HEALTH ASPECTS OF DISASTER PREPAREDNESS IN REPUBLIC OF MACEDONIA

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Land, Climate, Relief and Population

The Republic of Macedonia is situated in the central part of the Balkan Peninsula. It covers an area of 25,713 square kilometers and borders on Bulgaria to the East, Greece to the South, Albania to the West and FR Yugoslavia to the North.

Macedonia is predominantly mountainous country. The relief of Macedonia is characterized by large and high mountain massifs (14 mountain peaks higher than 2,000 m) giving way to extensive flat valleys and plains. About 19.1% of the country area are plains situated at altitudes from 80 up to 880 m. Six fluvial watersheds are covering the territory of Macedonia The largest are fluvial watersheds of rivers Vardar (20,535 sq. km), Crni Drim (3,350 sq. km), and Strumica (1,535 sq. km). There are three large tectonic lakes, twenty-five glacial lakes dating from Ice Age and fifteen artificial lakes.

Almost the entire territory of Macedonia lies between latitude 40° and 42° and is a transitional region between the Mediterranean and continental climates. Along Vardar and Strumica river valleys, the climate is temperate Mediterranean. The interior is characterized by a moderate continental climate conditions with warm and dry summers and cold and wet winters. Insufficient rainfall, about 500-700 mm annually, is unfavorably distributed throughout the year. The annual temperature variations are huge, ranging from +40°C, (summer) to about -30°C (winter).

According to the 1994 census, the total population of the Republic of Macedonia is about 2,001,368 inhabitants, 479,808 households, 553,213 dwellings and 167,568 agricultural holdings It is distributed over 1,753 settlements out of which 29 are large urban areas. The average population density in 1994 is 79 1 inhabitants per square kilometer. The capital of Macedonia is Skopje (450,000 inhabitants). Other major towns are Bitola (84,000 inhabitants), Prilep (70,000), Kumanovo (70,000), Tetovo (51,000), Titov Veles (47,000), Stip (43,000) and Ohrid (43,000).

Disaster Context

Republic of Macedonia is a disaster prone country exposed to natural and man-made hazards like: earthquakes, floods, wildfires, landslides, epidemics, etc. (Table 1). The adverse political developments in the Balkan region since 1992, accompanied by annual drop of industrial (15%) and agricultural (20%) production, impoverished the population, changing its social structure and creating low-income and poverty social groups highly vulnerable to any type of social and economic disturbances, in particular to those following the disaster conditions.

Table 1. Classification of Hazards by Social and Economic Impact

Major	Minor
Earthquakes	Landslides
Floods	Wildfires
Social problems	Droughts
Displaced persons	Hailstorms
	Winterstorms
	Epidemics
Industrial hazards	Avalanches
Ecological hazards	Accidents (Road/Air)

Geologic Hazards

Earthquakes: The seismicity of a country is related to destructive tectonic processes associated primarily with vertical movement of tectonic blocks Two regions of specific neotectonic features are

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well distinguished: West Macedonia, characterized by longitudinal (NE-SE), and Central and East Macedonia with transverse (E-W) stretching of principal tectonic morphostructures. The boundaries between this two regions is represented with relatively stable Pelagonian massif.

Earthquakes of magnitudes 6.0 to 7.8, from ten seismic zones (Fig. 1, Table 2) have historically been experienced throughout the country. The strongest earthquakes occurred in Pehcevo-Kresna (1904, M=7.8) and Valandovo-Dojran (1931, M=6.7) seismic zones. During the last 50 years few destructive, even catastrophic earthquakes, have been affecting the country[1].

Table 2. Major Earthquakes Occurring in the period 1900-1996

Seismic Zone	Date, GMT (d/m/y)	Time (h/m)	Coordinates		M (occurred)	Io	max M (expected)
			ϕ (N)	λ (E)			
1. **Skopje-Vitina**	26 07 1963	04:17	42 0	21 4	6 1	9	6.5
2. **Tetovo-Gostivar**	12 03 1960	11 54	41 9	20.9	5 7	8	6 1
3. **Debar-Peskopja**	30.11.1967	07.23	41.4	20 5	6 6	9	6 9
4. **Ohrid-Korca**	18.02 1911	21:35	40 9	20 8	6.7	9	6 9
5. **Valandovo-Dojran**	08 03 1931	01 50	41 3	22 5	6 7	10	6.9
6. **Pehcevo-Kresna**	04 04 1904	10 25	41 8	23 1	7 8	10	7 9
7 **Titov Veles**	14 09.1922	16 37	41.7	21.4	5 5	7-8	5.8
8. **Kicevo-Krusevo**	21.10 1988	02:18	41 3	21 0	4 4	6-7	5 8
9. **Bitola-Florina**	14 09 1920	02 09	41 0	21 4	5.3	7	5.7
10. **Tikves-Mrezicko**	09 07 1955	23 53	40 9	22 1	5 1	7-8	6.0

M - Magnitude (Richter Scale), Io - Epicentral Intensity (MCS Scale)

