EWC III
Third International Conference on Early Warning
From concept to action

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Multi-Hazard Risk Assessment at Different Levels with Extremum System Application

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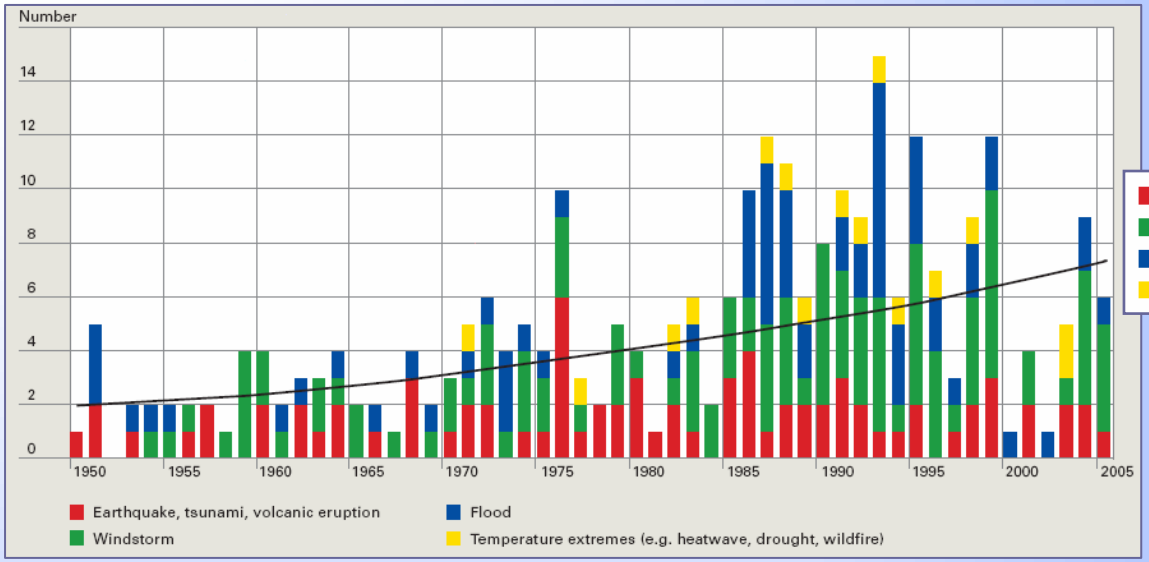
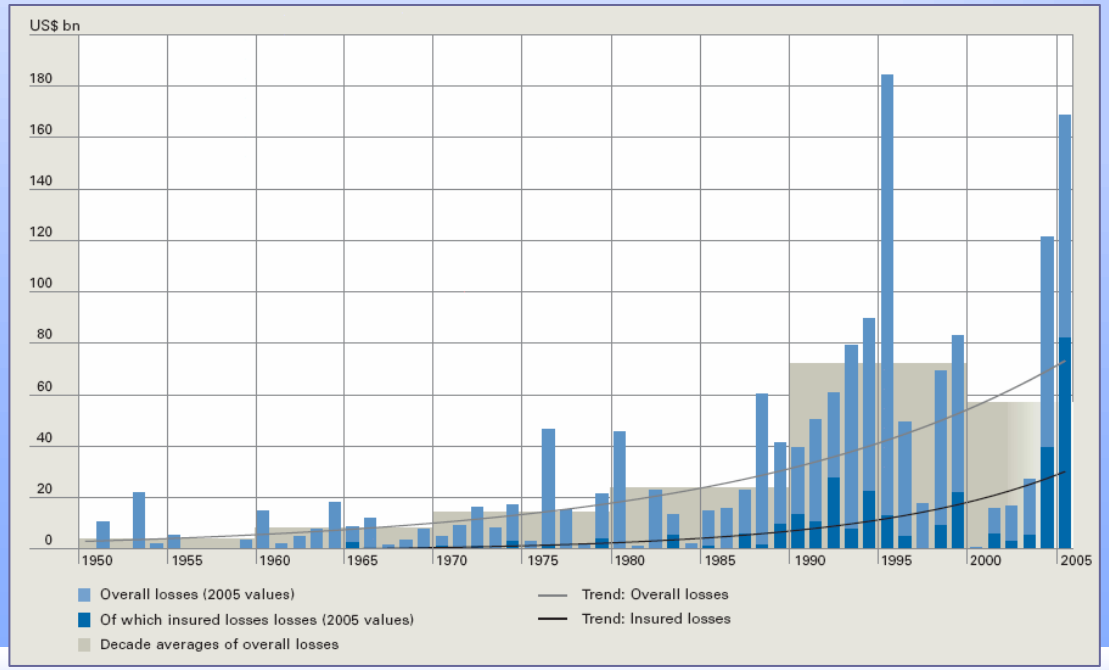
Great natural catastrophes in 1950–2005 MUNICH RE



Earthquake, tsunami, volcanic eruption
Windstorm
Flood
Other events (e.g. wildfires, drought, heatwave, frost)



Increase in the losses due to natural disasters is not random phenomenon and mainly dealt with growth of population, industry, infrastructure, commercial and economic activity in large cities, which are prone to different natural and technological disasters

For taking the proper decision about preventive measures for risk reduction and response measures just after an event the estimations of expected losses due to natural and technological disasters are very critical

Mathematical expectation of number of fatalities and injuries

$$M(N_j) = \int_{S_\Sigma}\int_{0}^{24}\int_{I_{min}}^{I_{max}} P_{Cj}(I)\, f(x,y,I)\ \psi(x,y)\, f(t)\, dI\, dt\, dx\, dy,$$

$M(N_j)$ – mathematical expectation of social losses within the settlement
$P_{Cj}(I)$ - law of earthquake impact on population providing the buildings survived damage due to event with intensity I
$f(x,y,I)$ - density function of earthquakes' intensity I probabilities within the unit area with co-ordinates x , y
$\psi(x,y)$ - population density within the unit area with co-ordinates x, y
$f(t)$ - function obtained on the basis of statistical analysis of data on population migration during the day time
I_{min} , I_{max} — maximum and minimum possible earthquake intensity within the given site

