

SMR: 1059/28

**FOURTH WORKSHOP ON THREE DIMENSIONAL MODELLING
OF SEISMIC WAVES GENERATION.
PROPAGATION AND THEIR INVERSION**

28 September - 9 October 1998

***Knowledge Bases and Procedures for
Risk Assessment***

presented by:

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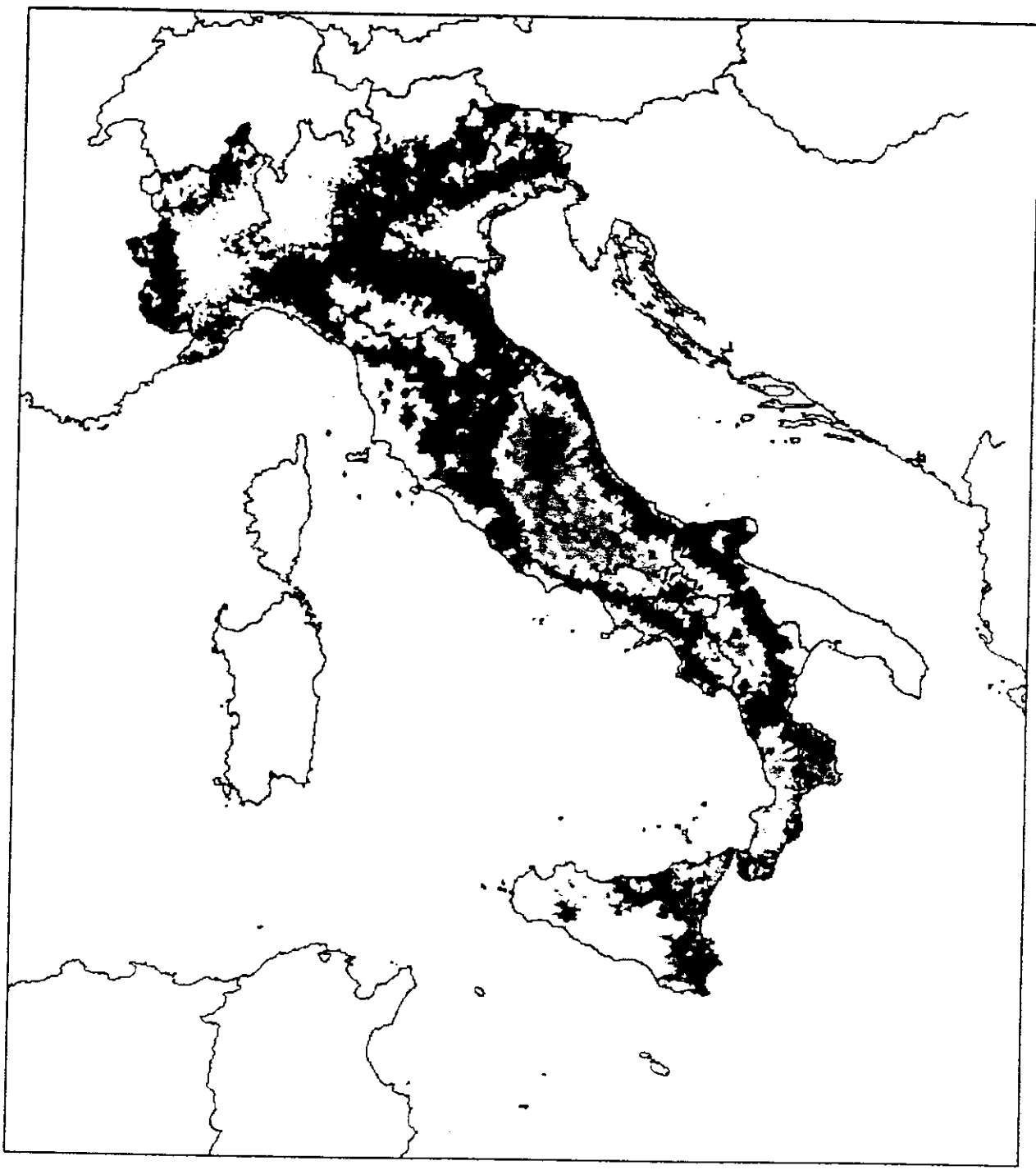
Politecnico di Milano
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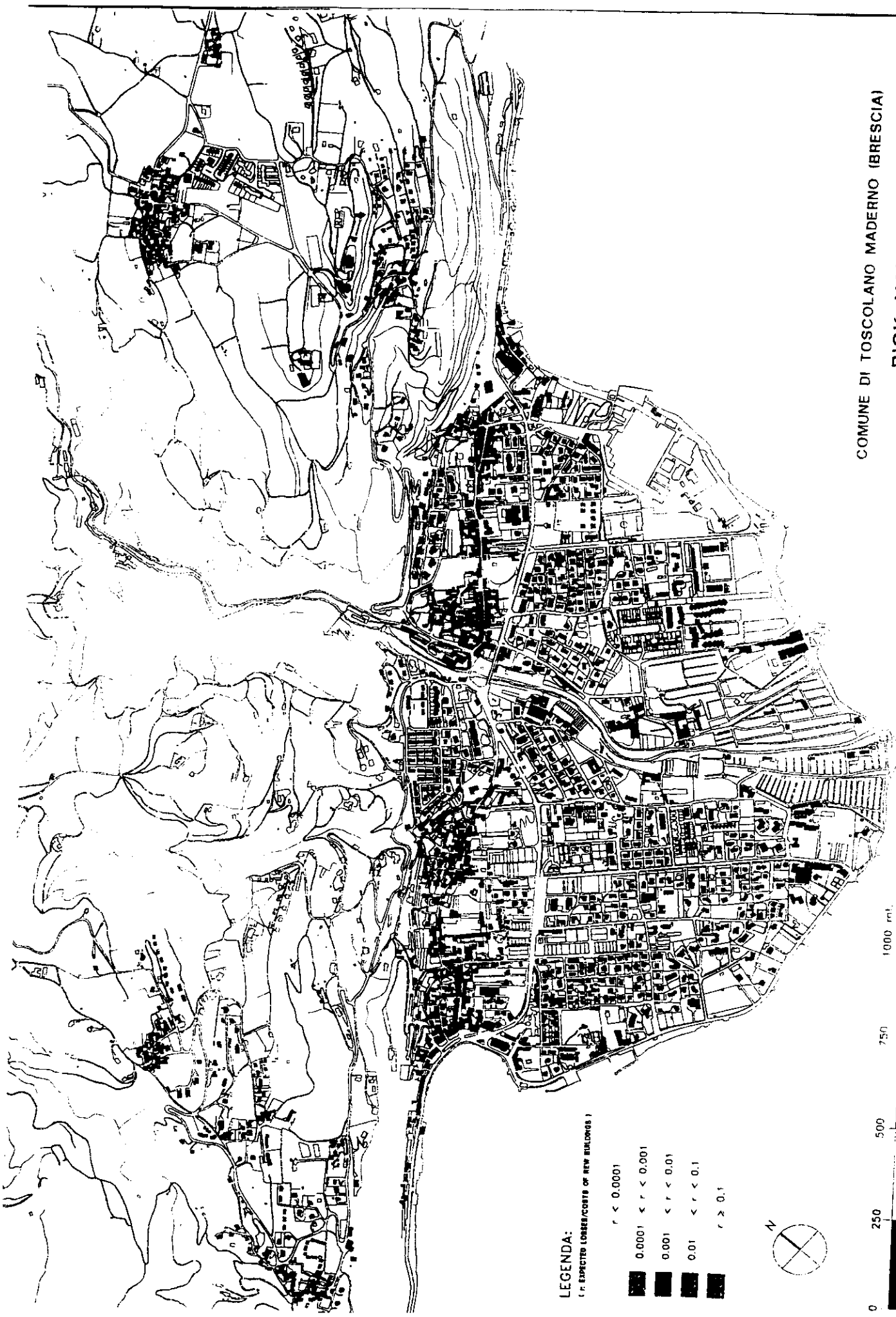
These are preliminary lecture notes, intended only for distribution to participants.

