

Theory and practice of pre-disaster planning for disaster waste management

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ABSTRACT: In order to facilitate quick, efficient, yet sustainable disaster waste management, it is believed that Disaster Waste Management Planning (DWM Planning), i.e. pre-disaster planning of disaster waste management strategy to improve preparedness, should take place. Although the same claim has been made repeatedly in government guidelines, in reality, the effectiveness of DWM Planning seems less promising. This study takes the first step to base our DWM Planning practice on sound theoretical background. For this, principles and criteria for effective DWM Planning was established based on literature survey and interviews, followed by an evaluation of current Japanese practice. The results suggest that 1) the principles/criteria are useful in highlighting the strengths and weaknesses of DWM Planning in practice, and 2) while pro-forma increases the number of DWM Plans, without continuing process of DWM Planning, it does not contribute to improved preparedness.

KEYWORDS: Disaster waste management, preparedness, emergency planning

1. INTRODUCTION

1.1 Background and aim of study

Disaster waste management (DWM, hereinafter) is one of the key considerations in disaster management, as disaster wastes affect the lifesaving activities, sanitary conditions of the public, and the quickness and quality of the longer term rehabilitation. In order to facilitate quick, efficient, yet sustainable disaster waste management from the early response phase, it is widely believed that DWM Planning should take place before a disaster occurs (Ministry of Environment, 2012; UNOCHA, 2012; USEPA, 2008; FEMA, 2007).

However in reality, it was evident in the case of Great East Japan Earthquake that pre-disaster planning for DWM and its effective implementation rarely happens. Preparation of a DWM Plan is strongly recommended by the national government,

but recent survey revealed that even after the Great East Japan Earthquake, the number of municipalities prepared with such a plan is not high (Chubu Regional Environment Office, 2012). There was also a general sense of incompetency of such a plan, among the devastated municipalities that managed huge amount of disaster waste after the event. One common argument is that such a response manual would be useless for “unexpected” events, just like the massive tsunami waves of the Great East Japan Earthquake. A similar reluctance toward DWM Planning has been reported in Australia as well (Brown et al., 2011a). Nevertheless, governments and researchers are encouraging production of DWM Plans more than ever (e.g., Ekici et al., 2009; Ministry of Environment, 2012). There clearly is a gap between theory and practice.

It is therefore important to firstly revisit the theoretical background for pre-disaster planning for

DWM, and to evaluate the current practice based on it. As DWM Planning is a common element of disaster preparedness elsewhere in the world, lessons learnt from one of the most disaster prone country, Japan, should have valuable implications for international audience.

This study takes the first step to base our DWM Planning practice on sound theoretical background.

1.2 Study method and structure

Firstly, existing theories on DWM Planning, and more generally, on effective preparedness (emergency) planning are reviewed to establish the reason and ideal approaches (i.e. principles) for DWM Planning. This will be followed by a proposal of a set of criteria for effective DWM Planning. Compared to the relatively recent recognition of the importance of preparedness planning in the waste management sector (Brown et al., 2011b), conditions for effective preparedness plan has been empirically studied over 30 years in the disaster management field. For example, Kartez and Lindell (1987) revealed the positive impact of planning exercise on the number of good disaster management practices adopted in local authorities. Secondly, an overview of the current situation in Japanese DWM planning will be introduced, followed by an evaluation of its effectiveness by the criteria mentioned above.

The first tier of the study is based mainly on academic literature survey, supplemented by interviews to local government officials responsible for DWM Planning from ten different authorities¹ in Japan. The second tier is based on government reports, guidelines, plans, and interviews.

