Implementation of multi-level public participation as the novel and sustainable approach for the flood simulation system to benefit communities of Tha Wang Pha District, Nan Province in preparedness to deal with flood situations.

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1. Communities of Tha Wang Pha District, Nan Province effected by flood situations.

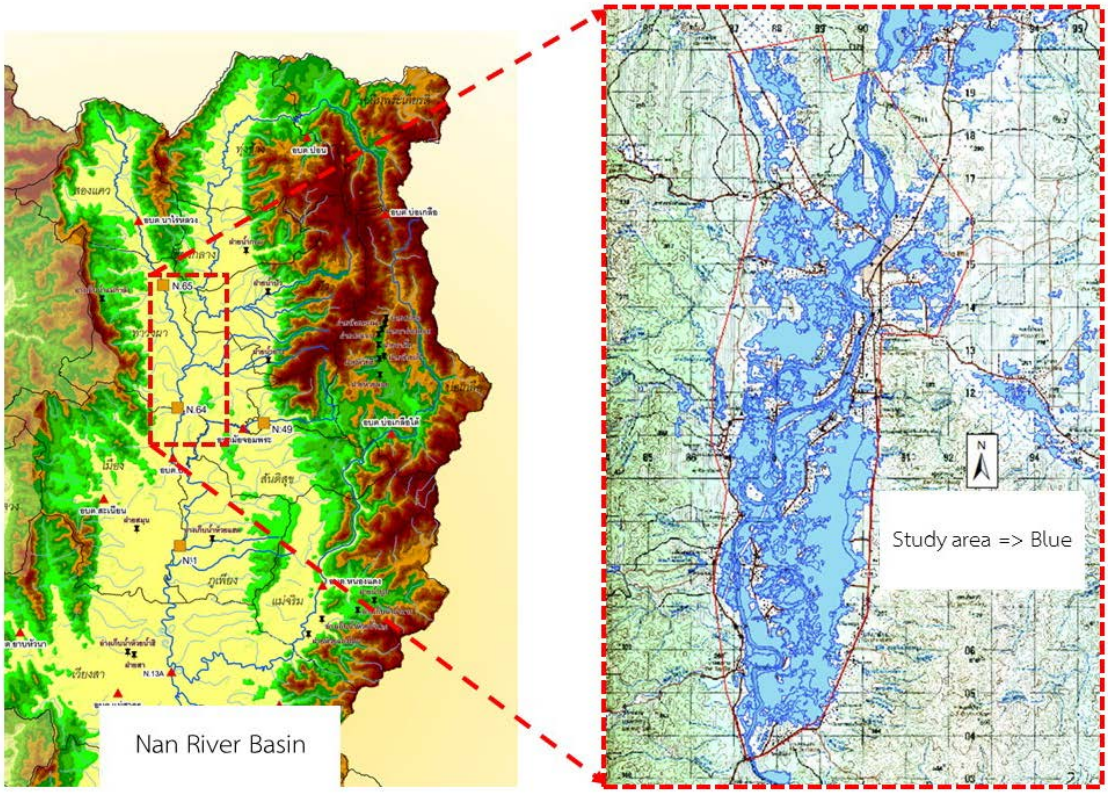

Figure 1: Tha Wang Pha District of Nan Province in the North of Thailand.

The area of Tha Wang Pha District, Nan Province, is a basin in the north of Nan Province that supports the whole Nan River that flows downwards and into the Chao Phraya River, see Fig. 1. Tha Wang Pha District is the first lowland area at risk or repeated flooding from the Nan River. Areas facing flooding situations are always experiencing overflows and have had a huge impact on the people. The recurring flooding problem in Tha Wang Pha District has both direct and indirect impacts on 50,519 people. We conducted the project that brought knowledge and technology of the flood simulation system of Tha Wang Pha District, Nan Province to the Nan Provincial Disaster Prevention and Mitigation (Nan DDPM) Office, Chiang Klang Branch and local administrative organizations of 7 sub-districts, to encourage teachers and students of Tha Wang Pha Pittayakhom School, communities and local administrative organizations of Tha Wang Pha District to use the knowledge that had been transferred as part of preparedness to deal with flood situations, and to encourage government heads and personnel of Tha Wang Pha District agencies to use flood simulation technology as part of determining guidelines or policies for dealing with flood situations.