Selection of the approach

- Objects
- Aim
- Scale
- Available data

Danno totale annuo atteso per comune espresso in percentuale della superficie abitativa



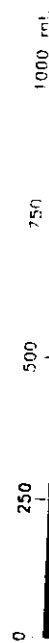
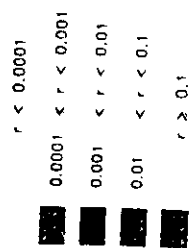


COMUNE DI TOSCOLANO MADERNO (BRESCIA)

RISK VALUES

AMPLIFICATION AVERAGE 3.0

LEGENDA:
(r = EXPECTED LOSSES/COSTS OF NEW BUILDINGS)



OBJECTS

AIMS

- Single building
- Building stock
 - scale
- retrofitting and repairing
- risk assessment
 - country
 - region
 - sub-regional area
 - town
 - village

OBJECTS

AIMS

- Public buildings
 - Monuments
 - Lifelines
 - Complex systems
- priorities
 - retrofit
 - estimate of direct and indirect damage
 - damage and functionality

The vulnerability:
information sources

The experience (observed damage)
is the main source

Other sources:

- numerical analysis
- expert judgment

Classification of techniques

- Direct
 - typological
 - statistics
 - mechanistic
 - mathematical models
 - hybrid
 - expert judgement
 - statistics
- Indirect
- Conventional

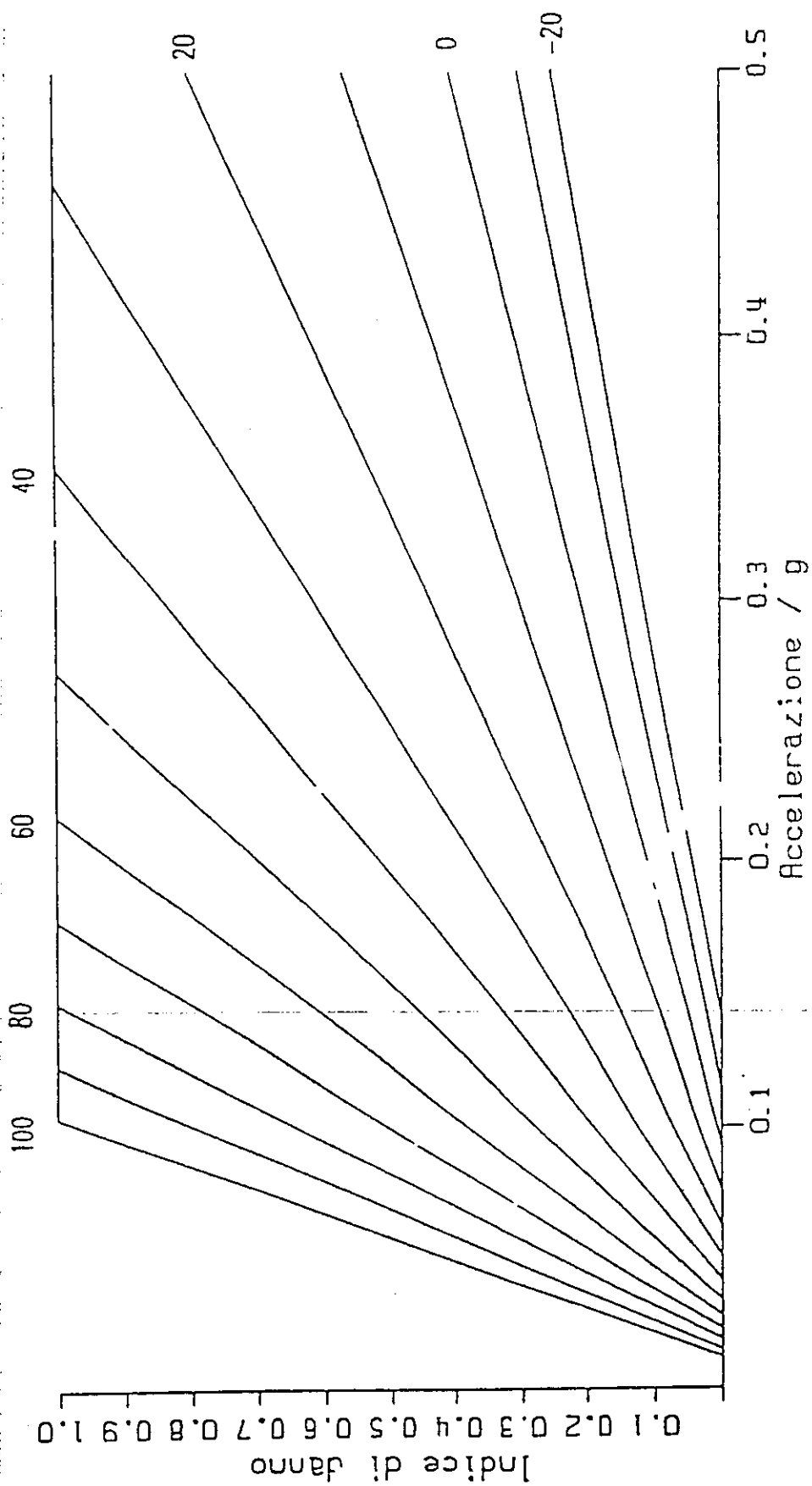
Damage probability matrices

		Damage states					
	Int.	0	1	2	3	4	5
Typ.	VII	0.05	0.15	0.30	0.30	0.15	0.05
	VIII	0.00	0.02	0.15	0.30	0.40	0.13
	IX	0.00	0.00	0.02	0.10	0.30	0.58

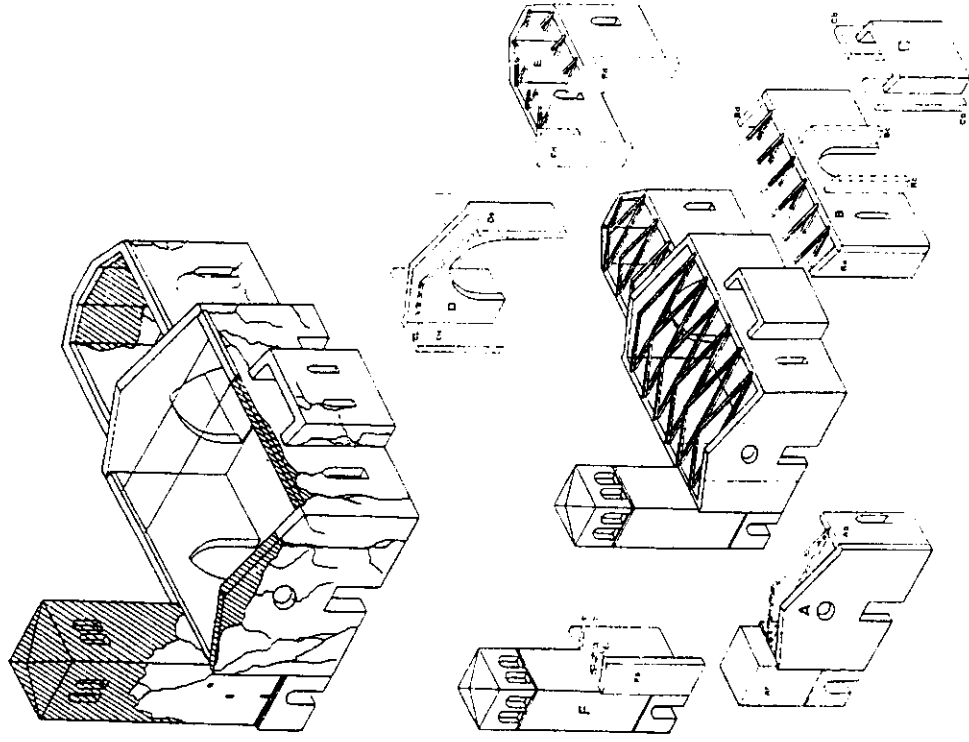
		Damage states					
	Int.	0	1	2	3	4	5
Typ. C	VII	0.58	0.30	0.10	0.02	0.00	0.00
	VIII	0.18	0.40	0.30	0.10	0.02	0.00
	IX	0.05	0.15	0.30	0.30	0.15	0.05

