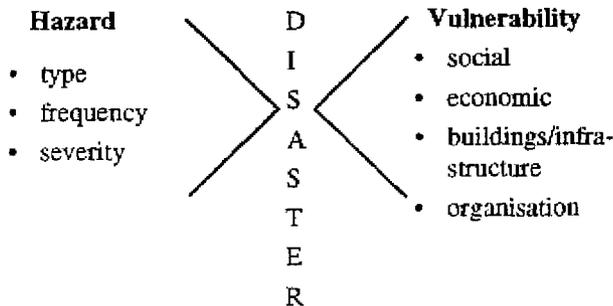


components of these two elements: for hazards severity, duration, frequency, location; for vulnerabilities those mentioned above.



Disaster = hazard + vulnerability; however, it is also key to recognise capacities hence, the aim is also to reduce vulnerabilities and increase capacities.

Fig. 2. The Pressure and Release (crunch) model.

Capacities and vulnerabilities

The crunch model serves to articulate vulnerabilities (negative aspects causing disaster) but traditionally does not include capacities - positive aspects of a given situation which may, when mobilised, serve to reduce risk by reducing vulnerability. Reducing the risk to natural hazards can be described in terms of *reducing vulnerability and increasing capacity*. At first sight such a statement appears simplistic, yet, within the complexities of risk reduction, with the minefield of political, economic and social factors, dictated by interest groups, each with individual agendas, agreement of the lowest common denominator for reducing risk provides the framework for movement forward.

This definition for action is useful for two other key reasons:

1. It is readily comprehensible by all. So often the notion of risk reduction is a stumbling block - a difficult to grasp concept seemingly unlinked to everyday life. To provide an easily understood framework usable at community, NGO, governmental and intergovernmental level begins a dialogue of commonality between key players.
2. The definition forces a recognition of what is *good* in a given situation, not only on what is bad. Capacity is a positive statement recognising existing measures and mechanisms already employed for reducing risk.

Hence the aim of the project was to identify hazards, vulnerabilities and capacities, with a view to identifying ultimately ways of reducing vulnerabilities and increasing capacities.

Research methods

During the risk evaluation four research tools were employed. These are:

1. Collection and review of existing research

The OCDS/IPADEL research team was anxious not to replicate any existing work carried out; it was also aware of its own limitations of time and resources and was relying therefore on previous studies for technical information, eg. earthquake in Lima, soil conditions in the ravine. To these ends technical information and background information were gained from the *Rebuilding Communities in Lima* workshop, January, 1995; previous work undertaken by Intermediate Technology, including in particular that of Andrew Maskrey and La Red; meetings with Defensa Civil; and earthquake vulnerability information from CISMID (the Japan-Peru Centre for Earthquake Research) at the Engineering University.

2. Observation

The purpose of the observation teams was to build up hazard maps of Caqueta relating to buildings and infrastructure. Data collected included approximate building age, state of condition, number of floors and construction materials. The observational research was carried out in two stages:

- by an IPADEL team prior to the risk evaluation who surveyed three sections of Caqueta, placing the findings onto computer for hazard map production, and
- during the risk evaluation when two sample areas were observed, the findings combined with house to house interviews collecting socio-economic information to form a "picture" of small communities.

3. Questionnaires at household and organisational level

Two sets of questionnaires were used to gather information. These were of:

- Organisational capacity. IPADEL staff conducted a questionnaire with local associations (market traders and social organisations) in Caqueta to provide background information on organisational capacity. Information gathered related to size of organisation, activities, breakdown of members by age and sex, frequency of meeting. Information also gathered related to perception of risk by ranking.
- Households. Brief questionnaires relating to social and economic data were conducted with households in each of the two typologies relating to dwelling. Information gathered related to number, age and sex of household members, income earning activities and approximate monthly incomes relating to family members.

In addition to the gathered data, life stories were gathered of a sample of households in order to provide qualitative data. A question check list was provided for the interviewer with questions relating to time living in household, reason for choice of location, and a recounting of any major disasters to have affected each family or community's livelihood.

