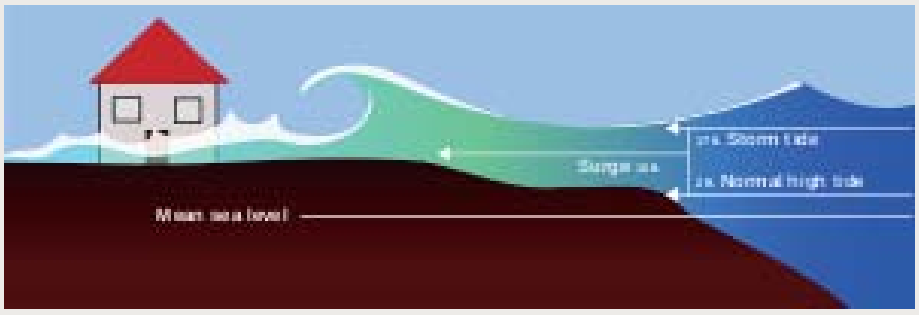
PROGRAM 7

Educational Material for Reduction of the Effects of Floods and Storm Surges in Coastal Cities: A Case Study of Dar es Salaam City in Tanzania

Proposer Informartion		**Wilbert Timiza Muruke** WMO Fellow at Kyoto University 2012/2013
Aims of Education/training		Knowledge, Interest, Desire, Actions
Target User	Type	Self learning-if, Education/training
	Direct user	School teachers, NGO/NPO staff, Community leaders, Government staff, Researchers, Students
	Trainee/ Indirect User	Students (Junior high school, High school, College/University), Local regidents
Focus of this Information		Implementation Oriented Technolgy (IOT), Process Technology (PT), Transferable Indigenous Knowledge (TIK)
Hazards		Tsunami, Storm surge, Flood, Flash flood
Type of Education/training		Lecture, Training Camp, Group discussion, Field trip, Self learning
Media/Material		Pamphlet
References		DRH 08,10,12,16,17,53,63, IPCC (2007),



Educational Material for the Reduction of the Effects of Floods and Storm Surges in Coastal Cities: A Case Study of Dar es Salaam City in Tanzania

Introduction

Extreme precipitation events cause floods and flash floods in many places around the globe and these rank highest among natural hazards with the most disastrous impacts on infrastructure, ecosystems, and human lives (Kysel´y, 2009). The recent increase of these events has been associated with the ongoing global warming which has influenced precipitation amount, intensity, frequency, and type in many places (IPCC, 2007). Although many other places suffer extended drought events, when high-intensity precipitation falls it results to flash floods which last for a short period of time with equally high destructive potential. Storm surge is another kind of hazard which impacts areas near big lakes and oceans. Likewise, global warming has resulted to the rising of sea level (possibly increasing the risk of storm surges) in many places thus threatening the existence of life and properties near water bodies now and in the near future (IPCC, 2007). With most cities traversed with rivers or located on the deltas of major rivers, this increases their vulnerability to floods. Coastal cities are most vulnerable due to their close vicinity to these water bodies, high population, low elevation, and unplanned human activities which include poorly planned infrastructures.

Any effort or technology and knowledge (such as the ones found in the Disaster Reduction Hyperbase (DRH) facility) to alleviate or slow down the impacts of floods and storm surges along the coastal cities is of great value. Early warning systems and education are some of the initiatives which are needed to alleviate effects of floods and storm surges. With the focus mainly on Dar es Salaam City in Tanzania, this pamphlet aims to impart disaster reduction knowledge to students and residents living in coastal cities to be able to participate in the activities which will help slow down or completely mitigate the effects of floods and storm surges. The material is divided into three parts: (1) Flood and storm surge awareness raising, (2) Community based flood preparedness and mitigation lessons, and (3) Tree planting session along the coastal belt. Illustrations and examples are derived from DRH **8, 10, 12, 16, 17, 53, and 63** contents and from flooding experience

Dar es Salaam City Profile

Location and population

Dar es Salaam is located in the eastern part of Tanzania mainland between latitude 6.6S and 7S and longitude 39E and 39.5E. Dar es Salaam is one of the fast growing cities in the world and Africa with a population of approximately 3.1 million and an area of about 1,000 km2 , a small area when compared to the total country' s area of 947,300 km2 (Tanzania NBS, 2010). About 8% of its land lies below 10m above mean sea level (Kebede et al., 2011).