Vulnerability factors

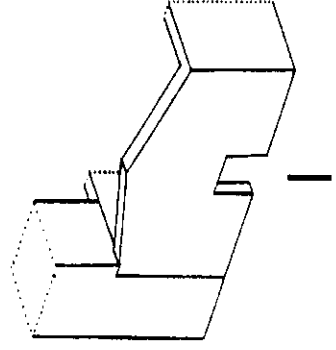
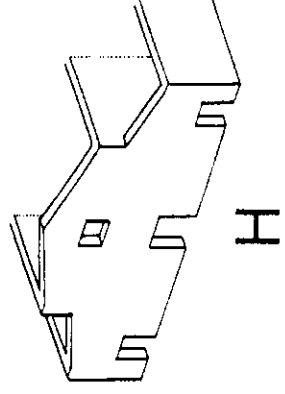
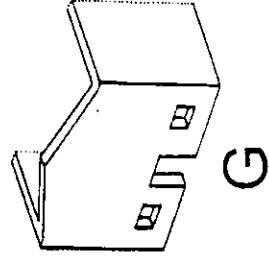
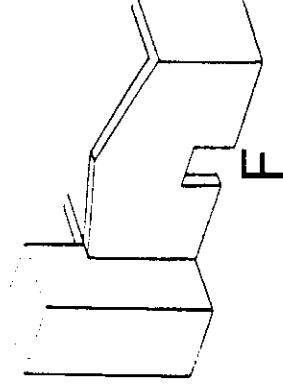
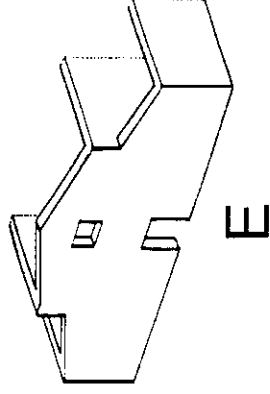
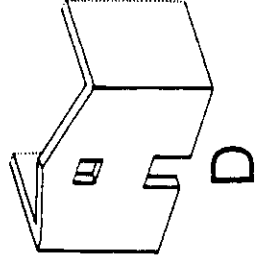
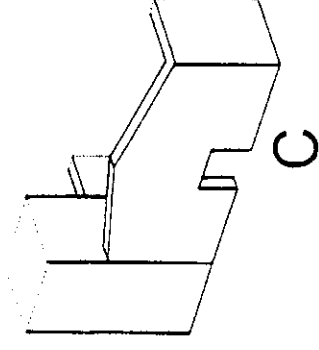
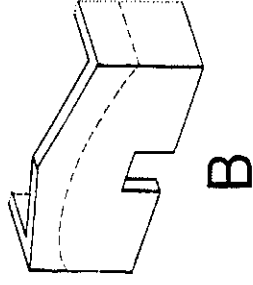
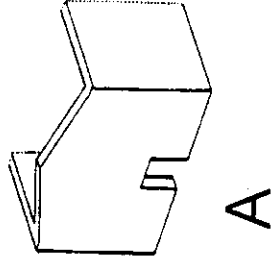
- type and organization of the resisting system
- quality of the resisting system
- conventional safety factor
- position of the building and foundations
- diaphragms
- plan
- elevation
- maximum distance between parallel walls
- roof
- non-structural elements
- damage and decay



