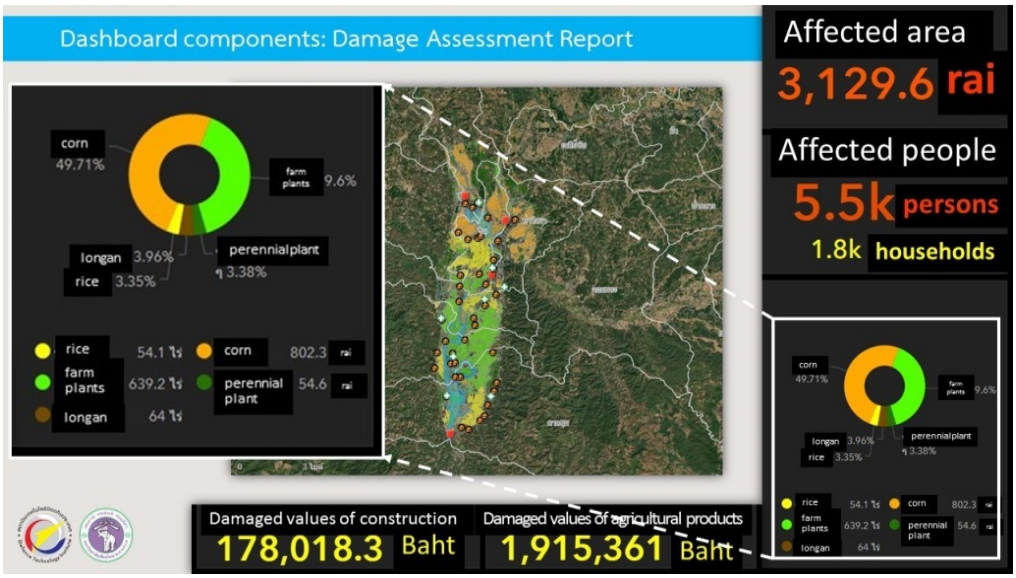

Figure 2. The flood simulation system.

The flood simulation system seen in figure 2 was created from Digital Elevation Model (DEM) data from flights of an unmanned aerial vehicle system to achieve the 10 cm. resolution of ortho-imagery. In this study, we selected the areas affected by the most severe flooding in 2006 as a criterion for simulating flood situations. There was information for assessing damage from surveys of areas affected by the past 10 year floods, land use map, ground survey of buildings, the number of layers/materials used, economic data value/property/productivity and surveyed accuracy of land use classification. The flood simulation system made available by ArcGIS online consists of three main components: 1) toolbar shown as the left dotted box of figure 2 working in conjunction with map display and links commands to display flood level simulation, agricultural activity data, water level reference stations, village locations, and administrative data; 2) map component shown as the middle dotted box of figure 2 for controlling the display of 2D/3D maps, details of affected villagers, agricultural data, and weather forecast; and 3) damage assessment dashboard providing the analysis of the area and the simulation of flood level by determining the water level in the situation at every input 20 cm. interval from reference stations of the Nan River. The value of the building and its assets, and the crop yield per rai and the value were calculated for damage assessment, as shown in the enlarged inset on the left of figure 2. This together with other information to form Geo-Intelligence for decision making was used to analyze the flood situation effecting the people in the area.

