Natural
Hazard
Research

THE 1982 URBAN LANDSLIDE DISASTER AT ANCONA, ITALY

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SUMMARY

This study describes the landslide that occurred in the City of Ancona, in central Italy, on December 13, 1982. An integrated view of the disaster is obtained by examining its political, social, logistical, financial, geological and geotechnical aspects, with particular emphasis on interactions among these factors. The report describes the evolution of both physical events and human response (including the debate over responsibility and the struggle of local politicians to obtain relief and reconstruction funding from central government). Geotechnical site studies at Ancona are criticized and appraised with respect to the use made of them by local politicians and planners.

The Ancona landslide, which destroyed or damaged 785 homes and affected 11% of this city of 108,000 inhabitants, was one of the largest of such disasters to occur in recent European history. Herein, it is evaluated as a complex, multi-faceted phenomenon or train of events, and compared with both the contemporary Italian natural hazards situation and a smaller landslide disaster which occurred in central-southern Italy shortly afterwards. Italian hazard response is appraised in the light of these disasters.

ACKNOWLEDGEMENTS

The information contained herein is derived from a variety of scientific and technical articles, which are listed in the bibliography at the end. Much information has also been obtained from a total of 518 newspaper articles collected by myself, dott. Alessandro Montanari of the University of California at Berkeley, and the Ufficio Stampa della Regione Marche (Giunta Regionale delle Marche, 1983). I was able to gather further information during a brief visit to the disaster area in January 1983, which was partly financed by the International Disaster Institute (now the Relief and Development Institute), London, U.K. Major support for this work was provided by the Graduate School of the University of Massachusetts, under Faculty Research Grant, 1982 No. 2-03415 "Seismic and Non-Seismic Landslides." I would like to thank these agencies for their support and also dott. Emidio Massi, Presidente della Giunta Regionale delle Marche, for the help of his administration. I would also like to express my admiration for their strenuous work on behalf of the people rendered homeless or jobless by the disaster.

Further thanks are due to dott. Alessandro Montanari (Berkeley, U.S.A.), Professor Renato Funiciello (Rome), Professor Uberto Crescenti (Ancona), dott. Marcello Principi (Senigallia) and, especially, dott. Leonardo Polonara, geologist of the Regione Marche, for his patient assistance and incomparable hospitality. The views expressed in this report are my own and not those of any other individual or official body. Any errors are also my sole responsibility.

PREFACE

This paper is one in a series on research in progress in the field of human adjustments to natural hazards. It is intended that these papers be used as working documents by those directly involved in hazard research, and as information papers by the larger circle of interested persons. The series was started with funds from the National Science Foundation to the University of Colorado and Clark University, but it is now on a self-supporting basis. Authorship of the papers is not necessarily confined to those working at these institutions.

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TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

Uno sfasciume geologico--the eminent nineteenth century writer Giustino Fortunato used in this term, literally "a pile of geological wreckage," to describe his native land. The phrase has been much used since to describe Italian natural disasters, which occur with what one might call "monotonous irregularity"--that is to say at irregular but frequent intervals. A natural disaster has been defined as the destructive interaction between adverse physical events and human socio-economic systems (White and Haas, 1975; Foster, 1980) and the seriousness of the damage caused in each new Italian calamity emphasizes the extreme vulnerability of the human social and economic systems in that country, where hardly a year passes without some major new catastrophe and a rash of minor ones. Besides being a physical event with socio-economic repercussions, the Ancona landslide disaster is clearly the result of misunderstanding, and even gross negligence, on the part of those who might have been able to recognize the warning signs and prevent the worst effects of catastrophe. Consequently, the short-term aftermath rapidly developed into something perilously close to a national scandal, with a welter of recriminations and counter-accusations. This report inevitably deals with these aspects of the disaster, although it is intended only to comment on the relevant aspects of hazard prediction, geotechnical science, and disaster management.

Italy can be fairly characterized as a land of steep slopes, mountainous river catchments and seismically active geological faults. The combined natural hazards of landslides, soil erosion, floods and earthquakes have taken a considerable toll on the national economy and life. Since 1945, natural hazards in Italy have left 11,000 people dead and caused 60,000 billion lire (U.S. $38 billion*) of damage. Although Italian earthquake disasters happen on average once every 4.8 years (Ganse and Nelson, 1981), landslides play a significant and increasing part in the national losses from hazards. A study by the National Geological Association revealed a dramatic increase in the incidence of damaging landslides over the period 1957-1970, when the number of recorded slides in Italy rose from 1,987 to over 3,000.

The country's National Order of Geologists compiled questionnaire information from 4,021 comuni** (municipalities), representing 49.8% of Italy's townships, and recorded that 1,072 urban centers are menaced by landslide activity. In one year, 1971-2, landslides blocked highways for 2,476 road-days. Floods, which often go hand-in-hand with landslides, have occurred in 1,520 comuni since World War II, but only 5% of those municipalities who responded to the questionnaire had actually commissioned scientific or technical studies of landslide or other ground stability problems.

The central Italian region of Le Marche*** (Figure 1) is particularly vulnerable to natural hazards. Of its 246 comuni, 230 are classified as "seismic," or likely to be endangered by major earthquakes. A 1963 study reported that landslides are common throughout the region, and have seriously damaged 122 urban centers, including Corridonia, Mogliano, Montappone, Monte Lupone, Monte San Giusto, Recanati and San Leo. One of the most well-known landslides in the region occurred on the western outskirts of its capital Ancona. The original "Barducci landslide" was 16 hectares in size

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* Monetary equivalents are given at the May 1986 exchange rate of U.S. $1.00 = 1550 Italian lire.

** See Appendix I for definitions of the comune and other administrative divisions.

*** Total population 1,409,845, distributed over 9,694 km^2 at an average of 145 persons per km^2.

ANCONA AND LANDSLIDE: LOCATION MAP

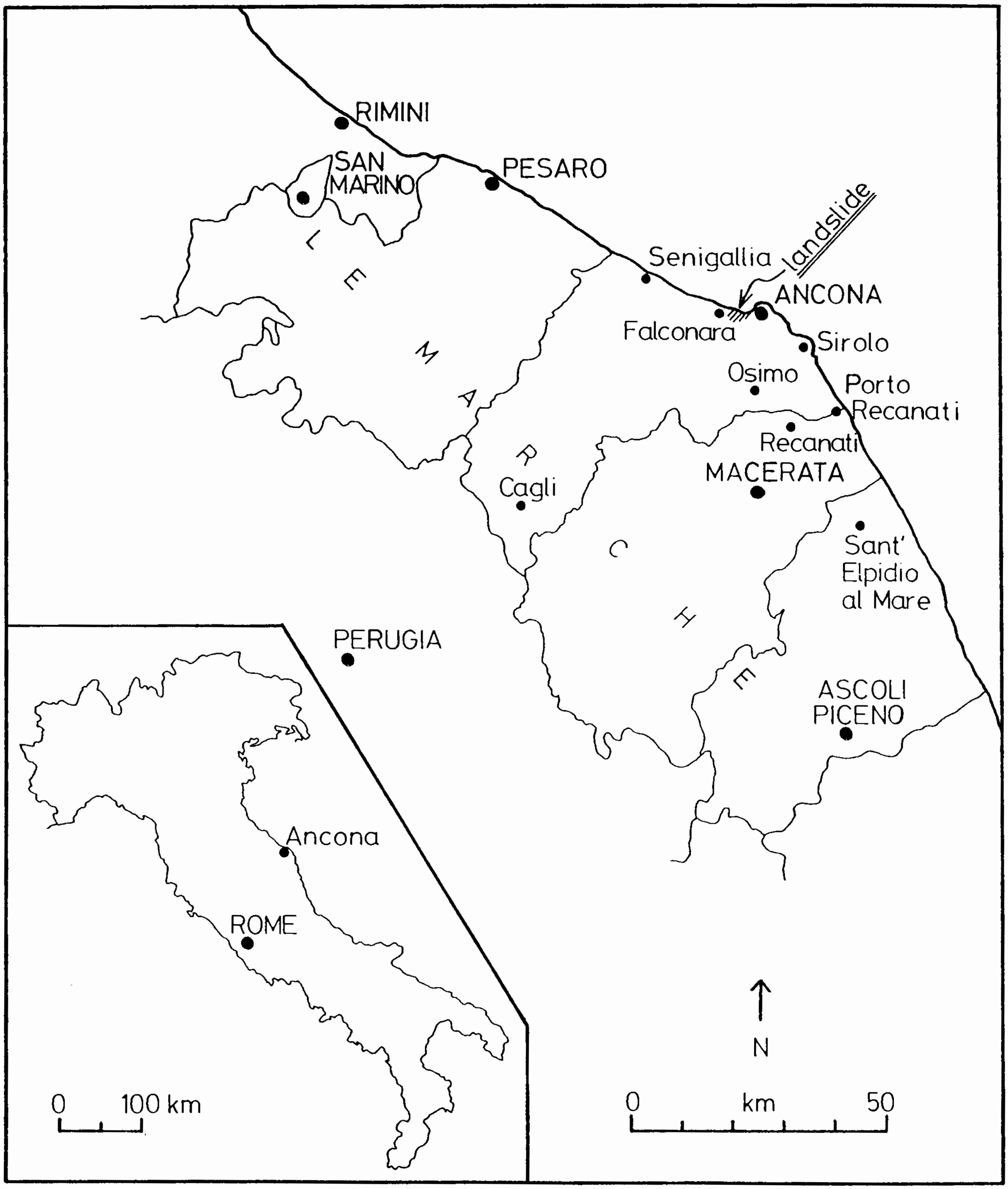


Figure 1

and constituted one of two rotational landslides on the Adriatic Sea flank of Monte Montagnolo (251 m). The slides were clearly of some antiquity and by no means stable: on July 23, 1962, the newspaper Il Giorno reported movement of the Barducci landslide under the stimulus of high pore water pressures in the saturated soil.

Evidently little was being done to ensure the stability of the slope--Il Giorno stated that the land was variously unmanaged, mismanaged or abandoned--and two decades later the entire slope slid abruptly towards the Adriatic Sea in a movement that involved 341 ha of land, 21 times the area of the original Barducci landslide. By this time a good proportion of the formerly neglected land had been urbanized and, although fortunately without a significant number of fatalities, the 1982 Ancona landslide caused very serious problems of damage and homelessness.

The disaster came hard on the heels of previous natural catastrophes. While the Italian Mezzogiorno was still heavily involved in the reconstruction of areas damaged by the November, 1980 earthquake (Alexander, 1982a), further tremors had occurred on March 21, 1982 with damaging consequences at Maratea in Basilicata (Alexander, 1985) and, closer to the Marche, at Assisi and Gubbio in Umbria Region on October 23, 1982. At the end of November, 1982, riverine floods caused damage near Lucca in Tuscany and in the Marche. Flash flooding occurred with disastrous consequences on the River Taro in Emilia Romagna, and the winter saw notable damage by new and reactivated landslides in eastern-central Italy.

The following report will therefore deal with the Ancona landslide as both a catastrophe in its own right and as a component of the national natural hazards problem, for which comprehensive legislation and measures are required. The report is divided into five chapters dealing respectively with logistical, political, physical and architectural factors, and the regional background of geological hazards. The first section describes the disaster as it affected the City of Ancona, the response of local and national government to the need for special powers and finance, and the evolving problem of mass homelessness caused by the landslide's destruction of housing. The second chapter describes the debate over who should be held responsible for the disaster, which rapidly burgeoned into a lively polemic and was referred to in the press as "a war between geologists and administrators." The reason for presenting this debate is neither to seek a final judgement on whose responsibility the landslide was nor to make further recriminations, but the debate is interesting and useful in that it throws light on the practice of decision making at several levels of government, and exposes weak points and inadequacies in that process. Similar reasons justify the analysis of relations between central and local government, which I present below, and which involved a complex process of bargaining for limited relief funds.

The third section of the report deals with geological and geomorphological (land form and process) aspects of the disaster. The main purposes of this part are to explain the physical conditions of the landslide zone, to give some indication of why the disaster occurred at the time and on the scale that it did, and to examine whether it could have been predicted. Architectural observations made on site after the disaster are presented in the fourth section, and in the final section the 1982 Ancona landslide is compared with other, contemporary natural hazard problems in Italy, in terms of both physical aspects and competing demands for relief.

