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Peru's national program for disaster mitigation

J. Kuroiwa & J. Sato
CISMID-FIC, National University of Engineering, Lima, Peru
Y. Kumagai
University of Tsukuba, Japan (Formerly: JICA expert to CISMID)

ABSTRACT: In 1989 the implementation of Peru's National Program for Disaster Prevention and Mitigation -PNPDPM, the main country activity for the IDNDR was started.

The key tool being used is microzonation. The urban expansion areas and the location of civil works are selected taking into consideration the construction cost and hazard degree of different natural disasters: earthquakes, floodings, soil failures, etc.

Microzonation methods and techniques were developed during the 1970s and during the 1980s they were applied to urban and regional planning for disaster mitigation in selected areas.

In 1988 Peru speeded up its process of regionalization. Taking this unique opportunity to get the new regional authorities involved in disaster prevention and mitigation activities, a model case study was started for the new Grau region in 1989.

By applying the developed methods and experience of Grau to Peru's other 11 regions, together with the set of measures being applied nationwide, these two elements for the PNPDPM. RENOM is the 2nd. region to implement the program. Additionally microzonation studies of various cities located in different regions are being conducted. It is expected that very soon the other regions will join the program officially.

1 INTRODUCTION & BACKGROUND

This paper summarizes the progress in the implementation of the Peru National Program for Disaster Prevention and Mitigation -PNPDPM- the country's main activity for the International Decade for Natural Disaster Reduction -IDNDR, 1990-2000.

The key tool being used is microzonation. The area under consideration is studied taking into consideration all disasters menacing that area: i.e. earthquakes, floodings soil failures, etc. For each case the hazard map is prepared. By superimposing all those maps the microzonation map is obtained. The area being studied is divided into sectors of different hazards.

In the built up areas the vulnerability assessment was made in each sector. For the expansion areas we have applied those results in land use planning, assigning the safest sectors for the main urban components such as residential areas of high density and those areas where the economic activities that the community depends on take place; and also in rural areas to optimize the location of civil works.

In this way the construction costs of urban infrastructure, buildings, and civil works are significantly reduced and the safety dramatically increased.

During the 1970s microzonation methods and techniques were developed Kuroiwa et. al (1978), Kuroiwa (1983) and applied to land use planning Kuroiwa et.al (1984), Kuroiwa (1986a). Since 1986 the application was extrapolated for regional development plannig Kuroiwa (1986b), Kuroiwa & Alva (1981).

In 1988 the process of regionalization in Peru was speeded up. i.e. 24 departments occupying 1'250,000 Km^2 began their transformation into 12 regions, of which 11 have already been organized and elected new authorities. See Fig. 1.

One of the main problems had had in the past was the lack of support from the political decision makers for developing and applying new methods and ideas. We thought that the newly elected authorities might be more willing to include disaster prevention and mitigation measures at this stage of organizing and planning the development of their new regions. As we are going to see later, we were right to use this unique opportunity.

The selected case study was the new Grau region, the first to be organized (1988) and the first to elect new authorities (1989) who took chair in January, 1990. This region has high seismicity, and there, the 1983 "El Niño" phenomenon caused the worst damage. In that year Peru's National product decreased by 12.4%. According to the National Institute of Development, half of that loss was caused

by the 1983 "El Niño".

The method being developed and the experience being gained is being used in the planning of some of Peru's other 11 new regions. The plans drawn up for the country's twelve Regions, together with the set of measures to be applied nationwide, form Peru's "National Program for Disaster Prevention and Mitigation". A draft of that program was presented during the IX WCEE, Kuroiwa & Tanahashi (1988), held in Tokyo & Kyoto in 1988.

2 REGION GRAU CASE STUDY A MODEL FOR THE PNPDPM

The new Grau region is the northermost Peru region with 1'900,000 inhabitants and an area of 41,000 Km^2. It is based on the former departments of Piura and Tumbes. See Fig. 2.

The microzonation studies for urban planning needs, usually cover an area of few km^2, whereas the new regions in Peru cover an average of 100,000 Km^2. To solve this problem priority was given to: the important cities and/or those with a high rate of population growth, those with physical safety problems and the location of important civil works.