4 PRA meetings

A series of meetings were carried out with market and housing association representatives to gather data using PRA methods. These included:

- **Community mapping**
On large sheets of paper participants were encouraged to draw their area (usually several blocks) and to map key buildings, eg cinema, storage depository in markets, church, etc.
- **Time line development**
A time line, usually from either 1970 or 1980 (depending on the age of the participants) until the present day was drawn. Participants indicated on the line key significant good and bad events; the former may include the finishing of roads or the installation of services: the latter landslide, tremors or significant fires.
- **Hazard mapping**
The map was then returned to and participants were asked to indicate on the map where these occurrences had happened.
- **Development of disasters matrix**
Identified disasters were then placed on a matrix with the headings of disaster, causes and possible solutions. Participants were also asked to state which was most important, second most important etc.
- **Discussion of results**
Finally results were discussed in the group, mostly around the matrix; many participants shared their own visions of how the identified situations could be improved.

NATURAL HAZARDS IN LIMA

The ravine area suffers from earthquakes and landslides along the Rimac valley which transects the city. In addition poorly enforced building and planning codes, high densities and rapid urbanisation increase fire risk in the area.

Earthquake risk in Lima

Peru lies at the junction of the Nazca and South American Plates. Of all the seismic activity in Peru,

Lima ranks as the second highest area. Since 1586, nine major earthquakes in Lima have been recorded, the last one being October 3, 1974, when 78 people died and a reported 2550 were injured. In particular Lima is vulnerable to earthquake damage due to soil conditions - since it is built on a desert, strip the flat land is comprised of boulders, gravel and sand. Maskrey (1987) identifies three areas within Lima according to vulnerability, of which the ravine falls into the third category;

- middle and high income areas - low vulnerability,
- Pueblos Jovenes, eg Villa el Salvador - low vulnerability, and
- inner city - high vulnerability.

In 1983 the National Institute for Urban Development (INADUR) undertook studies to prepare a Seismic Protection Plan for Lima Metropolitan Area for Defensa Civil. The Seismic Plan however was never implemented (Maskrey, 1987). Studies however found large amounts of housing in particular to be highly vulnerable for two key reasons:

- poor resistance of original structures and materials used and
- poor maintenance combined with intensive use of buildings through overcrowding.

The study identified two housing types in the old centre: those over 50 years old - older, larger houses built with heavy roofs, adobe walls with wooden joists were traditionally highly resistant to earthquake. However their resistance has been reduced through over use and neglect. The key reason for the deterioration is low income migrants sub letting rooms within such buildings causing overcrowding. The second housing type is of houses 30-40 years old - smaller, one storey adobe built with lighter roof, less vulnerable than their larger neighbours because of their small size and lighter weight.

Defensa Civil's study of one area of Lima, Lima-Cercado, found that of the 73,091 houses in the area, roughly 25% (18,087) were under risk of collapse. Another key identified problem was the presence of ambulantes, which in the event of a disaster, would not only themselves be highly vulnerable, but would also increase rescue services access.

A further study by CISMID (Hurtado, 1994) in Barrios Altos, in the same district of Lima-Cercado, predicted that of the 1,964 houses surveyed, 58% (1,137) were considered vulnerable to collapse, 13% (258) severe damage and 29% (571) moderate to light damage. Of the

population of 9,814, a moderate earthquake would cause 100 deaths, 1,000 injuries and 7,000 displaced persons.

Landslide and the ravine

North of Lima, the Rimac Valley, which forms the Caqueta ravine, is subject to severe mudslides, or *huaicos*. The *huaicos* occur from December - February each year, causing floods within the Rimac Valley floodplains as well as rapidly moving torrents of water within the valley. The effects of *huaicos* are felt in Chacacayo and Lurigancho-Chosica, peripheral districts of Lima; also Lima's water supply is affected as are transportation routes in and out of the city. In addition, farmland is affected. The effect on the River Rimac within Lima (including that flowing through Caqueta) is of torrents of water flowing in January and February each year. At that time the river may rise up to 5 metres. During PRA exercises perceptions of the *huaico* given by ravine edge residents in Caqueta included:

- "it has no effect on us since the ravine is so deep" and
- "it is a good thing since it serves to remove the rubbish and sewerage gathered on the ravine edges".

