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I. INTRODUCTION & BACKGROUND

Most human beings do not live and behave in harmony with nature, nor do they learn from past disasters. So nature continues hurting people and people harming the environment and the future perspective is negative due to unprecedented population growth and rapid technological development.

Although the communities working on natural disasters and technological emergencies, and the enviromentalists have the same aim: the wellbeing of the present and future generations, with a safe and healthy environment; and natural resources and an economy that will be able to sustain the increasing population, they rarely work together. This is specially true in developing countries. But there is no reason for such a lack of cooperation.

In general the knowledge remains inside each group, with no adequate communication between them. But what is worse is that simple, useful, practical know how, which is well known to the scientific and technological communities does not reach the Third World countries poors people, who need it most, to protect themselves and their properties.

Developing countries are much more vulnerable than industrialized nations to both natural and technological disasters, and environmental deterioration is also more severe there.

The explosive population growth, specially among the urban poor, makes it impossible to provide them with basic urban facilities and social services. The human settlements and dwellings, for a vast majority of the population, are built so precariously, usually by the people themselves, that the consequences of extreme natural events or major technological accidents may lead into catastrophies.

The rapid population growth also increases the pressure on natural resources and the environment, contributing to their degradation, and this intensifies the impact of disasters.

So, when the UN Environmental Programme -UNEP invited the author to present a paper for Committee Session: Technological and Natural Hazards Interrelationships; of the suggested topics, he selected the integrated approach to natural and technological disasters and their environmental consequences. It was thought that it might be useful to fellow nations to analyse the perspective, limitations, gaps and experience of a developing country that started a multidisciplinary approach to the mitigation of natural disasters 25 years ago; that was also trying to develop a global approach, to include technological disasters and environmental impact, into a general method for disaster prevention and mitigation, to be considered in its development model. It was also felt that it might be useful to industrialized countries, to help them find ways and means to assist poor countries in those matters.

The background to these efforts, and the resources available to try to respond to such a complex and difficult challenge can be described as follows. The initial reflexion was: To integrate both types of disasters, natural and technological, it is first necessary to have a clear idea of how to mitigate the negative impact of each one globally.

Following the catastrophic 1970 Peru earthquake, the author developed microzonation methods and techniques which include all natural hazards threatening the area of interest. Then the area is divided into sectors of different degrees of hazards. The resulting map is very useful for disaster prevention and mitigation planning.

As chief technical adviser -CTA of DHA-Geneva Disaster Mitigation Programs in Colombia (1988-91) and in Peru (1992-95), the author has the opportunity to address technological disasters, since this topic was included in both programs.

Very recently, in October 1993, the UN Centre for Urgent Environmental Assistance (UNCUEA) published comprehensive reports on technological disasters and their environmental impacts (1)* (2) (3). The findings, conclusions and proposals were summarized in a UNEP/UNCUEA publication following a Government Advisory Meeting held in Geneva on 22-24 November 1993 (4). All those publications were made available to the author at the end of February 1994.

In March 1994 a senior industrial consultant to the UNEP Industry and Environmental Office visited Peru for about 10 days for the purpose of preparing a proposal for an Awareness and Preparedness for Emergency at Local Level, APELL, program to be implemented in the country. Gaining direct knowledge of APELL, and discussing the matter with central government and local authorities, and private sector representatives was very informative.

The World Bank is making efforts to introduce into its development projects measures for disaster prevention and mitigation and for reducing environmental degradation. To get input from experts on the topics, the World Bank sponsored two meetings: in 1990 & 1992. The volumes resulting from those meetings (5), (6) contain interesting material on the matters, and were sent to the author in due time.

Figures extracted from a University of Colorado report (7), state that 73.3% of the technological incidents reported from 20 USA states, for the period of 1980 to 1989, were caused by earthquakes, 8.4% by hurricanes and 5.1% by floods. So a very quick review of earthquake damage reports was made. The data on spills, fires and explosions following the 1964 Nigata, Japan earthquake (8) disclosed interesting data, as well as the Loma Prieta 1989 earthquake included in Ref. 7; and the Northrige 1994 earthquake (9).