Climate

Tanzania has a tropical equatorial type of climate. However its climate has a great diversity due to the country' s diversity in topography. The country is characterized by two rainfall regimes: namely unimodal and bimodal rainfall regime. The seasonal rains over the unimodal regime occur between October and May (Msimu) over the Southern, South-western, Central, and Western areas of the country. The bimodal rainfall regime has two rain seasons, the long rain season (Masika) experienced between March and May (MAM) and the short rain season (Vuli) occurring between October and December (OND) over the Northern coast, North-eastern highlands, Lake Victoria basin, and the Islands of Zanzibar (Unguja and Pemba). Dar es Salaam City is located in the bimodal rainfall regime.

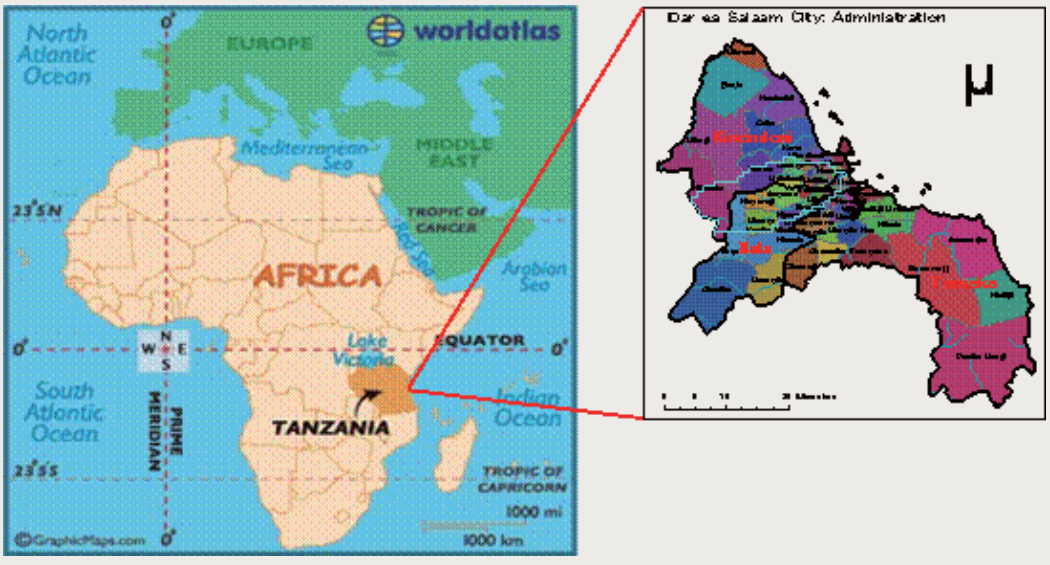


Figure 1: Location of Dar es Salaam City in Tanzania (Highlighted in light blue color is the Msimbazi river basin, one of the most flood prone areas in the city)

Figure 2: Aerial photograph of Dar es Salaam City center.

Flooding Events and Coastal Surges

Floods

A recent study done in East Africa shows that the short rain season (October to December) is projected to increase by more than 10% while the long rain season (March to May) is projected to increase by more than 15% (Shongwe et al., 2010). This study confirms other similar findings for the Eastern African region experiencing two rainfall season pattern (bimodal rainfall regime) including Tanzanian coastal areas where Dar es Salam is located, thus increasing the chances of flooding events.

A specific example of a flooding event was the one in Dar es Salaam City from 20th to 22nd December 2011, which caused significant impacts to the country' s economy. About 43 people were reported dead and the flooding left many people homeless while causing severe destruction of infrastructure, including houses, roads, and bridges. Cumulative total rainfall for three days amounted to 260.2mm at Julius Nyerere International Airport (JNIA) Station while 150mm was recorded on 21st December alone. This amount of rainfall was record breaking in the 58 years since the establishment of the station in 1953. Records of historical flood events that occurred in Dar es Salaam City from 1983 to 2011 are shown in Table 1.