SOCIAL, ECONOMIC, AND LOGISTICAL ASPECTS

Previous Disasters at Ancona

Like many settlements in Italy, Ancona has an ancient and complex history of natural disasters. It is situated on a small coastal peninsula (Figure 1), bounded on the inland side by soft Quaternary and Tertiary sediments that have been incised by streams and faulted and tilted by tectonic movements often associated with earthquakes. As a result, the city and its environs are variously susceptible to erosion, surge flooding and storm damage along the coast, stream erosion, landslides and river flooding on the coastal footslopes, and earthquake damage. Early records show that several churches on the Anconetan peninsula were destroyed by landsliding during the period 1600-1650 (the church of San Clemente ending up in the sea); in 1679 a church and leper hospital were damaged in the collapse of a slope at Capodimonte, in the historical center of the city. Further damage was caused by a severe storm and gale that occurred in the Adriatic basin on September 14-15, 1733, and by the earthquake of March 12, 1873 (Enciclopedia Italiana, 1933-42).

Yet, despite the seriousness of the threat from natural hazards, greater destruction took place during the Allied bombardments, of November 1, 1943, and thereafter, when 140 separate instances of damage were reported and the form of the city was irrevocably altered. Catastrophic flooding on September 5, 1956, claimed several lives, and the earthquake of January 25, 1972 (R 4.5), caused $300 million in damage and initiated a series of dangerous aftershocks that persisted until the following December. Although there were only two fatalities during the 1972 earthquakes, damage had not been fully repaired--and rebuilding was still in full swing--at the time of the 1982 landslide disaster.

The Event and Damages

At 22:35 on December 13, 1982 landsliding affected about 3.41 km^2 of the Adriatic coastlands on which the Anconetan suburbs of Posatora and Palombella, the hamlet of Borghetto, and part of the frazione of Torrette are situated. This area is located on the northern flank of Montagnolo and is sometimes known as the "frana Barducci" (Barducci landslide) area, after the principal buildings to be affected by long-term slope instability, the Villa Barducci, and a leather tanning factory of the same name. The successive rupture of water mains, which was recorded by pressure-monitoring instruments at a nearby pumping station, indicated that movement of the ground was sporadic, with surges occurring at 22:35, 22:40 and 22:50.

Eyewitness reports state that the sliding continued slowly until halting temporarily at 03:00 the following morning. Between 22:30 and 23:00 there were scenes of some confusion as about 4,000 people left their shattered homes, or the buildings in which they had been working, and sought shelter from the rain that was steadily falling. The preliminary evacuation was accompanied by a certain measure of panic, principally because the disaster was entirely unforeseen by those who were caught on the landslide, most of whom had little experience or conception of what was going on, and some of whom believed that an earthquake was either imminent or had occurred.

Housing

Two hundred and eighty dwellings were damaged, most of them multiple occupancy blocks so that the total number of homes affected was 785. Initially all of these were evacuated, although it took some days to impose and enforce evacuation orders.

Medical Facilities

The disaster area contained five medical facilities, all of them located in the suburb of Posatora: the Geriatric Hospital and the Oncological Hospital of Ancona, the Faculty of Medicine of the Universita degli Studi di Ancona, and two clinics, one a geriatric clinic with residential facilities. A total of 310 patients was immediately transferred to local hospitals at Torrette, Camerano, Jesi and Ancona Center. This operation involved the only fatality provoked by the disaster, when an elderly patient died of a heart attack while being evacuated from an intensive care ward. One hundred and fifteen patients were evacuated to the nearby Umberto I Hospital at Ancona center, and 42 were dispersed among locations in Ancona Province.

Evacuation took two hours and was necessarily rapid, as two wings of the Oncological Hospital showed signs of imminent collapse. Special problems were posed by 145 patients at this hospital, who were undergoing cobalt therapy and eventually had to be transferred to distant medical facilities at Ferrara, Florence and Bologna. Neuro-surgery patients from the geriatric hospital had to be removed to Bologna, Perugia, Teramo and Pescara. The Faculty of Medicine housed University Institutes of Anatomy, Biochemistry, Chemistry, Pharmacology, Hygiene, Medical Physics, Microbiology and Pathology. Many experiments were destroyed when the controlled conditions on which they depended were interrupted, and 3,000 students of surgery, biology and general medicine (including 400 foreign students) had their study terms prolonged and examinations set back.

Other Buildings

The list of other types of buildings damaged or destroyed in the disaster includes two gasoline stations, an automobile showroom, four factories (at one of which--a pharmaceutical factory--140 workers had to be laid off), a police station, two rows of shops, schools, a large hotel and conference center, and five churches. The cemetery at Posatora was also severely damaged, as it is located astride one of the main surface fracture lineaments crossing the landslide area.

Roads

The disaster area is crossed by two main highways and numerous minor roads, tracks and access roads. A section of the former strada statale No. 16, the "Adriatica" or "Via Flaminia," runs across the foot of the landslide, parallel and close to the Adriatic seashore and about 4 m above mean sea level. This road was pushed about 3-5 m above its pre-existing level as the toe of the landslide advanced; it rapidly became impassable and was not reopened until late January. Damage was also sustained by the strada postale, or post road, that runs across the landslide at about 870 m above sea level.

Railroad Lines

The landslide severely damaged 1,280 m of the main Bologna-Bari (Adriatic coast) railroad line. The damage occurred about 400 m west of Ancona station and, as the railroad traverses the foot of the landslide on the seaward side of the ex-Flaminia road, the length of track that was damaged effectively defines the basal width of the landslide. However, the road had partially arrested the advance of the debris toe and the railroad tracks were only lifted about 50 cm. This was, of course, sufficient to close the line (and narrowly miss derailing a train that was about to leave Ancona station for Bologna); and, as passengers then had to disembark and be transported by road on a detour of the landslide, trains on the following day were arriving at Bari from Milan and Turin an average of ten hours late (Il Giornale d'Italia, December 15, 1982).

However, the railroad line was less damaged than the road; after working around the clock, engineers were able to reopen one of the two tracks at 8:12 on Wednesday, December 15, subject to a 10 km/hr speed limit. On that day, 55 of 133 scheduled trains were able to pass over the damaged tracks. Although delays remained inevitable, rail traffic was 60 percent normalized by Thursday, December 16, only three days after the disaster. This prompt response on the part of the Ferrovie dello Stato was greatly applauded by the nation's newspapers, who contrasted it with the stultifying welter of political recriminations and machinations taking place in the centers of government.

Utilities

There is little information on the damage to electricity supplies, and it is almost certain that the effect here was limited to the landslide zone itself. The situation with respect to water and methane gas supplies was different. Water supplies were lost to Ancona, Candia, Varano, Massignano and part of Falconara. The following day schools throughout these places were closed, and they remained so until water supplies could be restored and tested for purity, which took several days. Although 60-70% of supply to Ancona City was restored within 24 hours, outlying frazioni were without water for a much longer period of time. A navy water transporter, the Basento, was drafted into Ancona harbor on December 17 and began pumping

1,200 tons of fresh water ashore to refill the serbatoio comunale (local reservoir) of Ancona. Water supplies were restored to 80% of houses by December 18.

Gas mains were ruptured under the Faculty of Medicine at Posatora and supplies to the city of Ancona had still not been restored on the Friday (December 17) after the disaster. Schools that had gas-fired central heating had to be closed and, as the date for reopening them receded with each new setback, the Christmas vacation intervened and many did not reopen until January 7. SIP, the national telephone corporation, reported that inter-urban calls could not be connected for some 19,000 Anconetan subscribers, who were also having difficulty making local calls which involved lines across the disaster area.

Special Equipment

A number of expensive pieces of equipment were damaged by the landslide. The University Faculty of Medicine building contained three electron microscopes, values at 1 billion lire ($645,000), which required specialist technical help to retrieve. A greater problem was posed at the Oncological Hospital, where a 600 million lire ($387,000) concrete vault contained two radioactive isotopes of ^{60}Co, rated at 1200 and 3200 Curies, which had been used for cancer therapy. Fears of emission of radioactivity were soon allayed, but it took a delicate operation, starting on the evening of Thursday, December 16, to remove the cobalt isotopes to safety in a vault of the military marines outside the disaster area. On December 18 a 60 m high mast owned by PTT and RAI (the national post and television corporations) was dismantled as it had suffered irremediable damage to its foundations. Finally, a number of expensive machines and other pieces of capital equipment were rendered unusable in the manufacturing and pharmaceutical factories located on the landslide. By December 16, newspapers were widely reporting that damage and all associated costs were estimated at 1,000 billion lire ($645 million), a doubling or trebling of the previous day's estimates.

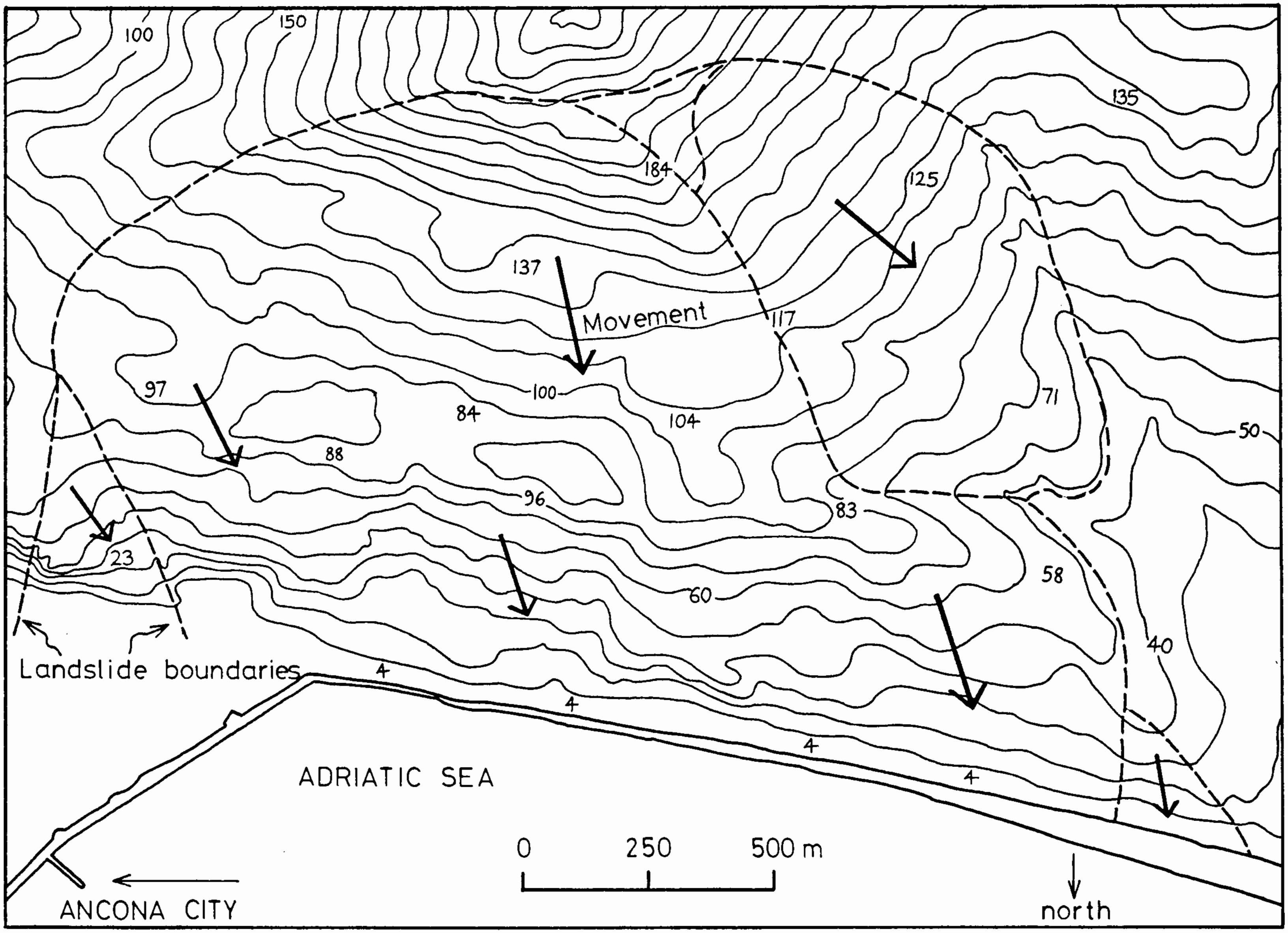
Dimensions of the Landslide

Physical aspects of the catastrophe will be discussed later in this report, but any picture of the disaster would not be complete without some indication of the physical extent and rate of the landsliding. As shown in Figure 2, there were two main directions of movement, in conformity with local topography. Although initial estimates put the area involved at 700 hectares, this was later reduced to 250-300 and finally established at 341. Slight lateral expansion at the base and along the sides of the landslide increased its width from c. 2,000 to 2,180 m by December 15, and retrogressive slumping brought the final headscarp-to-toe length to about 1,350 m. The mass of the landslide was probably nearer to 600 million tons than the 100 million suggested by one geologist when interviewed by the Coriere Adriatica, the main Anconetan newspaper.