However the annual *huaico* does serve to further erode the ravine, deepening it and ultimately widening it by causing further landslide along its deep banks (Fig. 3). Some evidence of the rate of erosion may be gained from conversations with local residents: older people remembered being able to wade across the ravine in the early 1950s (although this is uncorroborated). Other indicators by local residents state that the ravine is widening by about one meter per year: buildings now right on the edge of the ravine, less than forty years old, which were hitherto on stable land bear witness to rapid erosion of banks.

Juvenil Medina Rengifo, disaster specialist at Intermediate Technology carried out a study of the geological conditions of the ravine area: it is his belief that the ravine, and others similar within Lima, are the result of geological faults: the erosion caused by the Rimac river, and especially the coming of the *huaico*, serve to exacerbate an already existing problem.

Due to its location, the problems of the ravine have a high profile within Lima. Several initiatives at governmental level have been discussed for solving the problem. Some of these are:

- Covering the ravine

During the period of President Belaundes administration, in the mid 1980s, a project was developed to cover the ravine with a lightweight structure on which industrial enterprises would

operate. The plan also included relocation of the ravine dwellers to improve the area. The initiative did not come to fruition.

- Relocation to Ventanilla

In discussion with the Chief Adviser to the Head of Defensa Civil, it was his view that all of the area neighbouring the ravine, and those dwelling on the former garbage site, should be relocated to Ventanilla, a government owned relocation area far from Caqueta in the north cone of Lima. The ravine area would be zoned as parkland: all buildings and infrastructure would be removed and the area replanted.

- Creation of the Rimac River Authority

Legislation currently with Parliament for debate proposes the creation of a Rivers Authority for the Rimac River. Such an authority would provide one body of power responsible for the Rimac, including the ravine and those dwelling on it.

Little has changed so far, however, to improve conditions. Whilst ultimately solutions will doubtless rely on some degree of government intervention, discussions with local communities, experts and political bodies have revealed that the vulnerabilities of the governmental approach to date include:

- Reliance on large scale technical solutions
Solutions to date such as concreting the ravine banks would be technically complex and hugely expensive.
- Lack of co-ordination at political level
The Rimac ravine transects several municipal districts: a co-ordinated strategy would be very hard with different interests, points of view, etc.
- Lack of political will
Forced relocation on a large scale would be politically unpopular.
- A desire to solve all problems in one macro level initiative
The top down approach of one solution has proven to date impossible. A cocktail of small scale initiatives with differing time frames might prove more realistic.
- Limited resources
Large scale relocation (including new housing) and urban improvement (demolition of vulnerable housing and reuse) is very costly.
- Lack of community consultation
Communities themselves are aware of the problems, but chose to live in vulnerable areas in order to be