Table 1: Historical flood events information for Dar es Salaam from 1983 to 2011 (source: TMA)

No.	Year	Months	Monthly Total Rainfall (mm)			Meteorological Causes
			Observed	Long Term mean	Percentage of long term mean (%)	
1	1983	May	405.6	197.8	205	The rain was enhanced by El Niño
2	1989	December	175.6	117.8	149	Tropical Cyclone Alberta was to a large extent responsible for the heavy rains
3	1995	May	374.2	197.8	189	There was continuous rainfall for at least two days
4	1997	October November December	250.8 152.0 231.0	69.3 125.9 117.8	361 121 196	The rain was associated with strong El Niño episode.
5	1998	January February March April	107.3 123.7 155.2 319.9	76.3 54.9 138.1 254.2	141 225 112 126	The rain was associated with strong El Niño episode.
6	2002	April	569.4	254.2	224	The rain was enhanced by El Niño
7	2006	November December	240.9 230.4	125.9 117.8	191 196	The rain was enhanced by El Niño
8	2010	April	362.2	254.2	142	
9	2011	December	377.2	117.8	320	The rain was enhanced by the easterly wave (43 killed, destruction of properties and infrastructure)
10	2012	April	377.2	254.2	104	Convective activities during the March to May rainfall season.

Flooding of a major road along Msimbazi River in Dar es Salaam in .

Destruction of infrastructures

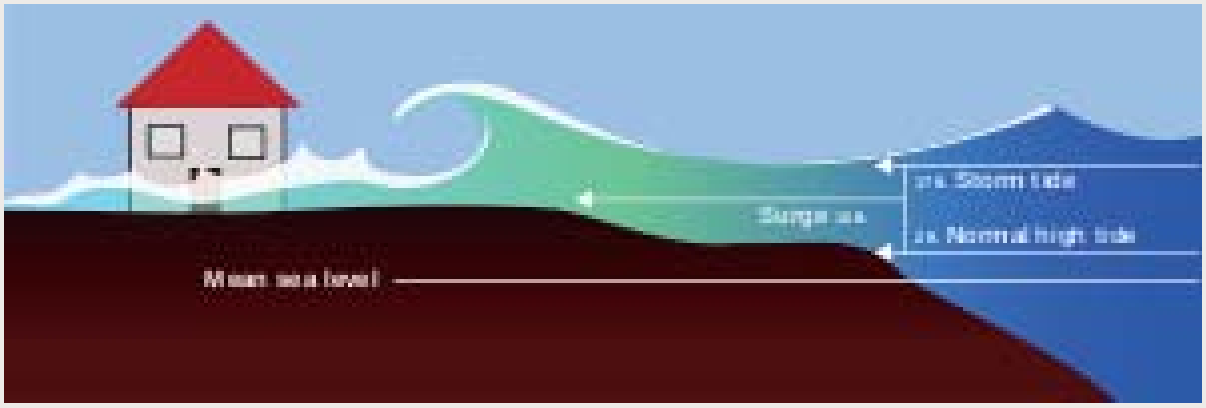
Rescue team at work during the flooding event of Dec. 2011

Rising water levels due to floods in low elevation areas

Figure 3: Flood events in Dar es Salaam City

Coastal Surges

"Coastal surge is an abnormal rise of water generated by a storm over and above the predicted astronomical tides" (NOAA). Storm surge may be caused by typhoons/hurricanes/tropical storms, onshore strong winds, and low pressure. In Tanzania 1m sea level rise per century is predicted to cause total land loss estimate of about 2,000 km2 (Mwaipopo, 2000) and Dar es Salaam would have to face very high cost of adaptation measures.



(a) Illustration of storm surge (Source: NOAA)

(b) Destruction from storm surge (Source NOAA)

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Figure 4: Storm surge

PART I

Awareness-raising for Flood and Storm Surge Risks:

Methodology:

1. For Communities

(i) Organizing folk song-events by:

- Contacting stakeholders, including city councils; local governments, in turn, will mobilize community members and various folk groups. Folk groups will be requested to perform songs and skits (drama) with themes related to flood and storm surge risks. (Figure 5, DRH53: Process Technology category).