The initial maximum velocity, during the first few hours of landsliding is estimated to have been 6 m/hr, which is in the middle of the "rapid" category of Varnes (1978). During the subsequent day, movement was of the order of centimeters or millimeters and the total movement over the period December 13-18 was about 50 cm, generally taking place at less than 1 cm/hr. Despite the slight tendency for the sides of the landslide to enlarge, most of thy movement in this zone took place in areas of pre-existent landsliding, particularly the area of the well-established "Barducci" landslide

Figure 2

1982 ANCONA LANDSLIDE : TOPOGRAPHY AND DIRECTIONS OF MOVEMENT



Spot heights in metres: contour interval 10.0 m

(Segre, 1919). On December 18, after mild rainstorms, the toe of the landslide moved forward 9 cm and retrogressive slumping caused two lateral fractures at the headwall, with small scarps respectively 6 cm and 50 cm in height.

Over the period December 16-21, the central zone, or ancient "Barducci" landslide area, moved forward 64 cm (including 20-25 cm on December 17 and 18), but after the initial convulsion no serious changes took place in the conditions of Posatora and Palombella, the two main urban areas affected by the disaster. On Monday, December 20, the landslide toe advanced 15 cm and its flanks enlarged slightly. Further surges took place at the end of the year, involving a maximum of 7 cm in 24 hours, which falls into the slower part of Varnes's "moderate speed" class of movement. Retrogressive enlargement of the headscarp area took place at this time on a minor scale and was accompanied by slight settling of the body of the slide. On January 4 further cracking was reported sub-parallel to contours at 120-130 m above sea level (i.e., towards the center of the landslide). Further movements of 1-2 cm at the head and 2 cm at the base of the slide were also reported on this day.

Evacuation and Special Measures

The initial process of evacuating damaged homes and other buildings was in no sense planned or managed. It is, however, clear that about 4,000 people spontaneously evacuated nearly 1,000 residences in or close to the disaster area.

On the day after the disaster, 200 beds were available in an evacuation center that had been set up at Ostra, in the Anconetan area, following the 1972 earthquake. By December 15, 180 people had been temporarily accommodated in the gymnasium of a nearby school, but most evacuees were being moved into hotels at the expense of the comune. The situation developed as follows:

Dates	In Hotels	Total Number of Evacuees
December 14		3,500 o
December 15	610 o	3,500 - 4,000 e
December 16	906 o	
	1,193 o	2,850 o
December 18	1,600 e	
December 19	1,900 e	
	1,562 o	3,661 o

0 = official total (comune) e = estimated total (newspaper)

The growth in the number accommodated in hotels masks a certain state of flux. On December 16, 259 people were evacuated by order of the Comune (municipality) of Ancona from the periphery of the landslide at Palombella; and on December 17, 265 people were evacuated from 182 buildings on the periphery at Posatora, while 125 people were allowed to return home after structural surveys had certified the houses safe for occupancy. A total of 434 families was evacuated from the suburbs of Posatora and Palombella, of which 31 left Posatora and 27 left Palombella as late as December 19. Finally, on December 20, the Civil Defense Office of the Ancona Prefecture issued the following complete list of evacuations and other consequences of the disaster (which was printed in the Ancona newspaper <u>Corriere Adriatico</u>, and elsewhere):

Evacuees from "Zone A"--the disaster area	2,346 (760 families)
Evacuees from "Zone B"--the periphery	1,305 (310 families)
Total Evacuees	3,661 (1,070 families)

Number of evacuees lodged in hotels	1,562
Number of evacuees lodged with relatives	323
Number of evacuees returned home	125 (30 families)

Number of residential buildings damaged: 280, comprising 875 homes.

Premises Destroyed:		Workers Affected:
Artisans	101	200
Commercial	42	129
Wholesale	3	118
Industrial	3	200
Various	5	18
Farms	31	45
Total:	185	710

The total cost of the catastrophe ran at 30-40 million lire per day during the first week of the aftermath, and the eventual cost of maintaining the homeless--which will be borne by the Comune of Ancona--is projected at 17 billion lire ($11 billion).

As in previous Italian disasters, much useful clean-up and rescue work was carried out by firemen, 200 of whom worked around the clock during the week after the disaster, principally to evacuate damaged buildings. These men were drawn from brigades in the Province of Ancona and also from Ascoli Piceno, Bologna, Chieti, Forlì, Macerata, Pesaro and Ravenna. The Comune of Ancona provided evacuation transport at no cost to those in need of it, so that people could remove belongings from their damaged homes, and local factories opened their workers' canteens in order to feed the homeless. In addition to firemen, about 1,000 police and military personnel were drafted into the area, such that, when road and rail gangs, demolition crews, firemen, technicians and scientists are considered, about 2,500 people were involved in the clean-up operation. Access to the disaster zone was care-fully controlled by setting up barriers on the access roads, and in this way people did not put themselves unnecessarily at risk from falling masonry. Also, during the first five days there was only one arrest for attempted looting, while, the disaster-stricken neighborhoods remained perfectly quiet. By January, a total of nine people had been expelled from the disaster zone and six of them had been charged with looting. Such figures indicate that looting was a fairly insignificant factor in this disaster.

Adjustments to the Landslide: Costs and Financial Considerations

In a comprehensive five-volume report published in 1970, the government's De Marchis Commission argued that 9,822 billion lire ($6,340 million) needed to be spent on ameliorating national erosional hazards including landslides (at 1966 prices). Since then the figure has been raised by 400%, but the probable cost of landslide damage by the year 2000 will, if the hazard is not treated, be 90,000 billion lire ($58 billion) indicating a cost:benefit ratio of 1:2.25. The following account of adjustments to the Ancona disaster will show that they were both necessarily complex and extremely expensive. They also involved a number of assumptions that, curiously, seem never to have been questioned or debated. The principal one of these is that the Comune of Ancona should assume primary responsibility for the plight of individual people and businesses affected by the disaster, while the national government should provide subsidies, as far as its financial position allows. How these assumptions were acted upon will now be described in detail and then both the assumptions and actions will be evaluated.

On December 15, 1982, the Comune of Ancona made an initial grant of 300 million lire ($193,500) for temporarily lodging the homeless, chiefly in hotels, and the task of requisitioning large numbers of hotel rooms began. By this time it was clear that a much greater program of disaster relief was required, and the Regione and Comune decided to have recourse to the Ministry of Civil Protection. This ministry had recently been created out of the disbanded "Extraordinary Commissariat for the Earthquake-affected Zones," an ad hoc group set up to coordinate national disaster relief and expenditure immediately after the southern Italian earthquake of November 23, 1980. The new leader visited Ancona on December 14, 1982, the day after the landslide. The seriousness of the disaster and the size of expenditure requested of central government by the Ancona and Marche administrations, brought further visits by the Minister of the Interior (December 17), and the Minister of Public Works (December 20).

When, on December 15, it became clear that the Ministry of Civil Protection was prepared to finance disaster relief, local government formulated the following package of requests, which was immediately sent to the Minister:

1) An immediate grant of 3 billion lire ($1.94 million) was required to finance the first month's lodgings for about 3,000 homeless people. The construction of 300-600 replacement homes should eventually be financed.

2) Indemnities should be given to victims who had lost their homes or personal effects in the disaster, and to businesses for the loss or suspension of production.

3) The government should finance the immediate repair of the damaged Bologna-Ancona railroad and the repair and succeeding stabilization of embankments on the "Flaminia" ex-state road.

4) Financial provision should immediately be made for a new hospital, clinic and University Faculty of Medicine to replace the medical facilities lost in the disaster.

5) The Posatora cemetery should be removed from the landslide, and money was also required to finance the building of by-pass water and gas mains that avoided the landslide area.

6) There should be financial aid for schools that were forced to close or increase their number of pupils as a result of the disaster.

No explicit information was given at this time on how it was expected that such funds would be obtained by the Exchequer or under what government program they could be disbursed, but the Marche Regional Council also asked the Minister for Civil Protection to declare Ancona a natural disaster zone using Law No. 50/52 of 1982, so that funds could be made more freely available, and secondly that the government promulgate a special law for disaster relief at Ancona. Senator Paolo Guerrini (PCI, Marche Region) also asked the Cabinet to declare the Ancona landslide area a full-scale disaster zone.

As a result of the October earthquakes in Umbria and November floods in Emilia-Romagna, such a law was, in fact, being debated at that time in the Italian Upper House. On December 15, 1982, the Senate approved Decree-Law No. 829 of November 12, 1982, which set aside 180 billion lire ($116 million), from the 1983 budget for natural disaster relief. It was immediately suggested that 80 billion lire ($51.6 million) be granted to Ancona (and the balance granted to Emilia-Romagna and Umbria), while the Comune of Ancona specifically requested the government to allot 110 billion lire ($71 million) for relief, repairs and emergency housing in the city.

In the knowledge that funds would almost certainly be forthcoming in some degree from central government, on December 16, the Comune of Ancona voted into approval a substantial package which dealt with the virtually complete reconstruction of damage (*in situ* or elsewhere), land stabilization and welfare of victims, all at the Comune's expense. The proposed measures can be summarized as follows:

1) Accommodation of the homeless in hotels, pensions, lodgings and evacuation centers.

2) A short-term feeding program for the homeless, and help with evacuation and storage of their belongings.

3) Evacuation and re-establishment of artisans', commercial and industrial investments.

4) Indemnity for the loss of homes, goods or commercial investments.

5) The suspension of mortgage and loan repayments during the emergency phase of the disaster aftermath.

6) Local and fiscal tax relief, plus special payment facilities to indebted victims.

7) Credit an mortgage facilities on capital owned or lost by businesses, plus once-off grants to cover loss of productivity and the payment of wages and salaries during the period of lost production.

8) Finally, the Comune voted to seek "disaster status" from the government, on a level with the 1980 Irpinian (southern Italian) earthquake-devastated townships.

By January 11, 1983, under the initiative of Ancona's Communist Vice-Mayor, the Comune had started to ask for 350 billion lire ($226 million), in two nearly equal draughts, for 37 separate repair, relief and reconstruction projects associated with the landslide. There was some justification for the large sums of money requested: by then evacuation and storage of goods and belongings (which involved some highly specialized removal of equipment) alone had cost 20 billion lire ($12.9 million).

The Comune of Ancona proposed the following plan of disbursements relating to reconstruction. Those people who lost their homes in the disaster would receive new ones, to a maximum floor size of 100m², plus grants of up to 40% of the cost of furnishings that had been destroyed. These grants would not exceed 40 million lire ($25,800) for a first home and 15 million lire ($9,670) for a second or other house. People who were able to repair their damaged homes would receive a capital advance covering the entire cost of the work. Building societies and banks could be given special inducements to grant mortgages for reconstruction, with a ceiling of 11% of their reconstruction costs (with a maximum of 150,000 life ($97) per m² for all premises except warehouses, where the maximum would be 70,000 ($45) lire/m²; otherwise, they would receive up to 80% of repair costs (not exceeding 100,000 life/m² [$64.50], or 40,000 lire/m² [$25.00] for warehouses).

There were three main problems over the proposed expenditures described above. First, the use of hotels for temporary lodging was vigorously questioned in terms of its superiority to other viable solutions; secondly, there was some difficulty in selecting a zone for reconstruction; and thirdly, the people rendered homeless by the disaster were not particularly sympathetic to the plans for rehousing them.

Evaluation

One of the most striking things about the Ancona landslide is that many victims had no insurance on which to draw. Indeed, there is no comprehensive scheme of natural hazard insurance in Italy, and it would be fair to say that the matter has never been seriously debated in the public forum. Instead, it is implicitly assumed that the state will indemnify victims against their losses and that local government will bargain with regional government, who will in turn negotiate with central government for the best possible deal on behalf of those affected by natural catastrophe. It did not happen quite this way at Ancona, as the city is also a seat of regional government, so that the Regional Giunta was rather more directly involved than usual, but the brunt of negotiations on behalf of the homeless and others who suffered loss was borne by the Comune of Ancona.