The studies for the Grau region were started in 1989, a few months before the new authorities took chair in January 1990. In February 1991 a workshop was held in Piura to let the new authorities, regional government officials and the academic & professional world know about the case study, to learn their ideas about how they were going to develop the region and speed up the gathering of data. In June 1991 an international workshop was held in Piura with the participation of wellknown international experts on microzonation and regional development planning to get their input. JICA and the UNCRD -United Nations Center for Regional Development- made this possible, together with the Grau Regional Government, the University of Piura and CISMID, The Japan - Peru Center for Earthquake Engineering Research and Disaster Mitigation, Faculty of Civil Engineering National University of Engineering . The counterpart in Japan is the BRI-MOC. Building Research Institute, Ministry of Construction.

The most frequent and destructive natural disasters which affect the Grau region were studied: earthquakes, tsunamis, "El Niño" phenomena, soil failure (liquefaction, soil expansion, collapsible soils) and landslides. The study results and the progress of the Grau region case study up to July 1991 were sent to the UNCRD, which was supporting that investigation. In that report emphasis was placed on the effects of the 1983 "El Niño " phenomenon which were catastrophic in the Grau region Kuroiwa (1991).

At the time this paper is being written (January-February 1992) 5 of the investigations have been concluded and the others are advancing as expected.

The microzonation studies with the guidelines for land use planning for disaster mitigation of important cities such as Piura, Madrid (1991), Tumbes, Tapia (1991), and Talara, Yamunaque (1991) have been concluded. Those cities also have physical safety problems and are growing very fast. Huancabamba, a town of about 10,000 inhabitants, is sliding down a slope. In this case due to the remoteness of its location and the town's high vulnerability to earthquakes and landslides, land use planning and defense works studies consisting of a canal located in its upper part to intersect the water flow coming from the mountains were included in the investigation, Gonzáles (1991).

The most important and useful result of the microzonation investigation for Piura , Tumbes, Talara and Huancabamba is that their expansion areas for urban uses were clearly defined. The characteristics of these areas are: low seismic waves amplification factor, medium to good soilbearing capacity, elevated with respect to surrounding areas so difficult to be flooded, no soil failure possibility, except for the Talara expansion area in which the existence of collapsible or expansive soil needs to be investigated.

As the cities grow toward the designated areas, the lifelines and buildings construction cost are substantially reduced and the safety dramatically increased with respect to the present built up areas. Table 1 shows the types of disasters that threaten the latter areas: That information has been used for the cities' vulnerability investigation.

Table 1. *Damage possibilities in the investigated cities in the Grau region.*

Location \ Type of disaster	Earthquake	Flooding*	Landslide & erosion*	Soil Liquefaction*	Soil expansion* and/or collapse*
Piura	S	S	L	I	L
Tumbes	S	S	I	I	S.D
Talara	I	S	S.D	S	I
Huancabamba	S	S.D	S	L	L

S=Severe. I=Important. S.D.=Some Damage.
I=Light or nil
*In some sections of the city.

The critical problem of Piura is that the poor people are invading the SE side, the lower part of the city, which was flooded in 1983 and the soilbearing capacity is low. This problem needs to be corrected during the implementation of the land use plan.

Something similar is happening in the lower part of Tumbes, which is flooded after

Figure 1. Peru new political organization. Microzonation studies in progress i.e. Zaña concluded.

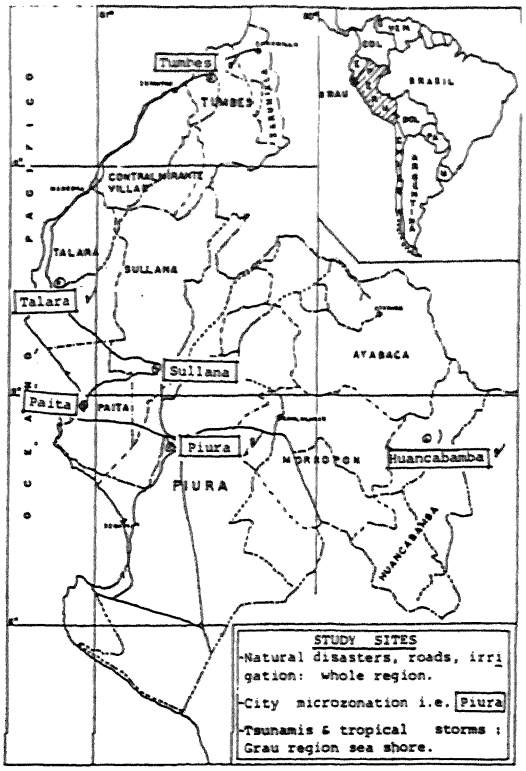

Figure 2. Grau region study case with investigation in progress or concluded.

heavy rain, as well as when the Tumbes river increases its volume over 1500 m^3/sec. In that area the seismic waves undergo great amplification.

