

The Damage and the Rehabilitation Process after 1990 Luzon Earthquake-some Cases of La Union and Nueva Ecija-

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The Damage and the Rehabilitation Process after 1990 Luzon Earthquake

— Some Cases of La Union and Nueva Ecija —

Yoshiyuki MURAYAMA and Shin-ichi HIRANO

Abstract The 1990 Luzon Earthquake ($M_s=7.8$) hit northern and central part of the Luzon Island on 16 of July which induced several types of damage. The damage varied widely with the cause and the place. In the coastal area of the Lingayen Gulf, the main cause of the damage was liquefaction. Some of them were very large in scale, so that they made settlements sunk. In the mountain area along the fault, great many landslides triggered by shaking, and strong motion itself did damage during the earthquake. In a few months after that, typhoon rains sometimes caused floods, and the houses and farmland were washed out or buried by the material supplied by the landslides.

The affected people were helped by the various kinds of assistance projects by the governmental organizations or NGOs. However, there are some problems in rehabilitation process after the earthquake. The authors have found two types of the resettlement based on people's own initiative and by the initiative of the governmental organizations or NGOs. There are certain difficulties in each type of the resettlement.

Key words : 1990 Luzon earthquake, liquefaction, landslide, flood, resettlement

1 Introduction

The Luzon Earthquake ($M_s=7.8$) hit northern and central part of the Luzon Island on 16 of July, 1990. The epicenter was located at 15.679°N and 121.172°E near Rizal, Nueva Ecija Province, and the depth was 25 km. The earthquake fault appeared along the Philippine Fault Zone, and many fault topography appeared along it. Horizontal and vertical displacements measured 6.2 m and 2.5 m, respectively. It stretches in the direction of NNW-SSE approximately 125 km long from Kayapa, Nueva Vizcaya Province to Dingalan, Aurora Province (Punongbayan *et al.*, 1992) (Fig. 1).

The earthquake caused severe damage in the Luzon Island. At least 2,000 people are missing or died, and more than 3,000 people were injured. There were three kinds of causes except strong motion, namely liquefaction, landslides and floods. The

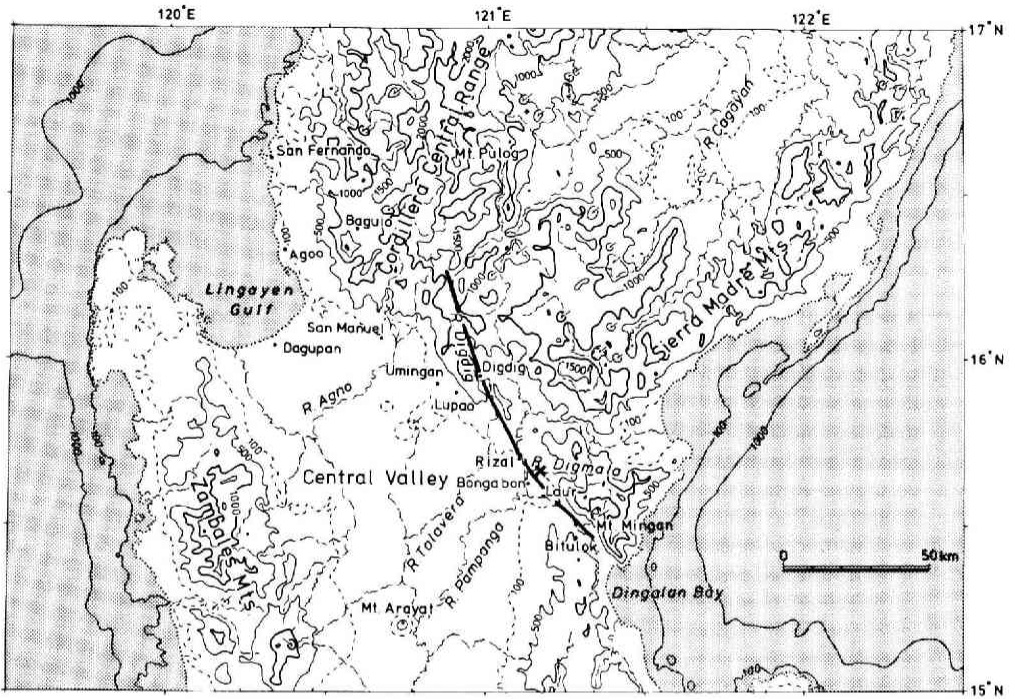


Fig. 1 Restored map of around the Philippine Fault Zone and epicenter of the July 16, 1990 Luzon Earthquake (×), in the central part of the Luzon Island.

Eliminating valleys less than 2 km across, contour interval is 500 m and isobath unit is fathoms.

strong ground shaking caused the collapse of many buildings and houses in the central Luzon Island. Liquefaction did severe damage in the provinces of Tarlac, Pangasinan and La Union. Landslides on valley slopes and floods affected the mountain areas near the fault. Many people lost their houses, and some of them had to evacuate and resettle.

It is intended in this study that what kinds of damage were caused by the earthquake, and how people worked for rehabilitation after the natural hazard. This report based on the field survey carried out in March 1993.

2 The characteristics of the damage and the land condition

2.1. The coastal area of the Lingayen Gulf — Pangasinan and La Union —

This area is located 100 kilometers or more away from the epicenter. However, this area was suffered severe damage by liquefaction as well as by strong motion.