In such cases, the money eventually comes from a variety of sources, including tax revenues managed by the State Exchequer and regional development funds of the European Economic Community. Demand for oil products in

Italy is relatively inelastic, such that one of the most convenient ways of raising extra revenue is by raising the price of gasoline at the pumps. The cost to the nation of the November 1980 earthquake was partly absorbed in a series of rises in the value added tax on gasoline, such that, at the end of 1982, gasoline in Italy cost more than three times as much as in parts of the USA (at the then current exchange rate). Following the Ancona landslide (and other contemporary disasters) the government's so-called serbatoio (reservoir) of natural hazard funds was replenished by a 21 lire/litre (1.35 cents) rise in the pump prices of gasoline, although a world fall in crude oil prices absorbed this increase in its entirety.

Although the Italian way of buffering poorer people against devastating losses from natural hazards by distributing those losses among the entire community is relatively humane, it is not without drawbacks. Indiscriminate taxation--such as that on gasoline--mitigates against lower income groups who have no direct responsibility for the disaster for which they are indirectly paying. Full-scale state aid can encourage a dangerous condition of dependence among the aided--a condition which Italian commentators have dubbed "assistentialism." Such a dependence became widespread after the 1980 earthquake and could easily delay recovery from the 1982 landslide, by relieving individuals of the need to exercise initiative. In Italy, suspicion of the motives and abilities of the state is almost hereditary, but there is thus a tendency to over-react and insist that the state compensate all victims of natural disaster, regardless of how they have put themselves at risk from the hazard.

The main criticism of the Italian method of coping with natural disaster is that it does not sufficiently encourage preparation against the inevitable disasters of the future. Potential victims (including agencies of the state who are concerned with constructing or maintaining buildings or structures) are not told that the availability of aid in the future will be governed by the preparations made at the present to mitigate hazards. Such preparations are implicitly assumed to be the responsibility of the state, yet there is no concerted national policy for disaster avoidance. The European Economic Community has prepared a directive to member states requiring them to carry out environmental impact analyses before major environmental modification schemes are put into effect. At present in Italy there is no such thing as an environmental impact analysis. The national policy for disaster relief is fundamentally an *ad hoc* one of handing out aid when and where it is required.

What is instead required is a full re-evaluation of the level of individual and corporate responsibility, and therefore the extent to which government funds may justifiably be used as disaster compensation. Banks and mortgage societies should require their collateral to be more comprehensively insured against hazards and, if the cost is too great to be borne by private insurance companies and individual insurers, the government should divert some of the "reservoir" of disaster relief funds to setting up a national hazard insurance scheme, like the National Flood Insurance Program of the USA. In the national economy less emphasis should be given to consumer goods (the Turin newspaper *La Stampa* reported on December 23, 1982, that Italians had spend 100 billion lire ($64.5 million) solely on video games during the Christmas shopping period), and more emphasis given to consolidating land, buildings and structures, including incentives for soil conservation and anti-seismic modifications to the built environment. Above all, there should be some explicit discussion of how far an individual is responsible for the safety and stability of his or her own property, and what the corresponding level of government accountability should be.

RESPONSIBILITY FOR THE DISASTER

This section will assess the extent to which the landslide was foreseeable, and the role played by geologists in forewarning of the disaster. The next section will give technical details of the site geology and slope stability, together with an assessment of the scientific value of the available information.

Pre-Existing Studies and Recommendations

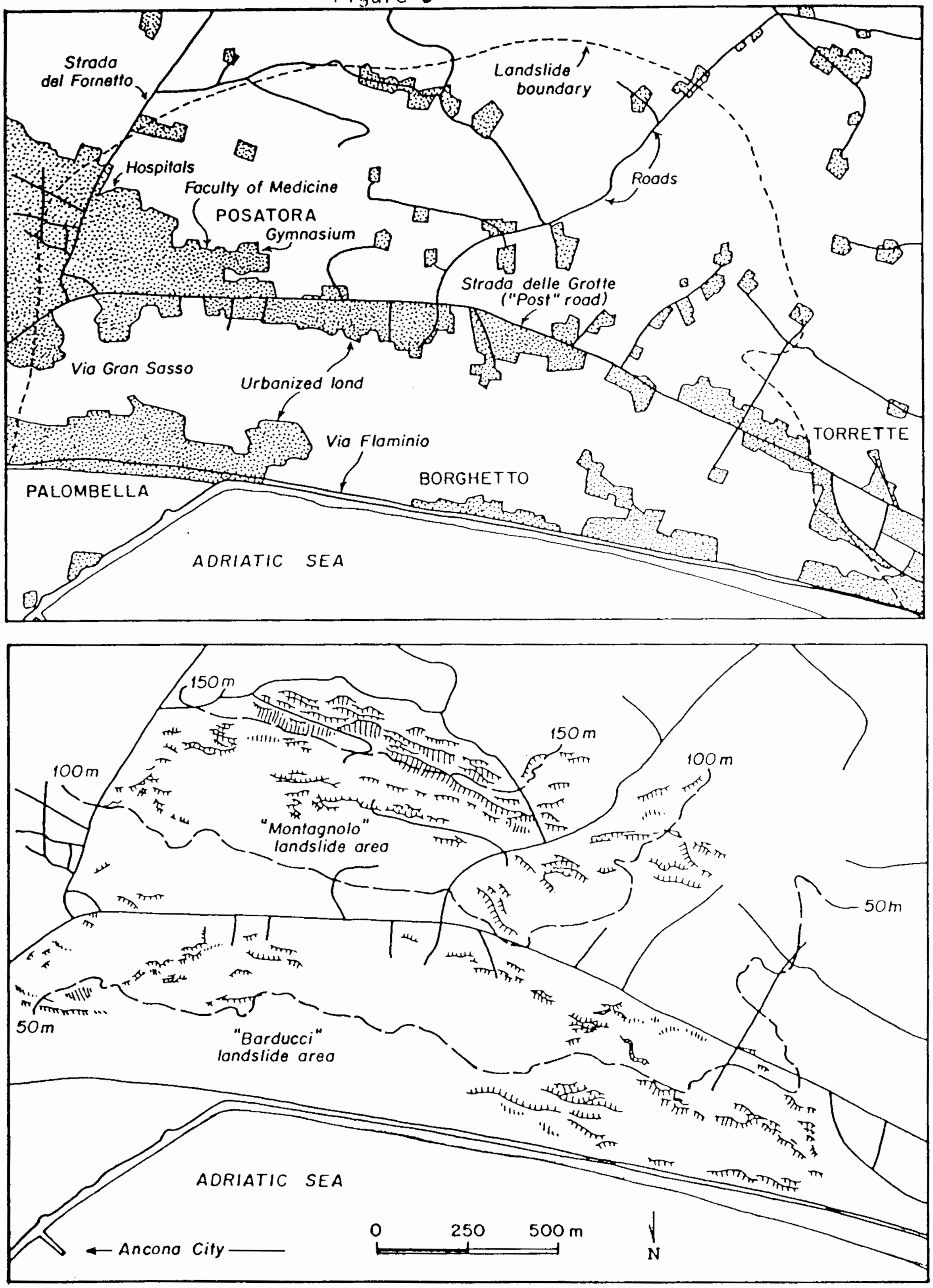
Two fundamental long-term causes of the Ancona landslide are the removal of material from the base of the slope (thus oversteepening it) by longshore drift in the Adriatic Sea, and the effect of deforestation in increasing infiltration on the slope and decreasing surface cohesion. In 1397, the Statuto del mare of Ancona prohibited the removal of stones from the natural mole along the shore at this point, but longshore drift has continued unabated. The period in which deforestation occurred is not certain, but slope instability was well established by the nineteenth century. The first report on the Barducci landslide was written in 1859 and other reports followed in 1920 (Brighenti, 1920), 1940 (Vecchiarelli, 1940), 1958, and 1960 (Selli, 1960). A major study of the area was carried out at the beginning of the century by Claudio Segre, an engineer of the Ferrovie dello Stato, or State Railways, whose Bologna-Ancona railway line was at risk (Segre, 1909). The findings of this enquiry will be dealt with in the next chapter but it should be noted that the report outlined a considerable risk of slope failure and recommended, among other things, the complete reforestation of that flank of Monte Montagnolo.

In 1957, the Ministry of Public Works (Consiglio Superiore LLPP) carried out a national study of the landslide hazard to roads which, when published in 1963, specifically mentioned the Borghetto-Posatora area as a zone of high landslide risk. Nevertheless, in 1964 local politicians condemned ANAS, the national road-maintenance corporation, for hasty consolidation works at Borghetto on the Via Flaminia, claiming that ANAS had ignored the long-term risk to slope failure (cf. Colosimo, 1982a, p. 34, Fig. 1.28a).

In the late 1960s, while the University Faculty of Medicine was being constructed at Posatora, the Ministry of Industry and Ancona Corps of Civil Engineers jointly commissioned a full-scale site investigation of the Montagnolo-Barducci slope, largely because substantial urbanization of the zone was planned. The report was completed in 1970, and it was adamant that in the interests of safety all further construction on the slope should be banned:

> . . . the local morphological picture is quite clear, and leaves no doubt over the connection between current instability and the occurrence of recent and ancient landsliding, which conditioned and continues to condition the precarious state of this zone.
>
> With respect to areas delimited as unstable [on a map compiled with the report], there are tracts where instability and fluvial dissection are particularly marked, such that further ground rupture will soon occur. The Barducci landslide area and steep slopes flanking the Posatora-Ancona coast road are examples of these more unstable areas. It is clear that there is full justification for the worries of the Corps of Engineers over the City Council's plan to develop beyond the western margins of the urban area, ever closer to the zones of major instability to the point of actually entering them (as is already occurring). These worries are even more justified given that we are dealing with a seismic zone [cf. Figure 3].
>
> [Of the new urbanization] These structures have been built as if the terrain was of the most secure and tranquil kind: they have been banked up with supreme unconsciousness of the risk to the stability of these precarious slopes, using heavy walls and flinging the excavated material immediately downslope of the new roadways, in a chaotic accumulation of disturbed clays.
> There are already signs of a forthcoming landslide--nothing more or less.

Figure 3



1982 Landslide: Roads and Urbanized Land (upper);
Surface Breaks of Slope (lower).

This document*, which clearly had official status, was subsequently shelved and ignored by the local administration and Corps of Engineers, despite its emphatic tone of warning. Indeed, if press reports are correct, the Head of the Corps of Engineers even went so far as to build his personal villa in the middle of the Montagnolo slope.

A further study of the landslide zone was carried out in the early 1970s and submitted for publication to the Accademia Nazionale dei Lincei in 1974. At the same time a lawyer made a study of the legal aspects of slope instability at Posatora, at the behest of the Law Court, or Tribunal, of Ancona. On December 9, 1970, the Ancona City Council responded to the adverse findings of all these studies by commissioning a "super enquiry," which in hindsight might also be named a "counter-enquiry." The findings of this important document were submitted to the Comune and published in 1974 (Ceretti, 1974), and will be discussed in the next section of the present report. For the moment it is sufficient to note that the published article of the "super enquiry" concluded that much of the Montagnolo-Barducci slope had a factor of safety of at least 1.5, which is 50% greater than the limit threshold for failure. Such a conclusion was not fully borne out by the data, which suggested that a much lower safety factor was to be expected.

Further indications of landslide risk were given in a special geological monograph, with maps of structure and surface geology, carried out by a member of the Institute of Applied Geology at Ancona University, and published by the Comune of Ancona and the Regione Marche. Since the landslide, much has been made of this document, but it consists of little more than a literature review. It also contains hardly any specific information on

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*The report is not referenced in the bibliography of this paper, as it was never published or made generally available.

slope instability at Montagnolo, yet it was obviously not intended as a direct predictive study in natural hazards, but as a summary of general geology.

Political Responsibilities

Despite a certain element of disarray, it is clear that the overwhelming majority of the eleven studies of slope stability around Posatora warned in advance that the area was one of serious landslide hazard. Yet a structure plan was formulated in 1962 and revised in 1973 without taking account of that hazard. This curious state of affairs demands some explanation.

The Ancona City Council was dominated during several important years of this period by the Christian Democrat Party, who held the majority from 1969 until 1976. In 1976, power was transferred to a center-left coalition between the PCI, PSI, PRI and PSDI (respectively, the Communists, Socialists, Republicans and Social Democrats) with a Republican mayor as a leader. The Christian Democrats went into opposition, holding 18 seats, which was about the same number as the Communists had, and the coalition government persisted until 1983. Thus, if there is any political responsibility for past errors of judgement to attribute, it would be about equally divided between Christian Democrats and the center-left coalition, both of which enjoyed power during the critical years of decision making.

