



ECOLOGICAL RISK ASSESSMENT AND RISK ANALYSIS

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If all seems too easy,
it unmistakably
proves that the
worker has very
little skill and that
work is above his
understanding.
Leonardo da Vinci

Main parts

- 1. Main definitions
- 2. Strategical risks for Russia
- 3. Risk and hazard classification

A photograph of an industrial facility, possibly a power plant or refinery, with several tall smokestacks emitting thick plumes of white smoke into a clear blue sky. In the foreground, there is a tall, multi-story building with a grid-like facade. The ground in the foreground appears to be a field or a construction site with some vegetation. The overall scene suggests an industrial environment with potential environmental impacts.

**ECOLOGICAL RISK ASSESMENT
AND
RISK ANALYSIS**



Н.А. Осипова

ТЕХНОГЕННЫЕ СИСТЕМЫ И ЭКОЛОГИЧЕСКИЙ РИСК



Учебники Томского политехнического университета

ИЗДАТЕЛЬСТВО ТПУ





МЫ? ПРИДЕМ? К ПОБЕДЕ? КОММУНИСТИЧЕСКОТО? ТРУДА!



The science of risks as the new interdisciplinary sphere of knowledge

We broke the world to pieces, named *them disciplines and tried to geometrically isolate them one* from another. As the result after 12, 16 and even 20 years of training the majority of trainees are graduated without deep and across-the-board understanding of unity of things. This has grave consequences for them and for the planet as a whole. (**George Ord**)



Main definitions

- **DISASTER** - accident or a natural catastrophe that causes great damage or loss of life
- **NATURAL HAZARD** – process, quality or state of some parts of lithosphere, hydrosphere, atmosphere or space, harmful to people
- **Safety** – a state of security of essential interests of person, society, country from any threats



Definitions of Risk

During last years the term “RISK” became very popular in different areas: engineering, economics, environment, management, biology & medicine, etc.

Different authors use this term in different senses.

Below we consider some definitions of risk in different sources.

Definitions of risk

There are many definitions of *risk* that vary by specific application and situational context.

The one is **that risk is an issue, which can be avoided or mitigated**

(where an issue is a potential problem that has to be fixed now.)

Risk is described both qualitatively and quantitatively.

Definitions of risk

Qualitatively, risk is proportional to both the expected losses which may be caused by an event and to the probability of this event. Greater loss and greater event likelihood result in a greater overall risk.





Definitions of risk

- In common risk is the chance that something undesirable will happen.
- Risk is described as a situation which would lead to negative consequences.
- *Risk* is considered as an indicator of threat, or depends on threats, vulnerability, impact and uncertainty.

Definitions of risk

Risk = (probability of event occurring) \times (impact of event occurring).

Risk = (probability of an accident) \times (losses per accident).



Strategic Risks in different fields of human activity

Sphere of vital activity	SR Parameters
Political	Political damage (degree of political instability, terrorist threats, level of defensibility of the country, level of trust to authorities by the population)
Economic	Economic damage (non-received gross national product, falling of performance level, investment into fixed capital, etc.)
Social	Social damage (decrease of average life expectancy, level of untimely death, share of the population below the breadline, etc.)
Natural - technogenic	Frequencies of emergency situations, economic and social losses (number of victims, number of people with the broken conditions of life, economic damage)
Scientific and technical	Scientific and technical damage (share of assignments for science in gross national product, share of hi-tech production)

Strategic risks in natural and man-caused spheres

These **risks** nowadays become of strategic character in connection with global changes of inhabitancy, development of technosphere and increasing scales of acts of nature. Principal **risks** for Russia in these spheres are:

1.Risks of development of dangerous natural phenomena (earthquakes, hurricanes, landslips, floodings, karst, forest fires, etc.) (risk importance 1.00);