In general, there is a lack of adequate information on the environmental impact of technological and natural disasters, even in advanced countries. Except for the most publicized and important man-made accidents, such as the Bhopal, India 1984 toxic gas escape, and the Mexico City 1984 liquid petroleum gas explosion, the data are incomplete.

In reports on damage caused by natural extreme events such as earthquakes, in general, there is no specific information on environmental impacts. There is an important job to be done in this respect.

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II. MULTIHAZARD NATURAL DISASTER PREVENTION AND MITIGATION. THE PERUVIAN EXPERIENCE

Field surveys of past earthquakes, floodings, tsunamis, landslides and other natural disasters have clearly shown that the degree of damage and its geographic distribution, largely depend upon the site conditions: soil characteristics, geology and topography. Based on these facts, after the catastrophic Peru 1970 earthquake, which left 67,000 victims, microzonation methods and techniques were developed during the 1970s (10), (11); improved during the 1980s, and updated in the early 1990s (12). Microzonation studies include all potential natural hazards menacing the area of interest. The area is then divided into sectors of different hazards. The safest ones are designated to the most important urban components, such as high density residential zones, and major civil construction projects. To the most hazardous sectors, appropriate uses are given, such as open recreational areas. In this way, physical safety is dramatically increased and in most cases, construction costs are reduced, as development is carried out in harmony with nature and lessons learned from past disasters.

Microzonation was first applied to urban planning for disaster mitigation in the early 1980s (13), (14), (15), and to regional planning in 1986 (16). In 1987 it was applied to the Trifinio regional development planning in Central America (17). The implementation of Peru's National Program for Disaster Prevention and Mitigation -PNPDPM- was started in 1989, with the Grau region model case study. The idea is for the methods developed and the experience gained to be applied in Peru's other eleven regions, and the resulting set of regional methods and techniques will combine to form the PNPDPM. This is the country's main activity for the IDNDR and the key tool being used is microzonation.

Despite space limitations and the need to highlight the environmental impact of NA-TECH disasters, the Peruvian experience on natural disaster mitigation is to be briefly included, for the sake of completeness, since it will be the basis for a NA-TECH-ENV disaster prevention and mitigation proposal. Also to let it be known how with modest international funding, and national efforts, it is possible to obtain practical and useful results.

2.1 Regional Approach to Multihazard Natural Disaster Mitigation Planning

At the time the PNPDPM was being drafted in 1986-88 (20), Peru sped up its process of regionalization. Its territory of 1'250,000 Km² comprising 23 departments was being reorganized into 12 new regions.

It was thought that the new regional authorities would be more prone to accepting new ideas in their regional development planning, as really happen. But there was no such luck with most of the local authorities; only some of them were exceptionally cooperative.

The average size of Peru's new regions is about 100,000 Km², but the microzonation investigation method developed for land use planning of urban areas only covers, in most of the cases, tens of Km². So for the regional development planning the areas to be investigated were prioritized using the following criteria:

- The region's major cities with rapid population growth;
- Those populations with physical safety problems, such as Huancabamba in the Grau region, that is sliding down a slope; and
- The location of important civil works.

The main aim of this project was to try to achieve a planned population growth, avoiding hazardous areas, and those areas where the construction cost may be increased by the soil's low bearing capacity and other factors. This is the problem that most endangers the future development Third World countries' urban conglomerates.

Grau, the country's northernmost region, was studied by CISMID -The Japan Peru Center for Earthquake Engineering Research and Disaster Mitigation, located on the campus of the National University of Engineering, Lima-Peru with the technical and economic assistance of the Japan International Agency -JICA, from 1989 to 1992.