The local structure plan was designed by engineers, architects and urban planners, who claim that there was no attempt on the part of the geologists to forewarn them of the danger of urban expansion in the 1982 disaster zone. Nevertheless, it is clear that the Comune was planning a more detailed approach to slope morphology at the time of the catastrophe, as it had ordered large-scale (1:10,000) contoured aerial photographs of the Posatora-Palombella zone (Regione Marche, 1980).

The immediate aftermath of the disaster saw a vigorous debate between members of the Comune and geologists with scientific interests in the area, as to who was responsible for forewarning of the landslide. The debate, dubbed "open war" by the newspapers, was heightened by legal considerations over the responsibility. Law No. 1684 of November 25, 1962, states that it is forbidden to urbanize actual or potential landslide terrain, and Article No. 426 of the Italian Penal Cost prescribes a 5- to 12-year prison sentence for anyone found culpably responsible of putting others at risk by construction in a zone of serious landslide or avalanche hazard.

With these provisions in mind, the Magistrature of Ancona opened an official enquiry into the disaster on December 18, 1982, and the Mayor gave evidence on December 23. But the task of determining responsibility was not easy, as it was first necessary to prove the cause of the disaster (which geologists correctly said would take at least two years of detailed study to accomplish).

Despite mounting criticism, the Ancona administrators succeeded in maintaining a united front. During the first week after the disaster, the Mayor insisted that none of the studies of Montagnolo had demonstrated the scope or scale of the risk there. He was supported by the Chief Planner who argued that the geological enquiries had created a picture of the Barducci landslide as a localized and superficial phenomenon. He added that the studies carried out for the "super enquiry" had been reassuring (Corriere della Sera, December 18, 1982) and, furthermore, that the member of the Institute of Applied Geology commissioned by the Comune to study landslide hazards in the Anconetan area had started too late, had focused attention on the Grotte al Passetto zone, not the Barducci landslide area, and had not indicated that Posatora and Palombella were substantially at risk*.

The Proletarian Unity Party (PdUP), who had been quick to expose the inadequacies of other political groups, countered by reminding the administrators that the Ministry of Public Works had come out emphatically against urbanization of the Montagnolo slope as long ago as 1962. When asked by newspaper reporters to comment on the accusations made against him by the Chief Planner, the commissioned geologist replied:

> The politicians committed the error of allowing construction to go ahead in a high risk zone, characterized by frequent landslides. All the local administrators knew perfectly well that the area is unstable, and in any case they had all the means of finding out (Corriere Adriatico, December 17, 1982).

This was an argument that could not easily be contested, but it did not entirely save the geologists from recrimination. The Chief Planner was quick to point out that, during his tenure as Chairman of the University of Ancona Sports Committee, the Head of the Department of Applied Geology at Ancona had arranged for the university gymnasium to be constructed in the landslide area next to the ill-fated Medical Faculty. In a letter to the Corriere Adriatico, (December 19, 1982), the Head replied that he was not then acting as geologist but merely as chairman of the sports committee. He added that the Institute of Applied Geology did not open until 1964, when the construction of the Faculty of Medicine had already begun. With regard to his own studies, the head geologist pointed out that he had recommended allowing development to take place on only 5% of the Montagnolo slope: on

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*None of these statements agree with an explanation of the work given in a preface to the monograph.

45% it should have been discouraged and on 50% absolutely banned. Further weight was given to geologists' case by the President of the Marchigian Order of Geologists, who insisted in an interview that the Ancona landslide had not been foreseeable.

Politicians of the current opposition were also called upon to explain themselves by the newspaper reporters. A Christian Democrat Senator who had once been Mayor of Ancona, told Il Giornale d'Italia on December 16, 1982 that there had been unanimous acceptance among the Ancona Council when the 1962 and 1973 structure plans indicated development at Posatora and Palombella. Furthermore, none of the geologists investigating the area had voiced any opposition. However, the influential newspaper Corriere della Sera put forward the hypothesis on December 17 that the Christian Democrats had voted to urbanize the coastal zone to the west of Ancona as much of the land belonged to the Curia (Church Commissioners) who stood to gain in the resultant speculation. However, the paper also reported the Christian Democrat point of view that no one had pointed out the risks of such development, and the geologists were now speaking with hindsight (il senno di poi).

At the same time, the Communist daily L'Unità reported in an interview with the Vice-Mayor of Ancona and a PCI councillor, in which he stated that:

> The problem of geological hazards is a national one. Here at Ancona, the Communists have tackled the problems of the city during the present emergency in an open manner, which everyone can observe. The city administration (Giunta Comunale) has been in existence since 1976, and the PCI has also greatly participated in the choices involved in implementing the structure plan of 1973. Only since then has there been recourse to any geological study [sic]. As a direct result, urbanization has been completely prohibited in the 'Barducci landslide' zone [sic]. If it hadn't been so, the toll in terms of economic loss and human lives would have been much greater.

It is worth noting with respect to this somewhat perplexing statement, that several apartment blocks were in the course of construction along the Ancona-Posatora "Post Road," and the unfinished buildings will now have to be demolished. However, it should also be noted that most construction on the Montagnolo slope took place over the period 1965-70; after the Ceretti-Dattilo study the only buildings to be constructed were seven apartment blocks, and three houses were modernized. Moreover, the PCI leader did admit (to Corriere della Sera) that it had been an error to allow construction to go ahead in the landslide zone. Having made its apologies, the PCI then turned its attention to a campaign to obtain full-scale disaster status for Ancona from the central government, so that the relief effort could be better financed, with more rapid consignment of allotted funds.

Geological Advice

The effect of the foregoing hiatus of conflicting and often incorrect assertions was to create a situation in which practically nobody succeeded in maintaining his credibility. A few words are necessary about the kind of information supplied to the public by the geologists. Press reporters were quick to seek comments from the director of the CNR Fenomeni Franosi (Landslide Phenomena) and Dinamica dei Versanti (Slope Dynamics) grant-assisted projects at Florence University. When asked what the causes of the Ancona landslide were, the director mentioned three: the load applied to the slope by constructing buildings, the lubricating effect of excessive rainfall, and the stress effects of earthquakes. Whilst it is probable that each of these factors contributed to the landslide, it is highly unlikely that any was a cause. A geologist from Rome University pointed out that the load effect of buildings on a 600 million ton body of earth was negligible; and heavy rainfall may cause pore water pressure to rise, resulting in failure of saturated ground (which is in many cases the most important cause of mass movement), but full lubrication will probably be achieved even in dry periods by pre-existing groundwater. Furthermore, the newspaper Il Tempo reported on December 17, 1982, that seismic activity in the Anconetan region on the night of the landslide had been minimal and, of course, the slope had not failed as a consequence of the 1972 earthquake (although it may have been significantly weakened).

The subject of groundwater also illustrated how perfectly valid geological information could be misunderstood by the press. An infra-red air photograph sortie was conducted at the beginning of 1983 and revealed that the body of the landslide was largely saturated with groundwater. This led even the more responsible newspapers, including the Turin daily La Stampa, to speculate that there was a subterranean lake under Monte Montagnolo, which had lubricated the base of the landslide. Geologists interviewed by the Turin newspapers described the Ancona slide as "a geological collapse without comparison in Europe" (even though a similar sized event had previously occurred at Fabrizia in Calabria), which is a generalization that can be contradicted by examples, including the prehistoric landslide at Flims in Switzerland, which was about three times as big as that at Ancona (Erismann, 1979).

PHYSICAL ASPECTS OF THE DISASTER

Geology

The following account is derived from papers by Segré (1919), Manfedini (1951), Ceretti (1974), Ceretti and Colalongo (1975) and Nanni (1980), and, to a lesser extent, from my own field visits.

At the Barducci landslide site the stratigraphic column consists of the following formations, from the base (maximum known depth 170 m) upwards: 1) blue marly clays of the lower or middle Pliocene; 2) blue marly clays of the upper Pliocene, differing little from the previous formation; 3) fossiliferous cobbles, gravels and sands of the lower Quaternary; and 4) mainly clayey alluvial and wash deposits (Ceretti, 1974). The deposits pass from compact, marly Pliocene clays at the base, to weaker, more complex or disturbed sediments above (Nanni, 1980). To complete the picture, stream valleys and the coastal strip are mantled by sandy clays forming a recent colluvial deposit; and cobbles, gravels and medium to fine sands occur along the coastal strip (Selli, 1951).

Three main tectonic phases have created the structure of the Anconetan region. In the middle Pliocene tectonic disturbance produced most of the structure that can be observed today. From the upper Pliocene to lower Pleistocene marine sedimentation was renewed during a phase of tectonically-induced subsidence, and finally, a slow uplift brought some of the Quaternary sediments to heights of 250 m to 300 m above sea level (e.g., at Montagnolo).

Ancona itself is situated on a monocline and there are anticlines in the Anconetan area at Falconara, Varano, Monte Conero and Agugliano. There are also a number of synclines, running WNW-ESE, of which the syncline of

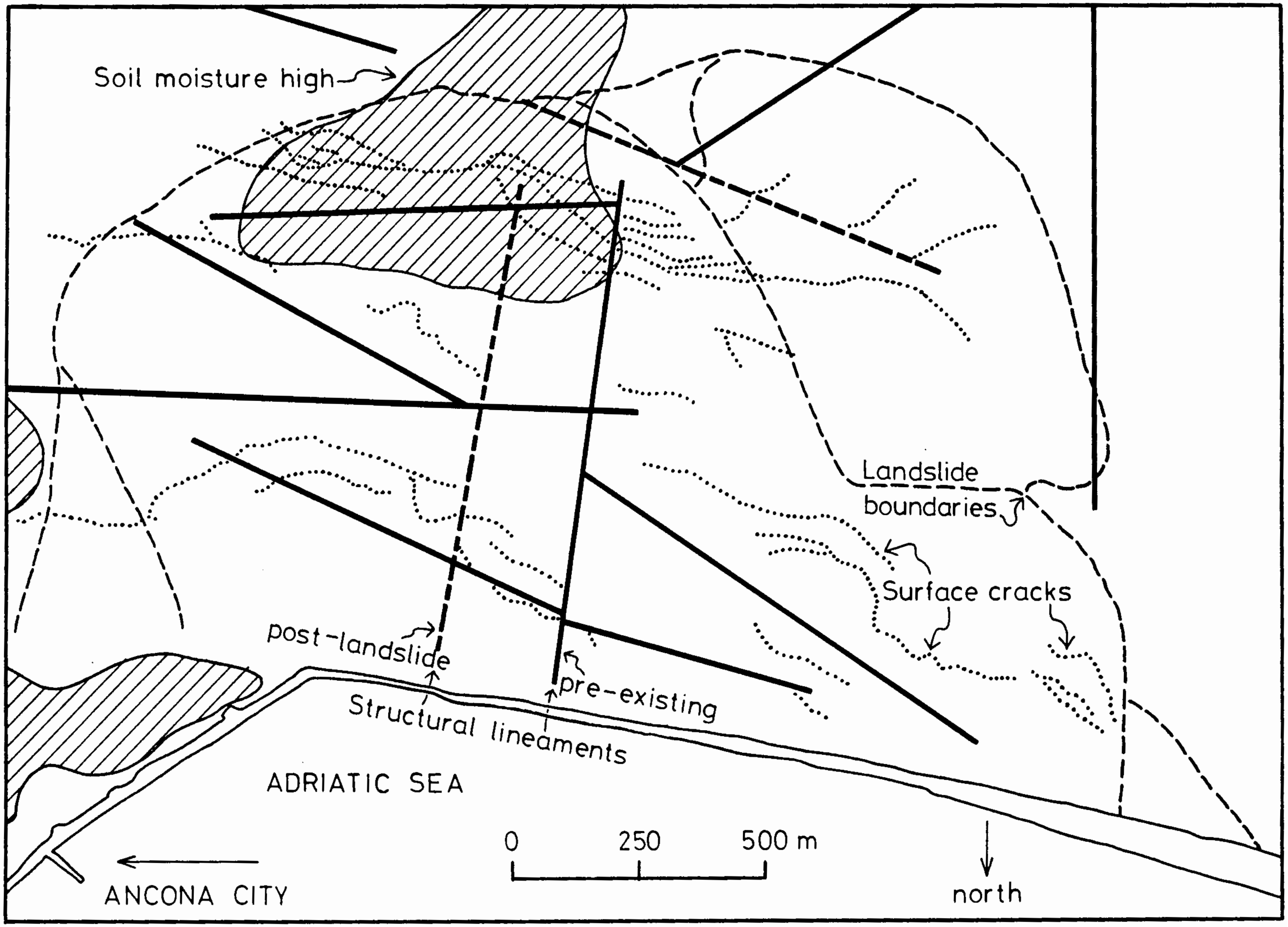
Tavernelle crosses the 1982 disaster area, ending close to the coast near Torrette (Figure 4). This structure is asymmetrical and is superimposed towards the NE upon the Ancona monocline, as a result of inverse faulting that has thrust it some 300 m over the adjacent structure.