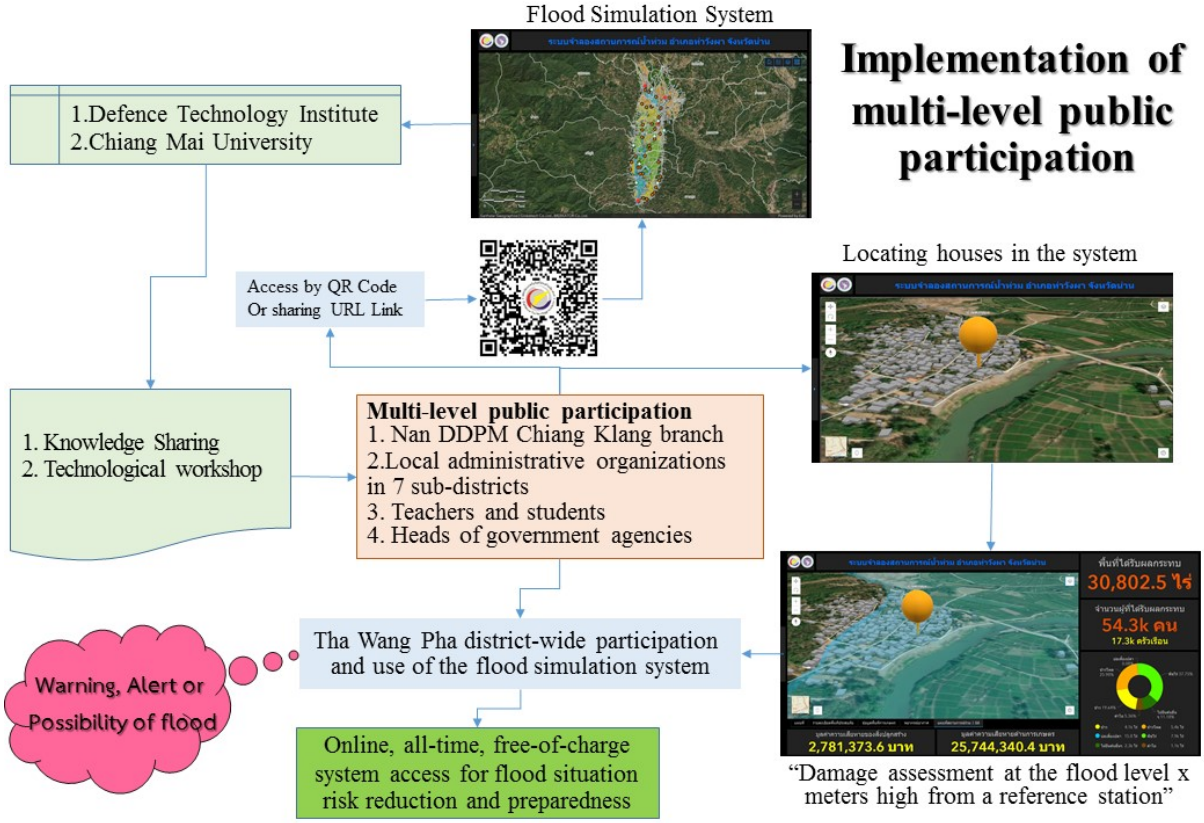

Figure 2: The multi-level public participation as the novel and sustainable approach.

2. The multi-level public participation approach for the communities of Tha Wang Pha District, Nan Province to deal with flood situations.

The Nan DDPM Office, Chiang Klang Branch sent 2 representatives to join 78 leaders and representatives from local government organizations in 7 sub-districts of Tha Wang Pha District, 36 heads and representatives of government agencies in Tha Wang Pha District, and 60 teachers and students of Tha Wang Pha Pittayakhom School in knowledge sharing activities, technical workshop and cooperation-building workshops, see Fig. 2. The workshops also hugely created added value of the flood simulation system through the embrace and acceptance of the executives of government agencies in Tha Wang Pha District. Results of validation and evaluation using questionnaires were evident that the activities and workshops met the project objectives. Therefore, the Nan DDPM Office, Chiang Klang Branch confidently use the system as part of helping Tha Wang Pha people in flood situation preparedness. Representatives of Local Administrative Organizations in Tha Wang Pha District, teachers and students of Tha Wang Pha Pittayakhom School and family members use the system as part of preparedness to deal with flood situations with confidence. Executives in local government organizations and government agencies in Tha Wang Pha District apply this modern and reliable knowledge and technology to formulate policies and practices to help Tha Wang Pha people cope sustainably with flood situations.

3. How can the multi-level public participation approach be leveraged to drive social innovation and improve communities?

3.1 The multi-level public participation approach to drive social innovation.

3.1.1 The flood simulation system was an integral innovation where knowledge, technologies and people were central to the multi-level public participation approach. To achieve the system, we applied several fields of knowledge that included field survey, UAV based terrain modeling, geo-spatial database creation, and flood damage assessment and dashboard creation. The other

essential part to the approach was technology where we adopted Geographic Information System, UAV and internet mapping. A group of researchers from DTI and Chiang Mai University was the key to drive this social innovation.

3.1.2 The multi-agency participation of the activities was at the heart of the project. We targeted at the principle element of the communities through the activities with the teachers and students of Tha Wang Pha Pittayakhom School so that they could extend the shared knowledge and technology with family members. Viewed as field mission operator, staff from seven local administrative organizations in Tha Wang Pha District, Nan Province were invited to join the activities. At the strategic level, district's executives in local government organizations and government agencies were introduced to the system so that they could formulate policies and practices in time of flood situations.

3.1.3 The availability and accessibility of the flood simulation system reflected an aim to drive social innovation and improve the life quality of the communities. We developed the flood simulation system under the principles of digital and web – based mapping where public access and utilization are all – time available, totally free of charge, and shared by sending URL link (https://www.arcgis.com/apps/dashboards/9676ba15b1ba43c7b62ad270b4c4c9c6) or QR code in Fig. 3 via any social media. With our public initiative leading to the multi-level public participation approach, we provided full public access to the system by the knowledge and technology transfer to the district's communities in preparedness for flood situations.

Figure 3: QR code to the flood simulation system.

3.2 The multi-level public participation approach to improve communities.

To ensure effectiveness, we pushed through a top-down approach by making local government executives well aware and willing to send their representatives to participate in the activities. Government agencies were related and intertwined with public services in their own right. That was how we conducted our project together with various and relevant parties, so successfully that we received the Inter-agency Award, see Fig. 4, from the Festival of Innovation Awards 2024. The award recognizes exemplary inter-agency initiatives that have reflected a sustained and institutionalized approach to collaboration. We were awarded in recognition of our effort in leading the program for flood mitigation and prevention.