The Southwestern area of Peru, including part of the Mariategui region and the whole Arequipa region is being investigated by a DHA-Geneva/Peru Civil Defense program with Canadian Government funding, during the 1992-1995 period.

There are still 10 more new regions to be covered during the 1994-2000 period. The participation of local universities in each regional program is critical, since they will be the core of the Regional Committees for Disaster Prevention and Mitigation. The presidents of all Peruvian Universities have already received the text of the PNPDPM for their consideration.

The JICA Third Country Seminar trained about 100 Latin American participants and nearly the same number of Peruvians during the five-year period from 1988 to 1992. Emphasis was given to microzonation and its application to urban and regional disaster mitigation planning. Priority was given to young university professors. So trained personnel are avilable for implementing the proposed program.

It is also of critical importance to obtain the effective participation of the local government authorities. Peru's Civil Defense and the Peruvian National Committee for the IDNDR are doing their best to meet these objectives.

2.2 Other Aspects of the PNPDPM

In addition to the critical problem of the disorganized growth of its urban centers, Peru faces two other critical problems, that may be common to Third World earthquake-prone countries. About 50% of the new dwellings are self constructed, not engineered buildings, with no seismic resistance. In the rural areas they use adobe or stone blocks with mud mortar and in urban areas unreinforced masonry buildings. The only way to try to solve this problem is through education, since they can not afford to pay for professional services.

The other problem is the existence of very old constructions weakened by past earthquakes, deteriorated by poor maintenance and built with seismically obsolete techniques in the old sections of the important cities.

A key stone of the PNPDPM is education, as one of the two goals for the year 2000 is that all Peruvians, including those living in the most remote areas should know what hazards threaten their communities and what they sould do to protect themselves and their properties.

II. NATURAL, TECHNOLOGICAL AND ENVIRONMENTAL DISASTERS AND EMERGENCIES

3.1 An Overview

The vigorous industrial expansion and unprecedented population growth of the present century, especially during the last few decades have increased the frequency, magnitude and transcendency of natural, technological and environmental disasters and emergencies. Just to mention one, the ozone layer depletion. (21), (22).

Large volumes of oil and gas are transported using large diameter pipelines crossings mountains, rivers and other geographical features. These very long pipelines are threatened by geological and climatic events such as earthquakes, landslides, floods, erosion, etc. that may cause major oil spills. The size and frequency of oil tankers crossing the oceans have grown rapidly. High winds and large sea waves may cause accidents.

Industrial facilities have mushroomed, specially in the First World countries, emitting large volumes of different types of gases, and producing large volumes of waste, some of them harmful to the environment. Not a few of such installations, manufactured goods storage facilities, transportation and distribution routes are also threatened by extreme natural events, increasing the probability of natural-industrial-environmental accidents.

The population, particularly of Third World large cities, are increasingly occupying marginal areas threatened by extreme natural events. There, the dense human concentration also produces severe water pollution and very serious atmoshperic contamination.

So the media are increasingly reporting disasters with large numbers of victims in developing countries; and huge economic losses, in industrialized nations, due to the added value of the exposed properties. News of environmental disasters is also becoming more frequent. For example, the big oil spill in Alaska due to the accident of a large oil tanker produced a serious local ecological impact. The cleaning of the polluted area, which caused significant wildlife damage, was costly and time-consuming. The Chernobyl radiological accident which contaminated land near the nuclear reactor, as well as the atmoshpere of various Central European countries, caused regional environmental impact.

But there are also on-going processes, which are causing global environmental impacts. These may be long-lasting and irreversible man-made disasters. The earth's atmosphere, the most vital life support, is suffering the onslaught of chemical products. The fragility of the earth's atmoshpere, a mantle of gases, a few kilometers thick where life in the form we know it develops, was dramatically pointed out when the Earth was observed directly by Neil Armstrong from the Moon, in the late 1960s. In the apparently lifeless Solar system of billions of kilometers of diameter, the earth, our home planet is the only place where human beings can live naturally.

