ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH

Final Report
ARCP2014-11CMY-Yamada

Adaptation of Solid Waste Management to Frequent Floods in Vulnerable Mid-Scale Asian Cities

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ARCP2014-11CMY-Yamada:

"Adaptation of Solid Waste Management to Frequent Floods in Vulnerable Mid-Scale Asian Cities"

Final Report Submitted to the APN

Part One: Overview of Project Work and Outcomes

Non Technical Summary

A series of field investigation and interview surveys revealed that disaster waste management framework developed from the Japanese experience, in which necessary functions are organized in 5 categories including operations, command, logistics, finance/administration, and planning, is also applicable in Thailand. Though some flood waste management plan has been developed at national level, there is no particular plan at the local level that deals with flood waste management, and development of local capacity is still a challenge. Based on the findings from the field survey, project developed the vulnerability assessment tool. Evaluation framework of the tool consists of six different vulnerability issue categories, with two to three criteria under each issue. The vulnerability issues are; (a) Reducing flood impact on usual waste management system (b) Securing flood waste management resources, (c) Adaptive planning and implementing plan for flood waste management (d) Preventing flood impact on buildings and infrastructures (e) Developing coping capacity of the people (f) Improving vulnerability conditions. It was reaffirmed that a vulnerability evaluation tool would be helpful for local officers to enhance their flood waste management capacity.

Keywords: Flood waste management, Vulnerability, Resilience, Bangkok, Hue

Objectives

(1) Resilience and/or vulnerability of current SWM plans for natural disaster in Asia and in the world is reviewed and assessed with development of the evaluation tool.
(2) The damages of past disaster are investigated, and resilience/ vulnerability of infrastructure and waste management systems were be analysed. Simultaneously, damages of recent great natural disasters and the way of management of waste derived from these disasters have been inspected.
(3) The awareness of local municipality on SWM in emergency case is also promoted by the sharing of the past experience thorough the seminar/workshop.
(4) Flood-resistant SWM is proposed in municipalities for resilient urban system adapting flood by restructuring of current SWM. Formulation and documentation are executed by scientific team from this project and municipality officer team together, and evaluated by local academic authorities as third party.
(5) Methodology of restructuring of SWM to be flood-resistant SWM is summarized under the consideration of local characteristics of vulnerability. The Methodology is compiled as a guideline and disseminated to other Asian city through the workshop on transfer of knowledge and experience for flood-resistant SWM in SEA.

Amount Received and Number of Years Supported

The Grant awarded to this project was:

US$ 37,000 for Year 1

US$ 34,000 for Year 2

Activity Undertaken

Year 1

- Development of capacity building program and curriculum for local municipalities
- Drafting planning guideline based on problems identified in Hue and Ayutthaya
- Data and parameter development for resilience and vulnerability to flood for municipal solid waste management
- Development of vulnerablity evaluation tool
- Resilience/vulnerability evaluation of restructured solid waste management

Year 2

- Finalizing Flood Waste Management Guidelines for Bangkok
- Capacity building workshop for local municipality officials (Hue)
- Capacity building workshop for local municipality officials (Ayutthaya and Bangkok)
- Explanation of research output to the municipal government
- Draft final report
- Knowledge sharing public forum
- Final report and project recommendations/dissemination
- APN project & financial reporting

Results

(1) Based on the data and record collection and stakeholder's interviews on flood waste management in both Thailand and Vietnam, the main findings are as follows;

- Flood waste management is undertaken in three phases, namely, before flood phase (i.e. from flood warning until inundation), during flood phase (during inundation), and after flood phase (after inundation until completion of flood waste disposal)
- Main activities in before flood phase include information gathering and analysis, arrangements for additional waste management resource (e.g. pick-up trucks, temporary storage sites), clean-up of roads and curb sides (emergency pick up), and flood waste prevention practice at households (e.g. evacuation of goods to higher place).
- Main activities in during flood phase include information dissemination (e.g. giving order to the public to store general waste in house when during flood), collection, transportation, and disposal of general waste and its ancillary activities (e.g. preparation of boats for collection).
- Main activities in after flood phase include information dissemination (e.g. information on temporary storage sites), collection, transportation, and disposal of flood waste and its ancillary activities (e.g. requesting additional budget and equipment).
- Some distinctive flood waste management strategies were identified, including mutual assistance framework for flood waste collection among municipalities, local cleaning campaigns ("Big cleaning day"), special waste collection method developed for during flood phase (using boats and walkways above water), and flood waste reduction based on local knowledge (e.g. high-floored housings, neighbourhood support on evacuation of household goods).

- Challenges of current flood waste management were identified, including disorganized command line, lack of safety equipment, inefficient collection vehicles, flood vulnerable flood transportation facility, and lack of preparedness plan and strategic planning.

Based on these findings, it could be concluded that the disaster waste management framework developed from the Japanese experience, in which necessary functions are organized in 5 categories including operations, command, logistics, finance/administration, and planning, is also applicable in Thailand. In addition, some important perspectives that should be included in the vulnerability assessment tool were identified, including the need to put light on both normal and diaster waste management system, incorporation of resilience of residents experiencing seasonal flood, and development of basic information related to flood risks and land use.

