Technical reference

“Preparation before disasters occur”

1 Organizational arrangement for DWM

1.1 Organizations need to prepare special arrangements for DWM before disaster strikes

- DWM consists of various tasks that are different from the waste management of normal time
- Many stakeholders are involved, including those not involved in normal waste management operations
- In order to tackle DWM tasks efficiently/effectively and cooperate with stakeholders, organizational arrangements for DWM should be designed before disasters
- Roles, responsibilities, and coordination frameworks should be pre-identified and communicated

1.2 Functions/tasks necessary for DWM

Operations	Command	Logistics	Finance/admin.	Planning
Collection	Target setting	Human resources	Contract	Plan marking
Separation	Public relations	Equipment	Payment	Information gathering
Transportation	External affairs	Facilities	Financial source	Information sharing
Temp. Storage	Internal affairs	Systems (incl. ICT)		Information analysis
Intermediate treatment				Information support
Final Disposal (incl. recycling)				

Figure 1 Organizational functions necessary for DWM

(Source: Flood waste management Guidelines for Bangkok)

- Disaster waste needs to be collected, separated (if any), transported, stored (temporary), and disposed. Intermediate treatment will take place if necessary or available. These are the “Operations” functions.
- Other supporting functions are necessary to put forward the DWM process, including “Command”, “Logistics”, Finance/administration”, and “Planning”.

- The actual organizational structure does not necessarily need to correspond precisely with the functional structure presented in Figure 1 (e.g. some people/team might need to undertake multiple functions).

Command

- ✓ Someone (or a team) needs to set targets (e.g. time limit for DWM) and decide the overall policy for DWM to effectively manage DWM tasks.
- ✓ Public relations, or the communication of information on what, where, when, and how people should discard disaster waste is necessary to minimize post disaster confusion.
- ✓ Coordination with internal and external stakeholders (see p.2) is also important.

Logistics

- ✓ DWM requires abundant resources, e.g., human resources, heavy machinery, trucks, vehicles, facilities and open space (for temporary storage).
- ✓ A team that deals with staffing and procurement should exist.

Finance/admin

- ✓ Contracts with private waste management companies (operators) and suppliers need to take place even during emergency circumstances to ensure appropriate spending.
- ✓ As local governments are the most likely to face financial difficulties during disasters, revenues need to be secured, typically in the form of grants.

Planning

- ✓ Information on the disaster situation (e.g. estimation of disaster waste amount, recovery of roads), sanitary conditions, residents' complaints, work progress, etc.) is crucial for DWM.
- ✓ These information should be integrated as an "Implementation Plan", to be communicated with stakeholders and revised as DWM proceeds.

1.3 Some tips for effective organizational arrangement

- The command line should be unified to minimize confusion of frontline workers (operators).
- DWM tasks change over time, so the organizational structure should be flexible.
- Make sure that the main team that deals with disaster response (e.g. the disaster management committee) recognizes the significance of workload/resources necessary for DWM.

1.4 Examples in Asia and the Pacific

Example 1. Organizational framework proposed for flood waste management in Bangkok

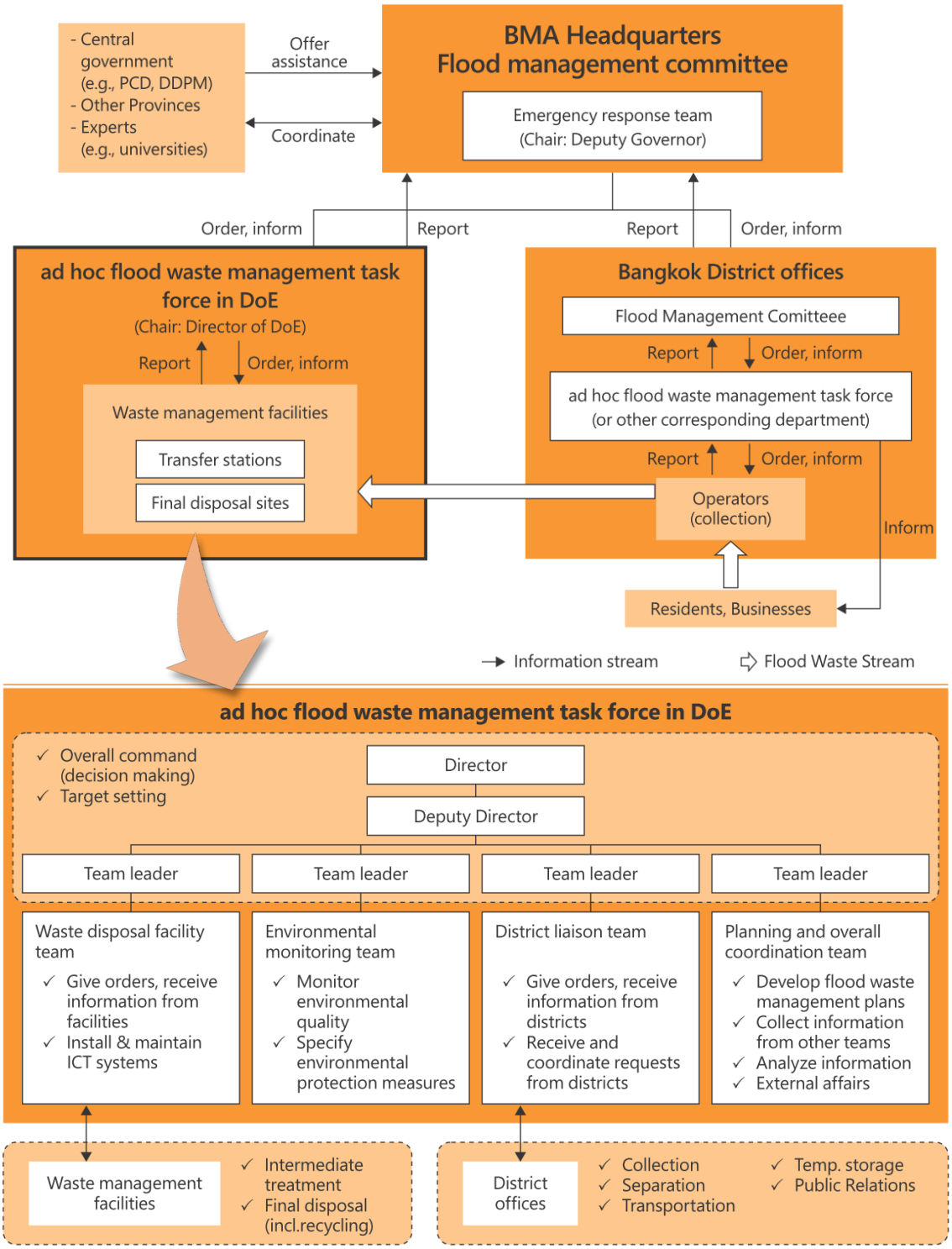


Figure 2 Organizational framework recommended for flood waste management in Bangkok (source: Flood waste management Guidelines for Bangkok)

