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THE VISIBLE SITE: DANGER SIGNS

In earthquake zones preventive measures generally consist of microzoning techniques based on mathematical models which simulate the real situation. These allow probable effects to be predicted (for example, an increase in seismic activity in the ground) using a series of calculations based on the specific parameters of the local situation.

But we know too that earthquakes leave marks both on the ground, on buildings and in the collective memory of the population. To find these marks the geologist has to tackle the problem in a special way. It is not enough for him to use calculations and projections; he must also record and interpret both the visible signs on the ground and those provided by the reactions of the community. These reactions can be seen in the changes made to the urban site or to buildings.

In order to analyse the vulnerability of the system one can thus follow a procedure which, by pinpointing and interpreting these marks, enables us to make a map of the danger signs. Such maps are useful documents for reducing the vulnerability of the system. The community needs to be aware of the danger if appropriate and sensible environmental measures are to be taken more effectively.

How the map was compiled

When we came to use the vulnerability analysis grid we realised that we know very little about why the community focused its original settlement on this particular area.

Analysis of San Lorenzello's history and town planning shows that the first centres of habitation were in the area uphill from Muro Filippo (cf. page 46), on detrital land at the foot of the limestone ridge. Through the centuries the inhabited area spread gradually downhill, finally occupying the whole of the tuff terrace and reaching the river. The reasons for the original choice were probably social, economic and strategic. It is possible, however, that this choice may also have been prompted by an empirical assessment of the risk of earthquakes. This hypothesis is widely proven by the fact that in many historic centres around the Mediterranean the original core of the settlement is more resistant to seismic shock than more recent constructions built on unstable land.

But what information did the original community have to guide it in its choice of a safe, or at least less dangerous, site?

In trying to answer this question we at once realised that our research would have to be multidisciplinary in structure. It was found that using just one specialist alone was not enough and could even be counterproductive. The geologist thus proceeded to cooperate with the geophysicist, town planner, architect, historian, but above all with the people living on the site.

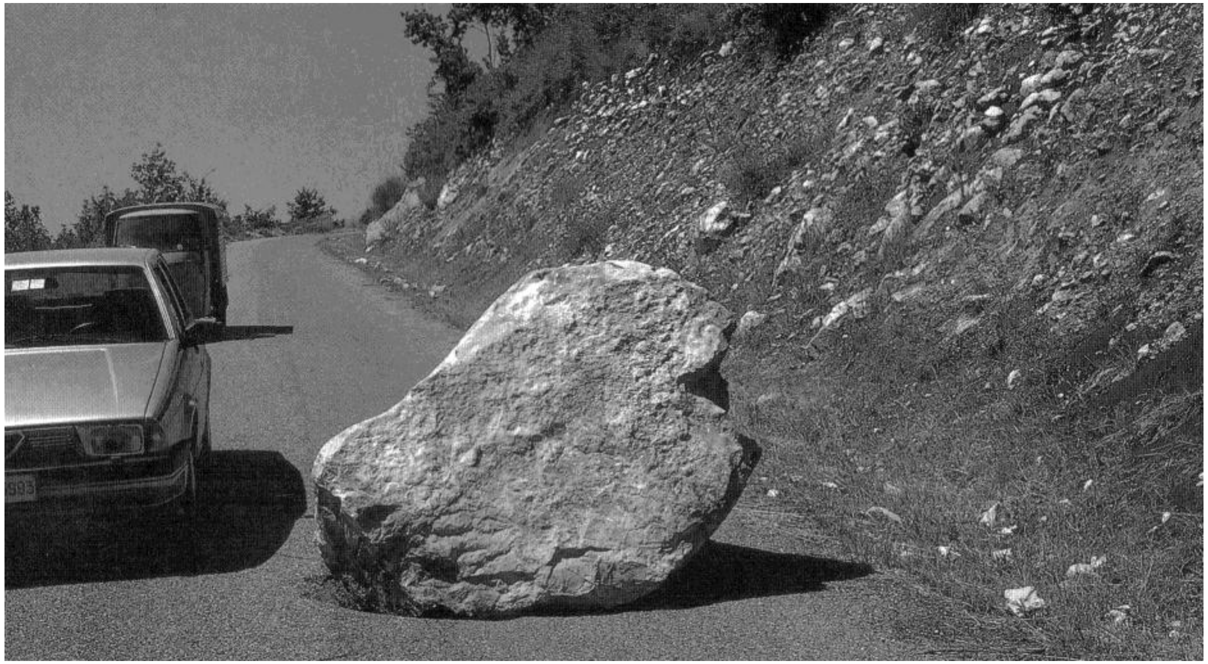
In San Lorenzello we studied the problems of instability (stability of the land, landslides) which might be caused by a seismic shock), with reference to features such as the soil and subsoil, morphology of the region and human activity. Specific studies were conducted which took the form of field analyses using the material available (maps, aerial photos, test borings), in order to learn more about the geological conditions at the surface and at depth, the geomorphology of the region and the degree of fracturing of the limestone ridge which threatens the historic centre.