(2) A spreadsheet based tool to evaluate the vulnerability of solid waste management was developed. It was opened to the public and is available at the following website (http://waste-management.asia/2015/08/666). The primary aim is to highlight the issues that need to be tackled to enhance resilience of the waste management system. Based on the key conceptual components of vulnerability and resilience (namely, exposure, sensitivity, capacity to absorb, capacity to respond, adaptability, and transformability) retrieved from literatures and past experience of flood/disaster waste management in Japan, Thailand and Vietnam, the evaluation framework was designed.

The evaluation framework consists of six different vulnerability issue categories, with two to three criteria under each issue. The vulnerability issues are; (a) Reduce flood impact on usual waste management system (b) Secure flood waste management resources, (c) Adaptively plan and implement plan for flood waste management (d) Prevent flood impact on buildings and infrastructures (e) Develop coping capacity of the people (f) Improve vulnerability condition.

(3) Three capacity development workshops were held in Thailand and Vietnam in which the local waste management officers discussed vulnerabilities and key preparedness activities using the tool developed in (2). The aim was twofold; to gain feedbacks on the tool from local practitioners to check the validity of tool design, and to clarify the effectiveness of the use of tool in a workshop.

89 (Thailand) and 116 (Vietnam) ideas and opinions were expressed in the discussion of the key preparedness actions. They were classified into 6 categories corresponding to the vulnerability assessment criteria. The analysis shows that the discussion was consistent with the framework of the vulnerability assessment tool. It also shows that issues related to limitation of human resources, budget, equipment, and facilities for flood waste management (Issue (b)) were discussed most extensively, whereas issues related to flood risks on waste management facilities and other infrastructures (issues (a) & (d)) were covered less. As an overall trend, ideas on “what” were presented (e.g. “encouraging financial support for flooded areas”), but there were much less opinions on the specific actions necessary to realize those ideas.

Relevance to the APN Goals, Science Agenda and to Policy Processes

Natural disaster including flood is increasingly alarming issue in Asia-Pacific region. More and more Asian cities are expected to face the disaster risk due to the climate change in

next few decades which fits the agenda of APN Third Strategic Plan. Disaster waste management is an often neglected but essential scientific issue to be addressed before and during the natural disasters. Waste management system should be well-designed and prepared prior to the occurrence of natural disaster in order to maintain the safe and sound environment for urban dwellers. Scientific output of this project in Asian cities contributes to the scientific community working on the issue of climate change such as IPCC for improved adaptation and mitigation strategies. This project ultimately objects to develop and formulate the resilient society to natural disasters. The outputs from this project supports policy makers with following features; (1) Knowledge transfer and dissemination to policy makers and local practitioners on importance and methodology for preparation of flood-resistant SWM to reduce the impact of global climate change. (2) Social investigation and analysis on resiliency of SWM to flood enables policy makers to identify practical way of improvement of the flood waste handing. It also helps them to understand the benefit of the interactive relationship with scientists. (3) Dissemination of the assessment of resiliency/vulnerability of SWM using evaluation tools that will be developed in this project

Self-evaluation

Almost all the planned activities have been implemented. Working with small to mid-scale cities was a challenge because of the language barriers and data availability.

Potential for further work

At the completion of this project, some areas of work are still remained for the further improvement.

1) Developed vulnerability assessment tool is tested by limited number of municipalities. During this project, field officers of the municipalities have evaluated their current vulnerability on flood waste management in their cities. However, we want the decision making officers to use this tool in the future because most of the commands in flood waste management phases are made by the decision making officers of the municipalities. It is important for the decision making officers to be able to identify the vulnerable area of infrastructures and system to appropriately implement flood waste management.
2) One planned activity we could not implement during this project was to promote the mutual cooperative agreement between local government and external actors. Assistance by external actors would be necessary to realize the importance of flood waste management. Preparedness of human networking enrolling the regional stakeholders will greatly help the initial action on flood situation.
3) Vulnerability assessment tool and the flood waste management guidelines for Bangkok could be applied to other Asian flood-prone cities. National Institute for Environmental Studies is pursuing the Emergency environmental management research. Within this research framework, we will continue to upgrade the contents of vulnerability assessment tool and the Flood waste management guidelines for Bangkok.

Publications [please write the complete citation]

Ishigaki T. and Kawai K. (2015) Evaluation of resiliency of solid waste management against flood, Sardinia 2015 session G16 presentation material.

Tajima R. (2015) Capacity development for local administration officers on flood waste management, Sardinia 2015 session G16 presentation material.

Yamada M. (2015) Coordination of investigation on flood waste management in Southeast Asia, Sardinia 2015 session G16 presentation material.

Kubota R. (2015) Development of flood waste guidelines for Bangkok, Sardinia 2015 session G16 presentation material.

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Preface

Globally, especially in the Asia and Pacific region, risk of flood has been increasing within the context of climate change. Against this backdrop, many Asian cities are urged to improve the preparedness for flood in the wake of rapid urbanization. This study aims to propose a model of resilient and adaptable solid waste management (SWM) against flood in Asian tropical/pluvial countries. State of urban SWM during and aftermath of flood is evaluated, by developed vulnerability assessment tool to assess resiliency/vulnerability of SWM against flood and restyling and re-planning of SWM is supported by capacity building workshops for local practitioners.