These two examples stress the importance not only of conducting studies and getting useful results, but also of securing the participation of the local authorities and the population concerned to ensure that the investigation results will be applied wisely, since the goal is to develop less vulnerable cities.

During the 1983 "El Niño" phenomenon hundreds of thousands of cubic meters of sand coming down from the city's upper part buried part of Talara. In general Grau region is desertic and so Talara, one of the concluded investigations, Vilela (1991), uses the treated sewage water from Talara's upper part that is relatively flat to irrigate the slope between both parts of Talara. The idea is to fix the sand, to help to reduce the pollution of the sea water where the sewage is discharged and to improve the city's microclimate.

Research in progress The microzonation studies of Sullana, the region's second largest city are well advanced. The effects of Tsunamis & tropical storms along the coast of the Grau region continue to be investigated to be used to select the location of beach resort complexes. The destruction of roads by the 1983 "El Niño" phenomenon caused the isolation of extensive areas. The types and causes of damage to the transportation system are being studied as well as how to reduce future losses. The location of future civil works is also being studied using microzonation methods and techniques.

Architecture graduates who have a good background in urban planning are working on the land use planning of Piura & Talara and new participants are being incorporated into the study group to cover other cities. They are being advised by a group of their former professors.

In November 1991, the progress of the Grau region case study was presented to the local authorities, civil engineers, architects and planners invited by the President of the Regional Assembly who is very actively supporting the program. This activity was most rewarding, not only as regards applying the results of the concluded portion, but also for starting new projects, as a number of mayors attended the meeting. Among them, it

is interesting to point out the case of Paita the region's main sea port. Requested by the city mayor, a development-disaster mitigation -environment investigation project is being started by a multidisciplinary graduate students group. This includes the following aspects: microzonation (Civil Engg.), land use planning (architecture), solid waste and sewage treatment, and the later use for agriculture in desertic areas (2 graduate students from Environmental Engg.), Industrial and fishing development (2 from Industrial Engg.), Professors from different UNI departments are advising those students but coordinated by CISMID.

Another request came from Tambogrande - which is planning to exploit a mine very close to the town. Due to their interest a development-disaster mitigation-pollution control project to be conducted by a multidisciplinary team is being planned.

An effort is being made to involve the local universities more: The University of Piura has civil engineering, industrial engineering and social communication sciences as well as a school of education. It also had on its own campus an experimental sewage treatment plant. And the National University of Piura has a good department of Geology.

3 APPLICATION OF THE GRAU EXPERIENCE TO PERU'S OTHER REGIONS

The contents of the JICA Third Country Seminars offered by CISMID during the last few years were selected bearing in mind the - PNPDPM.

The seminars gave emphasis to microzonation and its application to urban and regional development planning for disaster mitigation. It was considered that those topics would be useful to the Latin American participants in the seminars as well. The great majority of the participants were and will be young university professors.

The fruits came very soon. The president of the region Nor Oriental del Marañón (located south of Grau) RENOM, -in short, invited the first author for a lecture and a coordinating meeting. Two former participants at the JICA seminars: the Region's Secretary of Planning and a professor of the University of Cajamarca presented a proposal that a Regional Disaster Mitigation Institute be organized based on existing universities: University of Cajamarca, Pedro Ruíz Gallo - University and The University of Chiclayo.

A three year program 1992-1994 was prepared for the RENOM, taking into account the opinions of all the participants in the coordinating meeting. It is being included - in a Peruvian government proposal to a UNDP/ UNDRO program.

The RENOM experience is to be used in the relation of CISMID with other regions taking into consideration its limited capacity. The strategy is that the implementation of the program in each region is going to depend - mainly on their own efforts, and use will be made of existing facilities.

CISMID will provide advice and training, - through the seminars, symposiums and short - courses, which have been organized with JICA's support since 1986. Priority is being given to participants who are at present in charge of the regional disaster prevention and mitigation projects, or who will be at a future date.

The recommendation is being made to the regions to take the services of former UNI/CISMID students who have developed microzonation /land use planning as their professional thesis.