  Songs and drama will help reach more people who are usually marginalized and most affected by disasters due to either lack of formal education or poverty. Children and women are more at risk. In Tanzania, this activity can be implemented in the same manner using traditional dances which are popular and unique for every tribe or poems which are educative especially when played by a local expert to draw a lot of attention in every subject. This activity will result to change of behavior and lead to good result such as building of raised houses and keeping food in safe places.

- Identification of venue for the flood/storm surge awareness activities

- Preparation of the right material for the event such as in Figure 10.

- Long plans to incorporate climate/extreme weather and storm surge education into the city council plans and other stakeholders involved in the city planning and environmental protection activities

Figure 5: Folk song program for disaster awareness and evidence of good results (lower right pictures) in Nepal (DRH 53)

(ii) Create social networks such as in Facebook or Twitter to reach more people.

- Recently there has been a boom in the use of social networks which attracts large number of followers (mostly young people) seeking for the latest news around them and other places in the world and sharing of ideas and experiences in many cross-cutting subject matters. Most famous among them are Facebook and Twitter social networks. These social networks may be a good channel to deliver climate and weather information such as risks of floods and storm surges in the community. This activity can also be demonstrated during the folk song activities (***Figure 6***).

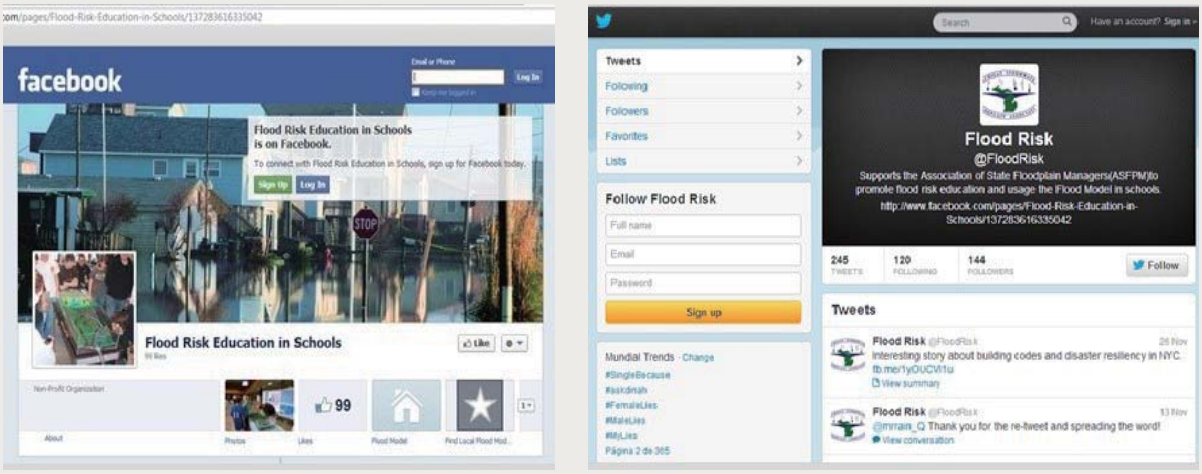


Figure 6: Examples of Facebook (left) and Twitter (right) pages for flood risk awareness

2. Schools and Colleges

(i) Selection of target schools and colleges:

The criteria could be vicinity to the flood risk areas and sustainability of the flood risk education. For example some colleges have already established environmental management divisions which will easily continue with the planned flood and storm surge education for students in a long term.

(ii) Preparation of teaching/demonstration materials.

Climatology of the area: This will enlighten the participants concerning the most likely period of the year when flood risks are high (Figure 7). Also past statistics of the past flood or storm surge events as highlighted in Table 1 will be presented for more understanding.

