Standing up to natural disasters

UNESCO contributions to the International Decade for Natural Disaster Reduction

Front cover
Dated 1856, this Japanese print from an old manuscript conveys all the confusion and distress caused by rainstorms and flooding.
© Meteorological Agency of Japan.
Courtesy of the Marine and Fire Insurance Association of Japan.

Back cover
A child's eye view of a volcanic eruption, painted by 14-year old Elena Boku of the Soviet Union.
Courtesy of the International Museum of Children's Art, Oslo, Norway.

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1990-2000

A storm is brewing . . . what will its cost be?
Windstorm-related events like this tornado cause an average of 30,000 deaths and $2.3 billion in damage worldwide each year.

Introduction

The torrential rains, 6-metre high waves and 200 kph winds that slammed across Bangladesh during a cyclone in May, 1991 were a dramatic reminder of nature's violent forces and the havoc they can wreak. More than 200,000 people lost their lives, and as many as 10 million were left homeless. Although this was the worst storm to batter her seacoast in twenty years, Bangladesh is no stranger to such calamities. Nor is most of the world, once the combined effects of flood, famine, earthquakes and hurricanes are tallied each year.

Weather watchers estimate that our planet experiences countless beatings throughout the year: 100,000 thunderstorms; 10,000 floods; thousands of earthquakes, wildfires, landslides, avalanches and tornados; and hundreds of volcanic eruptions, tropical cyclones, incidents of drought and locust infestations. Only the most dramatic of these make international headlines, but all cause damage to life and property.

Over the past two decades, natural disasters have claimed some 3 million lives and made more than a billion people homeless or sick: 90% of the victims came from developing countries. It may seem from these figures as if the number and frequency of violent events were increasing. However, a more likely explanation is that the world has simply grown more vulnerable to natural disasters. Especially in developing countries, the very density of population in afflicted areas — where increasing urbanization is often exacerbated by weak physical infrastructure and the effects of environmental change — may be the root of the problem. The vulnerability is certainly highlighted when one sees how easily communications systems can become paralysed, how safe-building codes and security measures can be disregarded, how inadequate the public information and education programmes tend to be, and how tenuous are the emergency plans designed to ensure survival once disaster has struck.

A global effort: the IDNDR

Believing that fatalism about natural disasters is no longer justified, and recognizing the need for a concerted global effort to reduce the impact of nature's violent forces on society, the United Nations General Assembly has declared the 1990s as the International Decade for Natural Disaster Reduction (IDNDR). In the words of Javier Pérez de Cuéllar, Secretary-General of the United Nations:

"The Decade offers an opportunity for the United Nations to demonstrate its catalytic ability to bring together the diversity of skills, resources and groups needed to stem the losses from natural disasters... It has the moral authority to call for disaster reduction efforts by all nations, including the developing ones where the toll from such disasters is most tragic in terms of human losses and economic set-backs. Further, the United Nations system has in place many programmes that promote various aspects of disaster reduction and through greater coordination and enhanced visibility, can accomplish more in the years ahead."

Within the United Nations family, each agency fulfils a specialized mission: health and hygiene, meteorology and operational hydrology, food and agriculture, disaster relief, refugees, technical cooperation, the environment — to name but a few. And each, in its own domain, will play a part in the IDNDR. UNESCO's role as the United Nations Educational, Scientific and Cultural Organization, is a broad one, covering every area in which the mobilization of intellectual resources and cooperation can open the way to peace and well-being for humankind. Activities leading to the prevention and mitigation of natural disasters — and the attendant disruption they cause to social, economic and cultural life — have been a concern of the Organization for many years.

UNESCO's role: planning, prevention and research

In this booklet we present a sampling of UNESCO projects that contribute to the IDNDR. Many of them can trace their origins to goals set by the Organization as long as thirty years ago. In 1960 the UN Economic and Social Council (ECOSOC) asked that UNESCO begin a comprehensive study of ways and means to reduce earthquake damage.

This was soon followed by the request that UNESCO undertake "seismological survey missions" to review the state of seismology and earthquake engineering in the various seismic regions of the world. In 1968 this mandate was broadened to include the scientific study of other natural hazards and by the following year activities related to tsunamis, volcanic eruptions, landslides and river floods were being implemented. It was in 1980 – after twenty years' experience in the field – that the study of natural hazards was fully integrated into Science Sector programmes at UNESCO, with responsibility for promoting research on the cause and effect of the hazards.

The launching of the International Decade has merely served to re-focus attention on these UNESCO programmes, and on their importance for reducing the vulnerability of society to natural hazards and risks.

Readers will note the great reliance on progress in science and technology, and on integrated approaches to solving environmental problems. UNESCO, especially through its intergovernmental science programmes, has long been at the forefront of promoting research and understanding of the basic processes regulating events on our planet: water cycles, soil-vegetation interactions, geological and geophysical phenomena, climate change. Application of this knowledge could result in immediate reductions in human suffering and losses.

This is not so easily accomplished, however. Planners must have access to reliable scientific information. Then they need the political will and resources to implement preparedness measures. Construction designs that are both affordable and disaster-resistant must be scrupulously followed. This requires the presence of people trained in construction techniques and the monitoring of safety standards. Finally, even the best early-warning systems in the world cannot protect a population that fails to hear the warning or has no means of reaching shelter before the storms breaks.

This booklet reveals the great variety of UNESCO programmes and initiatives that are serving the Decade's objectives. Hydrological models, for instance, can help anticipate the timing and volume of floods; understanding of plate tectonics or the mapping of earthquake fault lines can help planners to identify high-risk areas; by correlating numbers of casualties with specific forms of construction and failure mechanisms, architects and engineers can address the problem of building codes and hazard-resistant design; technical assistance on pilot projects can serve to demonstrate the benefits of selecting safe sites for the construction of community facilities such as schools, and the importance of training others in prevention strategies and maintenance techniques. The preparation of information materials, teaching manuals and how-to guides can help in the task of disseminating useful information to as wide an audience as possible. Broadcasting, satellite transmission systems, news agencies and the daily newspaper also have a role to play.

The communication of ideas and information is an integral part of everything UNESCO does. Activities for disaster prevention and mitigation are no exception, for they are also based on programmes of shared knowledge and the shared pursuit of knowledge. The Organization believes that all nations can contribute to and benefit from the common pool of experience. Whether the project is considered an educational, scientific, or cultural endeavour, it is the desire to promote the common good that links them together.

Science and technology at the service of humankind

The "S" in UNESCO: a major role from the beginning

The appointment of Sir Julian Huxley as UNESCO's first Director-General assured that science and technology activities would play an important role in UNESCO. He was himself a distinguished biologist, and an accomplished popularizer of science. In 1946 he wrote: "The application of scientific knowledge provides our chief means for raising the level of human welfare."

As the world was just recovering from an enormously destructive war, the founders of UNESCO also believed that another such catastrophe could be averted through the spread of knowledge and through international cooperation. UNESCO's Constitution noted that the Organization had been established "for the purpose of advancing, through educational, scientific and cultural relations of the people of the world, the objectives of international peace and the the common welfare of mankind for which the United Nations was established. . ." Obviously, science was an ideal medium through which to encourage cooperation for peaceful ends.

Almost since the beginning, then, UNESCO science programmes have sought an understanding of the physical nature and causes of hazardous phenomena. Part of this was a quest for knowledge for it own sake. Another part, however, was the desire to put science at the service of mankind by our ability to predict — and thus avoid — disasters of natural origins.

Change is an integral part of all natural systems — geosphere, hydrosphere, atmosphere, and life itself. A change in any one of these will result in adjustments in some, or in all, of the others as energy is transformed or expended. Some of these processes are so gradual as to be imperceptible, except to trained observers, through short periods of time. But when these occurrences take place in sudden, violent events — such as volcanic eruptions, earthquakes, avalanches, tsunamis (seismic sea *waves) or floods — they may have a cataclysmic impact on the environment and human beings.*

In the past, populations were entirely at the mercy of nature's fury. The only weapons against nature in revolt were flight, passive suffering, and perhaps the offering of sacrifices to pacify the unknown forces. Today, however, the application of science and technology can liberate mankind from the absolute powerlessness that our forefathers felt.

We will see in the following chapters how the application of hazard-resistant construction and reinforcement techniques combined with careful maintenance can make buildings and monuments safe from earthquakes and typhoons. In the case of Venice, we will also see how modern engineering in the form of giant, mobile sluice gates may provide a partial answer to flooding from high tides.

Risk assessment: a risky business

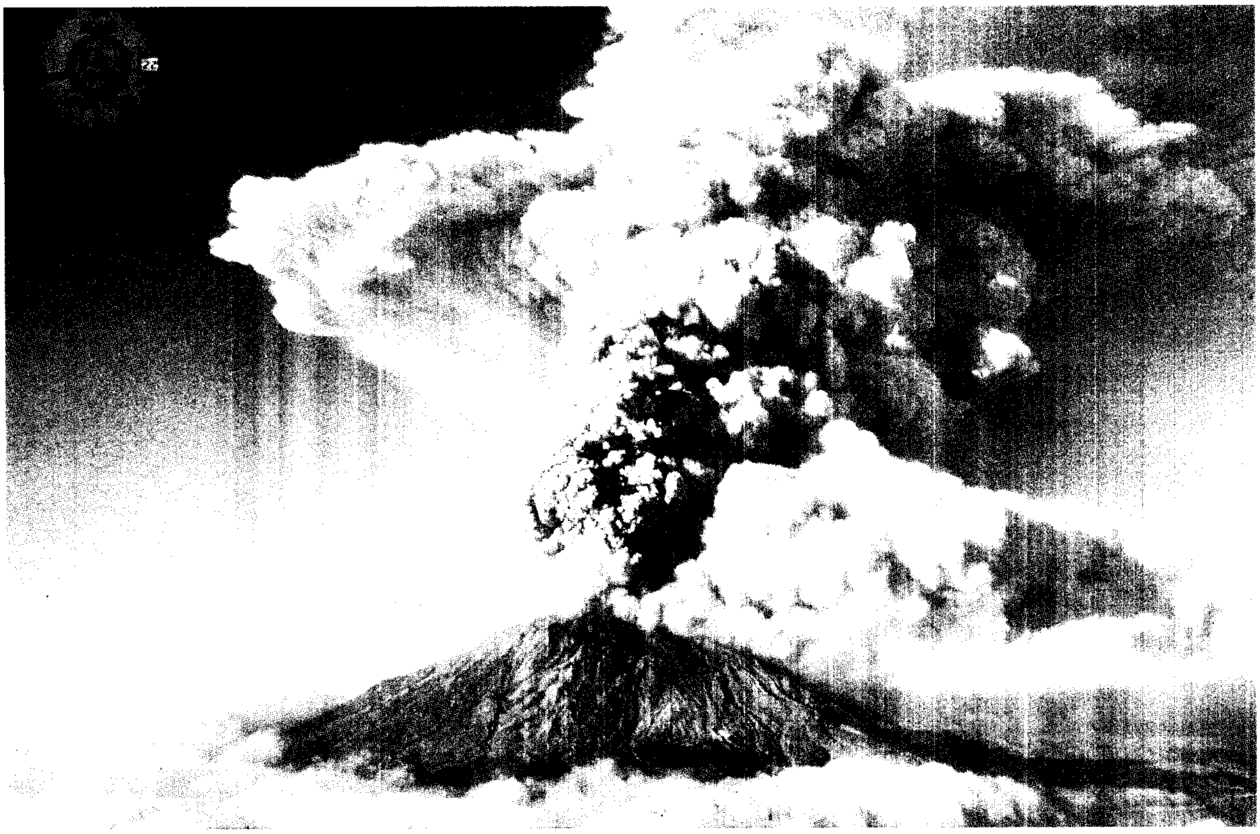
In trying to assess various disaster risks, both the planners and the practitioners of science have a whole panoply of tools at their disposal. Depending on the hazard, they may use historical records, portable instruments and gauges for on-site observation, laser guns, radioactive dating, aerial photography, remote sensing by satellite, mathematical modeling, computer simulations — or a combination of these.

Despite many uncertainties, their aim is to determine the vulnerability of specific areas and structures in relation to the likelihood, frequency or extent of the potential hazardous event. Based on this information, the civil authorities must decide what response they should make.

The threshold of acceptability of risk will vary from country to country and depends on a great number of factors: probable intensity of the event, whether or not people have confidence in the scientists' opinion and their monitoring equipment, the level of development of the country concerned, and the size of the endangered area's population and industry. Decision-makers may accept that the benefits of running a risk — namely continuity of socio-economic activity, improvement and protection of personal property, etc. — outweigh the disruption caused by evacuation and refugee-related problems.

Agence France Presse

A geologist measures the temperature of hot mud flowing from a volcano 16 km away.



U.S. Department of Natural Resources

Mount St. Helens in Washington State (USA) shown blowing its stack in May, 1980. The blast spewed rock, ash and hot gases at speeds up to 1000 kph.

The eruption leveled 600 square kilometers of once-productive forest and left a trail of debris for 30 kilometers. Reaching even further, ash fell over a 60,000 square kilometer area, killing crops and fouling water facilities.

U.S. Department of Natural Resources

Risk acceptance

Another factor is human psychology itself. The longer a risk takes to materialize, it seems, the greater the danger that it will be seen as unreal, even if its scientific probability remains the same or increases. Studies carried out by the Massachusetts Institute of Technology in the United States have shown that evacuations lasting longer than three weeks are unlikely to be tolerated if the expected event does not occur. Impatience mounts steadily, along with the wish to go home and accept the risk. Even after a disaster, survivors remain attached to their homes and are likely to rebuild in the same location.

There is the striking example of El Asnam, Algeria. Although destroyed twice by earthquakes within a quarter of a century (1954 and 1980), it has been rebuilt on the same site. But since all the Mediterranean side of Algeria is doomed to suffer from violent quakes, where could people build another town that would not be equally at risk in that hazardous region?

So hundreds of millions of human beings are living with the danger of a catastrophic earthquake, flood or volcanic eruption hanging over their heads. For the most part they have no alternative – one thinks of the Bangladeshis – for even if they wanted to they could not make new homes in regions free from such hazards. The earth is already overcrowded.

In the next pages we will examine some of these hazards in closer detail, preceding from most predictable to least predictable.

Mountains of fire from Vulcan's forge

In Shimabara, Japan, an idyllic seaside valley of tea farms, what began six months before as a relatively harmless eruption of lava had turned into a deadly flood of white-hot ash and toxic gases. According to a news report of 9 June, 1991, so intense was the heat and the force of the eruption that many of the victims were being identified by the shoes they were wearing. Some 8000 people living in the direct path of the lava or in villages declared off-limits had been evacuated. There would be no more school hikes up the crater of Mount Unzen for class picnics.