The seismicity of this area is, given its complex structure, still poorly understood, but seismological measurements over the period June, 1973-September, 1976 indicated three concentrations of epicenters (Crescenti, et al., 1978). In the sea north of Ancona earthquakes occurred during the measurement period with foci up to 6.1 km deep at Scoglio del Trave; on the coast southeast of Ancona, hypocenters were 2.7-6.7 km deep; and in the vicinity of Falconara Marittima and Torrette, west of Ancona, they were 2.5-4.8 km deep. No epicenters were located in the 1982 disaster area.

The relationship between landsliding and the geology of the disaster area is the focus of several hypotheses. Manfredini (1951) discussed the separating by faulting of emergent pre-Pliocene sediments NE of Camerano and Posatora (including the Ancona city area) from the Pliocene and Pleistocene deposits to the SW. This large-scale division is carried into the 1982 landslide area and, by virtue of tectonic disturbance, has contributed to the destabilization of surface materials there. Manfredini also cited the presence of fault intersections as adding to the lack of stability in the area, a fact that has received additional confirmation with the discovery of new lineaments following the 1982 slide (Figure 4). However, other authors (e.g. Segre, 1919; Selli, 1960) have blamed instability on the complexity of sediments and the lack of consolidation in Pleistocene deposits (coupled with weathering effects reducing the strength of the Pliocene marly clays).

Figure 4

1982 ANCONA LANDSLIDE: SOIL MOISTURE ANOMALIES, LINEAMENTS, SURFACE CRACKS



Courtesy of dott. Leonardo Polonara, Regione delle Marche.

Meteorology

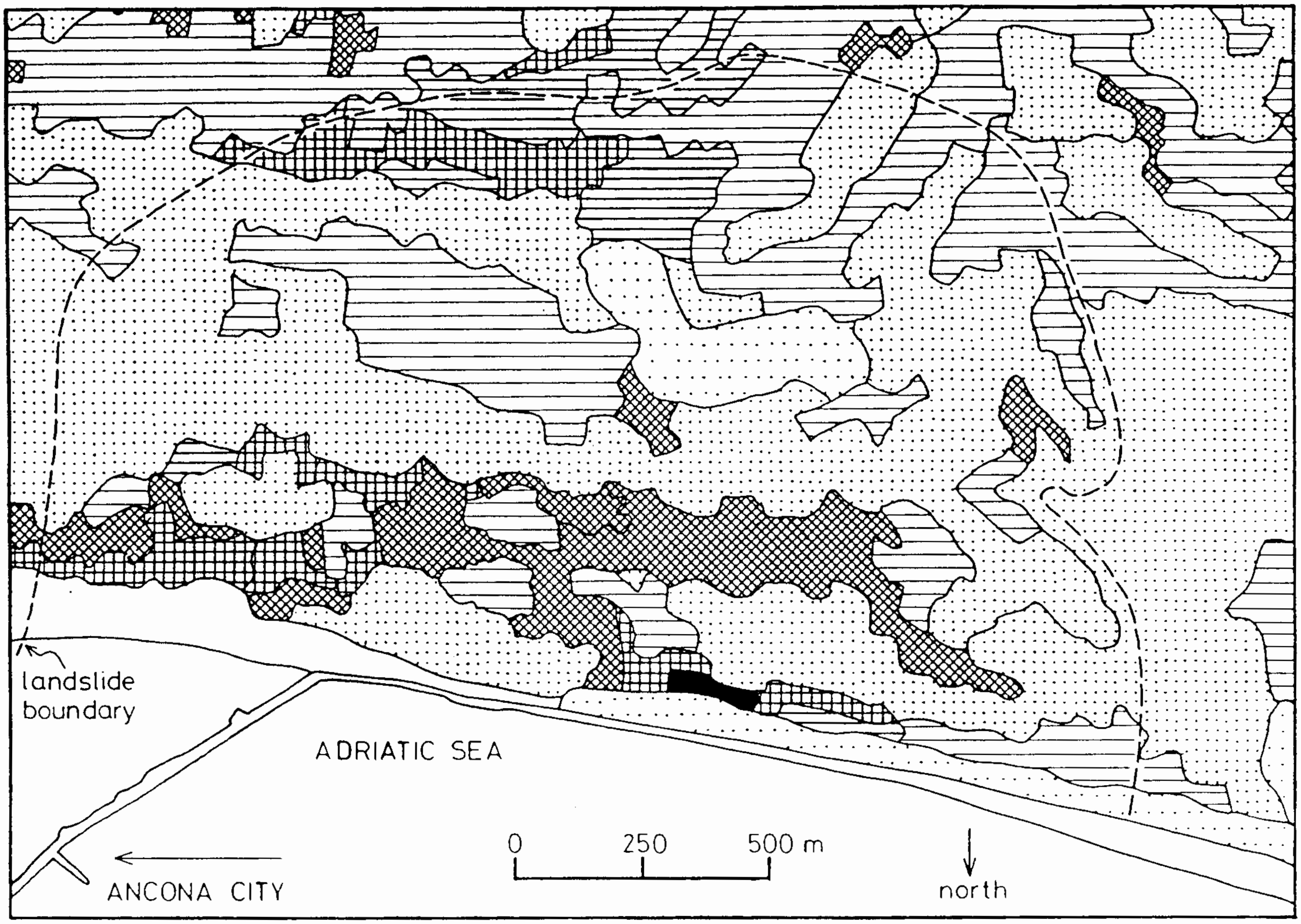
Given that the above geological factors are related to slope failure by pore pressure increases during saturation of the slope, it is necessary to consider the precipitation regime of the disaster area. As the volume of moisture needed to saturate the Montagnolo slope is high, the periods of greatest landslide risk will be those in which precipitation is consistently high, given heavy or persistent downpours after high antecedent rainfall conditions have maintained soil moisture at a high level. At Torrette, precipitation levels reach 100 mm per month in September and December, whereas at Ancona more than 190 mm falls in September and October, with slightly less in December (these are months when mean monthly temperature is falling from 18° to 16°C, but is still above the annual mean of 14° to 15°C). In spring and summer, the local climate is moderated by proximity to the sea and the lack of substantial topographic relief. Thus the autumn and winter are periods when rainfall is most likely to augment pore water pressure in slope soils, giving an immediate (as opposed to a long-term) cause of landsliding (Crescenti, et al., 1983).

Morphology and Processes of Landsliding

Colosimo (1982a) defined three types of geomorphological mass movement occurring at the Barducci-Montagnolo site during the years before the 1982 disaster: 1) superficial mud and debris flows took place during the season of high rainfall to a maximum depth of 5.0 m; 2) deep flows occasionally moved sediments to a depth of 10 m; and 3) lateral expansion of blocks bounded by faults caused creeping movement to a depth of 30 m. Thus the parameters of weight, and therefore the forces resisting overall landsliding, were continually changing position on the slope. Figure 5 (from

Figure 5

1982 ANCONA LANDSLIDE : SLOPE CATEGORY MAP



After Colosimo and Coppola (1979)

SLOPE ANGLE CLASSES:-

0 - 2.0°	0 - 3.5 %
2.0 - 5.2°	3.5 - 9.1 %
5.2 - 9.5°	9.1 - 16.6 %
9.5 - 14.0°	16.6 - 25.0 %
14.0 - 18.4°	25.0 - 33.3 %
18.4 - 26.5°	33.3 - 50.0 %
26.5 - 45.0°	50.0 - 100.0 %
45.0 - 90.0°	GREATER THAN 100.0 %

Colosimo and Coppola, 1979) shows that the form of the slope was complex, but with steep sections near the toe. Meardi and Marchini (1968) identified liquid mudflows, viscous or plastic flows, rotational sliding and soil creep at the site, but did not expect these various mass-movements to be necessarily coincident in time or location.

Ceretti (1974) stated that the upper (Montagnolo) and lower (Barducci) landslides were not connected and had shear planes extending to a depth of no more than 10 m. For the lower slide, shear creep was occurring as weathering progressively reduced the strength of materials and marine erosion gradually oversteepened the slope. Ceretti predicted the shear plane to be 4-8 m deep: at depths of less than 4 m cohesion successfully counterbalanced tangential forces, whereas deeper than 8 m normal forces associated with the weight of sediments mobilized sufficient friction to rule out sliding. He argued that the low stability at the base of the slope was the result of remoulding of sediments during past mass movements, reducing their shear resistance.

The actual morphology of the 1982 landslide is complex and, with respect to the position and form of the shear plane, is still the subject of debate at the time of writing. It is, however, clear that concerted movement has taken place over the whole area of the landslide, but involving different times, rates and directions of sliding, rotational as well as translational movements, and subsidence of blocks which have lost their confining lateral pressure in the downward movement of other segments of the slope. According to the configuration of small scarps and surface cracks, shear planes reach the ground surface in many places, and there are clearly multiple shearing planes which may or may not be connected at depth. Assuming, as seems highly probable, that shearing has taken place at great depth (perhaps even greater than 100 m) the landslide would fit into Varnes's classification (1978) as a combination of "rotational earth slump" and "translational earth block slide." This assumption will be further discussed below.

Proposed Causes and Remedies of the Slope Instability

Colosimo (1982a) attributed the Barducci landslide to slope hydrology disorders, uncontrolled urbanization, and both natural and human-caused erosion at the base of the slope. He regarded the upper Montagnolo landslide as the result of poor land management. Road building and urbanization concentrated slope wash and increased infiltration while disturbing the compactness of sediments, and deep ploughing of the non-urban areas also had an adverse effect on infiltration. Meardi and Marchini (1968) attributed soil creep and shallow surface mudflows at the site to the effects of wetting and drying cycles, with temperature changes, on the consolidation of swelling clays, and deeper mass movements to pore pressures. The causes of the 1982 landslide will be discussed in the next section.

Hypothesizing that only shallow failure would take place, Meardi and Marchini proposed that seven 4-5 m deep trenches, tapering upslope, be dug at the foot of the Montagnolo slope in order to drain it. The trenches would be orientated parallel or at 30°-40° to the direction of slope and would connect downslope to drainage wells. They would be filled with permeable materials such as cobbles and sand, and would interface with the wells through a barrier of porous brick. Constructing them at 30° to the slope would yield maximum interflow collection and the greatest possible slope drainage, but constructing them directly upslope would better help to preserve slope stability, by restraining the sediments at the slope foot.

In any case, the trenches and wells were never built (and nothing similar was constructed until after the 1982 disaster).

Ceretti (1974) made a series of five recommendations for preserving the stability of the Montagnolo slope:

1) Better measurement of stability-related variables, such as pore-water pressure, close to the urban areas of Posatora, Palombella and Borghetto.

2) Drainage and slope management of the Montagnolo (upper) landslide area.

3) Keeping all reverse-slopes dry and avoiding to construct steep embankments, with the spoil material abandoned at their base.

4) Monitoring rates of movement on the Barducci landslide, predicting the location of its shear plane and the forces involved in movement, as well as putting slope drainage schemes into operation.

5) Consolidating the basal road as a barrier to stop movement of the Barducci landslide, and consequent oversteepening of the slope above.

Interestingly, although it had not adopted any of these recommendations at the time of the 1982 disaster, the Comune of Ancona after the event considered building a substantial embankment for the Flaminia road and the railroad, in order to restrain the toe of the landslide. Measures had already been taken to control longshore drift, as the beach had receded 3 km during historical times, causing the base of the slope at Palombella and Borghetto to oversteepen. There are few indications as to whether such a project would stop the landslide from moving and the beach from cutting back. Thus, at the time of the 1982 disaster, virtually no steps had been taken to ensure the stability of the Montagnolo slope.

Although the actual failure mechanism of the landslide is unknown, the basic causes can be summarized. They consist of long-term and short-term causes (Costa and Baker, 1982). The long-term causes are:

1) Tectonics: intersecting faults, folds, fractures and lineaments.

2) Loss of the strength of sediments during weathering and deconsolidation.

3) The development of shear planes during past landsliding.

4) Deforestation and vegetation changes, with subsequent poor land management practices.

5) Poor slope drainage.

6) Increase infiltration caused by urbanization and mechanized farming.