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1. Introduction

Pluvial Asian countries are constantly threatened by natural disaster, such as typhoon and/or flood. According to Asian Development Bank (ADB), vulnerability to flooding will increase with urbanization, with a projected 410 million urban Asians at risk of coastal flooding by 2025 with impact of global climate change. And also, the number of people at risk of inland flooding will rise to roughly 350 million by 2025. In order to adapt to climate change, there need to be prepared sound policy and plans for flood-resistant Solid waste management (SWM) for quick recovery from flood damage and for sustainable development.

At the Thailand flood occurred in 2011, the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP) pointed out that lack of country-wide governance of water management, and what was seen in Thailand may not be natural disaster but rather, human disaster to worsen the natural calamities. The mega-cities that

have been developed in this region are challenged to maintain and to develop the urban function under threat of flood. On the other hand, vulnerable middle-scale cities that locate in this region would face more serious situation, where financial and technological capacity are limited when compared to mega-cities.

SWM is an essential municipal service which makes city liveable. Collapse of this service by sudden natural disasters will directly lead to collapse of city. There should be three types of issues on SWM with flood; loss of the function of waste collection and transportation by submerge of approaching way, excess of the waste treatment/disposal capacity by flood damage and/or huge waste generation, and inappropriate waste management in aftermath. Considerable health and environmental impact caused by SWM issues are waste-borne infectious disease, environmental pollution/contamination, waste dispersion, fire and so on. These additional calamities would be prevented by preliminary planning of SWM in case of flood.

Since occurrence of frequent and mega scale flood has been so familiar in pluvial countries such as Thailand, Laos, Vietnam, or Philippines, it is necessary to prepare strategic SWM adapting to flood.

This study aims to propose a model of resilient and adaptable solid waste management (SWM) against flood in Asian tropical/pluvial countries, in order to adapt to frequent flood events that would be influenced by climate change. Current situation of SWM plan mentioning natural disaster will be investigated in municipality in developing countries. Methodology for scoring resiliency/vulnerability of SWM plan against flood will be developed, and used for evaluating current SWM plan in middle-class city in Thailand and Vietnam, which are representative countries under threat of frequent flood event. Restructure of SWM for resilient urban system adapting flood will be implemented in case cities. Interactive cooperative assistance in emergency between municipalities or between municipality and industries/NPOs will be promoted through resiliency evaluation.

2. Methodology

In order to adapt to climate change, there needs to be prepared sound policy and plans for flood-resistant SWM (solid waste management) for quick recovery from flood damage and for sustainable development.

At the Thailand flood occurred in 2011, UN-ESCAP pointed out that lack of country-wide governance of water management, and it was seen that in Thailand may not be natural disaster but rather human disaster to worsen the natural calamities. Mega-cities that have been developed in this region would be going through challenges to maintain and to develop the urban function under threat of flood.

On the other hand, vulnerable middle scale cities in this region would face more serious situation, where financial and technological capacity is not enough compared to mega-cities. SWM is an essential service which makes city livable. Collapse of this activity by sudden natural disasters will directly lead to collapse of city. Since occurrence of frequent and mega scale flood has been so familiar in pluvial countries such as Thailand, Laos, Vietnam, or in the Philippines, it is necessary to prepare strategic SWM adapting to flood.

This study aims to propose a model of resilient and adaptable solid waste management against flood in Asian tropical/pluvial countries, in order to adapt to frequent flood events that would be influenced by climate change. At the beginning of the study, current situation of SWM mentioning natural disaster was investigated in Asian cities under threat of frequent flood event in order to find out the resilience/vulnerability of SWM plan against flood.

The project methodologies were based on the site investigation, system/politics analysis and documentation of flood-resistant SWM in SEA. The methodology used in each research group is summarized as follows:

(1) Document survey and interviewing were executed for evaluating current SWM plans mentioning natural disaster in Hue in Vietnam, and Bangkok and Ayutthaya in Thailand, that is well known to be familiar with frequent or mega scale flood in recent years. Simultaneously recent damage of natural disaster and the way of management of waste derived from the disaster has been inspected.

(2) Evaluation tool for vulnerability of SWM plan against flood were developed by feedback of results from the investigation (1). Flood-resistant SWM will be evaluated by scoring, ladder charts or diagram methods using factors of preparation of fund, machinery, dissemination, and feasibility, applicability etc. The tool is used for evaluation of current SWM plan in each target city.

(3) Vulnerable point of current SWM was discussed with local practitioners thorough the capacity development workshop, and the improvement actions were proposed in selected cities in Thailand and Vietnam for resilient urban system adapting flood by restructuring current SWM.

(4) Methodology of restructuring of SWM was compiled as a guideline and was disseminate to other Asian city through the workshop on transfer of knowledge and experience for flood-resistant SWM in middle scale and small scale municipalities in SEA.

3. Results & Discussion

(1) A series of field investigation and interview surveys revealed that a new planning framework for solid waste management at provincial level was being introduced (as of Nov. 2014), and some flood waste management guidelines had been developed at the national level. However, there is no particular plan at the local level that deals with flood waste management, and development of local capacity is still a challenge. It was reaffirmed that a tool that could be used by local officers to enhance their flood waste management capacity would be helpful. As for the management method of flood waste, the main findings are as follows;

- Flood waste management is undertaken in three phases, namely, before flood phase (i.e. from flood warning until inundation), during flood phase (during inundation), and after flood phase (after inundation until completion of flood waste disposal)
- Main activities in before flood phase include information gathering and analysis, arrangements for additional waste management resource (e.g. pick-up trucks, temporary storage sites), clean-up of roads and curb sides (emergency pick up), and flood waste prevention practice at households (e.g. evacuation of goods to higher place).