2. Risks of failures and accidents at potentially dangerous objects (0.94);

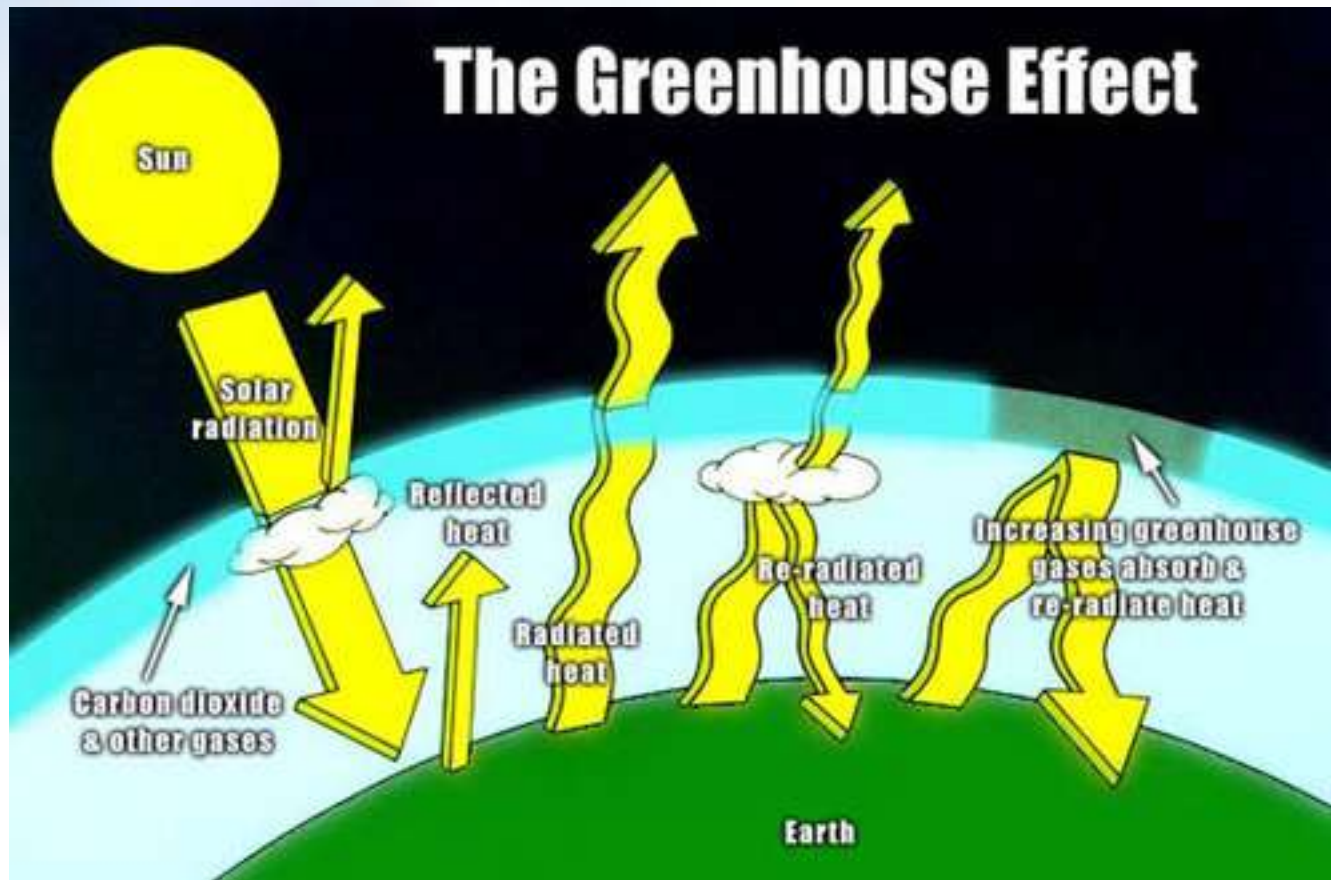


The nature itself from one side and the humans' activity from the other are sources of risks. The exhausts of large chemical enterprises, breaks in oil- and gas- pipelines etc. represent significant hazard and lead to high damage for population and environment.

3. Environmental contamination (0.43);



4. Risks connected with global change of climate, degradation of environment, planetary risks (0.24);

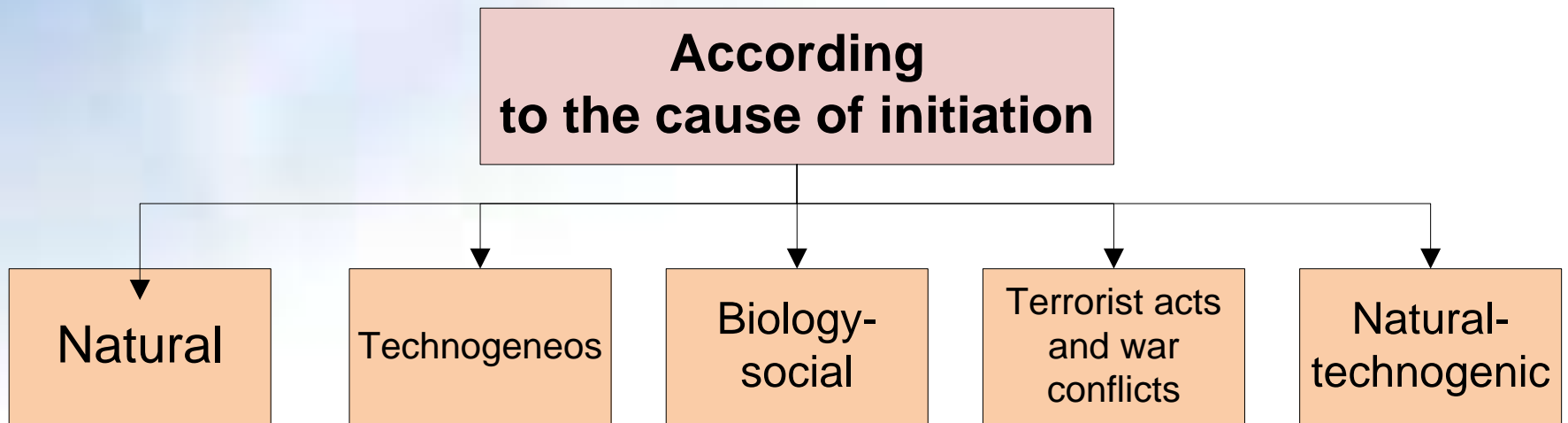


5. Exhaustion of natural and biological resources (0.15).



Risk and hazard classification

1.





Vulcano eruption

Natural risks are risks conditioned by catastrophic phenomena of the nature.