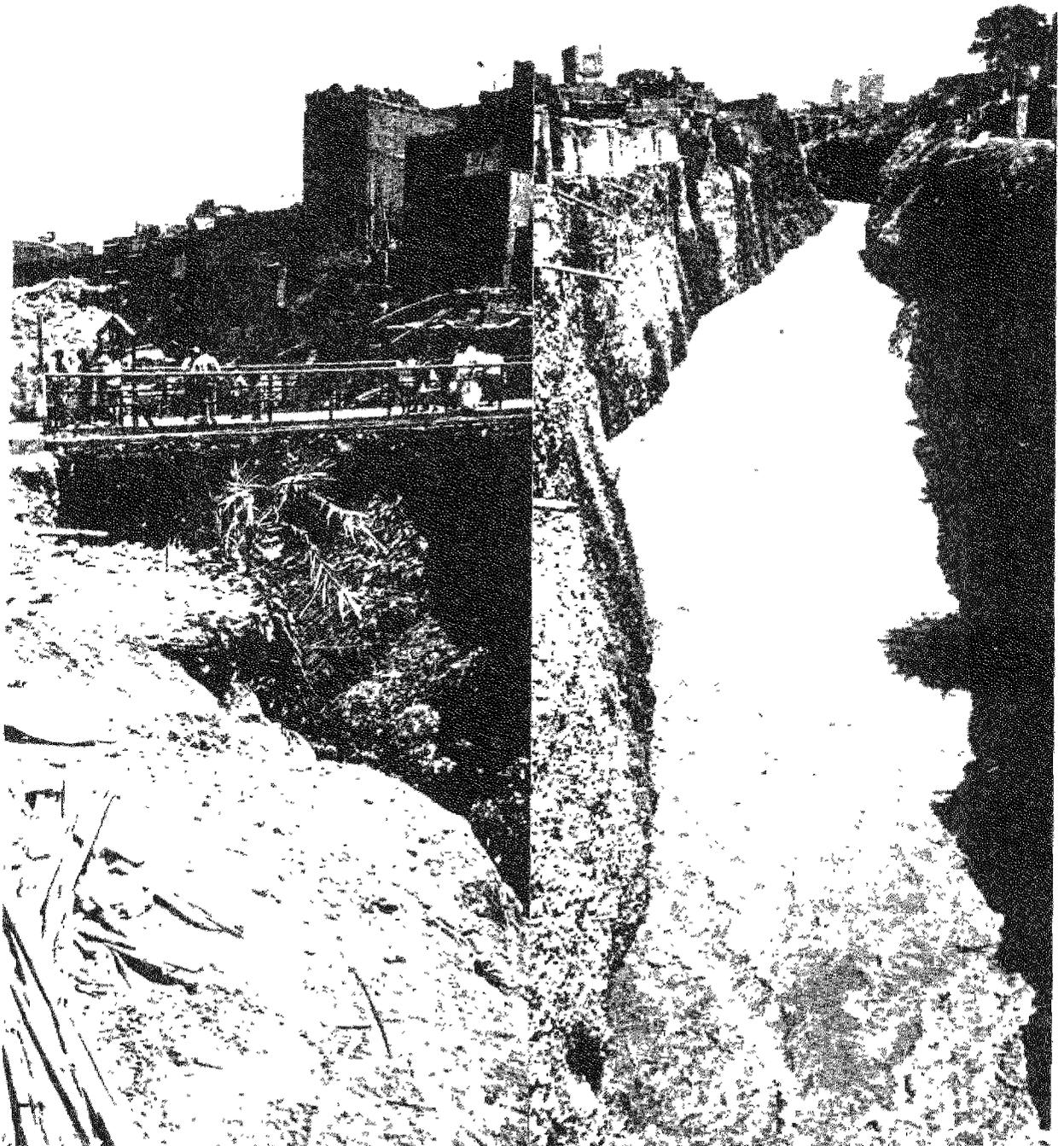


Fig. 3. A view of the ravine showing steep slopes; Left: the bridge over the ravine. Right: the ravine.