- Based on the lessons learned from the mega-flood in 2011, international experts recommended the Bangkok Metropolitan Administration (BMA) to arrange a flood waste management task force as shown in Fig.2.
- Districts are mainly responsible for collecting and transporting waste to transfer stations. They will give orders collect reports from operators, inform residents and businesses.
- Department of Environment (DoE) of the BMA is mainly responsible for managing transfer stations, final disposal, and coordination of districts. DoE will give orders and information to waste management facilities and collect their reports. DoE will also deal with the central government, other provincial government departments, and external supporting bodies (experts).

Example 2. DWM task force for after Tropical Cyclone Winston in Lautoka city, Fiji

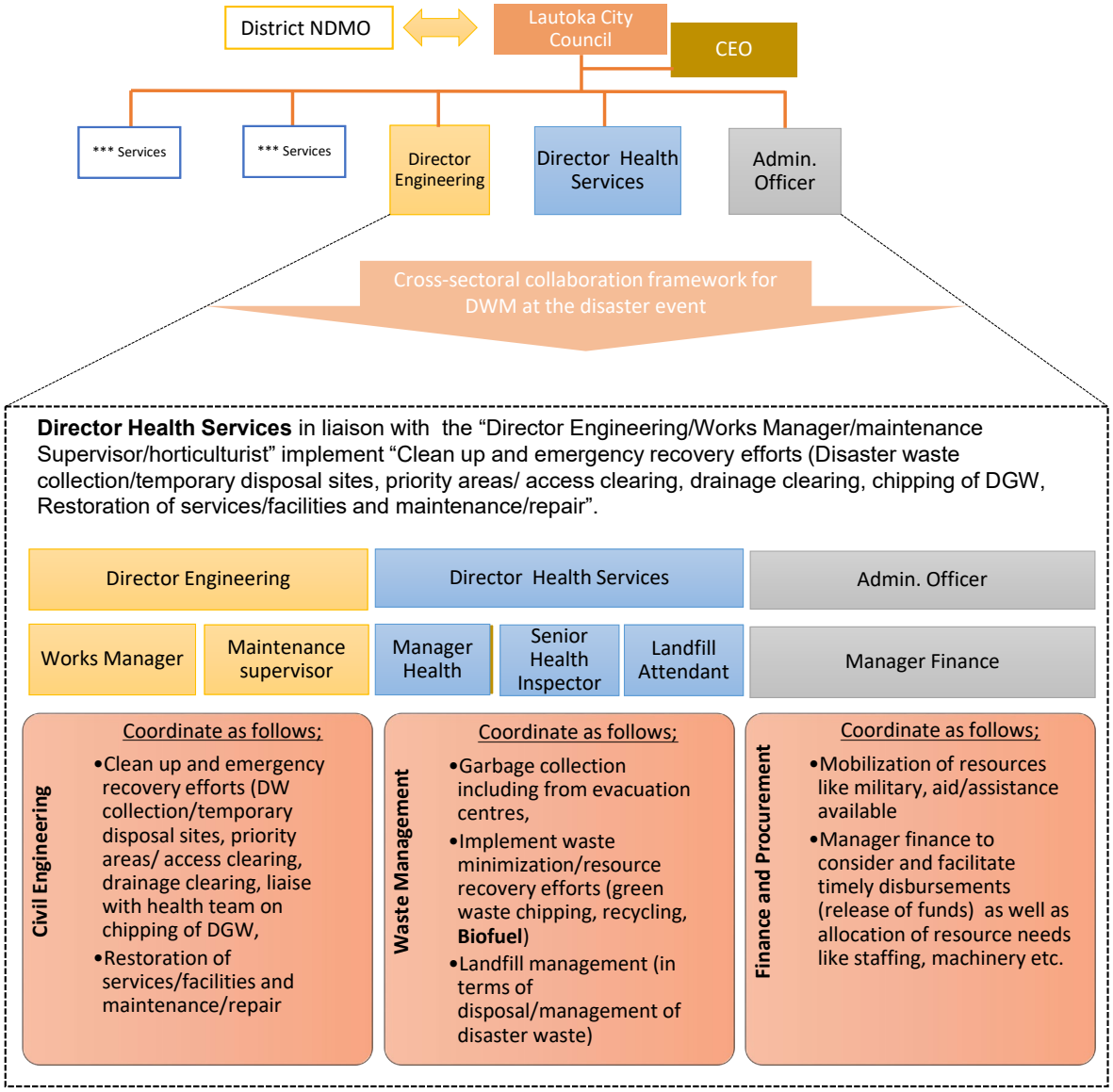


Figure 3 Organizational framework for disaster waste management in Lautoka, Fiji (Source: Shalend Singh, Senior Health Inspector, Lautoka City Council, Fiji, 2020" as a source of information)

- The National Disaster Management Office (NDMO) updates district NDMO office on councils' reports, negotiates Aid/donor agencies to secure funds and resources, coordinates Military assistance, procures machinery/equipment like chain saws/generators, etc., and coordinates work with NGOs
- DWM is responsible for local governments in assistance with the above activities supported by NDMO. Lautoka City Council conducts DWM with the following framework.