- Main activities in during flood phase include information dissemination (e.g. giving order to the public to store general waste in house when during flood), collection, transportation, and disposal of general waste and its ancillary activities (e.g. preparation of boats for collection).
- Main activities in after flood phase include information dissemination (e.g. information on temporary storage sites), collection, transportation, and disposal of flood waste and its ancillary activities (e.g. requesting additional budget and equipment).
- Some distinctive flood waste management strategies were identified, including mutual assistance framework for flood waste collection among municipalities, local cleaning campaigns ("Big cleaning day"), special waste collection method developed for during flood phase (using boats and walkways above water), and flood waste reduction based on local knowledge (e.g. high-floored housings, neighbourhood support on evacuation of household goods).
- Challenges of current flood waste management were identified, including disorganized command line, lack of safety equipment, inefficient collection vehicles, flood vulnerable flood transportation facility, and lack of preparedness plan and strategic planning.

Based on these findings, it could be concluded that the disaster waste management framework developed from the Japanese experience, in which necessary functions are organized in 5 categories including operations, command, logistics, finance/administration, and planning, is also applicable in Thailand. In addition, some important perspectives that should be included in the vulnerability assessment tool were identified, including the need to put light on both normal and emergency waste management system, incorporation of resilience of residents experiencing seasonal flood, and development of basic information related to flood risks and land use.

(2) A spreadsheet based tool to evaluate the vulnerability of solid waste management was developed. It was opened to the public and is available at the following website (http://waste-management.asia/2015/08/666). The primary aim is to highlight the issues that need to be tackled to enhance resilience of the waste management system. Based on the key conceptual components of vulnerability and resilience (namely, exposure, sensitivity, capacity to absorb, capacity to respond, adaptability, and transformability) retrieved from literatures and past experience of flood/disaster waste management in Japan, Thailand and Vietnam, the evaluation framework was designed.

The evaluation framework consists of six different vulnerability issue categories, with two to three criteria under each issue. The vulnerability issues are; (a) Reduce flood impact on usual waste management system (b) Secure flood waste management resources, (c) Adaptively plan and implement plan for flood waste management (d) Prevent flood impact on buildings and infrastructures (e) Develop coping capacity of the people (f) Improve vulnerability condition (Table 1). Evaluator need to answer questions (indicators) listed under each criterion, firstly by "Yes/No" and then by giving a score (1, 2, or 3) indicating the quality of the effort being questioned. The questions are weighted based on expert judgement, and scores will be calculated automatically for each criterion and vulnerability issue. The results will be presented in both table and diagram. In order to mitigate biased evaluation result, and also to enhance learning and capacity development, the evaluation work is intended to be done in a workshop, which will be also presented in this session.

Table 1. List of vulnerability assessment criteria

(a) Reduce impact of flood on waste management system	
	a.1 Waste management facilities are not exposed nor sensitive to flood
	a.2 Equipment for waste management system are not damaged by flood
(b) Secure flood waste management (FWM) resources	
	b.1 There is enough capacity in locality to temporary store waste
	b.2 The city has or can obtain enough resource to manage FW
(c) Adaptively plan for/implement FWM	
	c.1 Necessary plans and rules for flood waste management are prepared
	c.2 The ability of adaptive planning and management is sufficient
	c.3 Basic information necessary for planning appropriate and smooth FWM is available
(d) Prevent flood impact on building and infrastructure	
	d.1 Most of the housings will not be affected by flood
	d.2 Most of the factories and infrastructures will not be affected by flood
(e) Develop coping capacity of the people	
	e.1 Residents can effectively evacuate their household goods before the water arrives
	e.2 Residents can effectively separate, store, and dispose waste during and after flood.
	e.3 Socially vulnerable people are appropriately empowered to avoid social injustice
(f) Improve vulnerable condition	
	f.1 There is a system that enable improvement of FWM capacity
	f.2 There is a system that enable learning from previous flood events