Technogenic risks are risks connected with danger resulting from industrial objects and threatening a man and nature in the process of industrial activity.

Poisonous wastes were thrown stealthily into China river Manue which is a tributary of Sungary river. Red foamy spot stretched for 5 km. Sungary river falls into Amur river. Anyline and ksilol being in water cause dizziness, nausea, impact on liver and kidneys.

Citizens of 2 million Czilinn were forbidden to come close to the river



- Potato beetle invasion occurred in Russia for the first time 7 years ago

- **Biology-social risks** are risks resulting from the threat of infectious disease and group people's poisoning; infectious diseases of food-producing animals; agricultural plant pest diseases.

Avian influenza



Natural-technogenic risk

- Natural-technogenic risks are natural man-induced hazards. Thus, the earthquake could be a result of combination of natural and technogenic processes, induced by development of oil deposit.

- On the contrary, technogenic accidents and catastrophes taking place nowadays could result from natural disasters. For instance, as a result of an earthquake a nuclear reactor or hydroengineering unit could be destroyed, the consequence of which would be radioactive contamination and area flooding, correspondingly.

The earthquake and tsunami, 2011

The 2011 Tohoku earthquake and tsunami caused ruptures in multiple water mains originating from the city's water supply. Train service was also stopped due to damage caused to railway infrastructure.



Fukushima

Fukushima City is about 63 kilometres north-west of Fukushima I Nuclear Power Plant, the site of the nuclear accident that followed the tsunami. Although outside the nuclear accident exclusion zone, the levels of radiation in the city caused residents to remain indoors more, reducing economic activity.



- The Fukushima disaster is the largest of the 2011 Japanese nuclear accidents and is the largest nuclear accident since the 1986 Chernobyl disaster. Japanese officials initially assessed the accident as Level 4 on the International Nuclear Event Scale (INES) despite the views of other international agencies that it should be higher. The level was successively raised to 5 and eventually to 7, the maximum scale value.



- Many countries have advised their nationals to leave Tokyo, citing the risk associated with the nuclear plants' ongoing accident. International experts have said that a workforce in the hundreds or even thousands would take years or decades to clean up the area.