The last time Mount Unzen erupted was in 1792, but for more than a century almost no one paid much attention to the tranquil Buddhist sanctuary built in Shimabara to remember the 15,000 people who died following the blast. But the idyll ended abruptly when the volcano's gentle bubbling turned violent as a result of an earthquake, spewing forth pulverized lava and fiery fragments of rock from the sudden escape of gas. It is recorded that anyone who escaped the flow of hot mud was wiped out by the ensuing tsunami.

This tale is a sobering reminder of the dynamic but violent forces that slumber within the earth. At any moment they can awaken to cause death and destruction.

Studying the past to look into the future

But how can a dormant volcano be distinguished from an extinct one? Therein lies the uncertain science of volcanology. Scientists tell us that the only way to determine whether a volcano is dormant or not is to compare the length of its current dormant period with the length of other dormant periods that separated its eruptions in a recent past. Geology shows us that the history of the earth is nothing but a long series of change and violence. What was true in the past will remain so in the future, and cataclysms will recur again and again.

Of all nature's hazards, volcanic eruptions leave the most durable trace in the form of different kinds of lava and rocks. The study of this material allied with an ability to measure geological time by methods based on radioactivity makes it possible to check up on events which occurred thousands of years ago. Abnormal behaviour of a volcano must be constantly compared with *normal behaviour, and vice versa. This empirical evidence is crucial to the study of risk – the possibility of loss or damage to property or persons.*

An integrated approach to research and training

Efforts for reducing damage from volcanic eruptions have been focused on development of techniques for long-term detection and monitoring of potentially dangerous volcanos; drawing up of hazard maps – similar to those employed in earthquake zones – as aids to land-use managers, civil engineers, and others in positions of authority; establishment of a mobile early-warning system for volcanic eruptions; and preparation of emergency management and response plans in case of crisis. It goes without saying that UNESCO, in pursuing each of these goals, makes a parallel effort to improve scientific skills and technical know-how in the field and in the laboratory.

As in all its programmes, UNESCO provides support for national efforts to create and develop scientific training and research; at the same time, it strengthens and widens international cooperation in these fields so that they may grow within the region, especially among the least-developed countries.

In 1983, well before the launching of the International Decade for Natural Disaster Reduction, UNESCO and UNEP, the United Nations Environment Programme, carried out a survey of existing facilities for monitoring volcanos around the world. About 100 high-risk volcanos were identified. Hoping to address the needs and deficiencies revealed by the survey, UNESCO conducted a feasibility study for an International Mobile Early-Warning System for Volcanic Eruptions, known as IMEWS. Results showed it would not be possible to watch all high-risk volcanos and that the only practical solution would be an international pooling of resources.

For the past five years, in cooperation with the

Agence France Presse

This Pakistani family lost everything when an earthquake leveled their village.

Post-disaster missions for study and reconnaissance

India... Cameroon... Italy... Iran... Peru... Since 1962, UNESCO has dispatched close to fifty scientific missions in the wake of disasters, to investigate their cause and effect. While some of the other international agencies handle emergency relief, UNESCO's interdisciplinary teams — comprising experts in seismology, geology and earthquake engineering in the event of a trembler — will conduct on-site reconnaissance of the damage, assess the origins, and make long-term recommendations for different kinds of preventive measures. Such assistance may concern the geological setting, engineering requirements, building codes and regulations, repair and rehabilitation of buildings, restoration of cultural monuments, land-use planning or evaluation of social and economic impacts of the event.

Agence France Presse

A young survivor of the eruption of Nevado del Ruiz volcano in Colombia carries away his belongings to a waiting evacuation helicopter. Behind him, rescue workers begin digging out the less fortunate victims.

World Organization of Volcanic Observatories (WOVO), the project has been working to build an international system of rapid response and mutual assistance to better cope with volcanic crises.

Sleeping giants: warnings heeded and ignored

The ability to forecast volcanic eruptions depends on scientific research. But use of this information depends on effective decision-making processes and communication skills. During the International Decade, UNESCO will bring to bear its considerable experience in developing programmes for public education and effective information dissemination. If a disaster is likely, officials must decide when the public should be warned and how to ensure that the warning reaches all those who are vulnerable. The ability to warn – to be understood in local dialects and to communicate accurately and persuasively the probable threats to life and property, with enough lead-time for action – is the indispensable complement to any scientifically-oriented hazard reduction programme.

Although a multidimensional approach may be the only realistic way to identify and prepare for disaster, there are cultural and psychological differences between one society and another that may make its implementation extremely difficult. Two examples make the point.

More than 22,000 Colombians were killed as a result of a relatively small volcanic eruption on 13 November 1985, when Nevado del Ruiz, the northernmost active volcano in the Andes, erupted. Hot volcanic ash scoured and melted part of the ice cap on the volcano's summit, triggering debris flows of up to 70 kph that swept down river valleys and overran villages in their path. Under the icy gaze of the television cameras, the whole world watched the vain attempt to save a little girl from drowning in a sea of mud.

Colombian and international scientists, alerted by nearly a year of precursory activity, had warned that Ruiz might erupt and had even prepared a hazard zoning map that accurately predicted the tragic effects of the eruption only a week beforehand. Despite this information and the many indicators of impending disaster the total state of scientific art was not sufficient to warrant giving a public warning. Had a 'critical mass' of scientific evidence been achievable, the catastrophic loss of life, caused by a failure in emergency response, could have been averted.

In a second example, a large loss of life was averted on 18 May 1980, when Mount St. Helens volcano erupted in the United States. The eruption devastated an area as far as 29 kilometers from the volcano -- causing landslides, debris flow, and floods. Total economic losses have been estimated at $860 million. Two years before the blast, scientists had identified the volcano's potential hazards. When it began to show signs of renewed activity beginning in late March 1980, apparently building toward a major eruption, the hazard zone was evacuated. Access to high-risk areas had been so restricted that when the volcano finally erupted eight weeks later, the death toll was limited to 57.

Though natural hazards may be inevitable, the disasters they precipitate can be prevented or mitigated. Reliable prediction and warning, carefully planned emergency response, judicious land use policies, and hazard-resistant design have all led to notable successes. The International Decade for Natural Disaster Reduction offers an opportunity to apply these lessons on a global scale, making the whole world more hazard-resilient.

Mountains of water: Tsunami warning system in the Pacific

Volcanos are just one form of natural hazard whose danger UNESCO works to reduce. Another is the tsunami, also known as a seismic sea wave or, popularly, as a tidal wave. Strictly speaking, the popular term is incorrect, because a tsunami is not caused by a tide, but by earthquakes and occasionally by landslides or underwater volcanic eruptions.

The wave lengths of tsunamis are extremely long: from crest to crest they can reach several hundred kilometers. They travel at great speeds of over 600 kph. When they approach a coast and enter shallow water their length and speed decrease but their height increases, sometimes producing crests more than 30 meters high that crash with devastating force. Tsunamis cannot be seen easily from aircraft or ships because in deep water their height is only about one meter or so. Monitoring equipment is needed to detect their presence.

Records going back at least 1300 years show that in the Pacific Basin, tsunamis are held responsible for wiping out entire coastal communities, changing the landscape in many regions and causing the death of hundreds of thousands of people, including an estimated 36,000 on the islands of Java and Sumatra in 1883. More than 400 tsunamis have occurred in the region since 1900, and the dangers are intensifying due to the rapid population growth and development of port facilities, agriculture, refineries and aquaculture industries in coastal areas.

While most of the destructive tsunamis have occurred in the Pacific Ocean, devastating tsunamis have also occurred in the Atlantic Ocean, the Indian Ocean, and in the Mediterranean Sea. The impact on human societies can be traced back in written history to

1480 BC, when the Minoan civilization in the Eastern Mediterranean was wiped out by a great tsunami generated by the volcanic explosion of the island of Santorin.

Chilean disaster prompts action

On 22 May 1960, the most destructive tsunami of recent times struck the coast of Chile. All seaside towns between the 36th and 44th parallels were either destroyed or heavily damaged by the combined action of quake and waves. The toll included 2000 killed, 3000 injured, 2 million homeless and $350 million damage. Waves were estimated at 20.4 metres high. Having spent its fury in Chile, the tsunami went on to cause 61 deaths in Hawaii, 20 in the Philippines and 100 or more in Japan. The rampage cost Japan an estimated $50 million, Hawaii $24 million, and along the west coast of the United States and Canada several million more.

Early warning is of great importance for the protection of coastal populations from tsunamis. The first Pacific tsunami warning system was set up by the United States in 1948, with headquarters in Honolulu, Hawaii. With the aid of seismological equipment and high-speed computers the location of the triggering event can be determined. It is then possible to give an accurate time for the arrival of the tsunami at a specific coast because the movement of the waves through water follows known physical laws.

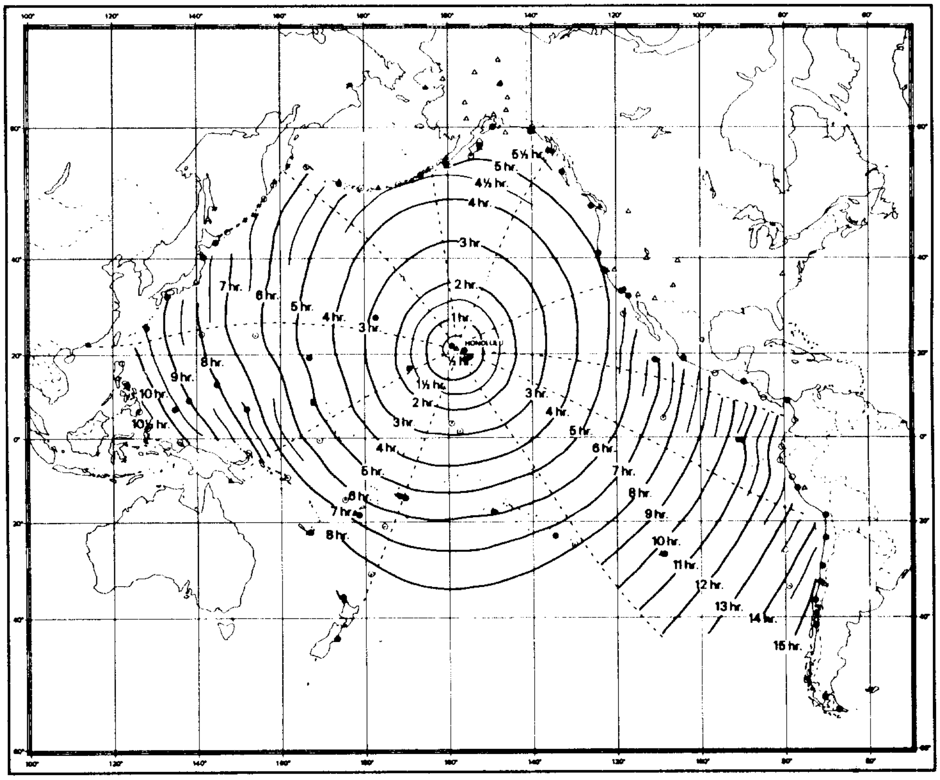
Following the great destruction caused by the Chilean tsunami, about ten countries and territories were prompted to join the Pacific Tsunami Warning System by contributing data and information. However, the participation of many more countries was needed to establish additional observation posts that would cover the region. Then in 1965, UNESCO's Intergovernmental Oceanographic Commission (IOC) accepted an offer made by the United States to expand its existing Tsunami Warning Center in Honolulu to become the headquarters of an International Pacific Tsunami Warning System. At the same time, member countries agreed to integrate their seismic, tidal and communications systems.

Today there are 23 nations belonging to the Pacific System, plus some territories that maintain stations for it. The System makes use of 69 seismic stations, 65 tide stations, and 101 dissemination point throughout the Pacific Basin. Besides the main Centre in Honolulu, there are two regional warning centres dealing with tsunami warning in the northern part of the Pacific, one in Alaska and the other in Hawaii. Another centre will eventually cover the southern Pacific.

The warning system: how does it work?

The system begins to function when a participating seismic observatory detects an earthquake of sufficient magnitude to trigger the alarm attached to the seismograph at that station. An information centre collects the data and, when it is sufficient, locates the earthquake and computes its magnitude. If the shocks are under the ocean or close enough to disturb the ocean floor a tsunami may have been generated. When reports from tide stations show that a tsunami poses a threat to the population in part or all of the Pacific, a warning is transmitted to the appropriate agencies for relaying to the public. At that point, according to predetermined plans, people are evacuated from endangered areas. Should the tide station indicate that no tsunami — or a negligible one — has been set off by the earthquake, then the evacuation plans are cancelled.

What is certain is that tsunamis are potentially dangerous, and a constant watch must be kept. Only international science, however, can provide the kind of coverage that an undertaking over such a vast area and involving so many national frontiers, requires. Yet it remains the countries themselves that are responsible for taking action to avert disaster.



International Oceanographic Commission/UNESCO

Tsunami travel time chart. Using instruments such as seismographs and tide gauges, scientists can forecast when a tsunami will arrive at a given coast.

When disaster looms, good public education campaigns and the dissemination of accurate information may be the crucial elements in saving lives.

UNDRO News, Jan Feb 1990, p 15

Landslides

Unlike earthquakes or volcanic eruptions — which result entirely from natural forces — landslides may be caused by man as well. This is especially true in mountainous regions of the world, where deforestation, the influx of large transient populations, tourism, road construction and similar human activities may contribute to existing environmental problems. Whatever their origin, snow and ice avalanches, rock-falls, mud-flows, landslides and floods, and all other catastrophic processes acting under the influence of gravity, take a terrible toll each year.

A number of UNESCO programmes are contributing to our understanding of the causes and consequences of these events. The Man and Biosphere Programme looks at land-use problems from an ecological point of view. Projects in Switzerland have led to experimentation with the cartographic representation of various hazards, and to efforts to develop integrated management practices that balance recreational, agricultural and industrial needs, with conservation of natural resources.

In Nepal, detailed mountain-hazard maps are being drawn up for use by decision-makers in their efforts to curb environmental degradation, and resultant soil erosion and loss of soil fertility. The maps are multi-dimensional and should lead to a much fuller understanding of landscape dynamics, including the human-environment interactions, so that prediction of the possible effects of implementing a given policy should be that much more reliable. Additionally, the Nepal project, through its incorporation of young Nepalese scientists, is seeking to reduce the region's reliance on foreign expertise.

The study of landslide hazards — as well as disaster management generally — has also benefited recently from state-of-the-art space technologies that make it possible to develop risk maps and to monitor change at a much larger scale than before. In the Andean region of South America, UNESCO is part of a joint project to develop new methods for mapping mountain hazards using some of these techniques.

A UNESCO project for "Protection of the Lithosphere as a Component of the Environment" is an example of an early international effort to cope with landslide hazards. Carried out between 1981 and 1984, the project was administered by the Soviet Union, with cooperation from landslide experts from China, France, Japan, the United Kingdom, the United States, and several developing countries. Publication of guidelines on landslide hazards zonation, plus workshops and multinational research studies have contributed greatly to risk reduction.