Moderate scale earthquakes (M<6.0) can cause serious problems, even devastation, since the traditional houses, particularly in the rural areas, are too weak to sustain them without substantial damage Earthquakes of magnitudes greater than 6.0 on the Richter scale are rather infrequent. However, when they occur, a widespread devastation might be expected in regions affected, due to the structural weakness of prevailing traditional urban and rural building typology constructed prior to 1964[2]. The earthquakes with magnitudes M=6.9-7.9 expected from the Pehcevo-Kresna and Valandovo-Dojran seismic zones will be catastrophic not only for Macedonia, but for the entire Balkan region (Bulgaria, Greece and FR Yugoslavia), creating probably the largest natural disaster effects ever occurred in Europe

Landslides: The landsliding in Macedonia, if occurs is mainly caused by torrents, or is related to earthquakes. During the large flooding in 1962 and 1979 (Table 3), significant landsliding was not recorded. Various modes of landsliding (rockfalls, topples or torrent deposition) are often recorded along disturbed, but unprotected slopes of principal and regional transportation routes. Some landslides are triggered by river-bank erosion. The concept of urbanization and availability of flat land around the existing urban areas have generally resulted in urbanization of naturally stable construction sites unsusceptible to landsliding.

Meteorological Hazards

Floods: The long term hydrological observations proved the unfavorable precipitation during the hydrological year The largest part of the rainfalls are concentrated in the middle and at the end of autumn, as well as at the end of winter and beginning of spring.

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[1] *The City of Skopje (1963, M=6 1, I=IX-X MCS) was devastated, 80.7% of total building area (including dwelling houses) was destroyed or heavily damaged and 75 5% of inhabitants were left homeless The direct economic losses were estimated at 15% of the GNP of former Yugoslavia for the year of 1963 In 1967, Western Macedonia (town of Debar) was struck by an earthquake of M=6 6 (I=IX MCS), causing widespread devastation in the municipality of Debar. Damaging earthquakes have recently affected Gevgelija-Valandovo (1990, M=5 6, I=VII-VIII MCS) and Bitola-Resen (1994, M=5.2, I=VII-VIII MCS) regions causing losses estimated as 2.5% and 3 35% of the GNP of the Republic of Macedonia for corresponding years, respectively.*

[2] *The Gevgelija earthquake caused structural damage to 1,120 buildings. In Bitola earthquake about 4,300 building were heavily damaged, out of which damages requiring evacuations were recorded for 996 buildings and family dwellings*

The most exposed regions to flooding are the valleys of Polog (municipalities Gostivar-Tetovo), Skopje, Pelagonia (Bitola-Prilep) and Strumica, actually the regions of the most valuable agricultural land, significant concentration of population, transportation systems and other lifelines, industrial, power and other facilities.

Table 3. Major floods affecting the Republic of Macedonia

Flood	River	Flooded Area (ha)	Loss in % of GNP
November, 1962	Vardar, Crna Reka, Struma	65.000	7.0
November, 1979	Vardar, Pena, Crna Reka, Struma, Treska, Pcinja	53.245	7.4

Damages and losses due to flooding in 1962 and 1979 were estimated at more than 7% of GNP, each (Table 3)[3]. The flesh floods have not affected country for the long period of time. However, the unfavorable urbanization patterns developed during last decades, altering of natural vegetation with profitable plants (grape), etc. reactivated the problem of flesh floods[4].

Wildfires: About 950 thousand hectares, or 36.8% of Macedonia's territory is covered with forests. The forest ecosystem of Macedonia encompasses 311 indigenous types of trees and shrubs, as well as 280 introduced ones. The total volume of wood, is estimated at about 79.5 million cubic meters, or slightly over 80 cubic meters per hectare. About 70% of the forested area consist of low-grade forests or shrubs.

Devastation of ecosystems due to fire is increasing, partially due to droughts and changes in overall climate conditions, but dominantly due to the negligence and inadequate fire protection measures in rural and forest regions. Wildfires are occurring seasonally, in spring (late March and April) and summer (July-August) when the regional climate conditions are characterized by high temperatures and low humidity. The large number of small fire incidents has a cumulative effect throughout the country (Table 4)[5].

Other Meteorological Hazards: Other natural disasters occur because of phenomena such as drought, storms, avalanches, lightning and hailstorms. The drop in agricultural production, which was particularly sharp in 1993 (about 20%) is mainly because of the disastrous drought. Hailstorms are affecting the agriculture seasonally. Although quite costly under present economic conditions, on balance, these disasters do not pose a major disaster problem in the country.

Biologic Hazards

Epidemics, except influenza, are not presently affecting seriously the country. The population is occasionally exposed to epidemics of gastro-intestinal diseases (enterocollitis, dysentery, hepatitis) in particular in regions with shortage of fresh water, or due to improper sanitary control of water supply systems in smaller towns or rural settlements. The endemic potential, however, exist and might easily be reactivated under unfavorable climate or in post disaster conditions. Because of that, preventive measures are usually undertaken in terms of epidemics surveillance, immunization of the exposed population, hygienic-sanitary supervision of water supply systems including the disinfecting of drinking water.