Another concern associated with the earth's atmosphere is global warming, but no comment will be included here, because of the aim of the paper, and space contraint. Ref. 21 provides an explanation of greenhouse effects including what would happen to the World and Canada if global warming would to occur.

3.2 Natural Disasters as the Cause of Technological Emergencies and Environmental Deterioration

There are not many data on specific natural disasters causing technological emergencies and/or environmental degradation. Some useful information can be extracted from a report of the University of Colorado (7), Fig. 10 of pag. 26. The percentages of hazardous material release, caused by natural events, in 20 USA states, from 1980 to 1989 were: Earthquakes 73.3%, hurricanes 8.4%, floods 5.1%, lightning 4.8%, winds 4.2%, storms 2.3% and other 1.9% (the last one includes: dam breaks, fire, fog, ice storms, tornadoes and landslides).

Table 3.1 Appendices, Vol. II of Ref. 1, provide the data of substances involved in 75 incidents that occurred in 24 developing countries, of which 39 were related to crude oil or oil products, 13 to ammonia and chlorine and 21 included a variety of products, of which 3 were pesticides.

Although extrapolation is not completely valid, for example for a mountainous country, where numerous landslides may be expected, it does provide a valuable hint for earthquake prone developing countries.

Bearing in mind this information, a quick review was made of earthquake damage reports. The 1964, Niigata, Japan, earthquake report (8) contains valuable information. Niigata is a port, with its industrial facilities including oil refineries, located near Japan's sea shore, built on top of saturated sand, in a flat low-lying area. On June 16, 1964, an earthquake of magnitude 7.5 shook the area. Its epicenter was located about 48 Km. N. from Niigata.

The most important lesson is the series of technological disasters that occurred in oil refineries, industrial facilities, and the spillage of inflammable products which ignited fires. Soil liquefaction, tsunami inundation, the destruction of roads and bridges; and the lack of adequate preparation of the local firefighters further complicated the situation. The 1964 Niigata situation, may well be what could happen in a Third World country at present.

A fire started in an oil tank at the newly erected Niigata Refinery, probably caused by sparks due to collision of the steel floating roof against the tank wall. Four and a half hours after the outbreak of the fire, because of many difficulties, only one fire engine arrived at the scene. By that time the crude oil of the tank was burning, and the fire spread, threatening the nearby residences. The order to evacuate was given.

Half an hour later an explosion occurred and the flames spread all over the premises, forming a second fire front. It progressed into a conflagration and 300 homes were burned down. For almost 3 days (34 hours) the fire progressed unchecked, until reinforcements arrived from the Fifth District Tokyo Fire Department.

The main concern was how to protect the firefighters in such a hostile surroundings and how to overcome their fatigue. The fire ignited at 1:00 p.m. on June 16. The whole team started to fight the fires at 5:00 p.m., June 18, and they lasted until 2:00 p.m. June 20. During the operation some tanks boiled over, gas was expelled and the tank covers blown off. The over flowing crude oil became ignited and the burning oil spread over the flooded surface.

By 10:00 a.m. of June 20, the fire in all the tanks was extinguished, except in the one where the fire had first started, which remained burning for 360 hours until the 30,000 Kl. of crude oil was consumed.

Other minor fires were also brought under control. The lesson from those incidents may be that storing inflammable or combustible chemicals, even in small volumes may be dangerous, in a high seismicity area, if they are not properly secured

Looking for a possible area where the APELL program might be applied in Peru, Mr. Bob Young a consultant to UNEP/IEO and the author visited a location in Callao, the country's main sea port, where are a number of large oil and gas tanks, on top of soft soil that may greatly amplify the seismic waves. The area is threatened by tsunamis and riverine type floodings. Some decades ago, that area was well separated from the urban zone, but at present, it is completely surrounded by population. A large magnitude earthquake, followed by tsunamis, as happened in 1746, when 97% of Callao's population was washed away, may lead into natural-technological-environmental disaster of great proportions. We both agreed that the area needed urgent attention, and was worth studying. The Niigata 1964 experience confirmed this appreciation.