3. Geospatial Data Generation and Analysis

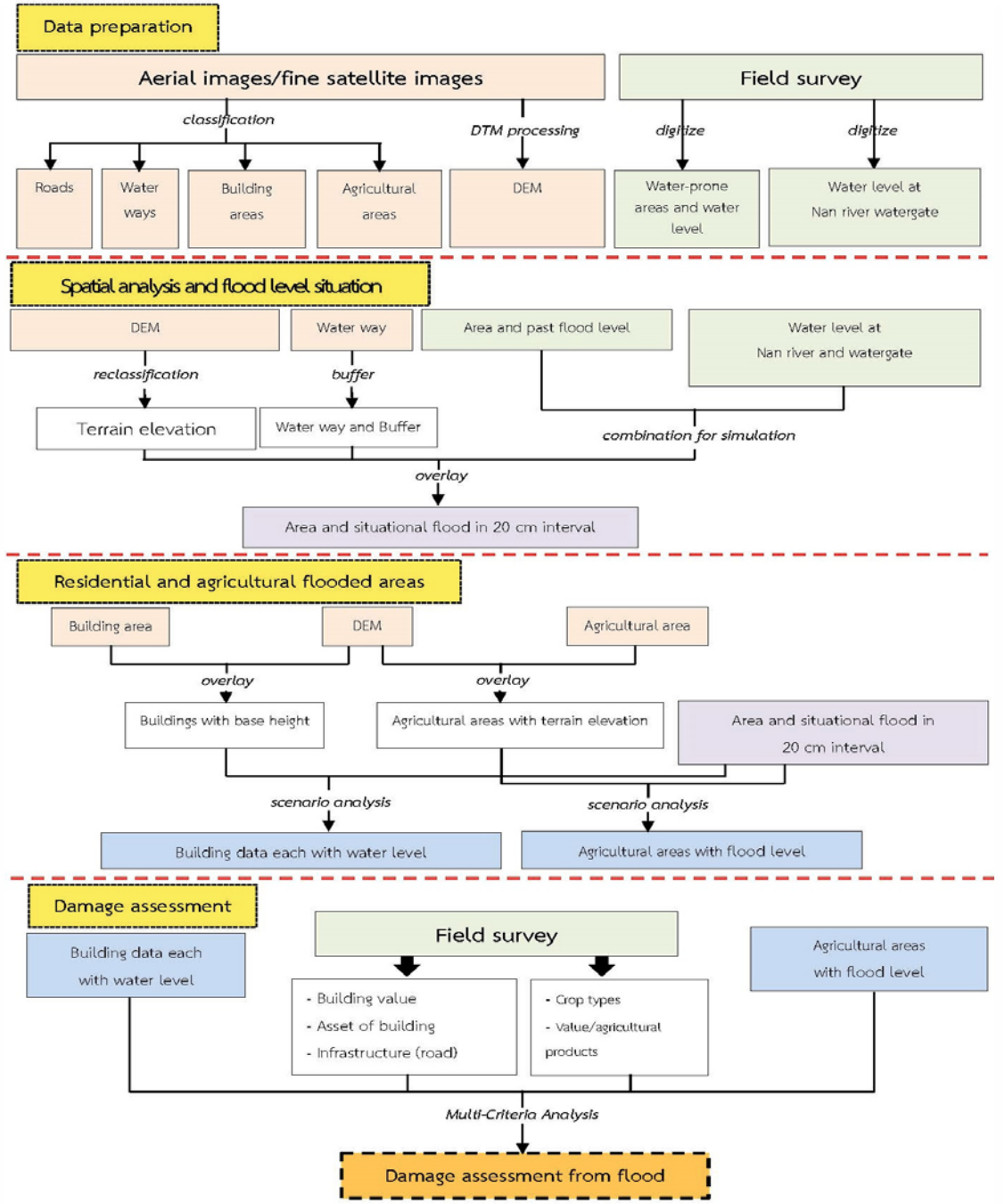

Figure 3. Geospatial database creation and analysis flowchart.

The geospatial database creation and analysis for the flood damage assessment is illustrated in figure 3. It was designed in form of a cartographic modelling diagram that consisted of 4 main steps. In data preparation, the UAV was used to fly over the study area and acquire 10 m. resolution images. That was with equal positional accuracy to ASPRS standard 1:500 map or no less than 0.125 m. The imagery data from this advanced UAV terrain mapping was used to produce 10 cm orthoimages with horizontal and vertical accuracy of no less than 8 cm. and 15 cm., respectively. The data was, then, used in the spatial analysis for contour intervals of 20 cm. that were pre-defined values of incremental flood simulation levels in response to user input. Residential and agricultural areas were thoroughly surveyed and updated to a land use map to reflect accurate and real values in 2021 and to produce temporal scenario analysis in multi-criteria analysis. Damage values, for example, rice at 1,113 baht/rai and house each at 49,500 baht, were adopted from guidelines for the damage assessment of Ministry of Agriculture and Cooperatives regarding flood-caused damages.