Figure 4: Receiving the Inter-agency Award.

We kept close contact with the representatives of the communities on Line platform for advices and support. We managed to help them to mitigate and reduce a great deal of flood-induced damage and loss. Since the knowledge and technology transfer of the simulation system to help the people of Tha Wang Pha District in preparation for flooding situations and the activities to engage four target groups before the August 2023 flooding incident, we concluded that the communities embraced the system for disaster management missions, for the policy and guidance towards flooding situations, and for the sustainable adoption of the flood simulation system. It contributed greatly to improve their quality of life with flood risk reduction. The pictures, see Fig. 5, show that, after the knowledge and technology transfer activities, the effected agricultural areas were reduced from simulated 6,520 rais to actual 1,827 rais, from estimated 11,500 people to actual number of 1,488 people, from simulated 3,700 households to actual 650 households, and from the simulated damages of 407,489.4 baht to construction and 4,851,304.5 baht to agricultural products to actual governmental compensation at 1,420,000 baht.

Nan Provincial Disaster Prevention and Mitigation Office at Chiang Klang branch

Chief of Tha Wang Pha District

Representatives of 7 local administrative organizations

Teachers and students of Tha Wang Pha Pitthayakhom School

RECENT FLOOD SITUATIONS IN THA WANG PHA DISTRICT DURING 8-15 AUGUST 2023

A view of flood situation on 9 August 2023

The expected governmental compensation is at 1,420,000 baht

A simulated scene

The simulated damages of 407,489.4 baht to construction and 4,851,304.5 baht to agricultural products

Figure 5: The system that drove social innovation and improved communities.

4. What are some examples of successful social innovation projects driven by sustainable solutions, particularly in the public services sector?

4.1 The successful social innovation project driven by public sector participation.

The recurring flooding problem, see Fig. 6, in Tha Wang Pha District has both direct and indirect impacts on 50,519 people. Government agencies in Tha Wang Pha District and Nan Province pushed forward their continuous effort to alleviate the severity of the flooding situations in Tha Wang Pha District. There have been frequent workshops before and after the situation arises. Government sectors and people in Tha Wang Pha District recognize the importance of supporting citizens and localities to take care of themselves within and across communities. There have been guidelines and encouragement for the communities to self-prepare for dealing with flood problems on their own or within their community apart from waiting to receive assistance or notification from relevant government agencies. We set the objectives to transfer the knowledge and technology of the flood simulation system for the communities so that they could themselves deal with flood situations, a sustainable solution. We also encouraged government heads and personnel of Tha Wang Pha District agencies to use flood simulation technology as part of determining guidelines or policies for dealing with flood situations. These target groups were a public portal of the district to use the system. We validated our solutions by questionnaires that extracted user acceptance and willingness of system utilization. We monitored the system view counts to guarantee the system's widespread public use as initially aimed at the beginning of the knowledge sharing and technology transfer.

Figure 6: Recurring flood situation in Tha Wang Pha District.

4.2 The successful project driven by sustainable solutions in the public service sector.

In 2023, our project titled "The transfer of knowledge and technology from the flood simulation system for the people of Tha Wang Pha District, Nan Province in preparation for flooding situations" received 650,000-baht grant from National Research Council of Thailand to bring the knowledge and technology of the flood simulation system of Tha Wang Pha District, Nan Province to benefit the people of Tha Wang Pha District in self-preparedness and less government-dependence to deal with flood situations. We were fully aware of the intertwined relations forming public schools in Tha Wang Pha District. Five officials of the Chiang Klang Branch were exemplary of linking the public with their duties by having registered district volunteers with public disaster prevention and mitigation. Seven local

administrative organizations across the District are tasked with self and local governance and represented by the locals, the first gateway to all forms of local and public initiatives of local administrative organizations of the sub-districts. Teachers and students of Tha Wang Pha Pittayakhom School and communities of Tha Wang Pha district were considered as the technocrat and technical gateway of the project to the communities. Where guidelines and policies were central to public initiatives and services, we engaged the government heads and personnel of Tha Wang Pha District agencies with the activities in view of technology acceptance leading to incorporating the system with forming part of the guidelines and policies. We issued official documents to request all the potential parties to be engaged with the activities, see Fig. 7.

