

**STUDY ON e-DISASTER COMMUNICATIONS BY USING
ADVANCED ICT IN THE KINGDOM OF TONGA**

FINAL PROJECT REPORT

December 2012

**Collaborative Research Team of
Kingdom of Tonga and Japan**

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Executive Summary

This project has been established for strengthen the capacity of the National Emergency Management Office (NEMO), which is the focal point of disaster management in Tonga, to communicate with communities in times of disaster and to make resilient communities to disaster by enforcing the capacity of communities to respond to disaster with the application of advanced ICT.

The official selection notice on the project by APT Secretariat was issued on 27 March 2012, and the total approved budget for the project was USD 54,251.20.

Through this Activity, in particular, following areas were deeply studied by researchers of Tonga and Japan:

- Emergency Alerts System for the local communities
- Disaster Information Systems

As a result of the study, it is recommended that systems like above are seriously needed in Tonga for helping immediate improvement of the capabilities against natural disaster. The project team is eager to realize the safer society by ICT and move on to the next step.

1. Project Information

1.1 Backgrounds

Tonga is one of the most vulnerable countries to natural disasters in the world, just located in 200km to the west of the Tonga trench which is the source of earthquakes and tsunamis and in the cyclone belt struck twice in a year in average. It is crucially important to establish an effective, efficient, comprehensive disaster management system for the nation.

Accumulated epicenters distribution along Tonga trench for past 110 years is shown in Figure 1.1. Figure 1.2 (Picture) shows devastated village in Niuatoputapu, northern outer Islands, hit by Tsunami in 2009.

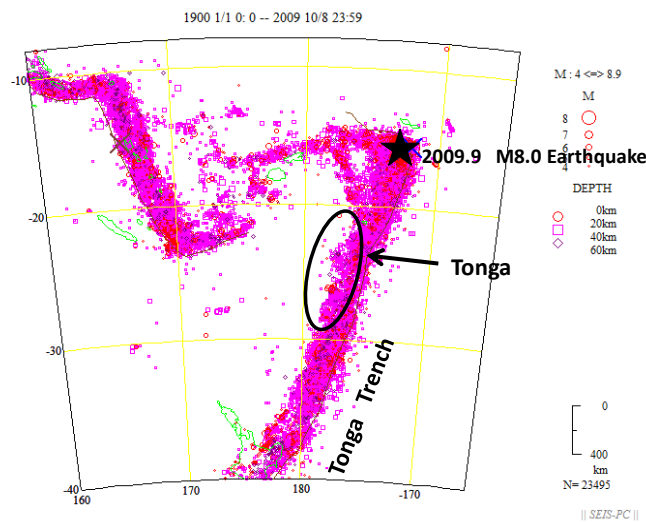


Figure 1.1 Accumulated epicenters distribution (1900-2009)



Figure1.2 Devastated village in Niuatoputapu Island hit by Tsunami in 2009

1.2 Objectives

The objectives of this project are to build resilient communities against disasters, and to strengthen the capacity of the National Emergency Management Office (NEMO) to collect and

distribute disaster information through applications utilizing advanced ICT by focusing on the following areas:

<Emergency Alert for high-risk communities >

To study on emergency community addressing system which can be used as an effective alert and communication measures to communities of which inhabitants can ensure urgent and reliable information before and during disaster time by using sound or voice delivering system such as broadcasting of alert sound through loudspeakers.

<Disaster Information Management>

To research on the systems which enable NEMO and rural areas to communicate and share in a timely and effective fashion with standardized formats to exchange information.

Through the research on this field, and the exchange of researchers and engineers between Tonga and Japan, both sides are expected to acquire concrete knowledge on the applications of advanced ICT which subsequently contributes to the development and diffusion of ICT, and its application to many different fields such as e-Disaster communications. The conceptual diagram of the objectives is given as Figure 1.3.

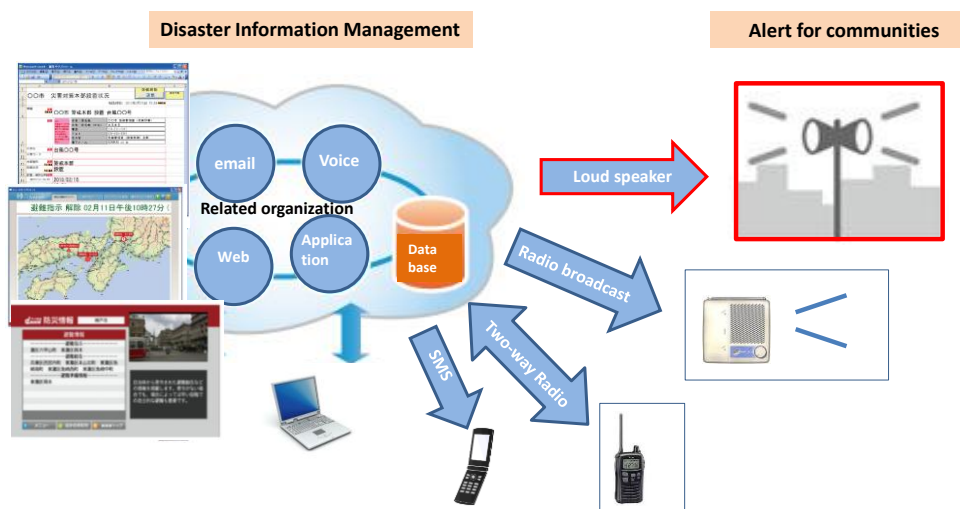


Figure 1.3 Conceptual Diagram of project objectives

1.3 Project Team

This study project has been conducted by researchers and engineers from each organization with each key role. The key roles for each organization were determined as shown in Table 1.1.

The list of the project members is shown in Table 1.2. Some parts of name of the organization, members of project team had been updated from application because of the current Government reorganization in Tonga. Figure 1.1 shows memorial photo of the core members just after the signing of MOU on the study implementation on 5th September 2012.

Table 1.1 Key role of each organization

Organization	Key role
Ministry of Information and Communications [MIC]	- Administrative coordination as the main applicant to APT - Total supervisor on project implementation - Overall grip and future planning for enhancing the result of this project - Arrangement for activities in Tonga
NEMO (Ministry of Works [MOW])	- Examination of the way to operate the Emergency Community Addressing System and the damage report system - Determination of the specifications for the damage report system - Examination of the operational standard for the damage report system
Ministry of Education, Women's affairs and Culture [MEWAC]	- Determination of the GPS to set up Emergency Community Addressing System - Examination of Operating rules of Emergency Community Addressing System at GPS
Japan Telecommunications Engineering and Consulting Service [JTEC]	- Project management - Account coordination - Responsible for the planning and execution of the Research - Framework of overall project and required reports - Arrangement for activities on Japan [main]
BHN Association [BHN]	- Advisor from the professional point of view regarding e-Disaster and IP network, including Emergency Community Addressing System - Necessary support for development of relevant documents - Arrangement for activities in Japan [sub]
ICT Overseas Volunteers Association [ICTOV]	- Advisor from the professional point of view regarding ICT and disaster communications - Necessary support for development of relevant documents - Arrangement for activities in Japan [sub]

Table 1.2 Member list of the project team

Name	Position/Title	Organizations/Institutions
Alifeleti TuiFua Tu'ihalamaka	Deputy Secretary, Communications & Corporate Service Dep.	Ministry of Information & Communications(MIC)
Finau Hufanga	Consultant (Frequency Engineer)	Ministry of Information & Communications(MIC)
Mafua-i-Vai'utukakau MAKAKA	Community Awareness & Training Officer	Ministry of Infrastructure (MOI), NEMO
Katsuya Terabayashi	Rural Development Volunteer	Ministry of Infrastructure (MOI), NEMO
Taniela Kula	Deputy Secretary, Geological Services Unit	Ministry of Land Survey and Natural Resources (MLSNR)
Ameria Sili (Ms.)	Assistant Geologist, Geological Services Unit	Ministry of Land Survey and Natural Resources (MLSNR)
'Ofa Fa'anunu	Director	Ministry of Infrastructure (MOI), Meteorology Services
Moleni Tu'uholoaki	Senior Forecaster	Ministry of Infrastructure (MOI), Meteorology Services
Sione Veikoso	Chief Engineer	Tonga Communication Company (TCC)
Solomone Finau	Chief Engineer	Tonga Broadcasting Commission (TBC)
Matangi To'aho	Head of IT Section, Policy and Planning Dep.	Ministry of Training (MET)
Pateli Vailea (Ms.)	Computer Programmer	Ministry of Training (MET)
Suzuo Uchiyama	Senior Consultant	Japan Telecommunications Engineering & Consulting Service
Masato Tamura	Director	Japan Telecommunications Engineering & Consulting Service
Makoto Handa	Director, ICT system Consulting	Japan Telecommunications Engineering & Consulting Service
Makoto Yamashita	Secretary General	BHN Association
Hachihei Kurematu	Vice President	BHN Association
Kosuke Dobashi	Deputy General Secretary	BHN Association
Takashi Kato	General Secretary	ICT Overseas Volunteers Association
Hiromichi Suzuki	Senior Consultant	ICT Overseas Volunteers Association



Figure 1.1 Core project members

2. Overview of the study

2.1 Project schedule

Overall activities and schedules of the project were shown in Table 2.1 and Table 2.2.

Table 2.1 Overall activities and schedule

Item	Japan team	Tonga team	Term
(1) Preliminary study (by remote discussion)	- Gathering, organizing and reviewing through existing information related to the study. - Discussion for idea illumination to agree on the appropriate methodology for the study. - Defining role and responsibility of each organization, project members list and detailed project scheduling. - Having common understandings on the result of Preliminary study - Clarification on the points to be discussed in the Joint Study in Tonga-1 and its detailed scheduling.		Apr 2012 to May 2012
(2) Joint Study in Tonga-1 (Japanese team visit Tonga)	- Reconfirmation on the project outlines. - Agree on MOU for the study. - Discussion on the scope of work of the study. - Problem finding through the meetings and site visit to the projects related organization. - Site visit to schools and communities to have right understandings on real situation of the evacuation place - Discussion on the pilot project system to be realized as a next step.		2-Jun-2012 to 10-Jun-2012
(3) Joint Study in Japan (Tongan team visit Japan)	- Transfer on the lessons learned from East Japan great earthquake disaster - Case study on utilization of advanced e-disaster and site visit for learning leading-edge e-disaster in Japan - Discussion on the requirements for Disaster Information System and Community Addressing System.		7-Jul-2012 to 16-Jul-2012
(4) Preparation of Interim Report	- Draft the Interim Project Report and Finalize the Account Summary	- Finalize the Interim report and submit to APT Secretariat	17-Jul-2012 to 8-Aug-2012
(5) Continued study	- Draft the technical specifications for the pilot system	- Organize requirement to the pilot system as main user (by NEMO) - Try to find financial resources for the pilot project	Jul-2012 to Aug- 2012
(6) Joint Study in Tonga-2 (Member from Japan visit Tonga)	- Finalize the requirements for the e-Disaster system - Finalize the requirements for the pilot system - Discussion on the financial matters for further plan. - Discussion on the action items for finalizing the study		8-Sep-2012 to 16-Sep-2012
(7) Works in Tonga and Japan	- Continue work on action items for finalize. - Preparation for applying pilot project		Sep- 2012 to Dec-2012
(8) Joint Study in Tonga-3 (Members from Japan visit Tonga)	- Finalize the contents of the final report - Discussion on the financial matters for further plan.		27-Nov-2012 to 1-Dec-2012
(9) Final report documentation and submission	- Create Final Report - Overall project activities and account matters		Dec-2012: Final project report
	- Finalize the Final report including account report with evidence	- Finalize the Final Report and submit to APT Secretariat	Feb-2013: Final accounting report

Table 2.2 Overall project schedule implemented

Activity items	2012 Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2013 Jan	Feb	Mar
0. Events													
APT Notification on selection	X												
Deadline for project activities												X	
1. Preliminary study and remote discussion													
2. Joint Study in Tonga - 1 (JST-1)													
3. Interim reporting phase													
Preparation of Interim report													
Submission to APT							X						
4. Joint Study in Japan (JSJ)													
5. Works in Tonga and Japan													
6. Joint Study in Tonga-2 (JST-2)													
7. Works in Tonga and Japan													
8. Joint Study in Tonga-3 (JST-3)													
9. Final reporting phase													
Production of Final report													
Submission to APT (Technical part)													
Submission to APT (Final accounting report)													

2.2 Basic policies

This study was conducted based on a generally known method for finding and improvement of the problems. The basic methodologies for the study were set as follows:

(1) Survey

- Survey on the current situation through meetings, interviews, hearing with organizations related to the areas concerned.
- Survey on related documents such as law, regulations, guidelines, manuals, reports, and plans.
- Survey on the latest disaster-related products and its trends.
- Implement survey on the sites for the pilot system for accurate and concrete design.

(2) Problem finding and Analysis

Based on the results of surveys above, experts from both teams analyze the situations and extract major problems.

(3) Planning

- To plan feasible and sustainable solutions to be applied to the main causes.
- To plan the milestone and the action plan for the real implementation.
- To apply any possible fund schemes for early realization of the pilot system if situation allowed.

3. Outline of the outputs

Major outputs of the study are divided into following three chapters and described respectively:

- Situation analysis: → Chapter 4
- Alert system: → Chapter 5
- Disaster Information System: → Chapter 6

4. Situation analysis

4.1 Summary of the survey result

Surveys on actual situations and analysis were implemented through the meetings with disaster related organizations, and studies on various kinds of disaster related documents in Tonga.

4.1.1 Problems found through the meetings

(1) National Emergency Management Office (NEMO)

NEMO is responsible for:

- Maintains the National Emergency Management System operations.
- Develops and maintain the National Emergency Management Plan.
- Focuses on a comprehensive approach to emergency management.
- Runs and trains staffs of the National Emergency Co-ordination center.

[Problems]

- Shortage of skilled officers. Impossible to provide a 24/7 duty on site.
- No common radio communication channel with other disaster response agencies.
- Office building is located far from MET and relatively vulnerable against tsunami or flood.
- Difficult to share the information among disaster related entities. (e.g. they recently use only paper and hand writing format).
- Insufficient communication measures with others besides telephone/fax
- Insufficient measures for information openness/transparency to media and the public.



Figure 4.1 Communication room in NEMO

(2) Meteorology office (MET)

Met is responsible to provide accurate and timely weather (tsunami), climate and coastal services, and the only an organization available 24/7 duty on site in Tonga.

[Problems]

- Insufficient dissemination measures to local communities (Indicated in dotted area in Figure 4.2)

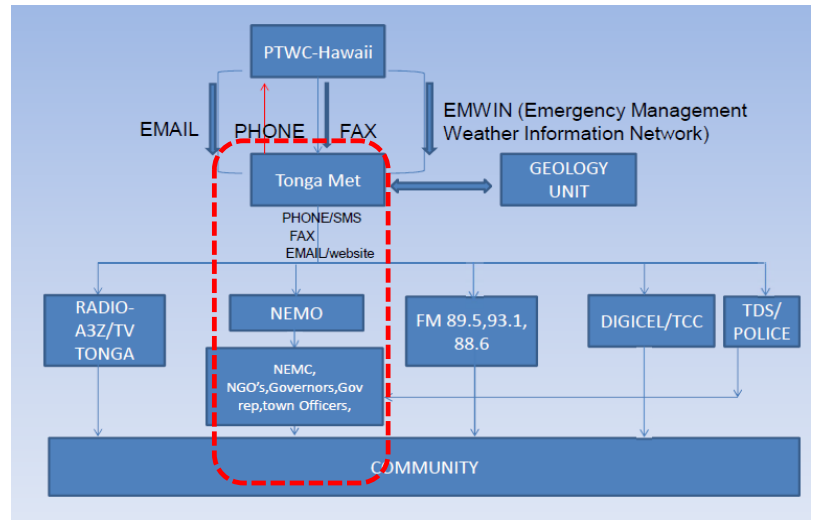


Figure 4.2 Tonga Tsunami Warning System Flow Chart

(3) Geology Service Unit (GSU)

GSU belongs to Ministry of Lands, Survey and Natural Resources and responsible for seismic observation and provisioning earthquake information for the public. Seismic observation network for Tonga and Fiji was commenced in 2003, and upgraded in 2007 by JICA technical cooperation program. Current network configuration is shown in Figure 4.3.

[Problems]

- Insufficient spare-unit/stand-by parts for the Tonga Seismic Network.
- Insufficient capacity on local-tsunami analysis.

