A high level of losses caused by natural disasters, typical for majority of countries in recent years, has resulted in a development of a number of national and international programs aimed at a mitigation of impacts and reduction of damages inflicted. Announced by UN "Decade of Combating Natural Disasters" has activated this process. An efficiency of the developed measures essentially depends on properly selected strategy of combating, reveal and analysis of reasons of the high losses.

In recent years, there was indicated in literature that a number and extent of natural disasters are increasing. An analysis of such events occurred on the Russian territory shows that there exist certain grounds for such a statement. Thus, in 1993 there was indicated an excess of a number of hydrometeorological phenomena and their extent as compared with average values for the last 7 years (see Table 1). Elemental Hydrometeorological phenomena on the Russian territory in 1993 have been linked mainly with marine phenomena and raising of a water level in the rivers above the critical points. Marine hazardous phenomena have been caused primarily by strong winds and waves, raising coast waters. In 1993 there were registered 48 such events, 70% of them taking place in fall and winter.

In addition to elemental hydrometeorological phenomena, in 1993 there were indicated such hazardous natural disasters as earthquakes, descent of snow avalanches and mud flows, and landslide processes.

There occurred 19 earthquakes, a majority of which has taken place on the Asian territory of the country, did not cause essential losses and damages. Snow avalanches descended in a region of the Northern Caucasus; they have been of various intensity and accompanied by human victims (perished: 29, injured: 10 persons), losses of livestock, blocking of the roads. A snow avalanche descent has occurred also in Kamchatka region.

Mud flows took place in April and May in the Northern Osetia. Landslides occurred in Karachaevo-Cherkesiya in April have not entailed significant effects but in June landslides blocked the waterway of the large Stavropol channel playing an important role in a survival and economic activity of the region.

In Dagestan in April a landslide destroyed 18 buildings and social structures. In June in a district centre Dalym, a landslide caused damages of buildings, economic constructions, a bridge, portion of roads and a water supply line.

Many natural elemental phenomena cause essential damages to the environment and technosphere, resulting in contagious diseases among a population, flooding of territories, damage of water and land resources, forests, animal world, etc.

In ranging natural catastrophes and effects thereof according to losses suffered by national economy it is widely used statistic analysis on the base of calculating mean long-term values of damage degree or casualties number. However this approach is faced with certain difficulties conditioned by insufficient statistic data as well as by the fact that standard deviations (root-mean-square errors) relative to mean values of analyzed indices are too large. This effect occurs in ranging natural catastrophes on the base of international statistic data as well as in using national data as a result of it the confidence intervals are overlapped and mean long-term values of damage degree become unreliable. Such large fluctuations in damage indices in practice result in fact that in ranging-catastrophes as a rule, are marked by their latest

considerable effect. The reasons for this significant uncertainty in mean long-term values of damages resulted from natural catastrophes require some additional investigations but currently some definite conclusions may by made.

First, as the investigations of many authors demonstrated the real character of damage value distribution substantially differs from Gauss distribution. Thus mean values and their standard deviations may not adequately describe the used statistic data. They should be necessarily replaced by other statistic characteristics. At present it is difficult to reveal such characteristics meeting the requirements of practice (simple to obtain) and theoretical representations of the processes investigated. Meanwhile some considerations may help in finding such characteristics.

First of all non-linearity and strongly expressed non-equilibrium state if investigated processes should be taken into account. As the investigations of a number or earthquakes dependence on their intensity described by Gutenberg-Richter law on electricity demonstrated,

$$\mathrm{Ig}\, N = A - BM$$

where A,B - electricity constants, N - a number of earthquakes with magnitude M, seismic processes possess the property of self-similarity in a wide range of time and space. One may think about self-similarity properties available in other geophysical phenomena resulting in natural disasters-hurricanes, floods, avalanches-taking into consideration their non-linearity and non-equilibrium state. The necessary criteria of self-similarity are not formulated yet, therefore these properties should be revealed electrically in every particular case.

The property of self-similarity is not an only reason for non-adequate description of natural disasters by mean values of their effects. More or less intensive phenomena make substantial contribution to such inadequacy. Thus in analysing earthquakes it is evident that the main contribution in total energy-release, and consequently, in total damage is made by rare major earthquakes. Therefore the mean damage value of earthquakes for a definite period of time will substantially depend on such incidental event as an earthquake of maximum magnitude which took place during this time period. All this results in unstable mean values and unacceptable major error in these mean values.