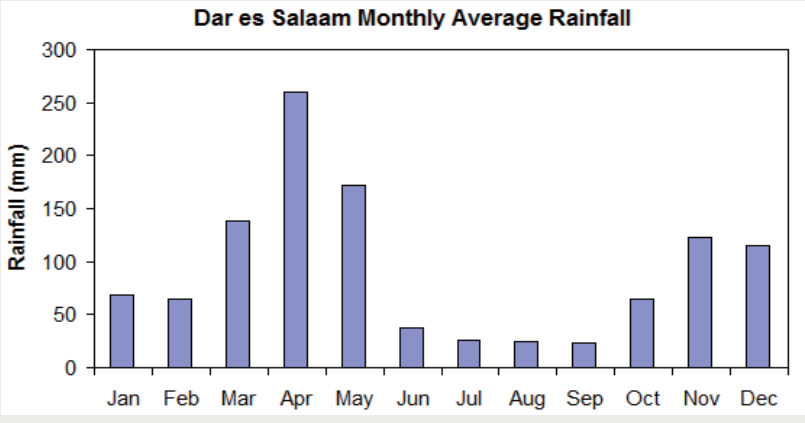


Figure 7: Dar es Salaam rainfall climatology

- Maps of the vulnerable areas: Explanation on why areas are considered vulnerable (e.g., low elevation, closeness to the ocean/rivers/lakes, and poor planning of buildings and infrastructures).

- Adaptation to and mitigation of flood/storm surges: Including building of stilt (raised) houses which can be used as evacuation centers and food storage during floods (Figure 8 from DRH 8,16, and 17)

- What to do **BEFORE** flood and storm surge disasters will include teaching the participants the techniques of building flood and storm surge resistant and adaptable houses and other structures (Figure 8), regular follow up with climate and extreme weather information such as those given in Figure 9, and knowing beforehand the safest places like high grounds and evacuation centers. Also, if possible, preparation of survival kits/materials including some food and water.

- What to do **DURING** flood and storm surge disasters (e.g., running to safety before it is too late and trying not to save properties for it may cost one' s life in the process).

- What to do **AFTER** flood and storm surge disasters: more follow-up of weather and Government information to make sure that the risk is low before going back to the residences or working places.

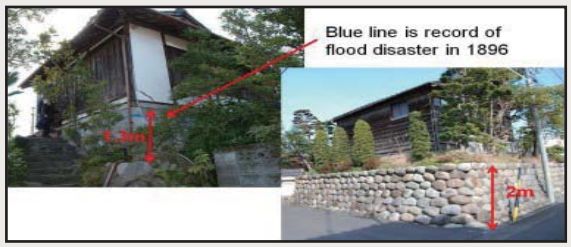
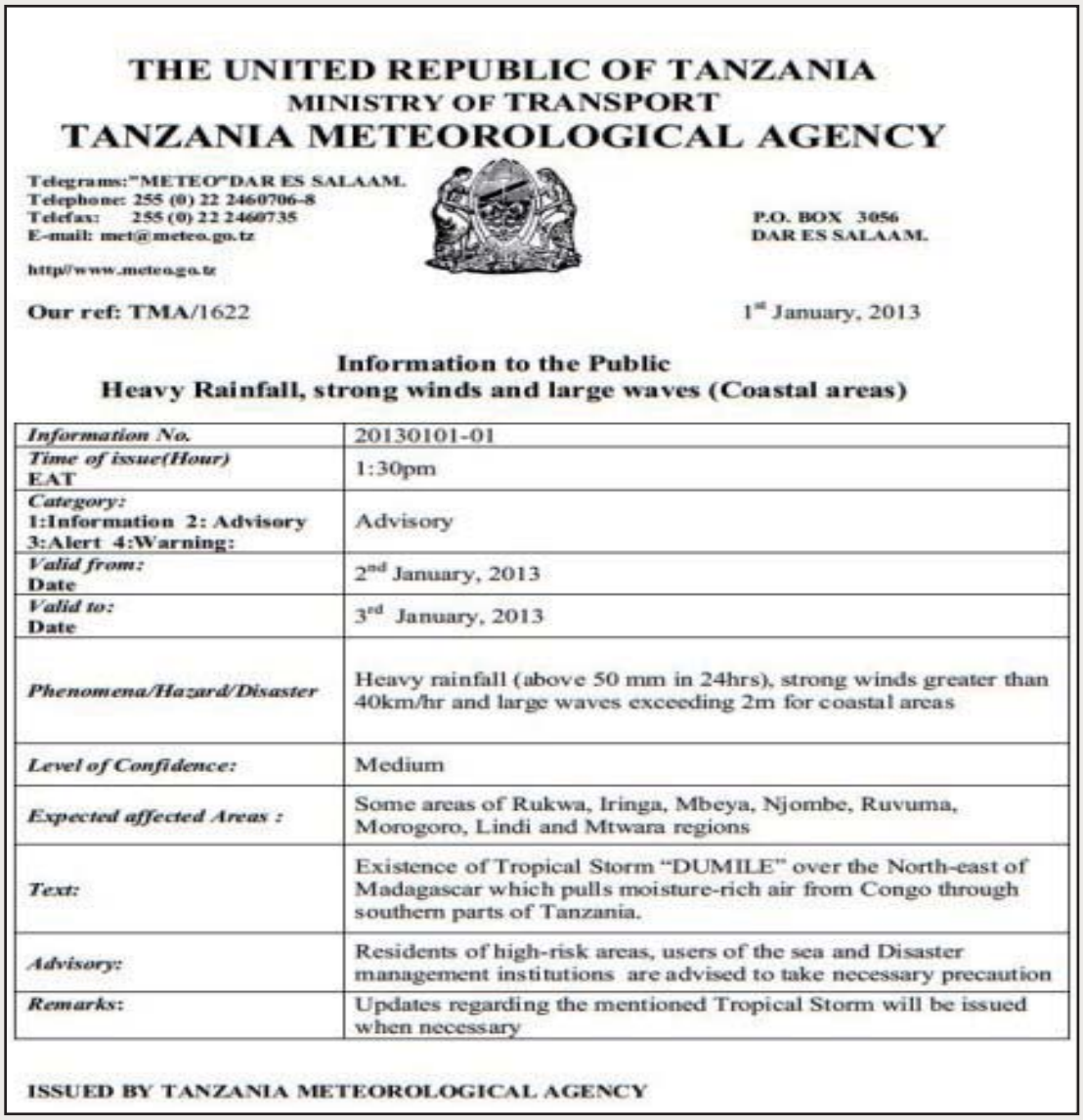