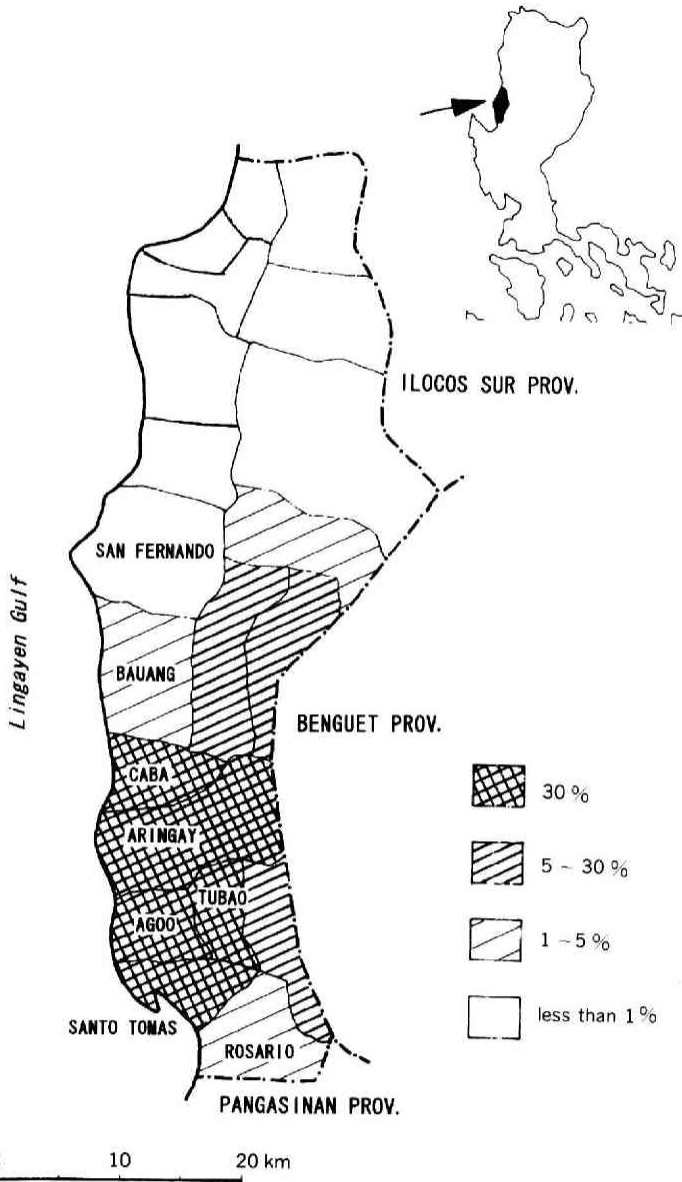


Fig. 2 The damage rates of houses in La Union Province.

The data about affected houses of each municipality are provided by the DSWD Regional Office I. The number of households of each municipality is used for calculation, because the number of houses is not available. The number of households is after 1990 census, that was enumerated right before the earthquake. It is not clear about the difference of the number of households in 1990 census from that of houses used by the DSWD.

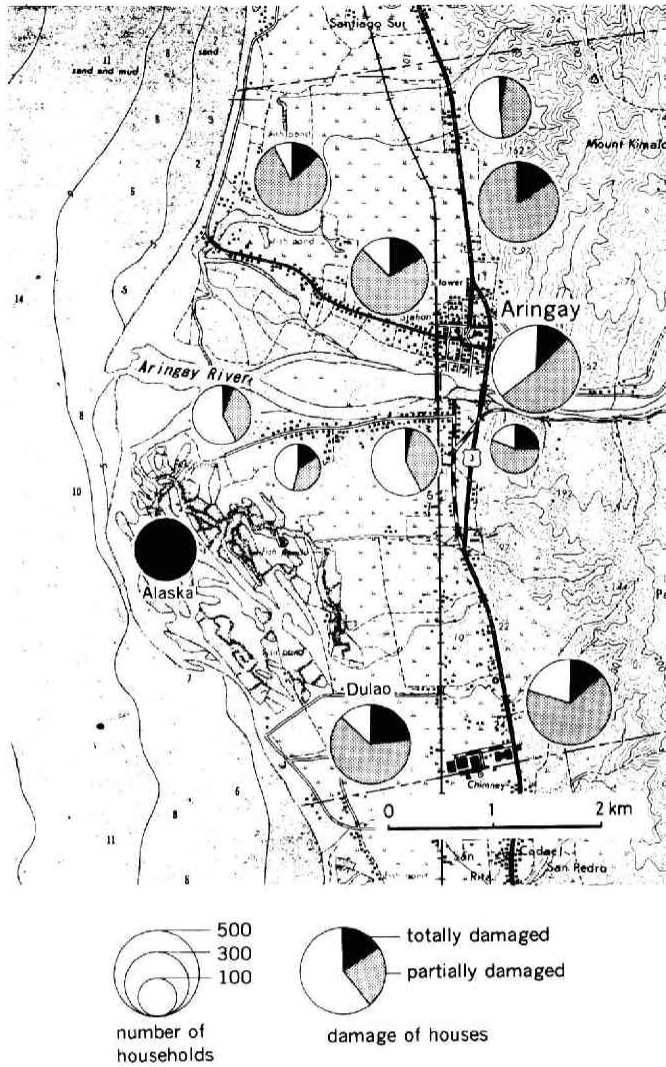


Fig. 3A

Fig. 3 The damage rates of houses in the coastal area of the three municipalities in La Union.

(A: Aringay Municipality, B: Agoo Municipality, C: Santo Tomas Municipality)

The data about affected houses of each barangay are provided by the DSWD office of each municipality. The number of households of each barangay is used for graphing, because the number of houses is not available. The number of households of each barangay is after 1990 census.

Dagupan City, Pangasinan, is located on the southern shore of the Lingayen Gulf, and is on the new fluvial sediments or even on the reclaimed land on the marsh. Lateral spreading alongside the Pantal River, land subsidence, sand boils, and many buildings tilting and/or subsiding were observed as the effects of liquefaction in Dagupan City (Photos 10 and 11) (Tores *et al.*, 1992, Yanagisawa *et al.*, 1993a)¹⁾.

The degree of damage is higher in the southern part of La Union than that in the northern part (Fig. 2)²⁾. However, Rosalio Municipality, at the southern tip of La Union, has experienced slight damage. It is clear that the land condition as well as the distance from the epicenter has effects to do with the degree of damage. There are alluvial plains that are formed by new sediments, in the municipalities of Caba, Aringay, Agoo, Tubao and Santo Tomas, where the rate of the damage of houses was highest in La Union.

Many sand boils were observed in the coastal area (Tores *et al.*, 1992, Yanagisawa *et al.*, 1993b), and many houses were severely affected (Figs. 3A, 3B and 3C). At some settlements there, the ground subsided so far as buildings have sunk into the sea. In the barangays (the smallest political units) of Narvacan, Santo Tomas and Alaska, Aringay, almost all the houses were sunk, in some sitios (small settlements in barangay) in the barangays of Raois, Santo Tomas and Dulao, Aringay, many houses were also sunk in the sea. Narvacan is located on the tip of the sand spit, Raois is on the shore of the mainland (Photo 5), opposite side of the sand spit, and Alaska and Dulao are on the delta of the Aringay River. Heavily damaged settlements are those which are next to the fish ponds or surrounded by them. It is supposed that liquefaction causes subsidence and lateral spreading simultaneously in large scale (Yanagisawa *et al.*, 1993b). The people of the settlements were forced to evacuate, and some of them could not return because there was no land to live.

2.2. The mountain area along the fault — Nueva Ecija —

The Digdig Fault is one of the most distinguished active faults. It stretches with high certainty in the direction of NW-SE or NNW-SSE. In the southern part of Nueva Ecija, it separates the mountain area on the northeastern side from the Luzon Central Valley on the southwestern side (Figs. 1 and 4).

In Carranglan Municipality that is located in the northern part of Nueva Ecija, the fault extends toward NNW direction into mountain area. It is developed along the Talavera River and the Digdig River. This area was suffered severe damage by surface rupture, especially along the Digdig Fault. Many houses collapsed in the barangays of Puncan, Digdig, Piut, Putlan, Minuli and Capintalan (Fig. 5). The loss of houses from the earthquake amount to 40 percent, in Piut. Other barangays that are located along the Digdig River, the percentage of the loss of houses reached ten or more. However, the ratio of damaged houses in some barangays that are located in



Fig. 3B Agoo Municipality

Fig. 3 The damage rates of houses in the castal area of the three municipalities in La Union.