Individual Seismic Risk

probability of death (or injuries) due to possible earthquake within one year in a given territory

$$R_e^N = H \cdot V_s(I) = (H/N)\, M(N_j)$$

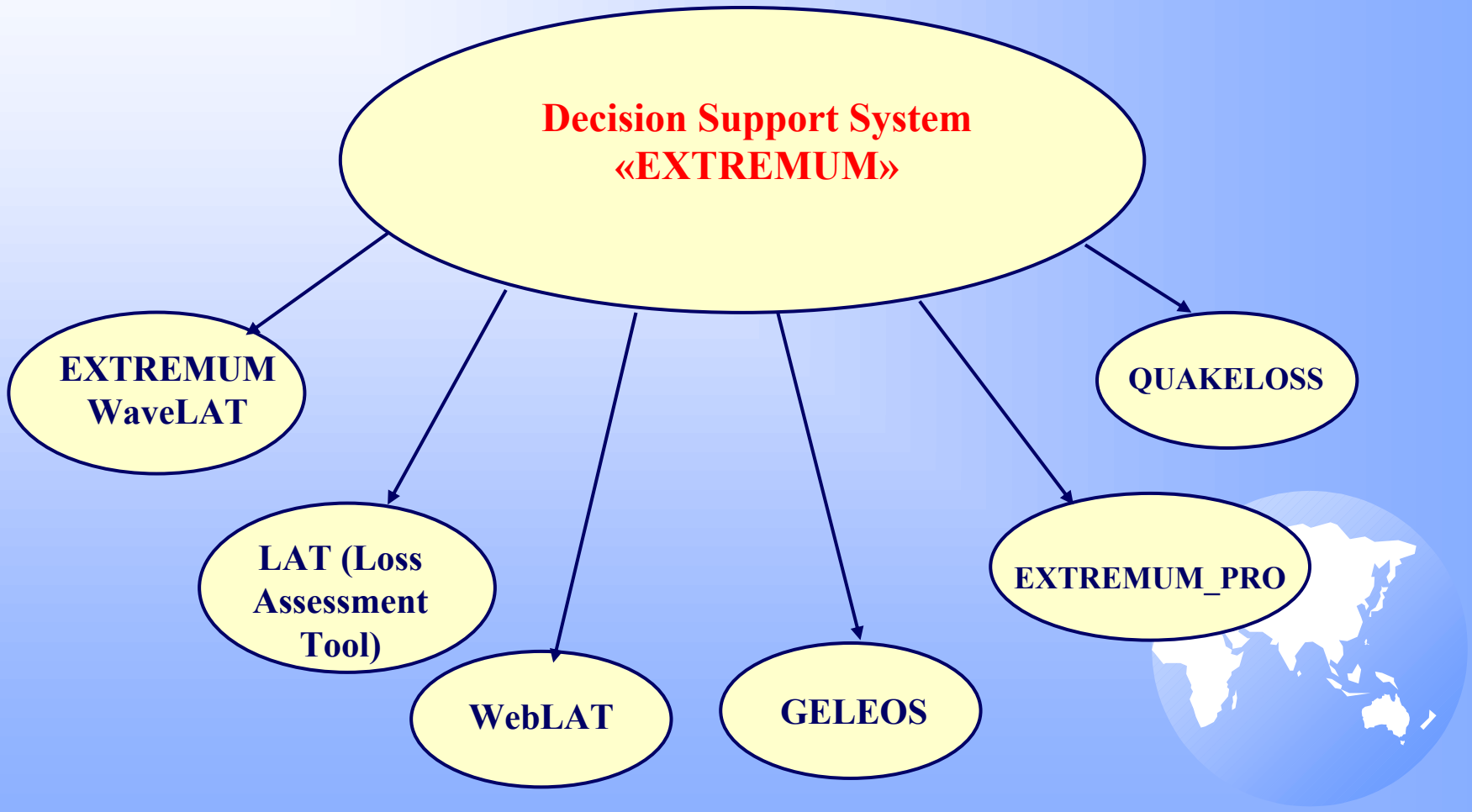
H – probability of seismic event per one year
$V_s(I)$ - vulnerability of population for the considered settlement
N - the number of inhabitants in the considered settlement

Integrated Individual Risk

$$R_e = 1 - \prod_{i=1}^{n} (1 - R_{ei})$$

n — number of considered emergencies of natural and technological character
Rei — individual risk due to i-th emergency

The Extremum System's mathematical models are based on procedure described in "The Methods of Earthquake Consequences Assessment» ands «Methods of Integrated Risk Assessment due to Emergencies of Natural and Technological Character»



System "Extremum" and its versions was developed at Extreme Situations Research Center Ltd. together with Seismological Center of IGE, Russia Academy of Sciences and Institute of Civil Defense, Emercom of Russia

Details of mathematical models and the forms of results visualization at different levels

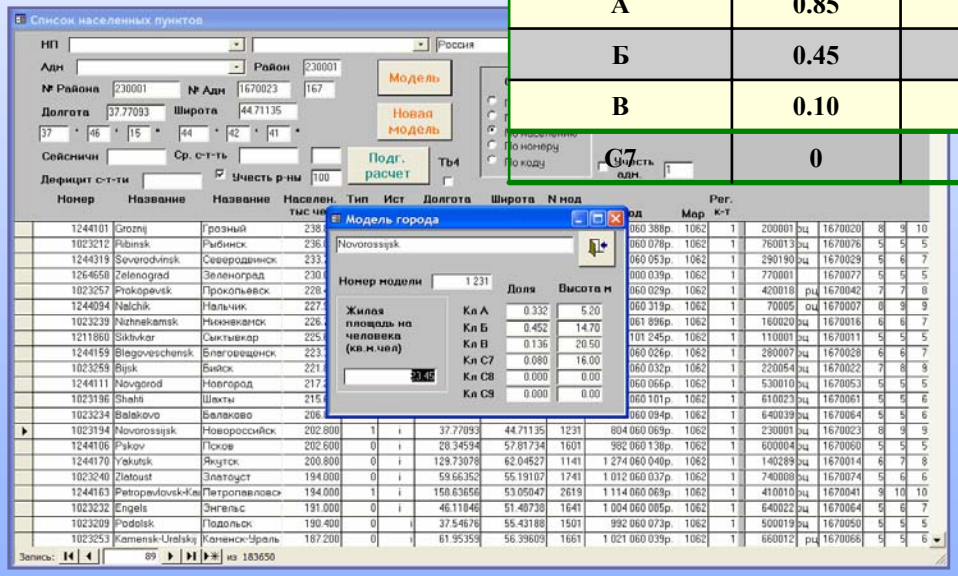
Details of models	Forms of loss and risk presentation on maps
Global level of loss and risk estimation	
Usage of macro indexes based on countries economic development; Usage of averaged models of hazards and vulnerability functions	Hypsometric layers; Isolines corresponding to different levels of loss and risk; Marks of different colour and size
Regional level of loss and risk estimation	
Usage of regional models of hazards and vulnerability functions	Hypsometric layers; Isolines corresponding to different levels of loss and risk; Marks of different colour and size
Local level of loss and risk estimation	
Usage of engineering methods of computations; Application of numerical methods for solving the problems	Zones (districts of settlements) of different colour
Facility level of loss and risk estimation	
Application of numerical methods for estimation of dynamical parameters of ground motion and structures strength capability; analysis of "fault and event trees"	Measurable index of damage, loss and risk

Details of databases on existing building stock

Building type according to MMSK-86	City model		Town model		Village model	
	%	Height, m	%	Height, m	%	Height, m
А	0.33	6	0.43	4	0.58	4
Б	0.45	15	0.48	6	0.39	6
В	0.14	21	0.08	9	0.02	7
С7	0.08	16	0.01	12	0.01	10