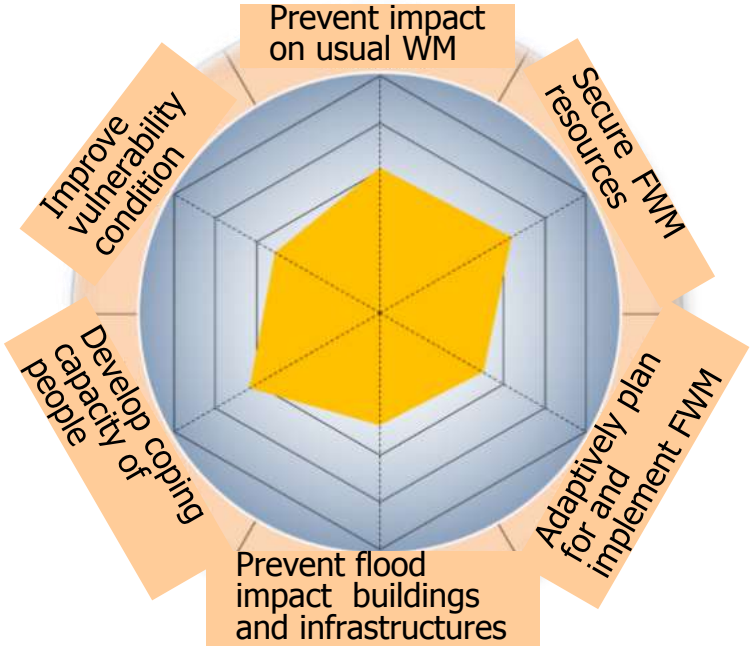

Figure 1. Example of output results

(3) Three capacity development workshops were held in Thailand and Vietnam in which the local waste management officers discussed vulnerabilities and key preparedness activities using the tool developed in (2). The aim was two-fold; to gain feedbacks on the tool from local practitioners to check the validity of tool design, and to clarify the effectiveness of the use of tool in a workshop.

Officers and practitioners of waste management were invited to the workshops (Table 2.). The timetables of the workshops are shown in Table 3. Participants were asked to use the vulnerability assessment tool in advance of the workshop. After a lecture on the basics of flood waste management, participants were asked to (re)evaluate their vulnerability in groups. Based on the evaluation results, a group discussion on key preparedness action was undertaken in groups. Final comments were given from experts, and a questionnaire survey was undertaken in which the performance and effectiveness of the tool and the workshop was asked.

Table 2. List of capacity development workshops

Place	Bangkok, Thailand	Bangkok, Thailand	Hue, Vietnam
Date	17 Jun. 2015	18 Jun. 2015	16 Jul. 2015
Participants	19 local officers from Bangkok (manager level: 0%, staff level: 100%)	4 local officers from Ayutthaya (manager level: 25%, staff level: 75%)	16 local officers, 3 practitioners from Hue and surrounding urban areas (manager level: 47%, staff level: 53%)

Table 3. Timetable of the capacity development workshop

10:00-10:05	Opening remarks
10:05-10:30	Lecture “Introduction to Flood waste management”
10:30-12:30	Evaluation of vulnerability using the Vulnerability Assessment Tool - Introduction to evaluation work (10 min.) - Evaluation work by groups (110 min.)
12:30-13:30	Lunch
13:30-13:50	Presentation on evaluation results
13:50-15:20	Identification of key actions to overcome vulnerability - Instructions and Icebreaker (15min.) - Idea sharing with post-its (15min.) - Structuring idea based on affinity diagram (35min.) - Prioritizing idea (10min.) - Presentation (15min.)
15:20-15:50	Wrap up
15:50-16:00	Questionnaire survey

89 (Thailand) and 116 (Vietnam) ideas and opinions were expressed in the discussion of the key preparedness actions. They were classified into 6 categories corresponding to the vulnerability assessment criteria (Fig 1). The issue numbers (i.e. (a)~(f)) correspond to the numbers of vulnerability assessment criteria shown in Fig x. The analysis shows that the discussion was consistent with the framework of the vulnerability assessment tool. It also shows that issues related to limitation of human resources, budget, equipment, and facilities for flood waste management (Issue (b)) were discussed most extensively, whereas issues related to flood risks on waste management facilities and other infrastructures (issues (a) & (d)) were covered less. As an overall trend, ideas on “what” were presented (e.g. “encouraging financial support for flooded areas”), but there were much less opinions on the specific actions necessary to realize those ideas.

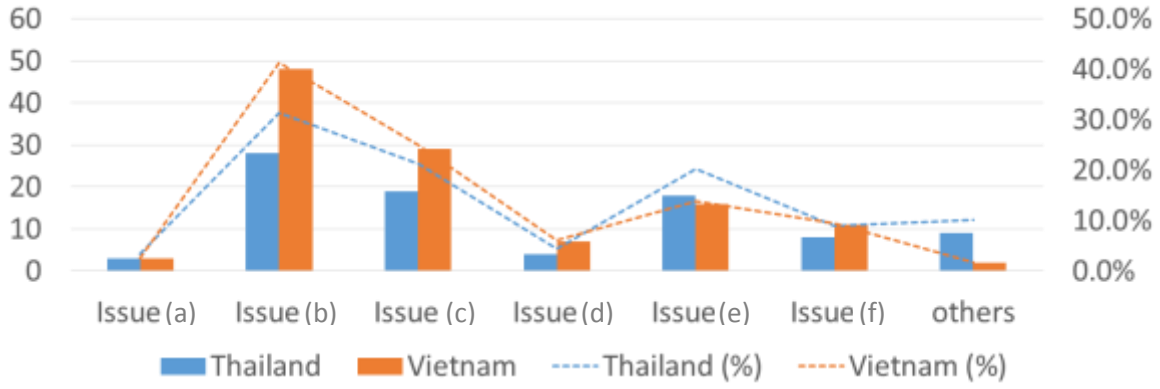

Fig 2 Results of the discussion organized by vulnerability issues

The evaluation results of the tool and workshop is presented in Fig 3 and Fig 4 respectively. Although there were some participants who felt difficulty in understanding the meaning of the

indicators, the indicators themselves were mostly evaluated as appropriate. Similarly, although some participants felt that the assessment work required by the tool is too heavy, the tool was mostly evaluated positively in terms of its usefulness and user friendliness. Regarding the effectiveness of the workshop, participants showed positive attitude towards preparedness actions. Participants showed slightly less confidence regarding the knowledge on key preparedness actions, which is considered to be consistent with the fact that participants had less discussion on detailed actions.