The great Alaska earthquake of March 1964 was the largest to hit North America in recorded history. It lasted 4 minutes and, exemplifying the multi-faceted nature of many hazards, it precipitated landslides, fires and tsunamis that carried the devastation thousands of kilometers beyond what is seen here.

Shared information for the benefit of each

The International Decade for Natural Disaster Reduction has given a new urgency to the mission of the Pacific Tsunami Warning System: to determine whether earthquakes have generated tsunamis, and to provide timely and effective information and warnings to the population of the Pacific in order to minimize the hazards to life and property.

According to the UNESCO-based head of the IOC, "Our immediate goal is to shorten the time of warning. In deep ocean the speed of a tsunami may exceed 600 Kph, and thus the need for rapid data handling and communication is obvious. It could mean the difference between life and death." The easiest way to achieve this, he says, is by increasing the number of locations in the early warning system. "We hope the IDNDR will provide the impetus for greater participation and support."

Whatever its limitations, the International Tsunami Warning System is recognized as a successful international programme. The member countries work together, but each must also accept a direct responsibility for mitigating the effects of tsunamis, the saving of lives, and the protection of property.

Earthquake prediction: probability, not predictability

Scientists tell us that in the present state of knowledge it is not possible to determine by observation or calculation, precisely where and when an earthquake will take place. For such pinpoint accuracy in time, space and magnitude, scientists would need detailed information on the stress fields and the mechanical properties of the earth's crust over wide areas. Even if technically feasible, obtaining the information would be prohibitively costly. Sometimes there are precursory phenomena observed: sudden changes in the level of minor seismic activity, slight deformations of the earth's surface, changes in magnetic or electrical fields, unusual rise or fall of water levels in wells, changes in the gravity field or abnormal behaviour of animals. But so far, none has proved a reliable indicator.

New data is constantly being accumulated and the accuracy of forecasts should improve. In the meantime, however, – and like the weatherman on TV – the experts express themselves in terms of probability: that an earthquake of a certain magnitude is likely to occur in a given area during a specified period of time.

The geological background

Because of its geological setting and long record of earthquakes, it is likely that seismic disasters will continue to occur in the Arab region. The area sits astride a mosaic of oceanic and continental plates, critical boundaries where the earth is unstable. These plates are in constant motion, jostling with each other and creating various stresses and strains in the process. Where they interact along their boundaries, important geological processes take place, such as the formation of mountains, earthquakes and volcanoes.

Plate tectonics, as the geophysical concept is called, explains the existence of seismic zones and provides one key to mapping these high-risk areas. It tells us where 90% of the earth's major earthquakes are likely to occur, although with little accuracy about when the events will occur. The reason is that plate tectonics have been going on for millions of years. Plate movements amount to 10 centimetres per year. But at any instant in geological time, for example the year 1992, we do not know exactly where we are in the worldwide cycle of stress build-up and strain release.

During the 1980 earthquake in El Asnam, close to 80% of the city was completely destroyed, with extensive damage to the countryside and valuable archaeological sites; around 10,000 people were killed or *injured and over 300,000 were made homeless. The damage to houses and public works amounted to more than $4 billion.*

An Arab example: regional cooperation for hazard reduction

In the wake of the devastation, UNESCO was invited by the Arab Fund for Economic and Social Development to organize a multidisciplinary project to study seismic risk throughout the Arab region, and to help implement plans for the long-term assessment and mitigation of risk. Like many such projects, regional scientific and research associations were also involved, and co-funding came from an outside body, the Islamic Development Bank (IDB). Ten countries were surveyed: Algeria, Egypt, Iraq, Jordan, Libya, Morocco, Saudi Arabia, Sudan, Syria and Tunisia.

A first concern focused on the establishment of national building safety codes, the enforcement of protective measures through improved structural design, and emergency preparedness involving public information and education. To accomplish these tasks, however, it became apparent that the Programme for Assessment and Mitigation of Earthquake Risk in the Arab Region (PAMERAR) would need to devote much time and energy to the training of scientists, technicians, and administrators so they would then be qualified to implement the plans. This is a long-term proposition requiring people experienced in engineering, earth sciences, education, communication and administration.

The results are promising. A number of national projects have been established to reduce earthquake risk. Some countries have developed seismic networks and Algeria has set up a National Centre of Applied Research in Earthquake Engineering which will serve as a common resource for the Arab region, and perhaps for other countries in Africa. By pooling their scientific and financial resources, the earthquake-prone countries of the Arab region are taking concrete steps to reduce the risks from this natural hazard. Their initiative is an important contribution to the International Decade for Natural Disaster Reduction.

Earthquake risk in Africa: partnership with non-governmental organizations

Like the other continents, Africa has its share of geological hazards although so far little work has been done to minimise the disaster risks. A joint programme to fill this need has been proposed, with UNESCO, the International Association of Seismology and Physics of the Earth's Interior (IASPEI) and International Commission for the Lithosphere (ICL) as co-sponsors. The programme would provide scientific advice in developing guidelines for the establishment of a seismological recording network, and it would encourage earth sciences projects of specific interest to disaster mitigation. A Regional Seismological Assembly – the first event of its kind on the continent – was held in Nairobi (Kenya) in 1990.

International science: how it happens, how it works

UNESCO as "mover"

To the uninitiated, the mysterious workings of international science may appear like some form of shadow boxing: there is movement, but the source is unclear because the actors are invisible. UNESCO's mission in its scientific programmes is to enhance the development of science, yet UNESCO itself does no scientific research. How does it happen? How does it work?

UNESCO's role is best described as the promoter of science, as the "mover" of scientific activity. It sets things in motion through the medium of other scientific and technological institutions. Where no suitable organization exists, UNESCO may help to create it. Often, UNESCO's initial support will go to national efforts to develop training and research establishments. But its ultimate goal is to strengthen and widen international cooperation in scientific and technological fields so that they may flourish within the region.

As in shadow play, UNESCO's presence is more felt than seen. All eyes are on the show, and it's the show that counts. An example may illustrate the point.

Building upon disaster: the Skopje earthquake

The terrible earthquake of 26 July 1963 which destroyed most of the town of Skopje, brought to light the need for a national Yugoslavian institution aimed at education, training and research in the field of earthquake engineering and engineering seismology. With UNESCO's assistance, this came to pass. The Institute of Earthquake Engineering and Engineering Seismology (IZIIS), opened its doors in a small prefabricated building on the University of Skopje campus in 1965, with a staff of ten, no laboratory equipment, and no equipment for performing analytical investigations. There being no qualified local staff available, foreign scientists were imported. Despite these handicaps, the Institute began its first two-year post-graduate course.

Within only ten years, the seedling had taken root. The staff had increased to fifty, including 25 professional engineers or scientists, and through its own efforts, the Institute had located the funds for the construction of laboratories and the installation of a country-wide network for measuring ground motion. Half the lectures were being delivered by local personnel – which meant additional funds became available as the international experts departed.

The Institute worked closely with local authorities in the reconstruction of Skopje and, as its experience and reputation grew, it helped the government apply national measures for minimizing structural damage in seismic areas. It carried out research on earthquake resistance in buildings, and on dynamics of soils and foundations. About 165 scientific and technical reports were issued, and another 130 papers were delivered at national and international conferences.

By the 1980s, the Skopje Institute recorded enrolment of 50 masters-degree candidates and nine doctoral candidates. Lectures were being delivered in equal numbers by professors from the Institute and international experts. A total staff of 130 occupied brand new premises that also housed equipment valued at $5 million.

When the need is great enough, and the will exists, institution-building can acquire a momentum of its own. This was certainly true in Yugoslavia. Had any doubts persisted about the importance of seismic research to the country's future, these were eliminated in the aftermath of further, devastating earthquakes – at Debar in 1967, Banja Luka in 1969, and in Montenegro in 1979.

It took UNESCO's know-how and United Nations funding to get the project "moving", but the Yugoslavs themselves invested twelve times as much as their partners. This is international science at work, through the medium of a national scientific undertaking.

The next step: national to regional

We mentioned earlier that UNESCO also contributes to international science by promoting regional cooperation and development. Disaster research is the perfect illustration of the benefits of such an approach. In-depth scientific study of the natural phenomena that cause disasters takes resources that are beyond the means of many individual countries. Moreover, a multidisciplinary perspective is involved, requiring input from specialists in different sectors of science and technology. Finally, hazards such as earthquakes are usually regional problems that transcend national boundaries, for their existence depends on plate tectonics, not politics.

Skopje lies at the heart of an active seismic zone crossing seven Balkan countries: Albania, Bulgaria, Greece, Hungary, Romania, Turkey and Yugoslavia. Each of them has suffered widespread loss of life and property. From 1970 onwards – exactly as it had done within Yugoslavia – UNESCO used its skills as a science promoter to set up cooperative research projects for surveying, evaluating and mitigating earthquake risk throughout the Balkan region. Project coordinators were appointed, assisted by someone from each of the participating countries, and a central office was established at the Institute of Earthquake Engineering and Engineering Seismology in Skopje.

The project document identified major objectives:

- *Modernization of the network of seismological stations in the Balkan region for uniform geographical distribution.*
- *Collection of information concerning seismic risks and earthquake prediction.*
- *Mapping of the hazards.*
- *Quantification of research results useful for regional planning and for design, repair and strengthening of buildings.*

Earthquakes have damaged many priceless cultural treasures like this striking Byzantine fresco from the Valley of Göreme in Turkey.

UNESCO/Dominique Roger

When highways and major transportation lines are disrupted, a whole economy may suffer.

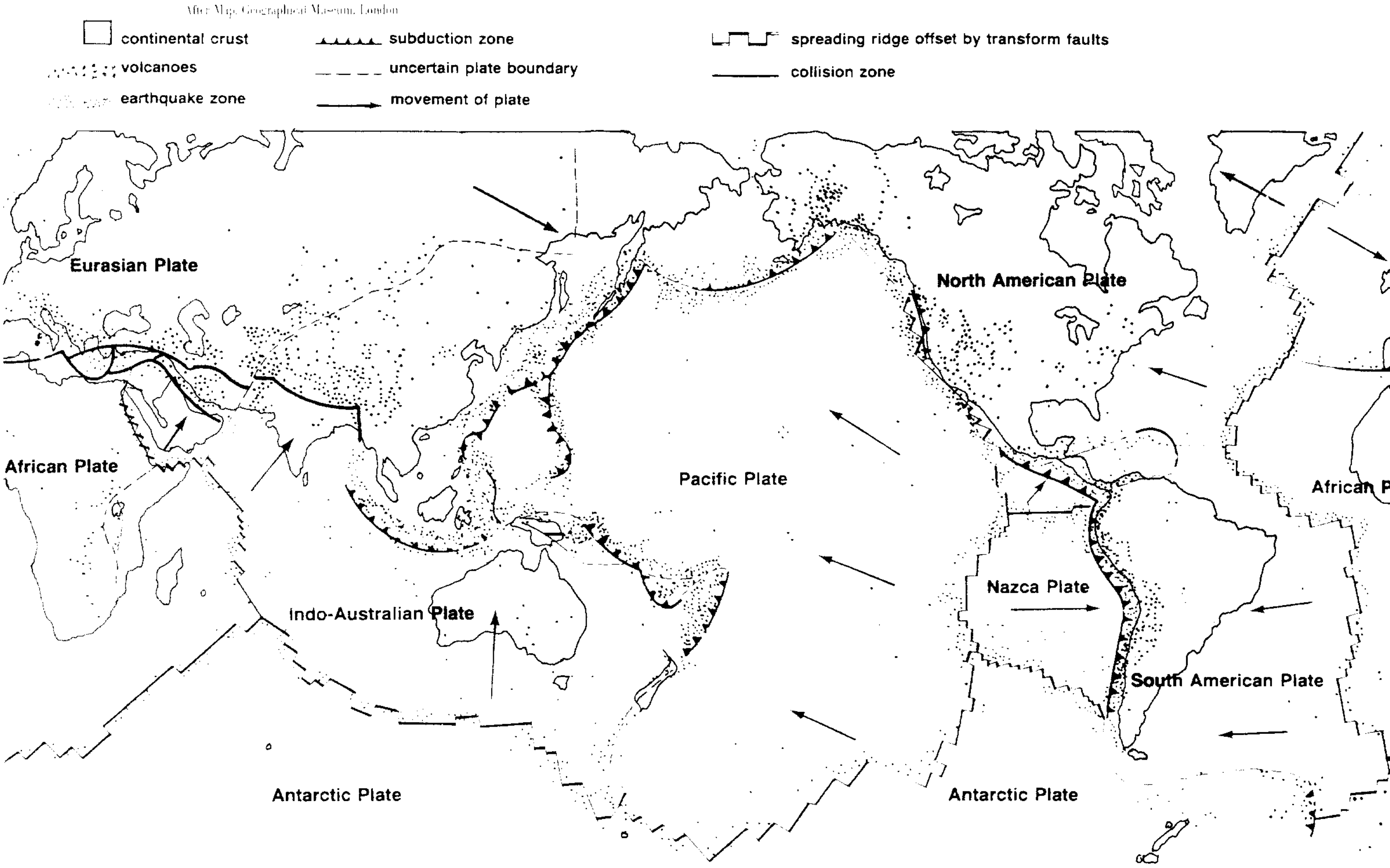
Agence France Presse

U.S. Geological Survey G. Reagor

Even when no lives are lost, natural disasters may cripple local businesses and hamper a community's ability to face emergencies in the future.

Composite map showing location of world's major volcanic eruptions and earthquakes in relation to plate tectonics.

After Map, Geographical Museum, London



- *Training of personnel needed to implement the studies and their applications.*

By the time the projects ended, each of these tasks had been addressed.

Some notable achievements

The achievements of the Balkan project can be measured in two ways: in terms of tangible scientific results, and in terms of their impact on the participating scientists and institutions. There were landmarks in each category.

Publication of a two-volume catalogue of earthquakes with its 500-page appendix of seismic maps represented the first unified, homogeneous and reliable source of information about the Balkans; the number of seismological stations in the region doubled; on the basis of data contained in the earthquake catalogue, the project produced one of the first comprehensive studies of seismic hazard conducted anywhere in the world. There were numerous microzoning studies which are a vital tool in the planning of urban and industrial settlements. These were followed by recommendation and studies concerning the resistance of buildings, the repair and strengthening of structures, and earthquake preparedness measures. In each case, a new technology was being introduced to the region. New equipment was installed, technicians were trained, and many high-quality technical reports were published.

Less easy to quantify, but every bit as significant in the context of long-term scientific advances, was the impact of the undertaking itself. Given the region's troubled history and the suspicion with which some countries viewed each other, it is little short of miraculous that UNESCO was able to bring the scientists and engineers together. But participants later agreed that the even distribution of obligations and project benefits among the countries concerned, actually helped to create a climate conducive to improved teamwork.