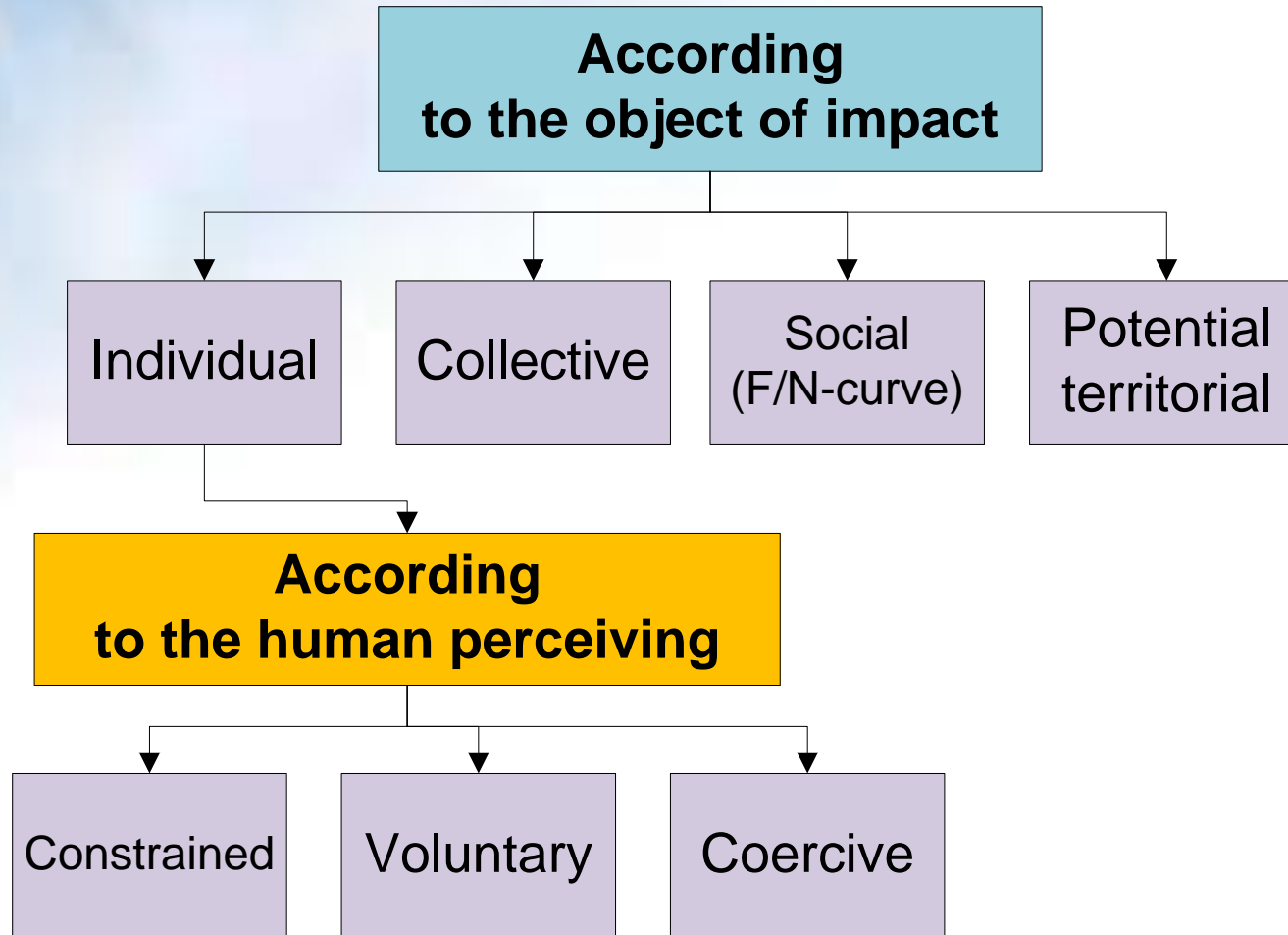




As a result of the landslide the part of soil covered the rail road at 1922 km of the Lazarevskoe-Chemitoqvadge span.

Risk and hazard classification

2



Individual risk

- is a frequency of the affections of a single individual as a result of the danger factors investigated.

$$R_{\text{ind.}} = N_{lo}/N,$$

where N_{lo} - number of lethal outcomes in a group of a number N which is subjected to a risk

Collective (integral) risk

- Collective (integral) risk determines the scale of expected consequences of potential accidents for people

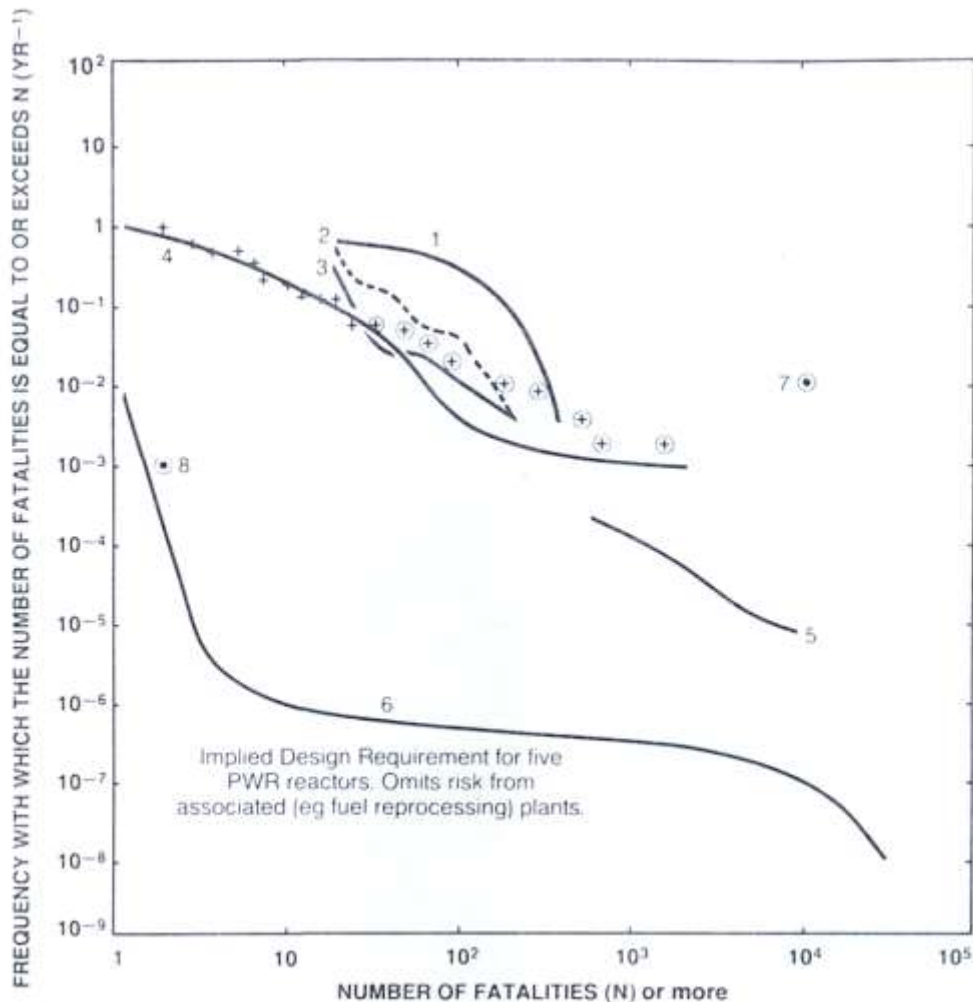
$$R_{\text{col.}} = R_{\text{ind}} \times N_R,$$

where N_R – number of people subjected to a risk

- .