The System EXTREMUM software allows to update the models of settlements

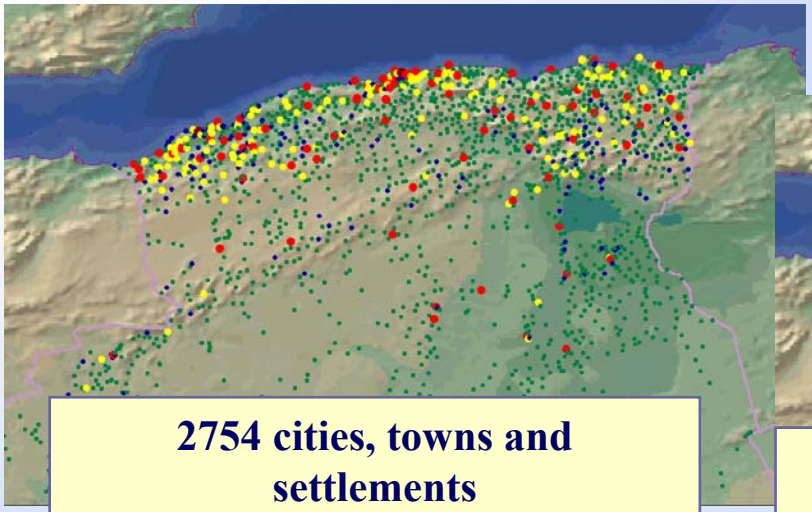
Building type according to MMSK-86	Krasnodar City model		Sochi City model		Tuapse City model	
	%	Height, m	%	Height, m	%	Height, m
А	0.85	3	0.01	3.0	0.07	3
Б	0.45	6	0.11	6	0.24	6
В	0.10	15	0.12	12	0.3	9
С7	0	0	0.76	15	0.39	12



Petropavlovsk-Kamchatsky City – 282 models for districts with uniform building stock

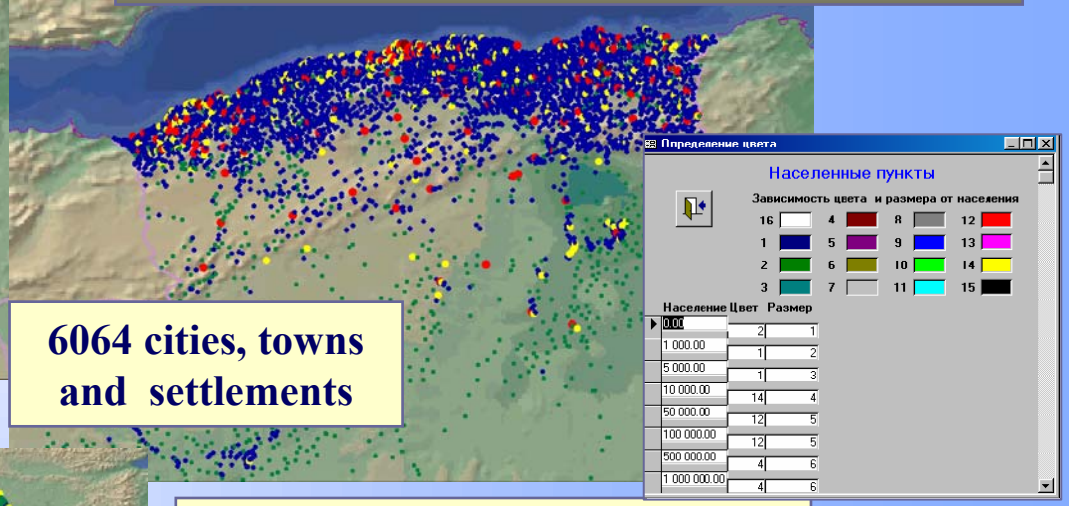
According to MMSK-86 scale:
buildings' classes А1, А2 (from local materials);
buildings' classes Б, Б1, Б2 (brick, hewn stone or concrete blocks);
buildings' classes В, В1, В2 (reinforced concrete, frame, large panel and wooden);
buildings' class С7, С8, С9 (designed and constructed to withstand the earthquakes with intensity 7, 8, 9)