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[3] *In flooding affecting Macedonia in November 1979 significant damages were caused to 25 out of 34 municipalities with pronounced effects in municipalities of Tetovo, Bitola, Prilep, Kavadarci, Titov Veles and the City of Skopje. Residential areas and the local infrastructure were significantly damaged resulting in collapse of 440, and serious damage to 4,195 buildings; interruption and damage to water supply and sewerage systems, and other municipal and local infrastructure facilities.*

[4] *The July 6/7 1995 windstorm, accompanied with torrential rain (about 175.5 mm/m^2 for 12 hours) and hailstorm, caused a flesh flood that within 2 hours wiped out the entire agricultural product of municipalities of Negotino, Kavadarci, Valandovo, Titov Veles and Radovis, flooded and damaged more than 1,000 individual dwelling houses, bringing misery and damage to affected municipalities estimated at 4.06% of GNP for the year of 1994.*

[5] *During the 6 days of localization and suppression of one of the greatest recent wild fires (Pogana, July 1988; municipalities of Gevegelia and Valandovo) mobilization of more than 4,100 inhabitants and specialized task forces was required. Four settlements (Bogdanci, Gavato, Balinci and Marvinci) were endangered by the fire which spread out over 3,000 ha. More than 44,000 cubic meters of wood pulp were destroyed and considerable damages were inflicted to the ecosystem. Out of 35 game species existing in the region, only a few were reestablished in a period of 3 years after the fire.*

Table 4. Statistics on Occurred Forest Fires

Year	Burned Area (ha)	Number of Fires	Damaged Timber Stock (m^3)	Average Burned Area (ha/fire)
1978	498	46	611	10.8
1979	186	45	446	4.1
1980	122	39	627	3 1
1981	266	29	1670	9 2
1982	1,002	72	716	13 9
1983	642	72	1559	8 9
1984	756	63	868	12.0
1985	2,772	139	15557	19 9
1986	599	53	2366	11 3
1987	7,782	191	7571	40 7
1988	5,812	163	30614	35 7
1989	1,571	71	19414	22 1
1990	5,761	185	83366	31 1
1991	445	38	1654	11 7
1992	9,695	211	23031	45 9
1993	17,630	428	292861	41 2
Total	55,539	1845	482931	
Average	3,471	115	30183	30.2

Source Ministry for agriculture, forestry and water management

Social Hazards

Political developments in the Balkan region including past sanctions undertaken by UN Security Council against FR Yugoslavia, the trade embargo imposed on Macedonia by Greece, war in Croatia, and Bosnia and Herzegovina, as well as the adverse economic trends in the region and the country, had significantly eroded the economy.

Out of about 2 million inhabitants, the total employment in Macedonia is about 457 thousands. The greatest economic and social problem is presently the high rate of unemployment; about 230 thousands in 1995/1996, with a tendency of further increase due to drop in production or company closure The steady decrease of the economic potential of the country resulted in gradual impoverishment of the population, and creation of low-income and poverty groups[6]. Considering that economically the most endangered social groups are living in the worst natural conditions and occupying dominantly the weakest building typology, it is expected that they will be the most exposed social group to short term destructive effects, as well as long term economic consequences

Vulnerability and Seismic Risk

Although some degree of general risk awareness among the people, professionals, planners and authorities exists, the composite risk assessment for Macedonia has not been yet undertaken on a systematic basis or applied to rigorous disaster management and preparedness planning. With the exception of very general hazard location maps, the hazard maps showing the severity, frequency and duration of hazardous natural phenomena (except for earthquakes) are not available. It is also case for integrated vulnerability and risk assessment in physical and economic terms. Single disaster analyses revealed a fact that earthquakes are paramount in Macedonia, overwhelming the effects of all other natural or man-made disasters. Social aspects of large disasters has also not yet been consistently assessed in an integrated manner, although the effects are partially understood in the last moderate scale earthquakes (Gevgelija 1990, Bitola 1994) as well as flesh floods (Negotino and Kavadarci, 1995)

To estimate disaster demands in terms of physical/functional losses of residential and public buildings, potential human casualty (morbidity and mortality), accessibility of principal and regional transportation routes, as well as corresponding risk-consistent and economically justified emergency preparedness elements at national, regional and municipal level, the source-to-source probabilistic

[6] *To resolve the social tension and provide a minimum life support, the Social Welfare Program (SWP) envisaged transfer of welfare funds to 24 thousand households (120,000 inhabitants) for 1993, 45 thousands (180,000) for 1994, and 60 thousands households for 1995. The budget allocated for SWP for 1994 was approximately 3 4% of the GNP for 1993, or at the level of the losses caused by 1994 Bitola Earthquake*

seismic hazard and risk studies (IZIIS, 1995) are performed for three characteristic levels of expected seismic action that comply with the seismic hazard levels incorporated implicitly in the existing legislation for design and construction in the territory of Republic of Macedonia, i.e.:

- ***FSE:*** Frequent scale earthquake, or earthquake of 5 years return period with 10% exceedence probability;
- ***MSE:*** Moderate scale earthquake, or earthquake of 10 years return period with 10% exceedence probability;
- ***LSE:*** Large scale earthquake, or earthquake of 50 years return period with 10% exceedence probability.

Residential Building Stock

Four types of residential and public buildings, including individual family dwellings (Table 5) are prevailing in the territory of Macedonia. Due to high vulnerability of earthquake non-resistant buildings of weak masonry and of traditional buildings of stone and fired brick masonry, in moderately strong earthquakes (5.2 < M < 5.9) of shallow (h = 10 - 15 km) earthquakes, this structural typology is usually suffering significant physical damages (in volume and intensity) causing substantial economic losses[7]. In strong to catastrophic earthquakes (M > 6.0, Io > VIII MCS) the physical losses in this building typology will be exceptionally high, causing significant human casualty, physical and economic losses.