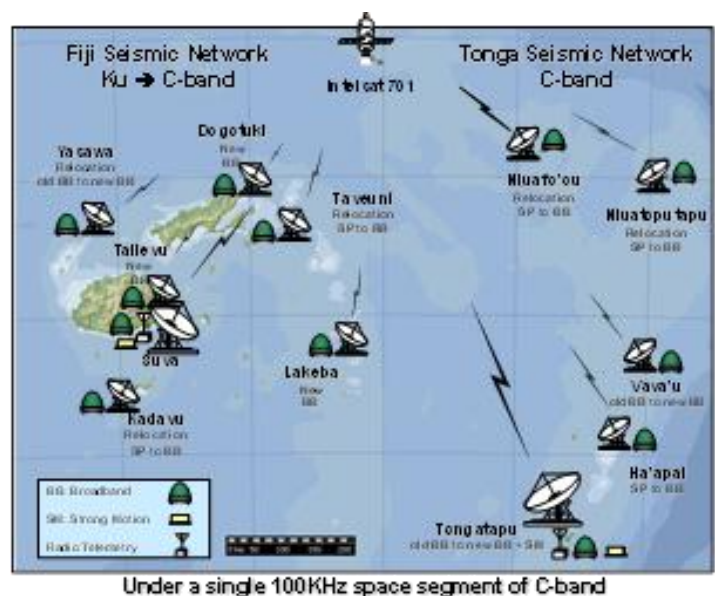


Figure 4.3 Tonga-Fiji Seismic Observation Network

(4) Tonga Communication Corporation (TCC)

TCC has been providing emergency massaging service (EMS) to the registered subscribers over their GSM-SMS function in cooperation with NEMO/MET. This service works very well in terms of rapidness of information dissemination.

Cell broadcast which is enhanced service of EMS is now under consideration for future introduction.

[Problems]

- Area coverage is not enough for rural area especially in remote island group.
- Subscriber penetration is not high especially in rural area. (50-60% in total)
- Office in not 24/7 (on-call-basis in night time and weekend)



Figure 4.4 Meeting at TCC

(5) Tonga Broadcasting Committee (TBC)

TBC is responsible for information dissemination at national emergency situation based on the law and regulations as public broadcasting station. Therefore disaster related information has been given highest priority in the broadcasting program in TBC. For instance, TBC changes program from ordinary contents to emergency one promptly based on the request from NEMO/MET, and broadcasting schedule time is tentatively expand to 24 hours in that case whereas normally scheduled from 6am to 12pm.

[Problems]

- Office is not 24/7 (on-call-basis during midnight)



Figure 4.5 Meeting at TBC

4.1.2 Problems extracted from related documents and reports

Through careful analysis on the disaster-related documents and reports available, following points were extracted as common problems in disaster management field in Tonga as well as other small pacific nations:

- Lack of information dissemination to the public.
- Lack of capacity of National Emergency Management Organization.
- Shortage of staffs of National Emergency Management Organization.
- Insufficient of information sharing among disaster related agencies.

Referred documents for the study are listed in the References at Chapter 11 of the report.

4.1.3 Hypothesis verification

Based upon the results of the analysis in chapter 4.1.1 and 4.1.2 above, it was verified that the core problems in the disaster management sector in Tonga totally consistent with the assumptions that we had hypothesized at the time of the J2 application.

4.2 Setting scope

The words like “Early warning” or “Disaster communications” or “Information dissemination”, it may include various kinds of fields of science and technology such as weather observation/forecasts, phenomena analysis, and alert to the public, etc. Therefore we set aside the field of observation/forecast since technologies for improving those areas are not original purpose of APT’s project. It was decided at the kick-off of the study project that scope of work should be specified for efficient and meaningful project implementation because of its wide and deep scientific extent of the natural disaster.

Figure 4.6 shows information flow of the early warning and the relation among major disaster related entities.

Based on the problems which recognized in 4.1.1 and 4.1.2, it was realized that problems can be consolidated into two objectives as follows and shown in Figure 4.6. :

- Objective-1: Establishment of emergency alert measure for immediate evacuation for the local communities
- Objective-2: Strengthening Information management capacity in the government and to the media/public before, during and after disaster.

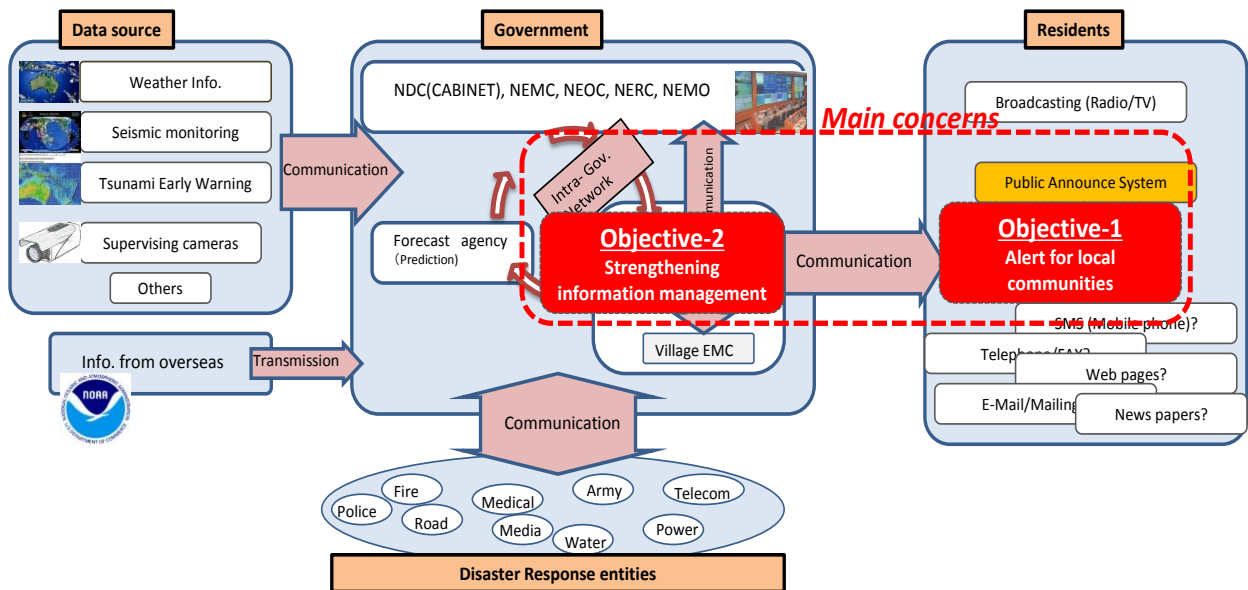


Figure 4.6 Scope of work of the study

4.3 Priority solutions

It was considered that lots of solutions including primitive ways were applicable to improve main objectives set in above. From those options, solutions/systems using advanced ICT in Table 4.1 were selected as prioritized measures as a result of discussion among researchers for the next step.

Table 4.1 Priority solutions

Main objectives	Solutions/Systems
Emergency alert for local communities	- Emergency Alert System (EAS) for local communities
Strengthening disaster management capacity in NEMO	- Disaster Information System (DIS) for NEMO

5. Emergency Alert System

5.1 Information dissemination

There are several means to disseminate emergency information to local communities from NEMO/MET. Table 5.1 shows considerable means for information dissemination and its evaluation on effectiveness. Some of them already exist in Tonga.

Table 5.1 Emergency Information dissemination measures

Measures	Effectiveness	Study further?
Broadcasting Radio	- Very effective way to nationwide dissemination - Not work when radio set is switched off	No (Already done in Tonga)
Broadcasting TV	- Very effective way to nationwide dissemination - Not work when TV set is switched off	No (Already done in Tonga)
Telephone/FAX (Fixed Telco line)	- Not efficient (it is one by one basis) - Not work when traffic congestion in disaster or network failure	No
Cellular phone	- Not efficient (it is one by one basis) - Not work when traffic congestion in disaster or network failure	No
Cellular phone (SMS)	- Very effective and practical for the registered subscribers - Both TCC and Digicel have been providing this service in Tonga. - Cell-broadcast is now under consideration for quicker transmission	No (Already done in Tonga)
Internet (e-mail)	- Not suitable for emergency alert (It is pull-method, not push) - Not work when network failure	No
Digital signage	- Effective if the sign can be seen - This should be a aux. option besides other measures -	No
Sound alert	- Most effective way to all inhabitants in the area - Area coverage depends on capability of speakers/sirens - No sound alert at all in Tonga so far	Yes

5.2 Sound alert methods

5.2.1 Comparisons

First of all, based upon its meaning of the J2 study, primitive methods, which not use communication network, such as Church bell, Portable loud speaker (Mega-phone), and loudspeaker-van should be excluded from the objected area.

Therefore, “Motor siren” or “Loudspeaker” as sound devices that connected to the trigger organization namely MET/NEMO through communication network may only remain to be studied further. Table 5.2 shows comparison on the sound devices.

Table 5.2 Comparison on sound devices

Items	Motor siren	Loudspeaker
Appearance(sample)		
Coverage (Radius)	Very wide (2-3Km)	Relatively limited (300-500m)
Cost	Reasonable	Reasonable
Weight	Very heavy (approx. 50kg)	Relatively light
Power consumption	Very high	Low-middle
Backup power	Generator needed	Battery available (24h)
Voice capability	Non (Mono tone only)	Yes (Siren sound/Live voice/Pre-recorded message/Music, etc.)
Frequent test operation	Difficult because of its serious sound level and tone	Easy (e.g. time signal at 5pm everyday)
Usage in ordinary life	Non	Useful (e.g. local announcement)
In total	Fair (ICT not applicable)	Better than Motor siren (ICT applicable)

It can be simply said that motor siren is appropriate for developing country such as Tonga especially in case of limited budget because of its simplicity and cost efficiency. But it can be concluded that Loudspeaker has much future expandability and scalability than motor siren if its small sound coverage could be overcome. Although we still keep those two

options for future deployment, it is assumed, in this study, that the loudspeaker should be given higher priority for further study, but motor siren.

5.2.2 Variations of loudspeakers

(1) Conventional models (Trumpet type)

There are two kinds of conventional models as disaster dissemination purpose in general. Comparison is shown in Table 5.3. Both types are applicable and combined based on the area-coverage design.

Table 5.3 Comparison on conventional loud speakers

	Reflex type	Straight type
Appearance		
Sound coverage (approx. radius. with 30W amp. Set up at 30m. 60dB)	200-400m	300-500m
Output (nominal)	125dB	128dB
Sound pressure (nominal)	110dB (1W,1m)	110dB (1W,1m)
Directivity	Normal/ broad (90deg.)	Rather sharper than reflex (60 deg.)
Weight (kg)	3-4 kg (easy to equipped to pole)	5-6 kg (easy to equipped to pole)
Power consumption	Lower than siren (can be back-upped by battery)	Lower than siren (can be back-upped by battery)

(2) Long reach models

Newly developed “Long reach speakers” are currently available in the market. Because of its cost efficiencies, these models can be applicable when objective coverage area is larger. It is also positive elements of these types that echo (sound-over-reach) can be minimized since area-overlap is much smaller than conventional speakers. For the ideal sound coverage, combination of conventional type and long reach type will be the best in terms of total cost optimization.

i) LRAD (USA)

Table5.4

Model	LRAD-360X Series
Appearance	 Dual 5 stack (Max. 10)
Sound coverage (80dB)	600m (Dual) - 2.8km (10 stack) in radius
Directivity	360 deg. Omni-direction
Power consumption	640w (Dual) - 3.2kW (10 stack)
Dimension size WDH (mm)	864x864x1029 (Dual) – 864x864x3469 (10 stack)
Weight (kg)	70.3 (Dual) – 233.6 (10 stack)
Wind velocity-resistant	92m/h
Details	http://www.lradx.com/site/content/view/2092/110/

ii) Whelen Engineering (USA)]

Table5.5

Model	- WPS-2900 Voice capable omni-directional sirens - OMNIALERT SERIES
Appearance	
Directivity	360 deg. Omni-direction
Details	http://outdoor.whelen.com/omnisirn.htm

iii) TOA (Japan)]

Table5.6

Model	Horn-array speaker
Appearance	
Sound coverage	Approx. 1km (4 stack) – 1.5km (8 stack)
Directivity	90 deg.
Details	http://www.youtube.com/watch?v=vNMidFsPEWA

5.2.3 Locations for loudspeakers

The loudspeaker should be installed at certain height for securing wider sound reach, and the location should be selected to cover the targeted inhabitants efficiently as well as electric power availability and communication circuit between signal origins.

Following styles are considered as candidate locations for the loudspeakers installation:

- Install on exclusive mast/pole for the speaker
- Attach to cellular phone towers
- Install on the roof top of high building

Since Long reach loudspeakers need huge electric capacity and battery backup is difficult for them, cellular phone towers where generator backup is available might be the best locations if the operator cooperates.

5.2.4 Summary on loudspeakers selection

The products mentioned in above should be selected and located in the right products in the right place basis. Detailed deployment of the loudspeakers will be specified in design phase.

As a recent trend, long-reach models are attractive from the cost efficiency and performance. Although unit price of long-reach models are generally higher than conventional model, total cost per coverage will become significantly lower.

5.3 Communication methods

5.3.1 Scope

Study on practical communication circuits between the origin of early warning and the sound alert devices are evaluated and summarized in this chapter.

- Origin organizations: Tonga National Activation Point (MET and/or NEMO)
- Sound alert devices: Loudspeakers installed in community sides

The conceptual scope of extent as a communication network that studied in this chapter is shown in Figure 5.1

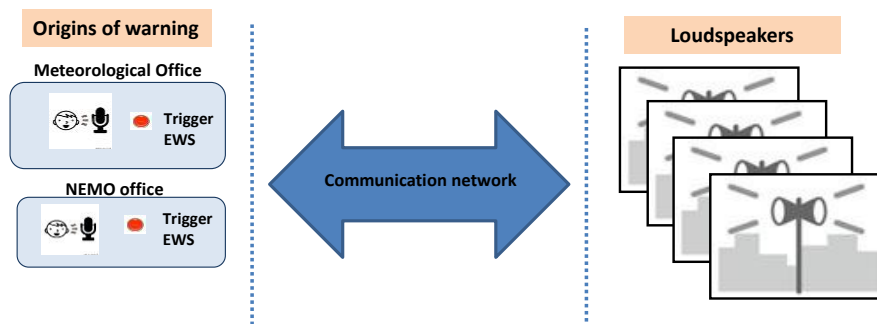


Figure 5.1 Scope of communication network

Based on the helpful knowledge described in “APT Report on Use and Examples of Radio communication Systems for Early Warning and Disaster Relief Operations (ASTAP/REPT2 (ASTAP19, Manila, 2011)”, the latest technology trends and actual conditions in Tonga were additionally taken into account for this study.

5.3.2 Geographical conditions of Tonga

Tonga consists of several island groups, and each island group is far more than 130km each other. The whole map of the Tonga is in Figure 5.2. And, because of its wide spread geographical characteristics of the nation, applicable communication methods for disaster warning are very much limited, and the issue might be better to divide them into following four section from Section-A to Section-D as classified in Figure 5.3 for making it simple.

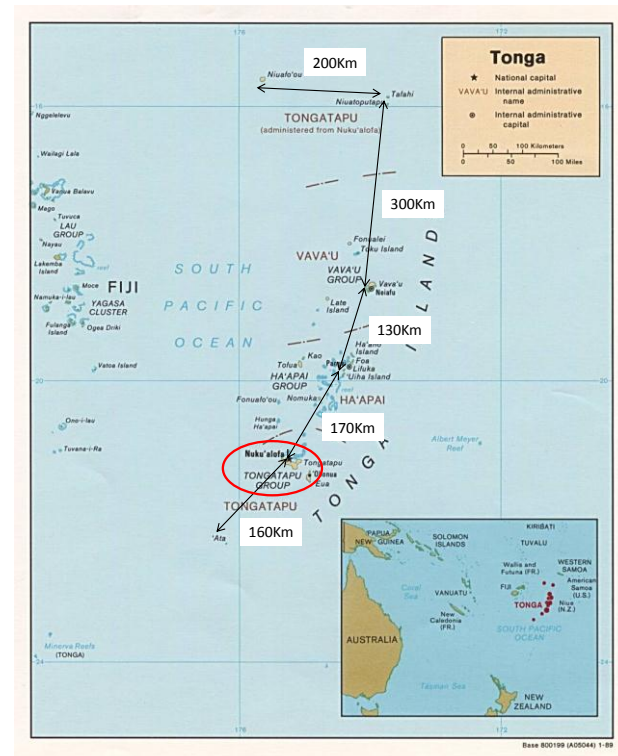


Figure 5.2 Whole map of Tonga

- A) Intra-island network (within Tongatapu Group):
Communication circuits within Tongatapu islands group
- B) Intra-island network Intra-island network (within Outer Is. Group):
Communication circuits within Tongatapu islands group
- C) Inter-island network:
Communication circuits between island groups
- D) Others:
Other circuits which are not classified in A nor B nor C.