Even at the most superficial analysis of catastrophic phenomena and disasters caused by hazardous natural phenomena, there can be separated three specific stages:

- a geophysical phenomenon causing a catastrophe;
- an impact on the environment and technosphere;
- aftereffects and damage caused.

At an analysis of genetic relations in this chain of events, the important role belongs to a condition of technosphere, a predisposition thereof to emergencies. In this connection, it should be mentioned that in 1993 on the Russian territory there were registered 765 emergencies of technogenic character, in 192 this number was 990. From a total number of emergencies occurred, including events of social, ecological, natural, and technogenic

emergencies in 1993 amounted 65%, in 1992 -- 64.5%. Thus, this value possesses a certain stability. However, a number of persons perished at technogenic emergencies increased by 20% during a year, and a number of persons injured increased by 28%, i.e. there exists a trend to increasing a gravity of the technogenic emergency impact.

The largest number of technogenic emergencies are the emergencies caused by explosions and fires. The second place occupy traffic accidents, but they occupy the first place with regard to a number of victims. The technogenic emergencies resulting in environmental effects caused by a penetration into the environment of various substances, including hazardous, toxic and harmful for the environment, are of a special concern owing to an extent of negative impact and also to transboundary effects. On the Russian territory in 1993 there were registered 15% of technogenic emergencies from the total number, and in 1992 this value was 17,5% Thus, there is observed a certain stability of a number of environmentally hazardous events among a total number of accidents and catastrophes.

The largest number of environmentally hazardous situations has been linked to petroleum and oil products discharges resulted from the accidents at main pipelines (in 1993 -- 23,4%, in 1992 -- 32,6%), at railway traffic (in 1993 -- 37,4%, in 1992 -- 25,8%), at freight ships (in 1993 -- 10%, in 1992 -- 5,6%). Next follow accidents caused by discharges of ammonia into the environment (in 1993 -- 9,7%, in 1992 -- 5,4%) connected with accidents of tank trucks and at food industry enterprises. Table 2 includes statistical data on the environmentally hazardous emergencies.

A statistical analysis of technogenic emergencies caused by environmental impacts during the last two years (1992, 1993) points to a presence of definite and sufficiently steady trends acting in the present social and economic situation in Russia.

The self-similarity character of damage value distribution, the damage resulted from natural catastrophes was determined by the investigations of a Russian scientist N.V. Shebalin. Thus to obtain the stable estimations of damage from natural catastrophes it is necessary to use the characteristics of self-similar laws of distribution. For these purposes characteristic damage values of events with a given characteristic repetition for instance, one in a century, may be recommended to use. Such a approach is recommended in publication. As the main contribution in a damage is made by more rare intensive phenomena, such value is intended to take the lowest level of a characteristic damage for an appropriate time period.

In estimation of damage an important role is given to the account of all the factors of natural catastrophes effects. The reasons for potential hazard increase may be regional destabilization factors of man-made effects on ecosystems.

To analyze potential danger related to effects of natural hazardous phenomena on technical objects and resulted from it industrial accidents it is necessary to determine cause and effect relations in this complicated cooperative process. Cooperative process, as used here, refers to phenomena related to coordinated interaction of a great number this process individual constituents.

At the same time there is no reason to consider that such a situation would not change as a result of an interaction between hazardous natural phenomena and a technosphere and environment. On the Russian territory, the highest risk of an occurrence of technogenic

accidents and environmental catastrophes is connected to phenomena causing a raise of water level in rivers and in water basins. In April and May, 1993 such phenomena took place in basins of rivers Western Dvina (Tver region), Yaryp-Su, Kuma, and Podkumok (Northern Caucasus), Ural (Orenburg region), Upper Ob (Novosibirsk region, Altaiskii Frai), Tobol (Kurgan and Tyumen regions), Northern Dvina, etc. The water level raise and flooding of the territories caused a desturction of buildings and engineering structures. A risk of destroying pipelines and sites of municipal and industrial waste damping is increasing significantly. Tremendous quantities of harmful and hazardous substances can penetrate water basins and rivers with the result of essential damage to the water ecosystems up to their destruction and nonrecoverable losses. Carrying out of biopatogenic substances from territories and agricultural (Farming) lands leads to a threat of contagious diseases outburst. Thus, during a flood in May 1993 persons suffered and 76 death cases. Destruction of roads and bridges by floods leads to raising of a risk of traffic accidents. The last, in its turn, leads to increasing of a risk of hazardous and toxic substances penetration to the environment during their transportation. The rise in the Caspian's level which has begun after 1977, is followed by settlements and industrial facilities, and communication facilities flooding, aroused by the flatness of the relief. Rising water level phenomena in Caspian Sea regions entailed a discharge of large quantities of petroleum products and residues of oil products to marine media. This resulted in serious losses of fish resources of Caspian Sea. But these problems are widely discussed.