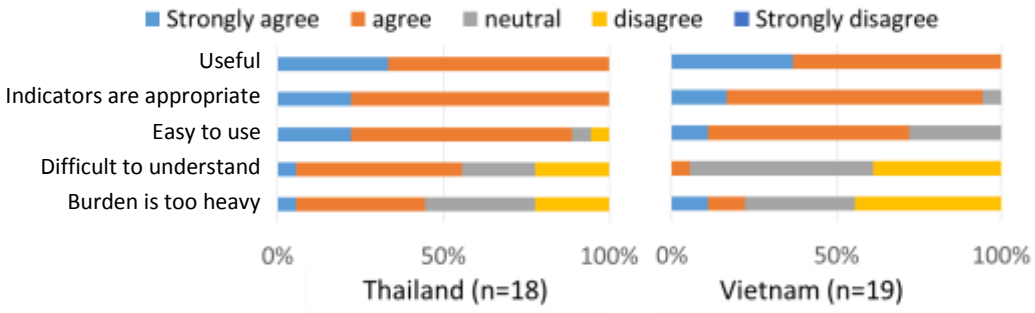

Fig 3. Results of questionnaire regarding the evaluation of the vulnerability assessment tool

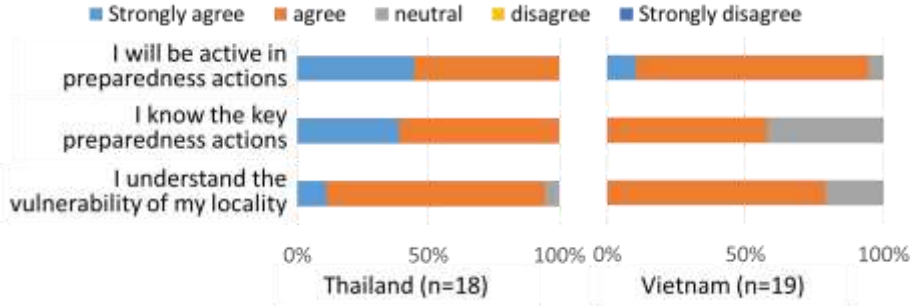

Fig 4. Results of the questionnaire regarding the evaluation of the workshop effectiveness

Based on the above results, it was suggested that the tool was effective in gaining better understanding of the vulnerability issues regarding flood waste management. It was also suggested that the workshop approach is useful to enhance motivation on preparedness actions. In order to enhance effectiveness of workshop, it should be designed to have participants discuss actions in more detail, for example, by involving managers and officers from different sectors.

(4) From the results obtained through this project, we proposed the methodology of restructuring of SWM to be flood-resistant one for the middle and small scale municipalities in SEA.

From the evaluation of flood waste management in municipalities in SEA as shown in above, preparedness action must be strongly required for restructuring the SWM plan as follows; (1) Check the command system in emergency case. (2) Estimate the flood damage and prevent/mitigate the vulnerable condition in advance. (3) Secure the SWM to be flood resilient. In the context of recovery from disaster situation, flood-resilient SWM must not be a resilient SWM in general, but system should be enabled to bounce back from the situation. (4) Mobilize the resource such as human, machinery or equipment, land (space), and

monetary. Cooperative association to external (e.g. industries, NGOs, other municipalities) or international organizations can be prepared. Municipal or public land other than evacuation area should be reserved for the temporally waste storage and vehicle parking.

Further, following points were stressed to take into consideration thorough the discussion with the experts at the wrap-up seminar held in Tokyo in February 2016. (a) Capacity building of the human resources for flood waste management must be necessary for preparedness action. In especial, there is a priority for development of human resource who can play a role as leader or facilitator in the flood waste management. Framework for the addition of incentive to the officers who knows disaster waste management is required. (b) Assistance by external actors would be necessary to realize the importance of flood waste management even though it should support the quick recovery from disaster situation. Preparedness of human networking enrolling the regional stakeholders will greatly help the initial action on flood situation. Interactive communication to be advised from external actors is important. (c) Command system at flood situation must be launched with the integration of the several relating authorities. Security affairs officers play a role as a facilitator under the authority of the provincial governor and don't belong to each municipality to avoid the confliction derived from segmentation. (d) Results of the assessment of current SWM plan and the capacity must be linked to policy making and implementation. This evaluation and feedback are taken place by periodically, even if they have not experienced natural disaster. (e) Cooperative actions from the industry to construct flood-resilient SWM (or flood resilient society itself) must be encouraged since it directly connects to their business continuity plan. The strong backbone of regional industry will support the quick recovery from the disaster damage.

These points should be regarded as more common issue for better management of flood waste in SEA, especially in the resources-limited municipalities. The knowledge is going to disseminate continuously to other Asian cities through the several media or events in future.