As CTA of the DHA-Geneva Disaster Mitigation Program in Colombia (1988-91), the author advised a tsunami study at Tumaco, a sea port located on the S-W coast of Colombia. Large oil and gasoline tanks are sited on top of soft soil in a low, tsunami inundable area. The population is rapidly approaching the tanks yard. If no remedial measures are taken now, the situation will soon be very similar to that in Callao, at present.

Specialized report (7) contains information provided by emergency responders on technological incidents caused by the 1989 Loma Prieta earthquake. Under the title "Fires and Toxic incidents" the January 17, 1994 Northridge earthquake Ref. 9 reported the technological occurrences. As the author stated, a great deal of the material presented was taken from the Los Angeles Times and the Daily News, so it included only the more publicized cases.

Earthquakes also cause long-lasting environmental consequences. For example, during intense earthquakes in mountainous areas a large number of landslides occur denuding hillsides. Trees and top soil built by nature over hundreds of years, fall down the slope and are lost, as happened in Guatemala during the 1976 earthquake, when more than 1,000 slides, large and small occurred. The Philippine, July 16 earthquake, generated massive landslides which caused major damage to mountain highways and pipelines (23). This is a common feature of earthquakes affecting mountainous areas.

A rare reference of specific environmental deterioration caused by an earthquake was include in the Ref. 24 report.

Ashes and mud flows generated by volcanic eruption may cause severe environmental consequences. For example, the mud flow caused by the El Ruiz volcano eruption in Colombia in 1985 razed the city of Armero, killing 23,000 of its 30,000 inhabitants (15). Armero was ill located, in a deposition area at the mouth of a narrow canyon which drained the N-E side of the volcano, where Arena crater, which erupted, is located. Near the canyon, buildings were completely razed to below the foundation level, and trees uprooted, as if by enormous bulldozers.

A report from the Natural Hazard Center of the University of Colorado (25) provides data on chemical products hazards as a result of flooding. Due to space restriction no comment will be included at this point. Some practical ideas may be extracted from that paper on how to secure containers to avoid spills and prevent the containers from being floated and washed away.

Many technological emergencies occur due to equipment failures, human error, vandalism or natural events with environmental consequences. The most common one is the rupture of oil pipelines. Just at the time this paper was being prepared, April 12, 1994, erosion at the Marañon river bottom in N-E Peru, broke a large oil pipeline. It was quickly controlled, but a certain amount of oil was released into

the river. In Colombia during the last few years, oil pipelines have been intentionally blown up many times, with different degrees of environmental consequences. In rural areas, the most frequent toxic incidents are caused by pesticides.

IV. PERU'S NATIONAL PROGRAM FOR NATURAL, TECHNOLOGICAL AND ECOLOGICAL DISASTER PREVENTION AND MITIGATION FOR THE PERIOD 1995-2000

Peru's National program for Disaster Prevention and Mitigation was started in 1989 as the country's main activity for the IDNDR, but it only includes natural disasters. Its advancement has been already reported (18), (19). The last report also contains the draft of a program which it was intended to implement during 1994-2000.

But the invitation to participate in the Yokohama Conference gave the author the opportunity to study technological hazards and their environmental consequences, as well as reviewing papers on natural disasters. It was thought, that in addition to preparing a paper, converting those results into action, may be a practical way of responding to UNEP/UNCUEA efforts, to mitigate the environmental consequences of NA-TECH disasters. So the original PNPDPM for the period of 1994-2000 is to be enlarged and modified, to include technological disasters; and coordination is to be made, with environmentalists, who are very active in Peru, at present. This may enable us to have a natural-technological-environmental (NA-TECH-ENV) program. The technological disasters investigation excludes oil spills in the ocean, and radiological emergencies, and only considers accidents that might happen in developing countries and it may lead to useful conclusions. It may result in a unique, almost fully integrated, multihazard disaster prevention and mitigation program for a developing country, that could be useful to other Third World nations.