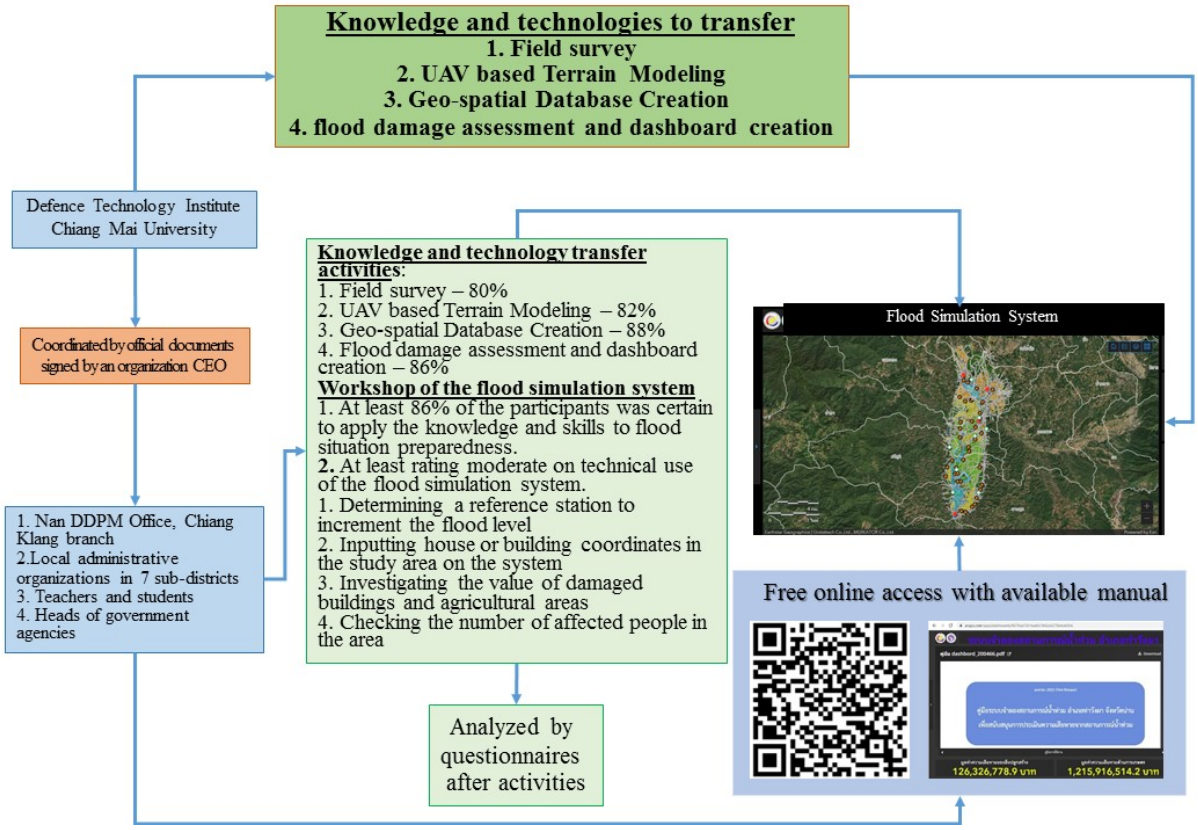

Figure 7: Official commitment for sustainable solutions in the public service sector.

5. What are the biggest challenges in scaling sustainable solutions for social innovation, and how can they be overcome?

5.1 The challenge to boost Thai youth interest in the knowledge underlying the innovation.

Figure 8: The challenge to boost Thai youth interest in science and mathematics.

Thai youth have decreased interest and deteriorated skills in science and mathematics that underlie nowadays innovations. In addition, the quality education system is concentrated in schools in urban areas. Therefore, it is important to create equality in education to reduce the lack of opportunities due to inequality in the education system for youth in rural schools. From the knowledge sharing and technology transfer activity at Tha Wang Pha Pittayakhom School, they showed keen interest and perfect 100% score of all the questionnaires, see Fig. 8. The challenge was to further use this finding to accelerate their interest in space technology or unmanned aerial systems found among the youth of Tha Wang Pha Pittayakhom School to those in other schools in Nan Province. This challenge can even take the community or districts' schools a step closer to achieve Sustainable Development Goals or SDGs, i.e. the Goal 13 by taking an urgent action to combat climate change and its impacts of repeated flooding problems with Objective 13.3b by promoting a mechanisms to increase planning and management capacity, valuing women, youth and local communities whereby bringing the flood simulation system to serve local communities and schools.

5.2 The challenge to extend the results to next water catchment areas.

Figure 9: The challenge to extend the results to next water catchment areas.

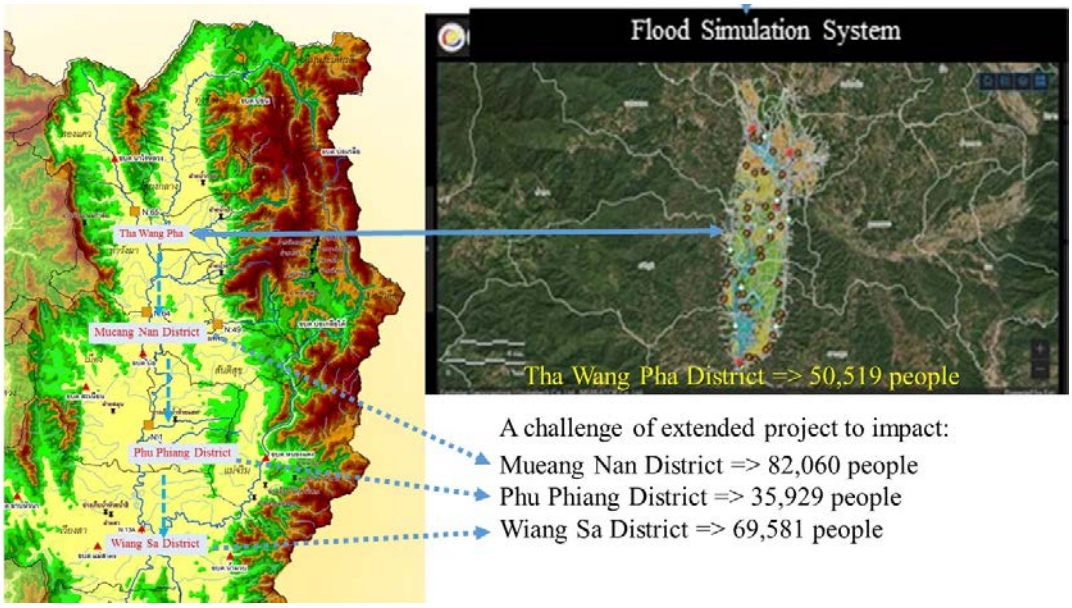

Figure 10: The challenge on extending the current public initiative.