- **Social** (set of numbers or functional relation) is the relation of a number of events, in which the number of injured persons is higher than a certain number, to this certain number of people

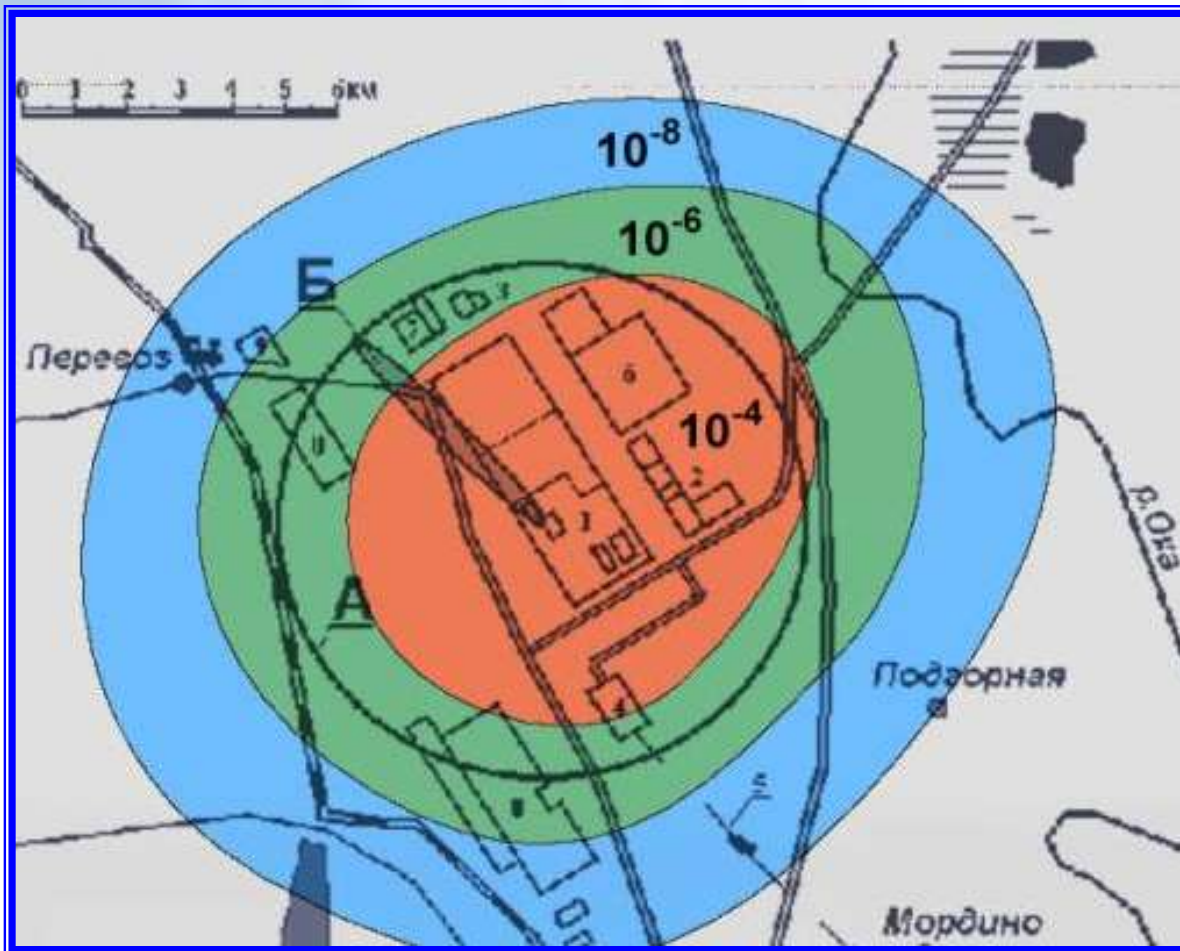
F-N-curve for risks from certain types of hazardous situations



1. Aircraft accidents. 1966-85. UK.
2. Railway accidents. 1946-75. UK.
3. Fires and explosions. 1946-75. UK.
4. All UK Sites involving "major hazard substances".
5. Canvey, after improvements.
6. Five PWR Reactors, conforming to implied design requirements, delayed deaths included.
7. Chernobyl, including delayed deaths (estimated).
8. Three Mile Island, including delayed deaths.

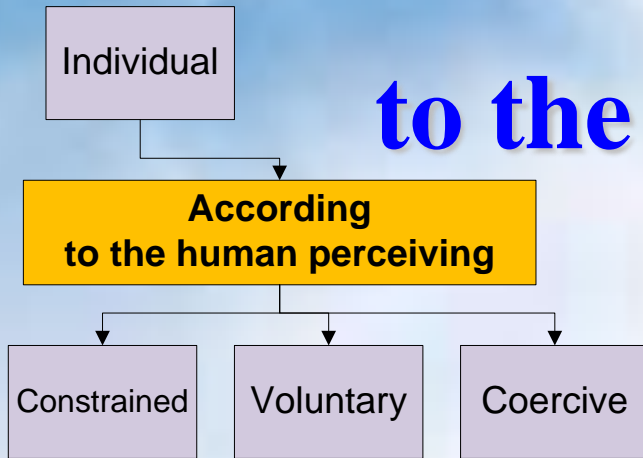
Potential territorial risk

(set of numbers or functional relation) is the space distribution of the frequency of a negative influence of a certain level



Distribution of potential risk on territory near to object on which failures with large emission of toxic substances are possible. By figures at isolines value of frequency of destruction the person (1/year), A – zone border of the people defeat calculated for scenarios of failure with identical weight of emission in all directions of a wind, Б – a zone of defeat for the separate scenario with the given wind direction.