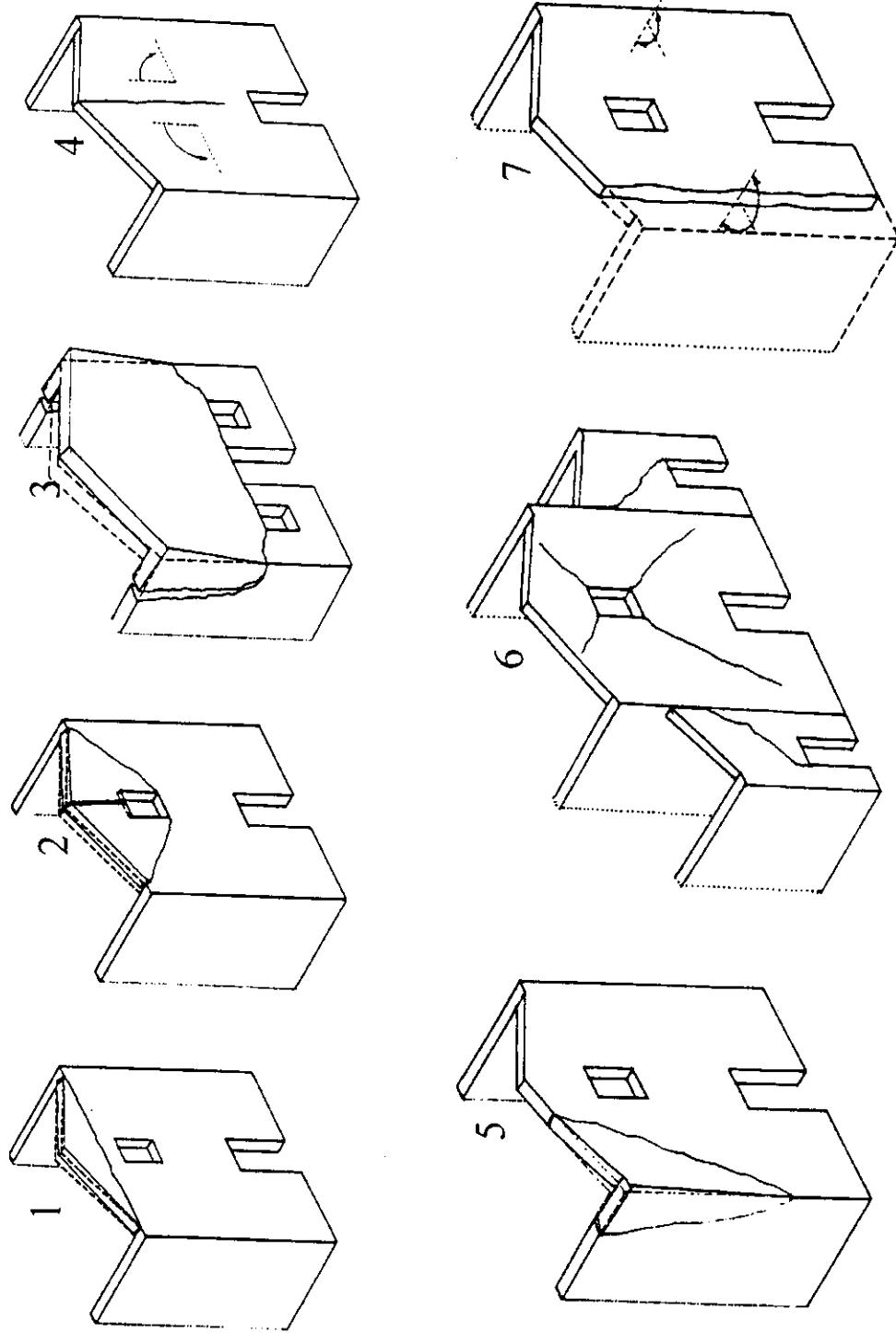
EXAMPLE OF A CHURCH SPLITTING



Sub-organism: façade typologies



Sub-organism: façade collapse mechanisms



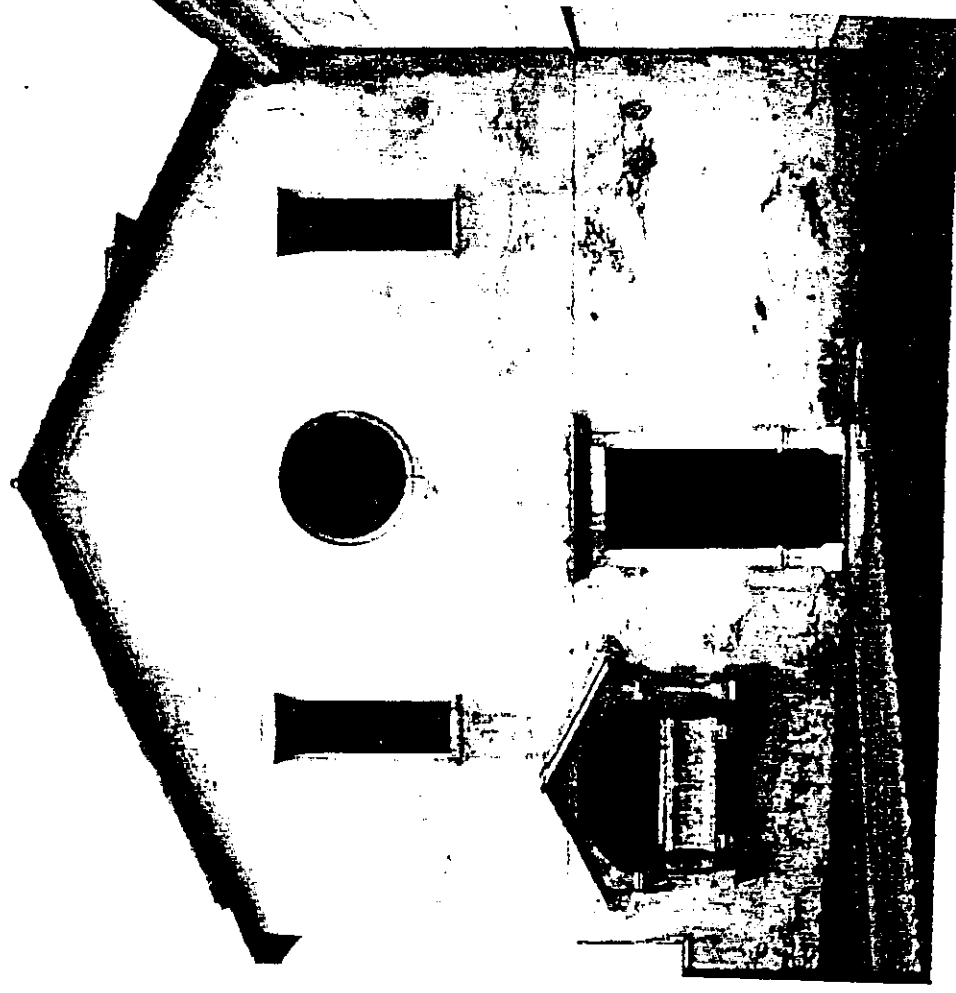
Sub-organism: façade

Correspondence matrix-typologies vs. collapse mechanisms

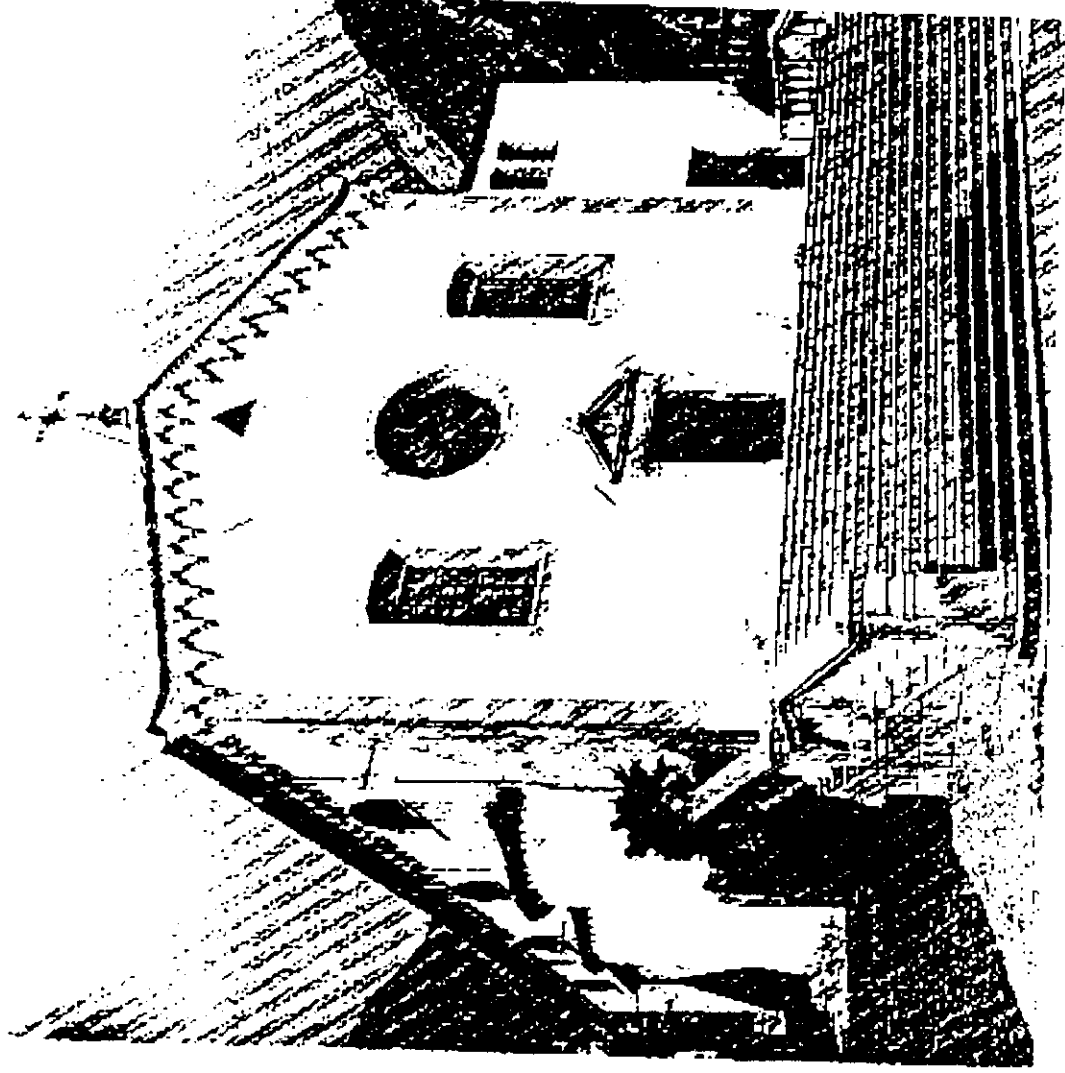
		Typologies							
		A	B	C	D	E	F	G	H
M e c h a n i s m s	1	1	8	3	1	0	3	1	0
	2	3	9	3	1	1	2	1	0
	3	0	4	9	0	1	0	0	1
	4	2	5	5	3	0	1	1	0
	5	0	6	2	0	2	1	0	1
	6	1	7	3	1	1	2	0	2
	7	0	1	0	0	0	0	0	0