Figure 8: Raised houses in flood-prone areas: Japan (top left), Bangladesh (top right), and USA (bottom right). From DRH 8, 16, and 17



THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF TRANSPORT
TANZANIA METEOROLOGICAL AGENCY

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DAR ES SALAAM.

Our ref: TMA/1622 1st January, 2013

Information to the Public
Heavy Rainfall, strong winds and large waves (Coastal areas)

Information No.	20130101-01
Time of issue(Hour) **EAT**	1:30pm
Category: **1:Information 2: Advisory 3:Alert 4:Warning:**	Advisory
Valid from: **Date**	2nd January, 2013
Valid to: **Date**	3rd January, 2013
Phenomena/Hazard/Disaster	Heavy rainfall (above 50 mm in 24hrs), strong winds greater than 40km/hr and large waves exceeding 2m for coastal areas
Level of Confidence:	Medium
Expected affected Areas :	Some areas of Rukwa, Iringa, Mbeya, Njombe, Ruvuma, Morogoro, Lindi and Mtwara regions
Text:	Existence of Tropical Storm "DUMILE" over the North-east of Madagascar which pulls moisture-rich air from Congo through southern parts of Tanzania.
Advisory:	Residents of high-risk areas, users of the sea and Disaster management institutions are advised to take necessary precaution
Remarks:	Updates regarding the mentioned Tropical Storm will be issued when necessary

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Figure 9: Typical extreme weather advisory issued by meteorological services (Source: TMA)

Figure 10: Disaster awareness material and education

A: Typical meteorological and environmental products in display during weather and climate aware raising campaigns by Tanzania Meteorological Agency (TMA)

B: Meteorologist explaining the meteorological products to students

C&D: Community members listening to the explanations

E&F: Government leaders visit the exhibitions as well to learn about the urgent disaster risk prevention education including environmental issues, flood, and tsunami risk reduction information (here one of the regional (prefecture) leaders was receiving explanation)

PART II

Community-based Flood Preparedness and Mitigation Lessons

In the tropics most extreme rainfall events are confined to local or regional scale. In the case of floods, the most vulnerable people are those residing in low-lying areas which are exacerbated by poor planning of infrastructures which include housing and drainages. It is with this aim that identification of flood prone areas and flood risks in the fast growing Dar es Salaam City as a sustainable and adaptive measure to extreme weather events will help decision makers to take more deliberate actions in city planning and also for the residents to make proper choices of their residencies for their safety and for the country' s socio-economic well-being.