Example 3 Pilot Project on Multilateral Stakeholder Involvement for DWM in Honiara, Solomon Islands

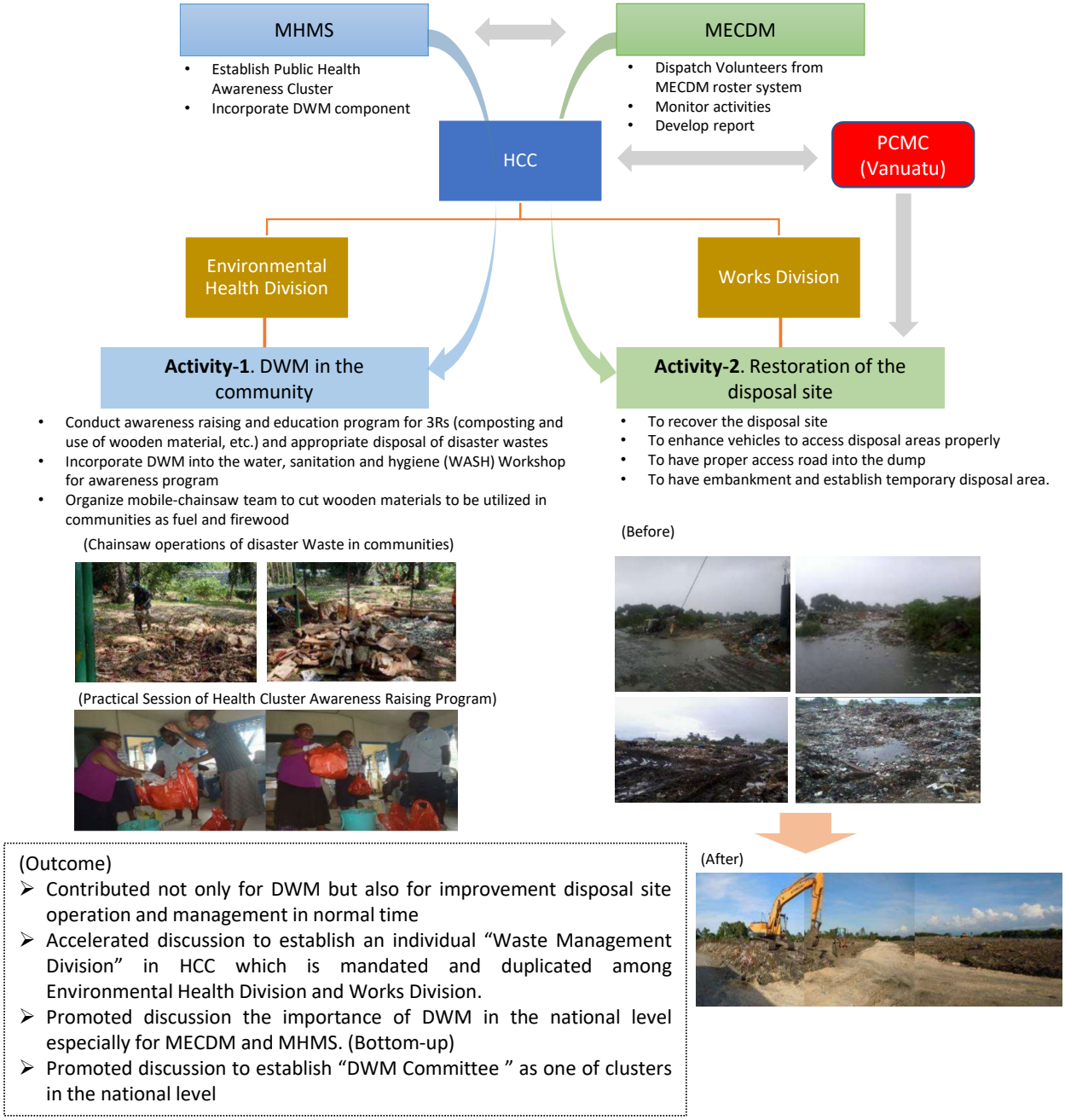


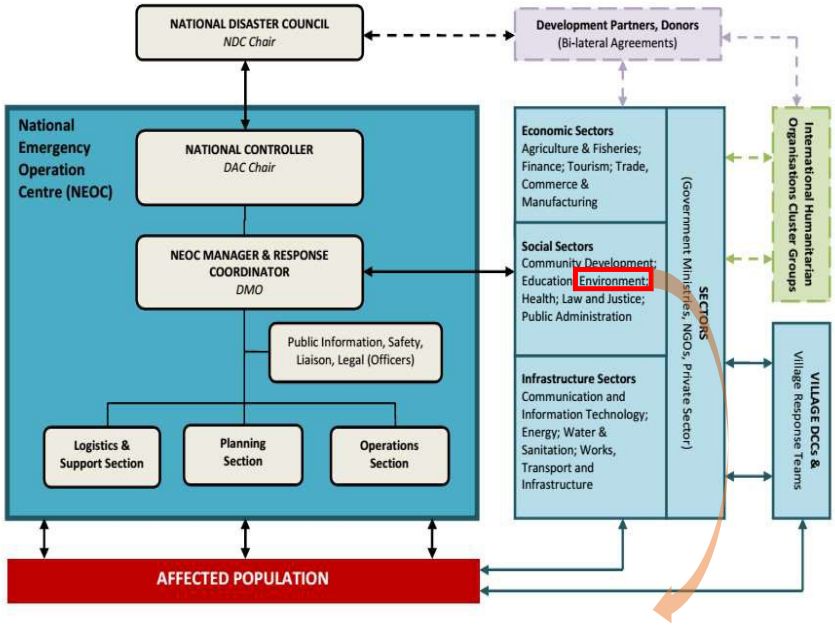
Figure 4 Institutional arrangement to conduct a pilot project on DWM in Honiara, Solomon Islands

(Source: The Report on J-PRISM Disaster Waste Management Pilot Project in Honiara, J-HOPE/MECDM, 2014)

- In April 2014, heavy rainfall poured over the Solomon Islands which resulted in massive flash flooding in the capital city of Honiara and other parts of the country.

- The flood has left a total of 22 people confirmed dead and more than 9000 affected with the loss of homes, properties, livelihoods, and basic infrastructures such as road access and bridges damaged and destroyed.
- The pilot project for DWM was established by Honiara City Council (HCC), Ministry of Environment Climate Change Disaster Management and Meteorology (MECDM), and Ministry of Health and Medical Services (MHMS) in assistance with the J-PRISM Project funded by JICA.
- The Landfill supervisor from Port Vila Municipality Council (PVMC), Vanuatu also joined to support the restoration of the disposal site in Honiara damaged by the flood through the sister city cooperation.
- The Solomon Islands had no experiences in place to manage disaster waste in the past by then.