Collaboration with the workmen at the site and the people living on it yielded useful pointers as to the language in which technical concepts should be expressed in order for them to be readily understandable by non-specialists.

The result was a summary table which matched scientific names with local vernacular terms, indicating what constituted a danger situation and what preventive and protective measures could be taken to eliminate the danger.

The map of danger signs

The findings of these analyses are summarised in the map and table which follow. The first thing to strike one is that dwellings sprang up in the middle of the area which presents no visible danger signs. But if we superimpose the map on a map of the local topography it would seem that the oldest part of the settlement was in an area prone to landslides.



It is possible, however, that the ridge was originally plentifully wooded so that the risk of fracture was considerably smaller than it is today and the danger zone too. The seemingly "safe" area extended further uphill, probably away from the core of the original settlement.

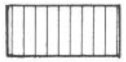
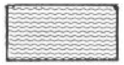
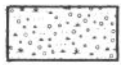
In the area in white, the only factors representing an obvious potential danger are those created by human action, namely cellars and caves dug underneath buildings or into the tuff rock face.

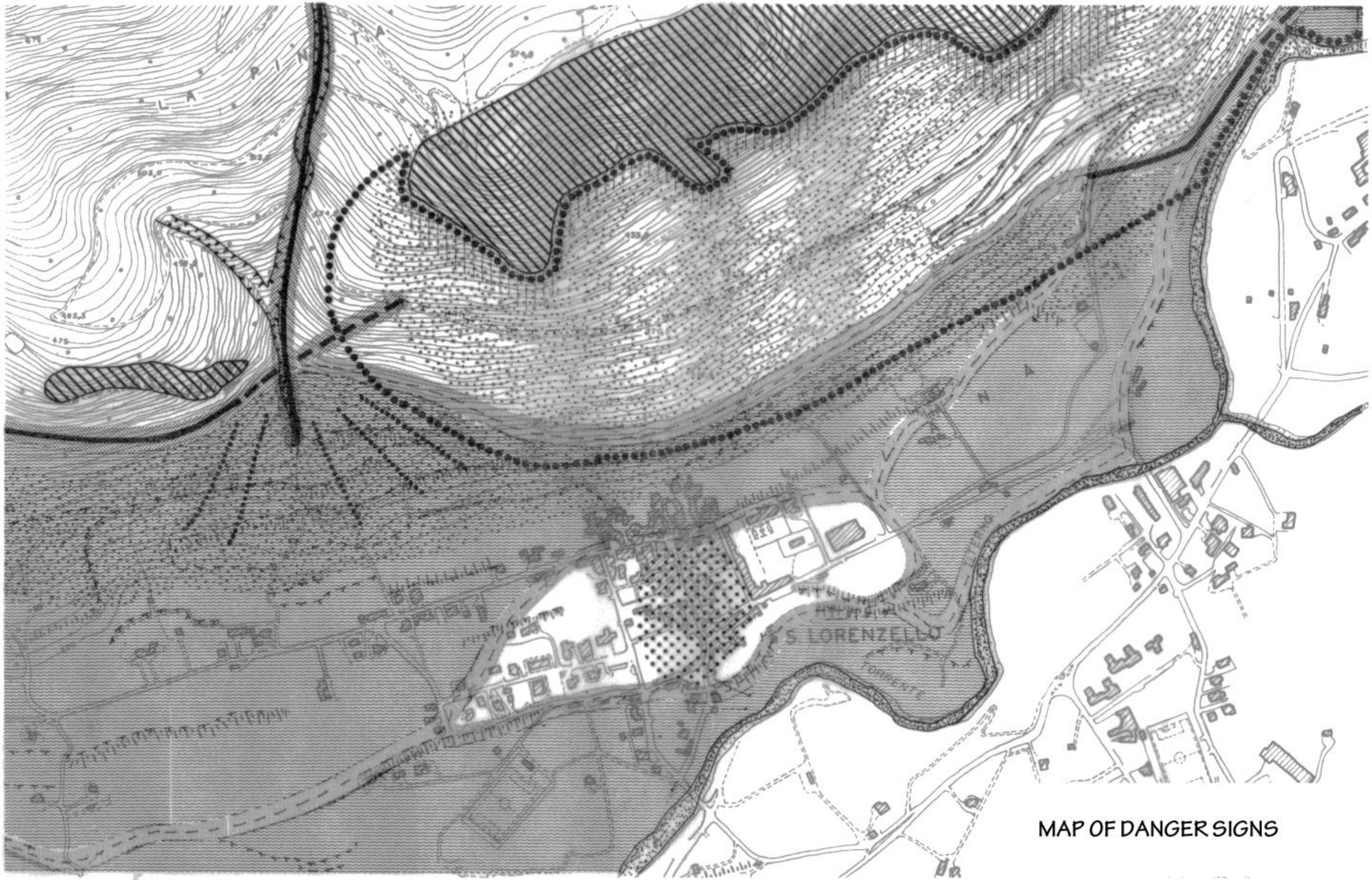
Use and potential value of the Map

The Map of Danger Signs is intended to locate potential danger situations and pinpoint the signs by which these can be identified.

It can be used for different kinds of interpretation and can help overcome the uncertainties and difficulties entailed in assessing seismic vulnerability. It may be used, for example, to identify measures traditionally used for protection against earthquakes, as in the case where everyone had a direct understanding of earthquakes and the community had its "earthquake culture", born of its own experience or that of its forebears. It can in particular point to the probable reasons why a specific site was chosen when the original core of the town was built. The Map can also help identify and solve problems concerning the physical features of the ground and the impact of human activity on the area.

In an effort to make the Map as good as possible, we sought to reevaluate indices which appear to be of secondary importance but which are in reality decisive factors in our understanding of risk. This Map is useful when designing models to predict the effects of earthquakes and in assessing the work needed to

	Sign	Scientific name	What may happen	How to minimise the danger
			Surface of terrain	
	**Steep rocky ridges with fissures and no vegetation.**	Steep rock faces, heavily fractured.	Fracturing allows large blocks to break off.	Do not build below until appropriate work has been done (preventive blasting, anchoring, nets, etc.). Detect displacements using sen-sors cemented into fissures, etc.