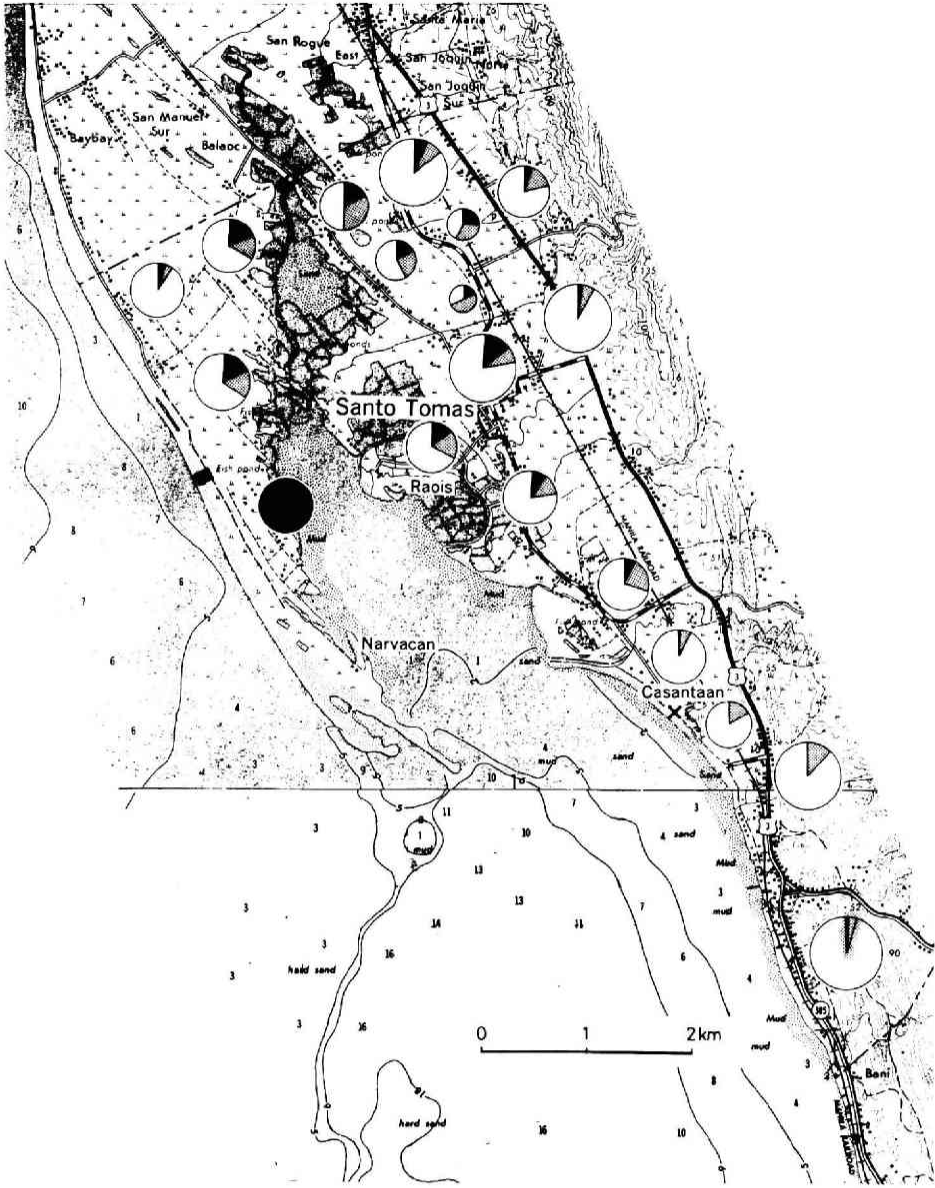


Fig. 3C Santo Tomas

Fig. 3 The damage rates of houses in the castal area of the three municipalities in La Union.

- × : new settlement built by the people from Narvacan
- : NHA project area



Fig. 4 Contour map of around the Digidig River, Nueva Ecija.
Contour interval is 200 m.

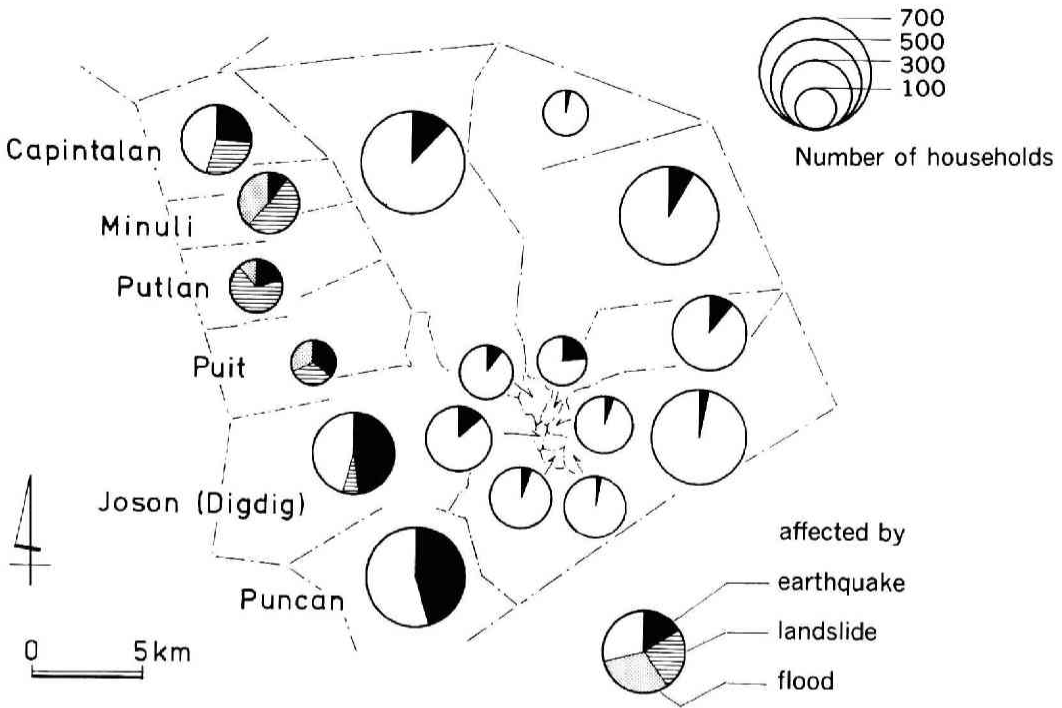


Fig. 5 The damage rates of houses in the mountain area of the Carranglan Municipality, Nueva Ecija. The data about affected houses of each barangay are provided by DSWD office of the Carranglan Municipality.

the distance from the drainage basin of the Digdig River is less than 10 percent (Fig. 5).