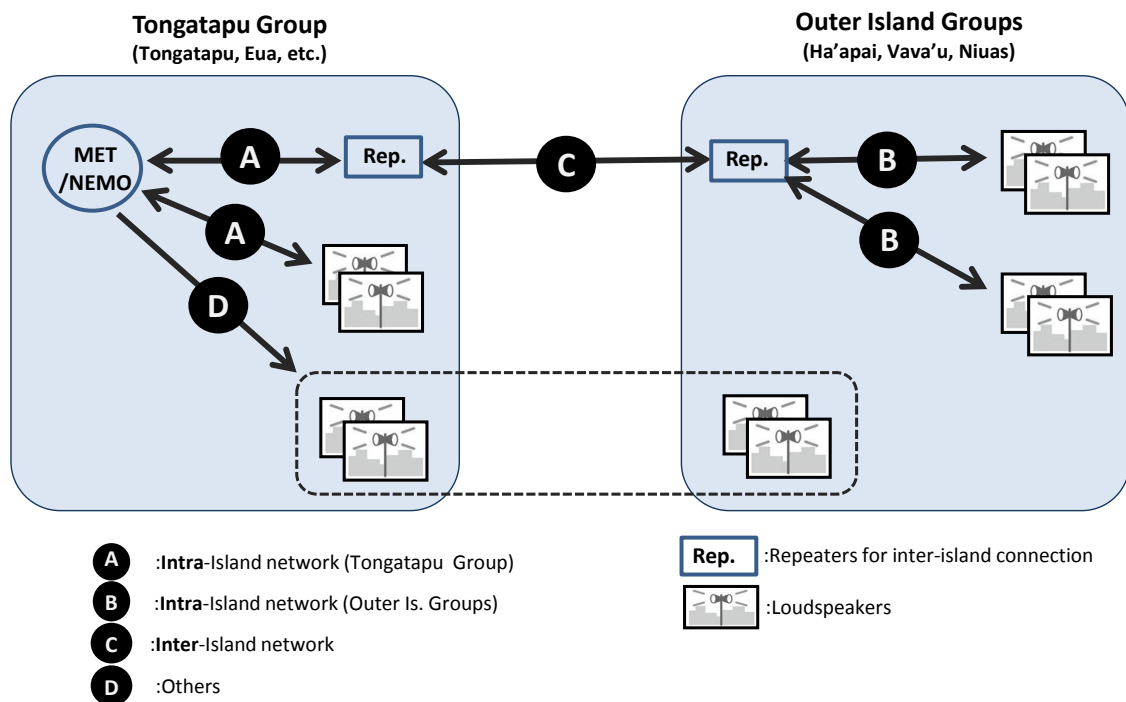
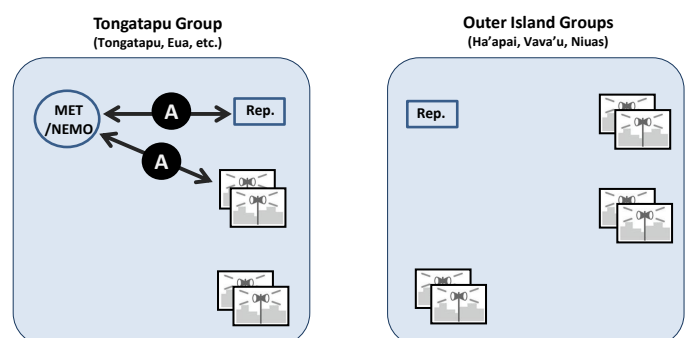


Figure 5.3 Network classification

5.3.3 Intra-island network (Section-A)

Several types of telecommunication means can be technically listed for this purpose, such as dedicated VHF/UHF radio link, IP- microwave link, Cellular phone, Land telephone, Internet, and so on. Technical evaluations on each method are shown in Table 5.7.



It is thought that the radio based networks are preferable because of its flat terrain of the Island and reliability against natural disasters. It is also desirable to have a broadband capability to the network since high speed internet will be available after commencement of optic-fiber-submarine-cable between Tongatapu and Fiji planned in November 2013. As a

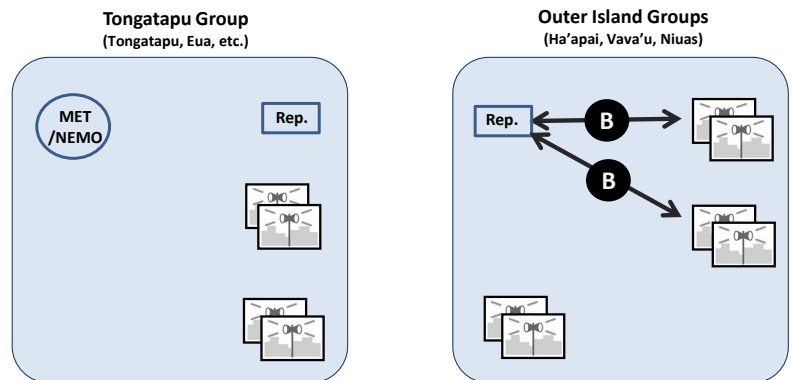
result of evaluation, dedicated IP-Microwave-link is the most recommended for the Section-A.

Table 5.7 Evaluation on Intra-island network (Section-A)

	Outlines	Pros	Cons	Comments
VHF/UHF radio-link (Dedicated)	Fixed two-way-radio link, Narrowband, Single channel, FM	-Reliable -Low cost -Long reach (wide coverage) -Broadcast capability	-Narrowband	Recommended
IP-Microwave-link (Dedicated)	Fixed IP broadband microwave link, licensed or registered , (e.g.802.11j)	-Broadband capability -Reliable -Low cost -Long reach -Interference free	-Small coverage when point-multi point configuration	Highly Recommended
Wi-Fi (Long distance)	Fixed IP broadband microwave link using WiFi, non-licensed or non-registered ,(e.g. 802.11g,n)	-Broadband capability -Reliable -Low cost -Long reach	-Risky on interference -Small coverage when point-multi point configuration	Recommended (Depends on frequency conditions)
Cellular phone &SMS	Triggering signal transmission over SMS function of Cellular phones	-Low initial cost	-Monthly cost -Risk on traffic congestion in after disaster -No voice capability	Not recommended
Land telephone line (PSTN)	Triggering signal transmission over telephone dial-up with modem	-Low initial cost	-Monthly cost -Risk on traffic congestion in after disaster -Not reliable in disaster	Not recommended
Internet (WiMAX)	IP connection over internet/WiMAX services	-Low initial cost	-Monthly cost -Risk on traffic congestion in after disaster	Not recommended
Leased circuits (TCC)	Triggering signal and/or voice transmission over analogue leased circuits with modem	-Low initial cost	-Monthly cost -Not reliable in disaster	Not recommended
Borrowing vacant bandwidth in backhaul of cellular network of the operators	Borrow certain bandwidth or channels or fiber-core in backhaul network between central office and cellular towers of the cellular operators	-Low cost if operator cooperated -Operation and maintenance by operators	-Limited locations for the loudspeakers -No guarantees on operator's cooperation	Considered as supplement network when cooperated

5.3.4 Intra-island network (Section-B)

Because PSTN including internet connections between Tongatapu Island and the other outer island groups are very much limited and only relayed by satellite communication circuits of TCC, and there is not a plan connected with submarine optic-fiber-cable for the time being, a broadband within the island groups is expected to need still more period for the realization.



Therefore, if we would introduce broadband one only within the island, it might be meaningless. Accordingly, it is considered that the circuits to each loudspeaker locations within the outer island group can be either broadband or narrowband as long as it utilizes radio based methods.

Technical evaluations on each method for this section are shown in Table 5.8. It is thought that the radio based dedicated network are preferable because of reliability against natural disasters.

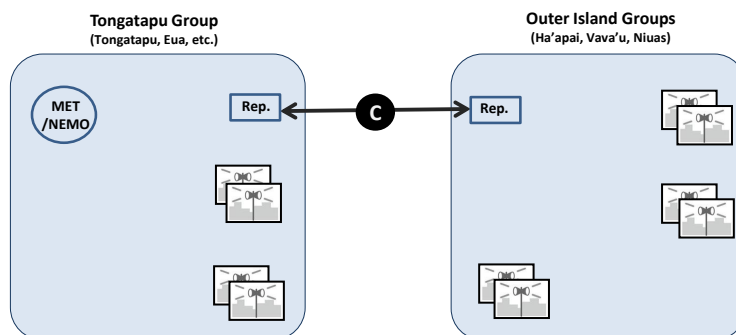
Table 5.8 Evaluation on Intra-island network (Section-B)

	Outlines	Pros	Cons	Comments
VHF/UHF radio-link (Dedicated)	Fixed two-way-radio link, Narrowband, Single channel, FM	-Reliable -Low cost -Long reach -Broadcast capability	-Narrowband	Recommended
IP-Microwave-link (Dedicated)	Fixed IP broadband microwave link, licensed or registered , (e.g.802.11j)	-Broadband capability -Reliable -Low cost -Long reach -Interference free	-Small coverage when point-multi point configuration	Recommended
Wi-Fi (Long distance)	Fixed IP broadband microwave link using WiFi, non-licensed or non-registered ,(e.g. 802.11g,n)	-Broadband capability -Reliable -Low cost -Long reach	-Risky on interference -Small coverage when point-multi point configuration	Recommended (Depends on frequency conditions)
Internet (WiMAX)	IP connection over internet/WiMAX services	-Low initial cost	-Monthly cost -Risk on traffic congestion in after disaster	Not recommended

5.3.5 Inter-island network (Section-C)

(1) General

Section-C means trunk-circuits between island groups. Because of the long distances between each island groups, far more than 130km on the sea, the applicable communication methods for those sections (Section-C) are technologically limited.



Technical evaluations on each method for the section are shown in Table 5.9.

(2) IP micro-wave-link and Wi-Fi

IP-micro-wave-link and the Wi-Fi are firstly excluded from the options because of their short outreach (to up to approx. 20km). And, HF-radio-link is not recommendable options because of its instability of the radio propagation.

(3) VHF/UHF radio-link

Regarding VHF/UHF radio-link, there might be certain possibilities that the long distance system with narrow band, PSK modulation which requires low C/N can be applicable for this section. It is desirable to study further on the feasibility through the trial in the next stage.

(4) Internet

Meanwhile, the capacity is limited though, there are internet lines in this section via satellite by TCC, and it is thought as the most practical solution from the aspect of the durability and cost. In this option, risk of traffic congestion at the time of disaster should be concerned. This can be a tentative solution till permanent line comes.

(5) Dedicated satellite link

Technologically, there may be an option to establish dedicated satellite link as section-C for this purpose. But this option is not realistic because of expensive transponder fee which is not affordable unless satellite network using shared transponder by south pacific country comes out.

(6) USP-net

The University of the South Pacific (USP), under the JICA project "ICT for Human Development and Human Security", installed USP-net Ku-band VSAT stations at USP centres located in Ha'apai group and Vava'u group of Islands of Tonga. These VSATs are providing Broadband services required for E-education and other network services in the locality. Subject to adjustments with governments and USP, it could possible to

utilize these facilities to serve as a part of disaster communication network in Tonga with minimal additional equipments installed. If USP-Net satellite bandwidth could be made available in case of disaster, it is the most realistic solution for the inter-island disaster communication network. However, this will take some time to come as the matter should be agreed upon with USP, the stakeholders of USP, national Telecom authorities, and disaster management organizations including other countries.

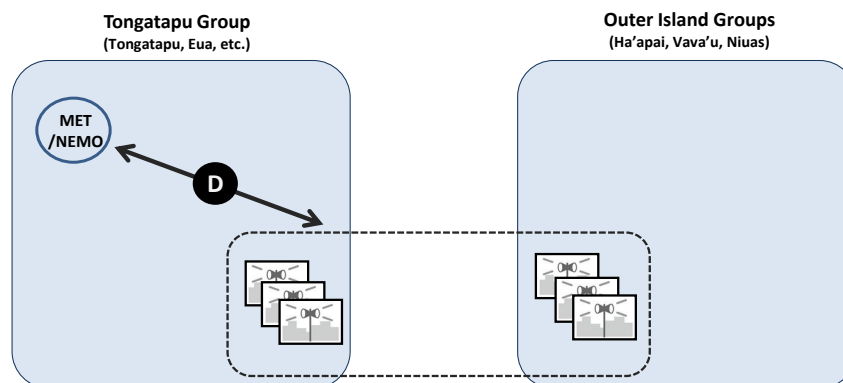
(Ref Dr. Pramanik, Kader Hiroshi; Introducing Satellite Based ICT Network in the Pacific Island Nations, ITU Journal Vol.42 No.12, 2012 Japan)

Table 5.9 Evaluation on Inter-island network

	Outlines	Pros	Cons	Comments
HF radio-link (Dedicated)	Fixed two-way-radio link, very low speed, Using radio modem	- Low cost -No recurrent cost	-Unstable or not reachable (Skipped)	Depends on location (Skipped)
VHF/UHF radio-link (Dedicated)	Fixed two-way-radio link, Long reach type Narrowband, Single channel, FM or AM	- Low cost -No recurrent cost	-Unstable or not reachable	Depends on distance (To be Studied more)
USP-net	See above 5.3.5 (6).	--	--	To be studied further more

5.3.6 Others (Section-D)

Section-D includes methods by which alert messages or siren-triggering signals can be sent directly to the loudspeakers locations all at once nationwide. Technical evaluations on each method for this section are shown in Table 5.10.



(1) Chatty Beetle

Chatty beetle, which is an iridium satellite terminal, is one of the most feasible methods for this section if recurrent cost is affordable. See website for detail (<http://www.chatty-beetle.org/index.html>).



(2) DTMF over A3Z radio broadcast program

- About A3Z

Radio Tonga 1, known as its call sign A3Z, the most far-reaching of all Radio Tonga's services operated by Tonga Broadcasting Commission (TBC), this channel broadcasts daily from 6am to midnight on a frequency of 1017KHz. In the event of local emergencies, such as tropical cyclones, A3Z has been known to stay on the air all night with constant updates from the Tonga Meteorological Service. A3Z can be heard throughout the entire Kingdom of Tonga, including the outer island groups of Ha'apai, Vava'u, and Niuafo'ou&Niuaatoputapu.

- DTMF over Radio broadcast signal

DTMF stands for Dual-Tone Multi-Frequency which is known as a sound heard when dialing telephones. DTMF over Radio broadcast technology for remote radio receiver activation in emergency case has been popular and well commercially used in Japan for local inhabitants using community FM broadcast for J-Alert which is Japan's national warning system. Utilizing capability of DTMF which can contains and transmit certain information using promised codes consists of some digits of numbers through audible bandwidth, an amplifier of loudspeaker can be remotely activated and/or inactivated when specific code comes. Moreover, pre-recorded announcement or some patterns of siren-tone can be played by designated codes programmed. To realize this system, only small DTMF encoder in the Studio and DTMF decoder with power controller of the amplifier in the other side are needed and they are technically well done.

Conceptual diagram of DTMF over A3Z radio broadcast program is shown in Figure 5.4.