2. Theories of pre-disaster planning for disaster

¹ Sendai city, Natori city, Kochi city, Nagoya city, Kumano city, Yokkaichi city, Aichi prefecture, Gifu Prefecture, Kochi Prefecture, Mie Prefecture

waste management

2.1 Definition of Disaster Waste Management Planning

Currently, there seems to be no clear definition of what constitutes DWM Planning both in the academic literatures and in practical guidelines. Different terms are being used, for example, “debris management planning” in the US (USEPA, 2008), and “disaster waste management contingency planning” in the UN (UNOCHA, 2012). Here, considering that DWM Planning is a form of preparedness planning in the waste management sector, we define DWM Planning as “a management process that establishes arrangements in advance of a disaster to enable timely, efficient, effective, and appropriate response to wastes generated by disasters”, based on the definition of preparedness planning made by UNISDR (UNISDR, 2009). It is important to note that the aim of DWM Planning is improved preparedness, rather than production of a written plan (as discussed further in 2.2). Disaster wastes would be managed (collected, transported, intermediately treated, and disposed) one way or another regardless of the existence of a pre-disaster planning exercise, but the timeliness, efficiency, effectiveness and appropriateness of such action would depend on how well agencies were prepared through planning. In addition, good DWM Planning is expected to be useful upon negotiating technical and financial assistance from government bodies (UNOCHA, 2012; USEPA, 2008).

2.2 Principles of effective DWMP

Here, we will provide a list of principles for effective DWM Planning, i.e., aspects of DWM Planning that leads to improved preparedness. The list mainly derives from principles and guidelines for effective preparedness (emergency) planning

proposed earlier in academic papers (Quarantelli, 1986, 1997; Perry and Lindell, 2003; Alexander, 2005). The common points made by these literatures were integrated into six principles listed below. Each of them is elaborated further considering the current debate regarding DWM (Fetter and Rakes, 2012; Brown et al., 2011a, 2011b; Ekici et al., 2009; Swan 2000), and the discussion we had with interviewees.

a) *DWM Planning should put emphasis on the continuing process (rather than its end product, a written plan), including educational and training perspectives.*

As stated by many authors, production of a written plan is not the ends in itself, but is a means to improve preparedness (Quarantelli, 1986; Perry and Lindell, 2003). In order to achieve this, the learning perspective of planning is important. Learning here does not mean mere superficial acquisition of knowledge. It also means gaining mutual understanding and profound understanding of protocols (*why* a specific action should take place). According to Quarantelli (1986), a true planning process should involve (besides production of a written plan)

- Developing techniques for training and information transfer
- Undertaking public educational activities
- Establishing informal links and ties between relevant groups
- Conducting disaster simulations and exercises
- Convening meetings for the purpose of sharing knowledge
- Thinking and communicating about future dangers and hazards
- Undertaking risk assessments
- Drawing up model laws and legislations

Hence, planning process is a continuing, never ending process. This is because knowledge about

hazard, vulnerability and capability of the community will change over time. For example, improved hazard risk assessment will lead to new estimation of disaster waste amount and composition. Availability of open space for temporary storage, local waste disposal firms, final disposal site capacity, and personnel within a local government will change. On a similar note, planning should provide testing and training components, for both publicity and examination of its function. Testing on regular basis will also allow newly assigned personnel to familiarize themselves with the response protocol.

b) *DWM Planning should address inter-organizational coordination through participation and coordination.*

This is important because many disaster response actions are actually undertaken by more than one agency. For instance, lifesaving would require coordination between military and fire department. In addition, problems arise when each discipline sees problems only in terms of its own capabilities (Kartez and Lindell, 1987). In this sense, there are two kinds of coordination to be achieved; one is to reconcile concrete conflicts, and another is to achieve mutual understanding. In achieving this coordination, Perry and Lindell (2003) note that emergency planning process is probably the most effective place.

This principle seems to apply no less to DWM Planning. Swan (2000) points out that enhanced participation in DWM Planning will promote information transfer between agencies, resulting in closer coordination during the actual disaster response. Within the context of DWM, experiences show that organizations whose work do not relate in normal circumstances need to collaborate in many respects. For example, the main organizations that

Table 1 Example of organizations that required coordination during the management of disaster wastes generated by Great East Japan Earthquake