4. Precise and Comprehensive Understanding of Emergency Situations

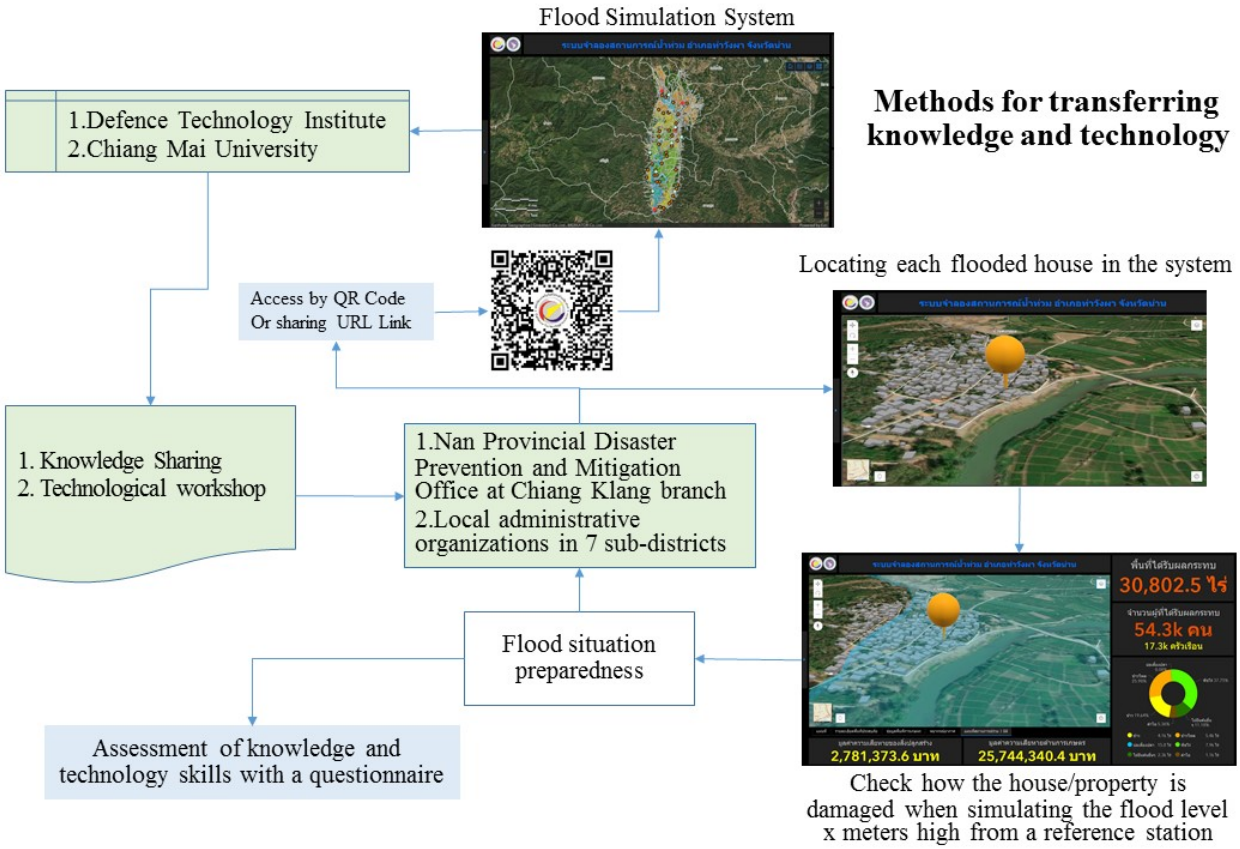

Figure 4. The proposed methodology for the transfer of knowledge and technology.