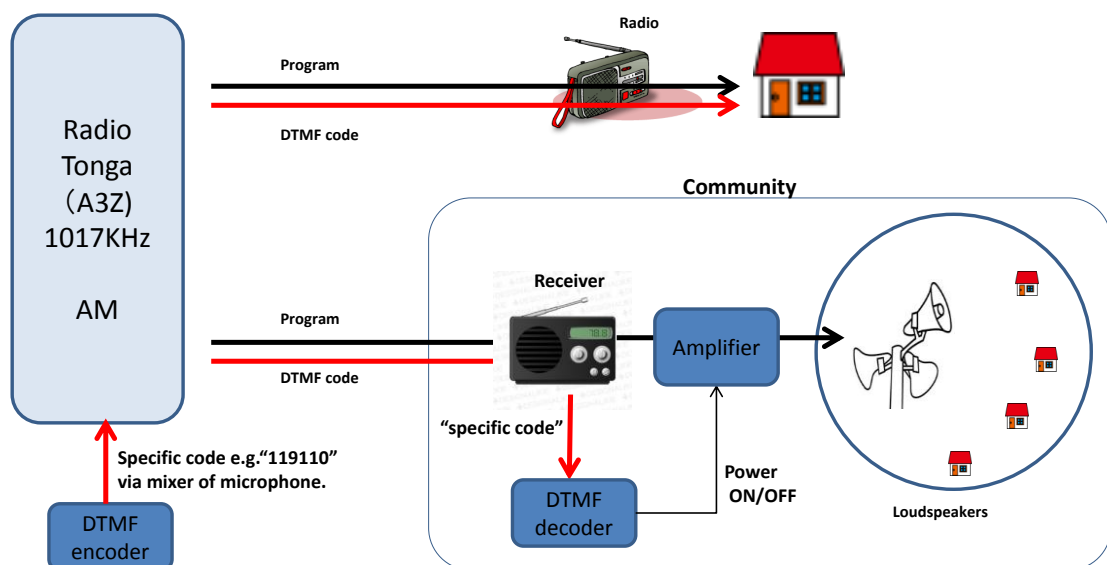


Figure 5.4 Conceptual diagram of DTMF over A3Z radio broadcast signal

Since DTMF over AM middle-wave broadcast, not FM, is very new, and applying this idea to the long distance via ionosphere reflection is also new, feasibility survey on these factors should be carefully implemented for realizing this idea. Because radio reception quality in very far islands such as Niua group (Niuafo'ou&Niuaotoputapu) where the radio signal would be affected and distorted by fading of radio signal caused long distance propagation via reflection of the ionosphere. If the radio reception quality could be confirmed as good enough for secure DTMF transmission, all loudspeakers in the nation can be controlled from the MET/NEMO via A3Z.

- Survey result (Reception quality survey in Niuaotoputapu Is.)

Since there was information from MIC that radio reception quality in the Niua's got worth in these days, Mr. Terabayashi, researcher of the project visited to Niuaotoputapu Island that located 600km north-east of the main island, and checked situation of the radio reception for a week.

Although the outreach of the middle-wave radio in particular day time considered to become short because recent solar activity is high in its 11 years cycle, the survey result concluded in relatively good even though the receiver used for the survey was very poor without external antenna. The report on the survey result is attached as Annex 2. Referring this result, it is assumed that "DTMF over A3Z radio broadcast program" can be the positive option for this network section if the receiver capability would be improved with external antenna.

Mid-term (one week or more) reception test using appropriate radio set should be implemented again by radio specialist in the next step for further realization.

According to TBC, in the future, there is a plan to build sub-transmission station in Vava'u Island to improve reliability of their service and reception quality in outer island including Niua group.

Reception quality in Niuaotoputapu could also be improved to install a trunk-radio-patch using HF radio between Vava'u and Niuaotoputapu, and then connect it to the existing local FM broadcasting station in Niuaotoputapu.

- Cooperation with TBC

It was confirmed in the meeting at TBC that they are interested in this idea and willing to cooperate as disaster mitigation is one of their mission.

- Conclusion

Although the feasibility needs to be reconfirmed by exact survey, this method will be the most cost effective solution for Section-D. Furthermore, this solution can be applied not only in Tonga but also for the other developing countries.

Table 5.10 Evaluation on others

	Outlines	Pros	Cons	Comments
Iridium Satellite (Chatty beetle) directly equipped to loudspeakers	Simple two way short messaging terminal, satellite based, can be trigger as external loudspeakers 	-Nationwide coverage -Stable -Low cost	-Recurrent cost (Iridium satellite phone)	Recommended (If affordable)
DTMF over A3Z radio broadcast	See below	-Nationwide coverage -Very Low cost	-Unstable (to be checked)	Recommended (Further study is needed)
Cellular phone & SMS	Triggering signal transmission directly to loudspeakers over SMS function of Cellular phones	-Low initial cost	-Monthly cost -Risk on traffic congestion in after disaster -No voice capability	Applicable if there is no other way (Basically not recommended)
HF radio-link (Dedicated)	Fixed two-way-radio link, very low speed, Using radio modem	- Low cost	-Unstable -Skipped	Not recommended
Internet (WiMAX or ADSL)	IP connection over internet services	-Low initial cost	-Monthly cost -Risk on traffic congestion in after disaster	Applicable if there is no other way (Basically not recommended)

5.3.7 Summary on communication network study

Summary of above studies on the communication methods are shown in Table 5.11. Section-A for Tongatapu group is simply summarized that IP microwave link is the best option because of its broadband capability, reasonable cost and reliabilities.

Meanwhile, Section-B and C are practically difficult since Section-C, which is limited like bottle neck, dominates for both sections. Since there are not any applicable options besides Chatty Beetle or internet for Section-C, and there are some applicable options for Section-D

such as Chatty Beetle or DTMF over A3Z, case like Section-B combined with Section-C does not make sense anymore. Therefore, Section-B and C may be categorized as auxiliary measures while main method consists of Section-A and D can cover almost all high-risk areas. Recommended nationwide network configuration for present situation is shown in Figure 5.5

Table 5.11 Summary of communication methods for each section

Section	Applicable methods	Practically recommended methods	Remarks
Section-A	-VHF/UHF radio link -IP microwave link -Wi-Fi	-IP microwave link	Higher priority on broadband capability
Section-B	-VHF/UHF radio link -IP microwave link -Wi-Fi	-VHF/UHF radio link -IP microwave link	-Section B is meaningless if there is not secure solution in Section-C. -Depends on the cost and necessity of broadband
Section-C	-HF radio-link -VHF/UHF radio link -Internet	-Internet	-HF/VHF/UHF radio link can be applicable if its stability could be proved -USP-net is an ideal if possible in the future (See 5.3.5 (6))
Section-D	-DTMF over A3Z -Chatty Beetle -SMS/Cellular phone	-DTMF over A3Z -Chatty Beetle	-Chatty Beetle is better if affordable -DTMF over A3Z is the most cost effective, and could be the option if one-way and its stability would be acceptably enough. -SMS/Cellular phone would be available if there is not any other feasible means.

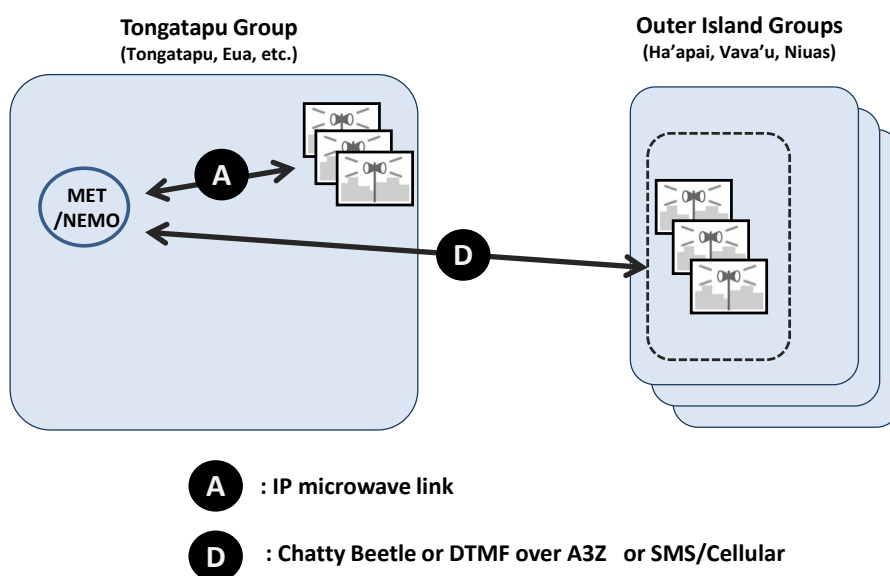


Figure 5.5 Recommended network configuration

Network configuration shown in Figure 5.5 is just tentative plan which should be restudied later based on the conditions at the time of full-scale deployment.

It is also noted that Section-B using IP microwave-link would be meaningful when reliable solutions for Section-C were realized in the future by e.g. commencement of submarine optic fiber cable for Ha'apai group and Vava'u group or by the USP-net or by other satellite transponder sharing scheme.

5.4 Design philosophy

5.4.1 Basic design policies on communication network

For the nationwide deployment of the emergency alert system, it is recommended to try to find the rational and cost effective combination from applicable solutions at that time, not to chase latest technologies. And, the solutions should reflect the latest situations of the telecommunications services available at the time of implementation because broadband situation including mobile telecommunication in Tonga is now rapidly progressing.

Besides above, following elements should be considered at designing phase:

- Simplicity
Try not to mix too much alert measures to the inhabitants as well as network elements.
- Reliability
Try to use well tested technologies and durable/maintenance free products with reasonable price.
- Usability
Consider ordinary usage of the system when it is not in emergency. It will not work if it is not used frequently.
- Sustainability
Avoid networks/products which consume recurrent costs. Consider affordability of the users for better sustainability.

5.4.2 Disaster scenario

There are many kinds and levels in natural disasters. For specifying the technical design requirements for the mission critical purpose like early warning, the worst case scenario should be adopted.

With regards to Tongan situation, the cyclones are the most cautious weather phenomena. But their course and the approach time are predictable and there would be certain time for

preparation or evacuation. Therefore, there were few victims caused by the cyclone in Tonga so far.

Then, assumed disaster scenario for the system requirements should be set mainly for earthquake followed by large tsunami that will not allow inhabitants enough time to evacuate.

Followings are the sample of disaster scenario which should to be concerned at the system design as basis of the requirements:

- Local earthquake Mw 9.0 (epicenter: 150km east. Along Tonga trench)
- Large tsunami (5m high) is predicted to arrive in 30 minutes after the earthquake
- The time is mid-night
- Commercial electric power black-outs after earthquake.
- All terrestrial telecom-services are not available because of traffic congestion or network failure

6 Disaster Information Systems

6.1 Necessity of Disaster Information Portal

The opening of the government possessing information to the public and the more transparency for the process of policy making have been required to further promote of fair and democratic government administration in Tonga. For this purpose, information opening mechanism that enable government possessing information can be shared jointly by the government and citizen, and that let the policy making process can be reflected appropriately by them. Since March 2010, the government of Tonga has established a new portal to start its operation as means of opening of the government information.

Under the same geographical conditions as in Japan, the archipelago of Tonga has suffered a lot of natural disasters such as cyclone, earthquake and the like every year and the interest in the disaster prevention counter-measures has arisen considerably very high. The 9.0 magnitude gigantic quake in the Great East Japan Earthquake that occurred in Japan on March 11th of 2011 and the aftermath tsunami have caused devastating damages in northern part of Japan. Those terrible disaster scene and images have been relayed over the world with a great shock.

The countries over the world including Japan which have suffered the calamities due to the natural disaster every year, had to have revised drastically their counter-measures against the natural disaster since that time. There is no unexpected natural disaster that the nature would bring about. We do not wonder that such a big earthquake with 1000-year-cycle and grave disaster would happen even tomorrow. Facing a fierce aspect of the

nature that has shown occasionally, we must continue to co-exist with the nature in the future.

Only disaster counter-measure from the hardware-based aspects that has been focused so far through the civil works and the strengthening of embankments would not be sufficient for such a huge disaster management to be supposed to happen in the future.

We have learned many valuable lessons from the current great earthquake that we have to confront with the disaster prevention measurements by utilizing a full mobilization of various software-based measures such as dissemination and penetration of evacuation routes and hazard mapping for residents, installation of an alert system, etc.

In this study, we had reached a conclusion that we have to make the most use of these lessons for Tonga which is situated in the same geographical environments as in Japan, and that we ought to take software-based measurements as follows:

- (1) To create "Information Portal for Disaster Prevention"
- (2) The Government and citizen should possess in common information on disaster even during the time before disaster occurrences

6.2 Contents

6.2.1 Survey on Japan's Disaster portal sites in service

Ministry of Information and Communications (MIC) of Tonga had established and commenced Tongan government portal in 2009. For this portal, an outside data center has been utilized for the operation. At the selection of data center, MIC has put, in particular, more emphasis on security counter-measurements and corresponding ability for natural disaster such as a revision of contents' substances, protection against hacking and the like. More than three (3) years have passed already since the inauguration of the portal operation and any troubles have not occurred in the center infrastructures. Accessibility to the portal system from users has arisen drastically high as compared with that of the starting time owing to daily-based revision and renewal of contents and their timely service provision to users.

Based on the operational experienced of Tongan government portal for 3 years, the most important factors for construction of the portal system for disaster prevention in Tonga can be pointed out in the followings:

- No problem can be considered for utilization of data centers as an outsourcing center. In conclusion, as for any portal in which we could not forecast "Access Traffic Peak" and "Traffic Volumes" for the outsourcing, we can take measures against each variation in traffics in short time with enough validity.

- The latest contents should be provided always. A contents-providing-type portal has, above all, a preferential importance to keep eventual freshness of contents that will be directly linked with the accessibility from users.

Taking above-mentioned subjects into consideration, we have conducted a survey on Japan's information portal for disaster prevention to study the requirements on the contents that seem to be necessary for construction of an information portal for disaster prevention in Tonga.

Actually, for this study, we have selected a survey target for information portals for disaster prevention that have been opened to the public by the following government organizations in accordance with the roles of Japan's government organizations:

[National level]

Organizations that provides information offering to common level in Japan:

- Japan's Meteorological Agency,
- Ministry of Land, Infrastructure and Transport

[Regional level]

Organizations that provides information offering to area residents which have an advanced measurement for disaster prevention:

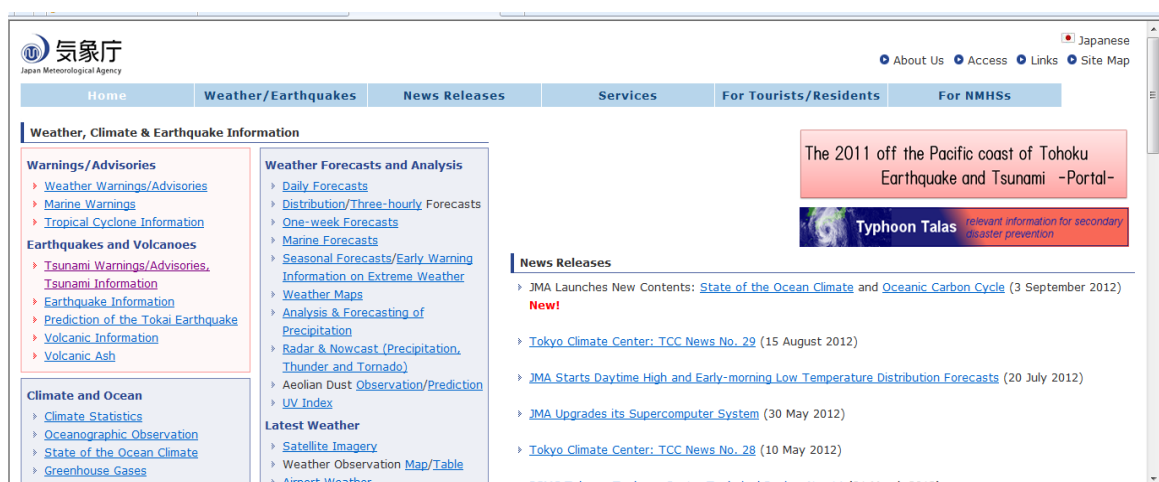
- Tokyo Metropolis,
- Osaka City

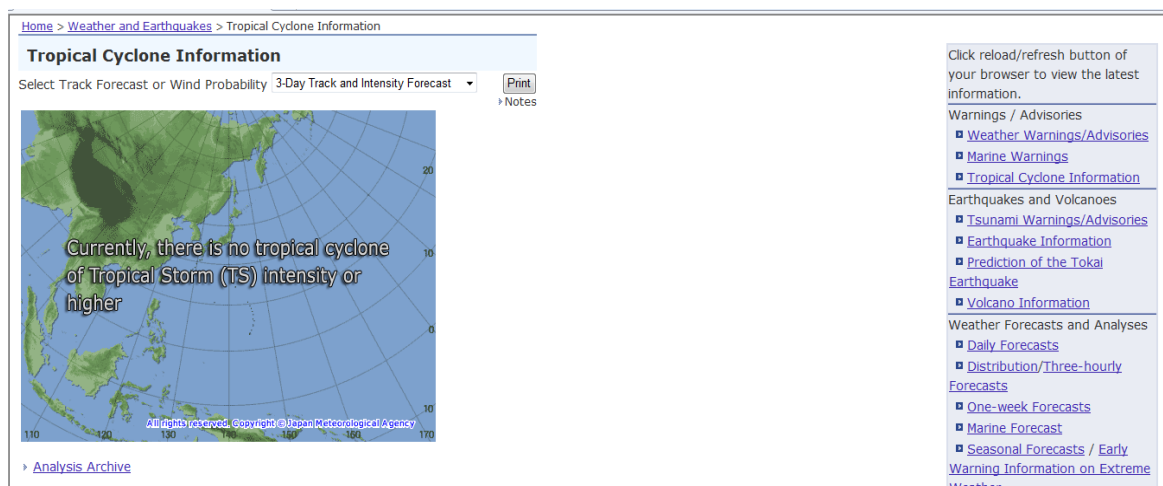
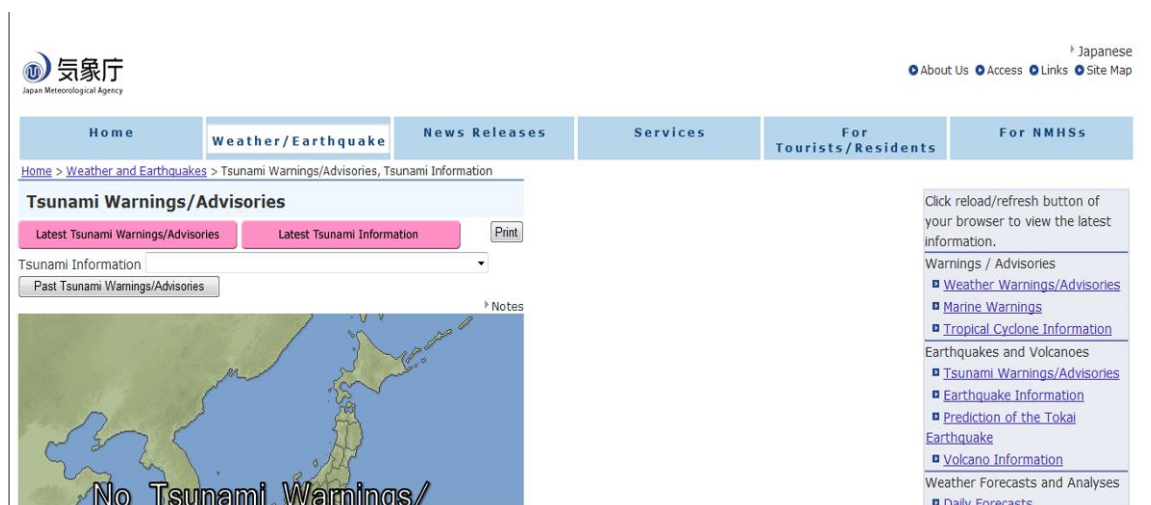
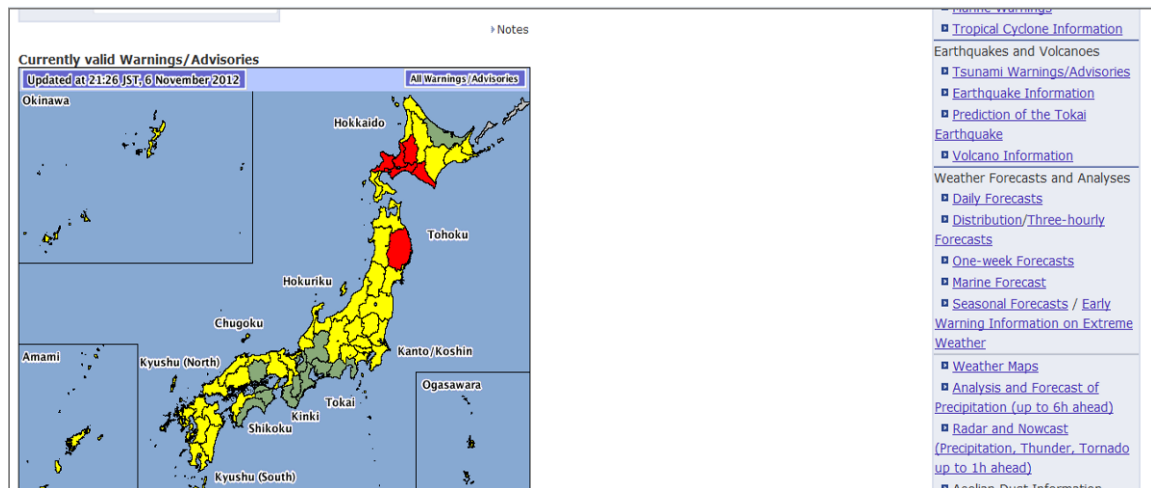
Screen shots of top and secondary pages of each website are shown in below respectively:

(1) National level

i) Japan's Meteorological Agency [<http://www.jma.go.jp/jma/indexe.html>]

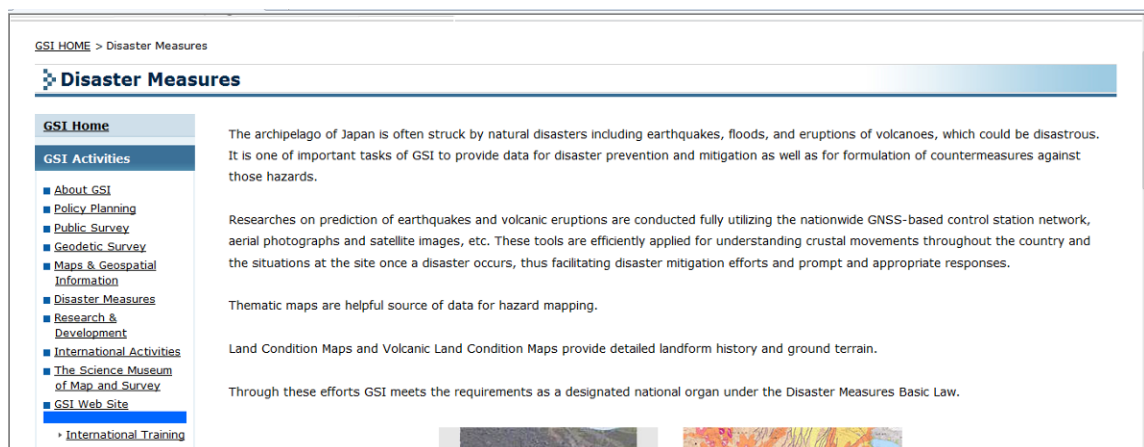
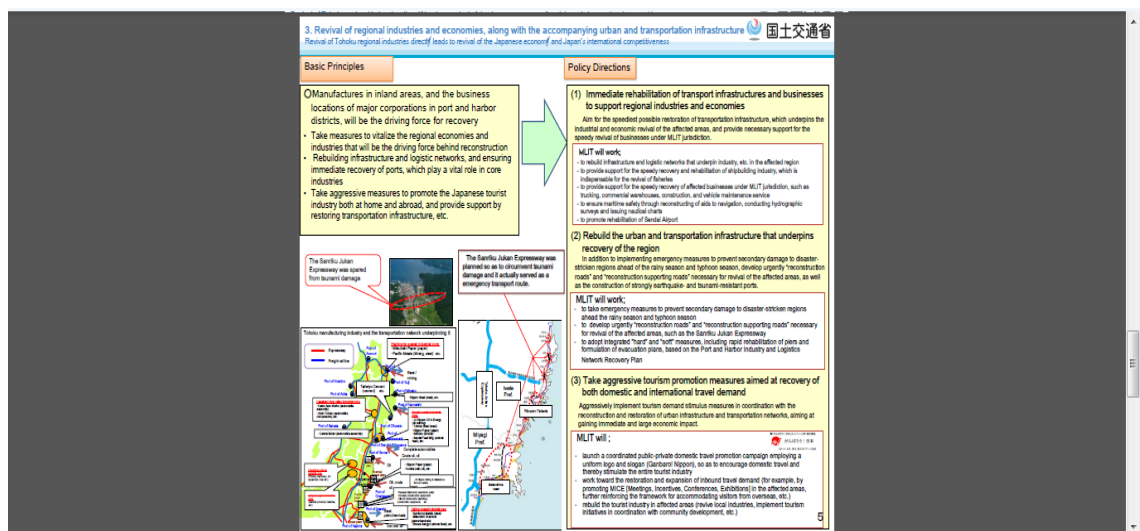
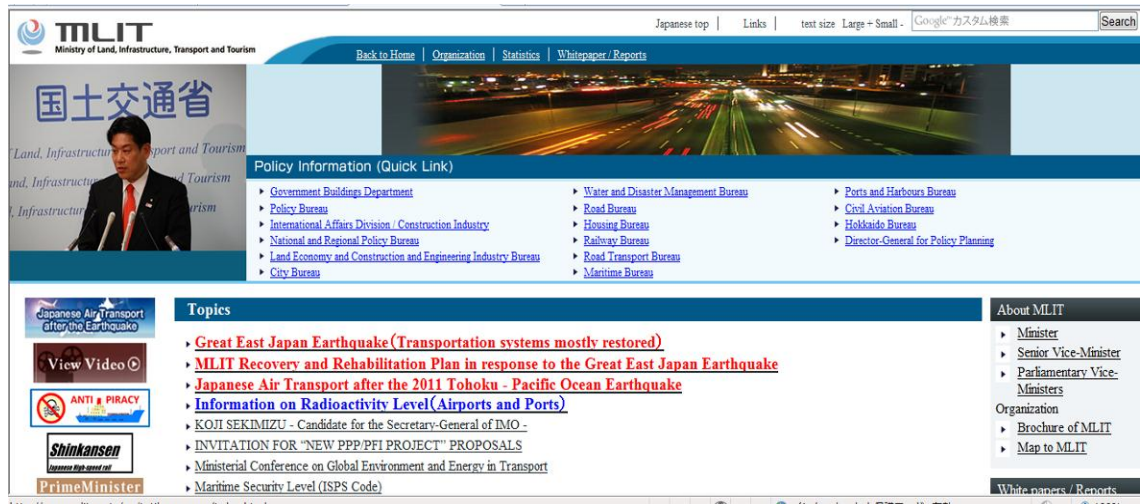
[Roles] To provide the latest disaster information on weather, earthquake, tsunami, etc. of whole nation, and issue warning such as evacuation instructions.





ii) Ministry of Land, Infrastructure and Transport [<http://www.mlit.go.jp/en/index.html>]

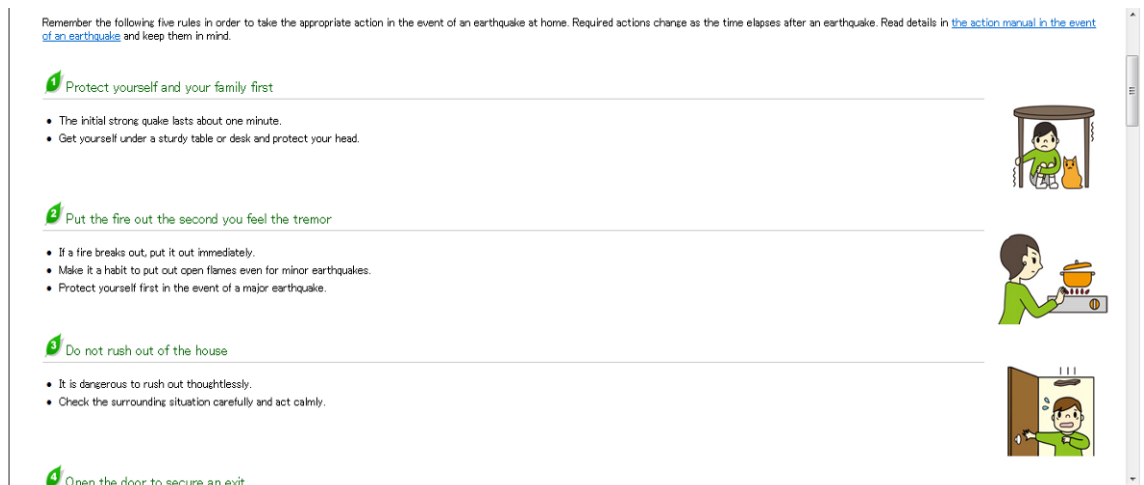
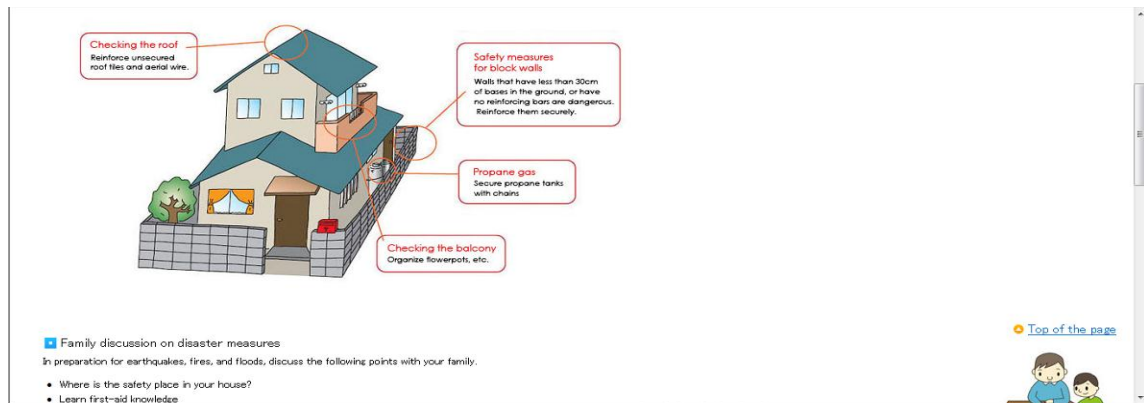
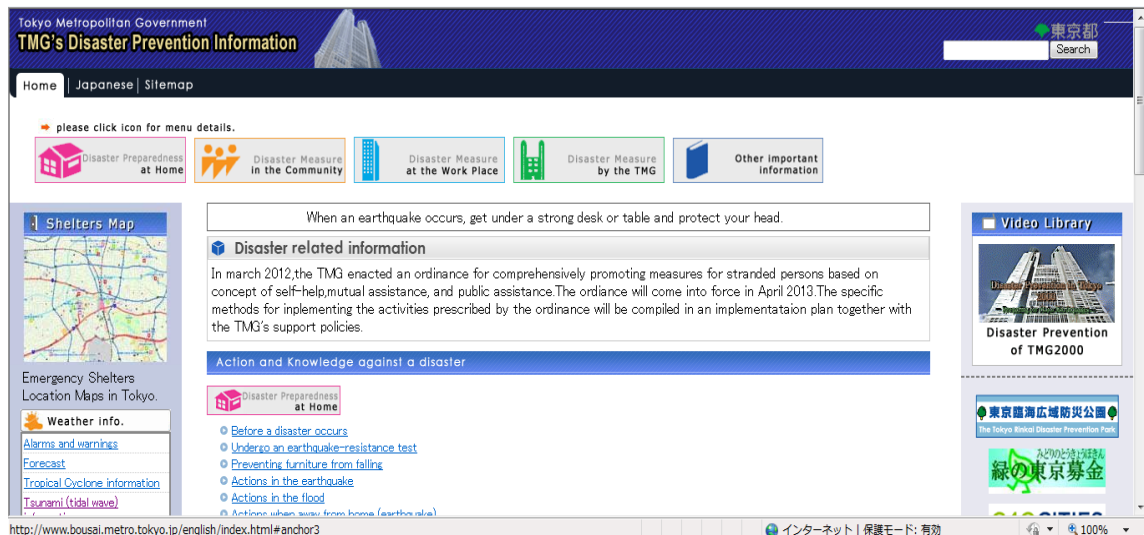
[Roles] Information provision for infrastructure administration and river innunciation warning on roads, river etc are issued on this screen.