Name of Organization	Type of Organization	Aspects that required coordination
Emergency management division	City government	Overall coordination of response activities
Civil engineering division	City government	Management of road clearance, demolition, and reconstruction work
Health division	City government	Organizing volunteers (who works for clean-up)
Waste management division	Prefectural government	Regional-scale waste treatment
Port authority	Prefectural government	Use of port backland as temporary storage site
Ministry of Land, Infrastructure, Transport and Tourism	National government	Use of recycled materials for the new dike
Ministry of Environment	National government	DWM policy, institutional arrangements
Constructors and wreckers	Private company	The actual road clearance, demolition, and reconstruction work
Industrial waste disposer	Private company	The actual separation and intermediate treatment work

took part in disaster waste management in the city of Natori on Great East Japan Earthquake are listed in Table 1. Usually, the city waste management section has nothing to do with the prefectural port authority, nor with private constructing firms. Table 1 also suggests that inter-organizational coordination is necessary throughout the entire disaster phase. Civil engineering division played a significant role in transporting disaster waste to temporary storage sites (in the response phase), whereas Ministry of Land, Infrastructure, Transportation and Tourism used the recycled materials for dike reconstruction (in the recovery phase). In terms of mitigation and preparedness, for example, land use planning division needs to be consulted regarding the seismic safety policy, and several other agencies need to be consulted for the coordination of open space usage (temporary housing, military base, etc.).

c) *DWM Planning should be based on research findings and accurate knowledge on disaster agent and response.*

The main argument here is that personal anecdotes or war stories should not be the only basis of planning (Quarrantelli, 1997). Heide (2005) also points out seven common beliefs in emergency medicine, which in fact are not necessarily true in reality. Instead of these “myths”, social science research findings should be referred to, including,

but not limited to, studies regarding institutional barriers, influence of intentions and behaviors of actors, and good practices of management. There are some research findings within the context of DWM as well, if not much. For example, Hirayama et al. (2005) showed that residents tend to separate disaster wastes better in cases where “peacetime” separation rules are adopted, compared to cases where “special” rules are existent.

Applying this principle too strictly may be problematic, especially when planners try to base their DWM Plans on “accurate” estimation of disaster waste generation. It is not possible to predict the exact amount of disaster waste upfront. As there seems to be no consensus on to what extent “accuracy” should be pursued, an alternative approach is to articulate the accuracy of the estimation DWM Planning is based on. For example, USEPA refers to the USACE Hurricane Debris Prediction Model with a note that it provides +/- 30% estimate of possible debris volumes that may be generated by various storms (USEPA, 2008). It is equally important to bear in mind that any pre-disaster prediction is not conclusive, and re-estimation needs to take place post-disaster. Research findings on the technical aspects of DWM should also be referred to, or could be included as technical guidance in the appendix of a DWM Plan.

d) *DWM Planning should focus on general principles than specific details to allow response flexibility and multi-hazard application.*

Perry and Lindell (2003) point out the following four reasons for this, based on past researches;

- Anticipation of all contingencies is simply impossible
- Very specific details tend to get out of date very quickly
- Very specific plans often contain so many details, leading to unclear or confused priorities
- More detailed planning documents tend to be larger and more complex, which makes it more difficult to use the plan as a device for training personnel

While these arguments seem to apply equally within the context of DWM, one might argue that sector specific plans (such as DMW Plans) should incorporate detailed response functions. The balance between detail and general is the key consideration.

Here, the recognition of the difference between agent-generated demands and response-generated demands described by Quarantelli could help. Agent-generated demands derive from a particular disaster agent, and as precise prediction of the type, scale, timing of disaster is impossible, these demands require more contingency approach. Response-generated demands are produced by the very effort responding organizations make to manage community disasters (e.g. evacuation is a common function for hurricanes, earthquakes, tsunamis, etc.). They could be approached by pre-planning, as they are common to all disasters (Quarantelli, 1997). Alexander (2005) notes that modern emergency planning is generic (or “all hazards”), meaning that the plan is written in general terms with specific chapters covering specific hazard types, which enables efficient planning, improved

preparedness for unexpected and/or multiple impact hazards.