Table 5. Population and Residential Floor Area by Structural Typology and Urbanization Patterns

STRUCTURAL TYPE	Total		Urban Areas		Rural Areas	
	Population	Floor Area	Population	Floor Area	Population	Floor Area
Earthquake Non-Resistant	**869,722**	**17,256,163**	**468,948**	**9,100,670**	**400,775**	**8,155,492**
Weak masonry constructed prior to 1960	241,215	4,826,257	87,296	1,694,115	153,919	3,132,141
Masonry constructed prior to 1971	628,507	12,429,906	381,652	7,406,555	246,856	5,023,351
Earthquake Resistant	**1,164,243**	**23,019,567**	**712,787**	**13,832,767**	**451,456**	**9,186,800**
Strengthened masonry	873,703	17,333,164	473,181	9,182,833	400,522	8,150,331
RC Frame systems	184,002	3,589,647	164,069	3,184,024	19,933	405,623
RC Shear wall systems	106,538	2,096,756	106,538	2,096,756		
Total	**2,033,964**	**40,275,731**	**1,181,735**	**22,933,437**	**852,231**	**17,338,292**

A significant level of earthquake protection of newly constructed buildings is achieved with implementation of 1964 and 1981 Codes for Design and Construction of Buildings in Seismically Active Regions. However, besides the engineering criteria, both Codes are also the economic compromise between the planed level of protection, development needs and the economic power and potential of the country. Consequently, a certain degree of vulnerability and potential for generating physical losses shall be expected also in the aseismically designed and constructed building typology, particularly when exposed to catastrophic earthquakes.

The results revealed the fact that Skopje-Vitina seismic zone (Fig. 2) generate the highest physical and economic loss potential, as well as evacuation and shelter needs; not because of the severity of the expected earthquakes, but due to very high concentration of population and material property (>30%). Because of dominant prevalence of highly vulnerable earthquake non-resistant building typology in the region of Eastern Macedonia, the seismic zone Pehcevo-Kresna is controlling human casualty potential (Fig. 3) for moderately strong earthquakes. Although relatively lower, the effects of Valandovo-Dojran seismic zone are of the same order as the effects expected from the previous two seismic zones.

Material property and human casualty loss potential pertinent to seismic zones located in Western Macedonia (Tetovo-Gostivar, Debar-Peskopija and Ohrid-Korca) is approximately the same and it is estimated at about 50% of the loss potential of aforemetioned three principal seismic zones.

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[7] *The typical example is Bitola earthquake of September 1, 1994 (M = 5.4, Io = VII+ MCS) which caused heavy damages to 4,309 buildings and direct economic loss of 2,205,040 thousand denars (75.6 million DEM), i.e., 3.4% of GNP of Republic of Macedonia for the year of 1993.*

Considerably lower destructive potential is estimated for seismic zones of Titov Veles, Kicevo-Krusevo and Tikves-Mezicko. Expected destructive effects are of local character because of the quantitatively different energy potential (M < 6.0) and consequently, considerably smaller territory, population and material property exposed.

Assessment of the vulnerability and estimates on possible losses related to public buildings (IZIIS, 1995) showed that physical loss potential is the highest for school and tourist buildings. Collapse potential is estimated from 19.0% (FSE) to 49.0% (LSE), whereas the potential for collapses and heavy damages, accompanied with temporary or permanent loss of function, is estimated at 33.0% (FSE) to 83.0% (LSE) of total existing gross floor area.

Health Care Facilities and The Health Care System

The network of health-care institutions covers the territory of Macedonia in approximately a uniform manner, with a slightly increased concentration in the region of Skopje where the Clinics of the Clinical Center and the Military Health Care Center (large Army Hospital facility) are located. The network of health care institutions in Macedonia consists of.

Medical Centers	16
Health Care Centers	16
Public Health Stations (Units)	7
General Hospitals	17
Clinics under the Clinical Center of Skopje	18
Clinics under the Faculty of Stomatology	7
Specialized hospitals for tuberculosis and other Lung diseases	3
Specialized hospitals for mental care	3
Institutes for Orthopedy and Traumatology	1
Centers for rehabilitation and prolonged care	7
Specialized hospitals	2
Specialized hospitals	10
Regional health protection institutes	10
National (Republic) Health Protection Institute	1

The medical units operating in rural regions of the country are associated either to the Regional Medical Centers or Health Centers. Out of the total number of rural medical units (297), 188 provide permanent MD service, whereas 109 provide limited MD service by visiting doctors. The medical centers, health centers and the outpatient stations provide primary health care through 435 general practitioner services, 113 industrial medicine services , 157 pediatric health care services for children of up to 6 years of age, 80 health care services for children over 6 years of age, 62 health services for protection of women, 27 health services for protection against tuberculosis and 7 health services for skin and venereal diseases.

The hospitalization capacities are a constituent part of the medical centers, the clinics, the general and the specialized hospitals providing stationary health protection including diagnostics, curing and rehabilitation, hospital care and treatment through concentration of highly specialized staff and relatively up-to-date equipment The total bed capacity in the country is about 10.645 beds or 5,5/1000 inhabitants; out of which 4849 in the general hospitals, 4695 in specialized hospitals, 685 in centers for curing and rehabilitation, 280 in spas and 136 in dispensaries. The Military Health Care Center provides an additional capacity of 465 beds.