7) Road building and associated disturbance of surface sediments.

8) Oversteepening of the slope by the actions of man, marine erosion at the base, or mudflows, landslides and soil creep on the upper sections.

Possible immediate causes include:

1) Seismic activity (which does not appear to be relevant in this case).

2) Increases in pore water pressure during saturation of the slope.

3) Liquefaction of sand lenses or layers at depth.

4) Progressive loss of stability following initial, small-scale landsliding (positive feedback).

The most important short-term cause is likely to have been increases in pore water pressure following heavy rainfall which occurred in November 1982, but it is not possible to say which is the dominant long-term cause. It is most probable, however, that one such cause initiated a gradual decline in strength, and therefore of the factor of safety F for the slope, in much the same way as Karl Terzaghi postulated for the case of the Frank landslide in Alberta, 1903. The decline ended in 1982 when the Montagnolo slope reached the F value of unity, and failure was inevitable.

Thus, in summary, slope failure at Ancona was the result of several long-term causes, including increases in infiltration and decreases in soil strength caused by urbanization, and poor land management. The main short-term cause of collapse in the progressively weakened sediments was probably high pore water pressures during saturation of the slope. Movements were complex and probably both shallow and deep-seated translational-rotational in character. Much could have been done to prevent the progressive decline in the factor of safety towards its threshold value of F = 1. Drainage, infiltration control and more careful urban development might all have delayed, if not prevented, slope failure. Geomorphological aspects of the site, such as disturbance of the ground surface, indicated _a priori_ that shallow mass movement is endemic there: but prediction of a large-scale deep seated movement could only have been accomplished by testing the hypothesis that it could occur. Instead, investigators specifically discounted deep-seated movements or a unified shear plane extending the whole length of the slope, and thus had developed no procedure for predicting them. Had this not been so, the mode of slope failure--if not the exact time of occurrence--might have been foreseen.

ARCHITECTURAL OBSERVATIONS

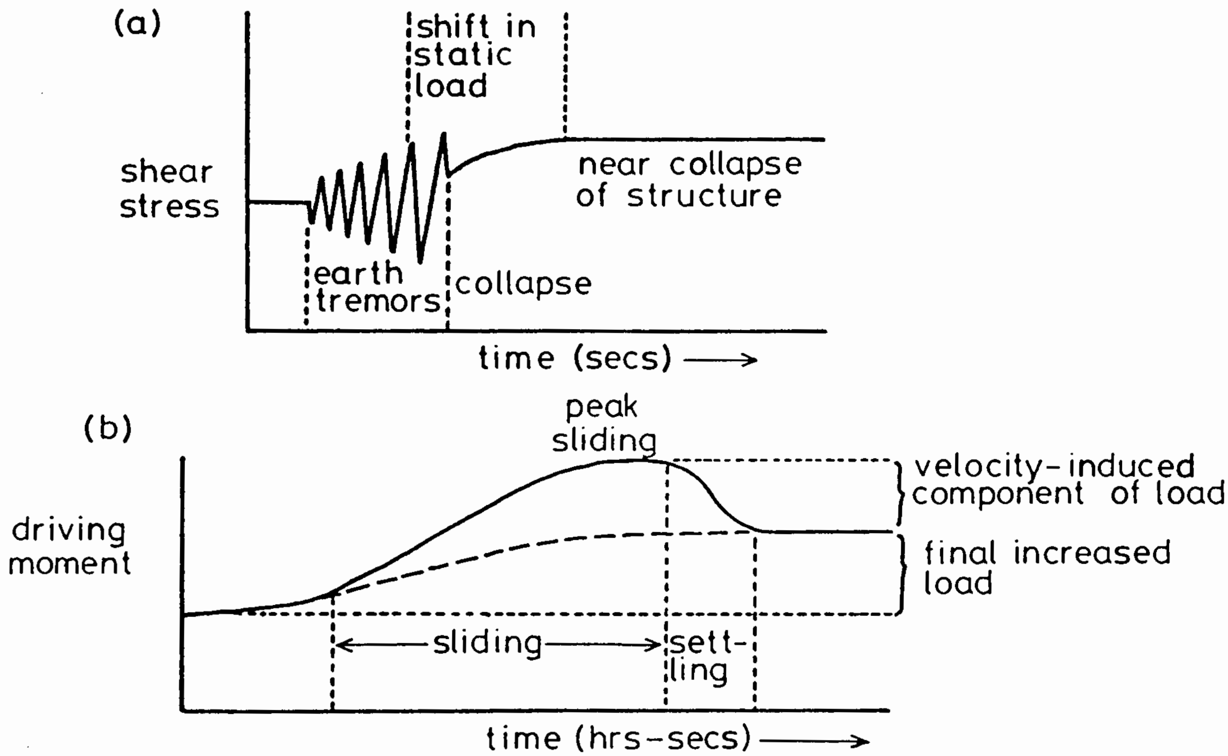
The following observations were made during my visits to the disaster zone during January and June-July, 1983. At Ancona damage to buildings and structures occurred almost entirely as a result of ground subsidence, although some structures were, conversely, raised relative to their original position. Subsidence is rarely a problem unless it involves differential movement of the ground: thus at Mexico City, for example, some buildings have undergone up to 9 m of subsidence without differential movement and still remain serviceable (Costa and Baker, 1981). Because of the complexity of patterns of ground movement, the Ancona landslide involved much differential subsidence, coupled with horizontal movements of between a few centimeters and several meters. Thus, many buildings were simultaneously slewed, tilted and subjected to differential movements under their foundations, which caused cracking. Very few structures collapsed: collapse was most common in retaining walls that were unable to withstand the increased pressure of soil and debris from upslope after they had suffered partial loss of foundational support.

Ferro-concrete buildings withstood the duress of the landslide better than either brick or stone buildings, probably because of having better rigidity at their bases and flexibility in their superstructures. Several three-story concrete buildings rotated out of the perpendicular (by up to 4.5°) without suffering notable failure of their superstructures, largely because they had rigid concrete pads as bases. In others the rectangular structure of columns and beams was distorted into a parallelogram since the joints between vertical and horizontal members were not strong enough to withstand the force applied by failure at the foundations. This caused windows to shatter, and often resulted in the collapse outwards of brick and plaster infill, which had not been strongly tied into the column-and-beam structure. Where infill did not collapse, it commonly cracked at its interface with the columns bounding it, or cracked in a unidirectional, diagonal pattern.

Many of the above observations are also true of earthquake damage, but there are fundamental reasons why landslide damage should be different. Earthquakes produce strong vertical and lateral stresses in buildings, resulting in compression and extension, and in sway. Shearing forces are usually concentrated at the base of the structure, where the combination of inertia produced by the building's weight and forces caused by ground acceleration is greatest. Once the shaking ceases, unless there has been foundational failure, the buildings will return to some semblance of static equilibrium load (Figure 6a).

On the other hand, a landslide involves the gradual build-up and maintenance of stresses--if differential subsidence occurs. The stresses caused by movement at less than, say, 3m/hr are unlikely to exceed greatly the stresses produced by gradual differential change in load (Figure 6b). Unless the building collapses, many of these stresses will remain. They will also greatly exceed earthquake stresses in duration (although not necessarily in magnitude). As in the case of earthquake damage, cracking tends to exploit lines of structural weakness in buildings, such as where masonry is poorly bonded or where walls are pierced by windows (which on an upper floor leave very little masonry under the eaves, resulting in cracking up to roof level). However, while X-shaped cracks often result from the alternating nature of stresses in the case of earthquakes, landslide-induced cracking tends to be diagonal and unidimensional.

Figure 6



HYPOTHESIS OF LOAD CHANGE ON STRUCTURES
DURING (a) EARTHQUAKES AND (b) LANDSLIDES

Such cracking tends to pick out weaknesses in brick or stone masonry, but stress can also be sufficient to shear right through bricks, as happened at Posatora to a number of well-bonded, brick-built curtain walls. Differential subsidence in masonry or brick buildings can also cause distortion of door and window openings so that lintels come away from the wall above them and drop down a few centimeters on one side (usually the downslope side).

In several cases, differential subsidence caused buildings to behave quite differently from their surroundings. At Borghetto the "Adriatica" road was elevated by the advance of the landslide toe, and some buildings sank relative to the road surface by about 10 m. At Posatora, complex rotational movements meant that the direction and degree of both rotation and slewing differed from building to building. At and above the 80 m contour, there was often a tendency for buildings to rotate so that their upslope points were lower than their downslope ones, such that they tilted backwards relative to the slope. This was primarily caused where blocks of land dropped into the cavity left by faster-moving downslope blocks. A particularly notable case occurred in the center of the landslide, just above the Posatora-Torrette "post" road, south of Borghetto. There, a thick-walled farmhouse of rubble masonry has rotated backwards (i.e. sinking on its upslope side). This initially occurred at some time during the distant past, after which the doors and windows were re-set perpendicular in the walls, which continued to lean. Unfortunately, further rotation occurred during the 1982 landslide.

Below the 80 m contour, surface movement tended to be faster on the downslope side, such that buildings situated on small scarps rotated towards the landslide toe rather than its head. In any event, buildings rotated either when they straddled lateral "scarpettes" (which faced either upslope or downslope) such that one facade sank relative to the other, or when they were situated on rotating blacks of ground, especially where these were sinking into spaces left by faster-moving blocks on the downslope side. These points illustrate that the position of shear planes connecting with the surface is critical to the stability of buildings, which will rotate or fracture most if they straddle some lineament along which differential subsidence occurs.

The results of my full-scale architectural survey of the damage at Ancona are published in Alexander (1984).

A BACKGROUND OF GEOLOGICAL HAZARDS

The National Context

The Ancona landslide can be compared with other natural hazards in Italy in a number of ways. It can be seen that the 1982 disaster at Ancona is the largest and most expensive--although not the most extensive--catastrophe to have happened in the Marche Region for some decades. In other respects, however, it differs very little from the other recent landslide or earthquake disasters, at least in terms of the kind of problem created. Even a disaster of minor notoriety involves very high relief and reconstruction expenditure. In Italy exact data on the cost of preventing landslides and floods (by structural engineering or non-structural methods such as relocation) are rarely given, but it is likely that such costs would be lower than the cost of a cleanup and rehousing operation.

It is also difficult to dissociate the case of Ancona in 1982 from other Italian disasters, in that the relief and reconstruction funds come from the same source and require that local or regional politicians from each disaster-stricken community bid with the same members of central government. Indeed, this practice was formalized as long ago as 1918, when Law No. 445 of that year provided for ad hoc state expenditure and the drawing up of a national list of comuni affected by disaster. It makes sense for both the local and national representatives of disaster-stricken communities to consider the overall demands for assistance as a complete picture, rather than as a series of individual cases. This would achieve a more rational apportionment of the limited funds that are available. It is thus encouraging to see that the government in Rome made some attempt to divide monies from the 1983 serbatoio between Ancona and the other centers of need, such as Emilia-Romagna and the Umbrian earthquake zone. It is also encouraging that there is some sign of a national policy on land consolidation: Law No. 25 of 1980 gave a detailed national prescription for coping with the national erosion and landslide hazard, although the measures outlined are too few and will probably be too poorly financed to achieve much of a solution.

The Marsico Nuovo Landslide of February, 1983

Only eleven weeks after the Ancona disaster, serious landslide damage occurred in southern Italy at Marsico Nuovo (Basilicata Region). Contrasts and similarities between the two cases make it instructive to compare them.

In February of 1983 Pergola consisted of about 300 houses in which over 1,000 people were living. The area is situated on three geological formations, the first two of which are separated by N-S and E-W intersecting normal faults:

1) The landslide itself developed on Miocene (Langhian) deposits of the "Monte Sierio" formation (Valduga, et al., 1969). This heterogeneous unit consists of gravels, calcirudites with cobbles derived from the underlying limestone-dolomite, marls, greenish clays and occasional breccie.

2) This formation is bounded to the north, a short distance from the landslide, by the outcrop at Monte di Tigliano (1,078 m) of the "Galestrine Flysch" unit, of apparent Lower Cretaceous-upper Jurassic age. It consists of shaly clays, marls (galestri) with marly-siliceous limestone and breccia intercalations, and isolated occurrences of calcarenite and conglomerate.

3) To the E and NE of Pergola there are sheets of colluvial debris, arranged with the distal end towards the hamlet, representing material derived from Monte Cugnone (1,160 m).

The 1983 landslide developed on units of sedimentary rock that are heterogeneous and highly variable in their degree of cohesion and cementation. They are bounded by faults which are partly obscured under slope-wash deposits.