Within the context of DWM, the composition of disaster wastes will vary widely according to disaster events. For example, earthquakes mainly produce disaster waste such as building materials (including wood and concrete), personal properties, whereas flood mainly generate flood damaged (wet) household items, soil, sand, mud, sediments, and materials from demolished houses (Ekici et al., 2009; Ishibashi et al., 2008). In addition, the amount of disaster waste will vary considerably between events, which will necessitate different strategies and specific technologies for each of them. On the other hand, literatures have identified some essential functions of DWM that should be discussed in pre event planning (Swan, 2000). The followings seem to be general in nature;

- Organizational structure, key staff members, and responsibilities
- Location of temporary debris management sites
- Pre event contracts and agreements
- Monitoring system to ensure sound implementation of contracts

Other essential general functions that should be discussed in DWM Planning need to be identified through further empirical research.

e) *DWM Planning should encourage appropriate and sustainable actions.*

Under emergency circumstances, there typically is a public pressure to act rapidly to recover normal life. This could lead to impulsive actions that could in fact slow down the recovery process, or actions that could have adverse impact on the environment, society, or economy (Perry and Lindell, 2003).

Appropriate and sustainable waste treatment measures are options on the upper tier of waste hierarchy, i.e. reduce, reuse, recycle and proper

disposal. In order to reuse and recycle disaster wastes, and to properly dispose hazardous substances (including PCBs and asbestos), separation is essential. On the other hand, separation of disaster wastes is time consuming, especially when they are commingled as a consequence of tsunami, hurricane, or floods. In terms of cost, there is an argument that recycle-oriented strategy would result in lower project fee compared to speed-oriented strategy in Japan (Ishibashi et al., 2008). However, a study from the US shows that excessive recycling could result in worse economic efficiency (Fetter and Rakes, 2012). This indicates that careful consideration on the level of recycling, with the local circumstances in mind, is important. Other than separation, improper temporary storage and final disposal could lead to environmental and health hazards, including groundwater contamination by heavy metal and hydrogen sulfide production (Hachimura et al., 2007). The environmental, economic, and social impact of DWM options should be assessed pre-disaster, when resource and time is not constrained. The fact that emergency legal waivers regarding environmental and health regulation tend to happen in DWM practices, observed by Brown et al. (2011), increase the significance of this principle. Measures to reduce disaster waste, such as anti-seismic enforcement of building, are elaborated in f).

f) *DWM Planning should include all four phases of disaster management, i.e., mitigation, preparedness, response and recovery.*

This point has been made by Quarantelli (1997) and Alexander (2005), but the theoretical background wasn't articulated in both. Similar concept has been adopted in DWM as well. For example, Swan (2000) develops his argument on DWM Planning using his Debris Management Cycle

model, which consists of four phases; normal operations, Increased Readiness, Response, and Recovery. However, it does not address the inter-relationships between the phases.

Nonetheless, evidence of inter-relationship between different disaster phases have been shown sporadically in researches and practices of DWM. For example, Hirayama et al. (2013) established that anti-seismic enforcement of housing (which is expected in mitigation phase) will impact the volume of disaster wastes to be landfilled (in the recovery phase). Similarly, our interview survey in Natori city indicated that demand standard of recycled materials to be used for reconstruction (in the recovery phase) affect the intermediate treatment process in the earlier stages of DWM. The extent of separation at the earlier stages is a major factor for the speed and quality of DWM.

2.3 Criteria for evaluation of DWMP

Finally, based on the discussion in 2.2, principles were converted into criteria to enable evaluation of DWM Planning practices. Among the effectiveness criteria provided in Table 2, a)~b) are mainly concerned with the process, which relates more to the learning and educational aspects. On the other hand, c)~f) are concerned more to the contents of the plan. Since the mere existence of a written plan, however fine its contents may be, is not sufficient to improve preparedness, it is important for a DWM Planning practice to equally meet criteria a)~b) and c)~f).

A common approach to make use of such criteria for evaluation is to adopt a five point scale. It is not the intention of authors to give an overall score, as the scale of measurement is ordinal, and some criteria seems to be more important than others. Instead, the criteria should help highlighting the strengths and weaknesses of the adopted DWM

Planning approach.

3. Current situation of DWMP in Japan

3.1 Institutional framework

In Japan, the municipal government is responsible for the disposal of disaster wastes. Prefectural and national government are supposed to be coordinators and advisors for municipal governments. However, in extreme events where the amount of disaster waste overwhelms the capacity of municipal government to dispose (e.g. the Great East Japan Earthquake), prefectural government had taken over some of the responsibilities of the municipal government.