So the original objectives of the PNPDPM, to be reached by the year 2000, needed some ajustments. They are at present:

- All constructions to be built in the country, need to be protected against natural and technological hazards and from environmental degradation caused by man's activities.
- All Peruvians, including those living in the most remote areas, should know what natural and technological hazards threaten their community and what they should do to protect themselves and their properties. They also need to be aware that in order to achieve sustainable development, natural resources need to be protected and wisely used.

Education is a key tool to meet those objectives.

4.1 Regional Approach

As in the original program, a regional approach is to be used. The program is underway in two regions, so investigation on technological disasters is to be added, including the identification of locations where these are most likely to occur, and the collecting of data on past disasters and their environmental consequences. The findings will be feedback into the program.

4.1.1 Program for Peru's Remaining 10 Regions

The PNPDPM for each one of the remaining 10 regions is to be implemented according to the following methodology:

- Identify the most frequent and destructive natural events, and study their possible effect in the region.
- Give priority to the urban centers to be studied according to the already stated criteria, and prepare their microzonation map, including all natural hazards threating the area.
- Identify which of those cities have important industrial areas, port facilities, or zones where technological emergencies are likely to occur. Prepare technological microzonation map.
- Superimpose both maps to obtain NA-TECH microzonation map.
- Promote the participation of the local authorities and effect to be applied in city land-use planning for disaster mitigation.
- Make risk assessment of natural and technological events, and develop disaster scenarios.
- Prepare emergency plans, disseminate them, and perform evacuation drill and/or on desk disaster simulation exercises.
- See to the careful preparation of educational material, specially fitted for the region, which includes the most frequent and destructive natural disasters, the location and type of technological emergencies that may occur and simple and practical measures for disaster prevention and mitigation.
- Develop training and educational activities for areas surrounding those where technological accidents may happen; organize APELL type programs.
- Systematically collect data relating to natural, technological and environmental disasters and emergencies and organize a regional data bank. This information is to be added to the Peru's National Data Bank for Disaster Prevention and Mitigation an on-going DHA-Geneva program. However some addition is to be made to clearly indicate environmental consequences of NA-TECH disasters and emergencies.
- Promote the participation of regional organizations working in environmental protection, and ask them to be involved in damage survey teams after the occurrence of natural and/or technological disasters.
- Participate in the PNPDPM's national level activities.

4.2 Strategy for the Success of the Regional Approach

For the success of the program at the regional level, there are two key points to consider:

- Involve the most capable people, interested in serving their communities and their region, with strong commitment to reach the objectives.
- The availability of funds for implementing the programs will be very limited.

The participation of local universities in the program is critical. University professors and top students, to start their professional thesis, meet these requirements. In addition, the various specialities which are taught there, permit a multidisciplinary approach, very necessary in this case. Some universities are well-equipped, and generally have good experience in organizing courses and seminars. This strategy has been successfully applied by the author since 1970, following the catastrophic Ancash, Peru earthquake of May 31st. of that year.

An aspect which needs to be improved is the participation of the local authorities. Under Peruvian law, the mayor is the Head of Civil Defense for his town or village. The Head of Peru's National Institute of Civil Defense, who is at the same time Chairman of Peru's National Committee for the IDNDR is

starting to take strong measures in an effort to overcome this problem. The participation of the educational authorities, school teachers and students is very important, since education is a key tool to effective results in the regional programs.

4.3 Activities at the National Level

At this point the reader may be aware that PNPDPM gives priority to ordering urban center expansion so as to occupy the least hazardous sectors around the cities. But there are other critical problem as well already mentioned in 2.2. Some non seismic resistant constructions are schools and hospitals, so urgent solutions are needed.