The entire health care network of Republic of Macedonia employs 4516 MD-s out of which 1328 general practitioners, 2730 specialists, 1086 stomatologists; 10.666 medical staff with intermediary and advanced medical training, 653 with elementary medical training, 6034 staff members with non-medical training and 308 associate staff members, or in total - 23612 staff members.

The health care facilities are physically less vulnerable since they are dominantly constructed in a period after Skopje earthquake of 1963. They are designed according to the provisions of 1964 and 1981 Codes for Design and Construction in Seismic Regions, thus it might be considered that their structural system is well protected. However, the capacity for nonstructural damage in strong and catastrophic earthquakes, easily can cause the loss of function in the period when their response

capacity to increased demands is indispensable[8]. It is estimated that functional loss potential ranges from 10.0% (FSE) to 67.0% (LSE) of existing gross floor area.

Table 6 Expected Physical and Functional Losses and Post-Earthquake Response Capacity Indices for FSE, MSE and LSE Earthquake Scenarios

EARTHQUAKE SCENARIO	FSE		MSE		LSE	
	min	*max*	*min*	*max*	*min*	*max*
PHYSICAL LOSSES (in%)						
Heavily Damaged						
Hospitals and Clinics	(KU) 7 69	28 82 (SR)	(KU) 13 10	45 58 (SR)	(BT) 31 87	48 12 (OH)
Medical Centers	(PP) 6.41	32.89 (SR)	(PP) 11 22	50 22 (SR)	(PP) 23 69	49 33 (SK)
Medical Units	(PP) 5 68	31.81 (SR)	(PP) 9 90	50.87 (SR)	(PP) 20 79	49 60 (SK)
Collapsed						
Hospitals and Clinics	(PP) 0 14	4 54 (SR)	(PP) 0 29	16.41 (SK)	(PP) 3.66	40.63 (SK)
Medical Centers	(PP) 0 55	5 19 (KO)	(PP) 1 17	21 97 (TE)	(PP) 6 29	48 96 (TE)
Medical Units	(PP) 0 40	2.75 (SR)	(PP) 0 84	25 62 (OH)	(KU) 3.25	42 18 (OH)
FUNCTIONAL LOSSES (in%)						
Hospitals and Clinics	(KU) 7 96	33.96 (OH)	(KU) 14 54	58 55 (SR)	(BT) 40 72	82 16 (SK)
Medical Centers	(PP) 6 97	36 95 (KO)	(PP) 12 39	64.25 (ST)	(PP) 29 29	82 01 (TE)
Medical Units	(PP) 6.08	34 56 (SR)	(PP) 10 74	63 63 (OH)	(PP) 25 62	79 09 (OH)
RESPONSE CAPACITY						
Emergency Response Index, I_i						
Hospitals, Clinics and Medical Centers	(PP) 3	219 (SR)	(PP) 7	667 (SR)	(PP) 4	1,142 (SR)
Medical Units	(PP) 9	848 (SR)	(PP) 29	2,528 (SR)	(PP) 135	4,106 (SR)
Response Index, I_p						
Hospitals, Clinics and Medical Centers	(ST) 3	12 (SR)	(ST) 3	19 (SR)	(PP) 5	25 (SR)
Medical Units	(SK) 3	70 (SR)	(SK) 4	115 (SR)	(SK) 8	160 (SR)

Note: Physical and functional losses are presented in % of total existing Health Care Region (HCR) floor area of corresponding medical building classes

High Risk HCR's: *SR-Strumica, SK-Skopje, OH-Ohrid, KO-Kocani, TE-Tetovo*
Lower Risk HCR's: *KU-Kumanovo, BT-Bitola, PP-Prilep, ST-Stip*

The emergency response *(I_i)* and response *(I_p)* indices are defined as.

I_i = Earthquake injury / Functionaly availabale floor area [cases / 1,000 sq.m]

I_p = Nonaffected population / Funcionaly avaliable floor area [cases / sq.m]

based on earthquake demands estimated in terms of expected human casualty (Figs 2 and 3) and the capacity of Regional Health Care System during the emergency impact phase.

For occurrence of FSE, MSE, or LSE earthquake in dominant seismic zone affecting the Health Care Regions of Strumica, Skopje, Tetovo, Ohrid and Kocani (Fig. 1), substantial physical and functional losses of health care floor area, accompanied with significant loss of post-disaster emergency response capacity,

[8] *The typical example is the Regional Medical Center, Bitola, which due to damages caused by an earthquake of M=5.4, was 24 hours out of function.*

shall be expected (Table 6, Fig. 4). Assuming that the resilience of Macedonian economy is quite low, it is unrealistic that much can be done through the engineering prevention

Irrespective of the spatial occurrence of earthquakes in the territory of Macedonia, the Health Care Regions of Prilep, Kumanovo, Bitola and Stip (Fig 1) are showing considerably lower potential to physical and functional losses (Table 6, Fig. 4) Although their post-disaster response and emergency response capacity will be affected to certain extent, the facilities in listed regions can be used as back-up to facilities located in the regions of high risk, storage for emergency supplies and equipment, whereas to the territory shall be given a proper weight in disaster preparedness operational plans.

