

Current Seismic Hazard Assessment and Creation of Early Warning System in the Republic of Armenia

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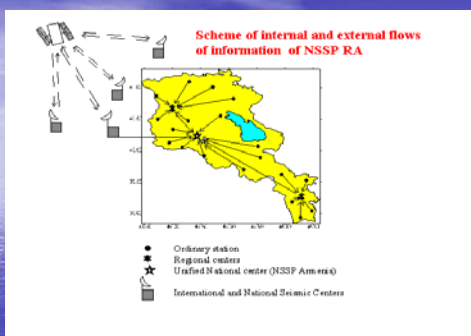
The Map of the Republic of Armenia and neighboring countries



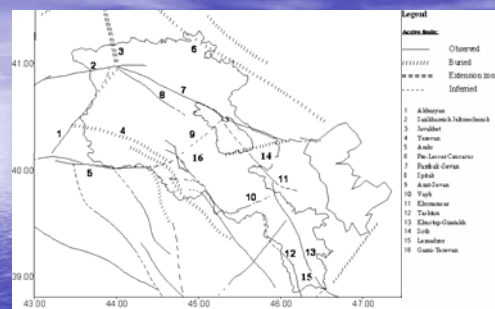
Biblical mount of Ararat



More than 30 parameters are measured at the more than 150 stations of Armenian NSSP National Observation Network



Recorded data are transferred to Data Acquisition and Analysis Center through various means of communication including satellite, Internet, mobile and stationary phone, electronic etc.



Schematic chart of active faults in the territory of RA and adjacent areas (16 faults)

Some favorable conditions below are available for the territory of Armenia to solve the problem of earthquake prediction:

1. Precursors appearance in the definite period of time.
2. Such dynamics of precursors quantity and their parameter (amplitude, frequency, accumulation in a definite area etc.) change which allows more precisely to define the magnitude, location and time of forthcoming earthquake.
3. Armenian NSSP specialists and officials who would fully take the responsibility for prediction.
4. The Law "On Seismic Protection" of the RA (valid since 2002) and NSSP status.

Current seismic hazard assessment includes:

- investigation of seismic parameters (spatial and temporal distribution of earthquake epicenters, number of seismic events and released energy, recurrence of earthquake and maximum magnitude of expected earthquake, most hazardous zones of earthquake occurrence, etc) on the base of Seismic Catalogue analysis;
- definition of probabilities of current anomalies' seismic realization based on testing of strong regional earthquakes ($M \geq 5.5$) and perceptible local earthquakes ($5.5 > M \geq 4.0$) and monitoring data time history analysis using "SeisHelp" software;
- outline of seismogene anomalies using "Dynamic Fields" software;
- probability evaluation of the site, time and magnitude of expected earthquake using "Expert" software;
- evaluation of crust stress based on monitoring data;
- complex evaluation of current seismic hazard in the territory of Armenia based on operative complex map using seismo-tectonic data and seismic zonation map of the territory of Armenia.

NON AUTOMATIC EARLY WARNING SYSTEM

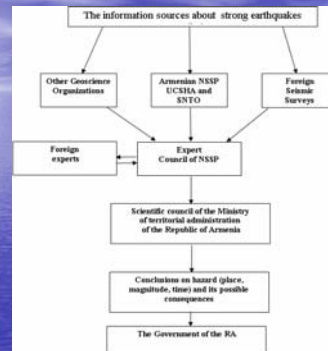


Figure 1. The simplified scheme of early warning system of the RA

- High probability of strong earthquake ($M \geq 5.5$) (figure 2)
- High probability of earthquakes of medium magnitude ($4.0 < M < 5.5$) (figure 3)
- Low probability of strong earthquakes (figure 4.)

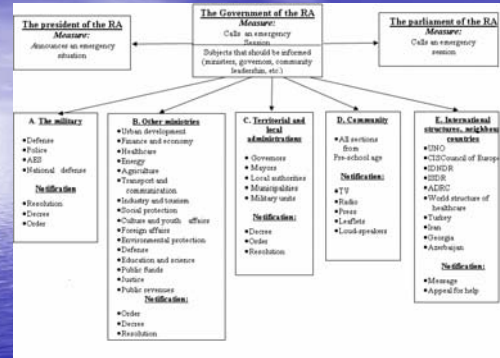


Figure 2. The scheme of non-automatic early warning system of expected strong earthquake with high probability

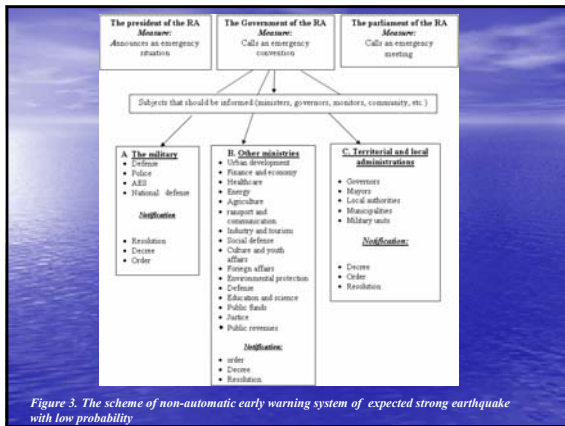


Figure 3. The scheme of non-automatic early warning system of expected strong earthquake with low probability