4.3.1 Educational Programs

The overall objectives of IDNDR can not be fulfilled in any country, without a good educational program for disaster prevention and mitigation, and its systematic and constant implementation. There are many examples in which life or death depended on an elementary knowledge of the hazard facing the community, and what the victims should have done to save their lives. Dramatic examples show us how important education is in disaster prevention and mitigation activities. They teach us what strategy should be used, what the content of the educational programs could be, and how to implement them in the most effective way.

The aim of the educational program is not only to save lives by preparing emergency plans, publicizing them and conducting drills; but also, where to locate the constructions and how they should be protected from the hazards that menace them, in such a way as to reduce the material losses that may disrupt the social and economic activities for a long time.

a) Formal Education for Disaster Prevention and Mitigation

It is generally thought that knowledge lasts for a long time, if it is well learnt in the early stage of a person's life. On the other hand, in developing countries with economical problems like Peru, there is a high percentage of drop outs at the end of the elementary and the beginning of secondary school education. So if disaster prevention and mitigation knowledge is to be provided to the great majority of the country's population, emphasis must be placed on educating students to face disaster in the primary level.

However there are some basic problems to be solved: what strategy can we apply to meet the objectives; what vehicle can we use to reach those students; what educational material is to be used, bearing in mind that the content is very important and should include information on local hazards; and how should all this knowledge feedback to the community.

The obvious vehicles are the school teachers who work in every corner of the country, but they will need special training during their university studies. For disaster prevention and education at university level, Peru's National Assembly of University Presidents, in response to a request from Peru's Civil Defense, recommended to all Peruvian universities to include courses on disaster prevention and mitigation and civil defense in their official programs. This needs to be implemented during the 1994-2000 period.

b) Educating the General Public and Peru's National Day for Education and Reflexion on Natural Disasters

For educating the general public, the planned participation of the media is very important: newspapers, magazines, TV, and radio, taking into consideration two main aspects: the contents of the material to be publicized, and the timing.

May 31st, anniversary of the Ancash, Peru, 1970 disastrous earthquake, has been declared by the Ministry of Education "The National Day for Education and Reflexion on Natural Disasters". The academic year in Peru goes from April to December. So two months, April and May, a very active educational programs have been scheduled. The media transmit material addressed to the general public and to students. The latter pick up the information under the guidance of their teacher. During these two months they also collect local information on disasters from the field and old publications and oral tradition. These data are to be included in the school education program as well as in a panel-news system. This annual campaign concludes on May 31st with a ceremony in every educational institution in which progress is reported and the importance of disaster education is stressed.

c) Contents of the Educational Material

It is very important to select relevant educational material to be used at different levels in the formal program or for the general public; and the geographic locations where it is to be applied. According to these principles a special publication was prepared (26) to train 300 school teachers who attended a workshop-seminar organized by Peru's Ministry of Education in December 1993. Once back in their schools all over the country, they, in turn, are training 30,000 teachers. The publication emphasizes the most frequent and destructive natural disasters occurring in Peru. Maybe the most relevant material is how to increase the resistance of unreinforced masonry, weak adobe, stone and mud plaster constructions, built by the poorest people by themselves, and where to locate them to reduce hazards.

Since the PNPDPM is being ajusted to include technological emergencies and environmental protection, as key actions for sustainable development, these materials are to be added. At this point the author would like to request advice and written materials to reach that objective.

4.3.2 Retrofitting Weak Buildings

This is not a structural engineers meeting, so only a short comment follows. To increase the seismic resistance of old adobe constructions, a shaking test was successfully carried out at the CISMID Structure Laboratory. It is known that a continuous collar beam at lintel level is the most effective element to strengthen adobe buildings with light and flexible roofs. Instead of using an incorporated reinforced concrete collar beam which is costly and difficult to build in, two pieces of wood put on top of the adobe walls fixed with steel bolts were used in several models, that were tested dynamically at 1:6 scale. This solution, which is very cheap and easy to assemble provided the same results as the use of the incorporated reinforced concrete beam (27). This very promising solution needs to be tested at full scale, especially to solve some connection details at the wall corners. The solution may be useful in all Third World earthquake prone countries. It is proposed to be a regional research topic.