3 According to the human perceiving



- **Compulsory** – for example, habitation near to a dangerous oil refinery enterprise



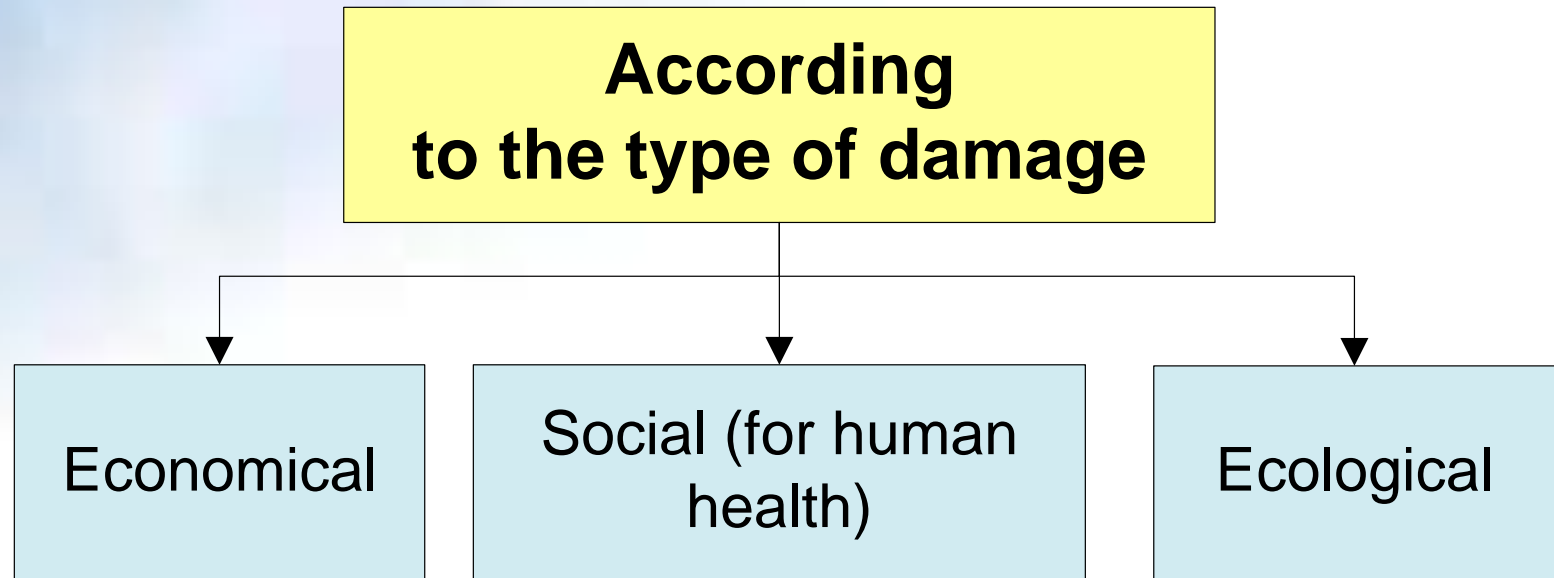
- **Voluntary** – extreme sports and tourism

Constrained are connected with dangerous occupation (for example, working in coal mine)



Risk and hazard classification

4



According to the type of damage

- **Economic damage** is a financial cost estimation of a negative impact on the economy

Or

is loss of material assets or loss of profit as a result of nature or technogenic accident

Social damage

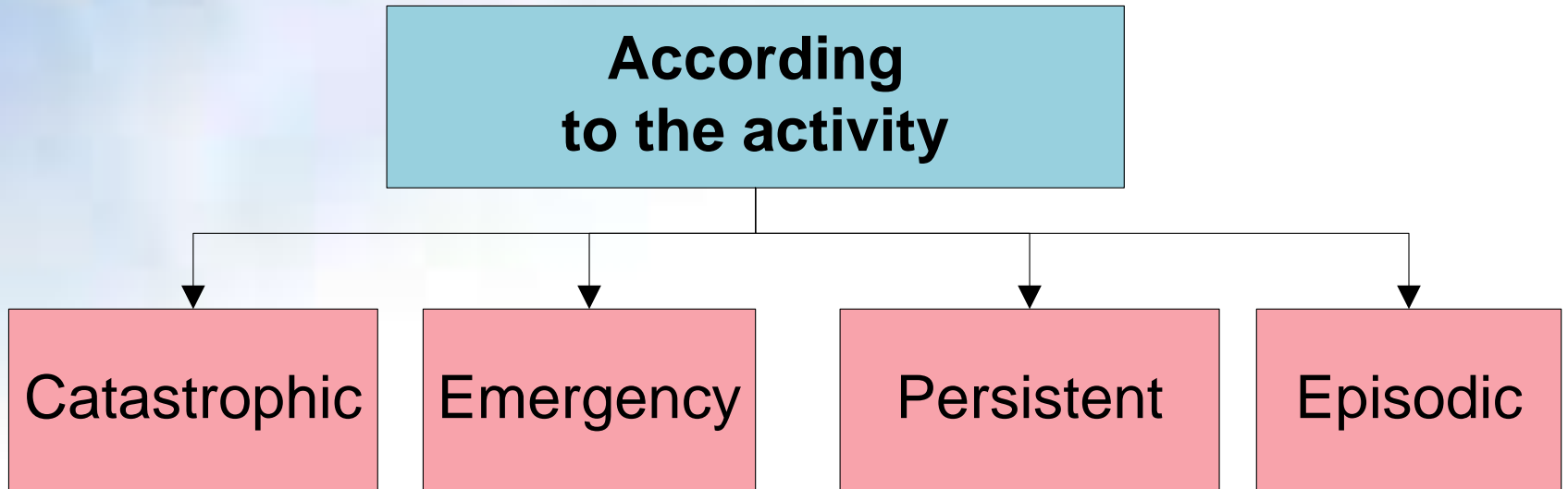
- is a damage or loss of the profit due to the falling-down of life quality, common sickness rate, mortality, decrease of the quality of recreation zones. It can be expressed as the number of sick, injured or died persons as a result of negative effects or in terms of money.

