Raumoco Watershed
Vulnerability Mapping
East Timor

October 18-31, 2007

Humanitarian Aid
ECHO
EUROPEAN COMMISSION

CONCERN
WE'RE IN THIS TOGETHER

REPÚBLICA DEMOCRÁTICA DE TIMOR-LESTE
R D T L

GREEN FORUM
Western Visayas

Contents

Executive Summary

"Hadomi Rekursu Natureza . . . Hanesan Ita Nia an Rasik!"

Lautem District Planning and Development Officer Lino Pereira aptly suggested adopting the slogan above in the closing program of the Raumoco Watershed Vulnerability Mapping calling all stakeholders to "love our natural resources as we love ourselves." He said that if they do not take care of their forests and rivers then they will also suffer the consequences.

Mr. Pereira represented Lautem District Administrator Olavio D. Jesus Monteiro in the Stakeholders Presentation of the results of the Vulnerability Mapping on October 31, 2007. The mapping activities were conducted from October 18 to 31, 2007 with representatives of the Sub-District Disaster Management Councils, local government units, the National Disaster Management Office (NDMO), partner local NGOs and Concern Timor Leste Staff. It was a direct application of the capacity building training on Participatory 3-Dimensional Modeling (P3DM) and Participatory Geographic Information System (PGIS) made last August 2007.

The mapping activities have been characterized with active people's participation providing opportunities for collective data sharing and analysis on identifying hazards, elements at risks, factors or causes why these elements are at risk and the communities' capacities to respond to disasters.

A smaller group, tagged as the PGIS Team (Participatory Geographic Information System), trained on how to digitize the information shared in the 3-dimesional model. Thematic maps on community resource-use, location of houses, infrastructures, and the hazards were produced. By overlaying the thematic maps, analysis were made on the extent of the impacts of these hazards.

The exercises linked the indigenous knowledge systems of the villages in the Raumoco Watershed with the 'cutting-edge technology' of the GIS.

This report gives a background on the vulnerability mapping activities, highlights of the community consultations, particularly on hazard, vulnerability, and capacity assessments.

Background

The Raumoco Watershed Vulnerability Mapping is a follow-up and actual application of the the Participatory 3-Dimensional Modeling (P3DM) and Participatory Geographic Information System (PGIS) conducted last August 2007 in Lospalos, Lautem District. P3DM was introduced as a tool for partner communities and other key stakeholders to understand better the physical and biological characteristics of their watershed and how hazards like flooding and drought impact their livelihoods and living conditions.

This is part of Concern Worldwide's Coordinated Actions for Disaster Risk Reduction Empowerment (CADRE) Programme. CADRE that is a 15-month project funded by DIPECHO under its 5th Action Plan for Southeast Asia. Earlier trainings on Capacity Building for Disaster Risk Reduction Programme in Lautem District were implemented from February 2005 to April 2006 under DIPECHO's 4th Action Plan.

CADRE aims to contribute in reducing the vulnerabilities of communities from disasters caused by floods and droughts through the development of sustainable, replicable, and coordinated preparedness and mitigation actions at the local, national and regional levels. Specifically, it works on improving the capacities and strategies of poor and vulnerable sectors and other key stakeholders for disaster risk reduction.

The Programme is currently focused in the Raumoco Watershed that is under the administrative jurisdiction of two sub-districts, namely Luro and Muro. The Watershed Divide covers nine (9) villages: Afabubo, Baricafa, Kotamuto, Lakawa, Luro, and Wairoke in Luro Sub-District; and Daudere, Maina II and Serelau in Muro Sub-District. Afabubo, Daudere, and part of Kotamuto suffer the brunt of annual incidents of flashfloods and all nine villages suffer food shortages caused by drought and the changing weather patterns.

Disaster Management Basic Concepts and Terminologies

Illustrated flip charts (Figure 1) were used to explain the basic concepts and terms in disaster management. Terms like hazards, disasters, vulnerable areas, risks, and elements at risk were defined using illustrations and definitions from an ADPC (Asian Disaster Preparedness Center) material in the orientation in Lospalos and community processing activities in the Sucos of Luro and Daudere.

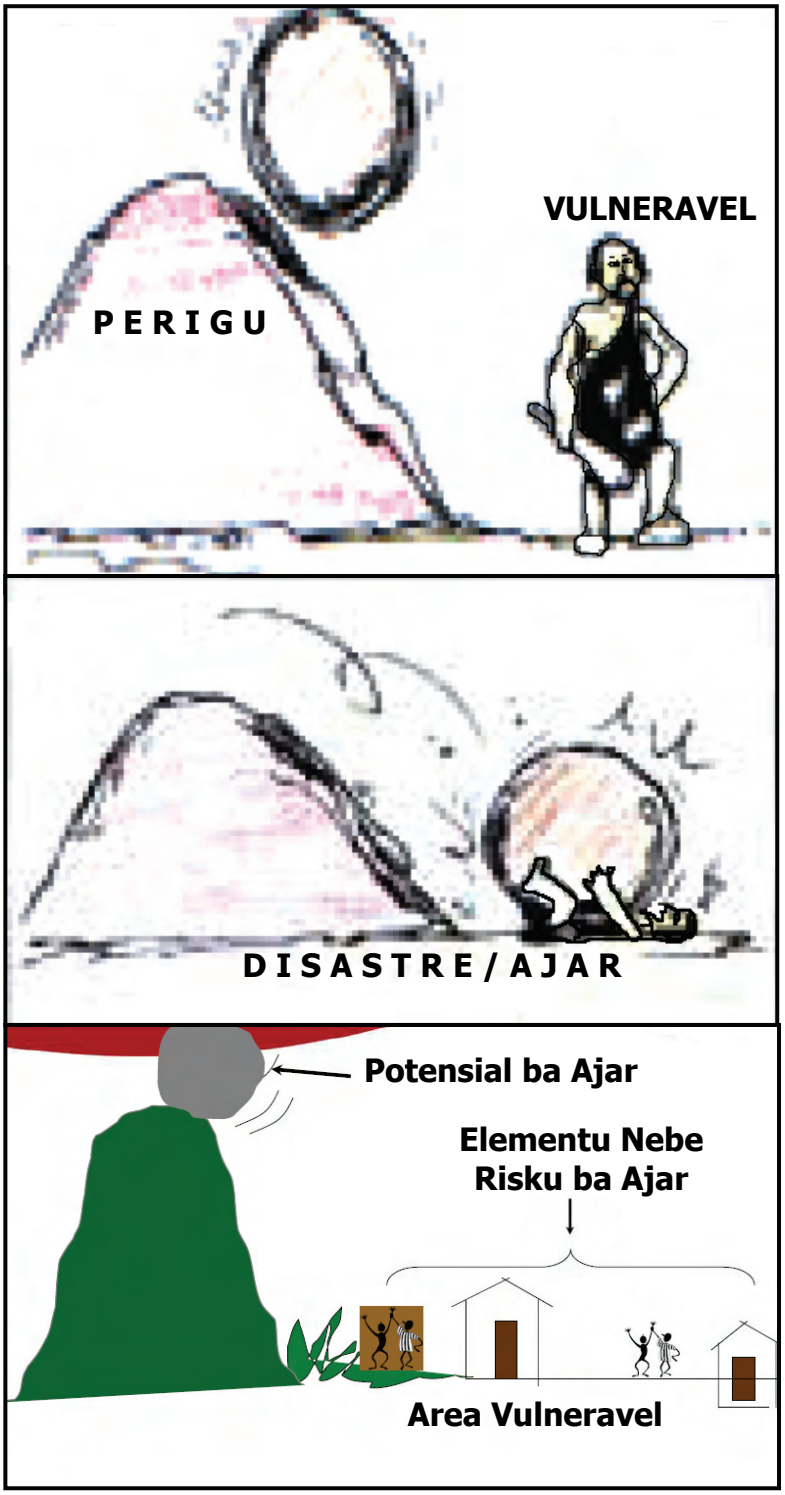


Figure 1. Illustrations used to define terms like hazards, disasters, vulnerability, and elements at risks.