We have already initiated public full access to self-preparedness for flood situations for 50,519 people of Tha Wang Pha District. It was promising since we kept Nan Province's strategic levels in disaster risk management informed on the project delivery and results. They were keen and active on helping us to help the people on flood relief and mitigation with our flood simulation system, see Fig. 9. We encountered the challenge to push forward the extension of the project to involve more 82,060 people of Mueang Nan District, 35,929 people

of Phu Phiang District, and 69,581 people of Wiang Sa District or totally 187,570 people with this successful project and to scale up this sustainable solution for larger social innovation. This challenge will align the public participation of the districts with UN SDG goals: Goal 11 by making cities and human settlements safe with a system for preparing to deal with flood situations. We also anticipate to match the Objective 11.5 by reducing the number of people affected with aims to protect the poor and those in vulnerable situations and targeting the vulnerable communities of Tha Wang Pha and other three districts vulnerable to repeated flooding.

5.3 The challenge to promote system ownership.

We chose Nan Province to be our study area because it suffers almost all kinds of disaster. Flooding is one of environmental risks the people of Nan Province always facing in monsoon seasons. As we reviewed literature on research and studies on disaster management of Nan Province, we learned that a number of projects were carried in various methods, objectives and achievements. As the activities went on, we learned from the District's public disappointment on other projects that were promised to but failed to deliver their flood risk results. It was such a challenge that we refrained the history to repeat itself by engaging every potential level in the communities with the activities and let them access the system as if they themselves own the system. We collected view count of the flood simulation system at 3,420 times, see Fig. 11. Thus, we assumed that approximately one in ten people of Tha Wang Pha District's directly impacted people of 36,419 people viewed our system and approximately one in three households of 12,367 flood - affected households viewed our system.

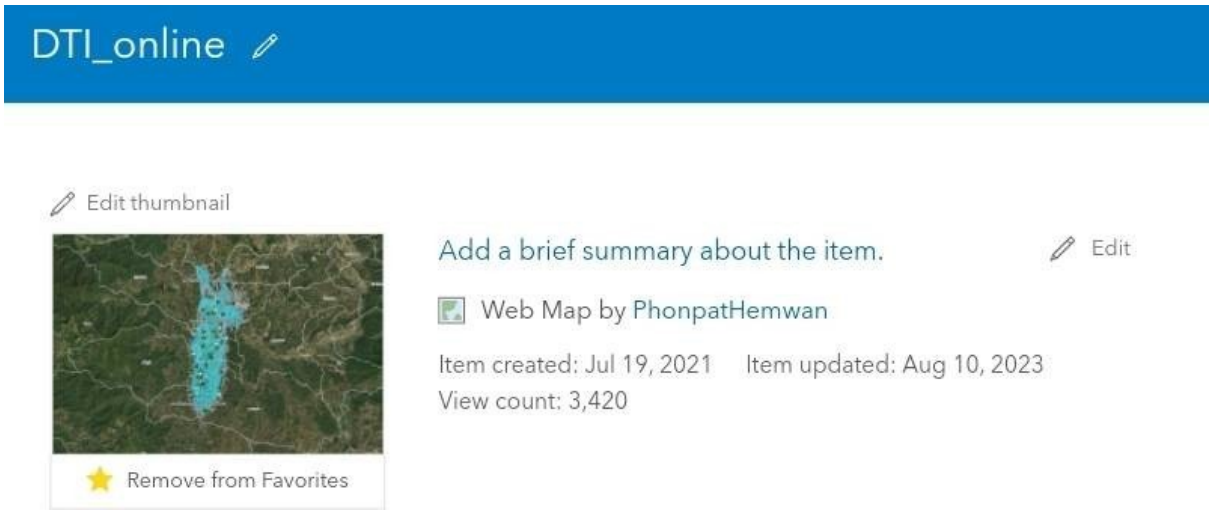

Figure 11: System view count as of 10 August 2023.

5.4 The challenge to strengthen immunity and capacity of the communities.

We considered climate change issues the challenge while our flood simulation system takes the engaging communities of Tha Wang Pha District close to the realization of Sustainable Development Goals or SDGs Goal 13 where our project takes urgent action to combat climate change and its impacts of recurring flooding problems. At Objective 13.1, we helped to promote this social innovation to strengthen immunity and capacity of the people of Tha Wang Pha District to adapt to climate-related natural hazards and disasters. With their full, all-the-time and free-of-charge access to the system, villagers and communities are aware of the water level and well prepared to deal with flooding such as by moving their belongings to higher ground. And at Objective 13.3b, we aimed to promote a mechanisms to increase planning and management capacity of strategic management levels of the Province to have the tool to plan, implement or enforce policies and guidelines on disaster management apart from physical endeavor shown in Fig. 12.

Figure 12: The challenge to promote a mechanisms to increase management capacity.

6. What role does technology play in fostering social innovation through sustainable practices, and how can it be utilized effectively?