Ecological damage

- is a damage for the environment as a result of the negative impact of both natural and anthropogenic processes which can be expressed in terms of money, as the dimension of polluted area and as quantitative characteristics of damaged ecosystems.

Risk and hazard classification

5





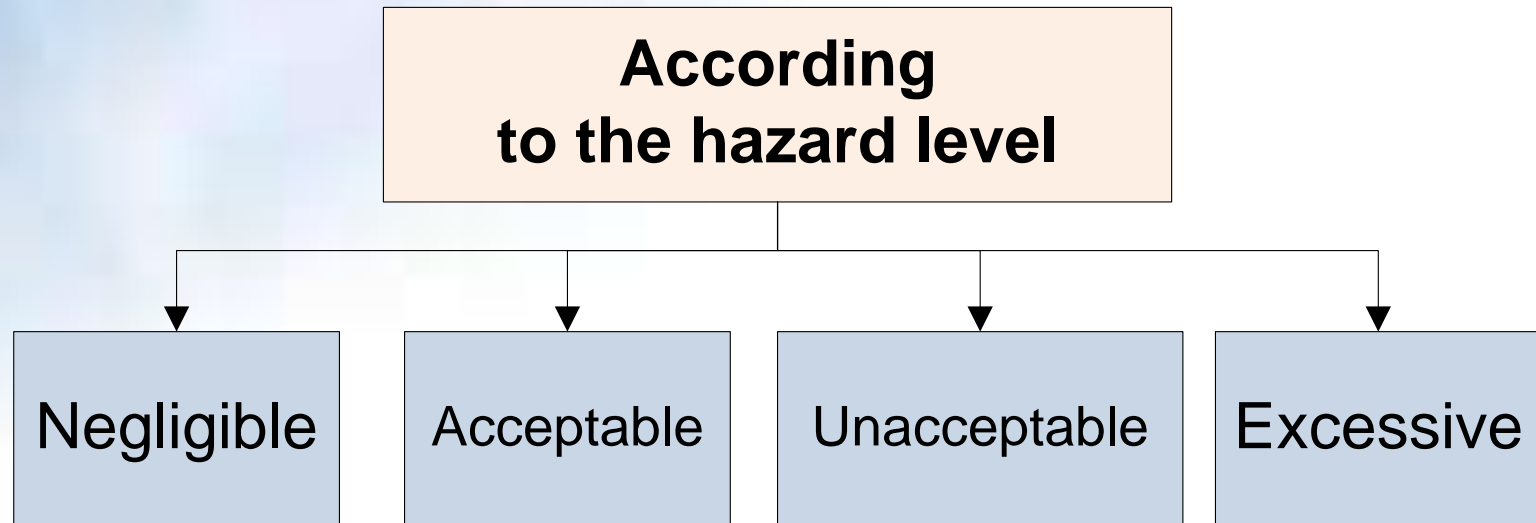
- Daily in the big and small cities of the country toxic clouds of exhaust gases are thrown out from pipes of the industrial enterprises, poisoning atmospheric air, doing a harm to biota, to health of people, to quality of superficial reservoirs and soils

According to the activity

- **Catastrophic risks** are sudden accidents at industry or natural disasters which have mainly destructive effect and are characterized with substantial force
- **Emergency risks** appear as a result of accident (breakage, crash, emergency)
- **Persistent risks** are “creeping”, slow processes which have a paralyzing or exhausting effect
- **Episodic risks** suddenly appear, they are unpredictable in force and form of influence.

Risk and hazard arrangement

6



According to the hazard level

- **Negligible** level is the level of the individual risk which does not lead to the deterioration of the life quality and economical activity, and does not cause a trouble of an individual
- **Acceptable** level is the level of a risk which the society is ready to accept for the sake of certain welfare or benefits in their activity

Or

it is the risk, the level of which is acceptable and reasonable in terms of economical and social considerations.

- **Unacceptable** level is the level of a risk determined by administrative or regulating authorities as the maximum, measures for its elimination are necessary in case it is higher.
- **Excessive** level is the level of the individual risk conditioned by economical activity, which exceeds the maximum permissible level.

The load on the nature came over the potential capacity of biosphere (по Д.Медоузу и др.,2007)



Рис. В-1. Нагрузка на окружающую среду и уровень самоподдержания (потенциальная ёмкость биосферы)

График показывает, что нагрузка на окружающую среду (экологический след) превышает потенциальную ёмкость биосферы с начала 1980-х годов.