(2) Regional Level

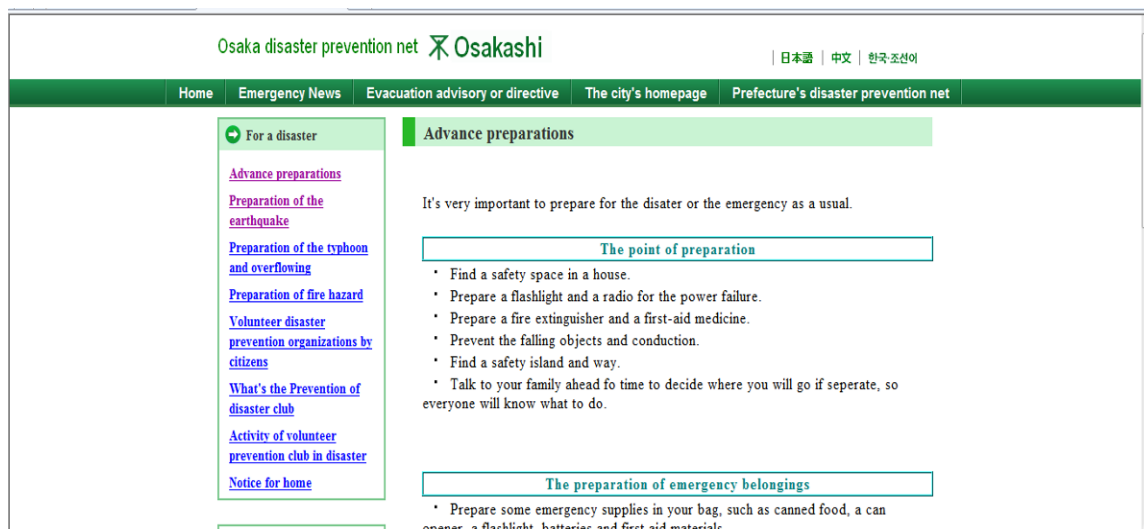
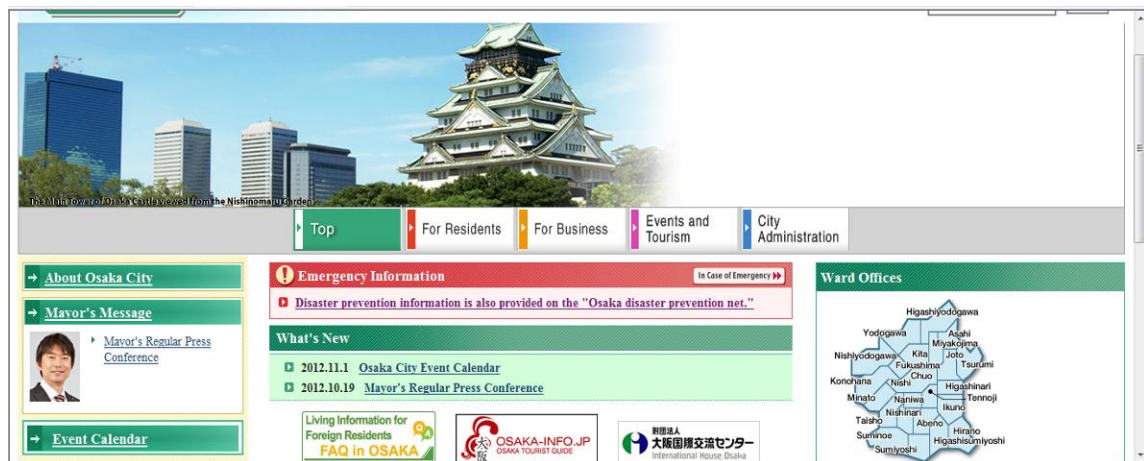
i) Tokyo Metropolis [<http://www.bousai.metro.tokyo.jp/english/index.html>]

[Roles] Evacuation sites at the time of disaster occurrence and service contents of the metropolis administrative organ for the residents are published for citizen of Tokyo Metropolis.



ii) Osaka City [<http://www.city.osaka.lg.jp/contents/wdu020/english/>]

[Roles] The Osaka City's portal introduces disaster prevention measurement, disaster prevention Kit and disaster prevention training.



6.2.2 Others

Pacific Tsunami Warning Center [<http://ptwc.weather.gov/>]

[Roles] Observation of earthquake and tsunami occurred in the world and issuance of warnings.



6.2.3 Users of the Portal

An information portal for disaster prevention in Tonga has to be constructed by the assumption that all people would enjoy and utilize it always in the country. Also, the portal should be utilized by particularly approved users like disaster response entities to download a disaster reporting files as a part of infrastructure through the access control by password authorization. Users are classified into following two groups:

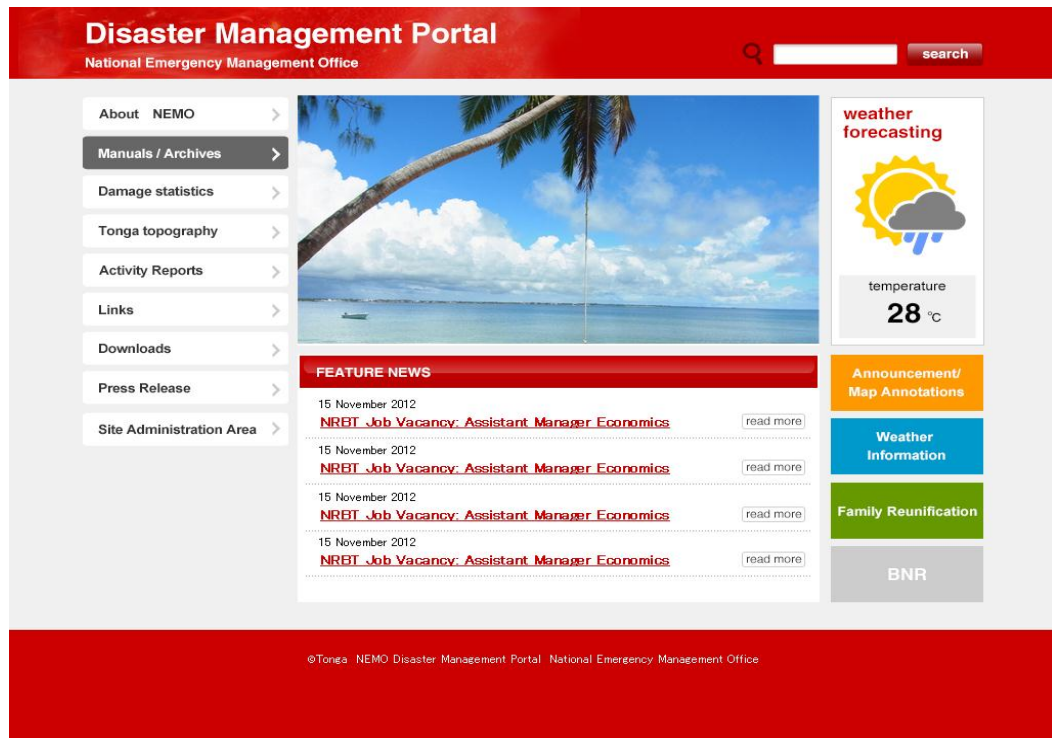
[User's Classification]

- 1) Unspecified large number of Tongan citizen
All citizens in Tonga as well as everybody in the internet can get access unconditionally to all opened information without limitation
- 2) Specified of users registered
In addition to the above, registered users such as officials can get access to the limited/secured contents through log-in by using PW authorization. Down/up load/up information for disaster management such as situation reports should be available for efficient management works.

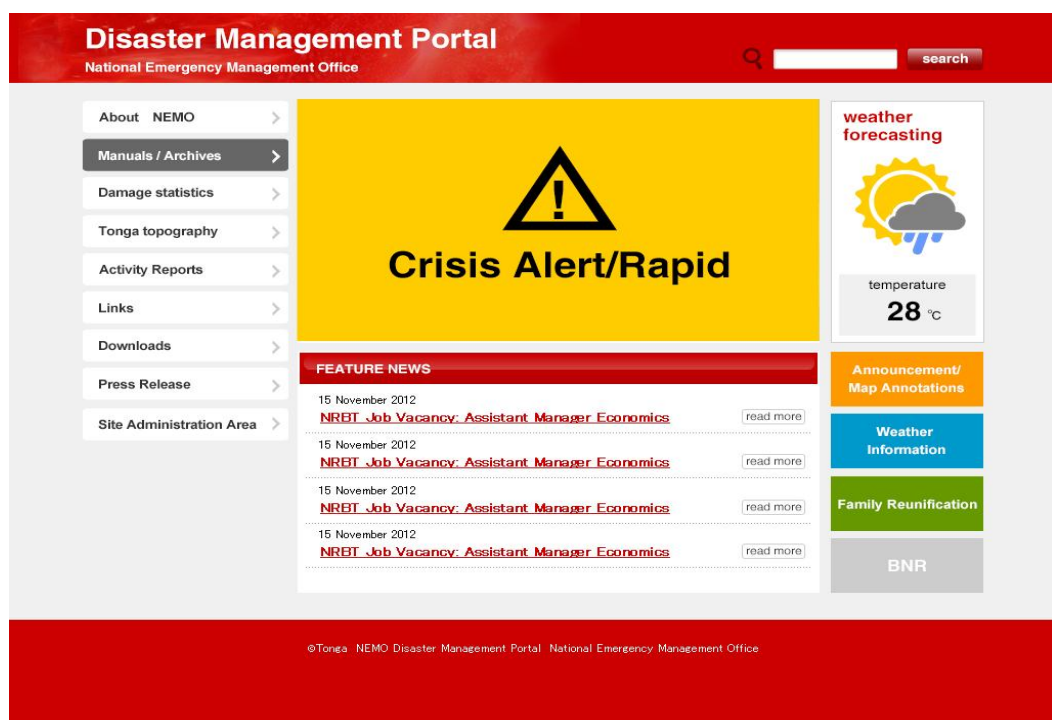
6.3 Designing concept

6.3.1 Conceptual design of the top page

(1) For ordinary scene



(2) For emergency scene



6.3.2 Site Map

Following are a proposed sample of the site map of the portal website:

About NEMO
Manuals / Archives
• National Disaster Management Plan and Emergency Procedures
• National Disaster Management Plan and Emergency Procedures National Emergency Management Plan(prepared under the provisions of the Emergency Management ACT 2008)
• Standard Operation Procedures for the National Emergency Coordination Centre
• Disaster Assessment Manual for the National Emergency Management office
• National Tsunami Plan
• Emergency Management ACT 2007
Damage statistics
• past Hurricane, Tsunami Information
Tonga topography
• Various Map
• Topography data
• Satellite imagery
Activity Reports
• Joint National Action Plan Climate Change Adaptation and Disaster Risk Management 2010-2015
Links
• overseas-----Pacific tsunami Warning Center
• domestic----- Government Portal
Tonga Meteorological Services
Downloads
• South Pacific Common Reporting format
Press Release
Site Administration Area
• Village Emergency Committee-Pangai,Hapai Island Contact Directory
• Stock List
Announcements / Map Annotations
• Tsunami Hazard Map
• Emergency Shelter Information
Weather Information
• Regional forecasts,Cyclone.Earthquake
• Climate Information
• Tropical Cyclone Information
• Tsunami Information
• Coast Watch Services
Family Reunification

6.4 Technical requirements

6.4.1 Outsourcing

The development of information portal system in Tonga would require:

- Procurement of Hardware/Facility Investment
- Human resources of ICT engineers such as SE (System Engineer) and CS (Customer Engineer).

Naturally, the development of portal system needs a certain amount of budget. Tonga seems to be short always of ICT engineers and ensuring ICT engineers may be one of the most difficult problems. On the other hand, if these works can be assured by way of outsourcing, we would be released from the above-mentioned problems and we are able to engage ourselves in doing a core business and to realize the cost reduction.

An application scope and trends of outsourcing in Japan has been expanding rapidly except for the military or top secrecy and the high security information related to individual person and the mission critical case. Now, the outsourcing has become one of the most practical choices.

As mentioned above, the data center of portal site of MIC of Tonga has been used in operation for more than three years. Trend for outsourcing seems to have been firmly established in Tonga. Outsourcing also can be categorized in the "Hosting" which can be taken in the wide sense of the "Cloud services" in recent word.

Table 6.1 shows an outsourcing comparison between "Case of on Premise" and "Case of Data Center" over the construction methods of information portal for disaster prevention in Tonga. The listed data in Table 6.1 may justify that the outsourcing for outside data center is properly reasonable.

Table 6.1 Comparison Results for Outsourcing

No.	Item	On premise	Outsourcing
1	Possession of center facility	Yes	No
2	Necessity for hardware engineer	Yes	No
3	Necessity for system engineers	Yes	No
4	Necessity of standby generator for center	Yes	No
5	Necessity for security measures	Yes	No, but Yes for only terminal equipment
6	Necessity for system operator	Yes	No
7	Problems for BCP (Business Continuity Plan)	Yes	No
8	Ownership cost	High	Low

6.4.2 Operation Management

Since Home Page of Ministry of Infrastructure of Tonga has not yet officially constructed so far, the human resources and technical supports from Ministry of Infrastructure to NEMO is unexpected for a coming portal operation. Therefore NEMO will have to take a full responsibility independently for operational administration of the information portal. In case that a disaster prevention information will be opened to the public from Tongan government portal (as a Sub Domain), MIC, which serves as an operational window body for data center contract and trouble complaining/help desk, may undertake some role of works mentioned in Table 6.2.

The operation and management of the system can be formed as shown Table 6.2 for both cases of “Operation of disaster prevention portal by individual domain” or “Information disclosure from Government portal (Sub domain)”. These are tentative allotments of responsibility roles in Tonga, subject to the further adjustment by related organizations in the future.

Table 6.2 Operation and Control Responsibility System

Item	Individual Operation	Sub Domain of Government Portal
Administration Window (Contract, help desk)	NEMO	MIC
Registration and renewal of contents	NEMO	NEMO
Initial cost and operational expense	Initial cost of data center operation expenses	Adjustable among users for operation costs
Operation and administration system of data center	Manning of responsible operator	MIC

6.4.3 Contents Management

As described in the Table 6.2 above, NEMO has to establish its own independency for any case of portal operation and administration. These are tentative allotments of responsibility roles among Tongan organizations, subject to the further adjustment by related organizations of Tonga in the future.

6.5 Standardization of reporting formats

As described in Site map (in the Chapter 6.3.2), all major sheets for reporting or recording purposes in Emergency Operation Centre (EOC) in NEMO, should be available through the

internet portal site to refer and download. Standardization as well as computerization/electronization of the formats will contribute strengthening efficient management and circulation of the disaster related information. In this study, Tongan team has converted all major reporting sheets to Microsoft Excel ® files from the original paper-based one (See Figure 6.1). The list of the sheets for reporting/recording is shown in Table 6.3, and sample sheets are shown in Figure 6.1. There are 22 sheets at present which meets pacific standard format, and it will be added according to the necessity. This result will be the great asset which contributes to establish information sharing mechanism in the next step.

The screenshot shows a Microsoft Excel window with the title 'Format ver2 - Microsoft Excel'. The spreadsheet is titled 'LOGISTICS LOG'. It has a header row with columns: Incident/Event, Serial#, Ref, Date, Item, Rating, Qty Ordered, Source, Received, Distribution, Remarks, and Signature. The spreadsheet is labeled 'Form17' in the bottom right corner.

The screenshot shows the 'EOC MESSAGE FORM(IN/OUT)' form. It includes fields for EOC, Routine Response, Priority, Immediate, Flash, Incident/Event, Message No., Date, Time, From, To, Situation Description, Action Taken, Feedback to Original Situation, and Sender/Receiver Details. It is labeled 'Form 1' in the bottom right corner.

The screenshot shows the 'SITUATION REPORT' form. It includes fields for EOC, Fill In, Routine, Priority, Immediate, Flash, Incident/Event, Date, Time, From, To, Copies to, Situation, SITSTAT, Current Operations, Community Response, National Assistance, International Assistance, Future Operations, Recommendations, Feedback to Original Station, and Sender/Receiver Details. It is labeled 'Form6' in the bottom right corner.

The screenshot shows the 'SITUATION STATUS' form. It includes fields for EOC Location, Incident/Event, SITSTAT No., Date, Time, From, To, Copies to, and a table for Situation Status with columns for No., Cost Est., and Source of Information. The table lists various categories like People, Permanent Dwellings, Businesses, Life Lines, and Schools and community buildings. It is labeled 'Form14' in the bottom right corner.

Figure 6.1 Screen shot of the electronized report formats (Sample)

Table 6.3 List of electronized formats done by NEMO

Sheet	Name of format
1	EOC MESSAGE FORM (IN/OUT)
2	MASTER OPERATIONS LOG
3	COMMUNICATIONS LOG
4	FILE CONTENTS LOG
5	SITUATION REPORT
6	EMERGENCY STOCKPILE INVENTORY REGISTER
7	RELIEF SUPPLIES DISTRIBUTION/RECEIPT
8	EOC STAFF MESSAGE FORM
9	PRESS RELEASE
10	SAMPLE BASELINE DATA RECORD
11	PROBLEM LOG
12	REQUEST LOG (IN/OUT)
13	DONATIONS/APPEALS LOG
14	SITUATION STATUS
15	INITIAL DAMEGE ASSESSMENT SUMMARY
16	INITIAL NEEDS ANALYSIS SUMMARY
17	LOGISTICS LOG
18	SIGN-IN/OUT REGISTER
19	EVACUATION CENTRES
22	VISITOR REGISTER
23	CONTACT LIST
25	EOC ALERT/CONTACT CHECKLIST

6.6 information sharing

Besides information sharing using disaster portal, information sharing by using file-sharing mechanism may complement to realize real-time-update of the disaster situation. Free or affordable File-sharing services/Data base services/On-line storage services are currently available as Cloud services in the internet which is worth to consider for future operation. "Dropbox"® is one of the major service that applicable for file-sharing among designated officials. (See Figure 6.2 and <https://www.dropbox.com/>)

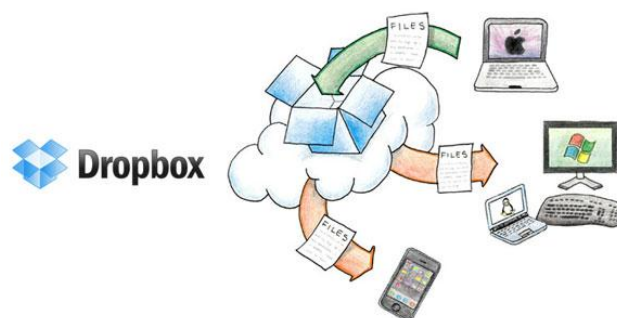


Figure 6.2 Conceptual drawing on Dropbox

Short messaging communication using Line (<http://line.naver.jp/en/>) or Twitter (<https://twitter.com/>) is also worth to be examined further for secure communication among disaster related entities as supporting communication means.