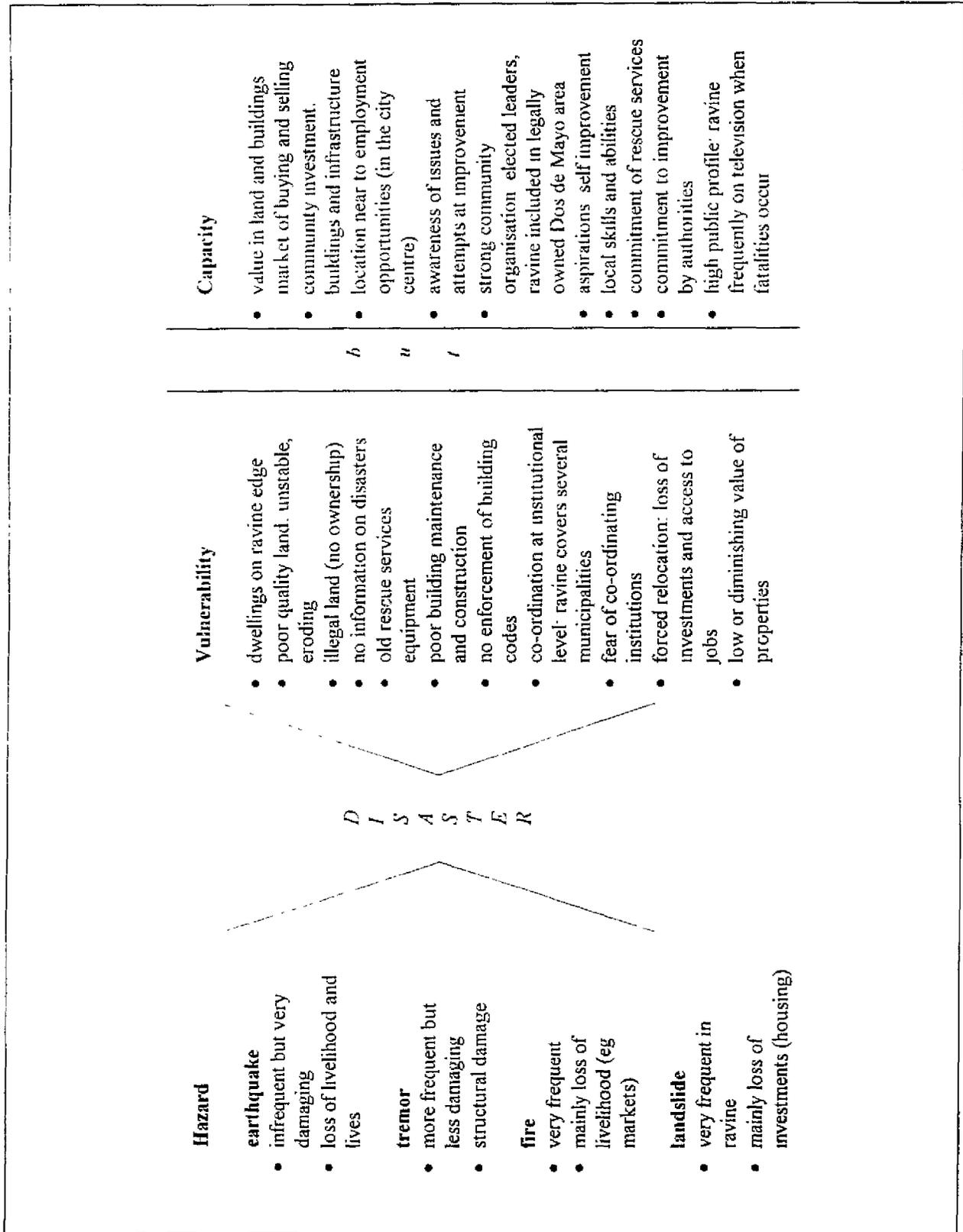


Fig. 4. Summary of key hazards, vulnerabilities and capacities in the ravine.