	**Steep slopes on face below rocky cliffs.**	Steeply inclined zones at foot of rocky ridges.	Steep slopes make it easy for blocks which break off terracing from the ridge or are unstably posi-tioned to move.	Slow or stop falls by planting trees and/or place earth levees parallel to the slope (block traps).
	**Blocks scattered over the slope.**	Unstable rock masses.	Future landslides probable.	Treat the slope. Set up system to monitor movements in most dangerous cases. Place plenty of tree breaks or artificial barriers.
	**Ground has undulations and fissures, walls deformed, roads damaged, etc. Land often waterlogged.**	Zones with undulations, ground fissures, waterlogged areas.	Ground may be unstable. Poor load-bearing capacity may, if an earthquake occurs, cause subsidence, landslips, mud-flows. The presence of large quantities of undrained water may reactivate pre-existing instabilities causing landslips. Liquefaction may occur.	Carry out thorough geotechnical analysis before doing anything. Detect surface movements (e.g. plant rows of indicator posts in ground). Build very rigid structures or provide pre-planned stress rupture points.
	**Deep ravines with eroded ridges along steep slopes.**	Deep incisions into slope (torrents) with active erosion.	Zone along incision is exposed to landslips and subsidence.	Observe prescribed safety distance from edge of incisions.
	**Accumulation of detrital ma-terial at mouth of incisions.**	Alluvial or dejection cone.	Unstably balanced material probably present	Verify presence of material. Check its stability and load-bearing capacity and detect any movements. Move if necessary.
			(Human) alteration of terrain	
	**Sharp non-wooded inclines (felling, fires, etc.).**	Inclined zones with little tree cover.	Blocks may loosen as a result of fire and break off.	Create tree breaks. Avoid unplanned deforestation. Detect movements using rows of posts.
	**Cellars and stores under houses**	Man-made subterranean cavities.	Ground acceleration likely to increase. Roofs and ceilings may collapse.	Do appropriate and regular maintenance work on roofs and ceiling.
	**Excavations and fill.**	Man-made notches with in-clines steeper than those which the mechanical charac-teristics of ground would suggest. Accumulation of ma-terial in poor state of balance.	Probable ground movement and/or rock falls. Roads may be deformed. Push against buildings.	Reduce inclines or do appropriate support and drainage work. Do sufficiently extensive geo-technical analysis before each operation. Compact the material. Move it if necessary.
			Structure of terrain	
	**Valleys, incisions, uplift, notches**	Probable faults and fractures.	Ground stresses could be intensified and/or may vary, so would be very dangerous if an earthquake occurred	Avoid building close to incisions. Do geological analysis to ascertain exact structure of subsoil.
	**Zones in which there are ab-rupt changes in the quality of adjacent or overlying rocks.**	Statigraphic or fault contacts.	Ground stresses may vary greatly at the point of interface between rocks.	Avoid building close to these zones until geotechnical studies have been done to ascertain how the various rocks relate to each other.