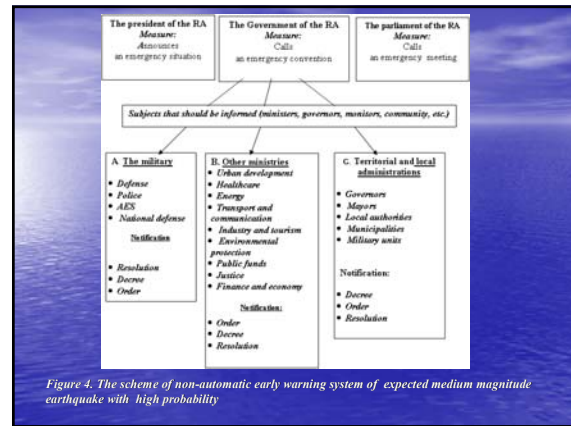


Figure 4. The scheme of non-automatic early warning system of expected medium magnitude earthquake with high probability

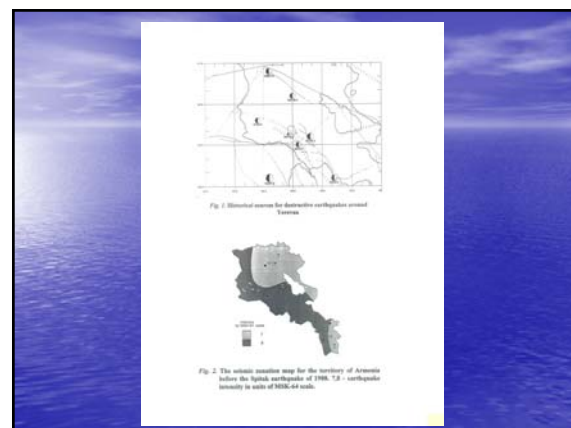
Task	Executive group		
	Probable strong earthquake	Strong earthquakes with low probability	Earthquake with medium magnitude and high probability
1 Assessment of hazard and possible losses	A, B, C, E	A, C	A
2 Creation of emergency situation staff	A, C	A, C	A
3 Assessment and preparation of Task Force	A, B, C, D, E	A, B, C	A, C
4 Extra assessment of buildings and structures' vulnerability	A, C	A, C	A, C
5 Cessation of activity of objects and reduction, prediction of possible dangers	A, B	A	----
6 Strengthening of observation stations, increase of measuring frequency	(A)	(A)	The Government (A)
7 Lifesupport of population of future earthquake zone	A, B, C	A, B	----
8 Evaluation of foreign aid demands	A	----	----
9 Less reduction elaboration demands	A, B, C	A	----

Table 1. The main tasks and executors of seismic hazard early warning

Task	Executive group		
	Probable strong earthquake	Strong earthquakes with low probability	Earthquake with medium magnitude and high probability
10 Isolation of population from vulnerable buildings and structures	A, B, C, D	----	----
11 Activity cessation of offices, organizations, industry	A, B, C	----	----
12 Isolation of population from vulnerable territories of second hazards (landslides, water cover, rockfall, etc.) or risk reduction (fire, toxic ejections, etc.)	A, B, C, D	----	----
13 Creation of population evacuation plan from the zone of risk	A, B, C	A, B	----
14 Strengthening of law and order preservation, prevention of panic	A, B, C, D	A, C	----
15 Appeal for help to international organizations and foreign countries	A, E	----	----
16 Aid delivery to the earthquake zone without delay	A, B	----	----
17 Decisions making	A, B, C, D, E	A, C	A, C
18 Warning	The Government	----	----