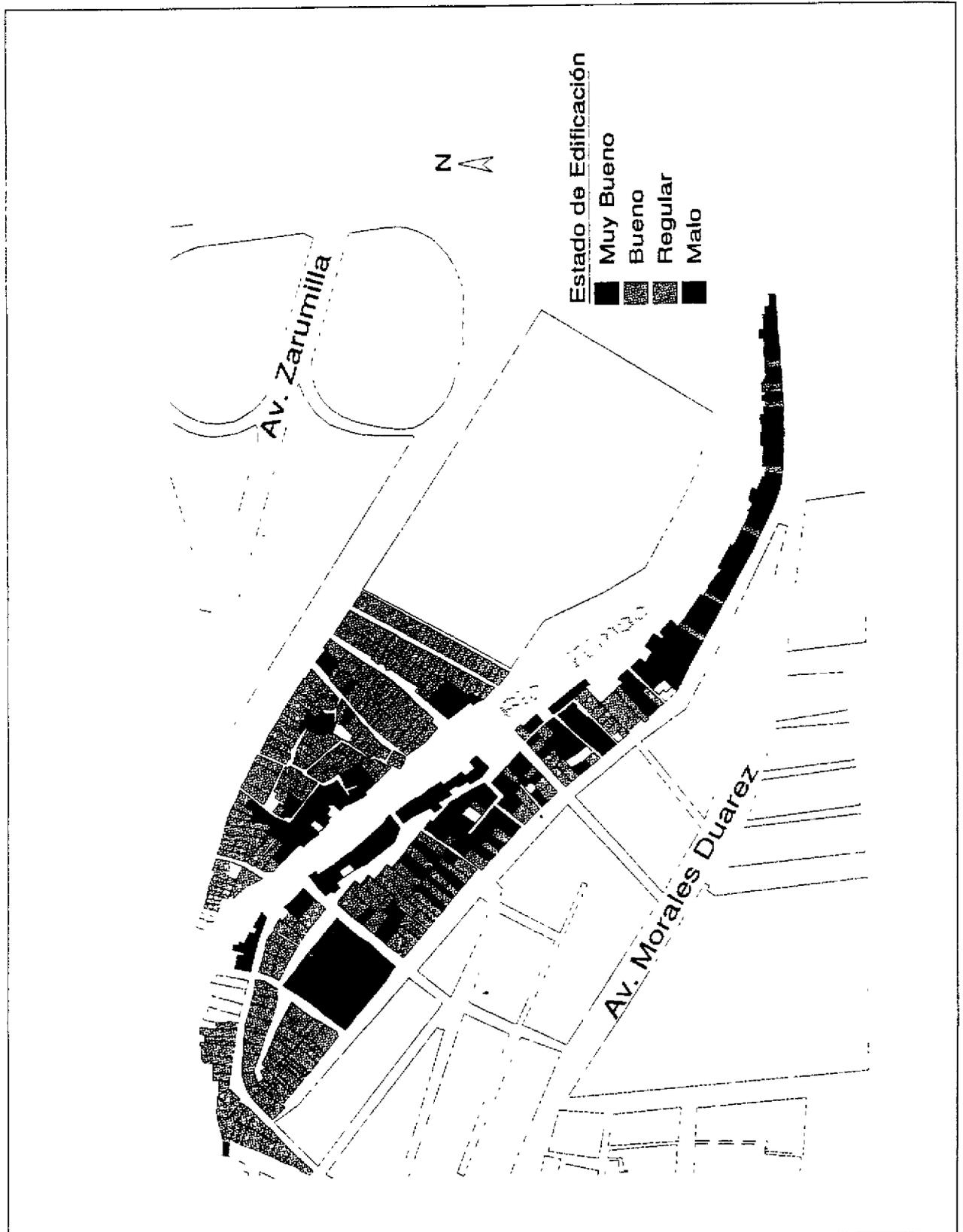


Fig. 5. Condition of buildings, Caqueta Ravine.

Maps were also produced for age of buildings, number of storeys and construction materials.

close to work. The research found that many families had moved to dwellings on the edge and would sell on their properties.

RISK EVALUATION FINDINGS

The following information presents the key findings of data gathering within the ravine area (Fig. 4). The findings include a summary of hazard, vulnerability and capacity, and PRA findings. PRA was undertaken with residents of Association Dos de Mayo, whose borders extend to the ravine edge. One street along the ravine edge was also chosen for a more detailed survey of building condition, residents and their incomes (Fig. 5). Data gathered was used as the basis for the following "Caqueta, Place To Live Without Risk" workshop.

Table 1. Historical profile

DATE	EVENT
1968	Tremor & landslide: 4 houses and 2 families affected
1972	Law passed to move local chemical producing factory to Ventanilla
1978	Landslide: 2 houses lost and 1 family affected
1983	Landslide: collapse of coliseo
1984	Landslide: collapse of wall

Community Perceptions (Table 2).

Representatives were asked to identify the key problems and possible solutions.