Moreover, many landslides occurred by strong shock, especially on the right bank of the Digdig River (Fig. 6). This area is located along the Digdig Fault. The lost houses from landslides amount to over 50 percent in the barangay of Minuli and Putlan, and it amounts to approximate 30 percent in the barangay of Capintalan and Puit. On the other hand, there are no houses lost by landslides at central Carranglan.

On 27 July 1990 and 26 August 1990, two typhoons hit the Luzon Island, and much precipitation flooded many rivers. The farmland and houses along the Digdig River were washed out or buried by flood sediments. There are approximately 30 percent houses lost by the flood in Minuli and Puit, but there are no houses lost in Capintalan, Digdig and Puncan (Fig. 5). Around middle reaches of the Digdig River, there are many landslides caused by earthquake shaking and heavy rain (Fig. 6), so the river channel of the Digdig River was filling up and overflowing in Minuli, Putlan and Puit.

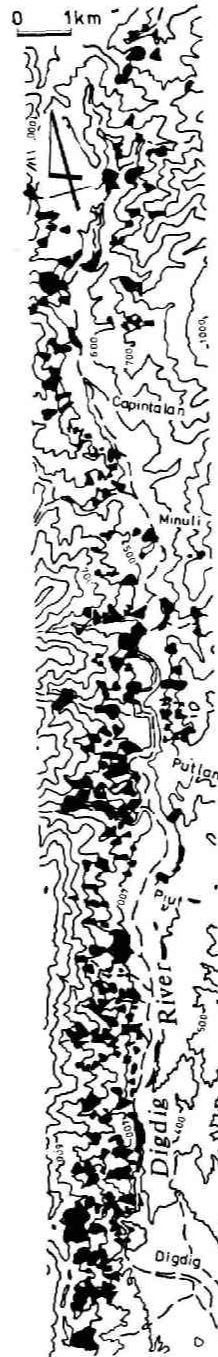


Fig. 6 Landslides distribution along the Digdig Fault.
(after Arboleda and Regalado, 1992)

In consequently, farmland and houses were covered with flood materials. On the other hand, there were few landslids around the most upper stream area of the Digdig River, so that the river bed was not buried. Around the down stream area, fine material was carried away by the flood, or boulder was trapped in the middle reach, so the land was not buried with sediments (Photos, 12, 13, 14, 15 and 21).

3 The rehabilitation process — some cases of La Union and Nueva Ecija —

The people who lived in the severely damaged settlements had to evacuate and resettle. According to the field survey in March 1993, it has become clear that there are differences in rehabilitation process between the resettlements based on people's own initiative (type A) and the resettlement carried out by the initiative of the government or international organizations (type B).

3.1. 'Type A'

3.1.1. The case of Alaska, La Union

Alaska is located on the delta of the Aringay River. All the houses sank in the main sitio that had more than 90 percent of the houses of Alaska (Fig. 3A) (Photo 1). About a half of the people who had lived there moved to the other sitio which is the only place for them to resettle in this barangay. They built houses there with the materials donated by the Red Cross. The land is possessed by ex-captain of the barangay and his relative, and the resettlers are not claimed to vacate. However, they have neither electricity supply nor water supply. The remainders moved to other barangays. Some of them were called by their acquaintances who had moved from Alaska before the earthquake, asking for the accessibility to highway and the convenience of water (Fig. 7).

3.1.2. The case of Dulao, La Union

Dulao is also located on the delta along the Aringay River. The residential areas are sited on beach ridges. Between these beach ridges, there had been many fish ponds, some of them were destroyed by liquefaction. In some of sitios in this barangay, Hawaii Sitio, Yaris Sitio and Berlin Sitio, most of houses sank (Fig. 3A) (Photos 2 and 3). The people evacuated from these areas to the railway track right after the earthquake, and then most of them moved to new settlement that was developed near Centro Sitio. The barangay captain asked the administrator for "imminent domain" of the land, and asked the Red Cross for housing material. The people who moved into the new settlement built houses by their own (Photo 4). People who came from the same sitio were allotted plots for housing as a group (Fig. 7).