The Event

Landsliding at Pergola in the Comune of Marsico Nuova took place in the afternoon and evening of February 28, 1983, setting about 3 km² of soil in motion at speeds of 1 m/day. Although meterological data are presently not available, it seems clear that high intensity rain was the immediate cause through the pore water pressure mechanism. Evacuation of damaged homes took place at the following rate:

Monday, 28 February	30 Homes	c. 150 people
1 March	40	196
2	54	
3	58	
4	68	224

The number of homeless people is not perfectly correlated with the number of homes that were officially certified by the comune as unfit for use, as eight dwellings were the properties of migrant families, who were not occupying them at the time. About 30 livestock stalls were damaged, as well as 42 feedstock repositories; roads, power lines and a water main were also severed. Owing to the relative slowness of onset of the phenomenon, deaths and injuries did not occur.

The Response

Almost immediately, 38 police, 54 carabinieri (national guardsmen), 22 firemen and 15 state foresters were drafted into the emergency area. The Prefecture of Potenza sent 24 trailers (a remnant of the 1980 earthquake disaster), which were promptly allotted to 96 of the homeless, while other victims found lodgings with relatives and friends. Indeed it is reported (Il Tempo, Rome, March 3, 1983) that the trailers were not used as a primary shelter, merely as dormitories, and the reason is most probably that the homeless were unwilling to depend too readily on state aid or develop too clear a separate identity as "victims" within their own community.

The blow to animal husbandry, on which the local economy greatly depends, was severe, and 400 head of sheep and goats had to be transferred to folds owned by the nearby Comuni of Grumento Nova and Villa d'Agri (respectively 10 and 20 km to the SE). Geological and technological assessment of the site were rapidly made, and some demolition of badly damaged buildings took place during the first few days of the emergency. Fresh water was temporarily supplied by two mobile tankers and it took about a week to restore electricity lines crossing the landslide area (the water main was, according to the Agri Valley Land Reclamation Consortium, too seriously damaged to repair in such a short period of time). Local quantity surveyers estimated the cost of repairing roads and utilities as 20 billion lire ($12.89 million) although it is not clear how realistic a figure this is. Damage to buildings is estimated at 10 billion lire ($6.45 million), again with an unknown level of accuracy.

Two members of the Italian government with constituencies in Basilicata took an immediate interest in the disaster. The Undersecretary of the Interior visited the landslide on March 4, 1983, while the Minister of Foreign Affairs raised the matter at a cabinet meeeting. However, there is no indication that either move had any positive result, other than to reassure local Christian Democrats and provoke their adversaries. Meanwhile, the Mayor of Marsico Nuova sent an emissary to the government in Rome to negotiate for emergency relief funds. The Minister of the Interior granted 100 million lire ($64,500) for the temporary relief of homelessness caused by the landslide, while the Minister of Civil Protection advised that more funds could be obtained if the Comune were to apply for insertion into the list of comuni to receive government help with reconstruction following the 1980 earthquake. These comuni are receiving financial aid under appropriations from the budget made with Law No. 219 of 1981, the southern Italian 1980 earthquake reconstruction law.

Criticism

Local trade unions were quick to point out the inadequacy of land stabilization policies in Basilicata. A plan of reforestation, slope terracing and other measures exists, with an annual budget financed in part by the European Economic Community Development Fund, and by regional and national government funds. However, the budget for 1983 does not include sufficient funds to combat the landslide hazard effectively--given that each of the ubiquitous slope instability phenomena requires a marked concentration of expenditure, usually of millions of lire per hectare. Furthermore, basic survey research into local mass movements is incomplete, and neither is there any concerted regional plan for their amelioration. Strangely, although the connection between intense rains and geomorphic mass movement was clear to all who were involved in the landslide, the fact that the headscarp area above a sizeable settlement was nourished by artesian water seems to have passed without comment.

Comparison with the Ancona Disaster

The Marsico Nuovo disaster brought into play a pattern of response that had become familiar in countless other landslide areas since in the early 1900s the geographer Roberto Almagia identified 700 damaging landslides on the Italian peninsula (Almagia, 1907-1910). It also demonstrated once again that the magnitude of hazard, together with associated costs, has grown much faster than government procedures to cope with it have evolved. The pattern of response, with all inherent faults, can be codified as follows:

1) A predictable geophysical hazard was ignored, despite warning signs (minor landsliding) some years before its main impact.

2) No strategy of prior preparedness was developed.

3) Urban environments co-existed tranquilly with the hazard, unprotected.

4) Sudden disaster caused mass suffering and made national news.

5) The estimated cost of damage was high.

6) Funding and hazard amelioration procedures were found to be inadequate.

7) The regional and national governments expressed an interest in the disaster.

8) Local government sent a representative to negotiate with high levels of government for financial aid.

9) Immediate aid fell short of the estimated need by an order of magnitude.

10) Long-term aid involved delay and complex negotiations.

11) People rendered homeless by the disaster must endure a long-term temporary solution.

12) In response to the cumulative effect of this and other disasters, national and regional plans of logistical and financial preparedness were belatedly drawn up, but they lagged the evolving hazard situation by a substantial margin.

In areal terms, the Marsico Nuovo landslide was approximately the same size as its counterpart at Ancona (although it was probably much shallower, and therefore smaller in terms of volume). Computing a series of ratios for the two disasters (Marsico Nuovo:Ancona), one obtains a ratio of relative costs of between 1:23 and 1:35, depending on the magnitude of damage estimates, but showing in any case that a considerably smaller value-amount of damage was caused at Marsico Nuovo. The ratios of homelessness and the number of emergency personnel involved in the clean up operation are each 1:16.3, indicating that the human dimension at Marsico Nuovo was proportionately greater than at Ancona. However, in terms of the proportion of needed relief funds that was immediately granted by central government, the situation is rather different. Ancona managed to obtain from central government 15.7 % of the cost of its landslide in primary aid, but Marsico Nuovo could only obtain 0.5 to 1.0 %. Although cost estimates at Marsico may be exaggerated, it is clear that the Marsico Nuovo disaster carried less political weight--and therefore valued less in relief money--than the Ancona disaster.

Thus one cannot say that the Marsico Nuovo disaster was a miniature version of the Ancona emergency, for the impact, effect and response associated with such disasters all vary in a non-linear way with the size of event. As a generalization, it may be that larger landslide disasters in Italy involve less over-estimation of their consequences and proportionally better response on the part of the authorities, while smaller disasters provoke more of an under-response.

CONCLUDING REMARKS

It is clear that the Ancona landslide could have been predicted and its worst consequences prevented. Apart from any political reasons why this did not happen, or any question of corruption or negligence, the disaster has shown that procedures for defining and coping with natural hazards in Italy need to be clarified and made more systematic. Given that disasters on the scale of the Ancona landslide occur frequently and that much of the nation is menaced by natural hazards, it is essential that better procedures be developed to cope with environmental disaster. There are five main sources of conflict which need to be resolved by clarifying the national policy. All of them are illustrated by problems related to the catastrophe at Ancona:

1) The relative proportions of national resources to be devoted to environmental consumption (i.e. utilizing the environment for benefit or profit) and environmental protection need to be clarified.

2) Procedures need to be worked out to define the relative levels of financial responsibility of local, regional and central government with respect to both hazard prevention and disaster relief. This is also true of the scientific and technical investigations that must necessarily precede hazard reduction schemes. At all three levels sources of funding must be identical and earmarked in order to mitigate future hazards and disasters. The guiding principle is always that prevention is better than cure, and is usually much cheaper.

3) The level of individual, or corporate, responsibility for disaster effects needs to be specified, rather than simply assuming that the various levels of government are responsible. In Italy, for example, no steps have ever been taken to prescribe the degree to which an individual is responsible for the safety and soundness of his or her own home. National disasters tend to provoke immediate underwriting by the government, even though the proportion of Gross National Product that can be utilized is usually inadequate to cover the damage. Giving some responsibility back to the individual would encourage better personal preparedness--for example, better maintenance of buildings, which has proved to be a critical

factor in earthquake damage resistance. Incentives, such as government sponsored hazard insurance (with premiums payable by the individual who is at risk) and property improvement loans or grants, are necessary.

4) Benefit-cost ratios need to be worked out for schemes of defense against hazards and compared with the probable cost of disaster relief if nothing is done until disaster strikes. Nationally, less emphasis should be given to personal consumption of goods and more emphasis to cooperative schemes of environmental defense. This is especially true in that natural disasters are capable of destroying resources that are precious yet irreplaceable. For example, social cohesion in the small communities of rural Italy often depends to a greater or lesser extent on the distinctive and historical character of the environment. If this is jeopardized or destroyed by earthquake, flood or landslide, the social community can begin to disintegrate, yet many such communities are at present defenseless against a very real threat from extreme natural events.

5) It is essential that a distinction be made between predicting an extreme event, such as a damaging landslide, and warning the affected population or taking other avoiding action. At Ancona, as in other Italian disasters, there was no "chain of command," formalizing who should be responsible for predicting the disaster and who should give warnings or find some way of absorbing the impact. It is only a matter of time before the next disaster happens in Italy in general and Ancona in particular. While it may not be possible to avoid future disasters, their impact could be significantly reduced if both scientists and governments had clearly defined, separate, but interacting, roles to play and responsibilities to assume.

At Ancona some attempt was made to predict disaster, and modest schemes of hazard prevention were designed. These were largely ignored by the city council, who nevertheless reacted rapidly to the disaster when it occurred. Individual responsibility for the damage was waived and government funds were substituted; what American commentators sometimes describe as "forgiveness money" was handed to the occupiers of the stricken hazard zone. Prior awareness of the hazard among politicians and citizens was low and discouraged, while geologists showed a reluctance to participate in the political aspects of hazard prediction (but were inevitably drawn into the political wrangle after the catastrophe had occurred). At the time of writing the long-term funding for disaster relief and reconstruction in Italy is uncertain, but as government response to the disaster is basically *ad hoc*, the lesson of previous disasters is that payment will almost certainly be delayed (Geipel, 1982), engendering further misery among disaster victims.

Finally, it is important to consider whether the pattern of disaster response in Italy is set, or whether it is changing in reaction to the repeated demands for relief. Despite the frequency of disasters and the similarity of relief needs after each one, there has been little progress towards a unified and effective national policy against natural disasters. The Italian approach is still *ad hoc*, fragmentary and lacking in substance. The creation of a Ministry of Civil Protection, although a formal recognition of the problem, can be viewed as little more than an attempt to reduce the amount of legislation needed, and the amount of conflict involved, in granting relief funds to stricken communities. Many of the fundamental issues, such as who is ultimately responsible for the consequences of disaster, have never been settled or even aired in the national arena. Funds for disaster relief are still only a fraction of the costs of disasters, yet individual victims or survivors are not told that they are responsible for the balance of costs, so that there is a break in the chain of responsiblity and accountability. As the cost of the Italian national of natural hazards and disasters is increasing, and there are strong probabilities of high future death tolls, it is essential that the issues of responsibility, preparedness and prevention be tackled at the earliest opportunity.

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APPENDIX I

NOTES ON POLITICAL GEOGRAPHY

Basic administrative divisions in Italy and the disaster area:

comune	Township, municipality (Ancona, pop. 108,466, December 31, 1978) Comune di Ancona--Ancona City Council.
frazione	Outlying settlement, not the principal nucleus of a comune, e.g. Torrette is a frazione of Ancona Comune.
provincia	province: 95 in Italy, 4 in the Marche: AN Ancona, MC Macerata, AP Ascoli Piceno, PS Pesaro-Urbino.
regione	region: 20 in Italy: Regione Marche: 9,694 km², pop. 1,409,845 (145 persons/km²).

ABBREVIATIONS

Political Parties

DC	Democrazia Cristiana	Christian Democrats
PCI	Partito Comunista d'Italia	Communists
PDUP	Partito d'Unita Proletaria	Proletarian Unity Party
PRI	Partito Repubblicano d'Italia	Republicans
PSDI	Partito Social Democratico d'Italia	Socialists

Ministries and Public Bodies

ANAS	Azienda Nazionale Autonoma delle Strade	State Roads
CNR	Consiglio Nazionale delle Ricerche	National Research Council
FS	(or FFSS)Ferrovie dello Stato	State Railways
LLPP	Ministero dei Lavori Pubblici	Ministry of Public Works
MPC	Ministero della Protezione Civile	Ministry of Civil Protection
PTT	Poste e Telegrafi	Post Office and Tele-communications
RAI	Radiotelevisione Italiana	State Broadcasting Corporation