There is one less well known problem with potentially more significant environmental consequences. This is the delta of the Volga problem. Between the Volga delta which covers the area of about 14000 Km^2 and the Caspian sea there is a bank zone, so called avan-delta, based on one of the terraces. At a time being the avan-delta covers 11000 km^2. More than 70% of this territory is over grown with higher water plants. Up to now the avan-delta was playing the buffer zone role. And it only the last couple of years when the water driving became vivid.

Further sea level rise would significantly complicate environmental and socio-economic situation in the delta region. The river and sea water mixing zone is moving to the north. There is a risk of sea water intrusion and backwater of ground waters of large area. The hydrochemical and hydrobiological modes are changing. And the last is a very significant, as the delta and the bank zone are serving as a natural filter, which regulates the pollution stream coming with river flow to the North Caspian. According to Russian scientists estimations this natural bank located "filter" has already accumulated about 1,7 billion ton of silt, which creates risk of secondary Northern Caspian's waters pollution if there would be some sharp changes in the hydrological situation.

An analysis of many catastrophic phenomena, caused by hazardous natural phenomena impact on a technosphere and environment, has demonstrated that at proper planning of economic activity with due regard to improbable hazardous phenomena numerous negative effects could be avoided. Thus, large-scale environmental impacts could be prevented by taking measures to preventing the harmful and hazardous substances penetration to water objects.

Such a result could be achieved by using administrative limitations to siting the objects with harmful and hazardous substances in a zone of hazardous natural phenomena influences. Forecasting the environmental impacts with due regard for a risk of a technogenic accident due

to various geophysical phenomena, can play a crucial role in selecting a safe site for an industrial object or engineering structure. An important role in preventing environmental and technogenic catastrophes should be played by an ecological expertise provided presently by the Ministry of the Environment Protection and Natural Resources. The State Ecological Expertise acts in accordance with the Russian Federation Law on the Protection of the Environment. Presently, there is under discussion a law on the ecological expertise which adoption should raise the efficiency of this activity.

Table 1

The raise of elemental hydrometeorological phenomena number in 1993 on the Russian territory

Elemental Hydrometeological Phenimena (E-MP)	**Relation of a number of E-MP in 1993 to average number of E-MP for the last 7 years**
Snowstorms	1,3
Days with snowstorms and frosts at temperatures below -40/-50°C	2,5
Days with strong winds and temperature above 30°C	3
Days with light frosts	10

Table 2

Figures characterizing environmentally hazardous technogenic accidents

Substance released into environment during the accident	**Number of accidents (% of the total number of accidents)**	
	1992	**1993**
Gasoline	1,11	2,48
Petroleum residue (mazut)	1,21	1,44
Oil	5,95	5,10
Methan	0,81	1,18
Chlorino	1,01	1,18
Benzone	0,30	0,65
Ammonia	0,81	1,70

Table 3.3

Cause and effects relation matrix of dangerous natural phenomena and man-made accidents effects (part 3)

1.	**Dangerous natural phenomenon**	***Earthquakes***				
2.	**Kind of effect**		Seismic effects on contructions			
3.	**Technical objects, exposed to dangerous natural phenomena effects**	Units of chemical and petrochemical industries, protentially hazardous industries	Stock places of hazardous and toxic substances	Landfills of hazardous wastes	Pipelines (oil, gas, etc.)	Dams and hydroerections
4.	**Scenarios of negative effects from dangerous natural phenomena on technical objects**	Destruction of technical facilities accompanied by explosions, fires, spills of hazardous and toxic substances	Destruction of stock places and depots, spills of hazardous substances into environment	Destruction of protection shells, spills into environment	Pipelines breaks, oil products and gas spills in environment	Destruction of dams, erections, building of water wall
5.	**Effects/Risks** *Levels: *** = strong, ** = medium, *= small, 0 = no risk*					
5.1	Threat of people morbidity and mortality	***	***	***	***	***
5.2	Flora and fauna					
	- Disappearance of populations or reducing their number	*	***	**	*	**
	- Reducing biological types or breaking trophical chain	*	***	**	*	***
	- Disappearance of habitation environments or damaging them	*	***	***	**	**
	- Disappearance of relic and valuable types	*	***	*	**	*
	- Appearance of obstacles on migration ways	0	0	*	0	**
5.3	Soils					
	- Reducing soil quality	**	**	***	***	***
	- Washing off nutrients	0	0	0	0	**
	- Landscape changing	0	0	0	0	**
5.4	Degradation of air quality	***	***	0	***	0
5.5	Water					
	- Reducing water quality	***	***	***	***	***
	- Water resources depletion	0	0	0	0	**
	- Changing water resources quality and performance	0	0	0	0	***
5.6	Buildings and constructions			0	*	**
	- Buidlings and constructions	*	*			
	- Monuments of culture and history	*	*	*	*	**