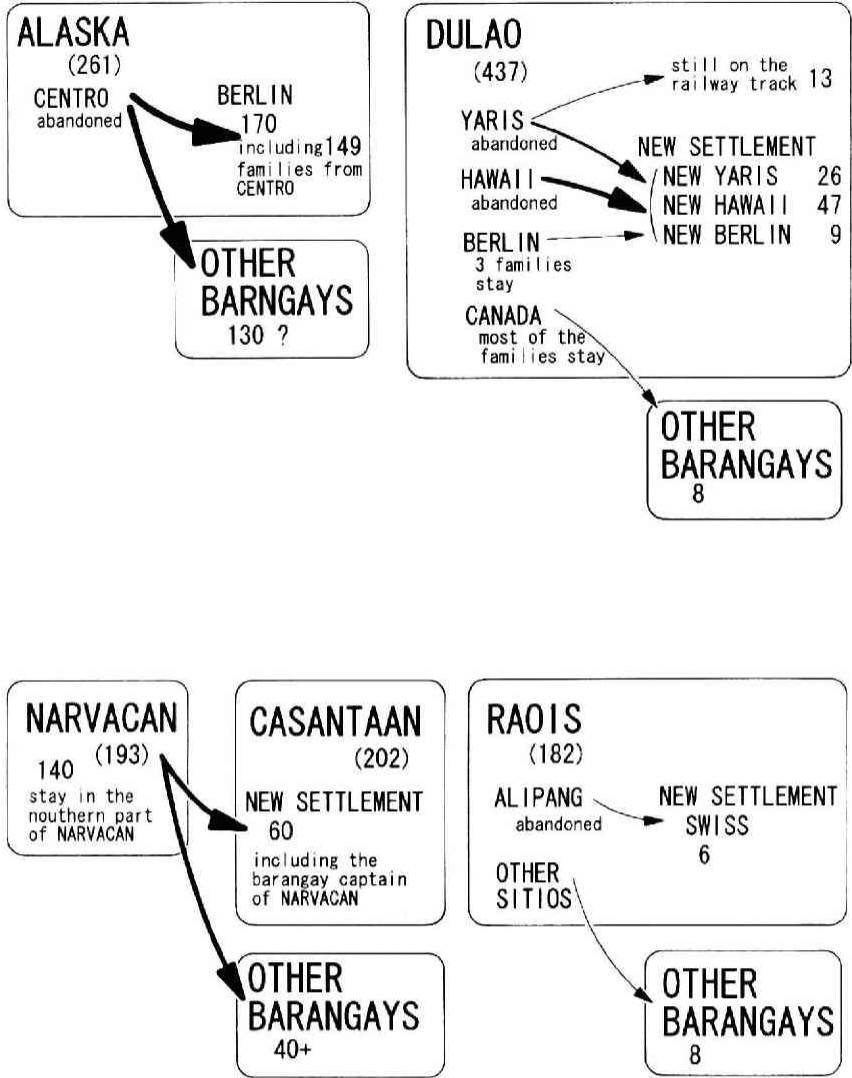
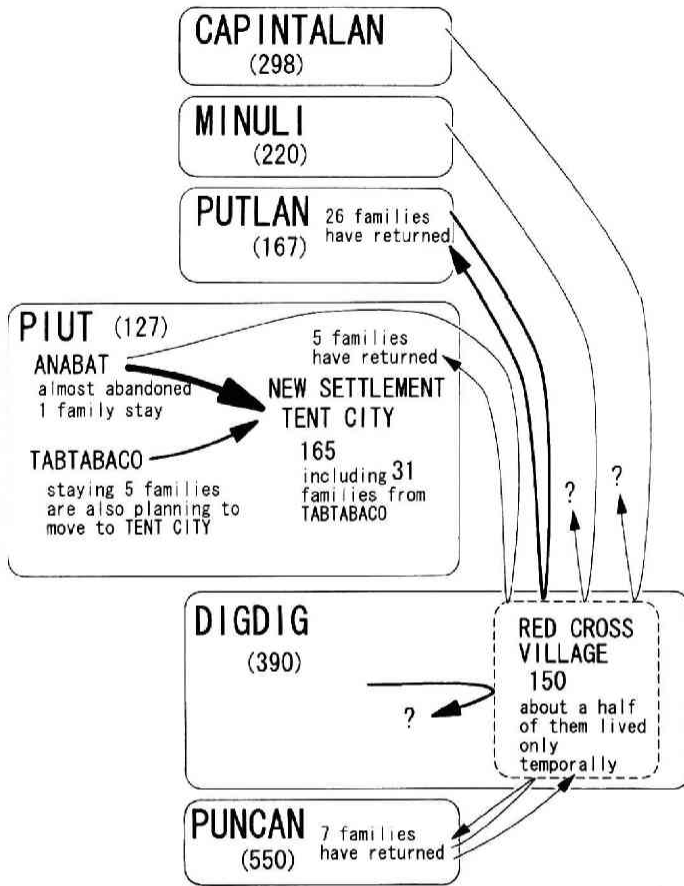
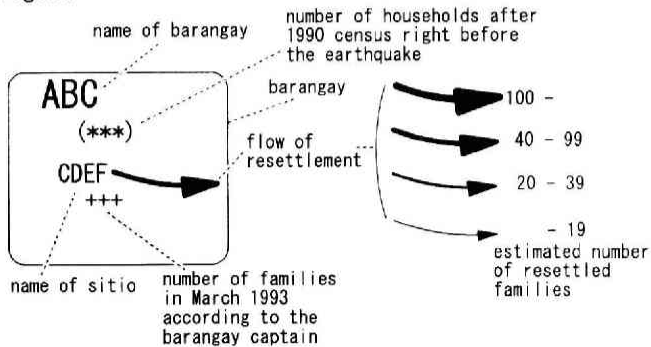


Fig. 7 The resettlement pattern.

It is not clear about the difference of the number of households in 1990 census from that of families according to the captain of each barangay.



Legend



3.1.3. The case of Narvacan, La Union

This barangay is located on the tip of a sand spit. In almost all part of the barangay, ground level sank 1-2 meters due to large liquefaction (Fig. 3C) (Photos 6 and 7). The people were forced to evacuate totally right after the earthquake, and then more than a half of them has returned to the area in the northern part of Narvacan where the land had remained to be resided. Some of the remainders built a new settlement in the southern part of Casantaan Barangay which is located on the shore of the mainland, where the barangay captain lives with 60 families. The rests have settled in the other barangays.

Most of people were supplied housing materials by NGOs, and their lives are economically viable (Photo 9). Fisherman of the village are fishing even after the earthquake³⁾. The people who moved into Casantaan are claimed by the land owner to vacate the place. This means that land problem is one of the keen issues here (Fig. 7).

3.1.4. The case of Piut, Nueva Ecija

At Anabat Sitio that is the main sitio of Piut, some of the houses were affected by the earthquake or landslides. All the remaining houses except one and most of farmlands along the river were washed out or buried on 27 July, eleven days after the earthquake.

People of this sitio moved to the area in the south of Piut, and they built a new settlement called "Tent City" (Fig. 4) (Photos 16 and 17). According to the people, this area is the only place where there were no hazards. As people moved into the Tent City from the other sitio of Piut, the population of the Tent City has increased. People of the Tent City have made plan for new settlement. However, the land is held by the Land Bank, people have to negotiate with the Bank about land use for their housing. There was neither electricity supply nor water supply in the Tent City. DSWD (Department of Social Welfare and Development) or the Red Cross recommends them to move to the Red Cross Village, but they do not want to hear (Fig. 7). The people think that they cannot make livelihoods there.

3.2. 'Type B'

3.2.1. The case of the NHA project area, La Union

NHA (National Housing Authority) develop a new residential area of 1.5 ha for resettlement of Narvacan people. The NHA project area is located on the outer shore of the sand spit to the north of Narvacan (Fig. 3C). The land clearance and infrastructural works completed in January 1993.

However no one lives there in March 1993. This area had been known to people of Narvacan as the place prone to flood, and was really affected by storm in December,

1992 under construction (Photo 8).

3.2.2. The case of the Red Cross Village, Nueva Ecija

The Red Cross Village was developed on the land of DENR (Department of Environment and Natural Resources). The land was granted by the DENR, and the housing materials were donated by the Red Cross. One hundred and fifty houses were built by each settler who came together from affected areas in Carranglan, under the condition that the houses can not be sold to others. There is enough water, electricity supply and even a school in the village. However, there are many houses with only one lady as a house keeper (Photos 19 and 20).

One of the reason people has moved out is accessibility problem. The village is located about 5 km away from the highway (Route 5) where people can sell *sawali*, walling material woven split bamboo strips, to buyers at high price. At the village, people can only sell at lower price. The making and selling of *sawali* is one of the most important cash income source for the people, so people returned to their former settlements which is located alongside the highway (Fig. 4) (Photo 18).

4 Some Remarks

The Luzon earthquake induced several types of damage. The damage varied place to place because of different causes. In the coastal area, the main cause of the damage was liquefaction. Liquefaction occurred in places on the coastal plain in the southern part of La Union Province. Some of them were so large in scale, that they made settlements sunk. These areas that were suffered most are located on the shore or on the reclaimed land. These are formed by young and loose sediments. In the mountain area along the fault, the authors recognize the sequence of several types of damage after the earthquake. Great many landslides triggered by shaking and strong motion itself did damage during the earthquake. In a few months after that, typhoon rains sometimes caused floods. The houses and farmland along the river were washed out or buried by the material supplied abundantly by the landslides.