Example 4. Unique organizational arrangement in Samoa



Group members' role for DWM coordinated by Ministry of Natural Resources and Environment (MNRE)

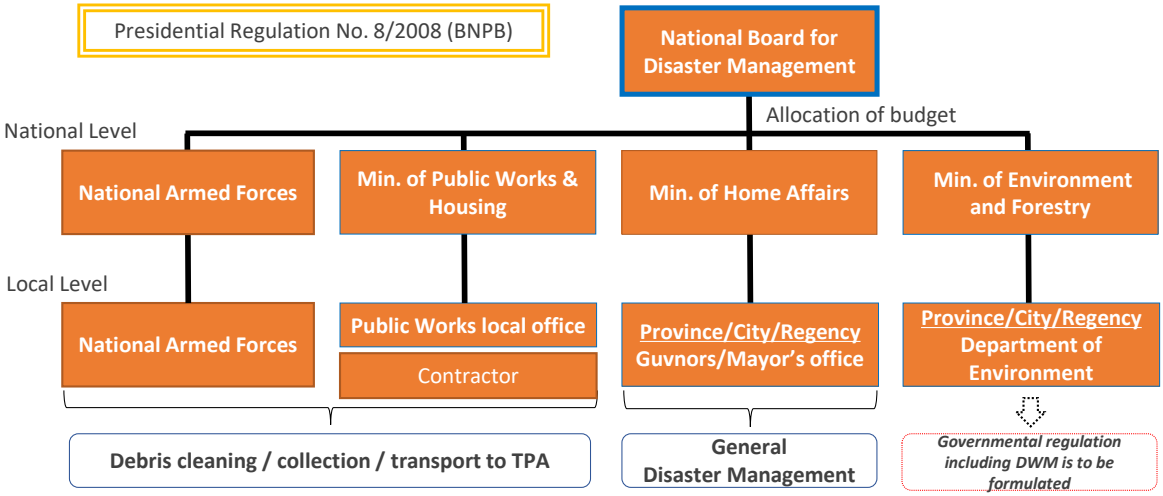
Assess for DWM
response to removal of wastes and debris from affected areas and disposal to landfills
following members
landfill especially for the designated temporary area within the landfill for disaster waste disposal and separation
with recycling companies both in affected communities (on site) as well as the landfill site
e NEOC

Member	Role
l Transport Authority (LTA)	Clearance for debris on the roads and bridges
noa Waste Authority (SMA)	Clearance for debris on the rivers
onic Power Corporation (EPC)	Clearance for debris of electronic lines
Works, Transport Infrastructure	Clearance for debris of buildings
Women Community and Social Development	Conduct awareness and ensure debris clearance at affected communities.

Figure 5 Institutional arrangements and stakeholders for Disaster Waste Management in Samoa (Source: Interview with Faafetai Sagapolutele, J-PRISM, 2020)

- The Landfill supervisor from Port Vila Municipality Council (PVMC), Vanuatu also joined to support the restoration of the disposal site in Honiara damaged by the flood through the sister city cooperation.
- The Solomon Islands had no experiences in place to manage disaster waste in the past by then.

Cross-cutting collaboration among national and local levels in Indonesia



- The coordination among National Board for Disaster Management, Ministry of Environment and Forestry, and Ministry of Public Works & Housing in the National level is principle, and Ministry of Environment and Forestry is the lead agency to support operation of DWM in local levels through the Department of Environment and the Public Works local office on the ground.
- The Guideline for DWM will be formulated by Ministry of Environment and Forestry in line with the Guidelines for Cleaning the Environment in Disaster Emergency.
- The DWM will be mandated to Department of Environment in the local level, in coordination of Ministry of Environment and Forestry after the governmental regulation on Specific Waste Management including DWM is formulated.

Figure 6 Current Institutional Arrangement for Disaster Waste Management in Indonesia (Source: Workshop in Indonesia, 2020)

- Disaster wastes and debris management are stipulated in the Presidential Regulation No. 8/2008 led by National Board for Disaster Management
- The guidelines for Cleaning the Environment in Disaster Emergency was developed by NBDM in 2015.
- Governmental Regulation on Specific Waste Management including disaster waste is to be formulated by the Ministry of Environment and Forestry in 2019.
- Min. of Environment and Forestry and Min. of Public Works & Housing with those departments in local levels are responsible for the policy, coordination, and operation on DWM in Indonesia (as above Figure)

2 Preparation of Temporary Storage Sites

2.1 The use of a temporary storage site (TSS) for DWM

- In order to maintain a sound living environment and public sanitation atfter the disaster, disaster waste needs to be collected quickly. For this, a place to store these wastes must be identified before collection.
- Temporary storage site (TSS) is a place to temporary store disaster wastes before they are treated or disposed of at treatment plants and/or landfills.
- Places that could be used as TSS should be identified before a disaster strikes to enable immediate commencement of disaster waste collection.

2.2 Typology of TSS

- Temporary storage site (TSS) is a place to temporary store disaster wastes before they are treated or disposed of at treatment plants and/or landfills.

  - **Primary TSS** is a place to aggregate disaster waste from damaged houses and other public spaces. Disaster wastes are temporarily stored and separated (if necessary) here before they are transported to intermediate treatment facilities, recycling facilities, secondary TSS, and/or landfills.
  - **Secondary TSS** is a place to undertake thorough separation of mixed disaster waste transported from primary TSS. Advanced waste treatment technologies are installed (see Figure 7).

Figure 7 Image of secondary TSS (Japan)

- Hereinafter, this document will only refer to primary TSS because secondary TSS will usually not be installed for DWM in most of the developing countries in Asia and the Pacific.

2.3 Places suitable for TSS

- Table 1 shows the criteria for TSS.
- Final disposal sites used for waste management in normal (disposal sites already closed) could be used as TSS. In that case, different cells from normal waste should be allocated for disaster waste storage.
- Not all of the criteria will apply for TSS used only for green waste. On the contrary, TSS used to store bulky wastes that potentially contain hazardous material should meet the criteria.