As it turned out, the climate of understanding between seismologists, geologists and engineers was so much improved by the Balkan experience, that a permanent earthquake risk reduction committee was set up under UNESCO's auspices. It is still functioning well.

International science through regional cooperation

The rather detailed history above concerns the development of a seismological network for the Balkan region of southeastern Europe. It shows how UNESCO makes international science happen, by taking existing institutions, improving their facilities and access to information, extending opportunities for training and research, and then plugging both the institutions and their staff into ever larger scientific communities. There is concern now about how to extend the reach of the Balkan project and to involve the greater European community.

What happened in the Balkans has been duplicated for South America — with the establishment in 1966 of a regional centre for seismology headquartered in Lima, Peru; for Southeast Asia, with the creation of an association for seismology and earthquake engineering now located in Manila; and for Arab states with the setting up of PAMERAR. Other institutions of international vocation have been set up in Japan and the United Kingdom. The circumstances and organization are different for each region, but there is a common purpose around the idea of sharing knowledge and resources in an effort to lessen the effects of earthquakes.

It is UNESCO — the catalyst — that makes this kind of scientific cooperation happen.

Fundamental science and the IDNDR: back to basics

Fundamental research underlies the applications

In preceding chapters, we have emphasized the applications of science and technology for solving human problems. But stressing the applications of science does not mean abandoning basic science. UNESCO places science alongside education and culture in its mandate because, as well as being useful, it has a value of its own.

Fundamental research plays a crucial role in the development of science, and experience has shown that many beneficial new applications and technologies may grow directly from basic science. Training is equally vital and complementary to research, which UNESCO recognizes in all its science programmes. They are in fact reciprocal activities, research constituting a key factor in training, and training being a preparation for research. International cooperation in both, by providing exchanges among individuals and pooling ideas, can help reduce the flagrant disparities in science and technology that lie at the heart of development problems.

Two intergovernmental programmes, one concerned with earth sciences, the other with water resources, furnish good examples of UNESCO contributions in the realm of basic research. They seek understanding of the processes that regulate our planet's history and functioning, an objective shared by the International Decade for Natural Disaster Reduction. Knowledge about the causes and effects of various natural phenomena – including hazards of geological or weather-related origins – should help us to predict the circumstances under which such events occur.

Our changing planet

To understand the changes which will affect the future of the earth's continents and islands, it is necessary to study both the geological processes going on right now and those from the past. This is not a local or a regional task, but a global one in which world-wide cooperation is indispensable.

The International Geological Correlation Programme (IGCP), a joint venture of UNESCO and the International Union of Geological Sciences (IUGS), was launched in 1972 with this idea in mind. Its aim is to compare and correlate, in space and time, all manner of geological processes, events and formations — including rocks, fossils and mineral deposits. Projects make use of and contribute to the further development of top-level scientific knowledge and technology, from deep-core drilling to space imagery. Developing countries benefit through association with the international scientific community, and by sharing in field and laboratory training that advances know-how.

Today, IGCP can boast of having 59 on-going research projects and more than 110 participating countries. A closer look at two of them will show that, despite their intimidating official titles, they are directly related to such "hazardous" events as earthquakes, volcanic eruptions, landslides and flooding.

Tracking ground movements

One project goes by the name "Regional Crustal Stability and Geological Hazards." Under the direction of a scientist from the People's Republic of China, this project performed extensive research on the stability of the subsoil, particularly in densely populated areas, as a precondition for planning the security of major engineering sites and underground mining activities.

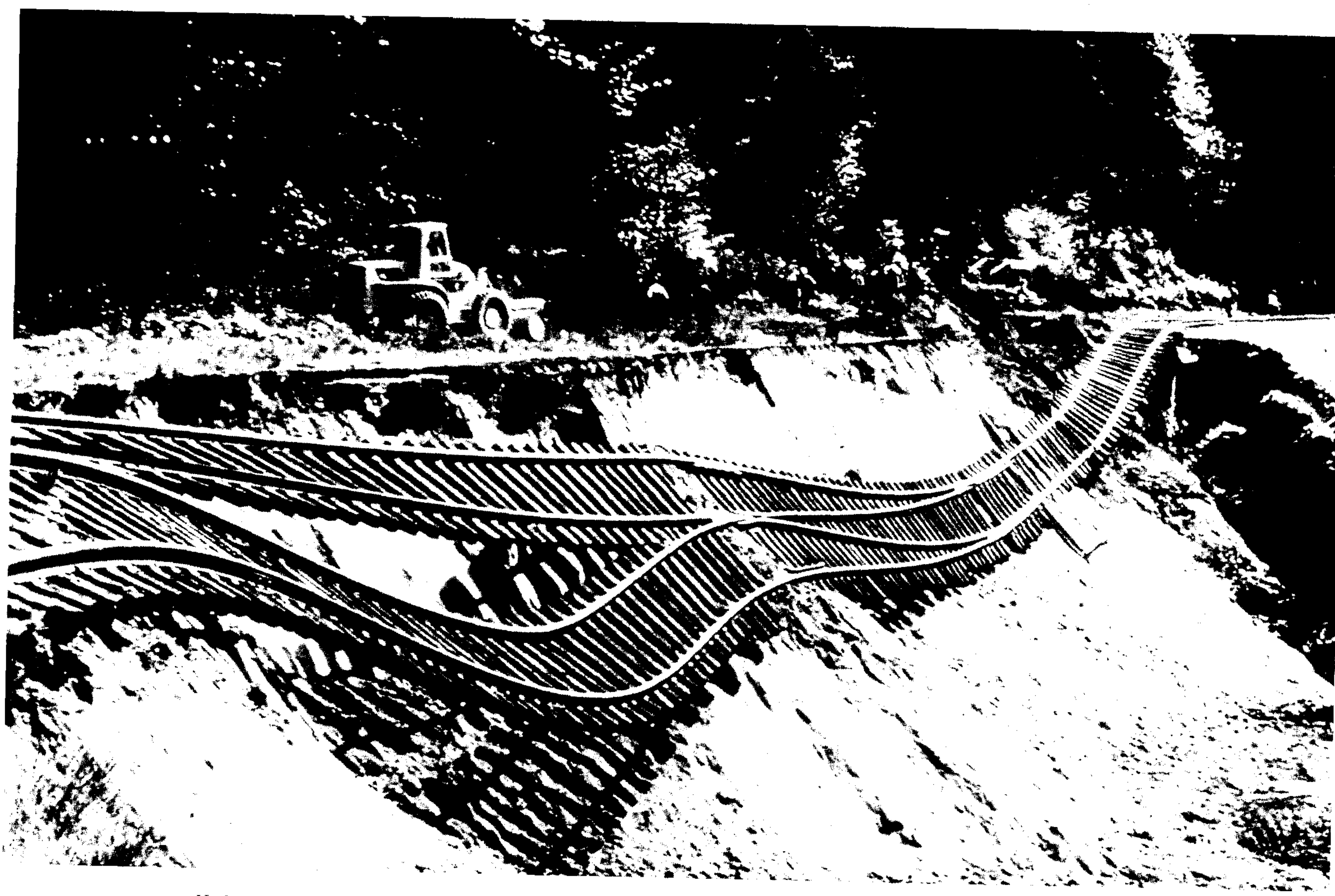
When the five-year project ended in 1990, it had made significant contributions to the development of methods and techniques for plotting all kinds of earth movements such as faults, earthquakes and landslides. Descriptions of how to detect, measure, monitor and model them under various circumstances were published in a series of highly detailed hazard maps. In keeping with the ground-rules of international science, many national groups — fourteen in all — from Argentina to Japan, also participated in the project. Four international symposia have been held to publicize the results, and a number of case studies drawing attention to particular problems and locations have also been published.

Tracking sea-level fluctuations

"Coastal Evolution in the Quaternary," another IGCP project, addresses a very different problem. Led by a Dutchman, it builds on a highly successful earlier project devoted to "Sea-Level Correlations and Applications" and aims for a global picture of changes relating to the rise and fall of the oceans during the 10,000 or so years since the last Ice Age ended. Scientists from 63 countries are participating in this vast undertaking, which could have major implications for coastal engineering projects and even for the survival of some of the world's largest sea-front cities: New York, London, Shanghai, Bangkok, Tokyo, Rio de Janeiro, Calcutta and Los Angeles, to name but a few.

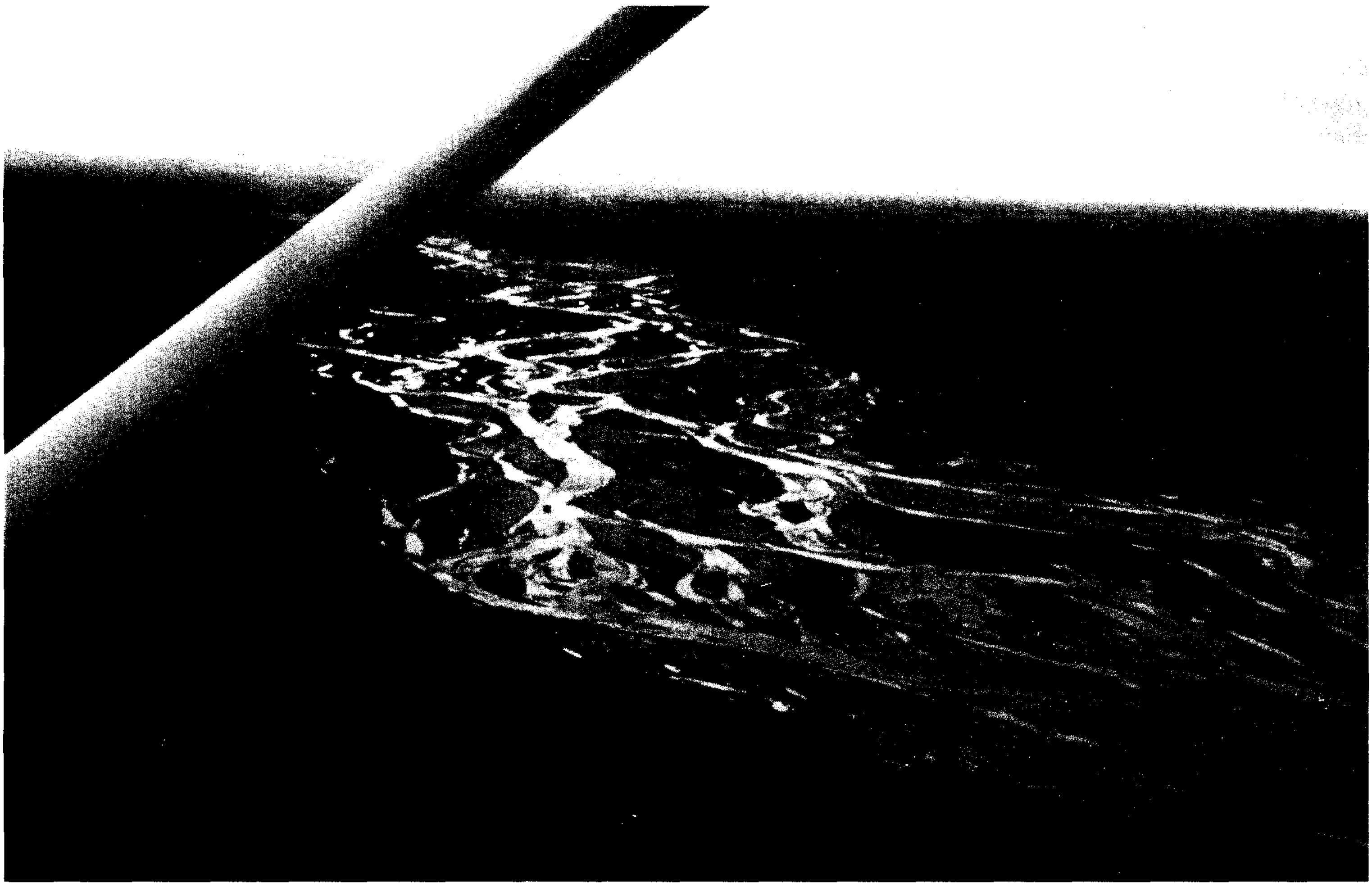
The processes being studies are both complex and interrelated, capable of mutually influencing each other in subtle but important ways. Climate and climate change play a big role: between 10,000 and 30,000 years ago, when large areas of the northern and southern hemispheres were covered by thick sheets of ice, sea-level was as much as 100 to 130 metres lower than now. By 6000 years ago, the continental ice sheets in North America and northern Europe had melted completely, raising sea levels by 10 to 15 metres per 1000 years, enlarging ocean area, and flooding low-lands. If the earth's temperatures continue to rise — as some scientists predict it will — the melting of ice caps in the Arctic and Antarctic, and the resulting rise of sea level could have disastrous consequences. IGCP will be paying particular attention to the dangers and preventive measures associated with sensitive coastal zones of South and Southeastern Asia.

Some projects under IGCP are more theoretical;



University of California, Berkeley

Understanding the causes and processes underlying natural phenomena is one concern of the international scientific community.



Groundwater Resources, Israel Association for International Cooperation

Mathematical and visual models can help scientists imagine the conditions under which flooding occurs and to take measures for preventing the worst.

some are more practical. But both will ultimately serve the interests of mankind. For the International Decade of Natural Disaster Reduction to succeed, the technical solutions must be firmly grounded in the principles of fundamental science.

Scientific understanding for better management of water resources

Freshwater is essential to life on earth, but it is unequally distributed across our planet. Some parts of the globe suffer regular flooding, while other areas may be dangerously short of water. The International Hydrological Programme (IHP) addresses itself to the long-term goal of advancing our understanding of these problems and processes, so that knowledge can be integrated into water resources management and hazard reduction planning. It improves scientific and technical knowledge of the water cycle, it helps train necessary personnel, it builds research and training institutions, and it promotes responsible management that will minimize risks in hazardous situations.

The importance of information and data

Since management decisions are only as good as the information on which they are based, great attention must be paid to availability, accuracy and completeness of this information. It should include data on climate, surface and groundwater conditions, and water use. A full understanding of hydrologic processes often requires knowledge of society's interactions with them as well. Environmental conditions and factors that determine relationships between climatic and hydrologic events – such as geology, topography, soils, vegetation cover and land use – also must be considered.

An intergovernmental programme like the IHP has a unique advantage when it comes to information-gathering. With the cooperation of member countries it can compile data from many sources and arrive at a global picture of water events that may be quite different from the narrower view.

A good example is found in the World Catalogue of Maximum Observed Floods, which succeeded thanks to cooperation at local, national and international levels. This effort, in which UNESCO was the coordinating partner, permitted collection of flood data from 95 countries, covering 1400 stations and observation sites. Each year, as we have seen, flooding causes major catastrophes. Knowledge of these exceptionally large floods – their origins, likely frequency and duration – is an essential starting point for learning how to minimise the damage they can do.