Updating the information about population distribution

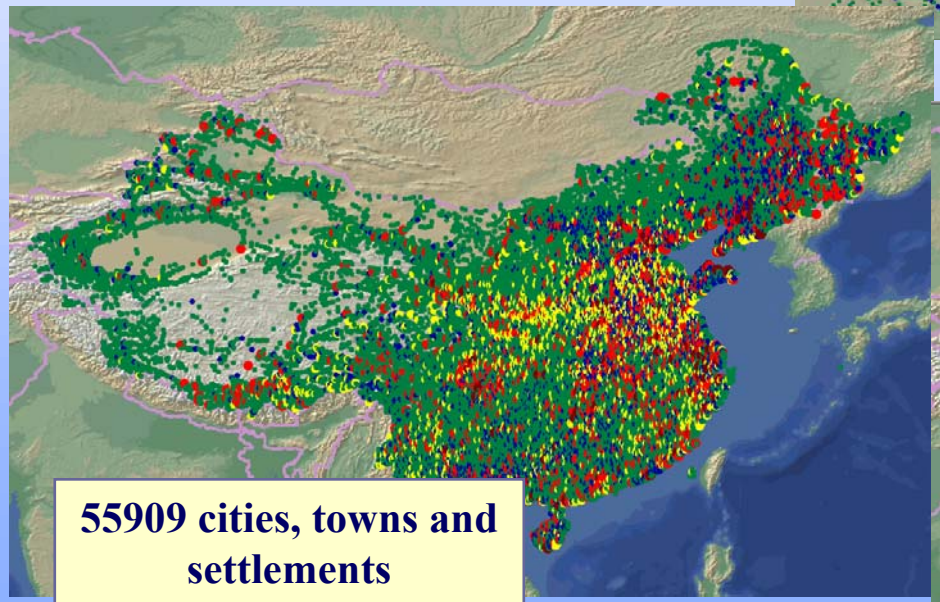


2754 cities, towns and settlements

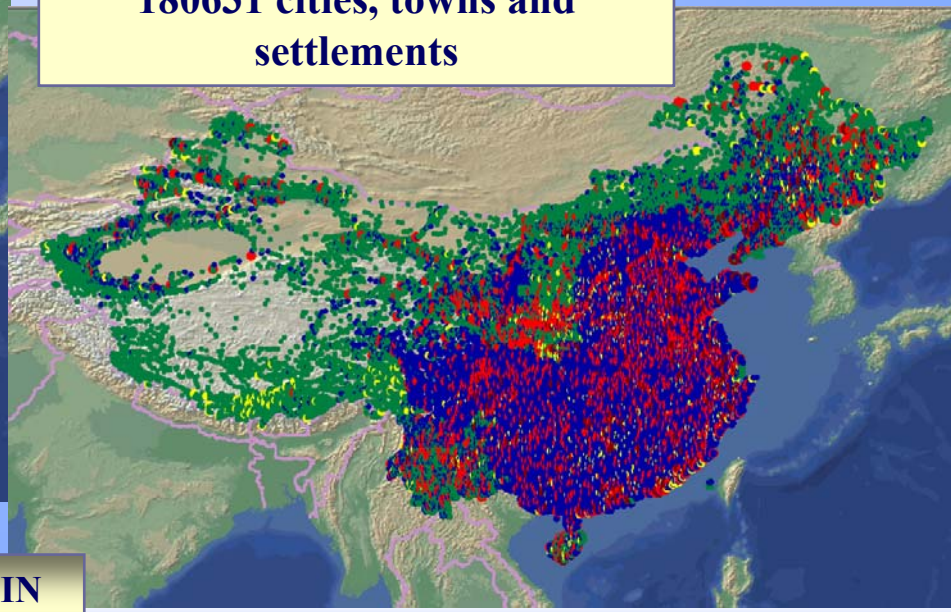
DISTRIBUTION OF POPULATION IN ALGERIA



6064 cities, towns and settlements



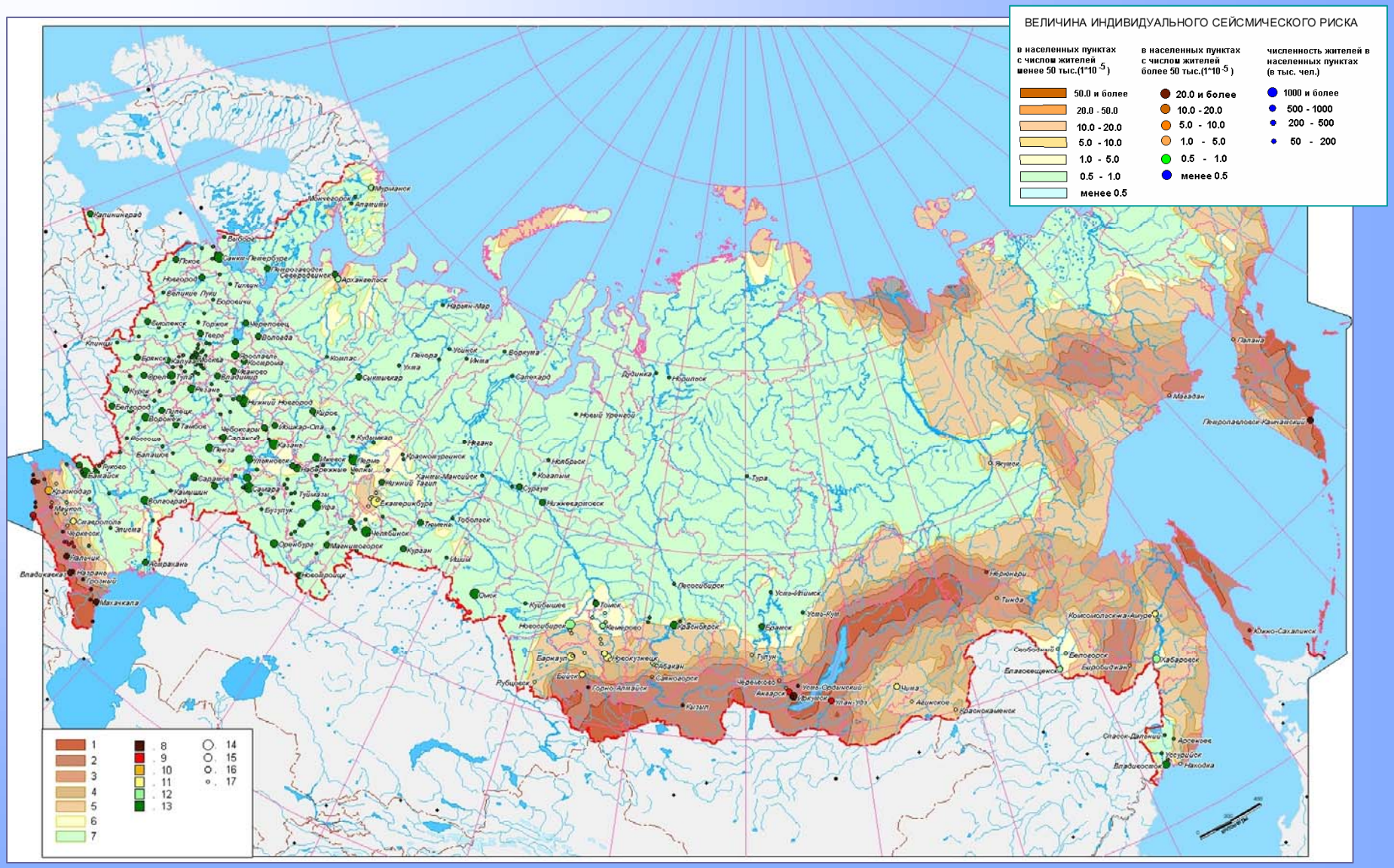
55909 cities, towns and settlements



180631 cities, towns and settlements

DISTRIBUTION OF POPULATION IN CHINA

INDIVIDUAL SEISMIC RISK ZONATION FOR THE RUSSIAN FEDERATION TERRITORY



INDIVIDUAL INTEGRATED RISK ZONATION FOR THE RUSSIAN FEDERATION TERRITORY

ПРИ ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЯХ ПРИРОДНОГО И ТЕХНОГЕННОГО ХАРАКТЕРА

ОРГАНИЗАЦИИ-РАЗРАБОТЧИКИ КАРТЫ:

Всероссийский научно-исследовательский институт по проблемам гражданской обороны и чрезвычайных ситуаций МЧС России (ВНИИ ГОЧС)

Центр исследований экстремальных ситуаций (ЦИЭКС)