Table 1 Criteria for TSS

Criteria	Reason
✓ Access is easy for disaster victims	For the convenience of victims. Some people (e.g. elderly) might need special assistance for disposal
✓ The site is not too close to residential areas	To prevent impact to the living environment (e.g. odors, pests and dusts)
✓ The site is not adjacent to rivers, canals, swamps, ponds, lakes, and drainage	To prevent environmental degradation. (in cases where disaster wastes contain hazardous substances)
✓ The site is not under high risk of flooding (wetlands, river banks).	To prevent disaster waste from scattering by flooding.
✓ The site is publicly owned and maintained. Farmlands should be avoided.	To enable quick use and return, and to avoid unnecessary burden upon closure of TSS
✓ The land is large enough (as a rule of thumb, more than 3000m^2 per TSS)	to receive the huge amount of disaster waste and to operate heavy machinery and trucks inside.

2.4 Things to do in normal time (for appropriate operation of TSS)

- Make a list of places that could be potentially used for TSS. (Some examples are shown in the next section)
  - Firstly, make a list of open spaces regardless of the criteria shown in Table 1.
  - Secondly, evaluate and rank the listed open spaces according to the criteria. Do not delete the open space from the list even if it does not meet the criteria.
  - Based on the list, discuss with the owner of the land and other disaster response units that might need to use open space for disaster recovery (e.g. for temporary housing, for parking) about the necessity of TSS and conditions to use and return the place when a disaster happens.

- Prepare for quick set up and operation of TSS after disaster outbreak
  - Roles and responsibilities for TSS preparation and operation should be clarified in the preparedness plan
  - Equipment to manage the site such as traffic cones, notice boards, etc. should be prepared
  - Set up an agreement with waste management companies for the quick arrangement of staff (operators) and heavy machines when a disaster happens.

2.5 Examples of TSS from past experience

Overview

- Examples of TSS from past DWM experiences in Asia and Pacific are shown below
- Different types of land are used for different purposes in the past. For example, a piece of wetland was used to temporary store green wastes, but this may not be suitable for bulky waste storage and separation
- Land adjacent to Landfills are typically used as TSS

Table 2 Examples of TSS [1]

Purpose	No.	Disaster type, country	Original state of land	Note
Storage, Separation of bulky waste for Recycling & Final Disposal	1	Flood, Japan	A Gateball playground (public)	• Disaster wastes were separated into 13 categories (vegetative waste, timber, bamboo, metal (small), metal (bulky), ceramic, slate, glass, PVC, concrete, cement, other combustibles, other incombustibles) • Need to place operators to maintain good separation
	2	TC, Fiji	Current disposal site. Before the use of waste landfill, the site was mangrove forest.	• The disposal site has several cells. • DW is temporarily placed in space secured as recycled yard according to the waste categories. • Then some of DW were recycled and most of DW was disposed of at the current disposal operation cell.
	3	TC, Tonga	Current disposal site. Before the use of waste landfill, the site was forest.	• DW was separately stored at the different places according to the waste categories. • Then some of DW were recycled and most of DW was disposed of at the current disposal operation cell.
	4-1	Earthquake, Nepal	Use of public and private open spaces	• Disaster wastes were transported to both at pubic and private open spaces in communities. • These sites were designated by community-driven decision.
	4-2	Nepal (Preparation)	Evacuation centers (park, industrial estates, etc.) including TSS	• Space in ten (10) evacuation sites in Lalitpur Sub-Metropolitan City are also utilize as the temporary dumping/storage site for disaster wastes

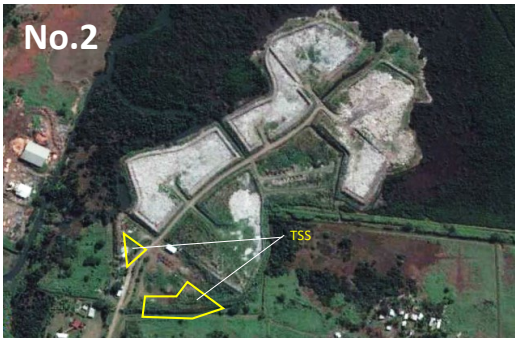
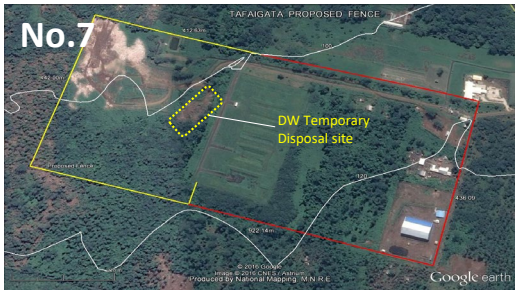


Table 3 Examples of TSS [3]

Purpose	No.	Disaster type, country	Original state of land	Note
Storage of green waste	5	TC, Tonga	Wet land and forest	• Temporary green waste storage area, Houfa village in Tonga. • It is announced by town officer on radio that here is acceptable for disaster green waste.
Storage & Recycling of green waste	6	TC, Fiji	Current disposal site. Before the use of waste landfill, the site was mangrove forest.	• Green waste was collected and dumped at the current landfill. • Then it was chipped and recycled.
	7	Samoa	Specific space for disaster wastes storage and usage at the landfill	• Recycling companies and waste pickers collected recyclable materials at the site. • Sands and soils were stored in the site and used as a cover soil at the landfill.
	8	Earthquake, Indonesia	The candidate site of the landfill in the future	• The candidate site secured by the local government to be used as a landfill was used as a secondary TSS. • The accumulated disaster wastes at the TSS can be utilized for the materials to build the dike in the future



Example 1: TSS allocation at disposal site in Samoa (no.7 in Table 3)