In order to cope with disaster wastes quickly and

properly, the Ministry of Environment requires municipal and prefectural government to prepare a DWM Plan in their guideline, “Guidelines for Measures against Disaster Wastes” (“the Guideline”, hereinafter). Technically speaking, this requirement for DWM Plan is not legally binding. The Guideline states the basic components of quick and sound disaster management under disaster circumstances, and is intended to be referred to upon DWM Planning in local governments.

Adoption of a jurisdiction wide disaster prevention plan, “Local Disaster Prevention Plan” (“LDP Plan”, hereinafter), is legally required by the Basic Act on Disaster Control Measures. An LDP Plan outlines the duties and tasks of government bodies regarding local disaster prevention, and

Table 2 Principles and criteria for effective disaster waste management planning

Principles	Criteria
a) <i>DWM Planning should put emphasis on the continuing process (rather than its end product, a written plan), including educational perspectives</i>	a)-1: Is it based on a formalized planning process?
	a)-2: Is there any communication process between relevant actors?
	a)-3: Is the plan regularly reviewed and revised?
b) <i>DWM Planning should address inter-organizational coordination through participation and coordination</i>	b)-1: Are there opportunities to communicate with related divisions within the city council? (e.g. emergency management, civil engineering, health)
	b)-2: Are there opportunities to communicate with related divisions in regional council and national government?
	b)-3: Are there opportunities to communicate with private entities?
c) <i>DWM Planning should be based on research findings and accurate knowledge on disaster agent and response</i>	c)-1: Is the plan based on technically sound hazard impact assessment (or damage prediction)?
	c)-2: Is the plan based on knowledge on locally available resources to tackle disaster wastes?
	c)-3: Is the plan based on guidelines produced by government or expert bodies?
d) <i>DWM Planning should focus on general principles than specific details to allow response flexibility and multi-hazard application</i>	d)-1: Does it focus on the general aspects of disaster waste management? (including identification of temporary storage sites)
	d)-2: Is it applicable to different kinds of disasters?
e) <i>DWM Planning should encourage appropriate and sustainable actions</i>	e)-1: Are environmental impact of temporary staging, intermediate treatment, and final disposal options recognized?
	e)-2: Is the DWM strategy consistent with waste hierarchy (reduction, reuse, material recycle, thermal recycle, and disposal)?
	e)-3: Are procedures for the treatment procedures and facilities of hazardous substances (e.g. asbestos, PCBs) specified?
f) <i>DWM Planning should include all four phases of disaster management, i.e., mitigation, preparedness, response and recovery.</i>	f)-1: Are all four disaster phases taken into consideration?
	f)-2: Are interrelationship of phases addressed (e.g. separation plan is consistent with the final disposal options)?

provides with disaster mitigation, preparedness, response, and recovery measures. Disaster waste management component is usually included in less detail compared to DWM Plans.

As shown in Fig. 1, municipal DWM Plan needs to be consistent with the LDP Plan within its jurisdiction, as well as those plans in the prefectural level. This means, for example, every plan should be based on the same disaster impact evaluation. Maintaining consistency between plans could be challenging, considering that each plan is made by different organization/division.