Participants gave various comments on the first illustration like: "a man walking probably to hunt in a full moon" but most said it is a man in danger of a falling boulder. Discussions followed with hazards defined as any man-made or natural situation that can potentially cause damage to people, their crops, houses, animals, and environment.

Disaster is distinguished from hazard as the actual event where widespread human, material or environmental losses occur and examples were given like floods, drought, and political conflicts.

Vulnerability ias a condition or sets of conditions that reduces people's ability to prepare for, withstand or respond to a hazard. While 'elements at risk' refer to persons, buildings, crops or other such like societal components exposed to known hazard and are likely to be adversely affected by the impact of the hazard.

Risk is the probability that a community's structure or geographic area is to be damaged or disrupted by the impact of a particular hazard, on account of their nature, construction, and proximity to a hazardous area. Capacities are defined as those positive condition or abilities which increase a community's ability to deal with hazards.

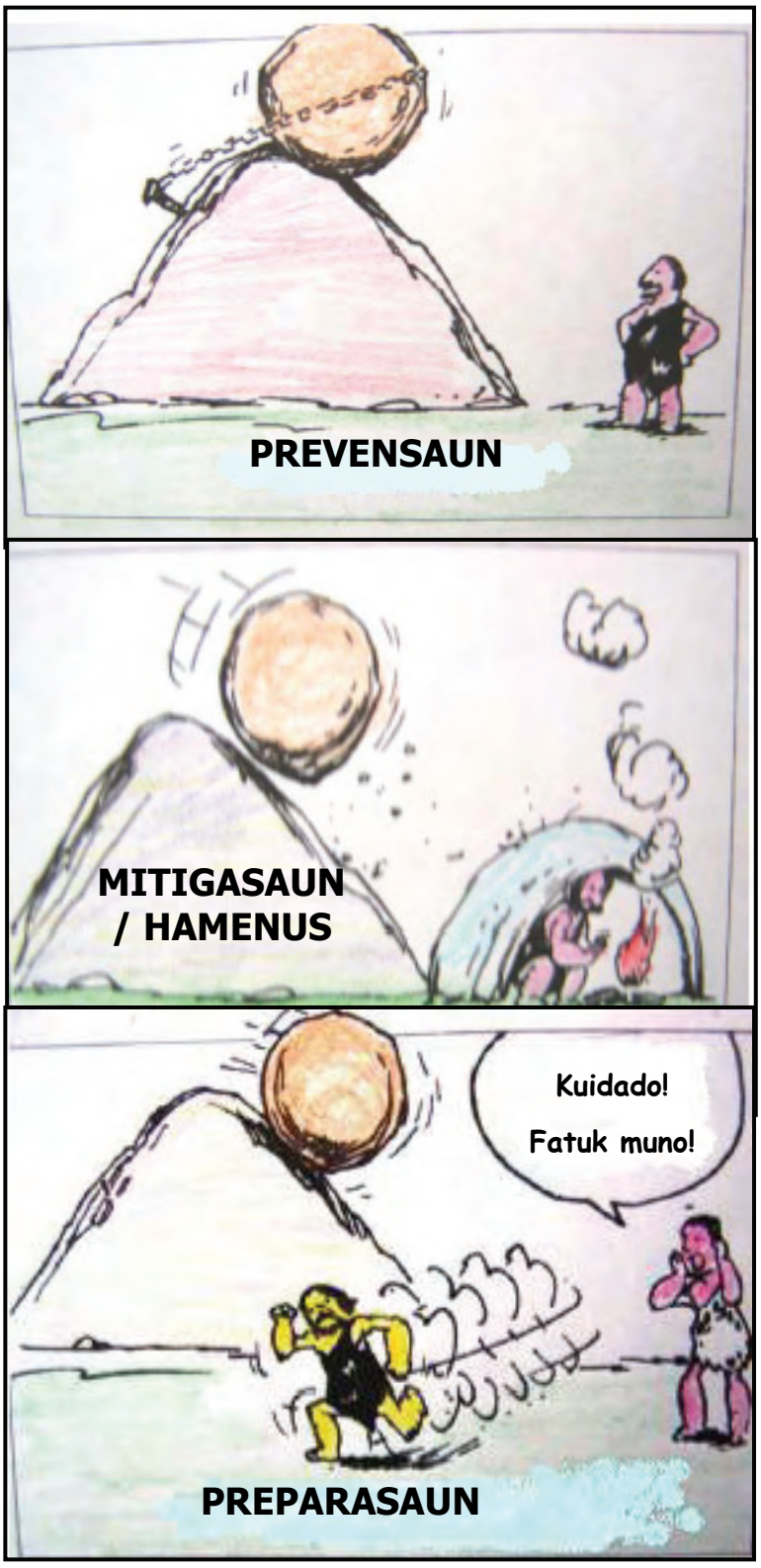


Figure 2. Disaster response options: prevention, mitigation, and preparation.

We tried to explain 'disaster risk' as a function of hazard, vulnerability and capacity. Then the term 'response', which are actions taken immediately after the disaster when exceptional measures are required to meet the basic needs of the survivors. These terms were also briefly discussed: relief, recovery, rehabilitation, reconstruction, and development.

The following disaster management options were emphasized:

- Prevention – measures taken to avert a disaster from occuring, if possible (to impede a hazard so that it does not have any harmful effects).
- Mitigation – measures taken prior to the impact of a disaster to minimize its effects (sometimes referred to as structural and non-structural measures).
- Preparedness – measures taken in anticipation of a disaster to ensure that appropriate and efective actions are taken in the aftermath.

Another option for the communities is to take the risks and suffer whatever consequences.

PGIS Refresher Course and Database Infrastructure Building

Before conducting field mapping, a smaller group called the PGIS Team, with representatives from the local government units (Sub District Administrator), NDMO (National Disaster Management Office), sub-district disaster management councils, local NGOs and Concern staff, was given refresher course on participatory GIS. The course involved the following:

- Review of digitizing techniques;
- Orientation on ArcGIS capabilities for spatial and statistical analysis;
- Risks, vulnerability and disaster response database.

Figure 3. The PGIS Team doing digitizing work and database infrastructure building.

Community Vulnerability Mapping Activities

The P3D model measuring 1.95 meters wide by 2.81 meters long was brought by truck from Lospalos to the upland village of Luro and later to Daudere. Representatives of the upland villages of the Raumoco Watershed namely: Baricafa, Luro Lakawa, Wairoke, Kutamoto and Afabubo gathered at the Sub-District Administration Office in Suco Luro on October 23-24. While the representatives of downstream villages of Daudere, Serelau, Maina 1 and Maina 2 gathered at the Village Office in Suco Daudere on October 25-26.