The affected people were helped by the various kinds of assistance projects by the governmental organizations or NGOs. However, there are some problems in rehabilitation process after the earthquake. The authors have found two types of the resettlement based on people's own initiative (type A) and by the initiative of the governmental organizations or NGOs (type B). There are certain difficulties in each types of the resettlement. The resettlers of 'type A' are economically viable, but land problem is an important issue for them in some cases. There are also problems with regard to the resettlement of 'Type B'. The NIIA project area is vulnerable to flood, and the Red Cross Village has the disadvantage on making livelihood. There are no residents

or fewer settlers than expected in these areas. In both types, people who lived in severely damaged settlements have tendency to find their resettlement place dispersively, with exception of the resettlers of Dulao and Piut almost all of whom have moved to newly built settlement.

Acknowledgment

The authors are deeply indebted to Dr. Punongbayan, Dr. Dindo and Dr. Daligdig of PHIVOLCS and Dr. Nakata of Hiroshima University for their continuous and valuable guide.

Notes

- 1) Most of the damaged buildings were repaired or newly re-built in the central part of Dagupan by March, 1993, but large amount of the tilted houses have not been repaired in the residential area in the south of Dagupan.
- 2) The damage rates of houses are calculated by the following expression.

$$(T + P/2)/H * 100$$

where; T : number of totally damaged houses

P : number of partially damaged houses

H : number of households

- 3) The main occupation of people in Alaska, Dulao and Narvacan was fishing. The people who move out of the settlement do fishing even after the earthquake.

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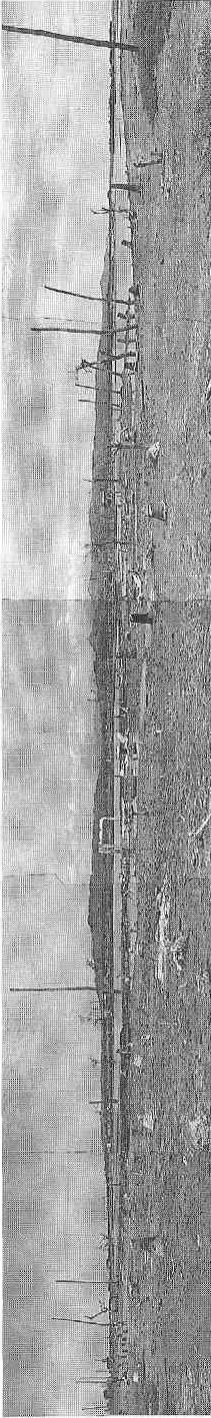