Modeling as a tool

Modeling activities are part of many IHP projects, some of which are directly related to the goals of the IDNDR. One of these concerns the forecasting of river floods and storm surges.

An important IHP contribution comes from developing models to simulate flood formation and impact under different geographical, climatic and hydrologic conditions. These models are required for improving our understanding of the underlying processes as well as for planning and designing of flood protection structures such as reservoirs, dykes, levee systems and polders. They also are needed for the real-time forecasting of floods, for warning communities and flood-prone areas of impending risks, and for managing flood control schemes meant to reduce damage.

Storm surges are a kind of long wave (in the same class as tides and tsunamis) that occur in shallow coastal areas or enclosed inland water bodies. Coastal floods linked to storm surges constitute one of the worlds' foremost natural disaster. The coastlines of the northern part of the Indian Ocean, China and other areas have frequently been subjected to severe surges. Although often generated by tropical storms like typhoons and *hurricanes, they can also happen in such non-tropical locations as the North Sea. The most devastating surges in this century are those that struck Bangladesh in 1970 and 1991, reaching 160 km inland and causing hundreds of thousands of human deaths*

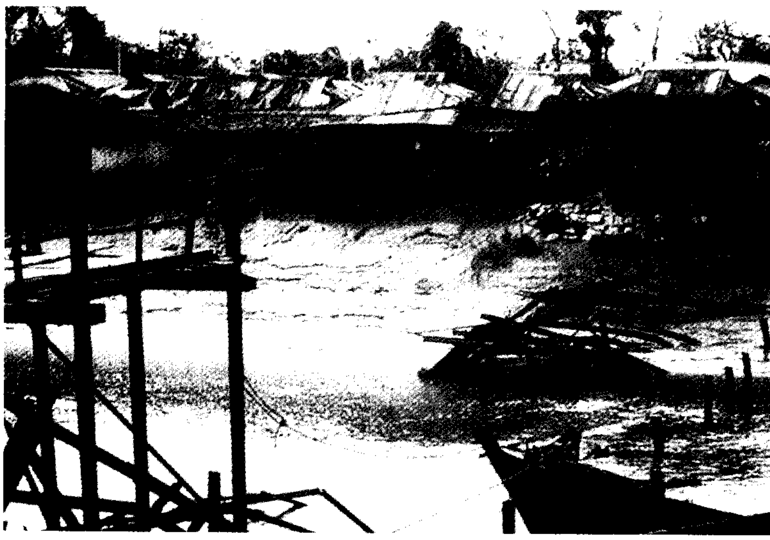
In devising models to help them forecast likely flooding from storm surges, scientists must include data about water depth, wind speed and direction, wave lengths, weather conditions, tides, river flow and coastline characteristics. An interdisciplinary approach is essential in putting these different elements together.

The Intergovernmental Oceanographic Commission (IOC) of UNESCO and the Intergovernmental Hydrological Programme (IHP) are trying to solve the problem of storm surge forecasting and investigation jointly with the World Meteorological Organization (WMO) by establishing an observing system in the Indian Ocean and surrounding coastal areas, and by devising models to help countries forecast likely flooding from storm surges.

Storm surges are a serious but short-lived hazard. A related long-term problem, also of interest to IHP, IOC and other intergovernmental groups, is that of sea-level rise in the event of climate change and global warming. The impact of such a rise could be disastrous in lowland areas due to accelerated erosion, increased risk of flooding, disruption of drainage and irrigation systems, intrusion of salt water into fresh water bodies and agricultural land. In turn, these disturbances would translate into costly economic, social and environmental effects. The impacts of man's activities, especially in the humid tropics, could be a major factor influencing the global climate situation.

Fundamental questions about the "how" and "why" of such phenomena must be addressed before any longer term planning can be accomplished. In many regions of the world methods unsuited to prevailing climatic conditions have been used to try to solve water-related problems, but with mixed success. The IHP encourages basic research and applications appropriate to specific regions as a prerequisite to disaster reduction schemes. At the same time it advocates integrated approaches to problem-solving as the first step towards better management of water resources.

Killer cyclones accompanied by violent winds, battering rain and surf up to 8 meters above normal strike regularly at the low-lying coastline of Bangladesh. A satellite-based early-warning system has helped in evacuating coastal dwellers, but no solution has yet been found to the long-term threat of sea-level rise in the event of climate change and global warning.



Thierry Boccon Gibod/Black Star

Drought & desertification

Different from other hazards

The hazards we have looked at in this booklet so far — earthquakes, landslides, tsunamis, volcanic eruptions, hurricanes and typhoons — all share certain characteristics. They are relatively sudden and are of short duration. They occur frequently on a global basis, which has allowed researchers to amass much data about them and to gain considerable experience in alleviating their effects. We have also seen that there is a common set of skills — a kind of "disaster mitigation kit" which scientists, engineers, and others can use to reduce their impact.

Long-term natural hazards such as drought and human-induced desertification, can be just as devastating as rapid-onset events, but to reduce their impact calls for a different set of skills. Generally, mitigating these hazards calls for greater ecological and social awareness, since emphasis only on technical solutions as isolated elements of a complex environmental situation, has led to some spectacular failures.

Pioneering research

Arid and semi-arid zones, lands of highly variable and sparse rainfall, cover one third of the earth's surface. Half the nations of the world have all or part of their territory in arid and semi-arid surroundings, which are home to 15% of the world's population.

UNESCO's interest in problems unique to these dry regions dates back to the 1950s, making arid lands research the oldest of the Organization's multidisciplinary environmental programmes. In the years since then, UNESCO has helped set up arid zone centres for research and training across the globe, it has produced landmark maps of the world's arid regions, and it has published numerous studies on key topics of common importance to arid lands. The list of countries involved reads like an inventory of the the planet's dry spots: Mexico, Chile, China, Egypt, India, Iraq, Niger, Nigeria, *Pakistan, Tunisia, Burkina Faso, Mauritania — to name but a few.*

All subsequent programmes, such as the Man and Biosphere Programme (MAB) or the International Hydrological Programme (IHP), owe much to the philosophical framework established during these early days.

A three-pronged approach stands out: an effort to integrate social and natural sciences, so that interactions between human beings and their environment are properly appreciated as part of the total picture; an emphasis on understanding basic cycles involved in the functioning of arid and semi-arid ecosystems, whether focused on water resources, vegetation, soil, climate or land-use patterns; and a desire to apply knowledge gleaned from this research to designing optimal land-use systems in drought-prone areas, so that land can be rehabilitated and local populations can face a sustainable future.

Why dryland ecosystems are particularly vulnerable

Dryland ecosystems are very fragile and prone to degradation. What begins as a natural phenomenon — such as a prolonged drought — is soon complicated by various human responses. Landscapes, vegetation and soil cover degrade much more rapidly than in more favoured regions and the drylands, once degraded, are extremely difficult and expensive to rehabilitate and make fertile again.

Around the edges of the African region known as the Sahel, for example, are traditional nomads who, over the centuries, have been able to survive by adapting to their precarious existence. Their great mobility has enabled them to range across vast distances in search of food and water for their herds, thus minimizing the dangers from both the seasonal and cyclical patterns of scarce moisture.

Today, however, the fragile equilibrium between man and his environment has been disturbed. Both the human and the animal populations have grown faster than the land can support. The provision of what planners call "infrastructure" — schools, clinics, fixed water points — has discouraged pastoralism as a way of life and encouraged more sedentary habits. The combined effect is to create yet more pressures on the limited pastureland and natural resources available. The cycle of deterioration is rapid and complete.

Two case studies — one specific to the Turkana tribe of Kenya, the other cutting across nine French-speaking countries in the Sahel — offer a glimpse of UNESCO's approach to combating the multidimensional problems of drought and desertification within the MAB programme.

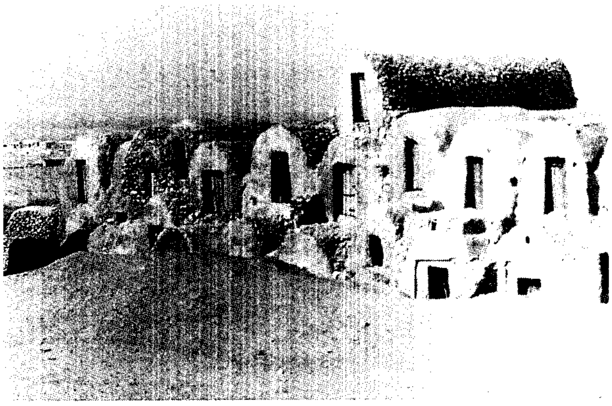
The Turkana Project: rangeland research and rehabilitation

The Turkana district of northern Kenya is an arid region of sparse vegetation and, in recent years, of even sparser rainfall. Despite its rather austere landscape, the area offers great variety in terms of geological formations, soils, micro-climates, vegetation cover, wildlife populations, and livestock. Some 180,000 - 250,000 pastoral nomads live in the region, but recurrent droughts and a dwindling resource base have created famine conditions, forcing many of them to become dependent on food aid. The Kenyan Government has asked for assistance in making the Turkana self-sufficient once again, while solving the problems of environmental degradation. The Turkana Resource Evaluation and Monitoring Unit (TREMU), initiated in 1985, answers their request.

Originally TREMU was a joint venture of the Kenyan authorities, UNESCO's Man and Biosphere Programme, and a Norwegian development agency. Now it is funded by the United Nations Development Programme (UNDP) and implemented by UNESCO. The

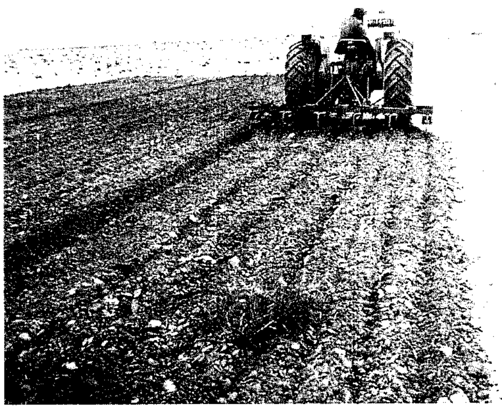
Until 20 or 30 years ago, shrubs and perennial grasses covered the grazing lands of Africa.

Overgrazing and a more sedentary life style have transformed the environment.



Whole villages have been engulfed by sand and abandoned.

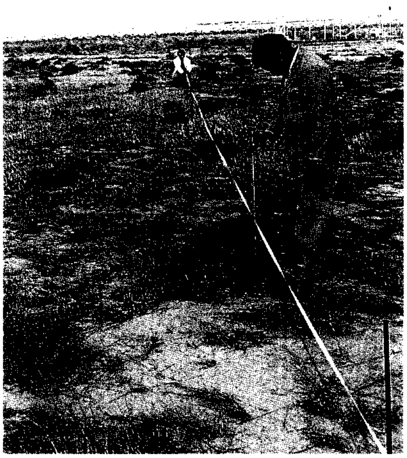
Small banks known as "jessours" are used to protect plantations and irrigated areas from sand.



Studies show that certain tilling practices are less harmful than other.

Trees grown in nurseries from hand-planted seedlings can help conserve soil and moisture while acting as sand and wind breaks.

Introduced species such as non-thorny *Acacia* or these cactus help protect fragile grasslands by providing a grazing alternative that is both attractive to livestock and very productive.



On-site training and demonstration are the key to better management of dryland resources.

Research shows that when properly managed, desert agriculture can flourish.

Page 30-31: all photos UNESCO-MAB

project team is gathering scientific information by conducting on-site research. Extensive livestock studies of camels, goats and sheep will investigate such factors as reproduction rates, milk yields, disease control, dietary intake and marketing practices. Parallel vegetation studies will focus on plant dynamics throughout the rangeland area, in an attempt to measure recovery rates of different species under varying conditions. The scientists run trials on plants and animals under controlled conditions, quantify results and build interactive models showing the impact of the different variables on the success or failure of alternative management techniques.

In spite of its relatively short duration the project has already produced some useful results. For example, it was found that a common dwarf shrub called Indigofera spinosa actually grows better if it is browsed on by livestock during the dry season. Too much browsing, however — leading to leaf-loss of more than 50% — is harmful. This information is important in formulating guidelines for good land-use management in pastoral areas.

TREMU has the advantage of building on prior MAB experiences in other parts of Kenya, where some of its guiding principles have already been tested, yet fine-tuning will be required to take account of the different cultural and natural settings. The long-term objective, in keeping with the IDNDR, is to demonstrate the value of using science and technology to reduce the hazards of existence in an arid land.

The Sahel: priority to building scientific competence

Another project, also aimed at mitigating the effects of drought and desertification in Africa, has adopted a broad regional approach. This project aims to strengthen the scientific capacities of Sahelian countries in managing agriculture, forests and rangeland. It unites nine countries — Burkina Faso, Cape Verde, Guinea

Bissau, Mali, Mauritania, Niger, Senegal and Chad — which are members of CILSS (for "Comité Inter-Etats de lutte contre la sécheresse au Sahel"), in a common effort to develop the science and the scientific skills needed to solve their regional problems. One or two institutions in each country has been designated as a research and training centre, thus allowing the programme to build on existing capability.

As in the Turkana region of Kenya, hazardous conditions in these Sahel countries result from a mixture of natural and human causes. It is a familiar pattern: a fragile environment, exploding population, dramatic increase in numbers of livestock, and uncontrolled extension of agriculture without concern for the resource base — all coinciding with nearly twenty years of relentless drought. As these pressures increase, the land becomes even less productive,and ever more vulnerable to drought and desertification.

In tackling these problems, CILSS has followed the now-familiar UNESCO approach of encouraging many activities at once: research and experimentation on ways of rehabilitating a devastated environment, arresting the encroaching desert, and enhancing productivity; recognition of training as an integral part of science and institution-building; provision of special educational assistance for high-level personnel who are responsible for implementing anti-desertification programmes; dissemination of results of research and integrated management techniques; and encouragement of scientific and technical cooperation and information exchange among the participating countries.

National benefits through regional cooperation

Despite certain shared characteristics, each country in CILSS has its own development plan, its own research interests and its own priorities. The CILLS project enables each country to retain this national identity and build upon it, while benefiting from intellectual and material resources available beyond its own frontiers. In this way, the institutions themselves gain experience in research and training, thus enhancing their own scientific capacities, and, in turn, assuring their greater participation in national development.

The choice of stations serving as focal points in each country illustrates the great variety of ecosystems and "wealth" available within the Sahel region: in Burkina Faso and Mali, for instance, protected areas known as biosphere reserves are being used. They cut across zones devoted to agriculture, livestock, and timber and, as part of UNESCO's biosphere reserve network, these parks play a special role in research on conservation of genetic resources. In Niger, two ranches have been identified as suitable sites; their inclusion will allow the project to make valuable economic and ecological comparisons between traditional free-range practices and modern ranch management. In Senegal, one station is located in a pastoral zone, while the other looks toward agroforestry.