Participants raised the following objectives:

- To learn and share information about the possible hazards of their villages;
- To use the P3D model in identifying disaster risks and pass the information to their villages;
- To learn technologies and experiences on animal husbandry;
- To learn technologies on protection of springs and water systems;
- To know how international NGOs like Concern, local and national government agencies and the villages can collaborate in disaster preparedness and response.

Table 1. Participating Sucos with their respective expectations for the community vulnerability mapping conducted in Suco Luro and Suco Daudere.

Administrasaun Sub-Distrito Luro Suco Luro Outubro 23-24, 2007	**Sede Suco** Suco Daudere Outubro 25-26, 2007
Partisipante: Representate husi Suco: • Baricafa • Luro • Lakawa • Wairoke • Kutamuto • Afabubo	Representate husi Suco: • Daudere • Serelau • Maina 1 • Maina 2
Esperança 1. Hatene informasaun liu husi mapa no aprende informasaun kona ba mapa 2. Hakarak hatene objetivo treinamento nian; 3. Identifika problema sira liu husi mapa; (perigu) 4. Identifika areas nebe iha problema; 5. Oinsa Concern halo intervensaun? (kolaborasaun - gob / Suco)	1. Hetan informasaun / konhesimentu atu oinsa hakiák animal / buat seluk bele hetan resultadu di'ak; 2. Aprende / simu konhesimentu atu responde ba problema bee mos nian; 3. Identifika desastre; 4. Atu hato'o informasaun konaba desastre iha hau / ami nia suco / aldeia (bee sa'e, raimonu); 5. Hatene tuir oinsa fo informasaun no hetan informasaun konaba disastre liu husi mapa; 6. Fo no identifika disastre

Figure 4. Vulnerability mapping activities in the Luro Sub-District Administration Building, Suco Luro. October 23-24, 2007

Figure 5. Vulnerability mapping activities in Village Center, Suco Daudere. October 25-26, 2007

Hazard Assessment

Participants identified the following hazards through focused group discussions:

1. Windstorms in February to June that also bring landslides, flashfloods, and riverine floods. Rains could come as early as November, especially when there is *La Niña*, but normal cyclone months are February-March for the north to south winds and May-June for the south to north winds.

   Hardest hit by the cyclones' strong surges are the houses in the hills and ridges. Several upland areas are prone to flashfloods destroying roads, overflow bridges, farm lands and contaminate sources of potable water. Rivers spill over causing floods to communities along the banks. There were tornados in Laicara, 2001; Salapuno, 2004; and Lereira, 2005.

2. Infestation by rats and grasshoppers / locusts is a major problem during the harvest months of February to April for corn and April to June for rice.

3. Outbreak of animal diseases is observed in July after the cyclone months.

4. Dry months would start from July to November but they have experienced long 10-month droughts that start as early as April up to January the following year.

5. Bush fires clear areas for dry agricultural practices (fallow system) and for grazing grounds of cows, carabaos, horses and goats but some fires could get out of hand and raze wide areas of regenerant and natural forests and even some houses.

   Elders in Luro cite a fire during Portuguese times that blazed their mountain for more than a month. They say that the environmental spirits left the place thus they are now prone to hazards like drying springs, flashfloods and landslides.

6. Diarrhea and malaria are cited as health hazards. One can get malaria at any time of the year but diarrhea is widespread during the months of November to January when it is the season of mangoes, with the flies, and rain starts to fall.

7. Political conflict is cited as a major hazard especially during election campaign periods. Issues are not sharply discussed but people quarrel on divisions on political parties, ethnicity and others like the martial arts gangs.

After the hazards, participants identified elements at risk and locate impact areas per hazard in the P3DM, these were noted by the PGIS Team in a working map for digitizing.

Chart 1. Seasonal calendar showing agricultural activities and hazards as provided by participants in the P3DM processing in Suco Luro.

		Fulan											
		Jan.	*Feb.*	*Marso*	*Abril*	*Maio*	*Jun.*	*Jul.*	*Ago.*	*Set.*	*Out.*	*Nov.*	*Dez.*
Atividade	Kuda batar												
	Prepara natar no kuda hare												
	Prepara fehuk, ai-farina & kuda nov-dez												
	Kuda fehuk, aifarina – koilheta jan.-out,												
Perigu	Anin Boot		DANI			BALA							
	Mota tun / Bee sae												
	Raimonu / halai / erosi												
	Bailoron nanuk / Raimaran												
	Sunu rai / ahi han uma												
	Pesti / Laho			BATAR		HARE							
	Moras animal nian												
	Karau												
	Fahi												
	Bibi												
	Manu												
	Diarea												
	Malaria												

Chart 2. Seasonal calendar showing agricultural activities and hazards as provided by participants in the P3DM processing in Suco Daudere.

		Fulan											
		Jan.	*Feb.*	*Marso*	*Abril*	*Maio*	*Jun.*	*Jul.*	*Ago.*	*Set.*	*Out.*	*Nov.*	*Dez.*
Activities	Kuda batar												
	Prepara natar no kuda hare												
	Prepara fehuk, ai-farina & kuda nov-dez												
	Kuda fehuk, aifarina – koilheta jan.-out,												
Perigu	Banjir / bee sa'e / flood												
	Anin boot / angin kencang / wind storm		UTARA			SELATAN							
	Tanah longsor / rai halai / landslides												
	Kemarau panjang / bailoron naruk / drought												
	Kebakaran / sunurai / bush fire												
	Hama (tikus, belalang, dll.) / peste / pests	BATAR			HARE								
	Tesi ai / penebangan liar / deforestation												
	Konflik politik / konflitu politiku / political conflict												

Digitizing information processed in the P3DM produced the following maps: updated resource use, hazards and the combined resource-use and hazards map.