Photo 1 Sitio Centro, abandoned settlement, in Barangay Alaska

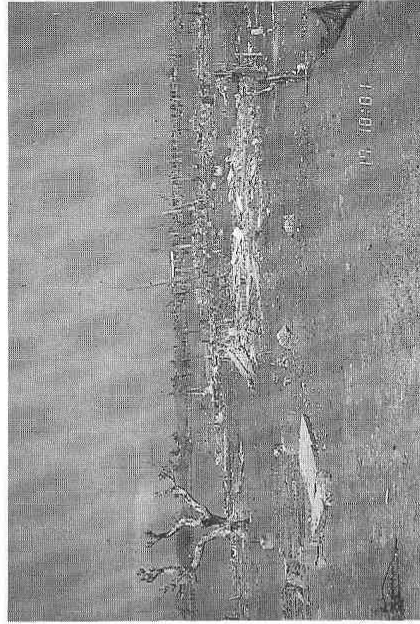


Photo 3 Sitio Hawaii, abandoned settlement, in Barangay Dulao

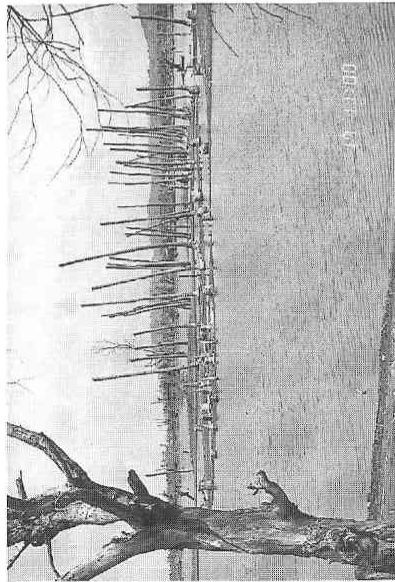


Photo 2 Sitio Yaris, abandoned settlement, in Barangay Dulao

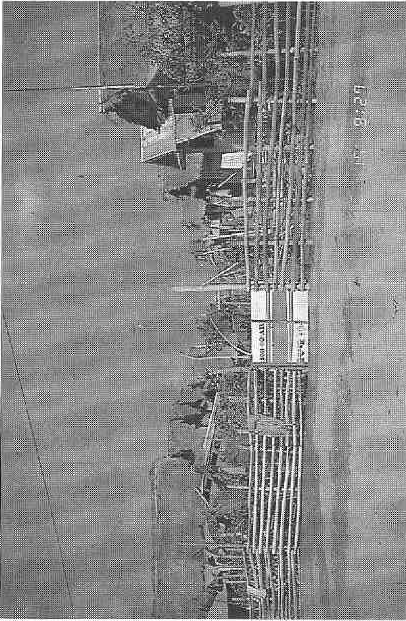


Photo 4 New settlement in Barangay Dulao



Photo 5 Abandoned house in Barangay Raóis

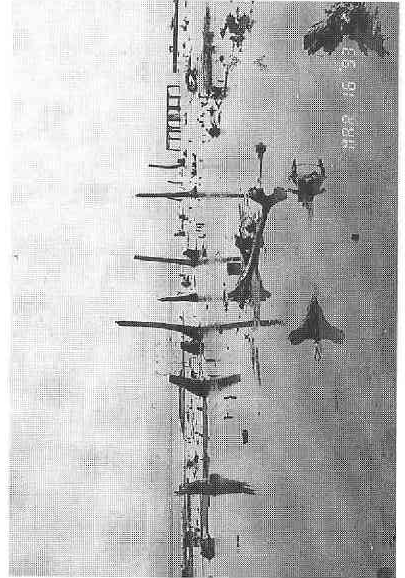


Photo 6 Barangay Narvacan, abandoned settlement

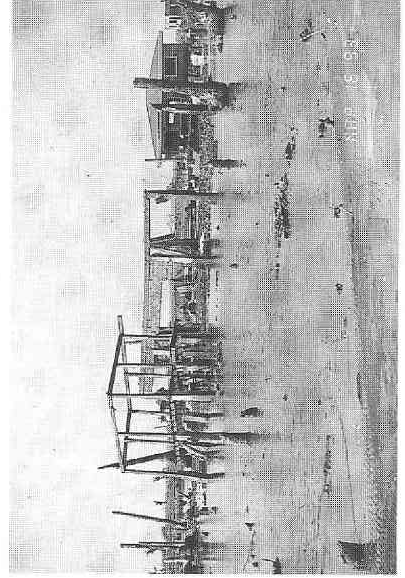


Photo 7 Barangay Narvacan, abandoned settlement

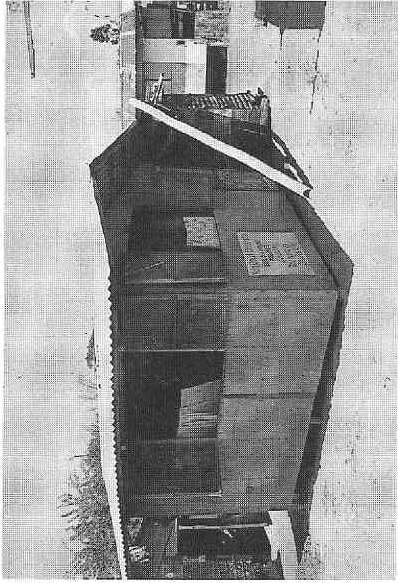


Photo 9 New settlement in Barangay Casantaan, inhabited by the people from Narvacan

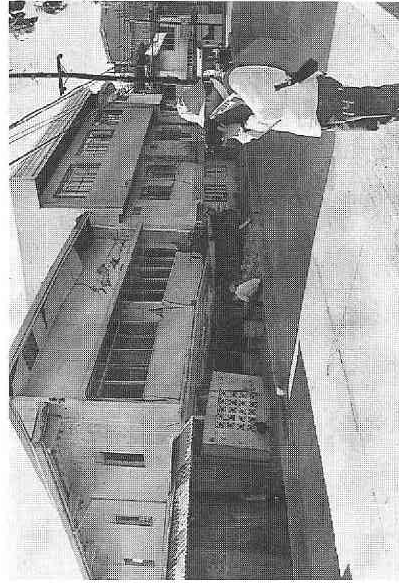


Photo 11 Tilted and subsiding building in Dagupan City

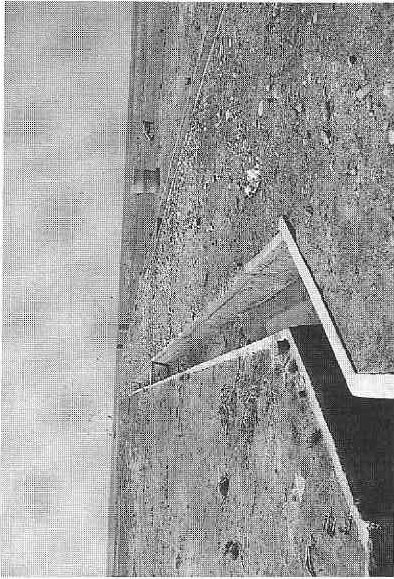


Photo 8 NHA Project Area, to the north of Barangay Narvacan
There are drain and wells, but no houses.

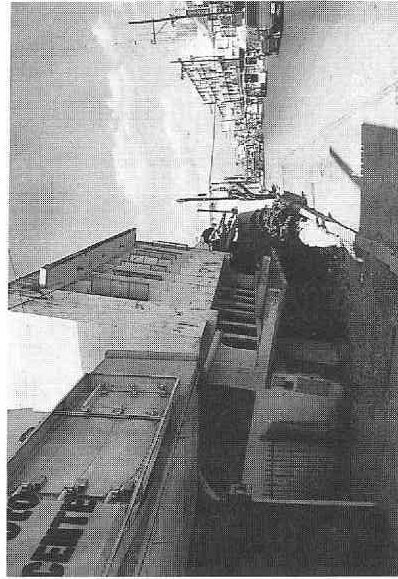


Photo 10 Tilted and subsiding building in Dagupan City

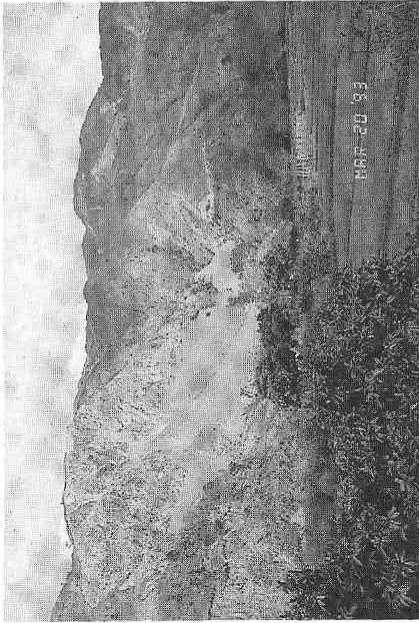


Photo 13 Barangay Capintalan

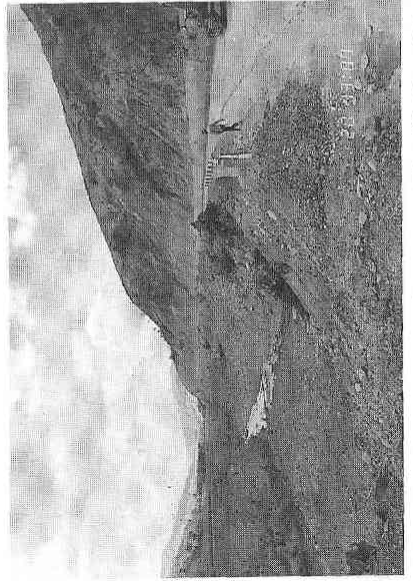


Photo 15 Northren part of Barangay Piut (20 Mar. '93)

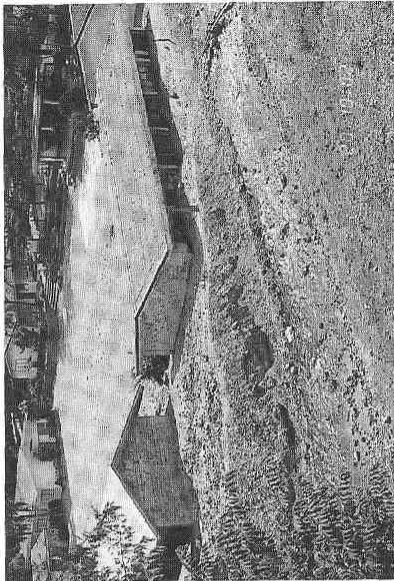


Photo 12 Santa Fe, school building burried by flood deposits

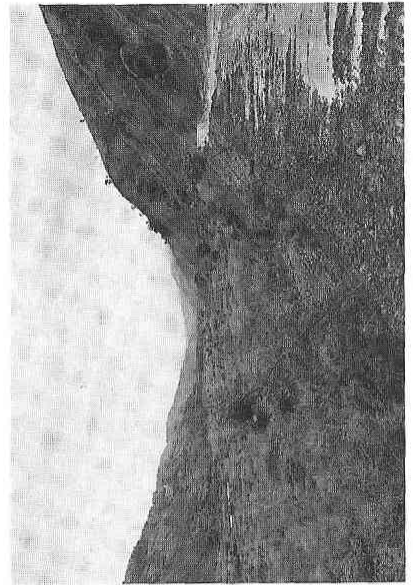


Photo 14 Northren part of Barangay Piut (Aug. '90)