These have developed alternative prefabricated construction methods using light, low-cost materials adequate for self-made dwellings and post-disaster reconstruction programs (28). Also methods for retrofitting masonry and reinforced concrete buildings have been developed, that may be useful to

strengthen schools and hospitals. The method had been applied to nearly 3,000 brick masonry dwellings and more than 150 reinforced concrete buildings (29).

V. SUSTAINABLE DEVELOPMENT

The principle of sustainable development may be the best way for the human being to live in harmony with nature. The economic development of all nations can only be sustained if natural resources are managed and protected wisely. Unfortunately man's activities both in industrialized nations and developing countries are degrading the environment.
One of the clearest examples of how degrading nature reduces land productivity and intensifies disasters is what is happening in Haiti, the poorest country of the Western hemispehre. It is a contradiction that Haiti, bathed by tropical rainfall suffers from drought. The people first deforested the rain forest. Then overgrazing exposed the topsoil to erosion. The naked hillsides have no capacity to retain rain water, causing flooding during intense rain, and no benefit to crops.

As in other developing country, after the UNCED 1992 conference there is great concern in Peru at present about the negative impact of many activities on the environment, on the part of the decision-making level, the media and educated public.

For example, under the title "It is a good business" the magazine Environment in its edition 58 of February 1994, reported that Peru's National Confederation of Private Enterprises, CONFIEP for short in Spanish, whose members are organizations such as the National Society of Industries, the National Society of Minig, the National Society of Fishery, etc., has taken up the challenge to manage the country's sustainable development. For this purpose CONFIEP has organized its Committee for Sustainable Development -CODESU from its initials in Spanish, to promote the concept of sustainable development among its members, the government and the general public and put it into practice.

There are many other public, academies and NGOs working on the topic, so it is not necessary for there to be any more; however it is wise to coordinate with them, especially with CONFIEP-CODESU, everything concerning the environmental impact of natural and technological disasters; and from that level give impulse to implementation of the APELL program in the country.

VI. CONCLUDING REMARKS

For man's wellbeing, it is necessary for him to live in harmony with nature, learning from lessons left by past natural disasters, and not harming the environment with his activities. The best way to achieve that goal, may be by putting into practice the concept of sustainable development.

6.1 Past disasters have clearly shown that devastating natural disasters occur mainly because:

- People build their homes and other facilities in hazardous areas such as: high earthquake intensity zones due to poor soil conditions, flood plains, areas threatened by landslides, mud flows, etc.
- The structures' strength is not sufficient to withstand the forces that will acts upon them during their useful lifetime.
- Old constructions, built with obsolete techniques and weakened by past events, continue to be used.

The knowledge to solve these problems is well known in the scientific and technical communities, but is does not reach the whom need it most, the poor people of developing countries.

6.2 The unprecedented population growth and the rapid technological development have converged negatively. The needs of more than 5 billion people are so great that nature is being overexploited and degraded, due to poor techniques used in some places; and industry offers a vast quantity of manufactured goods for their use, some of which are environmentally harmful products and by-products. Maybe the most harmful effects are being caused by the unnatural emission of CFCs into the atmosphere which is causing ozone depletion.

Unfortunately most people do not know what to do to reverse this negative trend.

6.3 The concept of sustainable development is not well understood by many people, especially by the vast majority of the Third World countries' inhabitants. So they degrade nature, reducing the continuous and balanced provision of natural resources for their needs.

Education maybe the priority action to be taken during the IDNDR remnant period. A new approach is needed so that knowledge and strategies for the prevention and mitigation natural, technological, and environmental disasters; and practical, useful ways of implementing them, may become a part of the population basic knowledge; and the people can thus put these principles into practice in their daily routine lives. How far away is this goal? ... It depend on each one of us.

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