6.7 Support tools

6.7.1 Surveillance cameras

Surveillance cameras located in particular high places will be extremely useful for right and timely decision making in disaster management scene. These cameras can be just reasonable model of web camera which don not have to be excellent, but must have heavy-duty and remote control functions like pan-tilt-zoom. (See Figure 6.3 for sample product)



Figure 6.3 Web camera

By the web camera, full motion picture can be monitored at Operations Room in National Emergency Coordination Centre (NECC) in NEMO building, and staffs in NECC can grip current situations at affected area in disaster scene. These pictures can also utilizes for other purposes such as public safety, broadcasting (weather news) during ordinary case. Since these pictures can be seen from all over the world via internet if it is linked from the disaster portal, it will contribute a lot to tourism in Tonga as well.

The candidate locations for the web camera might be:

- Towers of cellular phone (e.g. TCC tower in SOPU)
- Roof top of the MIC building
- Masts/poles for loud speakers in evacuation sites

Broadband IP network which required for the monitoring using web camera is described in chapter 5.3.3 and chapter 8.

6.7.2 Large screen in NECC

Besides white boards, large display sets is recommended in Operations Room in NECC. Every NEOC members can visually understand and share ever-changing information at glance by the screens. (See Figure 6.4)

Following information can be displayed on the screen under control by NEMO:

- Magnified screen of selected PC-monitors,
- Live pictures from observation cameras,

- TV conference with other location (via Skype-video, etc.)
- TV program (Tongan or Overseas/Satellite TV), and
- Others (EMWIN, etc.)



Figure6.4 Large screen

7. Milestone for the implementation

Since early warning system saves human life, earlier introduction is expected in a moment. However, taking some steps is suitable for the steady nationwide deployment concerning Tongan actual situation. A case study of the milestone for nationwide deployment of the national alert system in Tonga is shown in the Table 7.1. Phase-1 should be started from the year 2013 and the plan will complete in three years.

Table 7.1 Milestone for the nationwide deployment

	Phase-1	Phase-2	Phase-3
-Pilot project in Tongatapu main island	→		
-Surveying, planning and funding for full-scale implementation	→		
Full-scale nationwide implementation		→	
Enhance utilization and functions			→

8. Pilot project

8.1 Objectives

AS a practical first step for the steady progress of the milestone mentioned in previous chapter, it is strongly recommended to start with pilot project before full-scale implementation. Test and feedback as well as evacuation demonstration/drill can be implemented in the pilot project.

- 1) To introduce e-disaster communication network as an infrastructure for early warning and disaster information management.
 - Deployment of Early Warning System to selected high-risk areas to mitigate impact of disasters. Since the system uses both-way broadband IP radio infrastructure, the system can be used not only for early warning alert for evacuation but also for communication means for recovery activities while normal siren is only motor-generated sound.
 - Introduce Disaster Information System in the broadband intranet to strengthen capacities in disaster management in NEMO and ease disaster related organizations and local communities to share the information.
- 2) To demonstrate and establish above mentioned network system as a basic model which could be one of the standard in rural and remote islands for further expansion.

8.2 Outlines

Conceptual structure of the proposed pilot system is shown in Figure 8.1.

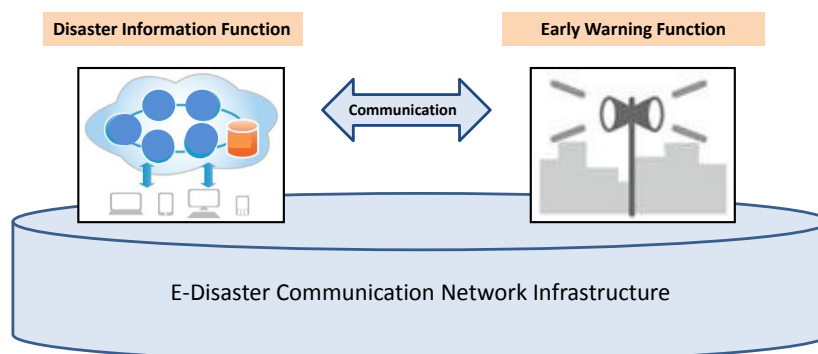


Figure 8.1 Conceptual structure of the proposed pilot system.

8.2.1 Major items to be implemented

The comprehensive “e-Disaster Communication Network” based on IP microwave digital radio link to be introduced as an infrastructure for the e-Disaster communication. On this infrastructure which has both way and broadband capabilities, following various applications/functions to be equipped:

(1) Early warning alert function for emergency evacuation

Utilizing its reliable IP broadcasting capability, early warning alert for emergency evacuation in the high-risk area will be realized. Since warning sound is generated by loud speaker not like traditional motor siren, various kinds of information including live voice announcement as well as siren-sound can be sent out to the public in the targeted area. Triggering of the early warning for tsunami is executed by Meteorological office.

(2) Disaster information function

Also utilizing IP based network, various application to support disaster response and recovery activities as well as disaster information management to be introduced. Various kinds of reporting formats will be created and shared on the network. Disaster preparedness plans, related maps and disaster related records will be also stored in the database time by time and can be referred from disaster related organizations. The information is uploaded on the disaster portal site which is linked from government portal.

Live and full motion picture from webcams equipped in suffered area will be available for helping advanced recovery activities.

“High-place webcam” will be installed on TCC’s 60meter-high tower so that the live picture of whole Nuku’alofa capital can be grasped for disaster recovery and public safety purposes. This picture can be viewed from all over the world through the internet during normal situation.

Large monitor screen will be installed in the command room in NEMO building to help proper sharing of visual information and right decisions.

8.2.2 System overview

Overview of the proposed system is shown in Figure 8.2.

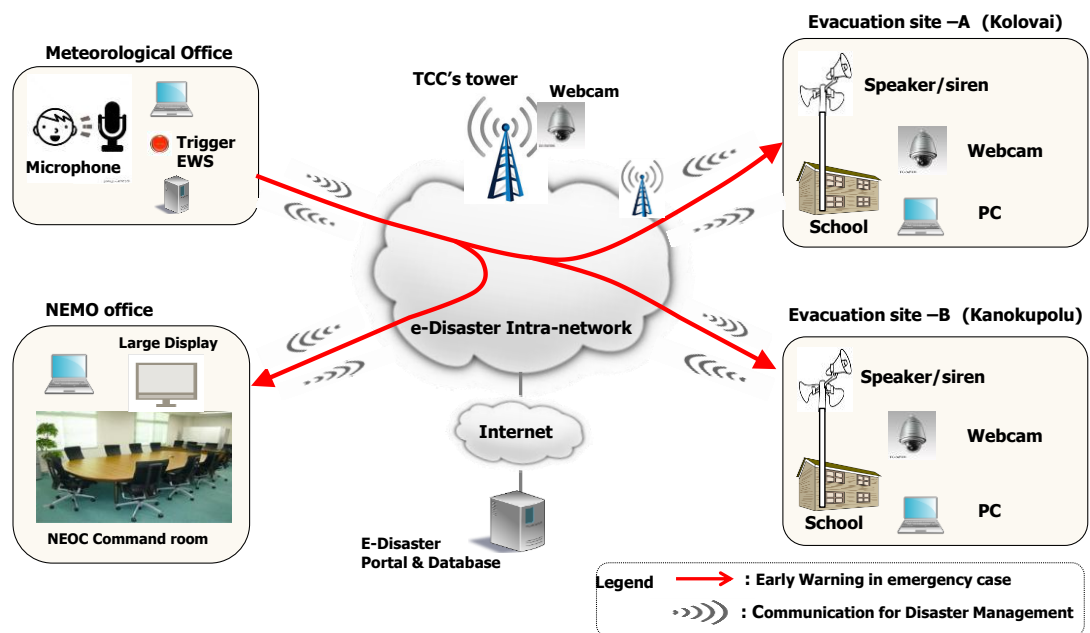


Figure 8.2 System overview of the proposed project

Sample appearance of loudspeaker for the pilot project is shown on Figure 8.3. This might be changed if long-range Omni-directional speaker was selected.

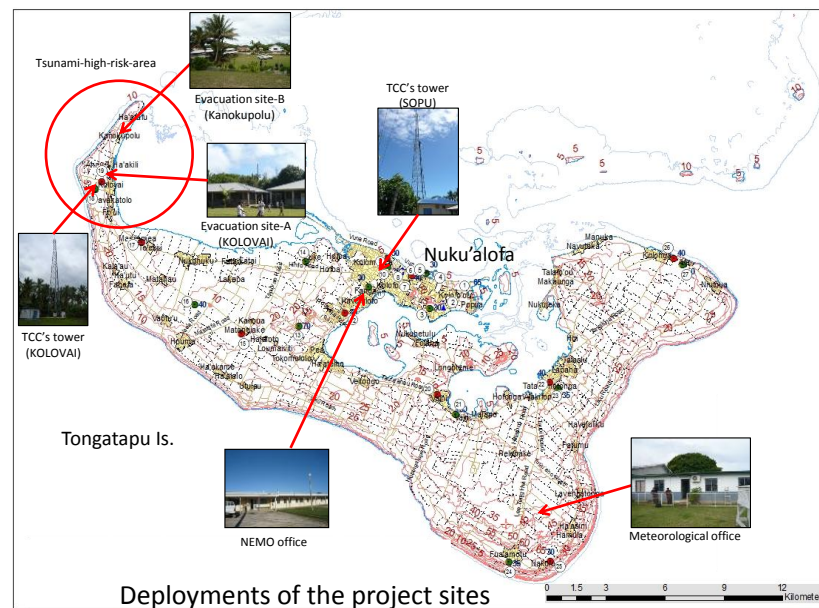


Figure 8.3 Sample image of loudspeaker for the pilot project

8.2.3 Project sites

Major project sites were planned in the following four locations. Geographic deployments are described in Figure 8.4.

- (1) Meteorological office: As a triggering center for the tsunami alarm
- (2) NEMO Building: As a center of disaster management activities.
- (3) Evacuation site-A: Kolovai Government Primary School (GPS) located in tsunami-high-risk area where evacuation site planed.
- (4) Evacuation site-B: Kanokupolu Government Primary School (GPS) located in tsunami-high-risk area where evacuation site planed.



*TCC's towers in above map will be used as radio repeater under TCC's cooperation.

Figure 8.4 Geographic deployments of the project sites

8.2.4 Site survey

Technical surveys at each project sight, and meeting with related organization for their cooperation were implemented through this study project. The line of site for the micro wave link was roughly confirmed, and cooperation for the project was agreed by each organization. Figure 8.5 shows snap of site survey to check the line-of-sight of the radio link from the roof top of the evacuation site.



Figure 8.5 Site survey

8.2.5 Technical specifications of the radio system

IP microwave link will be applied since it is highly recommended as the communication method in Tongatapu Island. Radio equipment using Wi-Fi spec. is not recommended for this purpose because of serious frequency interference especially in Nuku'alofa area.

Technical detail of the candidate product is shown as below:

- IEEE802.11j Standard
- 54Mbps at 20MHz system
- Maximum distance: 20-30km with high-gain antenna, P-P
- Frequency: 4920MHz, 4940MHz, 4960MHz, 4980MHz
- TX power: +15dBm
- Modulation: OFDM

Frequencies for above specification are vacant and radio license will be available in Tonga (MIC).

9. Regional cooperation

Every countries in south pacific region are facing common problems such as natural disasters, climate changes, lack of human resources and so on even though each of them are very small and not capable to individually overcome by themselves. Therefore, there is an idea on the establishment of the Pacific Information Center for Disaster Prevention. By this concept, capability of the meteorology and geology as well as emergency management in each country will be rationally improved against natural disaster. This idea is still in the concept, and further discussion is needed.

10. Other project concerned

There was early warning siren projects in Tonga after Tsunami in Niuatoputapu in 2009, but not yet realized. Currently there is a plan namely "Nuku'alofa Tsunami Early Warning System Pilot Project" that is underway and we should concern with them and coordinate each other for avoiding useless duplication or complications.

[Current situation]

- Outline of the project was to procure and install 5 motor siren systems on Digicel Cell Towers in the Nuku'alofa capital area/Central Business District (CBD) and to test out technical specification so as to formulate a sustainable early warning system for Tonga.
- MET who is a member of the APT-J2 study project (as well as proposed next APT-J3 pilot project) and responsible for the tsunami warning in Tonga planned to test and evaluate the pilot system, and expanding to the rest of Tonga will depend on the outcome of the present study.

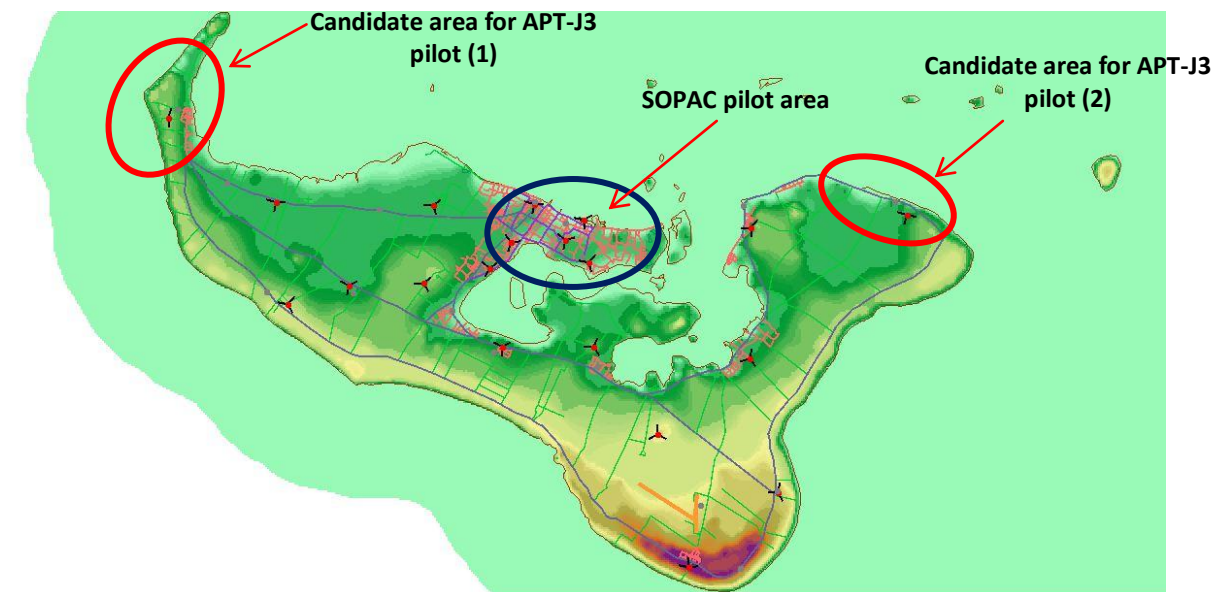
- A fund of 40,000.-USD from UNDP via SOPAC for funding sirens given the successfulness of the present pilot study.
- The procurement of the sirens is now underway, and is expected that in the year 2013 we commission the 5 sirens.
- MET admires the proposed J3 pilot system simply because it adopts loud speakers which can transmit both voice-message and siren-sound whereas the SOPAC's sirens which motor generated siren transmit a single warning tone only. This means that J3 pilot system is useful not only for early warning but also for the post disaster recovery activities and public awareness program too. SOPAC's sirens will use mobile phone networks for triggering in which they are highly subject to failure during disasters due to congestions.

[Final goal of the project]

- The original purpose of the SOPAC pilot is just test out technical spec. for studying and formulating a sustainable early warning system for the countries' tsunami vulnerable areas.
- MET prefers the idea of e-disaster ICT based multi-purpose early warning system because of its multi-purpose usages (Tsunami, Public Address, etc.) as well as it does not rely on the internet or mobile phone network.