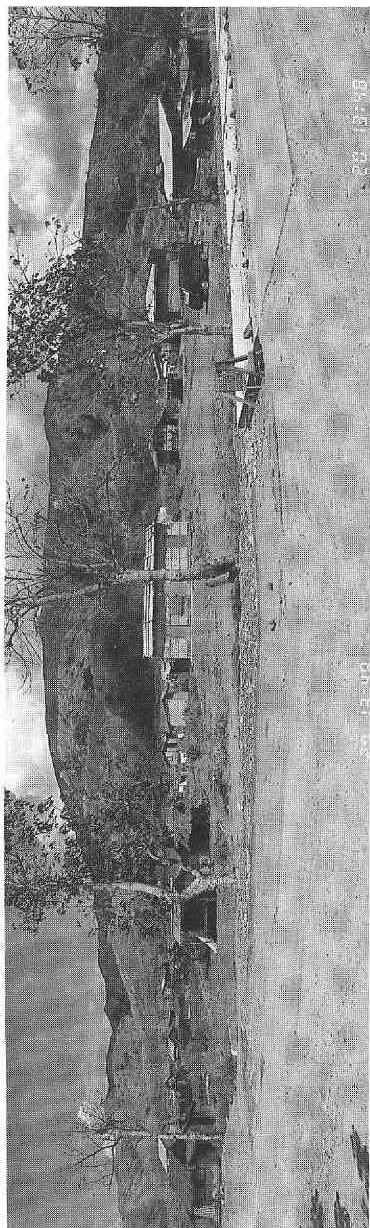


Photo 16 "Tent City" in Barangay Piut



Photo 18 A shed for *sawali* collection

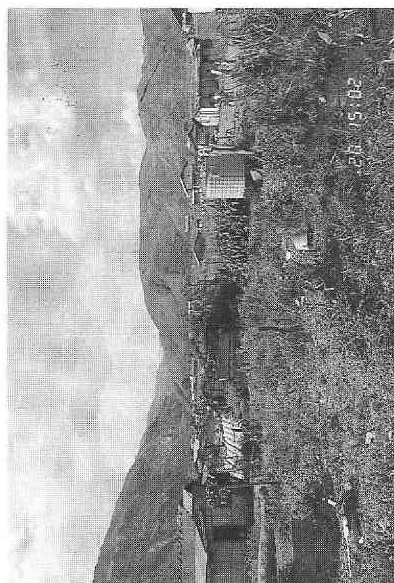


Photo 17 "Tent City" in Barangay Piut

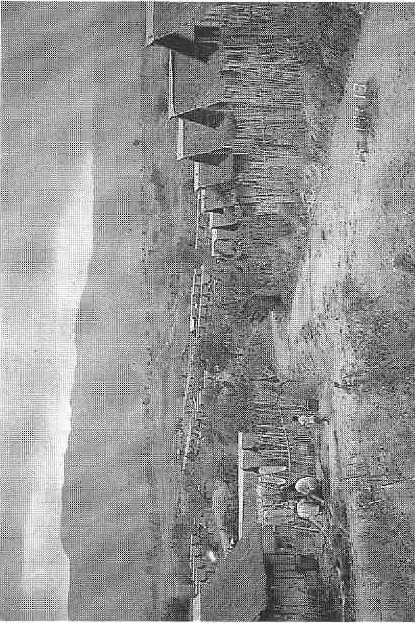


Photo 19 "Red Cross Village" in Barangay Digidig

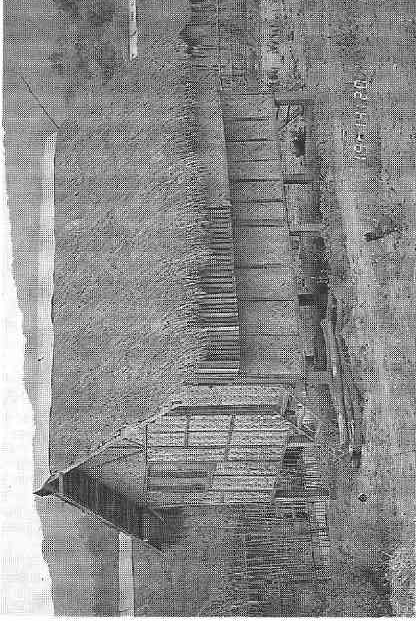


Photo 20 A house of the Red Cross Village

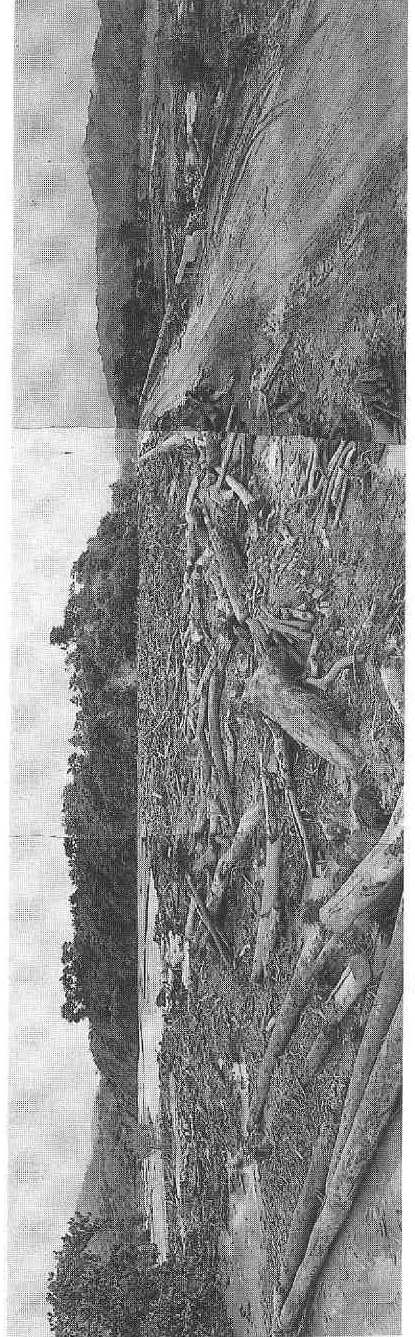


Photo 21 Dammed up by driftwood at Puncan Bridge (Aug. '90)