6.1 Role in fostering social innovation through sustainable practices.

Delivering the flood simulation system for the military Mobile Development Unit 31 in Nan Province, we conducted the study[1] with the purpose to assess the satisfaction with the flood simulation system expected to be used by the unit for the people of Tha Wang Pha District, Nan Province. We adapted the military concept of Intelligence Preparation of the Battlefield or IPB to design and develop the system. We followed its four steps including determining the environment of the flood situation area, explaining the impact of consists the flood situation, evaluating the threat from the flood situation, and considering how to deal with the flood situation classified by personal data. The meeting in Fig. 13 was held at Mobile Development Unit 31 in Nan Province where the questionnaires were gathered for the academic paper inserted in the footnote.

Figure 13: Role in fostering social innovation through military acceptance.

[1] Phimraphas Ngamsantivongsa. 2023. Satisfaction with the Flood Simulation System Case Study: Tha Wang Pha District, Nan Province. Defence Technology Academic Journal, Volume 5 Issue 11 / January - June 2023. p. 14 - 25.

We used questionnaires for civilian user acceptance and also published the results[2] of the activities that were attended by 50 participants, see Fig. 14, who then were presented with a set of 5 questionnaires to test the acquired knowledge and skills. The willingness to apply the knowledge and skills to flood situation preparedness of their workplace or missions was analysed through sub-questions and illustrated in a series of bar graphs. We concluded that 100% of the respondents agreed with the use of the flood simulation system in terms of building cooperation through knowledge and technology exposure, collaboration with relevant agencies, and support for the implementation of the flood simulation system. The official coordination of relevant agencies and institutes was the key for the successfully organized activities, making the implementation an innovative and successful method.

Figure 14: Role in fostering social innovation through civilian acceptance.

6.2. How can the technology be utilized effectively?

6.2.1 Study user requirements before building the flood simulation system.

Figure 15: Effective for Response Unit to Mobile Development Unit 31 of AFDM.

[2] Chamnan Kumsap, Vissanu Mungkung, Lanyanat Patanan, Phimraphas Ngamsantivongsa, Arisara Charoenpanyanet, and Phonpat Hemwan. 2026. The Flood Simulation System as a New Process for Public Participation of Local Administrative Organizations in Tha Wang Pha District, Nan Province. Accepted for Publication in Journal of Applied Informatics and Technology (JIT). Volume 8 Number 1 (2026) January – June. Accepted on 2 April 2024.

To ensure the technology implementation, we studied user requirements before building the system. We conducted the survey of user requirements for applications of 3D situation map for disaster relief missions of the Armed Forces Development Command (AFDM). We aimed at studying levels of user requirements at Response Unit, see Fig. 15, for applications of 3D situation map from three independent variances. Three levels of significance included the requirements for use of common 3D situation map on the level of severity from each natural disaster, the level of significance for quality of common 3D situation map for disaster relief missions, and the level of significance for features or use aspects of common 3D situation map for disaster relief missions.

After we delivered the flood simulation system to Mobile Development Unit 31 in Nan Province, we studied the user satisfaction with the flood simulation system from a meeting in Fig. 16, with the purpose to assess the satisfaction with the flood simulation system used by Mobile Development Unit 31 in Tha Wang Pha District, Nan Province, as a military tool for Intelligence Preparation of the Battlefield (IPB). It consisted of four steps: 1) determining the environment of the flood situation area; 2) explaining the impact of the flood situation; 3) evaluating the threat from the flood situation; and 4) considering how to deal with the flood situation classified by personal data. The questionnaire was used as a tool for collecting data. The satisfaction value was 4.18, while the standard deviation was 0.64, indicating good and acceptable cohesion.

Figure 16: Satisfaction survey of effective utilization of the system.

6.2.2 Engage top management with the activities.

We employed an official request as a mechanism to engage top management levels of Nan Province and Tha Wang Pha District with the knowledge sharing and technology transfer activities. We believed in top-down and bureaucratic management of rural administration and made the best out of it. We issued an official letter bearing DTI's top executive signature for a request of the meeting with the research team. The Chief of Tha Wang Pha District in yellow dotted box of Fig. 17 left was briefed with the objectives of the project. Support was overwhelming with a series of successive trainings and workshops that followed.

Head of Nan DDPM Office seen in yellow dotted box of Fig. 17 middle met with the research team as the project proceeded at the middle of the project phase. The effectiveness at a provincial level was the aim of the meeting and the result was accordingly immense. At top most provincial administration level, we were granted an opportunity to meet with and brief the Deputy Governor of Nan Province in place of the Governor, see yellow dotted box of Fig. 17 right. We gave the manual of the flood simulation system for provincial use and full report of the activities with 4 target groups to show the success of the activities. We received warm welcome from the dedication and contribution we did for the people of Tha Wang Pha District, in preparation for flooding situations.

Figure 17: Top management being engaged with the activities.

6.2.3 Implementation for effective utilization of the flood simulation system.

We studied and found out statistically how the representatives of the Tha Wang Pha people supported the implementation of the flood simulation system. We reported our study in an international journal by using some extraction and success of the activities for the knowledge and technology transfer of the flood simulation system attended by 50 invited representatives from local administrative organizations of 7 Sub-districts of Tha Wang Pha District, see Fig. 18. They were presented with 5 questionnaires to test their acquired knowledge and skills. The willingness to apply the knowledge and skills to flood situation preparedness of their workplace or missions were analyzed through sub-questions and illustrated in a series of tables. The results showed that the contents of the knowledge sharing were comprehended between 82-90%.

Figure 18: Participation of representatives of 7 Sub-districts of Tha Wang Pha District.