Сейсмологический центр Института геоэкологии РАН

ВЕЛИЧИНА КОМПЛЕКСНОГО ИНДИВИДУАЛЬНОГО РИСКА

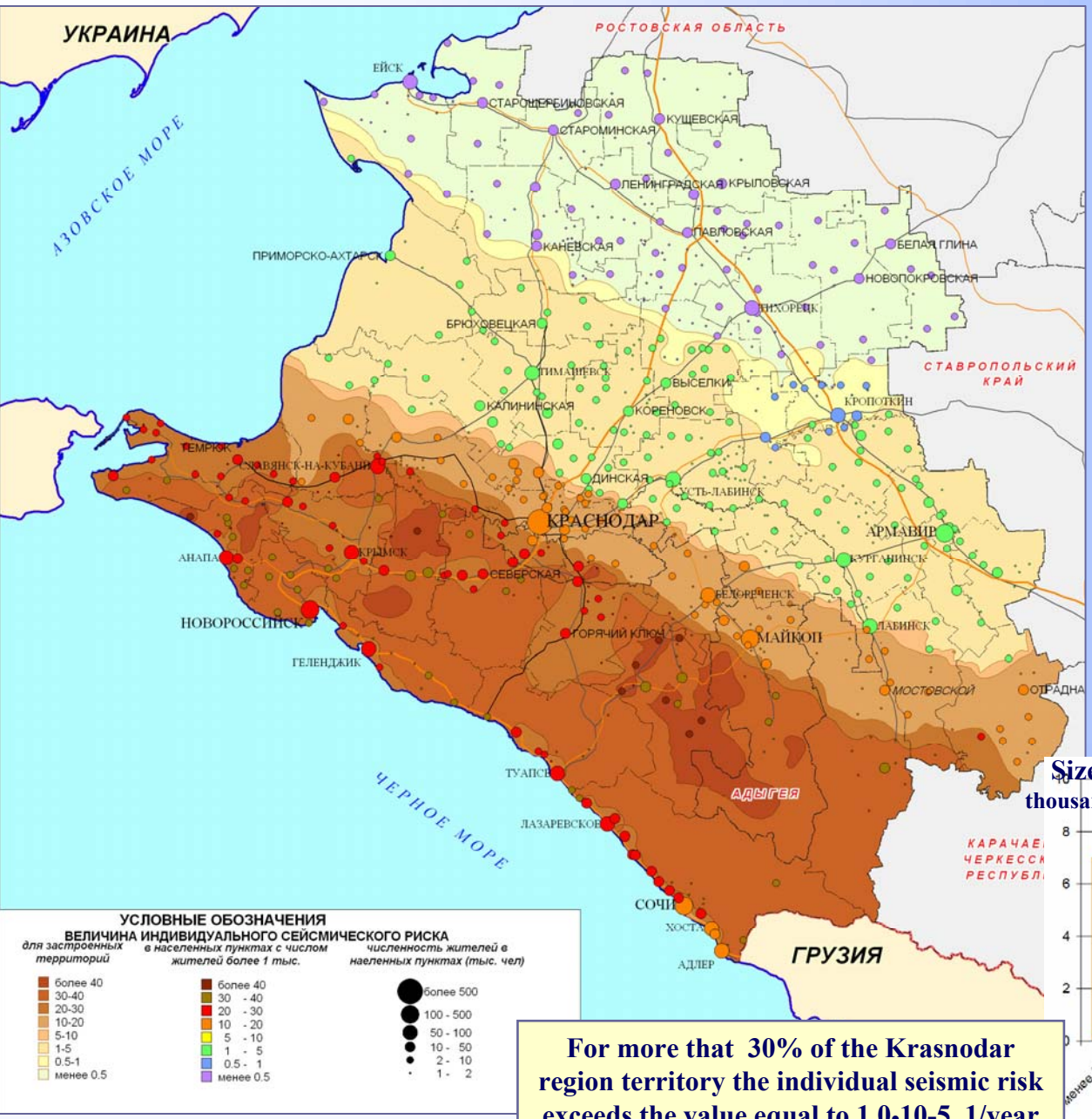
в населенных пунктах с числом жителей менее 50 тыс. ($1*10^{-5}$)	в населенных пунктах с числом жителей более 50 тыс. ($1*10^{-5}$)	численность жителей в населенных пунктах (в тыс. чел.)
50 и более	50 и более	1 000 и более
20 - 50	20 - 50	500 - 1 000
5 - 20	10 - 20	200 - 500
1 - 5	5 - 10	менее 200
0,5 - 1	1 - 5	
0,2 - 0,5	0.5 - 1	
0,1 - 0,2	менее 0.5	
менее 0,1		

Индивидуальный комплексный риск (ИКР) - вероятность гибели человека в год на рассматриваемой территории от опасного природного или техногенного воздействия

Авторы: М.А. Шакраманьян, В.И. Ларионов (отв. редактор), Г.М. Нигметов, В.И. Пчелин, А.А. Сорогин, С.В. Ульянов, Ю.А. Филатов (ВНИИ ГОЧС); С.П. Сущев, А.Н. Угаров, М.А. Козлов, В.В. Маше

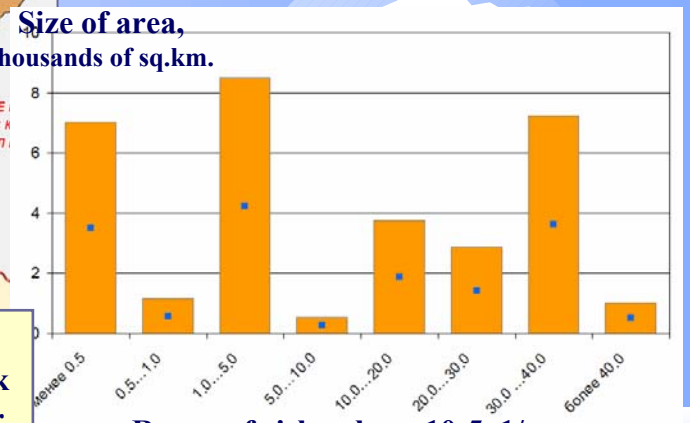
Contribution of technological and natural hazards to integrated risk value

MAP OF INDIVIDUAL SEISMIC RISK FOR THE KRASNODAR REGION TERRITORY



For 764 cities and towns with population more than 1 000 inhabitants values of risk are shown as circles of different size and color.

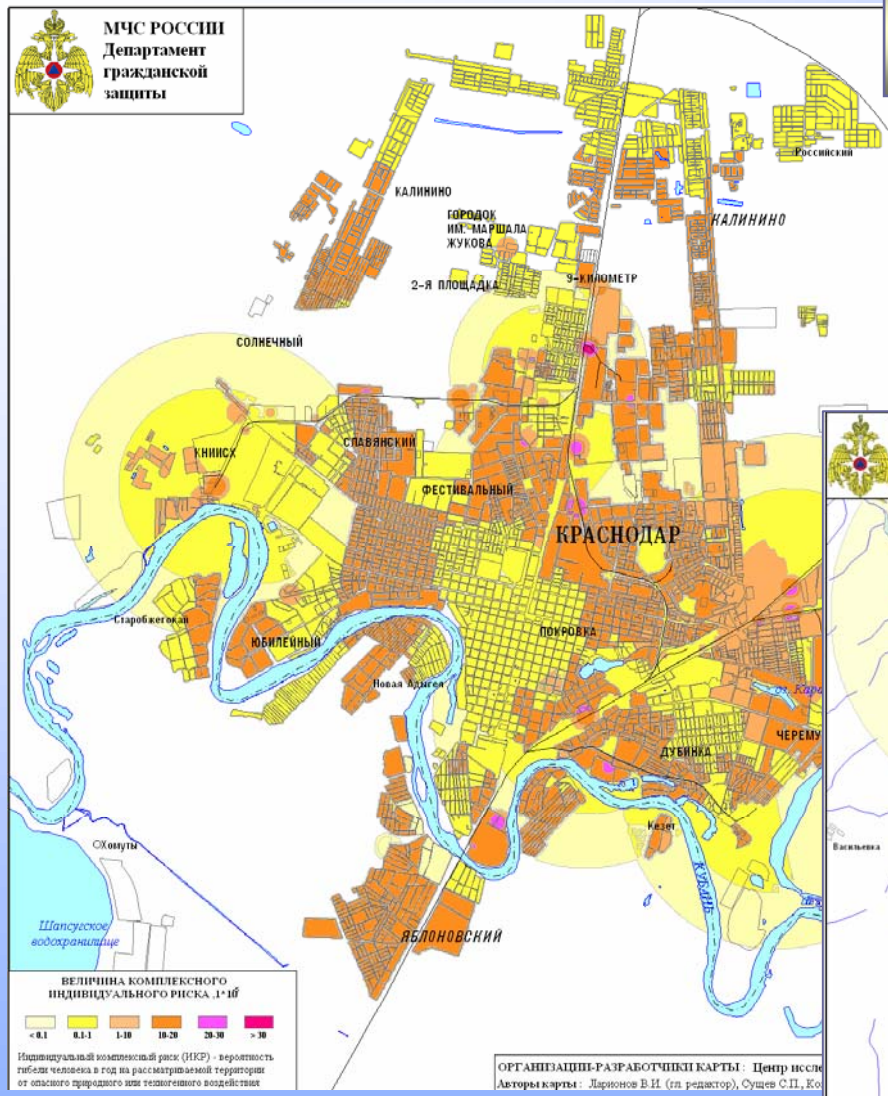
For small settlements with number of inhabitants less that 1000 people values of risk are presented as hypsometric layers.