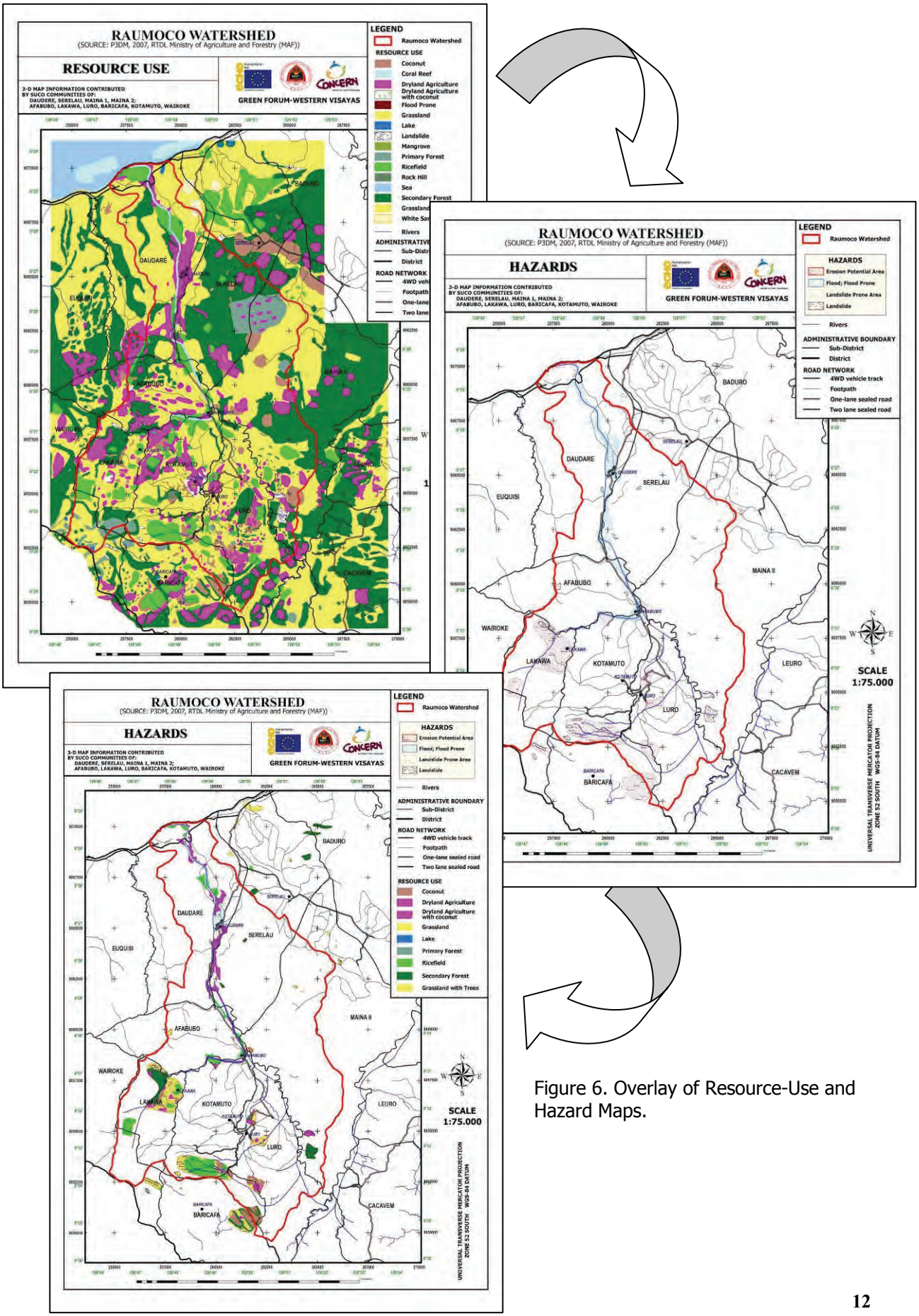


Figure 6. Overlay of Resource-Use and Hazard Maps.

Table 2 shows the hectarages per resource-use of the Raumoco Watershed and surrounding areas. Grassland and grassland with trees covered the widest area at around 13,336 hectares or more than 43% of the whole areas.

Primary forest is only 644 hectares while secondary forest covers 9,996.6 hectares. However, the secondary forests are areas where they regularly return for the shifting agricultural activities (fallows). Fallow areas are currently cultivated areas covering 3,076.3 hectares.

Table 2. Land-use of the Raumoco Watershed and surrounding areas.

Land-Use	Area (in hectares)
Ricefields	1,766.6
Coconut	1,170.4
Fallow area	3,076.3
Fallow area with coconut	161.7
Mangrove	16.5
Grassland	9,162.9
Grassland with trees	4,213.3
Secondary forest	9,996.6
Primary forest	644.0
White sand	102.3
Rock hills	13.1
Lake	26.6
River	39.1
Landslide	115.4
Total:	30,504.8

Participants defined in the P3DM the hazards and the GIS Team digitized the said information. The following are the areas per hazard (in hectares): erosion potential, 836.9; riverine flooding, 270.7; flashfloods, 104.9; existing landslides, 92.2; and additional landslide prone areas, 82.4.

Table 3. Hazards and resource-use areas in hectares

Resource-Use	HAZARDS					
	Erosion potential	Flood (Riverine)	Flash floods	Existing landslide	Landslide prone	Total
Settlement area		57.5				57.5
Rice fields	205.3		68.4			273.7
Coconut	181.4	1.1		5.4		187.9
Primary Forest				3.3		3.3
Secondary forest	126.1		3.4	36.4	42.0	207.9
Fallow area	44.8	206.5		15.2		266.4
Grassland	237.2	5.7	30.8	32.0		305.6
Grassland with trees	42.1		2.4		40.4	84.9
Total	836.9	270.7	104.9	92.2	82.4	1,387.2

In terms of resource-use, 57.5 hectares of settlement areas are affected by riverine flooding. This is very significant as houses are heavily clustered in these settlements. Other resource uses significantly affected are rice fields, 273.7 hectares; coconut plantations, 187.9 hectares; and fallow areas, 266.4 hectares.

Table 4 lists the sub-villages (Aldeia) per Suco that will be affected by the different hazards. Figure 7 is a map of the settlement site in Suco Daudere showing the location of 107 houses that are prone to flooding.

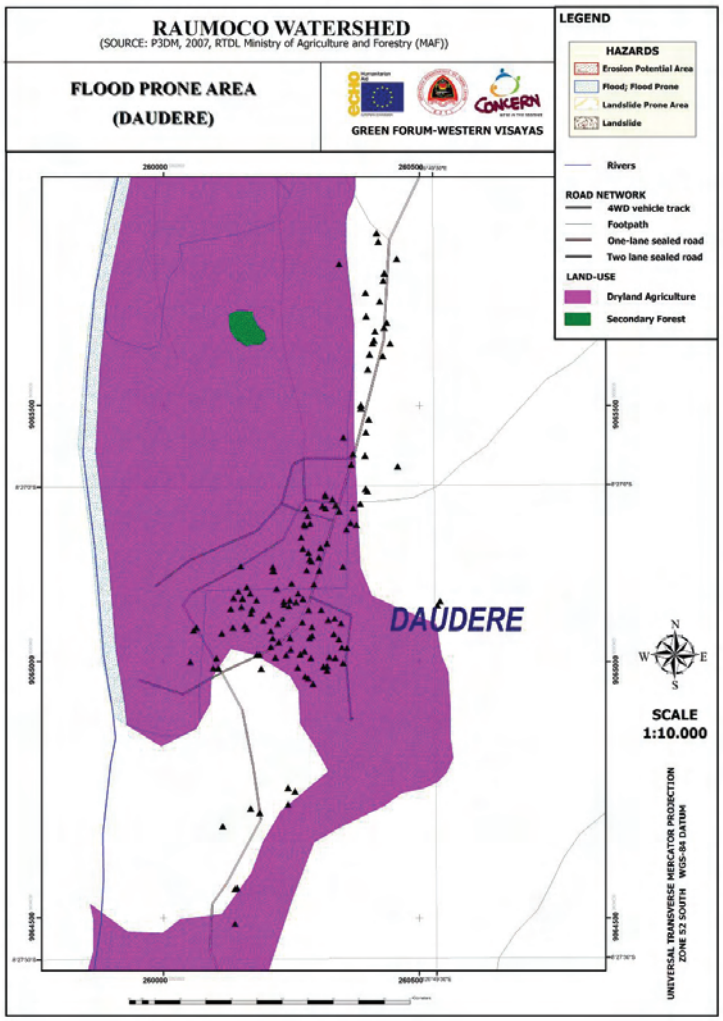


Figure 7. Flood-prone area map of Suco Daudere

Table 4. Hazards and sub-villages of the Luro and Muro Sub-Districts.