Table 3.2

Cause and effects relation matrix of dangerous natural phenomena and man-made accidents effects (part 2)

1.	**Dangerous natural phenomenon**	***Hurricanes (strong winds)***					
2.	**Kind of effect**	Strong wind loads, wind-iniatiated waves)					
3.	**Technical objects, exposed to dangerous natural phenomena effects**	Units of chemical and petrochemical industries, protentially hazardous industries	Stock places of hazardous and toxic substances	Dams and water basins	Port erections and oil depots	Transport and railway transport, ships	Landfills of industrial and household wastes
4.	**Scenarious of negative effects from dangerous natural phenomena on technical objects**	Destruction of technical facilities accompanied by explosions, fires, spills of hazardous and toxic substances	Destruction of stock places and depots, spills of hazardous substances into environment	Dams breaks and building of water walls	Destruction of port depots and oil depots	Transport accidents, ship wrecks transporting hazardous cargo	Destruction of protection barriers, discharge of substances
5.	**Effects/Risks** *Levels: *** = strong, ** = medium, * = small, 0 = no risk*						
5.1	Threat of people morbidity and mortality	***	***	***	***	***	***
5.2	Flora and fauna						
	- Disappearance of populations or reducing their number	*	***	**	*	**	***
	- Reducing biological types or breaking trophical chain	*	***	**	*	**	***
	- Disappearance of habitation environments or damaging them	*	**	***	***	***	*
	- Disappearance of relic and valuable types	*	***	*	*	*	***
	- Appearance of obstacles on migration ways	0	0	**	*	*	0
5.3	Soils						
	- Reducing soil quality	**	**	***	*	***	***
	- Washing off nutrients	0	0	***	0	0	0
	- Landscape changing	0	0	***	0	0	0
5.4	Degradation of air quality	***	***	0	*	***	0
5.5	Water						
	- Reducing water quality	***	***	***	***	***	***
	- Water resources depletion	0	0	**	0	0	0
	- Changing water resources quality and performance	0	0	***	0	0	0
5.6	Buildings and constructions						
	- Buidlings and constructions	*	*	**	***	*	0
	- Monuments of culture and history	*	*	**	*	*	*

Table 3.1

Cause and effects relation matrix of dangerous natural phenomena and man-made accidents effects

1.	**Dangerous natural phenomenon**	***Water level raise (floods)***			
2.	**Kind of effect**	Flooding of territories			
3.	**Technical objects exposed to dangerous natural phenomena effects**	Hydro installations and anti-flooding constructions	Pipelines (oil and gas, etc.)	Stock places of fertilizers, oil-products and other hazardous and toxic substances	Landfills of hazardous industrial an household wastes
4.	**Scenarios of negative effects from dangerous natural phenomena on technical objects**	Destruction and breaks of dams, building of water walls	Pipeline breaks, spills of oil and gas into environment	Destruction of erections, melting and discharge of toxic and hazardous substances into water resources and ambient air	Destruction of protection barriers and washing hazardous wastes into water bassins
5.	**Effects/Risks**				
	*Levels: *** = strong, ** = medium, * = small, 0 = no risk*				
5.1	Threat of people morbidity and mortality	***	***	***	***
5.2	Flora and fauna				
	- Disappearance of populations or reducing their number	**	*	***	***
	- Reducing biological types or breaking trophical chain	*	*	***	***
	- Disappearance of habitation environments or damaging them	***	**	**	*
	- Disappearance of relic and valuable types	*	**	***	***
	- Appearance of obstacles on migration ways	**	0	0	0
5.3	Soils				
	- Reducing soil quality	***	***	***	***
	- Washing off nutrients	***	0	0	0
	- Landscape changing	***	0	0	0
5.4	Degradation of air quality	0	***	***	0
5.5	Water				
	- Reducing water quality	***	***	***	***
	- Water resources depletion	*	0	0	0
	- Changing water resources quality and performance	***	0	0	0
5.6	Buildings and constructions				
	- Buidlings and constructions	***	*	*	*
	- Monuments of culture and history	***	*	*	*