As for other regions, whose losses and post-disaster operational capacity is in-between, the decision on the treatment shall be made based on elements presented in Table 6 as well as decided emergency management strategy tactics at national level.

On this ground, the priority for engineering prevention under the process of evaluation However, due to present economic conditions in the country and the wider region, which will hardly be changed in near future, an adequate preparedness is seen as the only possible cost-effective measure for efficient emergency management and response.

Transportation Network

It is estimated that 80.0% of the total length of principal transportation network (942 km) is exposed to moderate, while 18.3% to high potential for different geologic instabilities (Fig. 5). Out of 1,389 km regional transportation network, 78.8% is passing through terrain of medium, whereas 17 0% through terrain of high potential for geologic instabilities in seismic conditions (MSE earthquake, or stronger)

There is a high probability that, due to caused geological instabilities along the transportation routes, the regions of Debar, Struga and Ohrid (West Macedonia) and regions of Gradsko, Valandovo-Gevgelija-Dojran, Strumica, Berovo and Pehcevo (South and South-East Macedonia) will be inaccessible (blocked) in the case of MSE or stronger earthquake

Although not yet analyzed, it is estimated that the problems with other regional lifelines can be of the same character and order as with the transportation network.

Disaster Management in Republic of Macedonia

Traditionally, each large scale disaster in Macedonia and Former Yugoslavia as well, was treated individually through especially formed committees and directorates for physical reconstruction and rehabilitation of disaster stricken regions and revitalization of economic and social functions.

Interdisciplinary disaster management, including prevention and preparedness, is a relatively new concept used for efficient and effective mitigation of expected destructive effects of natural and man-made disasters

Engineering Prevention

Standard legislation defining the procedures and the demands for seismic protection mainly refer to problems of mitigating damages related to buildings, engineering structures and other facilities.

The seismic forces in design practice on the territory of Republic of Macedonia (and former Yugoslavia as well) were introduced for the first time by the Temporary Technical Regulations for Loading of Building Structures[9]. The seismic force was defined as a horizontal force proportional to the building mass, and depending on the seismic zone, it amounted to 1-2 percent of the total building mass. The seismic zones were defined with the seismic zoning map elaborated on the basis of synthesis of past earthquakes that occurred within, or affected the territory of Former Yugoslavia. Since no destructive earthquake had occurred in the period from 1945 to 1963, the professional and scientific community showed no interest in a more profound study of the effect of seismic forces upon the stability and the seismic safety of building and engineering structures.

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[9] *PTP-2, (Temporary Technical Regulations), Official Gazette of FNRY, 61/48*

The first Regulations for Construction of Buildings in Seismically Active Regions[10] were enforced in 1964, i.e , immediately after the catastrophic Skopje earthquake of July 26, 1963. The qualitative formulation of coefficients defining the seismic force was done in accordance with the concept of the then valid USSR aseismic code whereas the quantification was based on experiences obtained from the Skopje earthquake. Despite certain shortcomings. these regulations had a notable role in seismic protection of buildings and contributed a lot to focusing of the interest of the professional engineering community on protection of structures against seismic effects

Presently, the Technical Regulations for Construction of Buildings in Seismically Active Regions[11] are in effect. These regulations integrated the achievements of the Macedonian, the Yugoslav and world science in seismology, engineering seismology and earthquake engineering on the time of their elaboration, the experience gathered through compilation and analysis of effects of strong earthquakes upon buildings and engineering structures, the ample fund of experimental evidence available at domestic and world institutions on dynamic behavior of structural elements, substructures and complete structures in seismic conditions, the information on the type and the intensity of possible seismic effects and their characteristics obtained from the strong motion network of accelerographs installed throughout the territory of Former Yugoslavia, etc

For the ordinary categories of building structures, the Regulations prescribe definition of seismic forces by applying the method of equivalent static force, whereas for certain categories of structures and particular seismicity conditions the method of dynamic analysis based on adequately defined time histories of ground accelerations is required Defined in these Regulations are the bases for design and construction of seismically resistant structures, with a particular emphasis on reinforced-concrete and masonry structures.

The technical measures for repair, strengthening and reconstruction of high-rises (reinforced-concrete and masonry structures) are defined in the Technical Regulations for Repair, Strengthening and Reconstruction of Buildings Damaged by Earthquakes as well as Reconstruction and Revitalization of Buildings[12].

Until 1982, the seismic zones were defined by the Seismic Zoning Map of SR Macedonia[13]. From August 1982 till 1990, the seismic zones were defined by the Temporary Seismological Map of SFRY[14] in which the earthquake intensity was defined by using the MCS (Mercalli-Cancani-Sieberg) scale. A conceptual modification of the seismological maps was made in 1988 when they were elaborated for return periods of 50, 100, 200, 500, 1000 and 10000 years, defining earthquake intensities according to the MSK-64 (Mevedev-Karnik-Sponhauer) scale. For building structures, the map elaborated for a return period of 500 years is enforced as official[15].