Considered cases: 39

CHURCH OF OGNISSANTI IN FELTRE BEFORE THE RESTORATION



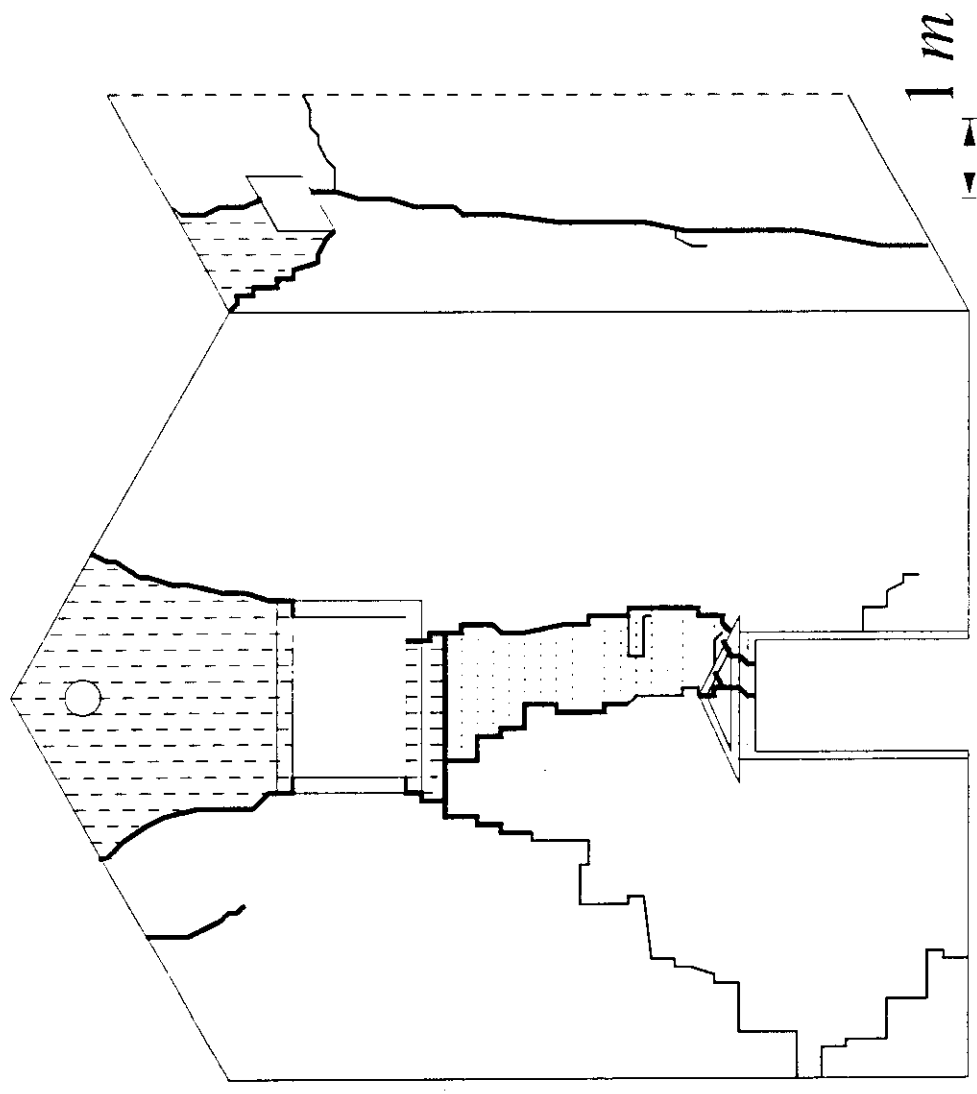
CHURCH OF S. MARIA DELLE GRAZIE IN GEMONA BEFORE MAY 1976



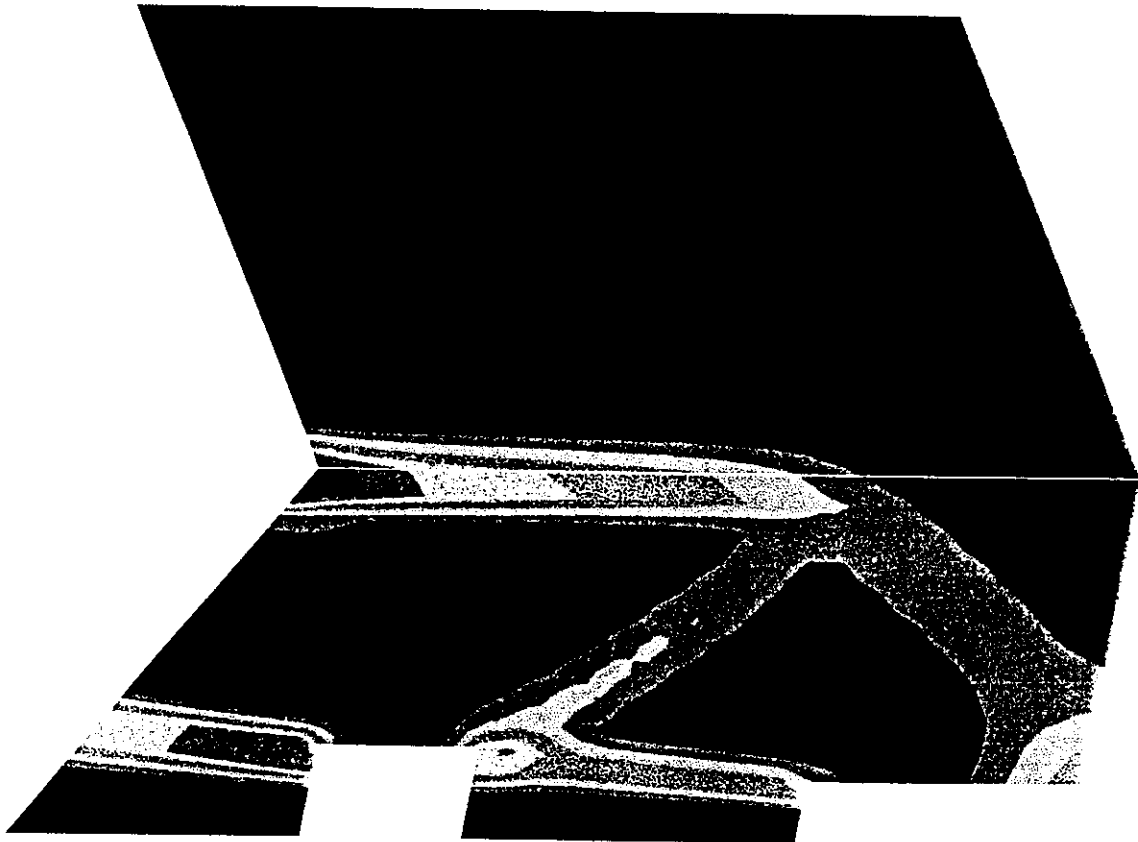
CHURCH OF S. MARIA DELLE GRAZIE IN GEMONA AFTER MAY 1976



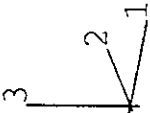
DAMAGES OF S. MARIA DEL FOSSALE IN GEMONA



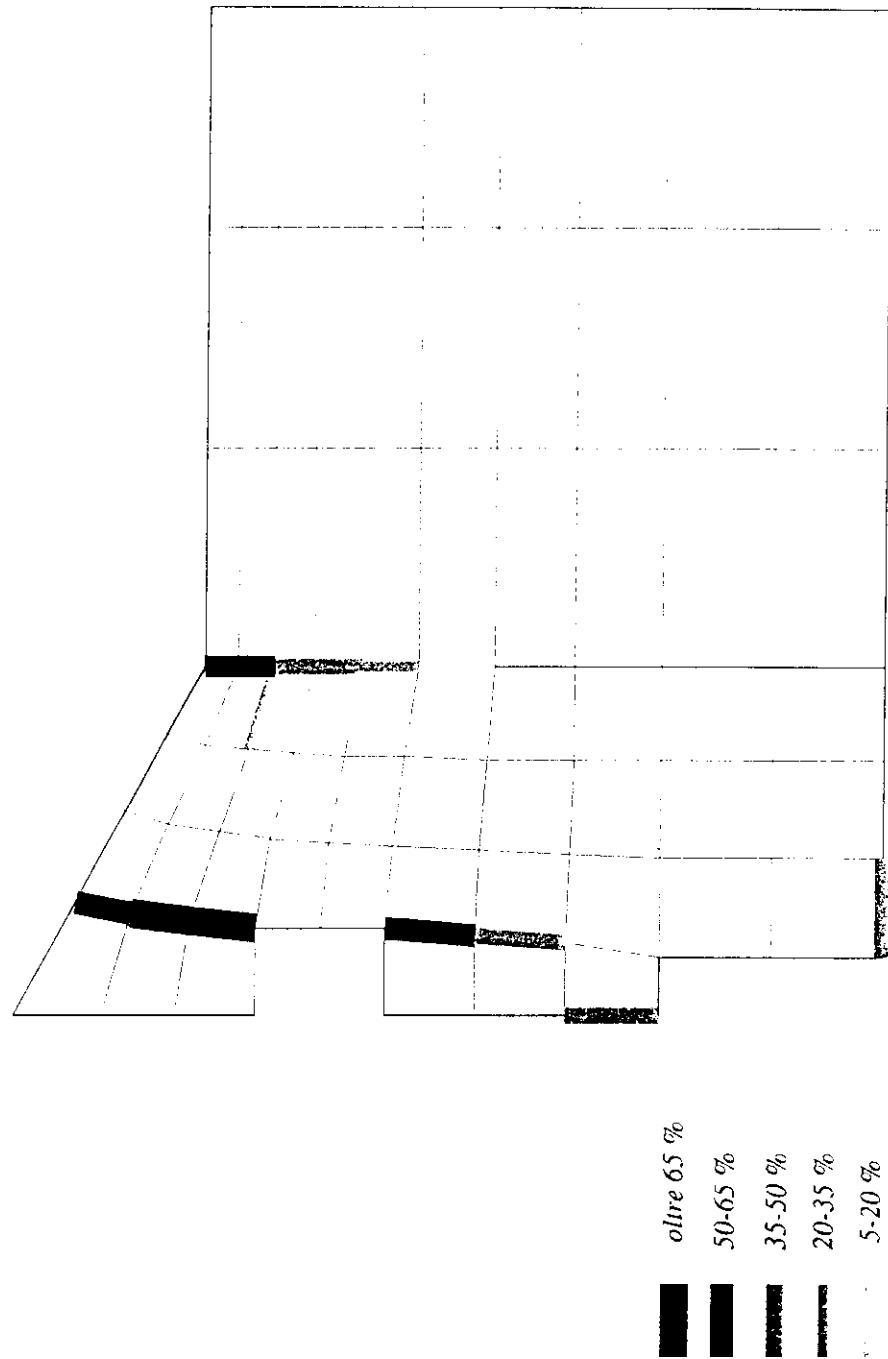
FAILURE MECHANISM - FINITE ELEMENTS MODEL (LAYER 1)