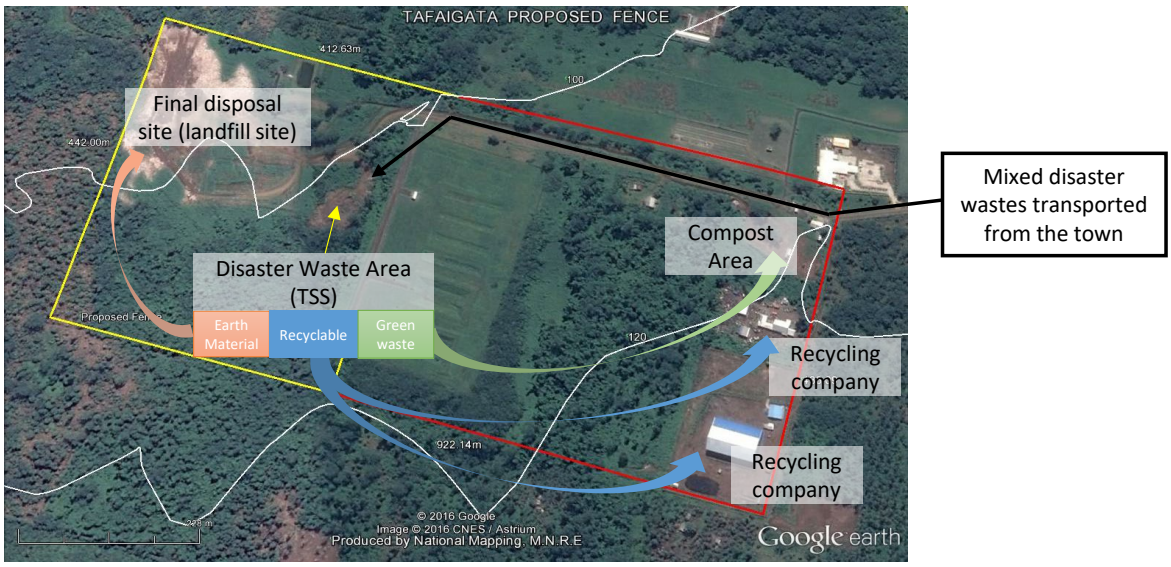


Figure 8 Temporary Storage Site area with the designated role for DWM at Tafaigata landfill

- Ministry of Natural Resources and Environment has allocated the TSS at the final disposal site in Samoa (Tafaigata landfill).
- At the disaster event, all mixed disaster wastes were transported at the TSS. Earth material, Recyclable and Green waste were separated at the TSS.
- Earth materials were used as cover soil at the disposal site, recyclables were collected by waste pickers and recyclers, and green wastes were used for composting respectively.
- Recyclers are operating their recycling business within the landfill boundary under the contract/agreement with the government (Public-Private Partnership Scheme).

Example 2: Use of TSS in the case of an earthquake at Palu, Indonesia (no.8 in Table 1)

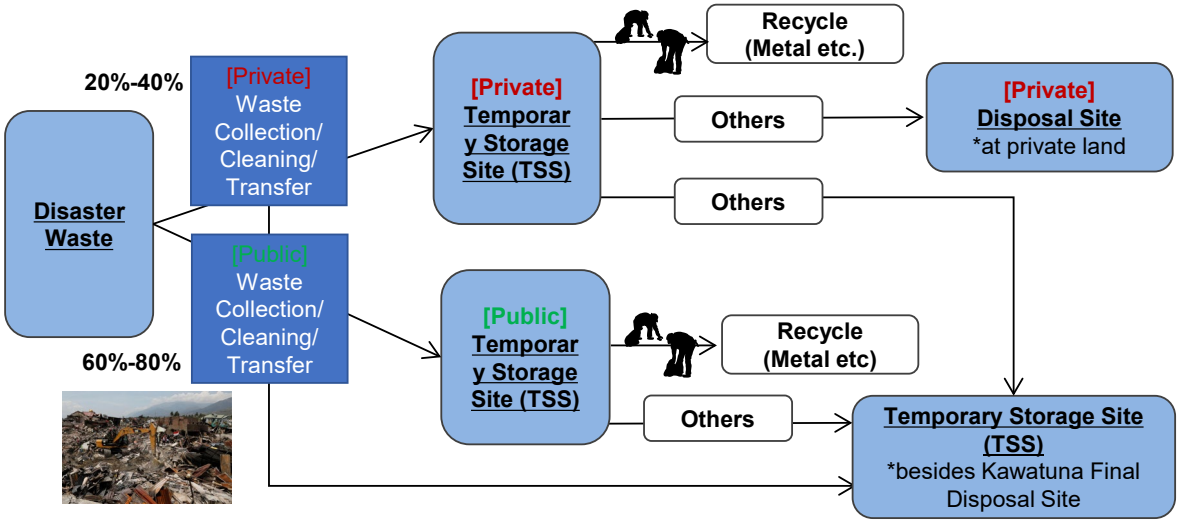


Figure 9 The role of TSS within the DWM process in Palu

- In September 2018 magnitude 7.5 earthquake occurred at Palu, Indonesia.
- The major earthquake triggered catastrophic liquefaction, landslides, and a near-field tsunami that resulted in direct damage, impact, economic loss, and loss of life.
- Both private and public lands were used as a TSS. The private lands were voluntarily provided by the landowners.
- Mixed disaster wastes were commonly accumulated at these TSSs for a long time, and recyclables have been collected by waste pickers.
- The government is not responsible for clean-up accumulated disaster wastes at the private TSS.
- The candidate site secured by the local government to be used as a landfill was used as a secondary TSS.

Example 3: Experiences of the 2015 Earthquake in Nepal

Figure 10 Segregation of recyclable objectives (Bricks, Stone, Wood, Iron, Roof tin sheet, etc.) from disaster wastes

- 3R related activities and Temporary Storage Sites (TSS) arrangement for DWM were not strategically planned and implemented after the event.
- Disaster wastes generated from the Kathmandu valley were piled up in the open space of the Tundikhel for nearly one year.
- Those materials were used later such as putting on the muddy road access to the landfill site and filling the lower private lands including the riverbanks of Bagmati and its tributaries.
- Archaeological debris were reutilized for the reconstruction of historical buildings and temples (recommendation from UNESCO).
- In addition, disaster debris was segregated and used in the riverbanks to reclaim the roadside and private land, to raise the level up to the road, and to fill the potholes of the graveled and earthen mountain roads.
- Useful and recyclable materials like wood and bricks by house owners were segregated, but remaining debris in the private land was deposited.

Example 4: Preparation for Temporary Dumping/Storage Site in Lalitpur Sub-Metropolitan City

- From the experiences of disaster events, (10) evacuation sites in Lalitpur Sub-Metropolitan City are selected to cover the function as the temporary dumping/storage site. (Figure 4)
- The DWM Guideline in Nepal will be developed.
- TSS management will be highlighted in the guideline for local governments to develop their own plan for TSS management.