S. LORENZELLO
MAP OF DANGER SIGNS

minimise the damage.

The multidisciplinary approach used in drawing up the Map is advantageous in purely technical terms too. It means that the gaps left by a partial approach to complex problems, frequently encountered when one tries to combine single-discipline, specialised analyses into an overall picture of the subject under review, can be plugged. When dealing with natural phenomena, consideration of each risk factor in isolation is often not very helpful for an overall appreciation of the danger and can actually cause the wrong kind of action to be taken.

The Map does, of course, provide "qualitative" data about risk situations and factors. But its value can be enhanced by the development of probability models which attribute different variables to the risk factors and measure the possible scenarios to which their interaction gives rise.

The Map may also be used in disaster prevention. In this case the risk analysis needs to cover all the danger signs and must include other parameters too, e.g. those relevant to building methods, structural changes or the presence of industries which create a risk.

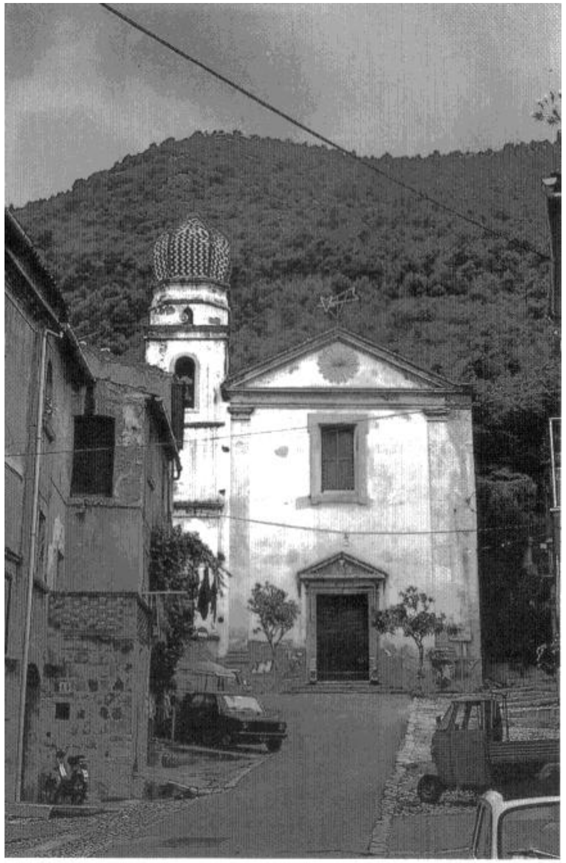
The Map should show not only danger signs but also those features of a site which help to protect and stabilise, so that these are not eliminated or changed. A case in point is the planting of trees, etc. in areas subject to landslips.

A few notes

The approach used in compiling the Map may be called "systemic" in that the danger is analysed in its entirety.

The Map of Danger Signs can thus help to analyse and reduce vulnerability whether the risk is either natural or man-made.

Thus it is important to stimulate an awareness of the risk by involving the whole community in the compilation of its "own" map. This would make it a product of the local earthquake culture and not an analysis done by outside experts, designed to raise community awareness but which would probably gather dust until a disaster actually happened.



For example, a document of the Emergency Services was found in the archives of the San Lorenzello town hall listing those firms which had machinery and equipment capable of moving large masses of debris. But this list would have been totally useless because it dated from a time when a major road was still under construction in the commune so that the information it provided was out of date.

If it is to retain its usefulness the Map must thus be an "open-ended" document, constantly updated by the population itself, in liaison with the organisations and bodies concerned (central and local government, research and monitoring units, schools, etc.).

It is also important that the Map should be prepared with the utmost scientific exactitude and that the problems and any solutions it proposes should be stated clearly. If it is to be truly effective, it must be useable not only by technical experts but also by administrators or the man in the street. So it is vital for the population to be directly involved in preparing the Map. This is essential if people are to be thoroughly aware of the risk without being permanently in a state of alarm.