The flood simulation system was designed and developed to provide a precise and comprehensive understanding of flood situations. An access to 2D/3D map was provided as a tab on the dashboard. Tabs for weather forecast, water situation, water level measuring station, and important locations were also easily accessed through the damage assessment dashboard for a comprehensive understanding of emergency situations. We, then, developed the method to transfer knowledge and technology of the simulation system to local administrative organizations in 7 sub-districts, to teachers and students in order for them to spread the acquired knowledge and technology to local communities, and to head of government agencies for them to cope with flood situations, see figure 4.

Activities of lectures for knowledge sharing and technological workshop for technology transfer were media to bridge the knowledge of project researchers from Defence Technology Institute and Chiang Mai University with the officials of Disaster Prevention and Mitigation Chiang Klang Branch as a change agent to end users. They were to help organize and advocate the activities to engage the research team with end users that included heads of local administrative organizations, teachers and students from Tha Wang Pha Pittayakhom School, and heads of government agencies. Shared bodies of knowledge included field survey, UAV terrain mapping, creation of a geospatial database and analysis, and creation of 3D common operating picture and damage assessment dashboard to support damage assessment from flood situations. Technological workshops were to transfer the use of the simulation technology from the researchers to all end-user groups. The activities were assessed by questionnaires to evaluate the skill of the target groups capable of, for example, locating each flooded house in the system, and checking how the house/property is damaged when simulating the flood level x meters high from the reference station. Furthermore, Line, a social media platform widely used in Thailand, was used to establish a social group for communications and assistance in using the simulation system at the end of the activities.

5. Harnessing Geo-Intelligence for Swift and Informed Emergency Response

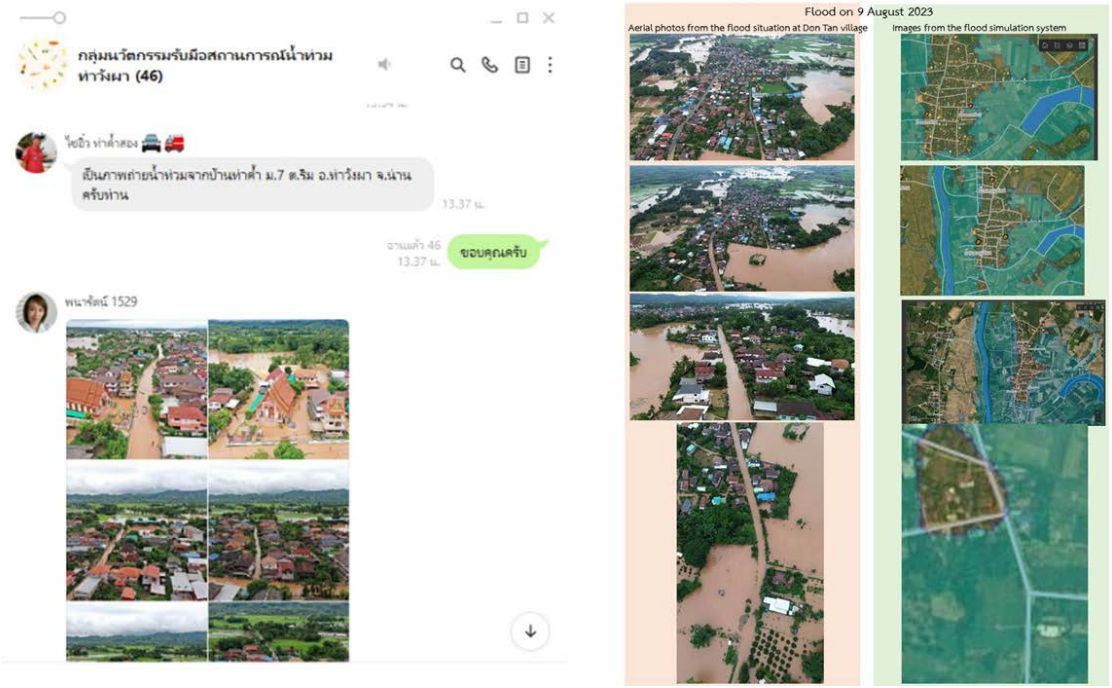

Figure 5. A social media channel for swift communications of the flood situations.