HAZARDS	SUB-DISTRICT								
	LURO						MORO		
	AFABUBO	BARICAFA	LAKAWA	KOTAMUTU	LURO	WAIROKE	DAUDERE	SERELAU	MAINA II
Erosion Potential Area	DIRIAMA	BUANOMAR DARA'A MUTU'U HUPANISI IRAOUBERE SARELARI	ONERABA	HAI-IA HAMALORO HOROWEI ILIRUTU IRABERE LEIKIRA LIUMIR LUIBERE MAULASIRI NUTUISI WEIR OSOLIU	SAPU-ISI SENISI TITIFAR	GUNIRA			
Flood Prone	CAIDAWA-FALUN ODOFURO						ANARUA JANAMBERE SUMAIRA VASSATOI	CAIDABARA	
Landslide		DADULAR LUA-PATAN LIBAHIRA		AILARINO	IRA IMIR	LAROBA	HUM RAUNU SIVE	HOKARA TAUROSO	ADARUKAS DEMIRA IRALAU HANA KAKAITA MAHU MECEARO
Flash Flood								LAICARA	NONIRA KAHU MAHU

Vulnerability Assessment

Factors that contribute to vulnerabilities for windstorms and floodings are geo-physical, biological and man-made causes. The geo-physical structure of the watershed is like a funnel - wide basin (13,393 hectares rain catchments) with a very narrow outlet (less than 100 meters wide). Biologically, there is only about 644 hectares of remaining mossy forest in the headwaters or 4.8% of the watershed area has natural vegetation that could absorb heavy precipitation and mitigate run-off.

Denuded hills and ridges expose houses and animals to storm surges / lack of trees as natural windbreaks. Location of communities and the materials and quality of house constructions are also important factors.

Portions of the roads are destroyed because there is no drainage, substandard workmanship, built along natural waterways or in a confluence of creeks and rivers. Bridges are destroyed because the 'landings' are not properly ripraped. Landslides are caused by combinations of steep slopes, denuded hills and mountains, clay soil type, and heavy downpours. Water systems are dirtied when flashfloods inundate spring sources.

There is strong recognition that the annual burning of bush, grasslands and forests hinders regeneration of natural forest and aggravated by the cutting of trees for fuel wood and housing materials. Springs that never dry up before even with long droughts are now drying. Habitat destruction is also linked to infestation of rats and grasshoppers as the natural predators of these pests are almost gone.

They see that if the trend continues then things will go worse for their children and grandchildren but their poverty situation and the absence of alternative agro-forestry and sylvo-pastoral technologies press them to continue with the burning of grassland, bush, and the remaining secondary and primary forests.

Their animals get prone to sickness after the typhoon months which they attribute to the season and poor immunization program. However, several elders say that they have experiences before when more animals died because others were vaccinated (virus could have been brought by vaccinated animals).

Contaminated water source and poor sanitation are seen to contribute to diarrhea outbreaks. Malaria is attributed to the carrier mosquitoes but they consider also poor nutrition as a factor that reduces their bodies' immune system.

Table 5. Hazards, factors and disaster responses identified by participants in the Suco Luro community processing.

Perigu		Faktores		Reasaun
1. Anin Boot (storms / cyclones) Udan la normal: 2003, 2004	Feb. – Marso: Dani (tasi-feto ba tasi-mane, loron14) Abril – Julho: Bala (tasi-mane ba tasi-feto , loron 15)	• Tempo / musim • Lokasi / geografis • Tesi ai arbiru	• Uma la forte • Anin boot iha foho leten / tutun	Tau sasan todan ba uma leten (mitig.) Kesi uma kakuluk (mitig.) Tesi / aparu ai besik uma atu la monu uma leten
2. Mota tun / Bee sae (floods)	Feb. – Julho	• Tesi ai mota ninin • Halo to'os iha rai lolon (endapan) • To'os iha mota ninin estraga	• Kanu foer / rai nakonu (intupidu) • Estrada aat / ponte aat	
3. Raimonu / halai / erosi (landslides / erosions)	Feb. – Julho	• Tesi ai arbiru • Natar / to'os besik rai monu • Halo to'os iha rai lolon • Lahan berpindah	• Tanah gundul (denuded) • Rai lolon / terjal • Rai ne'ebe liurai nian • Liuron besik mota-raihalai	Raimuno / halai: • Muda hela fatin (prep) • Kuda fali ai-horis (mitig) Erosi: • Terasering (mitig) • Kuda ai-horis • Hada fatuk, tradisional
4. Bailoron naruk / Raimaran / hahan menus (food shortage)	Dezembro – Febreiro Aug ka Nov - dalaruma (sometimes), dala 2-3 tinan ida	• Sunu rai • Tesi ai • Bomba husi funu / estraga forestal	• Hahan ne'ebe moris iha bailoron la kuda barak • Informasaun menus • Bee matan maran	Kuru bee (rai di'ak) Rai hahan extra
5. Sunu rai / ahi han uma (burn bushes / forests / homes)	Sept. – Nov.	• Menos info konaba teknologia foun	• La iha apoio merkado	Mentalidade, edukasaun (prev) Hamoris lei tara bandu
6. Pesti / Laho (pests)	Marso-Abril – Batar (corn) Maio – Junho – Hare (rice) belalang	• Tikus: Belum adanya pengetahuan tentang cara penanggulangan	• Belalang: tidak adanya cara dan pengetahuan untuk merespon	Perlu adanya cara penanggulangan baru Mengaktifkan cara mencegahan tradisional yang efektif
7. Diarea / Malaria	Nov. – Jan.	• Diarea: tempo has; tempo modo hahan barak (udan foin tau); sanitasi; bee fo'er; troka tempo (musim); la dun iha informasaun	• Malaria: susuk (mosquitos); sanitasi kurang; malnutrisaun (menus imudade isin); husi inan ba oan (bebe); informasaun la efetivu	Perlu adanya penyuluhan kesehatan Persediaan obat-obatan ditingkatkan Melakukan cara pencegahan malaria secara tradisional
8. Moras animal nian (animal desease)	Hori (after Dani & Bala) – Loro (impact, animals get sick)	• Karau: hemu bee fo'er, hahan / du'ut laiha; vasinasaun la sufiente; da'et; infeksi	• Fahi: moras kulit; asma • Bibi: moras kulit; diarea; matan • Manu: tetelo; ND	Perlu menambah vaksin Vaksinasi secara teratur dan menyeluruh

Table 6. Hazards, factors and disaster responses identified in the Suco Daudere community processing.