Following the technological workshop, the participants planned to use the knowledge to flood preparedness at 100% with measured skills at 100%. We concluded that 100% of the respondents agreed with the use of the flood simulation system in terms of building cooperation upon the knowledge and technology exposure, collaboration with relevant agencies, and supported for the implementation of the flood simulation system. The official coordination of agencies and institutes was the key for the successfully organized activities. That was to ensure commitment from government officials and to guarantee official support from the relevant agencies.

We found overwhelming encouragement of the respondents to the system in dealing with flood situations and other disasters. Following Senior Assistant Chief District Officer as Chief of Administration Group, acting as representative of Chief District Officer presided over the opening ceremony of the meeting of heads of government agencies in Tha Wang Pha District on February 1, 2024 (Fig. 19) at the administrative office of Tha Wang Pha District, Nan Province where the project's technical workshop was allowed to proceed as the first activity of the meeting. There were 36 heads of government agencies and representatives of government agencies attending the meeting and high value-added results from the flood simulation system were achieved.

Figure 19: Workshop with 36 heads and representatives of government agencies.

7. How can leadership and corporate culture drive a commitment to social innovation through sustainability?

7.1 Leadership with commitment by impact on public policy.

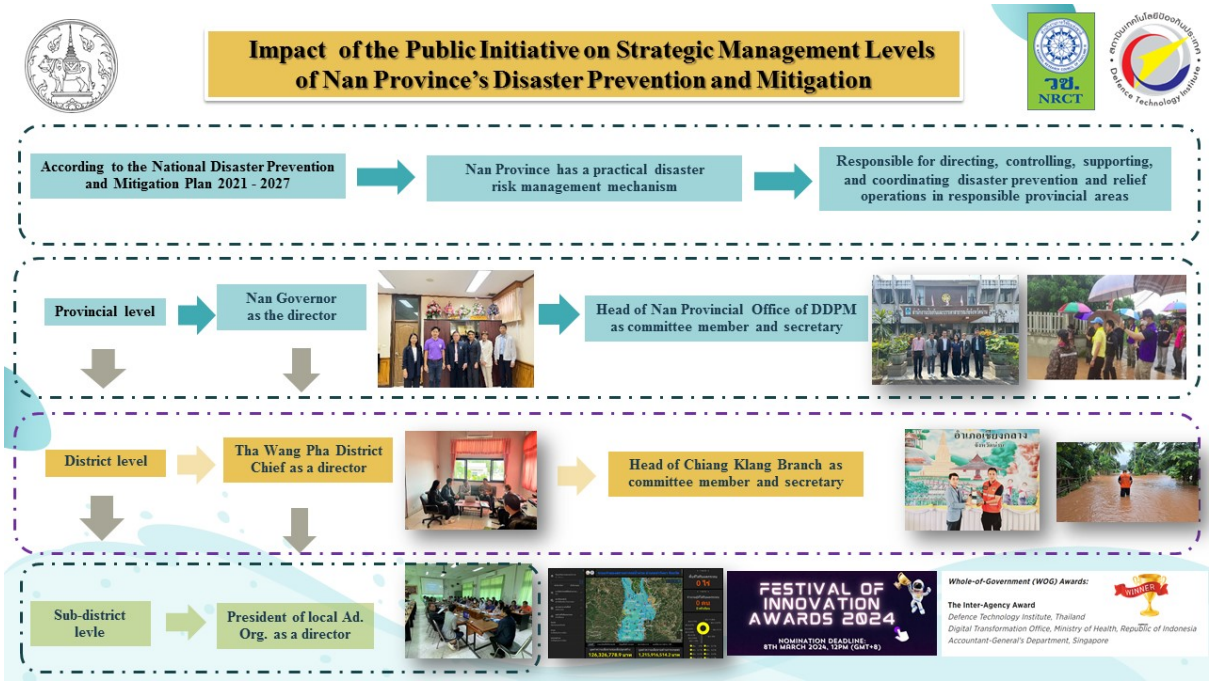

Figure 20: Driving leadership and corporate culture.

The National Disaster Prevention and Mitigation Plan 2021 – 2027 prescribes public sectors within the Ministry of Interior and relevant ministries to establish national, regional, provincial,

district and sub-district levels to have a mechanism for disaster risk management. Nan Province also follow the plan, see Fig. 20. We managed and implemented our knowledge sharing and technology transfer activities in an approach that enclosed all policy and decision making levels from provincial, district and down to sub-district levels. Although outside Tha Wang Pha District was beyond our study area, guidelines and practices came inevitably from the Nan Provincial level. We, then, requested official permission to pay courtesy call upon Nan Governor who acts as the director of Nan Provincial mechanism for disaster risk management. We informed Head of Nan DDPM Office who acts as committee member and secretary and kept him posted on our activities, see Fig. 21. We implemented our innovative strategies and commitment to excellence. It earned us this distinguished ASEAN Risk Awards' Public Initiatives in 2024, see Fig. 22. We were honored to be recognized by our exceptional contributions to the communities.

Figure 21: Driving commitment of the mechanism for disaster risk management.

Figure 22: Receiving Public Initiatives award in 2024.