4. Conclusions

In order to adapt to frequent flood events that would be influenced by climate change, we have conducted the research to propose a model of resilient and adaptable solid waste management against flood in Asian tropical/pluvial countries. Investigation on current situation of SWM during and after natural disaster revealed the resilient and vulnerable points in regional society against flood under threat of frequent flood event. Vulnerable condition on the command system in emergency and the mobilization of monetary resource in Thailand was indicated, whereas the human resources who can take a leadership or facilitate in flood waste management are necessary in Vietnam. In both cases, preparedness action can contribute to solve these vulnerabilities, and the development of capacity of the person who serves for municipal work should be necessary. An evaluation tool for vulnerability of SWM system against flood was developed and applied for Asian municipalities. Flood-resistant SWM will be evaluated by scoring, ladder charts or diagram methods using factors of preparation of fund, machinery, dissemination, and feasibility, applicability etc. The tool is used for evaluation of current SWM plan in each city. Vulnerability of SWM against flood was identified by local practitioners at the capacity development workshop, and the importance of resilient urban system adapting flood by restructuring current SWM was realized. Interactive cooperative assistance in emergency

case between municipalities or between municipality and industries/NPOs were also included in the proposed flood-resistant SWM. Methodology of restructuring of SWM was compiled as a guideline and was disseminate to other Asian city through the workshop on transfer of knowledge and experience for flood-resistant SWM in middle scale and small scale municipalities in SEA.

5. Future Directions

At the completion of this project, some areas of work are still remained for the further improvement.

1) Developed vulnerability assessment tool is tested by limited number of municipalities. During this project, field officers of the municipalities have evaluated their current vulnerability on flood waste management in their cities. However, we want the decision making officers to use this tool in the future because most of the commands in flood waste management phases are made by the decision making officers of the municipalities. It is important for the decision making officers to be able to identify the vulnerable area of infrastructures and system to appropriately implement flood waste management.
2) One planned activity we could not implement during this project was to promote the mutual cooperative agreement between local government and external actors. Assistance by external actors would be necessary to realize the importance of flood waste management. Preparedness of human networking enrolling the regional stakeholders will greatly help the initial action on flood situation.
3) Vulnerability assessment tool and the flood waste management guidelines for Bangkok could be applied to other Asian flood-prone cities. National Institute for Environmental Studies is pursuing the Emergency environmental management research. Within this research framework, we will continue to upgrade the contents of vulnerability assessment tool and the Flood waste management guidelines for Bangkok.

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Appendix

Conferences/Symposia/Workshops

Agenda/Programme (including title, date and venue)

Participants list (comprising contact details of each participant, including organisation, address, phone number, fax number, and email address)

Capacity Development Workshop for Flood Waste Management in SEA mid-scale cities				
Date: 17th of June, 2015				
Participants: BMA Department of Environment, District officers				
Venue: Bangkok, Thailand				
Bangkok	Time	Contents	In charge	Remarks
	10:00~10:05	Opening remarks	Dr. Yamada	
	10:00~10:30	Introduction to FWM	Dr. Ishigaki	
	10:30~10:50	Introduction (20)	Introduction: Dr. Tajima Overall facilitator: Aj. Sirin Facilitator: Dr. Komsilp Facilitator: Dr. Thantip Facilitator: Mr. Nopparprit Record keeper:	
		- Background and Objectives		
		- Instructions		
	10:50~11:20	Identifying FWM resources (30)		
	11:20~12:30	Evaluation of vulnerability (works in each locality) (50)		
		Presentation (20)		
	12:30~13:30	Lunch		
	13:30~15:10	Introduction (10)	Overall facilitator: Aj. Sirin Facilitator: Dr. Komsilp Facilitator: Dr. Thantip Facilitator: Mr. Nopparprit Record keeper:	
		- Objectives		
		Instructions		
		Icebreaking		
		Following activities conducted in a group. Participants are divided into 2-3 groups consisted of different municipalities/districts		
		Identifying preparedness actions (60)		
		*Braingstorming and categolizing appropriate actions for flood waste management		
		*Voting on the actions based on feasibility by group members		
		*Presentationby each group (20)		
	15:10~15:45	Wrap up	Overall facilitator: Aj. Sirin Feedbacks from Japanese researchers: Dr. Yamada, Dr. Hirayama Record Kepper:	
		- Comments and feedbacks from JP researchers		
		- Next step		
		- Closing remarks		
	15:45~15:55	Questionnaire survey		
	15:55~16:00	Closing remarks	Aj. Sirin	

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	Mr.	Pirun	KlamKlay	Khlong Sam Wa			
	Ms.	Praphaporn	Ampolpong	Khlong Sam Wa			

Capacity Development Workshop for Flood Waste Management in SEA mid-scale cities				
Date: 18th of June, 2015				
Participants: PAO officers, Sena municipality				
Venue: Bangkok, Thailand				
Bangkok	Time	Contents	In charge	Remarks
	10:00~10:05	Opening remarks	Dr. Yamada	
	10:05~10:30	Introduction to FWM	Dr. Ishigaki	
	10:30~10:45	Introduction (15)	Introduction: Dr. Tajima Overall facilitator: Aj. Chart Facilitator: Dr. Komsilp Facilitator: Dr. Thantip Facilitator: Mr. Nopparprit Record keeper:	
		- Background and Objectives		
		- Instructions		
	10:45~11:15	Identifying FWM resources (30)		
	11:15~12:15	Evaluation of vulnerability (works in each locality) (60)		
	12:15~12:30	Presentation (15)		
	12:30~13:30	Lunch		
	13:30~15:20	Introduction (20)	Overall facilitator: Aj. Chart Facilitator: Dr. Komsilp Facilitator: Dr. Thantip Facilitator: Mr. Nopparprit Record keeper:	
		- Objectives		
		Instructions		
		Icebreaking		
		Following activities conducted in a group. Participants are divided into 2-3 groups consisted of different municipalities/districts		
		Identifying preparedness actions (70)		
		*Braingstorming and categolizing appropriate actions for flood waste management		
		*Voting on the actions based on feasibility by group members		
		*Presentationby each group (20)		
	15:20~15:50	Wrap up (30)	Overall facilitator: Aj. Chart Feedbacks from Japanese researchers: Dr. Yamada, Dr. Hirayama Closing remark: Aj. Chart Record Kepper:	
		- Comments and feedbacks from JP researchers		
		- Feedbacks from participants		
		- Closing remarks		
	15:50~16:00	Questionnaire survey		