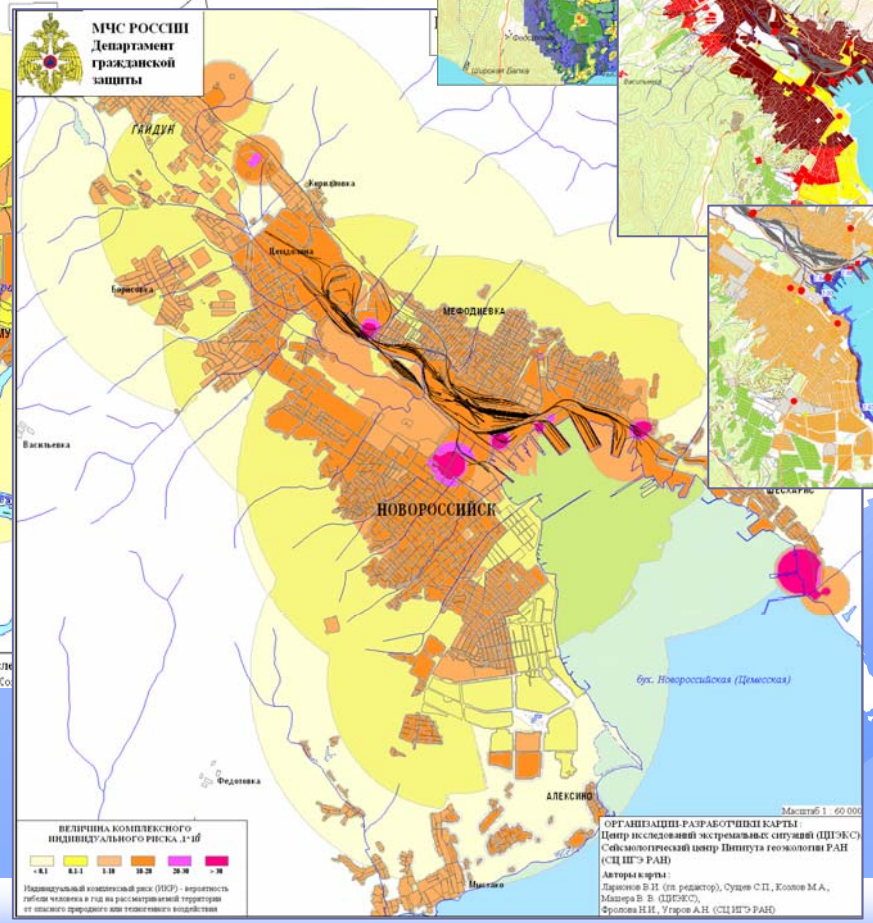


Range of risk values, 10-5, 1/year

For more that 30% of the Krasnodar region territory the individual seismic risk exceeds the value equal to 1.0•10-5, 1/year

INTEGRATED RISK ZONATION FOR THE KRASNODAR CITY TERRIORY





Technological risk

Earthquakes

Tsunami

INTEGRATED RISK ZONATION FOR THE NOVOROSSIJSK CITY TERRIORY

PROCEDURE OF EXPECTED DAMAGE AND LOSSESS ASSESSMENT IN “EMERGENCY MODE”

1. The information about the earthquake parameters (origin time, epicenter coordinates, depth, magnitude) is taken automatically from Web sites of Seismological Surveys or received by e-mail
2. Computations of expected damage extend, social and economic losses due to earthquakes and identification of the effective response measures with the Tool and its versions application
3. Expert estimation of the obtained results
4. Taking a decision about expected consequences estimation
5. Dissemination of messages about expected damage and losses

26 DECEMBER, 2003 EARTHQUAKE IN IRAN

Каталог землетрясений

Регион Iran_iiees | Добавить | Заменить | Удалить

Ном. 1126 | Дата 26.12.03 | Время 4 | Долг. 58.38 | Шир

Погибло расч 11256 - 37099 | Погибло факт | Ранено расч 3

DEC 26 01:56:52.3 29.002 N; 58.320 E; 10 G; 6.6; 1.1 402 SOUTHEASTERN IRAN. MW 6.6 (HRV), 6
(GS). MS 6.8 (GS). ME 7.1 (GS). Mo 8.8*10**18 Nm (HRV), 6.6*10**18 Nm (GS), 8.8*10**18 Nm (PPT). Es 9.
(GS). At least 30,000 people killed, 30,000 injured, 85 percent of buildings damaged or destroyed and infrastru
in the Bam area. Maximum intensities IX at Bam and VIII at Baravat. Felt (V) at Kerman. Surface faulting obser
Fault between Bam and Baravat. Maximum acceleration of 0.98g recorded at Bam. A detailed report on this earthquake can
be obtained from the International Institute of Earthquake Engineering and Seismology (IIEES), online at http:/
/www.iiees.ac.ir/English/Bam_report_english.html (neic)