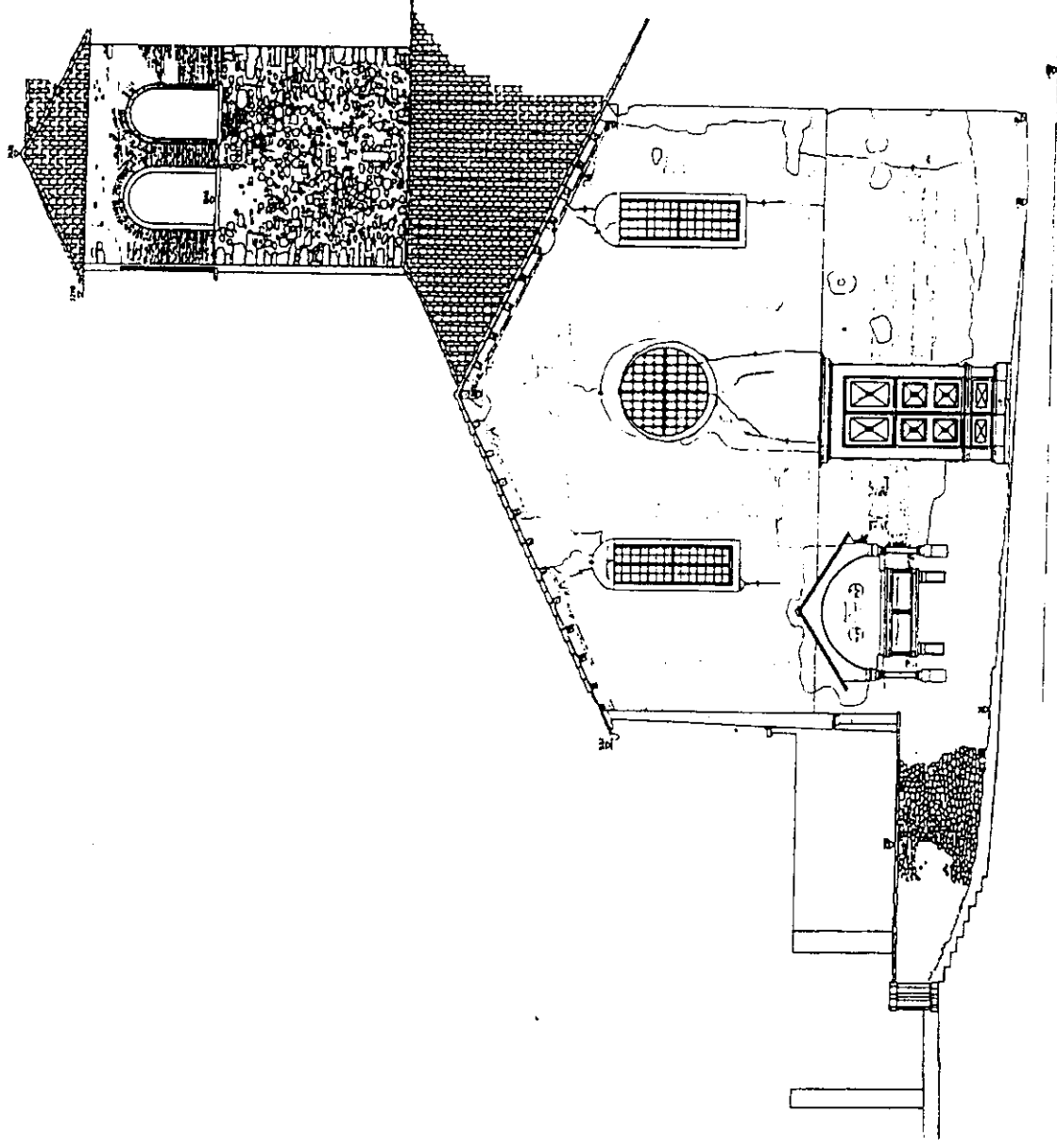
SECTION POINT 1	
PENER	VALUE
	+0.00E-00
	+8.00E+02
	+1.60E+03
	+2.40E+03
	+3.20E+03
	+4.00E+03
	+4.80E+03
	+6.48E+03



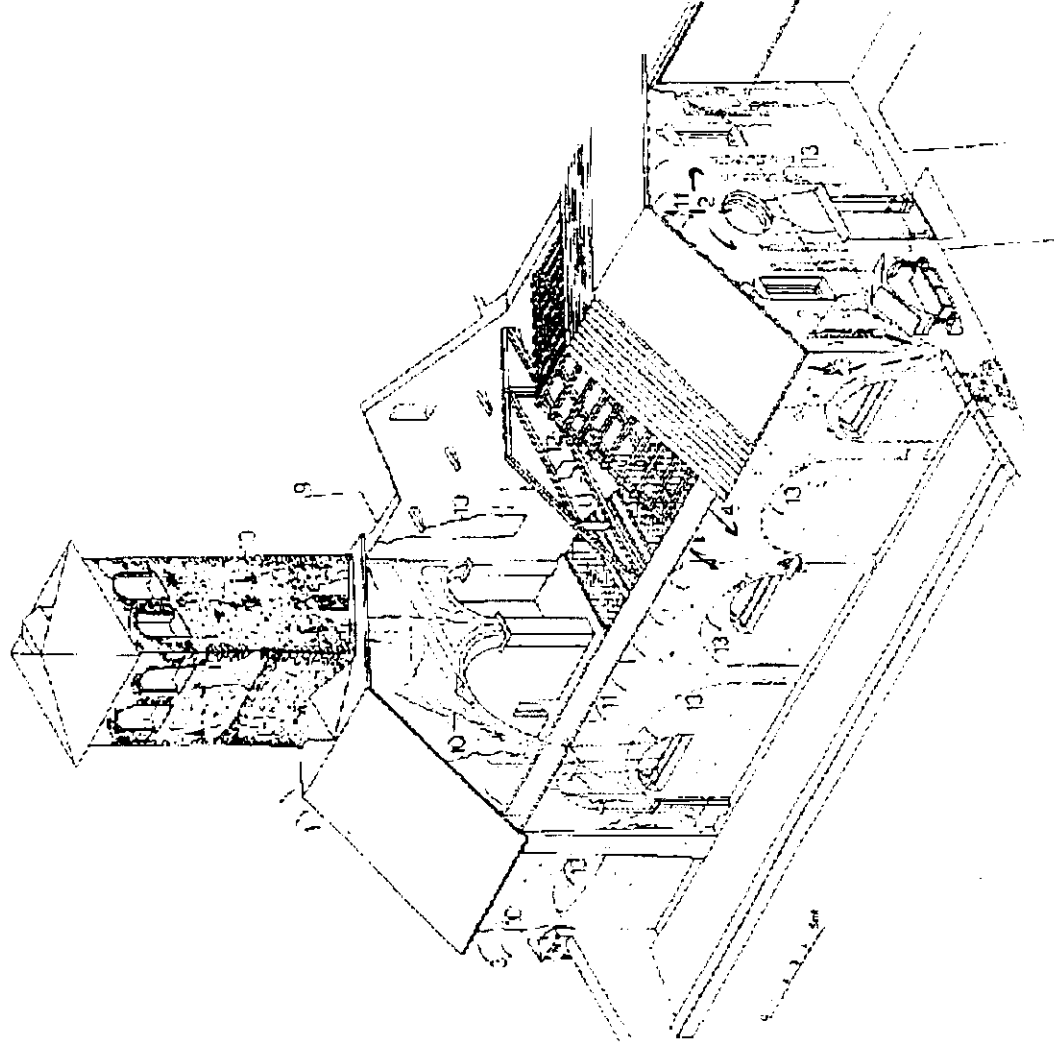
FAILURE MECHANISM - RIGID ELEMENTS MODEL



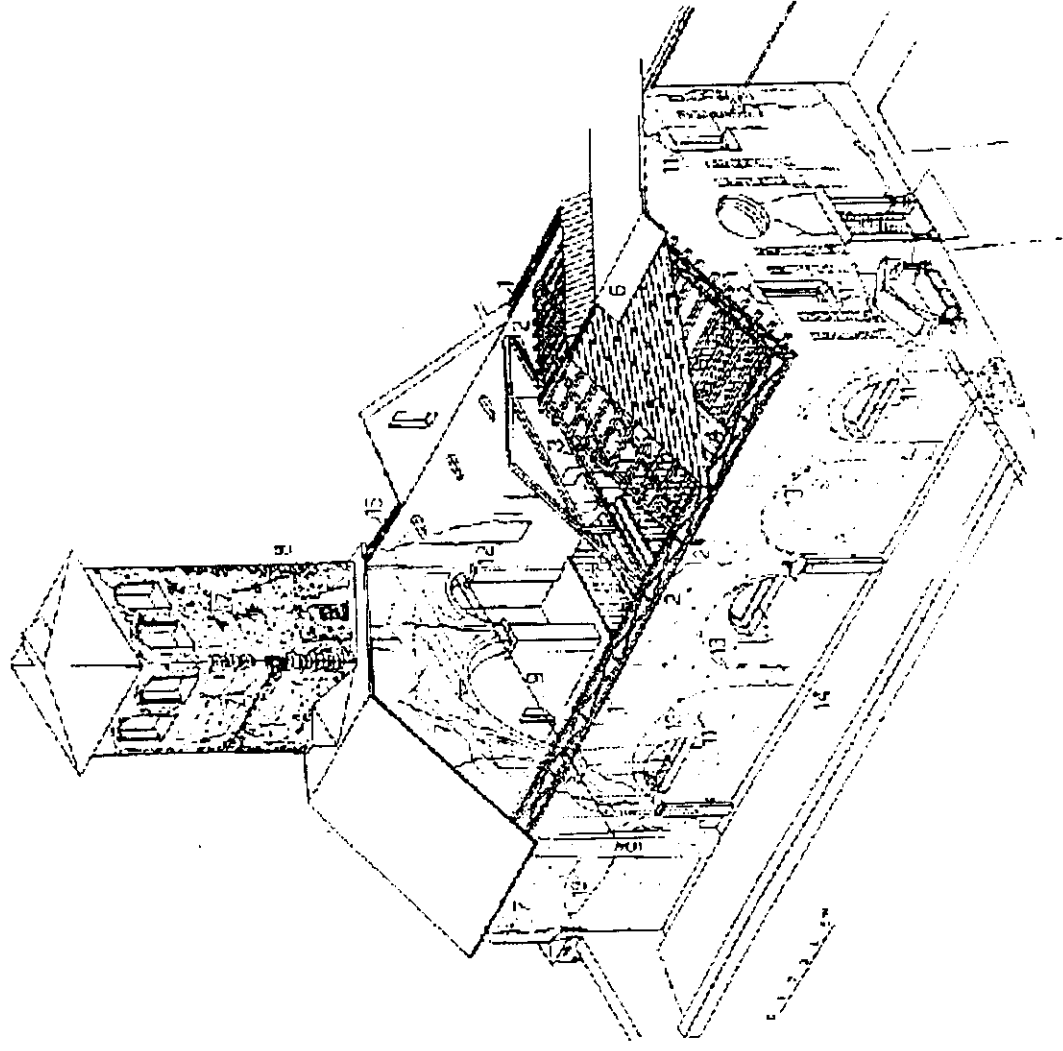
CHURCH OF OGNISSANTI IN FELTRE - THE FAÇADE