Perigu		Faktores	Reasaun
1. Banjir / bee sae / *flood* Toos, uma, natar, estrada, animal Bee matan sai fo'er	Janeiro – Julho 2000 – Julho 2001 – Febreiro 2003 – Maio 2004 – Marso 2007 – Julho	• Formasaun Geologiku – basia boot ho bee sai fatin kloot • Foho sira ne'ebe molik • Bee suli maka'as iha area rai aas – area agrikultura nian (natar) ass liu bee-matan no hela-fatin; • Ponte ne'ebe estraga – baki fatuk sira ne'ebe fraku ka laiha (tembok penahan) • Estrada ne'ebe estraga – la'iha kanu ba bee atu suli	Projetu iha Daudere & Afabubo: Bronzon – mota ninin; Irigasaun; Sentru Evakuasaun; Hoka-kaleng (silo) ba fini; Sistema ba-antes / Peringatan Dini – bee sa'e Formasaun komite Suco nian ba Gestaun Disastre nian
2. Anin boot / angin kencang / *wind storm* Puyuh / Tornado: Laicara, 2001; Salapuno, 2004; Lereira, 2005	Febreiro – Marso: Angin Utara Maio –Julho: Angin Selatan	• Anin boot husi tasi mane ne'ebe baku kona foho sira halo estraga barak	
3. Tanah longsor / rai halai / *landslides* To'os, uma, natar, estrada, animal, bee matan / florestal	Jan. – Julho	• Husi ema no natureza • Aihun sira la'iha • Rai manu-ten – area bokon no mamar • 'bee lihun' – bee mai husi bee-matan bar-barak	
4. Kemarau panjang / bailoron naruk/ *drought (food shortage)* Animal, bee maran, plantasaun, aihoris, moras lepra (sofre), me'ar	Julho – Novembre (bai-bain) 1982: Abril – Janeiro 2006: Abril – Dezembro	• Bailoron naruk – kondisi iklim • Bee-matan sira maran • Regulasaun la'iha ba forestal, liu-liu besik bee-matan sira	
5. Kebakaran/sunu-rai/*bush fire* Florestal, plantasaun, animal fuik (manu fuik, samean, niki, laho, meda, dll.)	Agosto - Novembro	• Tipo pratika agrikultura ne'ebe dominante • Informasaun menus / teknolojia alternativu • Markadu laiha ba produtu husi to'os metin	Hamoris fali lei tradisional (tara bandu) Informasaun / hasa'e konsensia (Concern & grupo joven) • Kompor buatan (efficient stove)
6. Hama (tikus, belalang, dll.) / peste / *pests* Tikus: batar, hare, aifarina, nuu Belalang: batar, fore, modo	Batar: Janeiro – Marso Hare: Janeiro - Maio	• Habitat ne'ebe estragadu (animal barak mak muda husi ailaran ba ataka to'os, natar) • Binatang pemangsa ba laho no gafinhotu laiha (manu-fuik, samean) no pratika kasa	
7. Tesi ai / penebangan liar / *deforestation* Papam, balok; kayu bakar; pagar; rumah rakyat	Julho – Outubro Bei-beik	• Situasaun akonomia, tesi ai hodi hetan osan atu fo-han familia	Lei lokal atu bandu (regula) ba tesi ai nian Reboisasi / kuda-fali ai-horis Forma grupo servisu komunidade
8. Konflik politik / konflitu politiku / *political conflict* Elisaun, kamp. politiku, rasa (etnik), arte-marsiais - Povo			

Capacity Assessment

Several villages have organized their Suco (village) disaster management councils and implemented mitigation and preparedness measures like the construction of gabions for riverbank stabilization and irrigation systems, flood early warning system, evacuation centers, and seed silos. There are, however, several Sucos (Serelau, Maina 1, and Maina 2) that have just started to join Concern's program and have yet to organize their village disaster management councils.

They recognize the value of maintaining the balance of the watershed ecosystem and the grave impact of the economic pressures that force families to continue burning the bushes and forests, cutting of trees, and destroying wildlife habitats.

The traditional systems of the *'tara bandu'* that prohibits the use of certain places as sacred areas should be revived. Colonial occupations and conflicts changed their settlement patterns and cleared forests of the indigenous sandalwood trees. They recognize that the degradation of their natural resource base has been deeply rooted to centuries of colonialism but they need to reverse the trend.

Table 7. Recommendations of participants from vulnerability mapping activities in Sucos Luro and Daudere.

Administrasaun Sub-Distrito Luro Suco Luro Outubro 23-24, 2007	**Sede Suco** Suco Daudere Outubro 25-26, 2007
Rekomendasaun:	
Komunidade: • Fatuk • Kuda ai • Tempo • Forsa/enerjia • Material lokal • Proposta ba gov. & INGO (Concern, etc.) – infraestrutura	• Proposta ba Concern ba apoiu hamenus impaktu perigu (Maina 2) • Fini ba hortikultura / agrikultura • Forma grupo feto nian (mata-pencaharian / kredit kecil) • Teknolojia konaba Agroforestal • Introduz metodu foun kona-ba fila rai atu aumenta rekursu • Proposta apoiu husi governu & ajensia seluk atu fornese apoiu merkadu ba produtu komunidade • Kontinua ho sistema bee nian ne'ebe iha planu iona (Lakawa) • Forma grupo komunidade konaba bee mos • Treinamentu Pratika kona-ba agrikultura & hortickultura • Aprende / estuda komparativa kona-ba pratika gestaun pesti iha fatin seluk
Suporta Husi Gov & NGO • Fatin evakuassaun (Anin, udan) • Estrada • Teknisi (geologic study) • Bibit	
Tradisional mekanismu peringatan dini • Manu lian – atu udan (Ma'lewet) • Ai-atahan monu – atu udan • Anin • Nehekliras (insect)	
Teknolojia foun • Ligasaun ho institusaun – ajensia meteorologiku nian	

For reforestation and other mitigation measures, the communities volunteer their time, energies and local materials but they need farm tools and implements, alternative appropriate technologies, and markets for their produce. They need exposure to community-based agroforestry, sylvopastoral and integrated watershed management sites. This should be complemented with 'social marketing' through community education and information campaigns.

They suggested the formation of sectoral organizations like women and youth to implement community programs on livelihood, education and information dissemination.

Government is called to repair the roads and bridges and provide heavy earth-moving equipments for civil works on riverbank stabilization.

Recommendations

Participatory land-use planning should be undertaken to define the strategic economic development and ecological protection strategies for the whole watershed divide. The remaining natural forests should immediately be protected with the mother trees, critical habitats and water spring sources mapped out and communities trained on participatory biodiversity assessment and monitoring.

Detailed geo-morphologic study should be undertaken to define the geo-hazard areas and prepare the resettlements for those affected by these hazards. Early warning systems should be developed with basic community traditional and technical hydro-meteorological monitoring tools. There should be close linkages with meteorological agencies at the district, national, and international levels with mechanisms for data sharing and analysis.

Local government units, national agencies and communities should develop protocols for immediate disaster responses per hazard with simulation exercises in schools and communities. Standards for constructions of houses, schools and other buildings should be established.

GIS capabilities of Government Agencies, LGUs and NGOs should be further developed with support for computer software and hardware.

Annex 1. Review Materials for Digitizing and ArcGIS Operations

The GIS team digitized the geographic features from the processed information using working maps and scanned topographic maps.

The team is divided into Group "Perigu" led by Pedrocu, digitized the hazard map, and Group "Topography" led by Mariano of NDMO, digitized the needed topographic data.

Both groups did georeferencing procedure before starting to digitize. These steps were followed:

In CartaLinx,

1. From the Main menu, select 'Image Conversion'
2. A pop-up dialog window appears, enter the image file to convert by pressing browse button to find the scanned graphic file of topographic map.
3. Then select the reference system 'UTM-52S'
4. Enter the minimum x, y coordinates and maximum x, y coordinates
5. Then enter the filename of the georeferenced bitmap file to save and end the conversion process.