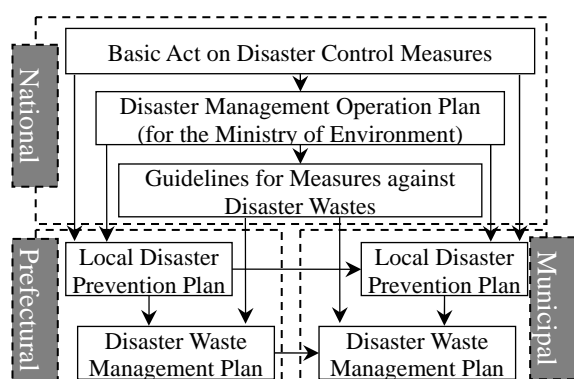


Fig. 1 Structure of preparedness planning in Japanese waste management sector

3.2 Overview of current practice

A number of public surveys had been conducted in parts of Japan to clarify the current situation of DWM Planning activities in local governments. Table 3 shows some of the results from past surveys on the number of DWM Plans adopted. The results show that DWM Planning is still not popular in Japan. The numbers are surprisingly low, ranging from 0% to 35%, considering that preparation of DWM Plan is strongly recommended by the Ministry of Environment, and massive earthquakes are anticipated to occur in Tokyo Metropolitan Area (which covers large proportion of the Kanto region) and Chubu region (Cabinet Office, 2011). A number of municipalities seem to have DWM component in their LDP Plan, ranging from

19% to 56%, but its quality is considered to be lower compared to a dedicated plan for DWM.

One common practice observed is production of guidelines and pro-forma by prefectural governments. The intention is to stimulate DWM Planning in municipalities. Past survey showed that 19 (out of 47) prefectures have already produced or intends to produce such guidelines or pro-forma, as of 2005 (Kanto Regional Environment Office, 2006). It was confirmed through interviews in Mie and Gifu prefecture, both included in those 19 prefectures, that over 90% of the municipalities have either adopted a plan or started the process of planning², most of which making use of prefectural pro-forma.

Table 3 Current status of DWMP activities (retrieved from existing surveys)

Mother population	DWM Plan adopted	DWM component included in LDP Plan
Chubu Region	35% (82/236)*	31% (73/236)*
Saitama Prefecture	0% (1/81)**	19% (15/81)**
Kanto Region	10% (38/370)***	56% (207/370)***

*Source: Chubu Regional Environment Office, 2013

**Source: SAISEIKEN, 2006. Note that this survey requested municipalities to send a copy of their DWM Plan, if any, and did not precisely ask whether the respondent had a plan or not. The actual number of municipalities that adopted a DWM Plan, or has DWM component in LDP Plan could be larger.

***Source: Kanto Regional Environment Office, 2006

3.3 Evaluation of current planning practice – a case study

Here, we will evaluate the DWM Planning and its consequences in Kumano city, using the criteria developed in 2.3. Kumano city is located in the coastline of Mie prefecture. Approximately 19,000 people live in the area of 370 sq. km. The waste management section is run by three white collar staffs, covering services from collection and disposal of general waste to more general management of the living environment. The case of Kumano city will illustrate the usability of our

² Confirmed from interviews.

criteria, and the findings resulting from the evaluation are considered to be applicable to municipalities in similar situations (a suburban-rural city with low population density and relatively small administrative human resource).

3.3.1 The characteristics of DWM Planning

The DWM Planning was based on a pro-forma prepared by Mie prefectural government. This means that the outline of the plan was already there, and the responsible staff basically had to fill in the specific names and numbers. Numbers include the

anticipated amount of disaster wastes. Throughout the planning process, no other organization had been contacted, except the prefectural waste management division which produced the pro-forma. The plan was adopted on March 2010.

The evaluation result is shown in Table 4. Firstly, it could be pointed out that most of the criteria concerned with the contents of the plan [c)~f)] scored relatively well. On the contrary, most of the procedural criteria [a)~b)] scored poorly.