Table 1. The main tasks and executors of seismic hazard early warning

Urgent early warning system



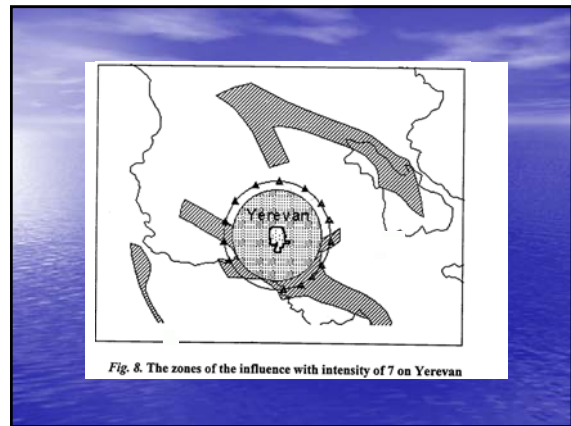
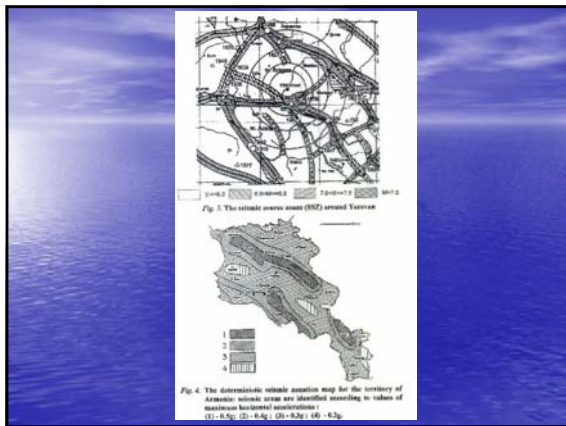
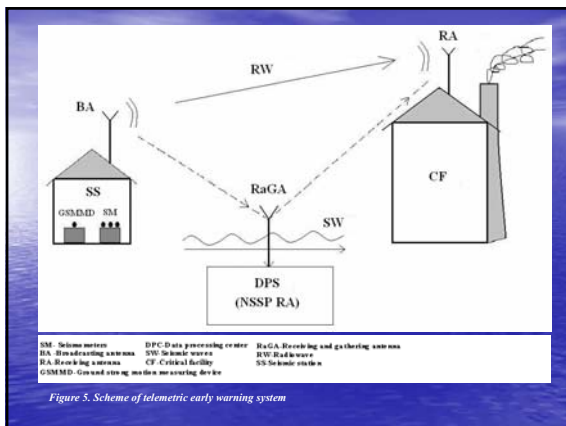
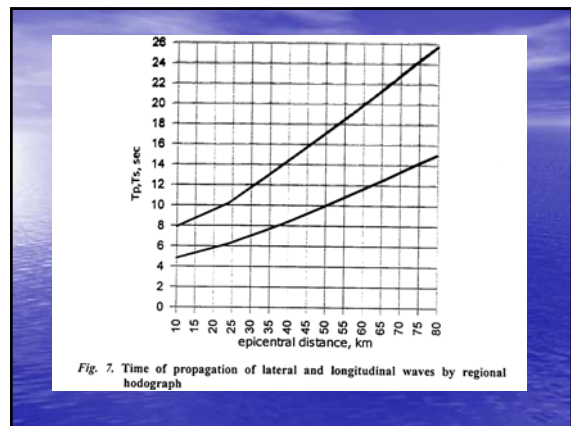


Table. Possible effects from 5 historical earthquakes in Yerevan

Earthquakes	Year	Magnitude	Distance from Yerevan (km)	Acceleration (cm/s ²)	T _p [s]	T _l [s]
Garni	1679	7.0	26	256	6.5	11
Dvin	893	6.5	23	196	6.0	10
Tskhadzor	1827	6.5	48	134	9.5	16.5
Ararat	1840	7.5	72	182	13.0	23
Talin-Aranch	972	6.5	53	129	10.5	18

$PHA = 0.72 + 0.44M - \ln \Delta - 0.00230792 \Delta + 0.28p$
 $\Delta = (h^2 + 4.5^2)^{1/2}$

where PHA - the peak horizontal acceleration in cm/sec²;
 h - hypocentral distance, km;
 p - is 0 for 50 - percentile values and 1 for 84 - percentile;
 M - surface waves magnitude
 Empirical attenuation relationship of ground strong motion for Caucasus area.



The cost of the earthquake early warning system of Yerevan city.

Name	Quantity	Price in \$US	Total
Field Stations			
3 component accelerations	42	3500	147000
Digital devices	42	2000	84000
Processors	42	4000	168000
Transmitters	42	2600	109200
Antennas	42	900	37800
Sources of Power	14	1200	16800
Cable	15	200	3000
The Central Receiving Station			
Receivers	42	3500	147000
Electronic cabinet	2	75000	150000
Sources of Power	2	2500	5000
Computers	2	15000	30000
Software Devices	2	10000	20000
Installation of the System	2	49000	98000
New Stations	4	3000	12000
Total			978000\$

Conclusion

The new system will consist of the two components:

- current seismic hazard assessment and early non-urgent warning (preparation time).
- urgent warning (earthquake hit urban area and rapid information is necessary).

The optimal EWS scheme consist of 14 control observation sites situated in the area with the radius of 30km from Yerevan city.

The game time before arrival destructive waves will be up to 10 second.

- The Hyogo Framework sets out specific priorities for action on early warning for all hazards and on associated risk assessment and preparedness. Following those priorities I would request ISDR secretariat and ADRC to help in establishment of people-centred regional earthquake early warning system in Caucasus through relevant bilateral and multilateral Projects and Programs.

Thank You