Drought may be an "act of God", but many of the subsequent disasters are man's own creation. As the preceding examples show, scientific knowledge applied to land-use problems in arid regions, holds the promise of a better future.

Building for survival

"Earthquakes don't kill people, collapsing buildings do"

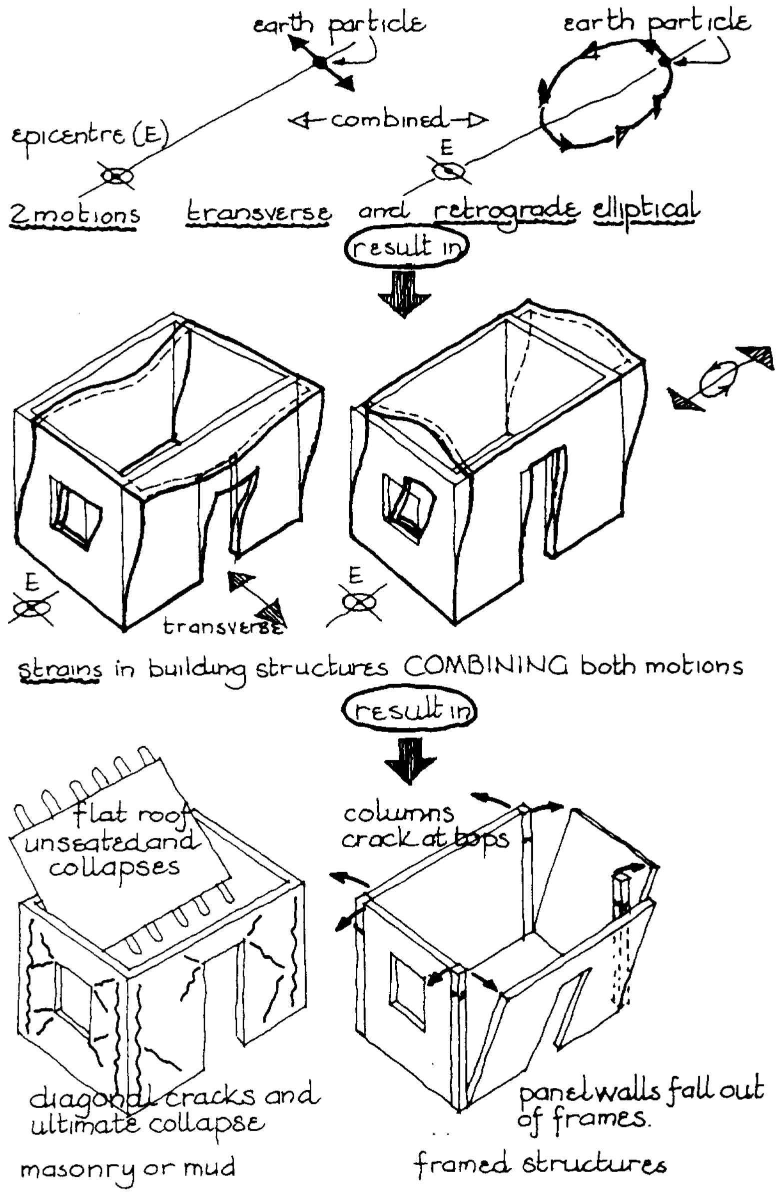
The truth of this observation by a UNESCO architect was never more dramatically illustrated than by casualty figures for two spectacular earthquakes of 1988-89. In Armenia, out of the 25,000 deaths announced, more than 6000 were teachers and students who perished in educational institutions as walls buckled and tons of concrete came crashing down on them. In San Francisco, where strict earthquake-resistant building codes apply, there were 60 deaths, and these occurred because the steel girders of a double-decker bridge gave way, crushing commuters in their automobiles beneath.

Natural hazards may well be inevitable: they result from forces over which we have no control. But the losses and damage these hazards engender – the disaster part of the event – need not be. Providing the right preventive measures are taken, death and destruction can be minimized.

Since the 1960s, UNESCO has included architectural advice in its package of educational services to member countries. Working out of headquarters in Paris or through regional offices in Bangkok (Thailand), Dakar (Senegal) and Santiago (Chile), the architects advise national authorities on school reconstruction costs and priorities in the aftermath of disaster.

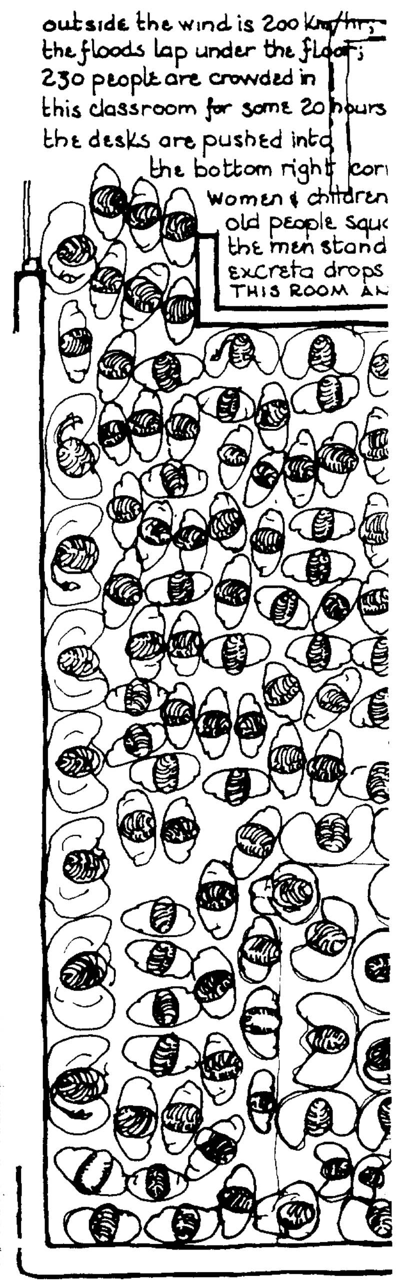
Their first task is to assess the damage to school facilities and to draw up a document giving detailed estimates of reconstruction and rehabilitation costs for prospective funding sources. They may suggest ways to set up temporary classrooms, using tents or prefabricated structures, so that learning can go on uninterrupted. Once the emergency is over, they may propose ways of reinforcing existing structures or of building new buildings at a different, and safer, location. At the same time, they may recommend curriculum changes with the idea of incorporating instructions on how to

EARTHQUAKES



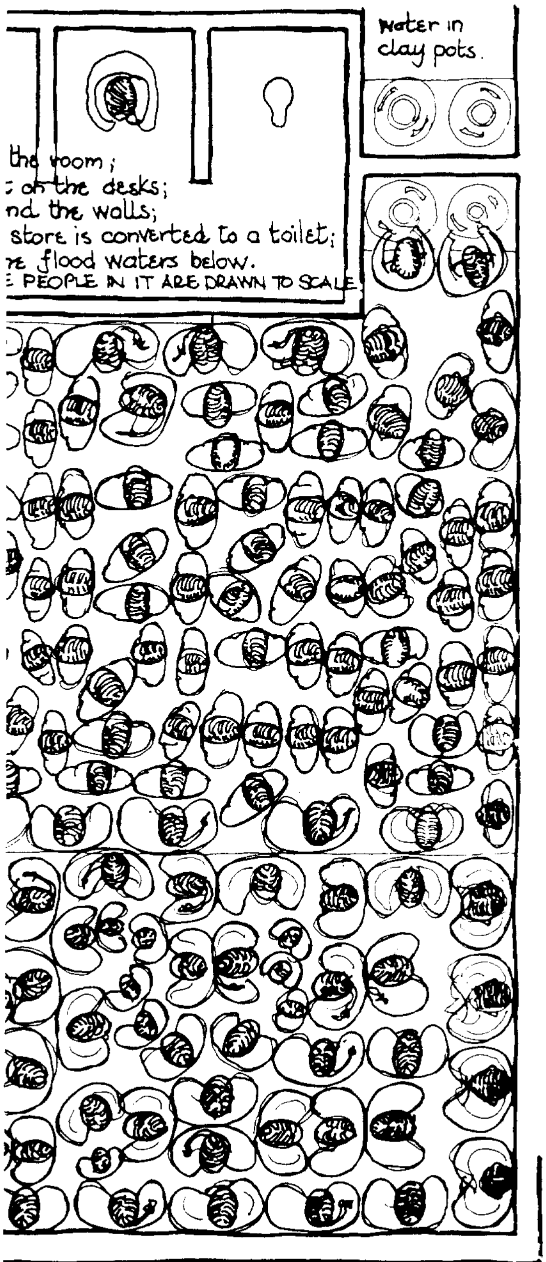
From D.J. Vickery, School Buildings and natural Disasters, UNESCO 1982

These drawings from a UNESCO handbook show why certain kinds of building construction are not resistant to earthquakes and other natural hazards.



D.J. Vickery, School Buildings and Natural Disasters, UNESCO 1982 *evacuate a building rapidly, or what supplies to bring to an emergency shelter, or on how to protect buildings against further damage.*

Dual purposes: a disaster-resistant school building can also serve as a refuge and focus for relief activities. Only clean water, toilets, simple cooking facilities and a storage space are needed, beside assurance that the building is safe. This drawing to scale shows how 230 people might occupy a classroom during a cyclone.



The multiplier effect

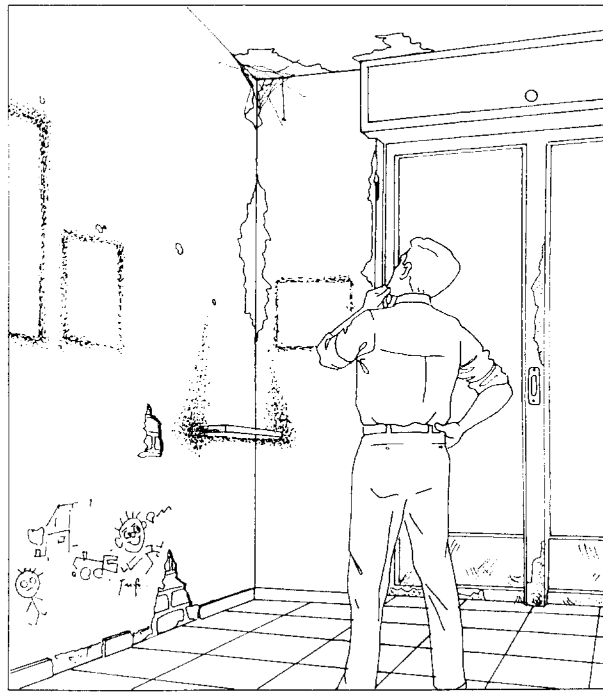
UNESCO is not a funding agency. It must rely on the multiplier effects of its "starter" grants, pilot projects and the construction of prototypes for mobilizing resources from outside sources. Projects may attract the attention of external donors, but the best results are usually obtained when the local community, together with national authorities, make a commitment to see the project through for themselves. In this way, very basic programmes for training technical personnel in simple construction techniques and maintenance routines can have a major impact in reducing the damage from natural hazards.

A good example is Viet Nam. Following three decades of isolation and war, the Vietnamese embarked on a country-wide campaign to build new schools. In terms of numbers, the effort was a huge success: by 1985, 15 million children were enroled and using 100,000 classrooms. But in terms of quality, the campaign was less than successful, for structures were erected without any regard for safety, sound engineering principles, or disaster-resistance.

Viet Nam, like many countries in the tropics, is subject to battering by frequent storms that combine gale-force winds with torrential rains. A study estimated that 85% of the nation's school building are probably vulnerable to these typhoons. After a single storm in northern Viet Nam, government statistics revealed that 1,520 classrooms, 1,106 laboratories, and 760 teachers' quarters had been destroyed. What were the causes?

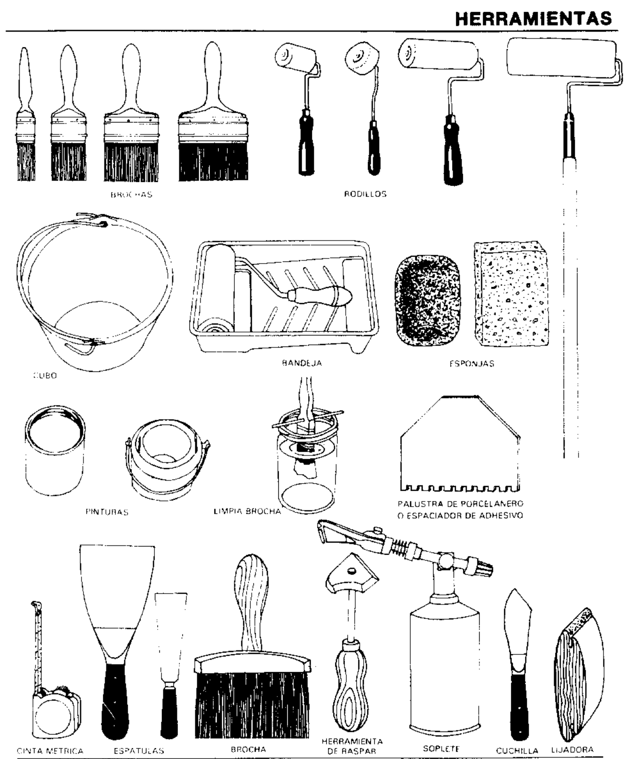
UNESCO's consultant identified a whole list of factors: poor site selection in exposed areas; wrong shapes or size of buildings; failure to reinforce structural elements with supporting pillars or ties; weak hinges on *doors and windows – usually the first point of collapse; failure to bolt or bind the roof to walls and rafters, and walls to foundation; low-quality building materials; inadequate use of trees as wind breaks; neglect of maintenance tasks. The list could apply to many disaster-prone countries beside Viet Nam, and indeed, similar inventories exist for Peru, Fiji, Algeria, Sudan, Mexico, Soviet Armenia, Venezuela and Tonga – to name a few of the other countries where UNESCO has worked with local authorities in the wake of disaster.*

This "report card" of structural weaknesses, however, was the beginning of a rewarding partnership with the Vietnamese to develop prototypes of buildings able to withstand typhoons. Training workshops were



An example of the Spanish-language maintenance manuals produced in association with UNESCO and showing in words and images how to keep buildings in proper repair.

Illustrations: Guayo Autor



organized, guidelines for safe construction were drawn up, and checklists of available local materials and how to reinforce them were created. Out of this came one prototype design for a totally new school, and one prototype for ways of strengthening existing structures.

Beside the technical features of typhoon-resistant architectures, the project included plans for administrative linkages and support, for getting Vietnamese manufacturers to supply needed reinforcement materials, and for developing awareness on the part of authorities, teachers, and the public about the importance of various safety measures. At the very least, strongly-built schools can be designated as disaster centres – another example of the multiplier effect.

The foregoing example describes how the control of school design and construction can protect structures at risk from typhoons and cyclones. Earthquakes are another natural hazard whose impact UNESCO has long worked to counteract, with programmes much like the one above.