The concept, criteria and standards for protection of engineering structures against seismic effects are defined by the Technical Regulations for Design and Analysis of Engineering Structures in Seismic Conditions. The Regulations that are still to be published contain categorization of engineering structures, definition of seismic parameters, local soil conditions and methods for computation of seismic forces Elaborated into details are the additional seismic effects like the hydrodynamic seismic pressure, inertial earth pressure of the soil masses for design of underground and embedded structures, as well as for different types of structures defined are load combinations for definition of extreme effects. Although the Regulations were finalized in June 1985, they are not in effect yet.

Monitoring, recording and analysis of seismic effects, acquisition and processing of data on the manifestations of seismic phenomena upon the surface geological formations, the soil, the engineering and other structures as well as elaboration of seismological maps are regulated by the Law on Participation of the Republic in Financing the Seismological and Engineering Seismological

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[10] *Official Gazette of SFRY, 39/64*

[11] *Official Gazette of SFRY, 31/81, 49/82, 29/83, 21/88 and 52/90*

[12] *Official Gazette of SFRY, 52/85*

[13] *Official Register of SRM, 2/79*

[14] *Official Gazette of SFRY, 49/82*

[15] *Official Gazette of SFRY, 52/90*

Investigations[16] as well as the Programs for Development and Improvement of Seismological and Engineering-Seismological Activities in the period 1986 - 1990[17], i.e., in the period 1991 - 1995[18].

Seismic monitoring of dynamic behavior of soil, dam body and foundation under strong earthquakes, i.e , seismic monitoring of induced seismicity is regulated by the Technical Regulations for Seismic Monitoring of Large Dams[19]. Monitoring of this type of engineering structures in normal conditions is regulated by the Regulations for Monitoring of Large Dams[20].

Construction of structures, i.e , elaboration of technical documentation, preparatory works and the construction itself, i.e., reconstruction of structures and technical supervision are regulated by the Law on Construction of Capital Investment Facilities[21]. This law refers to construction of all building, infrastructure, lifeline, hydraulic civil engineering and other civil engineering structures, including all the installations, facilities and equipment which are in function of the purpose of the structure or solely the installations, the devices, the facilities and the equipment provided that they make a self-dependent technical-technological entity

Physical and land use planning (development planning and spatial planning at national, regional and municipal level, general and detail urban planning for urban, and urban layouts for larger rural areas) including regulations for elaboration and corresponding legislation for enforcement of stated plans as well as criteria and conditions for construction, are regulated by the Law for Spatial and Urban Planning[22].

To define the level of losses of national goods and specify concrete measures for overcoming of inflicted losses, loss assessment due to natural disasters including earthquakes shall be made by using the Unique Methodology for Estimation of Losses Due to Natural Disasters[23].

The above stated standards and legislative provisions for earthquake design and construction shall be implemented and realized by construction companies as well as qualified and specialized institutions. Within the frames of the governmental authorities and ministries themselves, no other services, except for the technical inspection, exist for monitoring and supervising the implementation of these regulations in practice

The preventive protection of population, material property and the entire living environment of Macedonia against other natural or man-made disasters is regulated by abundant legislation. The most essential are the following laws

- Law on water[24]
- Law on protection against fires[25]
- Law on protection against explosions[26]
- Law on health care[27]
- Law on protection of animals against contagious diseases[28]
- Law on protection of flora against diseases and damages[29]

accompanied extensively by complementary regulations and ordinances.

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[16] *Official Register of SRM, 18/83*
[17] *Official Register of SRM, 9/86*
[18] *Official Register of SRM, 12/91*
[19] *Official Gazette of SFRY, 6/88*
[20] *Official Gazette of SFRY, 7/66*
[21] *Official Register of SRM, 15/90*
[22] *Official Register of RM 4/96*
[23] *Official Gazette of SFRY, 27/87*
[24] *Official Register of SRM , 6/81, 13/82, 37/87, 51/88, 20/90, 23/90 and Official Gazette of RM 24/91, 83/92*
[25] *Official Register of SRM 43/86, 37/87, 51/88 and Official Register of RM, 12/93*
[26] *Official Register of SRM 4/78, 10/78, 51/88, 36/90 and Official Register of RM, 12/93*
[27] *Official Register of RM, 38/91*
[28] *Official Register of RM, 83/92*
[29] *Official Register of RM, 83/92*

Emergency Management

Protection of lives and public health as well as protection of property against natural disasters (earthquakes, floods, landslides, avalanches, heavy storms, failure of high dams and flooding of embankments, draughts, atmospheric and other disasters that might endanger the lives and the health of the people or their properties to a higher or lesser extent) is regulated with the provisions of the Law on Protection Against Natural Disasters[30] and the Law on Defense[31].

For smaller scale disasters, protection and rescue of population and material property during emergency impact phase as well as in post-disaster period is organized through the existing institutions and the services of the country (police, fire fighting brigades, first medical aid, etc.). In the case of large scale disasters (catastrophic earthquakes for example) or impending catastrophe from natural phenomena (catastrophic flood), the protection of population and material property will be organized through the Civil Defense According to the Law on Defense, the Army of Republic of Macedonia might be involved only for mitigation of disaster effects, upon direct presidential order of the President of the Republic of Macedonia. The mode of involvement is directed by the ordinance of the Minister of Defense.

The Civil Defense forces are organized by the Government and shall be used for emergencies in a way defined by the ordinance of the Government[32]. The civil defense is headed by headquarters, with duties and mandate defined by the Law on Protection from Natural Disasters[33].