The transfer of knowledge and technology is to provide a source of geo-intelligence for people of Tha Wang Pha District to have the swift and informed awareness of flooding situations and prepare for emergency response. Geo-intelligence was the product of geospatial data generation and analysis discussed in Section 3. The transfer was the process to gain the acceptance of the system by representatives of the 7 local administrative organizations in Tha Wang Pha District, Nan Province, teachers and students of Tha Wang Pha Pittayakom School, and head of government agencies in Tha Wang Pha District. The activities also enabled the research team to establish a social media group, see figure 5 left, for the research team to communicate with the activities participants. Figure 5 right shows that through this communications channel that the member of the social media group was facilitated with swift and informed flood situation preparedness for emergency response.

6. Results and Discussion

6.1 Target Group I: Chiang Klang branch and heads of local administrative organizations

The research team held the knowledge sharing and technical workshops between 13 – 14 June 2023 for Nan Provincial Disaster Prevention and Mitigation Office at Chiang Klang branch and representatives of 7 local administrative organizations of Tha Wang Pha district with total 80 participants. There was also the workshop to help them understand how to use the system. They were evaluated acquired skills from trial use, assessed their attitude towards the transferred knowledge, and evaluated potential deployment of the system in their disaster management missions. Important points gathered by the questionnaires included: 1) knowledge and understandings before and after each training topic; 2) capable tool for flood situation preparedness; 3) Significance and useful steps for actual use Essential to improve operations and relevant agencies to support operations; 4) Information obtained helpful in decision making/planning for dealing with flood situations; 5) In support of the use of modern technology in dealing with flood situations; 6) The system being able to reduce loss/damage from flood situations; 7) Concepts and policies for using the system applicable to other disasters; and 8) The results be expanded to benefit other areas. The questionnaires showed 80 percent or more of 80 participants being able to acquire the knowledge and to use the system in flood situation preparedness, see figure 6.