This activity will be done using a participatory approach, with the knowledge that community members have a lot of knowledge about many environmental problems they are facing and somehow have ideas of the solutions but there might be some missing links between community leaders and the community members. Therefore this could be a good opportunity for various groups in the community to work together to solve their common problems including reducing the vulnerability to flood and storm surge events.

i. Identification of the vulnerable areas as part of step-by-step implementation of community-based flood preparedness and mitigation process, also well explained in DRH 63 (Figures 11 and 12)
ii. Visiting the vulnerable areas, conducting flood evacuation drills, and cleaning/un-blocking of sewage systems.
iii. Presentations by groups to share experiences about the exercises and any other knowledge concerning flood preparedness and mitigation.
iv. Discussion and evaluation of the activities including giving reminders on the available means of communicating impending flood or storm surge events (e.g., through radio, television, mobile phone, and Internet).

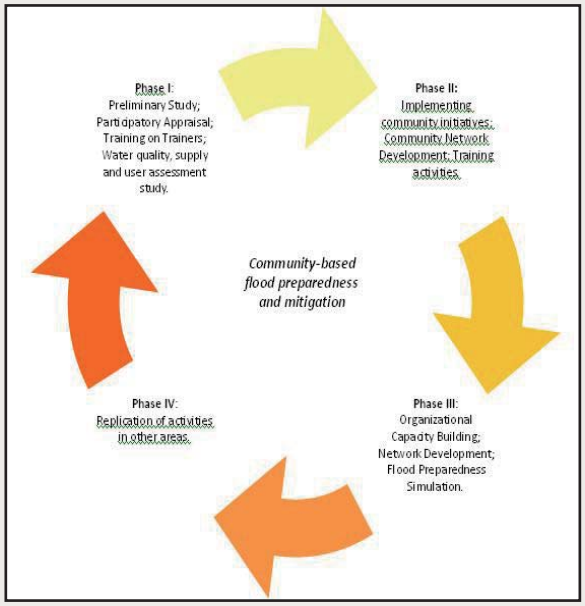

Figure 11: Involvement of the community in flood risk preparedness (left) and possible implementation process (right).