Another way to provide assistance to regions is by conducting microzonation studies in different cities which are the native towns of National University of Engineering students who are being directly advised by CISMID professors. In this group are included: Huancayo (Andrés Cáceres), Ayacucho and Ica (Libertadores Wari), Arequipa (Arequipa) and Zaña (RENOM). The region's name is in parenthesis.

The microzonation of the city of Ayacucho has been just concluded, Quintanilla (1992). It has a population of over 100,000 inhabitants, is located 400 km. SE from Lima and - about 2800 m. above sea level.

It has two main problems: the fast migration from the rural areas to the city due to social political problems; and the fact - that part of the city is located and is expanding toward an inclined area with easily eroding soils. During the rainy seasons materials are carried from the slope to the inner city burying the drainage canals which need constant maintenance.

The land use planning of Ayacucho has been made by INADUR -National Institute of Urban Development, which in general is not followed. Some comments and corrections have been made to this plan recommending that the city grow toward the southern part where the rock is very shallow, has high bearing capacity, the seismic waves are estimated to have very low amplification and the area high enough not to be filled with material coming down from the city's west side.

It is worthwhile to include some comments on the Zaña microzonation investigation being carried out in the RENOM. The town, at present with about 10,000 inhabitants, has been completely destroyed at least twice since the XVI century. During the southern hemisphere summer of 1578, weeks of downpours of rain - and subsequent flooding razed the town, and two centuries later, an earthquake destroyed it again. This case stresses the importance of studying the effects of past disasters by reviewing historical data, sometimes lost - under an inappropriate title as happened in this case, Williams (1992). The 1578 "El Niño" phenomenon was well documented because the Indians claimed that they could not paid taxes because of the catastrophic effects of

the floodings. A mission was sent to the area to investigate the case and a 500-page report was prepared, Huertas (1991).

The idea is that those studies be used as a direct example of microzonation and land use planning for professors and students of selected specialities of local universities, who will do this type of work in their respective regions.

In addition, the CISMID Geotechnical Laboratory is conducting studies of microtremors and soil investigations in different locations in the country.

4 CONCLUDING REMARKS

Microzonation is proving to be a remarkably useful tool for addressing the direction of the expansion of urban conglomerates and to select the location of major civil works.

According to experience of past disasters caused by earthquakes, flooding, volcanic activities, landslides, etc. the extent of damage and its geographic distribution mainly depend on the soil characteristics, the geology and the topography of the area. By studying these in advance, it is possible to reconcile man and nature, using lessons learnt from past disasters to select the location of urban expansion areas and the location of civil works. In this way the cost of man made constructions are substantially reduced and their physical safety is dramatically increased.

The program first identifies the most frequent and destructive natural disasters that menace each region, and studies them, for inclusion in the microzonation investigation to be made, to select city expansion areas and civil works locations.

This information is also the basis for the regional disaster mitigation data bank, which is very useful not only for a rational and safe social and economic development, but also to prepare educational material to be used in formal courses on disaster prevention and mitigation in schools and for information to the general public through the media.

In February 1992, the president of the University of Trujillo invited the first author for a lecture and coordinating meeting regarding the formal inclusion of courses on disasters in that university. It follows a resolution of the National Assembly of University Presidents, in which they recommended that all Peru's universities include courses on disaster prevention and mitigation and civil defense at two levels: A general course to be taken in all specialties in which the basic knowledge is included; and an advanced part to be included in existing courses, but without increasing the program credit too much. For example in mining engineering, rescue in confined spaces, in structural engineering, safety evaluation of damaged buildings, etc. A book to be used for the education of school teachers in disaster prevention and mitigation is being written in CISMID.

In this way the PNPDPM is being implemented. It has two goals for the end of the IDNDR:

- All constructions to be built in the country need to be protected against natural disasters.
- All Peruvians including those living in the most remote areas need to know what disasters threaten their communities and what they should do to protect themselves and their properties.

Finally, it is clear that the success of the PNPDPM and the accomplishment of those two goals will greatly depend on the effective participation of all of Peru's regions.

So a great effort is being made to involve every region in the program. The Grau case study has enabled us to gain experience in applying microzonation to the planning and implementing of disaster prevention and mitigation measures in a region; and in particular we have learned how to approach the regional and local authorities to persuade them to make the program their own. A publication with the Grau region experience is being concluded at present. It includes results and guidelines as to how each region should develop its own programs using the personnel and resources existing in each region.

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