Household Surveys found that households on the ravine edge had access to total monthly household incomes which ranged from 200 - 1000 Soles. Residents had been on the edge from between 50 years to 2 years.

DANGERS	PROBLEMS	SOLUTIONS
Landslide of houses into the ravine	Ravine is very steep	Raising of the height of the river
	Broken sewage pipes leak into the soil	Construction of a covering over ravine
	Erosion of river undercuts ravine	
Bridge is in danger of collapse	Foundations are exposed	Repair and replace wood concrete walkway
Pollution of river Rimac	Dumping of garbage and sewage	
Pollution of air by local factories	Health of community especially eye, nose and ear problems	Relocation of factory away from residential zone

Table 2. Community perceptions.

Historical Profile (Table 1)

Community representatives were asked about particularly memorable natural disasters. Residents stated buildings fall into the ravine "all the time"; children also fall in from the edges and from the bridge on a weekly basis (the sides in places have been removed for tipping garbage) (Fig. 2). Ironically the garbage often saves lives through providing a "cushion" for those falling in.

Despite the dwellings being officially illegal (building is prohibited within 25 m of the ravine edge), all had bought their properties, and most would be anticipating selling them on. Hence despite the clear risk associated with living on the edge of the ravine, property retains an exchange value. Families are continuing to buy and sell as well as consolidate their property. Additionally, there appears to be a high diversity of employment including formal and informal employment types.

NEXT STEPS

There is no affordable, all embracing solution to reducing vulnerability in the ravine. Past initiatives bear witness to this. However whilst stalemate continues and little is done (due to lack of resources, political will and the exclusion of actors in decision making) other interventions to *mitigate* risk are possible. As a result of the workshop, groups are better in touch (especially between communities and municipality); also the profile of risk awareness and the need to reduce vulnerability has been highlighted. Workshop participants from the ravine dwellers association also talked about organising their own risk awareness meetings.

There are hurdles however outside the scope of influence of this project. The approach taken has been that any shift, however small, that increases capacity and reduces vulnerability, is a positive output. Ideally political will would have been galvanised more - to some extent the continuing embarrassment of the ravine dwellers plight is the greatest galvaniser. Interest in this project was heightened shortly after its completion when a three year old child was killed falling into the ravine. After press interest, Senior Municipality Officials visited the offices of IPADEL to enquire about this work; action however has yet to be forthcoming. It is sadly ironic that macro change may in the end come as the result of one large disaster.

As Phase Two of this project, further interventions regarding ravine improvement through lobbying and community organisation are planned. Of the seven initiatives developed from the workshop (including strengthening fire services, improving fire awareness in markets and NGO training) the two key projects directly relating to the ravine are:

Ravine Environmental Improvement Programme;
Reducing risk through participatory urban improvement

The aim of the programme is to improve environmental conditions in the ravine area of Caqueta. An essential aspect of the eighteen month project is to inform and mobilize all interest parties - at community, NGO, municipality and government levels - towards common agreement for action. The project comprises two stages: Mobilization for Action, and Dissemination. Stage One comprises three related activities, aimed at informing interest parties and galvanizing action. Hence:

1. Mobilization for Action

- Mobilization at Community and Municipality Level. Through a series of community and

municipality level workshops participants will explore options for improvement and develop strategies for their implementation. Hence *continuing improvements at community level will be a feature for this activity.*

- **Institution building.** Governmental, municipal and NGO level organisations will be invited to awareness raising seminars/workshops, as well as being provided information on the ravine: opportunities, problems, etc. In addition, different institutions will be invited to work together in the formation of a *ravine improvement working group.*
- **Feasibility studies.** Technical, economic, legislative and social options will be explored by local and international experts for environmental improvement.

Throughout the project information from one activity will be made available to the other through a quarterly news-sheet.

2. Dissemination

The outputs from each of the three activities will be disseminated widely as options for improvement. Information will be presented at Governmental, NGO and municipality levels with a view to mobilizing action for change, and for securing national funding for implementing change.