No.	Title	Name	Surname	Institute/Company	Telephone	Fax
1	Mr.	Naowarat	Kalwop	Sena Municipalilty	035 201 380 086 226 0123	035 201 560 - 214
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4	Mr.	Prathurng	Pruksaphon	Pak Hai		

CAPACITY DEVELOPMENT WORKSHOP

FOR FLOOD WASTE MANAGEMENT IN SEA MID-SCALE CITIES

Time: July 16th, 2015

Venue Green Hotel, Hue City, Vietnam

Program

9:00~9:30	Registration
9:30~10:00	Opening speech by NIES's Representative (Dr. Tomonori Ishigaki) Welcome speech by HUSC's Representative (Dr. Vo Thanh Tung, Vice-Rector) Group photo
10:00~10:30	Introduction to FWM
10:30~10:45	Short break
10:45~12:30	Introduction (20) - Background and Objectives - Instructions - Ice breaking Evaluation of vulnerability (works in each locality) (60)
12:30~13:30	Lunch
13:30~15:10	Presentation of Vulnerability Assessment Tool (20)

	Introduction (10) - Objectives - Instructions *Following activities conducted in a group. Participants are divided into 2-3 groups consisted of different cities/towns.* Raise any issues in the vulnerability assessment tool and categorize them(30) *Write down any preparedness actions to solve the issues raised above* Identifying preparedness actions (40) - Share opinions and categorize Presentation (20)
15:30~16:00	Wrap up - Comments and feedbacks from JP researchers - Comments from participants - Next step - Closing remarks - Certificate
16:00~16:15	Questionnaire survey

LIST OF PARTICIPANTS
CAPACITY DEVELOPMENT WORKSHOP ON FLOOD WASTE MANAGEMENT
Time: July 16th, 2015
Venue: Green Hotel, Hue city

No.	*Full name*	*Organization*	*Position*	*Section*
1.	*Le Thi Minh Hien*	*Hue city, Thua Thien Hue Province*	*Officer*	*Env.&Nat. Res.*
2.	*Ha Trong Hai*	*Hue city, Thua Thien Hue Province*	*Officer*	*Urban Management*
3.	*Tran Quang Tap*	*Hue city, Thua Thien Hue Province*	*Officer*	*Urban Management*
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5.	*Phan Thanh Tan*	*Huong Tra Town, Thua Thien Hue Province*	*Officer*	*PC's Office*
6.	*Ngo Thi Thu Van*	*Huong Thuy Town, Thua Thien Hue Province*	*Officer*	*Env.&Nat. Res.*
7.	*Vo Kim Manh*	*Huong Thuy Town, Thua Thien Hue Province*	*Officer*	*Env.&Nat. Res.*
8.	*Le Quang Long*	*HEPCO, Thua Thien Hue Province*	*Engineer*	*MSW collection*
9.	*Le Phuoc Quang*	*HEPCO, Thua Thien Hue Province*	*Officer*	*Planning*
10.	*Mai Thi Minh*	*DOC, Thua Thien Hue*	*Deputy Head*	*Infrastructures*

	Thuy	*Province*		
11.	*Ly Thanh Trung*	*DONRE, Thua Thien Hue Province*	*Officer*	*Env.&Nat. Res.*
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13.	*Nguyen Chi Tam*	*Hoi An city, Quang Nam Province*	*Officer*	*Env.&Nat. Res.*
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17.	*Tran Quang Khoa*	*Dong Ha city, Quang Tri Province*	*Officer*	*Env.&Nat. Res.*
18.	*Le Anh Tai*	*Quang Tri Town, Quang Tri Province*	*Head*	*Env.&Nat. Res.*
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Funding sources outside the APN

None.

List of Young Scientists

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I've learn about process how to prepare flood waste before flood occur, how to solve the problem when and after flood affect. Case studies from Ayutthaya and Hue are quite similar, people knows what will happen to them due to the frequency of flood. They accept flood and have know-how to manage flood waste. Evaluation tool that presented by NIES is interesting. If all local government uses this tool to evaluate, it should be helpful for central government to support properly. However, this tools must consider about consist factor with real situation in each country.

Glossary of Terms

BMA: Bangkok Metropolitan Administration

DWM: Disaster waste management

NIES: National Institute for Environmental Studies

NPO: Non-Profit Organization

SEA: Southeast Asia

SWM: Solid waste management

UN-ESCAP: United Nations Economic and Social Council of Asia and Pacific