Data assignment started after all geographic features were digitized. Each group created data fields for entry by adding fields in geodata tables.

The GIS team was taught to create those fields before assigning information. These steps are followed:

In CartaLinx,

1. There are three tables on the table panel, the nodes table, the arcs table and the polygons table. Point the cursor on either of these table and press right-click.
2. A pull-down menu appears, select 'Add field', a dialog window displays.
3. Enter the name of the new field, and select the data type for that field.
4. Finally, press 'Add' button to add that field to the data table.

The steps are repeated if there are more fields to add.

The data fields are:

Group "Perigu" – 'Perigu', (Text, 20 characters); 'Fahin', (Text, 25 characters) and 'AreaHas', (Single-Precision Real number), all created in Polygons table.

Group "Topography" - 'Desc', (Text, 20 characters), inputs will be either "River" or "Road"; 'RoadName', (Text, 20 characters); 'RoadStatus', (Text, 15 characters); and 'RiverName', (Text, 20 characters), all created in Arcs table.

The F3 key is used to assign all feature properties in their respective CartaLinx coverage files, the perigu.lnx and topography.lnx.

The ArcGIS were introduced to the GIS team by showing them its capability and the tasks it can perform in working with maps.

ArcGIS Working Environments:

ArcGIS has two (2) working environments:
Single-user (project) and **Multi-user** environment

In either 2 environments you can use the three ArcGIS Desktop applications:

ArcCatalog- is the application for managing your spatial data holdings, for managing your database designs, and for recording and viewing metadata.

ArcMap- is used for all mapping and editing tasks, as well as for map-based analysis.

ArcToolbox- is used for data conversion and geoprocessing.

GEODATABASE

A data model for representing geographic information using standard relational database technology. It supports the **storage and management of geographic information** in standard database management system tables.

Two Types of Geodatabases:
Personal Geodatabases and **Multi-user** Geodatabases

	Personal (Single-User)	**Multi-User**
DBMS	Microsoft Access (Attribute Tables)	Microsoft SQL Server, Oracle, IBM DB2, IBM Informix
Limits	Single-User Editing 2 GigaByte size storage	Multi-User Editing Database size & # of users is up to RDBMS limit

The team was also informed that CONCERN's copy of ArcGIS 9 is a single-user license. A 'security' key will be used to run the program. It should be attached at the back of the desktop computer on a designated USB slot located at the first slot of second row for USB connections. The key is a flash disk, colored light maroon, and it is mandatory to be plugged on that slot every time the ArcGIS program runs. Pedrocu was given the responsibility to keep the key.

The GIS team started exporting the digitized features (nodes, arcs, polygons) from the processed hazard information gathered from the working map and 3D model in Daudere and Luro.

Steps on migrating (exporting features) CartaLinx to ArcGIS 9:

In CartaLinx,

1. From the Main menu, select 'File'
2. Then, select 'Export' function
3. A dialog box will appear. Choose what feature to export, either Node as for points, Arcs as for lines or Polygons as for area feature. Then select the file format as output file. Choose the ArcView Shape file format (.shp file).
4. Enter the export filename and press ok button to start the export process and the exported file will be saved.

In ArcGIS 9,

1. Open the ArcGIS 9 Desktop program icons, ArcMap and ArcCatalog.
2. Make both program windows viewable in the screen
3. In ArcCatalog, from the Main menu, select 'File' then select 'Connect folder' function.
4. A pop-up dialog will appear, select the folder to connect so all spatial (geographic) and geodatabase files on that folder will be organized and maintained under ArcCatalog.
5. Select the file (.shp file) and drag it to the ArcMap's table of contents (displaying layers) found in the left side panel of window. The layer features just added are now displayed automatically in the data view frame window.
6. Set the coordinate system to Universal Transverse Mercator - 52 South (UTM-52S) by double-clicking the group layer name in the Table of Contents.
7. Then the 'Data Frame Properties' dialog window will appear. Select the 'Coordinate System' tab, then from the list of coordinates system groups, click 'Predefined', then click 'Projected Coordinates Systems', select 'Utm', then select 'WGS 1984'. Finally, scroll down to the list, choose the 'UTM 1984 Complex UTM Zone 52S'.

Designing the Map (Lay-outing)

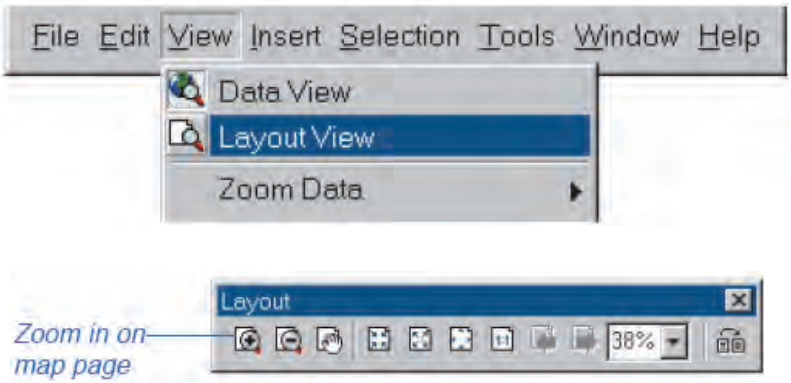
The GIS team were shown how to make map layouts beginning on what map elements to put and overlaying sequences of layers.

Map elements needed are as follows:

- Map Title
- Scalebar
- Legend
- North arrow
- Logo
- Map reference information – Universal Transverse Mercator Zone 52 South
- Source information – from the 3D Model, topographic map and data from MAF office

Steps in completing the map lay-out

1. Decide how big is the layout. Set the page size first. Go to 'File' in the main menu. Select 'Page and Print Setup', then set it according to the desired paper size for the layout.
2. Set up the map page by switching from data view to layout view.

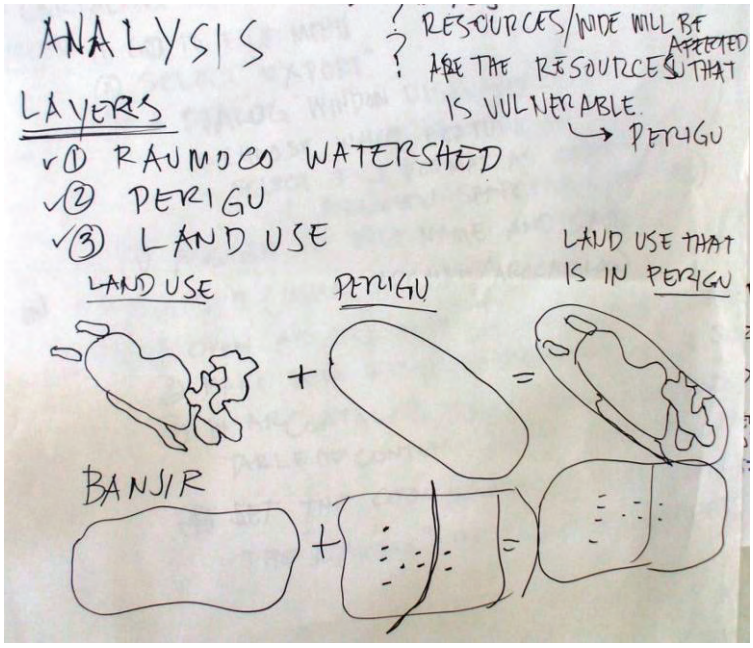


3. The map page filled by a data frame containing the currently displayed layers. The Layout toolbar also appears.

   The Layout toolbar contains tools for zooming and panning.
4. Set the map scale by double-clicking the group layer in the table of contents. A data frame properties dialog will display and select the data frame tab. Enter the map scale.
5. Insert all map elements, one at a time in the Layout View by selecting 'Insert' from the main menu.
6. Finally, you can now print the map layout you created.