An Indian engineer has developed a method using interlocking timbers as an earthquake reinforcement "ring" beam. The timber-tie beams are the only earthquake protection affordable to villages so remote that building materials are brought in by porter. Already 250 primary schools in India are equipped with the reinforcement, and similar applications are being planned for Nepal, Argentina and other seismic zones. Once the prototype is developed, benefits multiply rapidly.

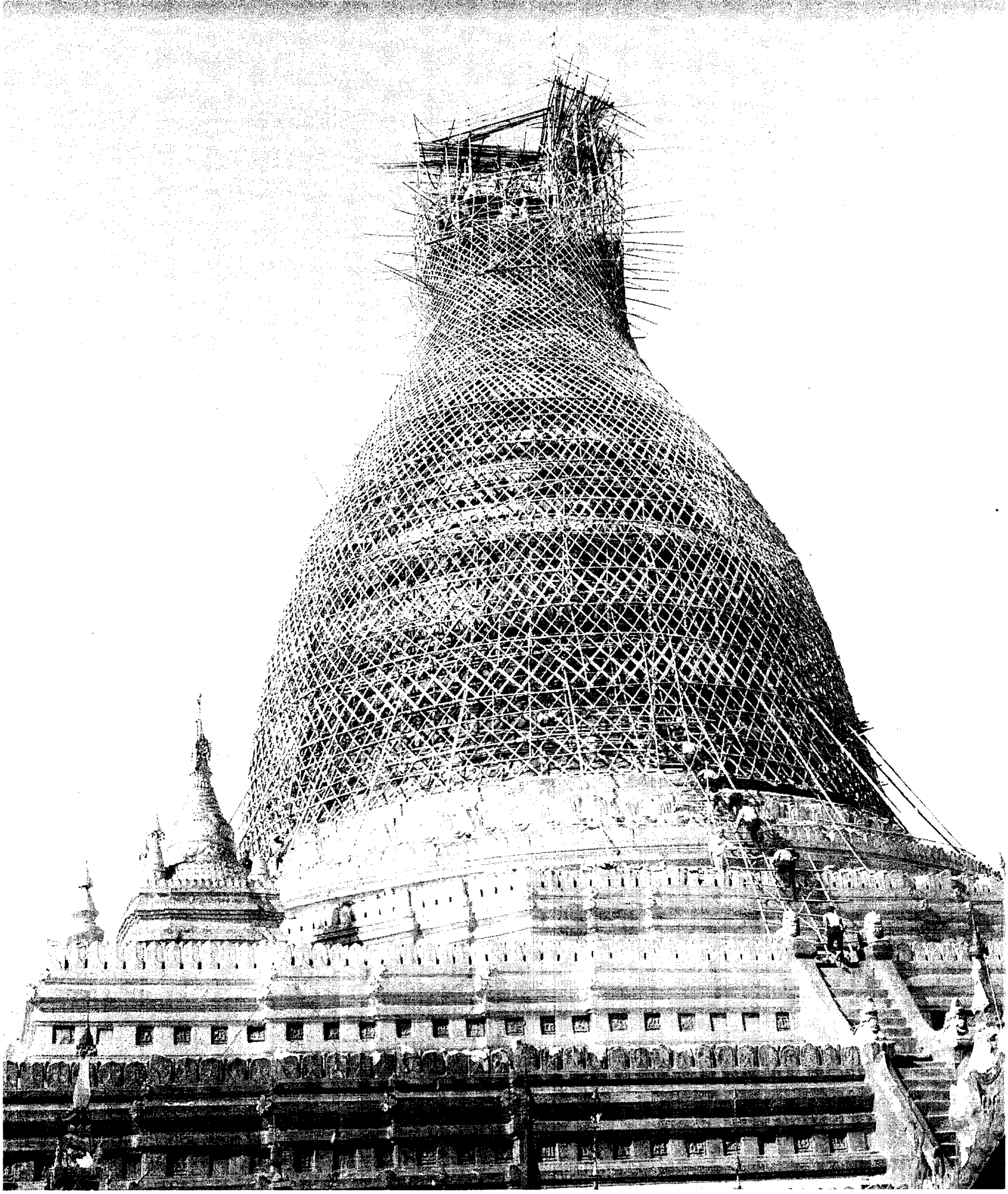
Good maintenance:
cost-effective hazard reduction

Finally, a word about preventive actions which are so basic and obvious that they have often been overlooked: good maintenance and repair. Although common sense may dictate to some people the wisdom of keeping buildings in a good state of repair, not all people see the connection between maintenance work and disaster prevention. In many cultures the skills required are not taught, and there is no place to turn for guidance.

Now UNESCO is working alongside education authorities to fill this gap, by developing training materials that deal specifically with good maintenance practice. The manuals are prepared in consultation with people from the communities concerned, they are written in the local language, they give clear instructions about what needs to be done – everything from leaky faucet repair to painting, plastering and roof reinforcement – and they demonstrate in words and pictures exactly how to do it.

The approach is a modest one, but there are many advantages in these do-it-yourself manuals. They are inexpensive to produce, they can be custom-tailored to a particular situation and, at the same time, with small modifications they can be adapted to the training needs of other communities. Perhaps best of all, such manuals promote self-reliance and self-instruction, as they are now doing in such diverse countries as Nicaragua, Venezuela, Bhutan and Nepal. By setting standards that are clear to everyone, each person involved in the project can measure progress made and see how his or her area of responsibility contributes to community goals. The incorporation of repair and maintenance routines into daily life could save lives when disaster strikes.

A British architect and former UNESCO buildings specialist has neatly summarized the urgency of building for survival: "In most rural settlements throughout the world, the school is the largest building in town. During the day, it houses most of the younger generation on which the future of any community depends. In a natural disaster, therefore, the school has to survive, since an entire generation in it may be at risk."



Looking like lattice-work, this bamboo scaffolding protects an 11th-century temple in Pagan, Myanmar, damaged by earthquake in 1975. Inscribed on the World Heritage List, this major Buddhist site comprising 5000 temples, royal dwellings and other monuments, has benefited from restoration work that both reinforces the structures against future seismic shocks and restores them to their former glory.

Safeguarding the past

The irreplaceable cultural heritage

Once unleashed, the violent forces of nature respect neither geopolitical frontiers nor cultural integrity. In 1982, the town of Popayan was razed by an earthquake. Other earthquakes have devastated Pagan, the ancient city of 2000 Buddhist pagodas in Myanmar; Kotor, Yugoslavia, home to magnificent romanesque frescoes; and Göreme, the valley near Istanbul, where cone-shaped rock formations and troglodyte monasteries provide an awesome testimony to the Byzantine Age. In Bangladesh, the ninth-century Buddhist monastery at Paharpur is threatened by regular and heavy flooding, as is the historic city of Venice, whose 1000 palaces and churches hold treasures from every era of European civilization. The slave-trade island of Gorée, just off the coast of Senegal, has also fallen victim to a difficult environment. The salty atmosphere corrodes metal structures, winter winds and tornados lash at rooftops, while the eroding action of the sea completes the process of destruction.

When disaster strikes, the cost of losing part of man's cultural heritage must be added to the tragic toll in human life and suffering. No figure is adequate for something that is irreplaceable. However, studies have shown that much of the damage could be avoided if the right measures were taken to reduce vulnerability and ensure emergency safeguards. For instance, although general engineering principles of earthquake resistance are now well-known, they are seldom applied to historic buildings in high-risk areas. Also, since protection of the cultural heritage is rarely integrated into civil and military protection schemes, looting and unnecessary demolition often occur in the wake of catastrophe.

If requested, UNESCO will intervene and advise on restoration or safeguarding of the cultural heritage. Some of the best-known international campaigns for cultural solidarity have actually had their starting point in the emergency that followed a natural disaster.

Venice is one example, Guatemala City another. Assistance has also been given to El Asnam and Tipasa in Algeria , rocked and destroyed by violent tremors.

In the immediate aftermath of disaster, of course, assistance will focus on help to any human victims, on the need to mobilize emergency forces and to restore essential services. Under the circumstances, protection of cultural property is a secondary priority and must be seen to by authorities at the local site. Initial safeguarding measures can include: the marking of damaged monuments to spare them from the bulldozer, organizing a guard service, evacuating movable property, providing temporary covering such as tarpaulins or sheets to protect exposed objects, and the drawing up of a preliminary inventory of damage done.

It is at this stage that UNESCO expertise is often called for. In consultation with appropriate authorities – architects, urban planners, engineers, scientists, specialized museum personnel and local leaders – a practical scheme is devised for the restoration work. When possible, this action plan provides not only for the restoration of the sites, but also for the improvement of the environment and the installation of certain safeguards against future risks.

At Borobodur in Indonesia, a conservation laboratory set up to study the famous ninth-century Buddhist temple, has also been supplied with seismographic equipment which acts as an early warning against volcanic and tectonic earthquakes. In Pagan, where earthquakes are considered a permanent threat, experts have been labouring to reinforce the ancient temple

Convention Concerning the Protection of the World Cultural & Natural Heritage

The adoption of a World Heritage Convention by UNESCO's General Conference in 1972 broke fresh ground by affirming the existence of a World Cultural and Natural Heritage which belongs to the whole of mankind, and by inaugurating a vast project to define and inscribe on a World Heritage List sites and monuments of such outstanding value that their protection is the responsibility of everyone. In so doing, it ushered in a new form of cooperation and solidarity among nationals and people.

The List published in January 1991 shows a total of 337 properties in 73 countries, of which 245 are cultural sites, 78 are natural sites, and 14 combine cultural and natural features. All are deemed to be of "outstanding universal interest and value" as recognition requires. As its title suggests, the Convention's main purpose is the safeguarding of the heritage, whether it be architectural monuments and ensembles, landscapes, or nature reserves.

It is interesting to note that, from its beginning, the Convention has made explicit reference to natural calamities and cataclysms, which it defines as serious fires, earthquakes, landslides; volcanic eruptions; changes in water level, floods and tidal waves. Properties included on the World Heritage List, which are also threatened by some kind of natural hazard, are placed on a "List of World Heritage in Danger" where they become eligible for "priority consideration" and for financial assistance from an emergency fund. For example, after the historic centre of Quito, Peru was damaged by an earthquake, the World Heritage Committee granted emergency assistance under the World Heritage Fund to restore the most affected buildings.

Like all such accords, the World Heritage Convention confers certain benefits and privileges. To be included is prestigious, and recognition by the international community can provide a much-needed incentive to national authorities to take responsibility for the heritage in their care seriously. In addition, countries become eligible for technical assistance, training in conservation, and other kinds of expert advice.

With 117 participating States, the World Heritage Convention is the world's most ratified agreement on conservation. The IDNDR now provides an opportunity to build on what has already been accomplished.

walls. A new drainage scheme under construction at the Paharpur Vihara in Bangladesh, is aimed at protecting the monument from regular and damaging floods. In the Azores, earthquake-damaged buildings in the port of Angra have been rebuilt as part of an overall urban development programme that respects the architectural flavour of the 17th-century city but improves on some basic amenities.

An 'ounce of prevention' is good value

As in its education programmes, UNESCO has come increasingly to stress the importance of regular maintenance work as an essential part of good preservation practice. The state of preservation of monuments may prove crucial in the event of an earthquake. Earthquakes cause masonry to break up. But experience has shown that masonry properly repaired and maintained, even without precautionary strapping or reinforcement, has resisted with a minimum of damage and sometimes without any damage in the event of an earthquake, whereas in the immediate vicinity buildings that were poorly maintained or not maintained at all were dislocated or collapsed.

Good upkeep means that all monuments should be periodically inspected; any weakness should be noted immediately and remedied as soon as possible. Nevertheless, in earthquake areas more than anywhere else, the work should be carried out with great care, for the slightest carelessness can be dangerous. UNESCO encourages programmes for the training of qualified local people, often in tandem with other international organizations, funding partners or educational institutions. Where complex monuments are concerned, however, it is often advisable to include a variety of specialists, who work with the architect or engineer as part of a team. Such an operation could include a vulnerability study, a geotectonic survey of the area, an analysis of the foundation soil, photogrammetric studies and the production of a seismic map that pinpoints the location of each monument and shows its relation to the earthquake zones.

Not all projects are so ambitious. Staff in the Archaeological Museum of Chile and in Mexico have been taught how to protect the fragile objects in glass showcases from earthquakes — thus safeguarding what is known is movable property. These are modest actions, but taken cumulatively, they too can make significant contributions to risk reduction.

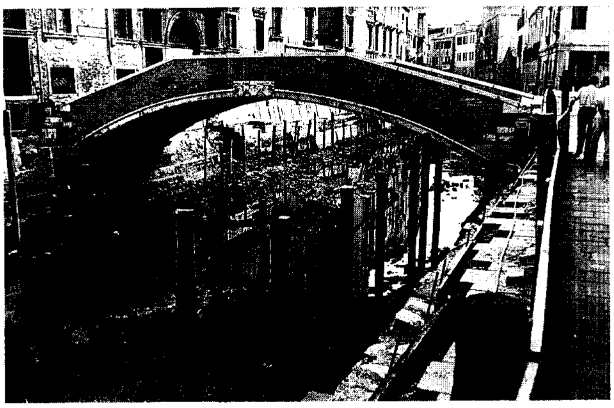
Venice: complex interactions between cultural and natural environments

One of the best-known of UNESCO's cultural rescue missions has probably been its campaign to save Venice from high water and subsidence. Tidal floods, known as "acque alte", have always occurred in Venice; but in recent years they have increased in frequency and magnitude. On 4 November 1966, a storm surge of exceptional height and duration washed across the city, flooding the lower storeys of buildings and covering St Mark's Square by more than a meter of water. The whole world suddenly took notice of the growing dangers threatening the City of the Doges. Was this landmark of human civilization doomed to vanish into the sea?

On 2 December 1966, UNESCO's Director-General launched an appeal on behalf of "our common human heritage". He was soon joined by other international organizations, by national authorities, research institutions, private groups, and sympathetic individuals from around the globe in a campaign to restore Venice to its former glory, and to find ways to halt the accumulative effects of water damage, a deteriorating environment, and subsidence.