Ravine Environmental Improvement Programme;
Bridge Improvement Party for Community Mobilization and Risk Reduction

Funding for this project has already been provided by the British Embassy in Lima. The project is due for completion in September 1996. The project is improving two pedestrian bridges crossing the densest area of the Caqueta ravine, through community mobilization and self help.

The principle benefits to the community are to:

- Prevent accidents and death, especially of small children,
- Increase safety for other pedestrians, and
- Mobilize communities for greater self help and a taking of responsibility of their own neighbourhoods.

The idea is therefore to improve the bridge through a bridge improvement party, wherein organised groups will provide new solid, irremovable bridge sides. After fixing the sides others (principally women and children) will paint murals on the sides. In the evening there will be a party.

CONCLUSIONS

Towards increasing capacity and reducing vulnerability

Some of the best initiatives however require no funding; rather a change in values and perceptions of key actors. Many of these can be achieved without great economic input; rather a shift in perception to recognise the capacities already existing along the ravine. Fundamentally this perception needs to be at governmental/institutional level, and requires a move away from macro, top down non-participatory planning to a micro, bottom up approach, utilizing a participatory methodology for action. In concluding, the following five points, evolved during the project, stand as beginning points for this shift in view.

1. Effective mitigation measures include participation in decision making at all levels.

A key vulnerability lay in the lack of trust between different key actors: municipality, NGOs, Defensa Civil, community groups. Each appears to perceive the other of having a different agenda to their own. Communication is often limited to directives, ultimatums or resistance.

2. Perception of acceptable risk (however extreme) is outweighed by livelihood considerations.

The ravine edge dwellers are only too aware of the risks that they face. Their presence however lies in the proximity of the ravine to the city centre, where income earning is possible, and the lack of affordable shelter.

3. A key capacity is people: aspirations for betterment, skills and abilities.

The existence of strong community organisation, upgrading and maintenance of shelters, is testimony of the ability of individuals and communities to cope with such extreme conditions. All too often this vital capacity is overlooked, especially by governmental authorities who can remain oblivious to the capabilities of communities.

4. Macro scale solutions may ignore micro scale community capacity.

The solutions of the governmental authorities lay exclusively in macro scale initiatives: forced relocation of entire communities - measures for which gaining political and economic support would be titanic. Whilst aiming at such large one off gestures smaller, mitigating activities are being

ignored, which may not offer solutions but which would improve conditions

5. Even the most vulnerable areas have economic value.

A key finding of capacity was in the existence of a property market on the ravine edge, even amongst some of the most vulnerable dwellings. Several of those interviewed had lived in their houses for two or three years. Many saw their dwellings as "stepping stones", where families would dwell for a few years before moving on to better housing.

NOTES

1. Action planning is described in *Housing Without Houses* by Nabeel Hamdi, Van Nostrand Reinhold, New York, 1992; in addition *Making Microplans* by Nabeel Hamdi and Reinhard Goethert, IT Publications, London, 1988.
2. The crunch model, or pressure and release model is used in the United Nations DMTP manual *Vulnerability and Risk Assessment* by Coburn, Spence and Pomonis; in addition recent publications including *At Risk; Natural Hazards, Peoples Vulnerability and Disasters*, by Davis, Wisner, Blakie and Cannon, Routledge, 1994.
3. A clear explanation of capacities and vulnerabilities can be found in the chapter "A framework for analyzing capacities and vulnerabilities" in Anderson, Mary and Woodrow, Peter, *Rising from the Ashes; development strategies in times of disaster*, Westview Press (Boulder, Colorado) and UNESCO Press (Paris, France), 1989, pp. 9-25.
4. Earthquake risk in Lima is summarized in the paper 'Seismic safety of the Lima metropolitan area', by Jorge E Alva Hurtado, Professor of Civil Engineering, CISMID, presented in the publication *Issues on Urban Earthquake Risk*, BE Tucker *et al*, 1994, Kluwer Academic Publishers, The Netherlands, pp. 251-264.
5. Lima has a Modified Mercalli Intensity level of X, only superseded by XI to the south of the country.

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