At the district level, the District Chief of Tha Wang Pha District is to establish and direct a mechanism for disaster risk management with Head of the DDPM Nan Provincial Office at Chiang Klang Branch to act as a committee member and assistant secretary. We worked closely with the acting head of Chiang Klang Branch to organize our knowledge sharing and technology transfer activities. The system was warmly welcomed and accepted for use as a tool for the mechanism of disaster risk management in Tha Wang Pha District. Since we engaged district and sub-district strategic levels with the knowledge sharing and technology transfer activities by official documents, we have counted 3,420 views of the system, indicating significant impact on communities of Tha Wang Pha District.

Figure 23: Flood situations in Ban Don Ton and the networked reporter with permission.

We could keep up-close pace on flooding situations in Ban Don Ton of Sri Phum Sub-district (Fig. 23 left) with the village's Deputy Headwoman (Fig. 23 right), a member of the Line group as our reporter. We were successful in helping the community in Ban Don Ton upon August 2023 flood through this Line group with its Deputy Headwoman and other members to have what-if situation awareness and preparedness for flood risk reduction. Using all the available data, we estimated the damage value at approximately 5,258,793.9 baht, see Fig. 24. Additionally, the significant risk reduction and damage prevention and mitigation were seen from the simulated 11,500 people to the actual 1,488 people, from the simulated 3,700 households to the actual 650 households, and from the damage simulation, 407,489.4 baht for construction costs and 4,851,304.5 baht for agricultural products to the actual government compensation of 1,420,000 baht. We concluded that our knowledge sharing and technology transfer activities yielded good output and outcomes of public initiative to full public access of the technology for flood preparedness and risk reduction. We created a significant impact when public safety was significantly evident at the system's acceptance and embrace of the policy and decision makers.

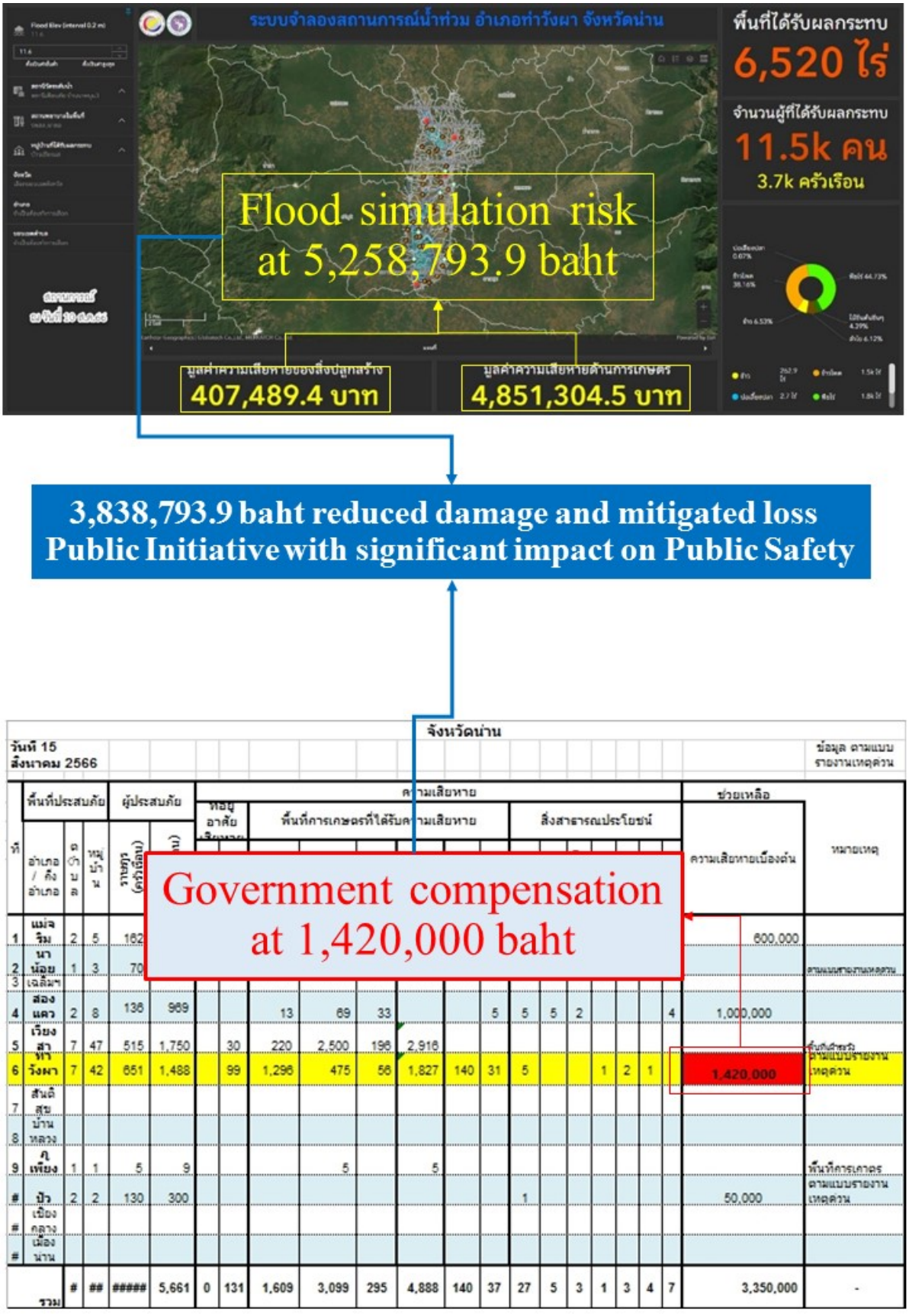

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Figure 24: Commitment to social innovation with sustainability for public safety.