	Ном.	Место	Дата	Вр. мест	Долгота	Широта	Магн.	Глуб	Погибло расч	Погибло фак	Ранено расч	Ранено факт	
1	1126	Iran_neic	26.12.2003	5	58.27	29.01	6.7	33	18 - 221	30000	110 - 1008	30000	DEC
3	1126	Iran_gs_ras	26.12.2003	4	58.38	29.24	6.8	33	417 - 3168		1247 - 10776		
4	1126	Iran_emsc	26.12.2003	4	58.34	29.05	6.8	30	1201 - 6939		2751 - 18661		
5	1126	Iran_bgs	26.12.2003	4	58.27	29.01	6.7	33	50 - 862		342 - 4445		
6	1126	Iran_iiees	26.12.2003	4	58.38	29.08	6.5	13.2	6795 - 25035		19085 - 38122		
7	1126	Iran_neic_27_12	26.12.2003	4	58.288	28.99	6.5	10	2853 - 13200		6486 - 27926		
8	1126	Iran_neic_significant	26.12.2003	4	58.32	29.002	6.6	10	6094 - 23346		16700 - 38041		
9	1126	Iran_iiees_recon_team	26.12.2003	4	58.38	29.08	6.5	8	11256 - 37099		33717 - 45066		

Краткая информация по населенным пунктам

Нас. пункт Bam

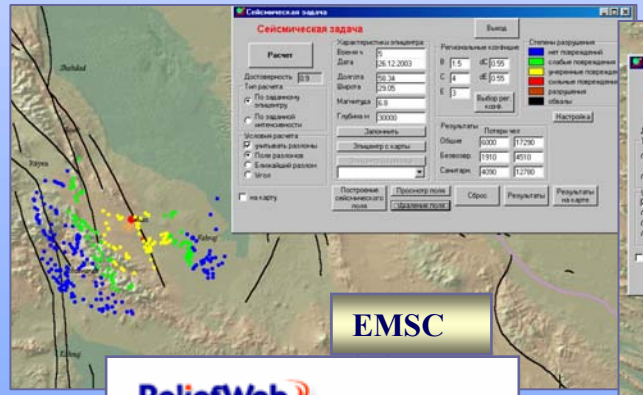
Ср. ст. повреждения 4.75 | Относительный мат. ущерб 0.95

Общая численность привлекаемого личного состава 63 920

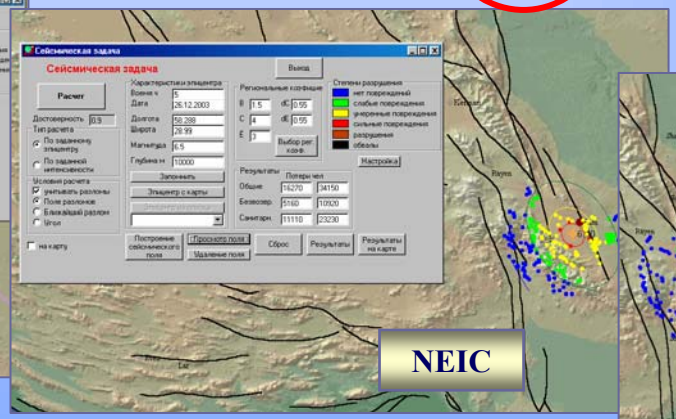
Выход списка | Подробная информация

Нас пункт	Адм. единица	Населен. тыс чел	Безв потери	Сан.тяж потери	Сан ум. потери	Сан.лег потери	Легкие повр-я	Умер. повр-я	Тяжел. повр-я	Разру-шения	Обва-лы	Реал. инт-ть
Bam		80.000	20 - 29420	10 - 10960	40 - 11580	20 - 16360	0.000	0.008	0.034	0.123	0.828	8.750
Douletabad		1.500	110 - 230	47 - 120	55 - 120	140 - 210	0.017	0.096	0.241	0.318	0.223	7.780
Bore		0.349	70 - 130	42 - 48	45 - 50	65 - 70	0.000	0.039	0.135	0.269	0.557	8.750
Efikan		0.349	70 - 130	42 - 48	45 - 50	65 - 70	0.000	0.039	0.135	0.269	0.557	8.750
Poshtrud		0.349	70 - 130	42 - 48	45 - 50	65 - 70	0.000	0.039	0.135	0.269	0.557	8.750
Berevat		0.349	70 - 130	42 - 48	45 - 50	65 - 70	0.000	0.039	0.135	0.269	0.557	8.750
Cheholcherag		0.349	70 - 130	42 - 48	45 - 50	65 - 70	0.000	0.039	0.135	0.269	0.557	8.750
Bervat		0.349	70 - 130	42 - 48	45 - 50	65 - 70	0.000	0.039	0.135	0.269	0.557	8.750
Nartij		0.349	65 - 120	36 - 45	39 - 47	60 - 70	0.007	0.074	0.197	0.310	0.413	8.590
Jafarabad		0.349	55 - 100	29 - 40	31 - 42	50 - 65	0.019	0.121	0.247	0.348	0.265	8.310
Pechem		0.349	43 - 85	23 - 35	25 - 37	45 - 60	0.044	0.182	0.290	0.381	0.102	8.170
Haje-Esker		0.349	38 - 75	19 - 33	21 - 35	41 - 55	0.065	0.211	0.310	0.392	0.023	8.010
Kork		0.349	33 - 65	16 - 30	18 - 32	38 - 50	0.089	0.237	0.329	0.396	-0.051	7.930
Hekenesun		0.349	23 - 47	10 - 24	11 - 26	29 - 44	0.147	0.282	0.366	0.378	-0.173	7.750
Mohammedabad		0.349	23 - 47	10 - 24	11 - 26	29 - 44	0.147	0.282	0.366	0.378	-0.173	7.780
Durab		0.349	19 - 39	7 - 22	8 - 23	25 - 40	0.177	0.301	0.381	0.355	-0.215	7.690
Fakirabad		0.349	15 - 33	5 - 19	6 - 20	22 - 35	0.215	0.320	0.392	0.324	-0.251	7.520
Nezamabad		0.750	11 - 26	1 - 20	2 - 21	20 - 39	0.302	0.391	0.355	0.160	-0.209	7.180

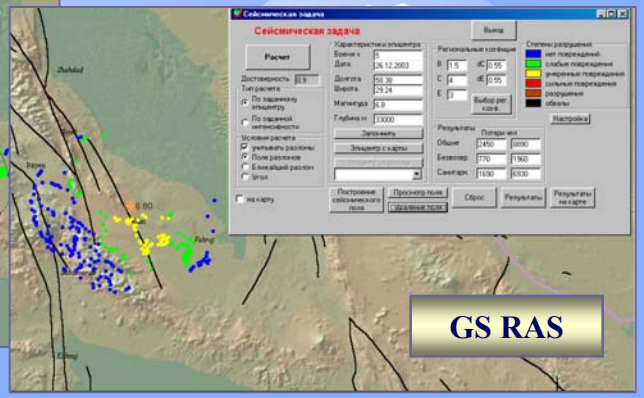
Запись: 1 из 95



EMSC



NEIC



GS RAS

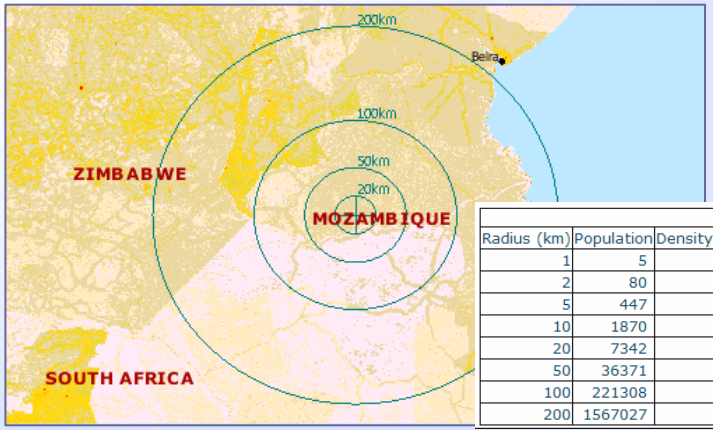
ReliefWeb

Source: Agence France-Presse
Date: 22 Jul 2004

Late last month Iranian authorities revised to 26,271 the number of dead from the December 26 quake, which Bam officials had earlier said killed 43,000.