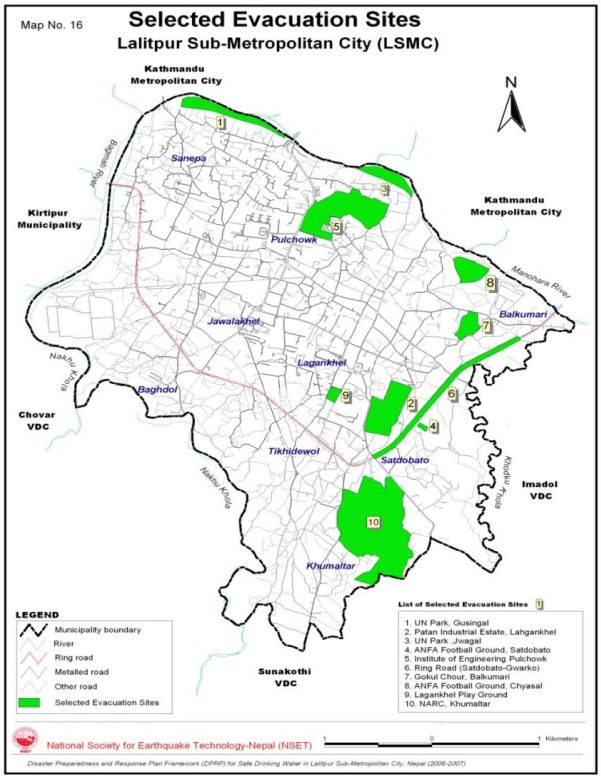


Figure 11 **Selected evacuation sites (that could be used as temporary dumping/storage sites) in Latipur Sub-Metropolitan City**

(Source: LEAD Nepal, 2020)

3 Preparedness actions for Disaster Waste Reduction and Recycling

3.1 Importance of waste reduction

- Waste reduction comes at the top of the waste hierarchy, and the same principles apply to DWM.
- Household goods and buildings become waste when they are ruined by a disaster. This means, by avoiding or mitigating damage to household goods and buildings, we can reduce the amount of disaster waste.
- Waste could be a cause of disaster by inhibiting the function of our infrastructures (e.g. drainage). Hence, keeping the living environment clean is another way to reduce disaster waste.

Table 4 Examples of actions for disaster waste reduction

Action type	Overview of action		country	Note
Mitigation of disaster impact	Installation of a personal water gate		Kingdom of Thailand	- A temporary water gate made by board, made by the resident with simple construction work - Damage to furniture caused by slow inundation could be reduced
	Discussion on disaster waste disposal at the proposed new landfill			- Since the current final disposal site doe not have enough capacity, construction of a new disposal site is under discussion. - The disaster waste management space at the new site is also discussed.
Maintenance of sound living environment	Prevention and collection of canal wastes		Kingdom of Thailand	- Wastes dropped into canals can clog the drainage system and increase the risk of flooding - Wastes are regularly collected by district officers using boats and waste collection points - Public relations campaign is done by the government to prevent people from trashing into canals
	Prevent fallen trees by the wind and collection of Green Waste		The Republic of Fiji	- Pruning trees in the public area to reduce green waste generation by the strong wind - Pruned green waste is chipped and recycled for mulching materials for parks, composting and fuels for boiler
	Cleanup campaign to prevent clogging of drain.		The Republic of Fiji	- The community cleans garbage littered on the drainage and side of the road around twice a year. - The function of the drainage channel is maintained by the cleaning activity, and consequently rainwater can be properly drained and flood can be prevented.

3.2 Recycling of disaster waste using readily available technology

- In order to dispose disaster waste appropriately enough to meet the environmental restrictions introduced in the area, some waste management technologies could be useful.
- Recycling technologies used for typical types of disaster waste (i.e., wooden, concrete, etc.) are introduced below.

Table 5 Examples of readily available recycling technologies for DWM

Waste type	Overview of technology	country	Specifications	Use before and during disasters
Wooden waste	Chipping machine for green waste recycling  Before disaster  During disaster	The Republic of the Fiji Islands	Mobile shredder Traction type Engine: > 75 hp Max capacity: 10” Weight: >1,800 kg Clutch: Manual	Before disaster: Green waste from public area is chipped and recycled for mulching materials for parks, composting and fuels for boiler During disaster: Wood waste from cyclone stored at the disposal site and chipped there for recycling.
Concrete waste	Recycling facility for construction wastes located at the disposal site 	Brazil	• Sorting machine • Excavator with braking function • Others	Before disaster: Construction waste mainly concrete debris is recycled at the site. During disaster: DW mainly concrete debris will be recycled at the site and residue will be disposed of at the disposal site.
Others	Using DWM as raw materials and fuels for cement production 	Japan	DWM by Iwate Pref. government after the Tohoku Earthquake (example of Taiheiyo Cement Corporation) Capacity: ca.1000t/d	Before disaster: Cement is produced from raw materials (limestones, etc.), MSW, and by-products from mining, construction, waste treatment, power plants etc. During disaster: Disaster waste can be used as raw material and fuel for cement production (in the cement pyroprocess). Separation and control of chlorine is required.
		Nepal	Segregation and use of construction materials from disaster wastes	Construction materials from disaster debris were segregated and used in the riverbanks to reclaim the roadside and private land, to raise the level up to the road and to fill the potholes of the graveled and earthen mountain roads.