The GIS Team was given an example on how to analyze geographically using the ArcGIS 9 operation program. They were shown samples of ArcGIS 9's analysis functions from simple display of geographic features to complex analysis.

To have our own example, we started by asking questions about what 'Perigu' can affect their place and what are the resource uses at stake if 'Perigu' comes.



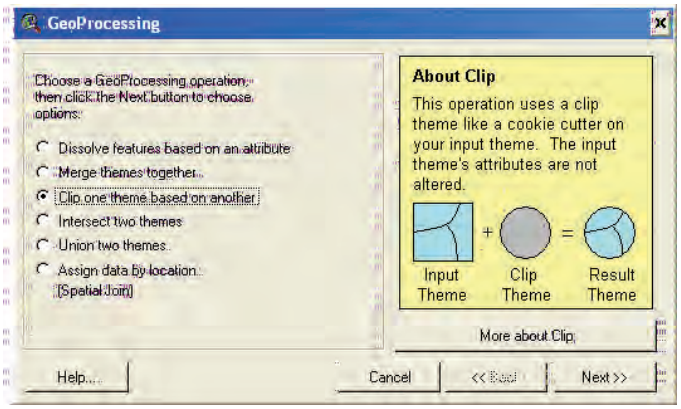
The figure shows the variables for analysis. Each of the layer or thematic map describes particular geographic information. Overlaying 2 different layers, and combining different sets of features using GIS analysis function, will a produce new layer of features set.

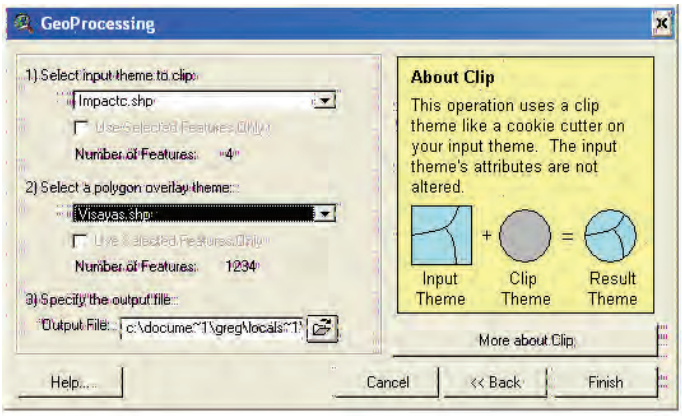
The process was done in ArcView 3.3's 'Geoprocessing Wizard' because of ArcGIS 9's ArcToolBox program is not working. The program just simply terminates when we tried the 'clip features of overlay' function.

These steps were followed:

In ArcView 3.3,

1. From the Main menu, select 'File' then choose 'Extensions'
2. A pop-up dialog window appear, select 'Geoprocessing' from the list of available extensions. Press 'OK' button to activate the extension.
3. From the Main menu, select 'View' then choose 'Geoprocessing Wizard'
4. Geoprocessing dialog appears, select 'clip one them based on another'. Press 'Next' button.
5. Then in step 1, select the shape file theme as input to clip, then in step 2, select polygon theme to overlay. The last step is to browse where should the output file will be stored.
6. Select 'Finish' button to start the processing.





Annex 2. Schedule of Activities. Participatory Vulnerability Mapping

Day	Topic	Contents	Methodology
PGIS Refresher Course & Database Infrastructure Building			
Oct. 18	Oreintation and levelling-off	• Levelling on disaster management basic concepts & definitions.	Lecture & plenary discussions
Oct. 19	Review geographic data digitizing techniques	• Operations of GPS hand-held rovers • Heads-up digitizing technique • Building and importing datasets into digitizing softwares: CartaLinx and ArcGIS	Lecture / hands-on field demonstrations & computer operations. GIS Team
Oct. 20	Orientation on ArcGIS Capabilities for Spatial and Statistical Analysis	• On Relational Database: structure, relationships, objects, attributes. • Creating geo-attributes on digitized information • Filtering features or locations, customizing maps based on specific feature attributes. • Interactive feature inquiry. Modelling queries and over-lays.	Lecture / plenary / group discussions. GIS Team
Oct. 22	Risks, Vulnerability and Disaster Response Database	• Principles of digital database. • Database design process. • Data gathering design. • Determining tasks, roles & responsibilities of stakeholders in data gathering, maintenance and monitoring.	Lecture / plenary / group discussions. GIS Team
Vulnerability Mapping. Participatory Data Gathering & Digitizing			
Oct. 23-24, Upstream Villages	Processing with representatives of Sucos: Baricafa, Luro, Kotamuto, Lakawa and Wairoke (10-12 pax / suco)	• Plotting of geo-physical and hydro-meteorological hazards. • Identifying vulnerable populations per hazards, • Plotting elements at risk (resources & infrastructures), • Mapping disaster responses (household and institutional). • Continuing digitizing of gathered information.	Workshop groups focused discussions. Process documentation.
Oct. 25-26, Downstream Villages	Processing with representatives of Sucos: Afabubo, Maina II, Serelau and Daudere (10-12 pax / suco)		
GIS Data Integration for Resource Use, Disaster Vulnerability & Risk Analysis.			
Oct. 29	Thematic & Analytical Maps	• Production of thematic maps: resource-use, hazards, vulnerable populations per hazard, elements at risk, preparedness, response & rehabilitation capabilities.	ArcGIS operations. GIS Team
Oct. 30	GIS spatial analysis.	• GIS thematic map overlays for qualitative & quantitative analysis. • Participatory qualitative / quantitative assessments • Simple & detailed guide in updating the database.	ArcGIS operations. GIS Team
Oct. 31	Stakeholders presentation	• Presentation of output to community representatives and other stakeholders.	

Annex 3. List of Participants

The following participated in the Vulnerability Mapping activities from the orientation, participatory field data gathering, data analysis and stakeholders presentation:

1. Januario Da Costa
2. Zelito Dos Santos
3. Laurentino Belo
4. Tomas Fonseca
5. Jeremias Paulo
6. Sejaltina Rodriques
7. Gil Salazar
8. Cornelio Eusebio Ribeiro
9. Joaquin Preto
10. Jaime Pinto
11. Francisco Lopes
12. Suzana Savio
13. Livio Marques Cabral
14. Herminia Dos Santos
15. Armando Nolasco
16. Tomas Da Costa
17. Angelino M. Soares
18. Rita Pires
19. Julio Pereira
20. Martinho Fatima
21. Mariano da Costa Camões
22. Rolando C.X. Dos Santos
23. Pedruco Capelão
24. Ashutosh Dey
25. Jose Ferreira
26. Pedro da Silva
27. Jenilda Silva De Oliveira