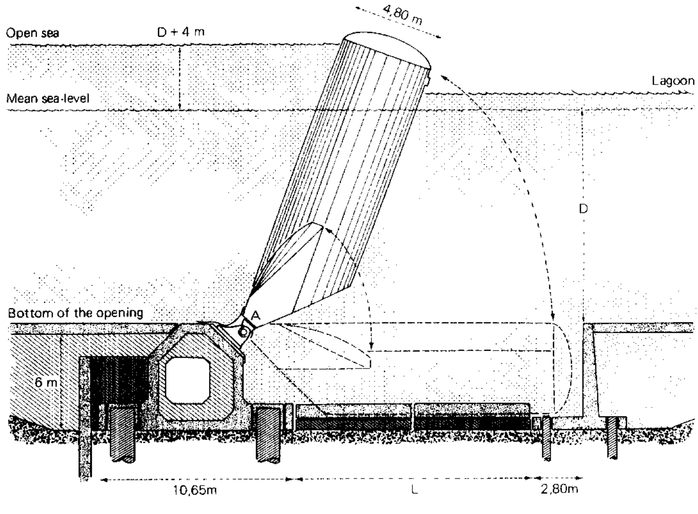
As a first step in the action plan, some sixteen thousand paintings, sculptures, and frescoes — including items found in church sacristies — and some 550 palaces, churches and convents were inventoried. Lab-

The combination of rising sea-level and subsiding foundations could spell the end of one of the western world's most beautiful cities.



The UNESCO campaign to save Venice has recognized both the scientific and the cultural dimensions of the problem. Restoration efforts began from the bottom up.

Mobile sluice gates positioned at the three main entrances into Venice lagoon could provide relief from high tides and persistant flooding.



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oratories were established for the cleaning and restoration of stone, and for repairing damaged artefacts such as water-logged manuscripts and altar pieces. Several churches and other historic buildings were saved. Arts festivals and other fund-raising events were organized.

But perhaps the most valuable contribution from UNESCO did not directly concern either art or monuments, at least not in a narrow sense of the word. Instead, the Organization's greatest achievement was in taking a holistic view of the problems of Venice, and in seeking to show how an understanding of the causes – both social and environmental – might provide the key to safeguarding her unique cultural heritage.

This interdisciplinary approach, which included inputs from social scientists, town planners, architects, hydrologists, geophysicists, marine biologists, hydraulic engineers, historians, urban geographers, and legislators, was an undertaking of unprecedented complexity. One part looked at urban structures and their relation to the physical environment; another identified various interactions between Venice and its lagoon. The integrated results of both parts would lead to scientific solutions for protecting Venice.

Today, more than twenty-five years after the fateful flood, the work continues. Historic buildings and works of art damaged by salt water continue to be restored. Courses on the technology of stone conservation allow students from countries as far away as China, Haiti, Venezuela and Ethiopia, to benefit from the experiences of those who have worked in Venice; and scientific studies on the feasibility and possible impact of different engineering projects for protecting Venice are still being conducted.

The option considered by the Italian authorities would prevent the exceptional tidal surges from ever reaching the city, by temporarily closing off the lagoon from the sea. Under this scheme, huge floodgates – measuring 300 meters long by 15 meters high and located at each entrance to the lagoon – could be pivoted shut whenever major disaster threatened. For the less spectacular floods, less costly devices such as low walls and pumps would be installed in low-lying areas.

It could take ten years or more to complete the large-scale works that will ultimately provide protection from storm surges. In the meantime, UNESCO continues to play its part as a facilitator and coordinator of the complex research effort which such an undertaking implies.

In November 1990, UNESCO and various Italian bodies signed an agreement launching a "Programme of Research on the Venetian Lagoon System." The scientific objectives are threefold: to conduct process studies using experimental sampling techniques; to build models of the lagoon ecosystem; and to carry out environmental impact studies.

In addition, UNESCO has been entrusted with responsibility for mobilizing the international scientific community to contribute to this and other research for the safeguarding of Venice and its lagoon. In many ways, it is uniquely suited to this role. Within its own walls there are experts ready to explore – as part of an interdisciplinary exercise – the ecological, economic, social, aesthetic, cultural and scientific dimensions of Venice and its lagoon. Outside, UNESCO can marshal the talent of top institutions and individuals the world over, creating a truly international network of support for this cultural heritage.

Whether a single temple or a complex entity like Venice, the cultural heritage of each people is an expression of its ingenuity and creative genius. By bringing the same ingenuity to bear in helping to protect and preserve such monuments, UNESCO and its partners are assuring for future generations the survival of the delicate thread that links past to present.

Helping people to help themselves

Rejecting fatalism at the community level

The IDNDR is not just about science and technology. It is also about how people perceive themselves and their relation to the world around them. Do they feel they can influence their lives for the better? Can they reduce risks? Explicit in the rationale for disaster reduction during the 1990s is a rejection of fatalism and passivity in the face of natural disasters. Yet how to instil a sense of control over the natural environment, when endless cycles of disaster – abetted by poverty, unemployment, cruel living conditions and marginalization from the centres of power – all conspire to suggest the hopelessness of resistance?

UNESCO addresses itself to this problem through each of its programmes – opening doors, suggesting new ways of doing things, providing alternatives. It reaches out to people and offers a helping hand. Not through gifts of money or things, but by giving a psychological boost, and perhaps some organizational know-how, of the kind that encourages both individuals and communities to help themselves.

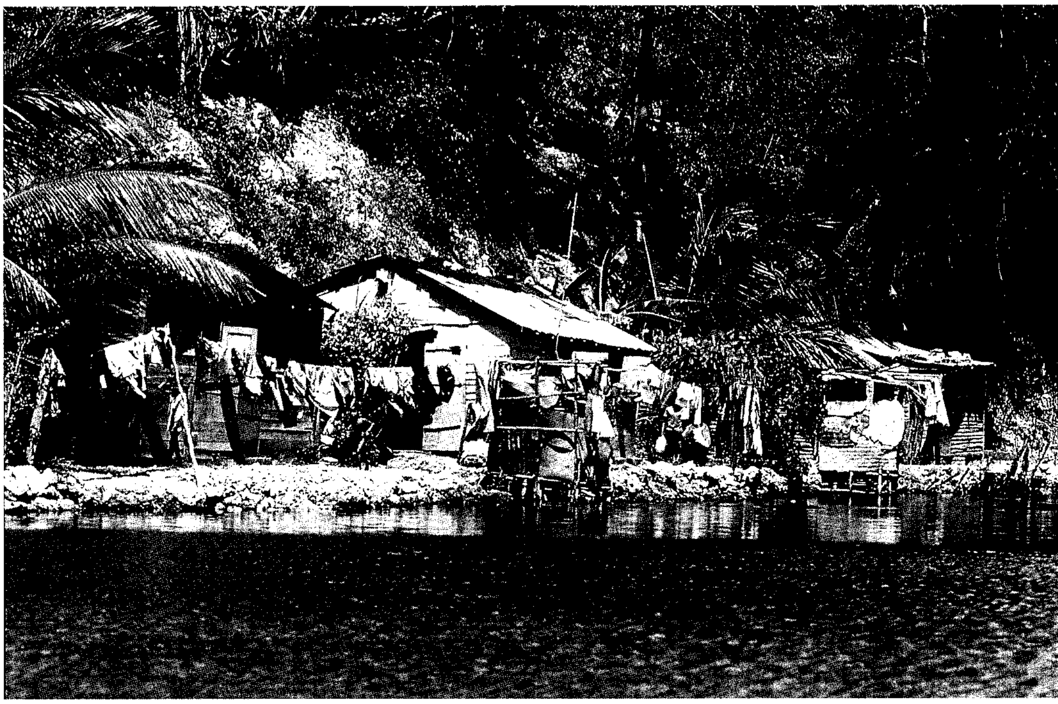
Many discouraged and passive people live in the squatter settlements outside the big cities of the developing world. Neglected or ignored by the authorities – for whom they are either nuisance or embarrassment – they benefit from no municipal services and must fend for themselves. In seeking to help such communities, UNESCO adopts the same multidimensional approach that informs all its activities.

In the first instance, it seeks to understand the social problems and characteristics of the squatter settlement. What are its link with rural areas? What is its social structure, its hierarchies? How does the so-called informal sector work? What are its human and economic resources? In the second phase, having evaluated the needs and dynamics of the community, UNESCO works with the local population to define priorities for action and to ensure the broadest participation

Altagracia Reyes

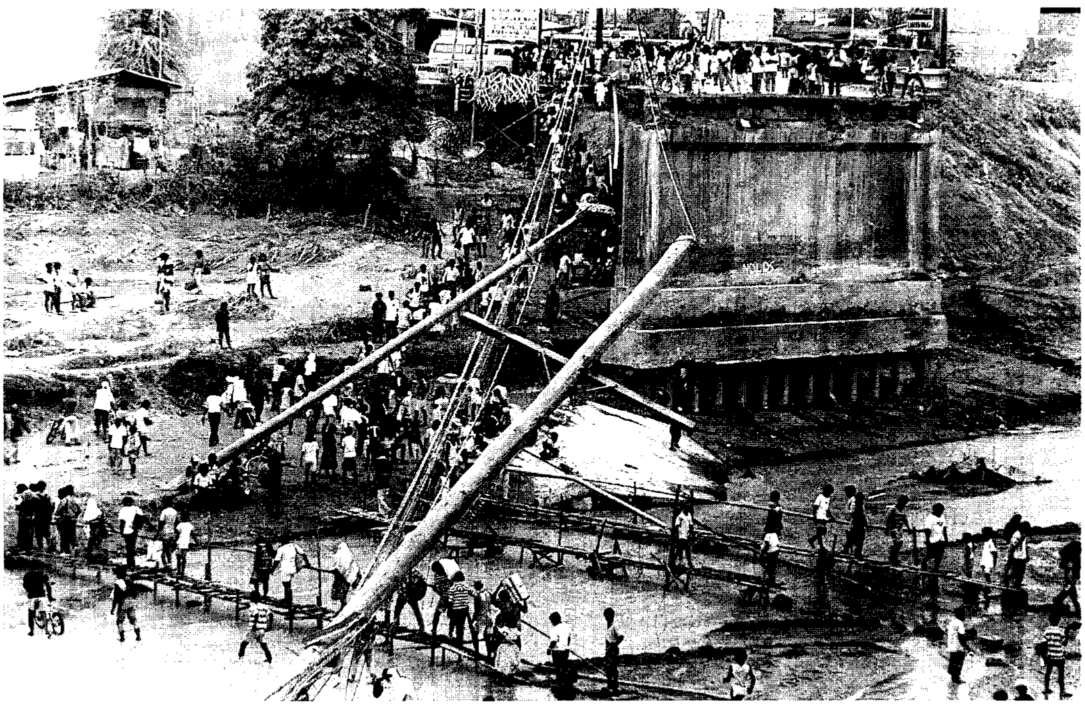
Even people who are poor can do much to improve their daily lives.

With only minimal help from the outside, the barrio of Rio Salado has installed sanitation, built steps leading to the city above, and constructed a low stone wall to prevent flooding.



W. Tochtermann/UNESCO

Despite flash floods and mudflow resulting from the combined effects of a typhoon, earthquakes and the eruption of Mount Pinataubo on 15 June 1991, residents of Angeles City, Philippines improvised these wooden bridges to help them cross the river.



Agence France Presse

possible. Using poster campaigns, public meetings, training manuals, tombolas — whatever encourages interest and pride — the project then moves to implement the plan that will bring tangible improvements to peoples' lives.

Barrio Rio Salado: a case study

The barrio of Rio Salado in the Dominican Republic is home to 4,000 people who live without amenities of any kind. Although close to the city of La Romana, the community receives no municipal services. Beside the lack of facilities, Rio Salado is handicapped by being just next to a river that often floods, by mudslides and erosion after heavy rains, and by its location at the bottom of a steep cliff. On the top sits La Romana, symbol of all that is desirable but unattainable. Until UNESCO's intervention in 1987, there was no access from the riverbottom to the plateau above.

As so often happens, the key to getting things done in Rio Salato lay in finding a local "someone" of influence who would support the self-help project and use his or her prestige to get others involved as well. In this case, the person turned out to be none other than the Archbishop who, as luck would have it, also happened to be the president of a development fund for the eastern part of the Dominican Republic. His considerable influence as a spiritual leader, as an experienced fundraiser, and as a general "mover", made his appeals irresistible.

The second key figure was provided by UNESCO: a consulting architect with degrees in urban planning and engineering, who had grown up in Dominican Republic but earned another diploma from a French university. Her fluency in the local idiom, her ingenuity and immediate sympathy and rapport with the people of Rio Salado, helped assure the success of the project.

The first encouraging sign came when a major sugar corporation just next to the barrio volunteered free office space for the architect. Then a community association was created to set priorities and organize the work detail. Installation of electricity, a sewage system and clean water were designated the most urgent needs, and soon the consultant was at her drawing board. In 1989, construction began. Financial donations were received from UNESCO's co-action programme and through the Archbishop's good offices, while labour and materials were supplied by the barrio itself.

Since this humble beginning, and with only minimal outside assistance, the people of Rio Salado have accomplished miracles. They have created an "infrastructure" — giving themselves water, electricity, roads and a sewage system. They have built a school where, after class hours, public meetings can be held to discuss the next phase in their self-help project. They have installed sanitary units comprising washing facilities, toilets and showers. Along the riverside, low walls now protect the barrio from high waters, and 1000 steps — the equivalent of 19 storeys -- now lead to the top of the previously inaccessible plateau.

These, then, are the outward signs of progress in a poor squatter settlement of Central America. But the greatest transformation is invisible: no longer marginalised, nor mere passive victims of an inclement social and natural environment, the people of Barrio Rio Salado have shown they can shape their own future. This is the true meaning of the International Decade for Natural Disaster Reduction.

Conclusion

The launching of the International Decade for Natural Disaster Reduction is a means of focusing attention on the particular problems associated with calamities of natural origin, and what can be done to limit their impact on human populations.

UNESCO, by virtue of its exceptionally broad mandate covering education, the social and natural sciences, culture and communication, is uniquely placed among the international agencies to contribute to this effort. Whether directed towards architectural and engineering improvements that make school buildings or cultural monuments more hazard resistant; whether aimed at research on underlying causes of natural phenomena, or on empirical observation; whether focused on the human dimensions of disaster avoidance, on training or information-sharing – the UNESCO perspective is multi-disciplinary and gives priority to solutions able to integrate the scientific, cultural and social dimensions of a problem.

The activities presented in this booklet are by no means comprehensive. Instead, we have selected a few projects that appear to us to be representative of the kinds of approach, and kinds of substantive areas, in which UNESCO is working to make the world a better place for all.

The effects of the actions which UNESCO undertakes, which may be relatively small in themselves, are greatly amplified by the actions of others. These "others" are too numerous to mention, although they are indispensable to the success of the projects. They include: the mission-oriented agencies of the United Nations family; international non-governmental organizations; national bodies; research institutions; universities; local authorities and private individuals.

International cooperation is based on the idea that the sum is greater than its parts. Natural disasters affect every corner of our planet, without regard for political boundaries or level of development. Although in some respects the requirements for the developing and industrialized countries of the world may differ, they share a common challenge in the face of natural disasters and the havoc they wreak.

J. Richardson, Island Business

Perched atop the matchstick remains of his typhoon-damaged classroom, this young Fijian displays a certain ambivalence familiar to schoolchildren the world over: pleasure in realizing there will be no school tomorrow, but distress in knowing what this could mean for his future.