Example 1: Preparation for recycling: disaster waste treatment flow from the case of Honiara, Solomon Islands

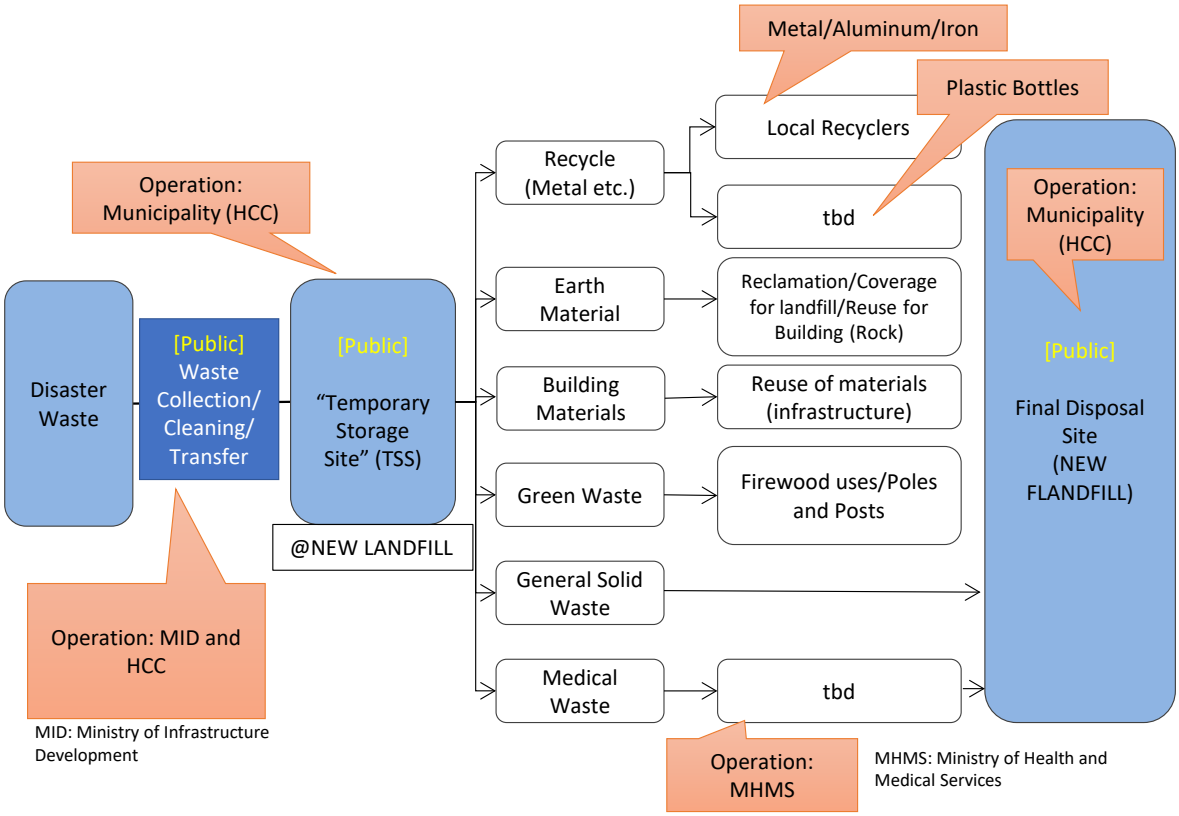


Figure 12 Current Discussion on DW Treatment Flow with stakeholders in Honiara (Source: DWM workshop in the Solomon Islands, MECDM and MHMS in collaboration with MOEJ, Government of Japan, 2000)

- The below figure was developed by stakeholders in Honiara City Council (HCC) to develop the disaster waste treatment flow in line with waste management in ordinal time.
- The orange-colored boxes are recommended activities and operations for DWM.
- Through the discussion "Waste Management Division" was established in 2019 who is the mandate division in HCC for waste management including DWM at the disaster event.
- The proper management for plastic bottle and medical waste are still challenging issues in HCC.

Example 2: Discussion on DWM treatment scenario development with/without TSS in Samoa

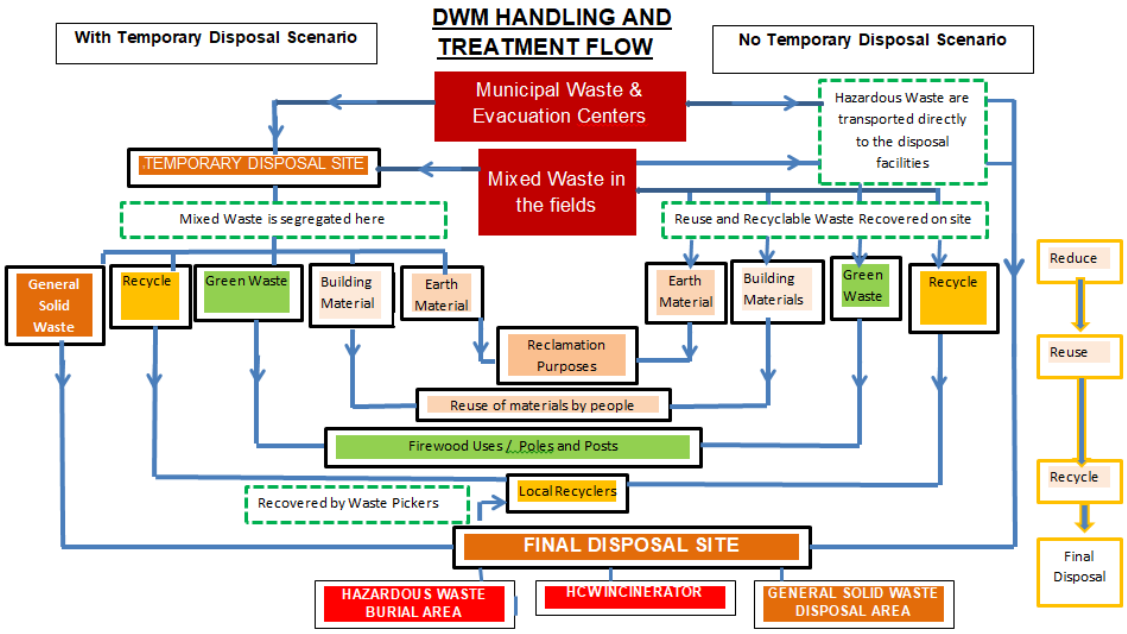


Figure 13 Disaster Waste Handling and Treatment Flow in the Pacific
(Source: Regional DWM Guideline in the Pacific, J-PRISM-II and SPREP, 2000)

- The scenario was identified for the development of "Regional DWM Guideline in the Pacific" conducted by J-PRISM II/SPREP.
- The scenario is consist of two components which are with/without temporary storage sites.
- 3Rs are encouraged in both scenarios.
- Separation at source (without TSS) is also encouraged for the materials including earth material, building material, green waste, and recyclables to be locally utilized.
- The roles of a recycling company and an informal sector such as a waste picker are also highlighted.
- Hazardous waste is recommended to transport directly to the disposal facilities, not through the TSS.