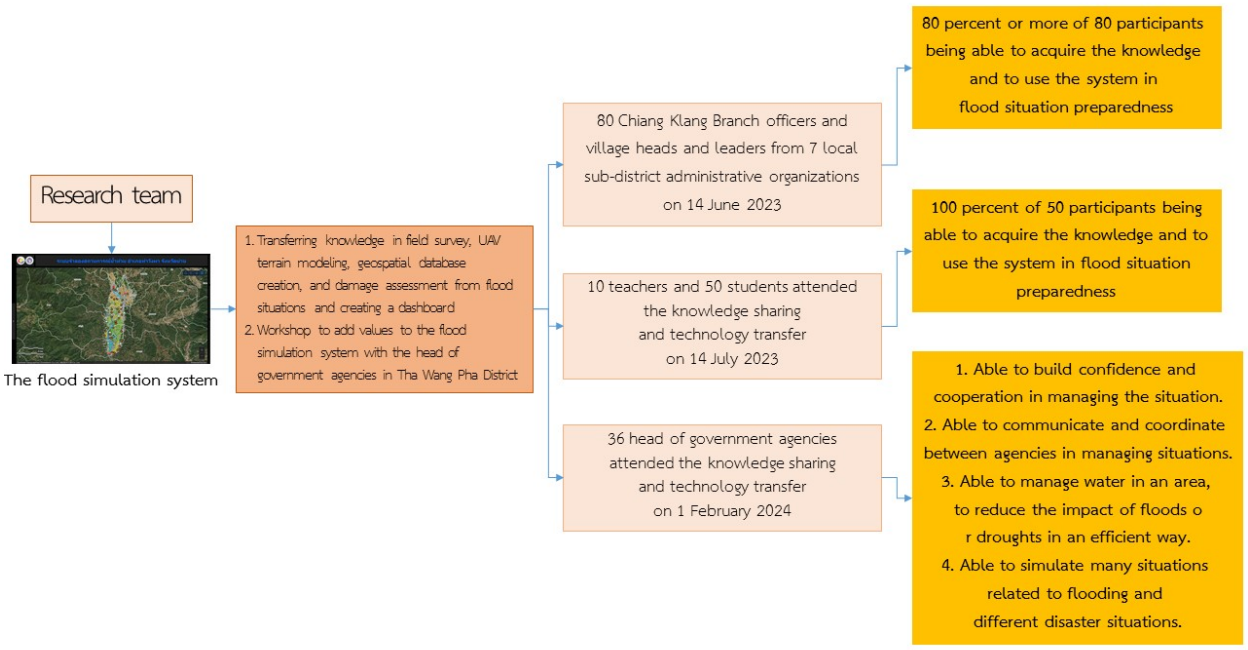

Figure 6. Transferring knowledge and technology for the people of Tha Wang Pha District.

6.2 Target Group II: Teachers and students of Tha Wang Pha Pittayakhom School

The research team held the second activity on Friday 14 July 2023 at 0800 – 1230 where 10 teachers and 50 students attended the knowledge sharing and technology transfer. Assessment of before and after knowledge sharing and evaluation of skills after using the simulation system were conducted with questionnaires to gather details of their knowledge and understanding before and after the lecture. They also an interview questionnaire to assess their skills to use the simulation system. Important points gathered by the questionnaires included: 1) Knowledge and understanding before and after the lecture to determining reference stations and water levels, to enter the location coordinates of houses or buildings in the study area on the system, to verify the value of damage to buildings and agricultural areas, and to verify the number of affected people in the area; 2) Skills in using the simulation system for determining reference stations and water levels, entering coordinates for the location of houses or buildings in the study area on the system, verifying the value of damage to buildings and agricultural land, and verifying the number of affected people in the area. The questionnaires showed 100 percent of 50 participants being able to acquire the knowledge and to use the system in flood situation preparedness, see figure 6.

6.3 Target Group III: Heads of government agencies.

The third activity transferred knowledge in field survey, UAV terrain modeling, geospatial database creation, and damage assessment from flood situations and creating a dashboard to heads of government agencies. The workshop was provided for an opportunity to add values to the flood simulation system for important points gathered by the questionnaires including concepts and policies for applying the system to alleviate other disasters, the thought of applying the system to planning for flood situations to benefit the people, the thought of expanding the system to benefit others and opportunities to create values in other areas, and how to apply the system to other aspects of disaster relief, see figure 6.

Heads of government agencies gave answers to the interview questions that showed their willingness to add values to the flood simulation system, including:

1. Providing accurate and understandable the system to citizens can build confidence and cooperation in managing the situation.

2. Using the system to communicate and coordinate between agencies can increase efficiency in managing situations.

3. The system can be used to manage water in an area, to reduce the impact of floods or droughts, to plan for water use in the dry season, to store water, and to manage water resources in an efficient way.

4. The system can help to simulate many situations related to flooding, such as different types of flooding, water flow systems, and the surrounding environment; allowing the system to be adapted according to the characteristics of different disaster situations.

7. Conclusion and Recommendations

Tha Wang Pha District is the first floodplain with repeated flooding problems to have ei-ther directly or indirectly effected 50,519 people. The knowledge and technology transfer was the process to create activities where officials, authorities and active teenagers of the district can be engaged with the flood simulation system. The target groups have undoubtedly embraced the system for their flooding situation preparedness. The participants who work in cooperation with others during flooding incident hugely valued good relationships with other government agencies, the network of cooperation to cope with the flooding situation, and the cooperation of many agencies especially located along both sides of Nan river banks. Suggestions included the similar and extended simulation system being pushed forwards to a larger extent. The extension and suggestion of this best practice should be recommended to other local administrative organizations. More room for improvement is necessary to keep the system alive and responsive to the ever-changing climate change. The geo-spatial database creation needs annually and seasonally updated field survey for timely flood damage assessment and more accurate dashboard presentation.

8. Acknowledgments

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