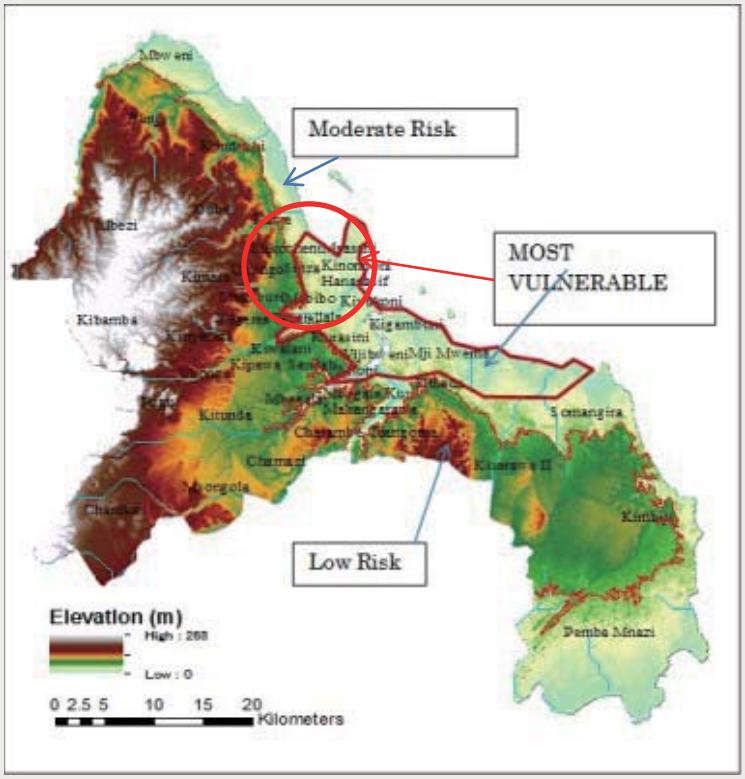

Figure 12:
Flood-prone areas in Dar es Salaam City in Tanzania

PART III

Planting of Trees Along the Coastal belt

Tanzania is bordered by the Indian Ocean to the east and boasts of about 940km of coastline. Dar es Salaam' s coastline is part of this long coast line and hence exposes the city to tsunami and storm surge risks. A clear example is the loss of 11 lives due to the 2004 Indian Ocean Tsunami event. Although most of the deaths were due to high and strong tsunami waves, not much was recorded concerning the storm surge or tsunami waves reaching over land (Obura et al., 2006). However, having this experience together with the ongoing global sea level rise due to global warming (which will exacerbate the situation) it is necessary to have countermeasures such as planting of protective forest barriers, preferably mangroves along the coastal belt (which is not so expensive as compared to hard engineering measures, according to DRH 10). This will protect the city structures, people, and all the properties against future cases of tsunami or storm surges.

How to do this Activity:

i. Make official communication with the responsible parties, including municipality authorities, local governments, National Environment Management Council (NEMC), and the Environmental Division of the Vice President' s office.

ii. Convene a short meeting with all parties to discuss the problem in depth while arousing the interest of the partners by explaining the importance of the activity. It will be necessary to identify target areas, community groups (members) to be involved (e.g., volunteers), and coordinators. Also it will be the right time to discuss sources of funding, types of tree seedlings to use and the acquisition process, possible planting day, as well as all the technical procedures involved as it is well explained in DRH10 and 12 (Figure 13).

iii. Propose possible tree planting day(s).

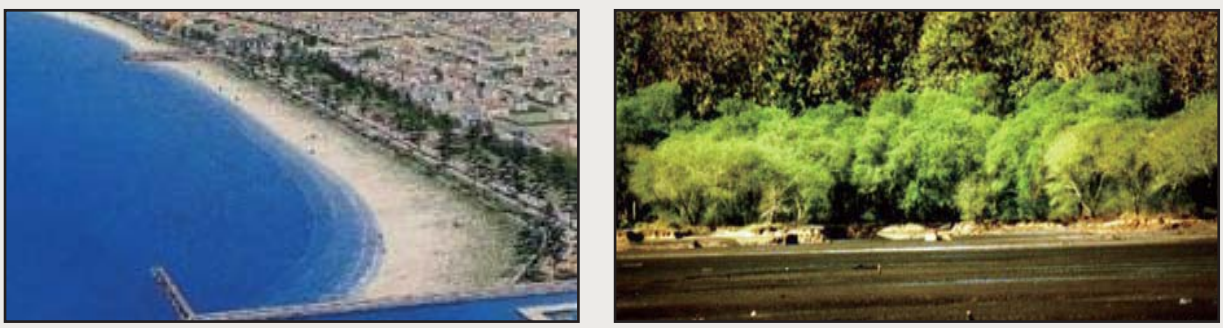

Figure 13: Coastal forest barrier in Japan (left) and mangrove forest in East Java (right) (DRH 10 and 12)

Acknowledgments

I would like to sincerely thank the organizers of this course for their patient teaching and careful explanation of the course materials. I also would like to thank my fellow coursemates for their positive contributions toward achieving my goals.

Some of the materials used here were taken from the DRH-Asia contents and my research work conducted during my WMO-Kyoto University fellowship, together with other sources.

Expected Outcomes

- Improved community understanding and awareness of natural and social components of floods and storm risks.
- Strengthening community preparedness to deal with floods through development of affordable technologies.
- Narrowing or closing the existing gap on communication between community members and decision makers to facilitate the implementation of activities related to flood and storm surge risks in the city.
- Establishment of coordinated framework involving community, academic, NGOs (e.g., Red Cross), and local and central Government, which is necessary in preparing for multi-hazard scenarios facing the whole community.

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DRH 8: Indigenous knowledge from Japan experience: Prevention, damage reduction and erosion control by flood disaster (TIK)

DRH 10: Application of Mangrove forest for countermeasure against tsunami disaster (IOT)

DRH 12: Tsunami disaster mitigation technique by coastal greenbelt (IOT)

DRH 16: Stilt house building technology for flood disaster reduction in flood-prone areas (TIK)

DRH 17: Indigenous knowledge on flood risk management in Bangladesh (TIK)

DRH 53: Implementation of Folk-Song Program in Disaster awareness raising (PT)

DRH 63: Community-based flood preparedness and mitigation in Bidara Cina, East Jakarta (PT)