3.3.2 Implementation of DWM Plan

Table 4. Evaluation of DWM Planning in Kumano City, Mie

	Criteria	Score	Justification
a)-1	Is it based on a formalized planning process?	--	Planning was based on pro-forma. No formal process in place
a)-2	Is there any communication process between relevant actors?	+	Discussion with the prefectural waste management division took place
a)-3	Is the plan regularly reviewed and revised?	--	Never since its adoption (in 2010)
b)-1	Are there opportunities to communicate with related divisions within the city council? (e.g. emergency management, civil engineering, health)	--	No communication was undertaken with other division
b)-2	Are there opportunities to communicate with related divisions in regional council and national government?	+	Discussion with the prefectural waste management division took place
b)-3	Are there opportunities to communicate with private entities?	--	No communication was undertaken with private entities
c)-1	Is the plan based on technically sound hazard impact assessment (or damage prediction)?	+	Plan is based on damage prediction made by prefecture. However, there is no regard to range or alternative scenarios
c)-2	Is the plan based on knowledge on locally available resources to tackle disaster wastes?	-	Potential temporary storage site is identified, but no option is identified. Other local resources, including personnel, equipment, private contractors are not explicitly discussed.
c)-3	Is the plan based on guidelines produced by government or expert bodies?	++	Plan is based on a pro-forma produced by the prefecture
d)-1	Does it focus on the general aspects of disaster waste management? (including identification of temporary storage sites)	++	Plan focuses on the general aspects, including role allotment, basic workflows, and potential temporary storage site
d)-2	Is it applicable to different kinds of disasters?	+	Plan assumes earthquakes and water damage, but no consideration given to other types of disasters
e)-1	Are environmental impact of temporary staging, intermediate treatment, and final disposal options recognized?	--	No explicit consideration of sustainability of treatment options
e)-2	Is the DWM strategy consistent with waste hierarchy (reduction, reuse, material recycle, thermal recycle, and disposal)?	+	Recycling is encouraged, but the priority is unclear
e)-3	Are procedures for the treatment procedures and facilities of hazardous substances (e.g. asbestos, PCBs) specified?	++	Treatment of asbestos and PCBs are articulated in specific
f)-1	Are all four disaster phases taken into consideration?	-	Response and early recovery only
f)-2	Are interrelationship of phases addressed (e.g. separation plan is consistent with the final disposal options)?	--	No. Separation is not linked with treatment and disposal options

++: sufficiently yes, +: yes, but not sufficient, -: no, but not absolutely, --: absolutely no

Kumano city was hit by a strong typhoon in September 2011. The peak rainfall was 135 ml/h, which caused flooding elsewhere. The total amount of disaster waste generated in the city was over 5,000 t. Interestingly, the DWM Plan was not referred to in this case. According to the officer who was in charge of DWM, although they knew that the plan was there, they didn't bother to open it up. The reason was because he recognized it as a product of deskwork, which would not be applicable in reality. Why did this happen?

Firstly, the DWM Plan was developed by a predecessor in the office. At the time of disaster, there was no one involved in the planning process within the waste management section. Secondly, as clearly shown in Table 4, the DWM Planning performance was poor in terms of process. More precisely, there had been no opportunity to review and revise, or use the plan for training or exercise. As a consequence, the new officer that faced the disaster could not make use of the plan. In fact, from the authors' point of view, there were some useful information in the plan, including schedules and flow charts for response action. If the DWM Plan were referred to, as one of the officer's retrospect, coordination with the prefectural government might have been undertaken more smoothly.

3.3.3 Implications from the case of Kumano city

This case underscored the significance of principles a) and b) in particular. Without proper training and reviewing process, the plan will eventually be untouched. This reflects one of the Japanese specific context. In Japan, local government officers are transferred to different divisions regularly, normally within 3 years. This was also the case in Kumano city. Under this condition, regularly review of the plan is important all the more.

Secondly, the use of pro-forma to enhance

DWM Planning at municipal level should be undertaken with caution. Although it seems to have merits in increasing the number of produced DWM Plans, as the Kumano city case illustrated, it does not necessarily lead to good DWM Planning, i.e. increased preparedness. Considering the scarcity of personnel compared to the day to day workload in the waste management sector, especially in small scale municipalities, the use of pro-forma has rational to some extent. Therefore, pro-forma should be used as a basis of continuing planning *process*, preferably with some technical assistance.

4. Conclusions

Based on theories of preparedness planning, it was confirmed that pre-disaster planning for DWM has potential to contribute to quick and appropriate disaster waste management in several ways, especially when it was recognized as a continuing process, rather than a one shot practice to produce a written plan.

The evaluation of the current Japanese practice based on our newly developed DWM Planning principles/criteria suggested that 1) the principles/criteria are useful in highlighting the strengths and weaknesses of DWM Planning in practice, and 2) while pro-forma increases the number of DWM Plans, without continuing process of DWM Planning, it does not contribute to improved preparedness.

At last, we would like to note that the list of principles and criteria is tentative, and should be empirically tested and improved further.

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