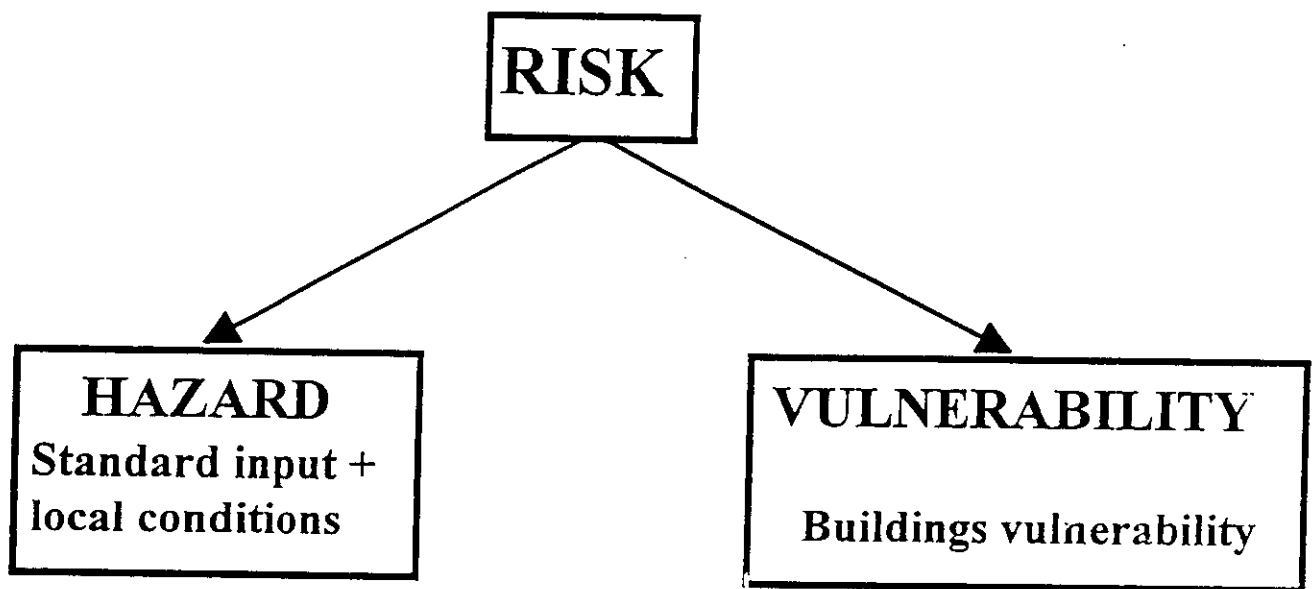


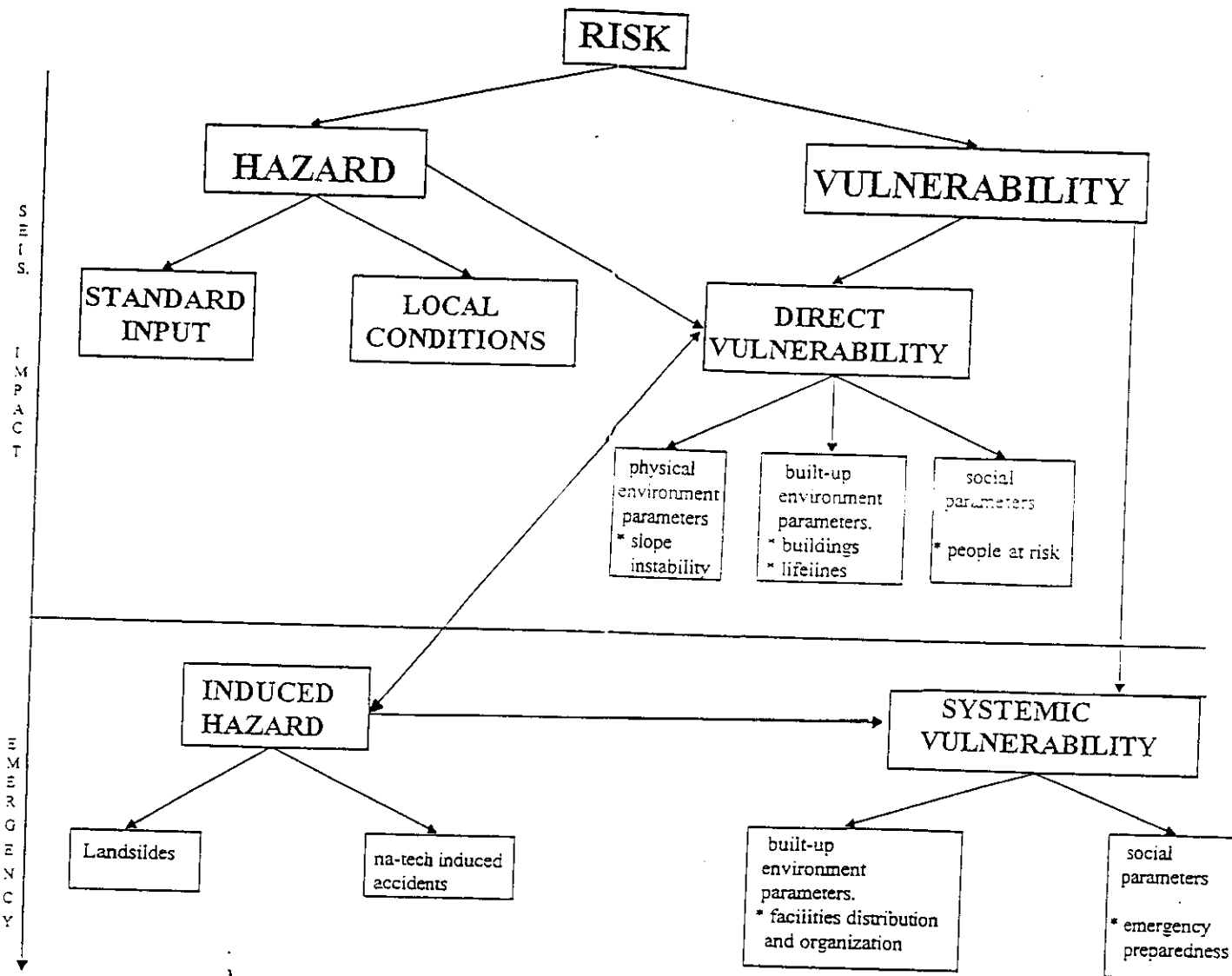
PRINCIPAL VULNERABILITY FACTORS



GENERAL LAYOUT OF STRENGTHENING MEASURES







<i>TYPE OF SERVICE</i> <i>related to:</i>	<i>EXAMPLE</i>	<i>GEOGRAPHICAL</i> <i>SCALE</i>	<i>DISASTER</i> <i>PHASE</i>
emergencies, diseases, criminality, accidents	hospitals, fire and police departments	local and regional (sometimes national)	emergency
everyday life	post offices, chemistry, nurseries	local, neighborhood	recovery and reconstruction
cultural	cinemas, theaters, museums	local, regional, national	recovery and reconstruction
city or metropolitan services	fairs, universities main libraries	regional, national, international	reconstruction