Organization of actions for mitigation, or elimination of a threat, or effects created by occurrence of a natural disaster is defined in Disaster Management Plans. The content of Disaster Management Plans is precisely defined by the Law on Protection from Natural Disasters[34].

At municipal level, Disaster Management Plans for protection from natural disasters are enforced and administered by the Municipality, whereas in their elaboration and synchronization the Government participate within its mandate.

Criteria for planned and organized evacuation of population in case of, or under the threat of a military conflict as well as other circumstances (natural or man-made disaster) are defined with the Regulations for Criteria for Evacuation of Population of SR Macedonia[35].

Relief System

In case of large scale natural or man-made disasters or epidemics, in accordance with the Constitutional Law of the Republic of Macedonia[36] an emergency state might be declared for the entire, or only a part, of the territory of the country. The state of emergency shall be declared by the Parliament of the Republic of Macedonia by 2/3 majority, upon request of the President of the Republic of Macedonia, the Government of the Republic of Macedonia or minimum 30 (out of 120 to 140) members of the Parliament. The validity of the decree is 30 days.

If the Parliament can not be convoked due to disaster effects and created conditions, President of the Republic of Macedonia shall declare an emergency state, that shall later be ratified at the first Parliament session.

The Government of the Republic of Macedonia is authorized to enforce ordinances (with the power of law) for directing and monitoring of all activities during the state of emergency. The authorization terminates when the end of the state of emergency is declared by the Parliament

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[30] *Official Gazette of SFRY, 39/77, 47/89*
[31] *Official Register of SRM, 8/92*
[32] *Official Register of SRM, 8/92, Chapter VI*
[33] *Official Register of SRM, 39/77, Chapter V*
[34] *Official Register of SRM, 39/77, Article 48*
[35] *Official Register of SRM, 34/87*
[36] *Official Register of RM 52/91*

The Government of the Republic of Macedonia is also responsible for organizing protection of population and material properties and coordination of all sectoral activities. It directs all measures for protection and orders participation and involvement of all human and material resources.

During the state of emergency, The Government of the Republic of Macedonia can order directly, or through Republic Headquarters of Civil Defense (a normal practice), the mobilization of· 1) Civil Defense Forces: 2) Public Service for Monitoring; Alarming and Information; 3) population; and, 4) other relevant subjects which, according to the Law on Protection Against Natural Disasters are responsible for effective and efficient protection of population and material property.

The Civil Protection System of Republic of Macedonia is a form of organization, preparedness and involvement of population, state and local self-management authorities, enterprises, public institutions and services for providing protection and rescue of population and material property from consequences of external military action, state of emergency and other disastrous conditions. The Civil Protection is organized and prepared in the whole working and living environment.

The Civil Protection System of Macedonia comprises of three elements: 1) self-protection, 2) protection and rescue measures, and, 3) Civil Protection Forces.

Self-protection is the most mass and fundamental form of protection and rescue of population for preservation of the human and material potentials of the country. It is organized at every single family level, administrative or public building, urban unit, urban area, local community, enterprise, public institution and service, as well as all other living, working and mass gathering locations.

In the framework of self-protection, population is being prepared for active participation in protection during the disaster impact phase, i.e., rescue, first aid, primary decontamination, location and extinguishing of smaller and initial fires, shallow debris rescue, reporting on dangers as well as participation in sheltering, evacuation and care of affected population.

Protection and rescue measures are being planned, prepared and executed to prevent hazards caused by war destruction, state of emergency and other disasters as well as for minimizing and mitigating the consequences of the disaster that has taken place

The preparedness for protection and rescue is based upon the estimated degree of danger, the size of the territory affected and the vulnerability of the exposure. These measures shall be conducted by enterprises, public institutions and services, local governments and state authorities

The protection and rescue measures include: 1) Warning of the population; 2) Evacuation of the population; 3) Sheltering, 4) Rescue from ruins, floods and explosions, 5) First medical aid; 6) Fire protection; 7) Detection and posting dangerous zones, decontamination and similar RBC protection measures; 8) Care for population; 9) Camouflage: 10) Blackout. 11) Assistance in preservation of resources essential for survival (protection and rescue of food supplies, water and other resources); 12) Terrain rehabilitation; 13) Urgent establishment of control and order in the affected area; 14) Establishment of services of public interest; 15) Protection and rescue measures accounted for development of spatial and urban plans, and, 16) Other types of protection and rescue measures.

Civil Protection Forces are responsible for undertaking all humanitarian activities and tasks related to effective end efficient protection and rescue of population and material properties in the territory of the country as well as for providing conditions for direct and immediate intervention for preventing disaster occurrence and mitigation of effects caused by war destruction, state of emergency, or other disasters.

According to the way of organization and involvement, the Civil Protection Forces are composed of 1) Local forces (headquarters, commissioners and units), and, 2) Maneuver forces (headquarters and specialized units) of civil protection.

Local Civil Protection Forces (Fig. 6), formed within the enterprises, public institutions and services and units of the local self-management authorities, shall be involved in protection and rescue operations in war conditions, state of emergency and other disaster conditions at the locations where they have been formed and in the neighboring endangered areas within the municipality/region where they have been formed, if necessary.