[Relation between two pilot projects]

- Candidate site for proposed J3 project is western peninsula or north-eastern seashore where the most vulnerable areas against tsunami in Tongatapu Island. (Indicated in Red circle in the map below)
- Site for SOPAC project is Nuku'alofa capital area. (Indicated in Blue circle in the map below)
- Both sites do not overlap each other and carefully controlled by MET.
- MET will ensure that both the pilot projects operate in different areas without any duplication.
- Site for J3 can be said as real rural area where broadband infrastructure is needed and is better condition for the test of further enhancement to other outer island situation.



11. References

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List of Annexes

Annex-1 Records of exchange activities implemented

Annxe-2 The report on the survey result of “DTMF over A3Z radio”

Annex-1 Records of exchange activities implemented

1. Joint Study in Tonga-1

(1) Schedule

Date		Activity Plan		Remarks
		AM	PM	
2-Jun-12	Sat		Leave JPN for Tonga by NZ90 at NRT19:00	
3-Jun-12	Sun	08:45 Arrive at Auckland		
4-Jun-12	Mon	NZ970 AKL07:20 - Nukualofa 11:10	12:30-13:30 The site visit to Met office after the arrival. 14:00-15:00 Briefing on the schedule 16:00-17:00 Japanese embassy and JICA	
5-Jun-12	Tue	09:00-09:30 Education Ministry courtesy call (CEO) 09:30-10:00 Courtesy call to MIC CEO 10:00-11:00 Project Kick-off meeting (MIC conference room) (1) Chair-Persons (Tonga & Japan) (2) Greetings from Tongan side (3) Greetings from Japanese side (4) Briefing on Project Outline (Mr.Tamura) (5) Singing the MOU -----Morning Break----- 11:30-12:30 Presentation and discussion (1) Project Presentation (Mr.Uchiyama) (2) Presentation on Japan's Disaster Prevention (Mr.Yamashita)	Meeting with MIC and NEMO (MIC conference room) 13:30-14:30 MIC presentation about ITC policy and related issues 14:40-15:30 NEMO presentation & discussion (Mr. Mafua) 15:30-16:00 MET presentation & discussion (Mr.Moleni)	(1) The other related agencies were invited to the meeting (2) MOM was taken by MEWAC and has been distributed
6-Jun-12	Wed	09:00-0930 Courtesy Call to Acting CEO of MOW 09:30-11:00 Site visit to NEMO	13:30-14:30 Visit to TCC 15:00-16:00 Visit to Geology Service Unit	
7-Jun-12	Thu	10:00-16:30 Site visit to three GPS (Teeki, Kolovai and Kanokupolu) arranged by MEWAC		
8-Jun-12	Fri	9:00- Courtesy call to Prime Minister 9:30-12:00 Wrap-up Meeting at MIC conference room - Confirmation on result of JST-1 - Discussions on Interim Report, Tonga Team visit to Japan and J3 - Others	14:00-14:30 Japanese embassy (+JICA) to explain on result of JST-1 15:00-15:30 Courtesy call to Prime Minister	
9-Jun-12	Sat	NZ273 Leave Nukualofa 11:20	13:20 Arrive at AKL	
10-Jun-12	Sun	NZ99 Leave AKL 8:25	16:50 Arrive at NRT(Tokyo)	

(2) Members visited from Japan

- Mr. Suzuo UCHIYAMA, Senior consultant, JTEC/Project leader
- Mr. Masato TAMURA, Director, JTEC/Project coordinator
- Mr. Takashi KATO, Secretary General, ICT Oversea Volunteers Association
- Mr. Makoto YAMASHITA, Secretary General, BHN Association

(3) Photo



Photo with Prime minister of Tonga, Lord Tu'ivakano (Center)

2. Joint Study in Japan

(1) Schedule

Date	Day	Schedule		Hotel
		AM	PM	
July 7	SAT	NZ273 Leave Nukualofa 11:20	13:20 Arrive at Auckland	Hotel Grand Chancellor Auckland Airport http://www.grandchancellorhotels.com/nz/aucklandairport/default-en.html TEL: +64-9-275-7029
July 8	SUN	NZ99 Leave Auckland 8:25	16:50 Arrive at NRT(Tokyo)	Shinjuku Washington Hotel http://www.shinjuku-wh.com/english/ TEL:+81-3-3343-3111
July 9	MON	08:30 Pick up Hotel 09:30-11:00 Orientation JTEC office 11:20-12:20 Early lunch 12:20-13:00 Move to MIC	13:05 Meet Ms. Ikatai at MIC B1F entrance 13:10-13:30 Courtesy call on Ministry of Internal Affairs and Communications(MIC) 13:30 - 15:20 Lecture from MIC : -Utilization of ICT for Disaster management in Japan -Information dissemination to general public in 3.11 East Japan great earthquake disaster	Shinjuku Washington Hotel
July 10	TUE	9:00 Pick up Hotel 10:00-12:00: BHN Orientation at JRC office	13:00-14:30 Presentation from JRCat JRC office 16:00-17:00 Visit EMO of Shinjuku Ward of Tokyo Metropolitan to see disaster management system in municipal office	Shinjuku Washington Hotel
July 11	WED	8:30 Pick up Hotel 9:30 JTEC office (Exchange of opinions on J3 pilot project)	14:00-16:00 Visit NHK (Broadcast) Emergency Correspondence at Disaster times	Shinjuku Washington Hotel
July 12	THU	Leave Tokyo for KOBE	13:50-15:30 Presentation by Disaster Reduction and Human Renovation Institution (DRI)	Kobe JICA Kansai TEL:+81-78-261-0341
July 13	FRI	10:30-12:00 Presentation by Asian Disaster Reduction Center (ADRC) Leave KOBE for TOKYO	16:00-17:00 Wrap-Up Meeting/Exchange of Opinions (Tentative)	Shinjuku Washington Hotel
July 14	SAT	City Tour or preparations for leaving	Leave JPN for Tonga by NZ90 at Narita 19:00	Non-Stop
July 15	SUN	11:30 Arrive at Auckland		Hotel Grand Chancellor Auckland Airport
July 16	MON	NZ970 AKL07:20 - Nukualofa 11:10		

(2) Members visited from Tonga

- Mr. Alifeleti Tuifua Tuihalamaka, MIC
- Mr. Mafua I Vaiutukakau Maka, NEMO, MOW
- Mr. Katsuya TERABAYASHI, NEMO, MOW
- Mr. Matangi Toaho, MEWAC

(3) Photo



At Ministry of International Affairs and Communications

3. Joint Study in Tonga-2

(1) Schedule

Date	day	Activities		Remarks
		am	pm	
8 Sep	Sat		19:00 Dep. NRT NZ90 -	
9 Sep	Su	09:00 Arr. AKL		
10 Sep	Mon	07:20 Dep. AKL NZ970 - 11:10 Arr. Nukualofa	13:00-15:00 Site survey in Tongatapu (No.1) NEMO 15:30- Japanese Embassy 16:00- JICA	Car transportation (MIC)
11 Sep	Tue	9:00-11:00 General meeting (by core members at NEMO) 11:00-12:00 Technical meeting with MIC	13:00-14:30 Meeting & Site survey in MET 14:30-16:00 Preliminary inspection to GPS area	Car transportation (MIC)
12 Sep	Wed	9:00-11:00 Technical meeting with MIC (Frequency, TCC, installation works, etc.) 11:00-12:00 Meeting with MIC (Confirmation on To-Do-Items for J3 revision)	13:00- Site survey in Tongatapu (No.2) - Candidate GPSs	Car transportation (MIC)
13 Sep	Thu	9:00-10:00 Meeting with TBC 10:30-11:30 Meeting with TCC	13:00- Site survey in Tongatapu (No.3) - TCC towers	Car transportation (MIC)
14 Sep	Fri	9:00-12:00 Wrap-up meeting by core members	Meeting with MIC/NEMO Spare	Car transportation (MIC)
15 Sep	Sat	11:20 Dep Nukualofa NZ273 -	13:20 Arr. AKL	Car transportation (MIC)
16 Sep	Sun	08:25 Dep. AKL NZ99 -	16:50 Arr. NRT	

(2) Members visited from Japan

- Mr. Masato TAMURA, Director, JTEC/Project coordinator

(3) Photo



Technical discussion at MIC

4. Joint Study in Tonga-3

(1) Schedule

Date 2012		TAMURA	SUZUKI
25 Nov	Sun	0950 Dep. NRT NZ4147/NH909 1400 Arr. Hongkong 1920 Dep. Hongkong NZ38	
26 Nov	Mon	1115 Arr. AKL	1825 Dep. NRT NZ90
27 Nov	Tue	0940 Dep. AKL NZ970 1230 Arr. Nukualofa PM Meeting MIC/NEMO (Briefing)	1235 Arr. AKL
28 Nov	Wed	AM Meeting MIC/NEMO PM Meeting MIC/NEMO	0940 Dep. AKL NZ970 1230 Arr. Nukualofa
29 Nov	Thu	AM General Meeting PM MIC/NEMO	AM General Meeting PM MIC/NEMO
30 Nov	Fri	AM Meeting MIC/NEMO PM2:00- Embassy of Japan/JICA	AM Meeting MIC/NEMO PM2:00- Embassy of Japan/JICA
1 Dec	Sat	AM Meeting MIC 1930 Dep. Nukualofa NZ977 2230 Arr. AKL 2359 Dep. AKL NZ0035	AM Meeting MIC PM Meeting JICA
2 Dec	Sun	0605 Arr. HKG 0955 Dep. HKG NZ4148/NH912 1450 Arr. NRT	(Documentation) No flight
3 Dec	Mon		1130 Dep. Nukualofa NZ273 1430 Arr. AKL 2359 Dep. AKL NZ35
4 Dec	Tue		0605 Arr. HKG 0955 Dep. HKG NZ4148/NH912 1450 Arr. NRT

(2) Members visited from Japan

- Mr. Masato TAMURA, Director, JTEC/Project coordinator
- Mr. Hiromichi SUZUKI, ICTOV

(3) Photo

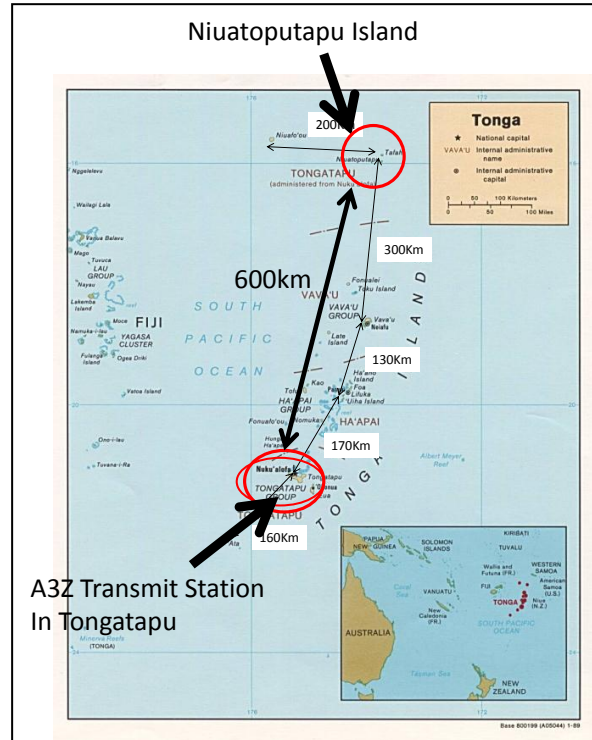


Meeting at MIC for project finalize

Annxe-2 The report on the survey result of “DTMF over A3Z radio”

1. The purpose of the survey

For the installation of the Early Warning System in Niuatoputapu, it is prerequisite to secure the safe and reliable measures to activate the system. The national broadcast radio signal (A3Z) is one of the measures taken into consideration. The purpose of this survey is to investigate the radio reception quality of A3Z at the most far-off island (600km far) to examine if it is possible to activate the system by overlaying DTMF signal on the existing radio broadcasting wave.



2. The methodology

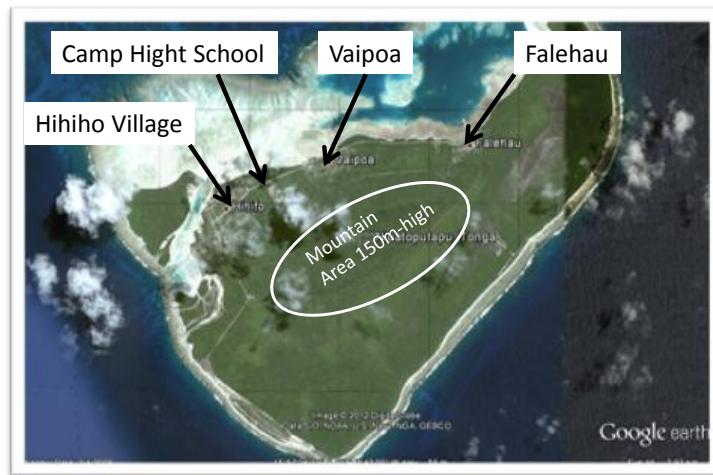
- 1) use the radio receiver (portable, car radio)
- 2) evaluate the quality of the radio (any places in the villages in Niuatoputapu, ideally outside of the buildings or near to the window in the buildings)
- 3) Every three hours, the evaluation should be recorded in the format given.

Note:

- The battery of the receiver should be full.
- If it is a portable radio receiver, the direction and the position of the antenna should be tried to find the better reception.

3. The investigation staff

This observation was done by Mr. Katsuya TERABAYASHI, a researcher of this project who has been working as a professional airplane pilot for 6 years with a considerable experience of using a UHF, VHF, and HF radio, equivalent of having the certificate of the aviation radio operator.



Location map of the Niuatoputapu Island



Portable Radio receiver used for the test (SANYO RP-6165F)

4. Result of the evaluation

The signal qualities evaluated at each time/location were shown in the table below:

Date/Time 2012	06:00	09:00	12:00	15:00	18:00	21:00	24:00	Location
Aug. 28 (Tue)						4 : mobile Neiafu		Vava'u
Aug. 29 (Wed)	4 : mobile Neiafu	4 : mobile airport						Vava'u
Aug. 30 (Thu)								Flight Cancel
Aug. 31 (Fri)				5 : Car radio High School	4 : mobile Camp	4 : mobile Camp	4 : Car radio Hihio	Niuatoputapu
Sep. 1 (Sat)	4 : mobile Camp	4 : mobile Camp	3 : mobile Camp		Tafahi island			Niuatoputapu
Sep.2 (Sun)		Tafahi island			4 : mobile Camp	4 : mobile Camp		Niuatoputapu
Sep.3 (Mon)	4 : mobile Camp	3 : mobile Camp	2 : mobile Vaipoa	2 : mobile Camp	3 : mobile Camp	4 : mobile Camp		Niuatoputapu
Sep.4 (Tue)	4 : mobile Camp	3 : mobile Camp	5 : mobile Falehau	2 : mobile Vaipoa	3 : mobile Camp	4 : mobile Camp		Niuatoputapu
Sep.5 (Wed)	4 : mobile Camp	4 : mobile Camp						Niuatoputapu

*The evaluation was rated in the following number:

[5: Good reception with no noise]

[4: Understandable but with noise]

[3: Poor but understandable]

[2: Can hear but unable to understand]

[1: Hardly hear]

This is a qualitative evaluation which is subjective and comprehensive, including the following factors: interference, noise, stability, the quality of voices.

5. Recorded data

The each audio sound of the radio has been recorded by an IC recorder in MP3 format.

6. Conclusion

The survey was conducted between 31st, Aug and 5th, Sep. During this period, every 3 hours, the reception of the radio has been investigated by the receiver. Though there was varying degrees in the reception according to the recorded time and place, there were no results when the radio was not received at all throughout the investigation.

In general, during the daytime the reception is weak, in particular between 12 and 18 o'clock. However depending on the place and means the radio was received in a good reception even in the daytime. For example the car radio could receive in a good reception even in the daytime on 31st and in Falehau the radio was well received even with the mobile radio during the daytime.

It might be difficult in some cases depending on the place and time to listen to the radio program with a mobile radio. However, for the purpose of sending a trigger signal for Early Warning System on the radio wave, A3Z is reliable enough if the receiver is installed in an appropriate place. The investigation was carried out in the low lying area where villages are and also in the other side of the mountain to Nukualofa where the transmitter is located.

Therefore, as a conclusion, it can be considered that this method can applicable if the receiver is fixed type with external antenna which directed to Nuku'alofa.

For reference, the result above can be said as severe-side or conservative because solar activity as of investigation was the most active in its activity interval of 11 years when the long distance middle-wave propagation is usually hard.

(End)