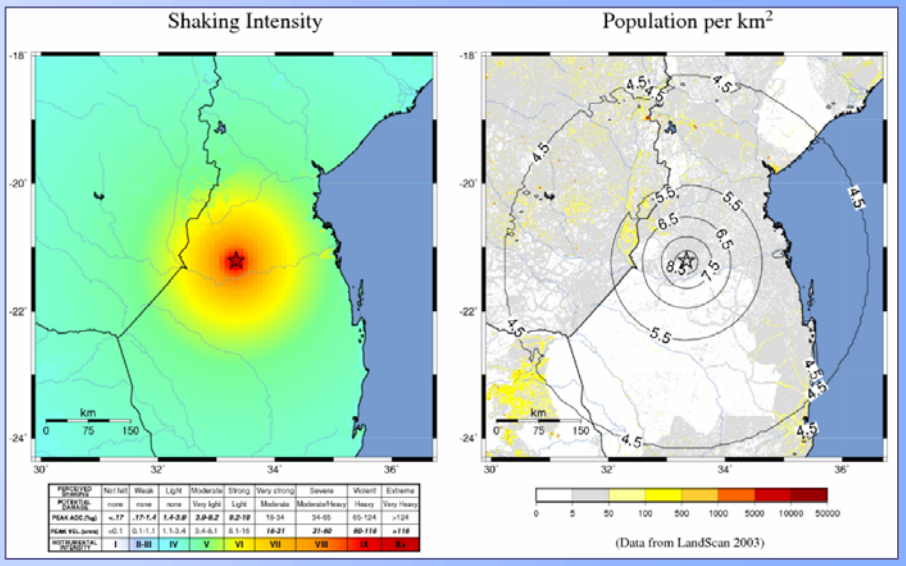
ESTIMATION OF HUMAN IMPACT DUE TO THE 22 FEBRUARY, 2006 EARTHQUAKE IN MOZAMBIQUE

Population exposed to shaking	
MMI Intensity	Population
X	1,000
IX	8,000
VIII	32,000

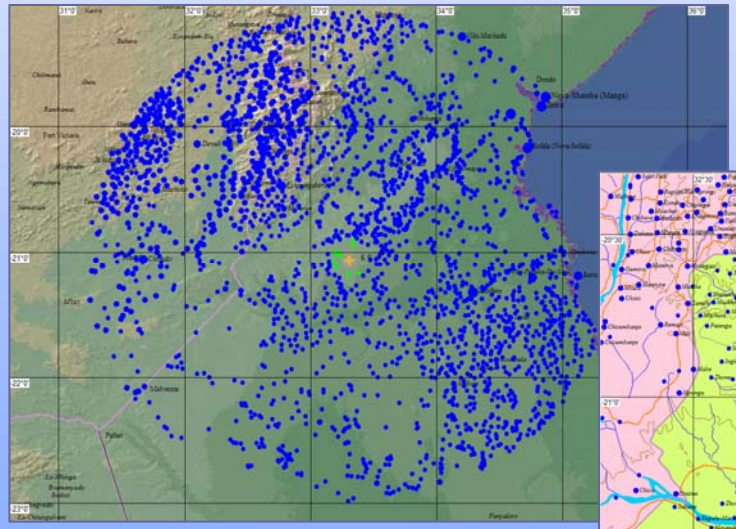


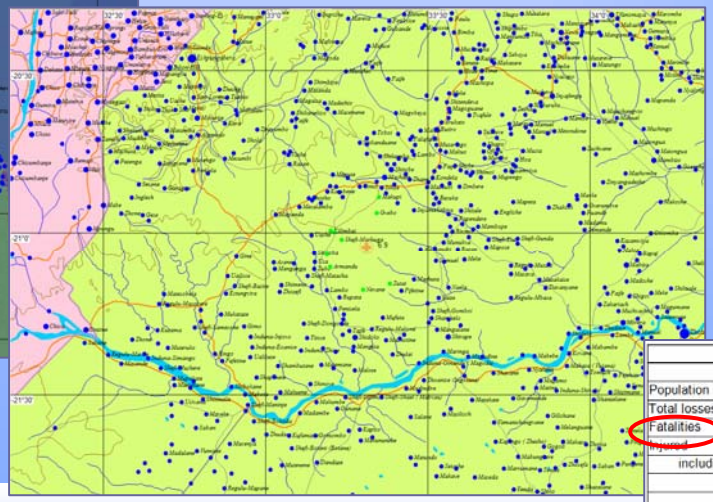
Radius (km)	Population	Density (people/kmI)
1	5	5
2	80	6
5	447	5
10	1870	5
20	7342	5
50	36371	4
100	221308	7
200	1567027	12

JRC Alert Tool



PAGER System





EXTREMUM System

Characteristics	Values
Medical Situation	
Population in striken area, persons	2 922 206
Total losses, persons	23 - 289
Fatalities	2 - 43
Injured	21 - 246
including extremely heavily injured	0 - 43
heavily injured	0 - 43
slightly injured	21 - 160

As a conclusion it should be noticed that the researches carried out within the Russian Federal Programs during more than 10 years, allowed to develop Procedures and a Tool for multi-hazard risk assessment and expected damage and casualty estimation in “emergency” mode. These procedures and tool have been tested under the Council of Europe's Eur-OPA Major Hazards Agreement, as long as earthquake risk is concerned

For further development of the tool, joint efforts are highly desirable, first of all for the creation of a knowledge base about past event impact, which is necessary for calibration of the tool. In addition, for eliminating, as far as possible, the uncertainties in databases on population, building stock and parameters of simulation models, significant joint efforts are required

Existing models for hazard, damage and loss assessment should be improved by joint efforts of the scientific community.

Application of concurrent methods developed within PAGER, EXTREMUM and other systems, may increase significantly the reliability of expected loss estimations

It would be useful to integrate the upgraded tools into a Global Disaster Alert and Coordination System which should develop basing on initiatives by OCHA, JRC and other partners

Thank you for the attention

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