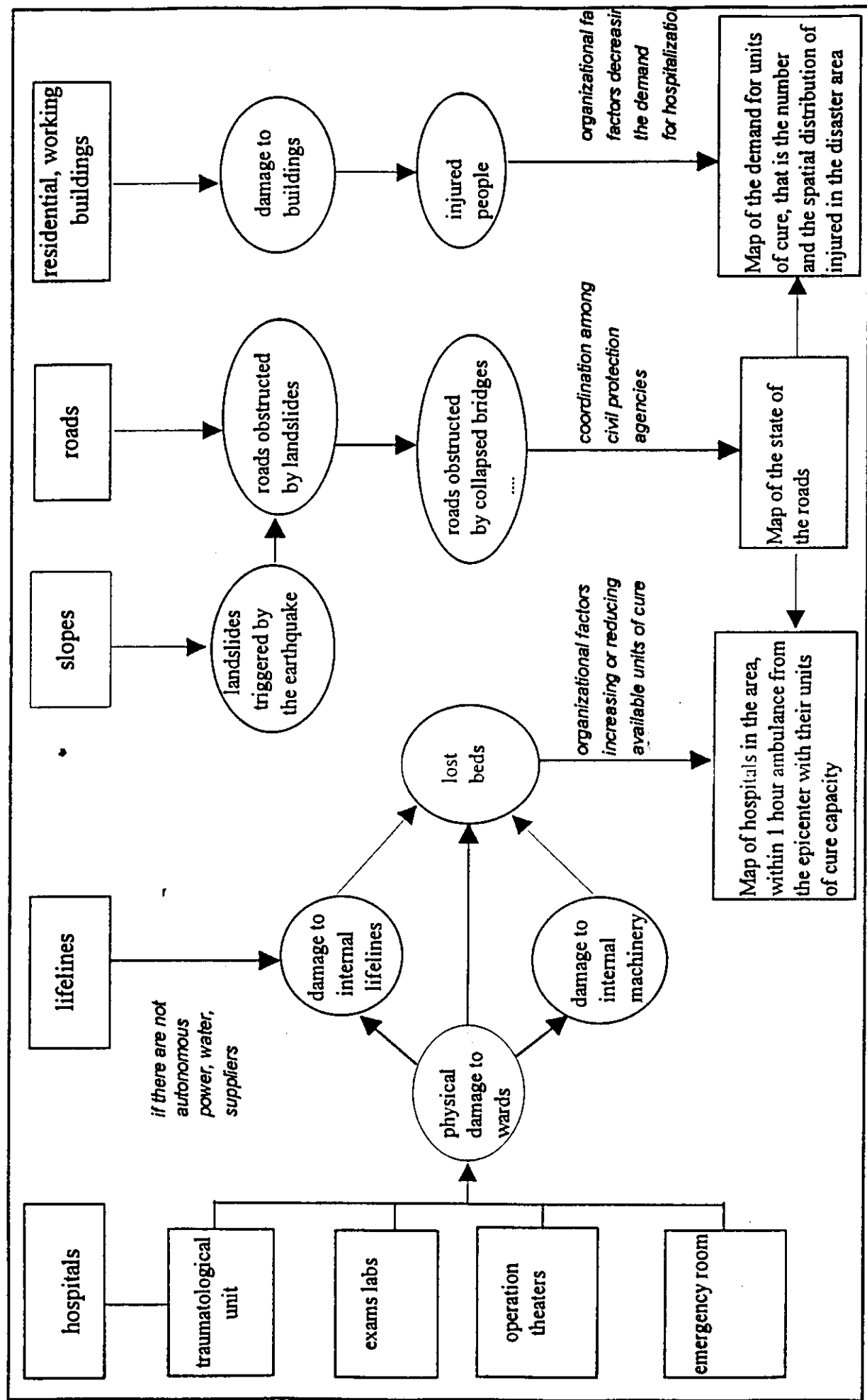


Fig.2 Framework showing the connection of hospitals with other systems

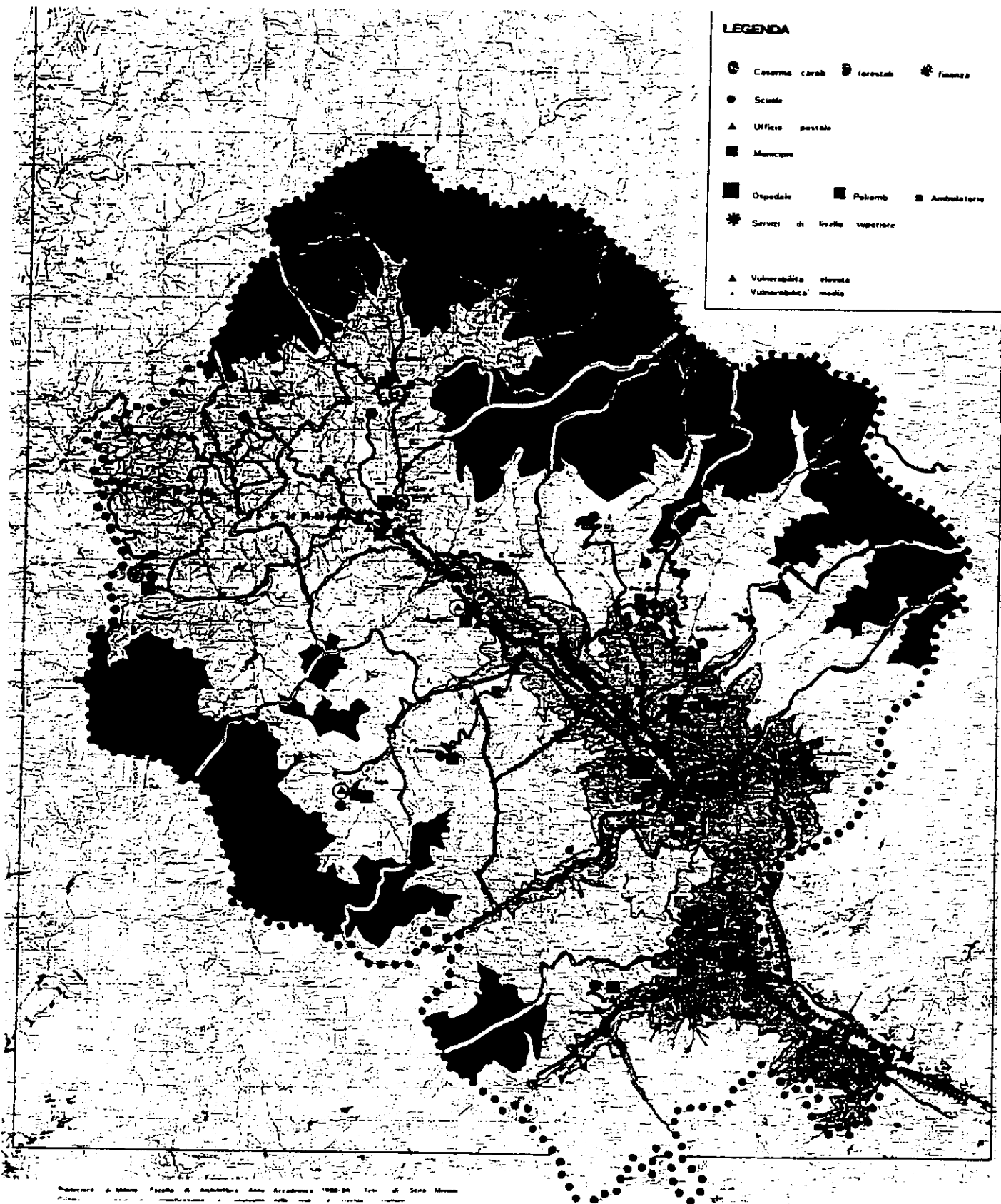


TABELLA 5.19

Estimated value of the cost of damage, of the number of victims and the number of collapse .

Vulnerability Distribution for Garfagnana sub-region

GARFAGNANA								
Municipality	munic. code	Volume thous. of m ³	Building num.	Inhabit. num.	Damage million of liras	Victims	Collapse	Injured people
Barga	3	1302600	2819	4290	66241	0	0	0
Camporgiano	6	365760	876	1170	38097	2	4	9
Careggine	8	125745	349	463	12789	0	0	1
Castelnuovo di Garfag.	9	696270	1094	2307	49550	0	0	0
Castiglione di Garfagn.	10	336015	816	1093	27408	0	0	0
Fosciandora	14	131595	343	368	9059	0	0	0
Galliciano	15	511290	1184	1773	30135	0	0	0
Giuncugnano	16	125286	325	394	19412	15	30	52
Minucciano	19	431871	1100	1558	40587	49	133	301
Molazzana	20	169380	456	661	12895	0	0	0
Piazza al Serchio	23	331593	781	1129	40724	15	22	55
Pieve Fosciana	25	295764	696	1000	23132	0	0	0
San Romano in Garfag.	27	219513	694	795	22112	0	0	1
Sillano	29	179562	623	737	21253	1	3	4
Vagli Sotto	31	171624	517	689	21915	8	16	28
Vergemoli	32	115479	430	488	8730	0	0	0
Villa Collemandina	35	242544	718	784	21091	0	0	0
TOTAL		5751891	13821	19699	465132	90	208	451