GLOBAL ENVIRONMENTAL CONCERNS:

- Population growth
- Climate global change
- Ozone layer depletion
- Loss of biodiversity
- Desertification and deforestation
- Increase of the number of natural disasters
- Pollution of environment (chemical, physical, radioactive etc.)

Impact of chlorofluorocarbons (CFCs) and other ozone-depleting substances (ODS) on human health

Past (and current) emissions of CFCs and ODS result in increases of ultraviolet radiation reaching the Earth's surface which can pose several health effects

- Increase of melanoma and non-melanoma skin cancers;
- Cause or acceleration of eye cataracts development;
- Reduce effectiveness of the immune system;
- Impact on nutrition (e.g. reduced plant yield);
- Damage to ocean ecosystems and reduced fish yield (by killing microbial organisms in the ocean)

Desertification

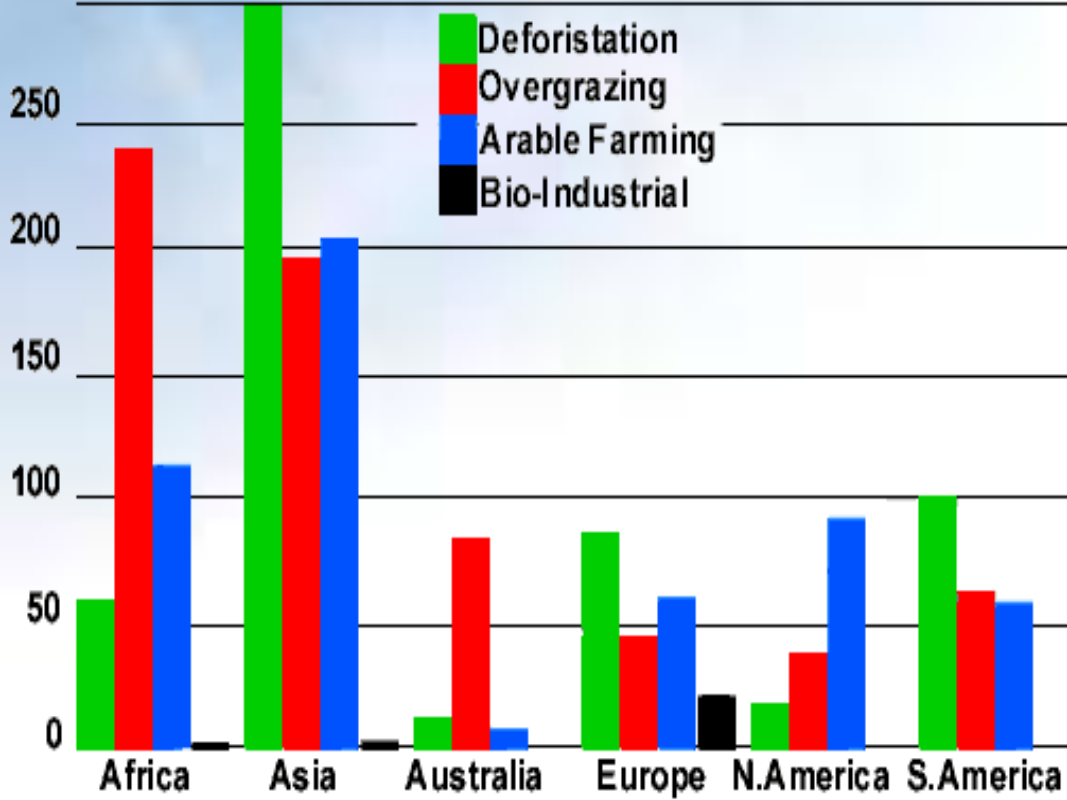


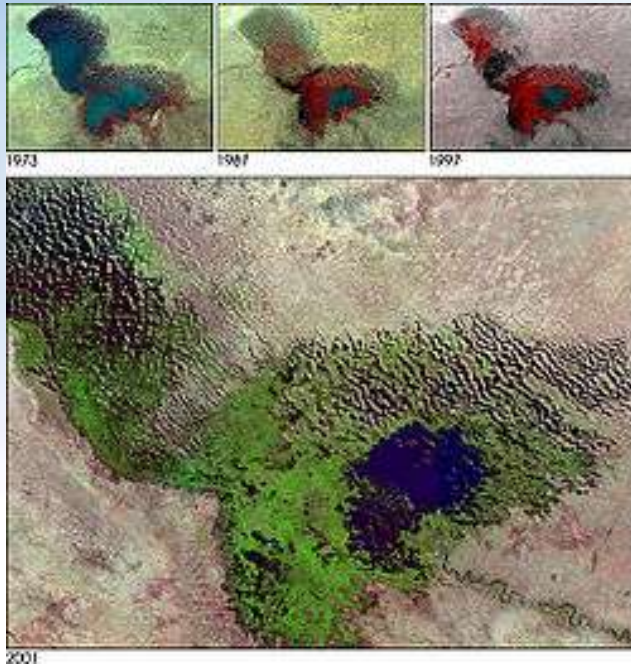
- Desertification is the degradation of land in drylands. Caused by a variety of factors, such as climate change and human activities, desertification is one of the most significant global environmental problems



300 Million Hectares

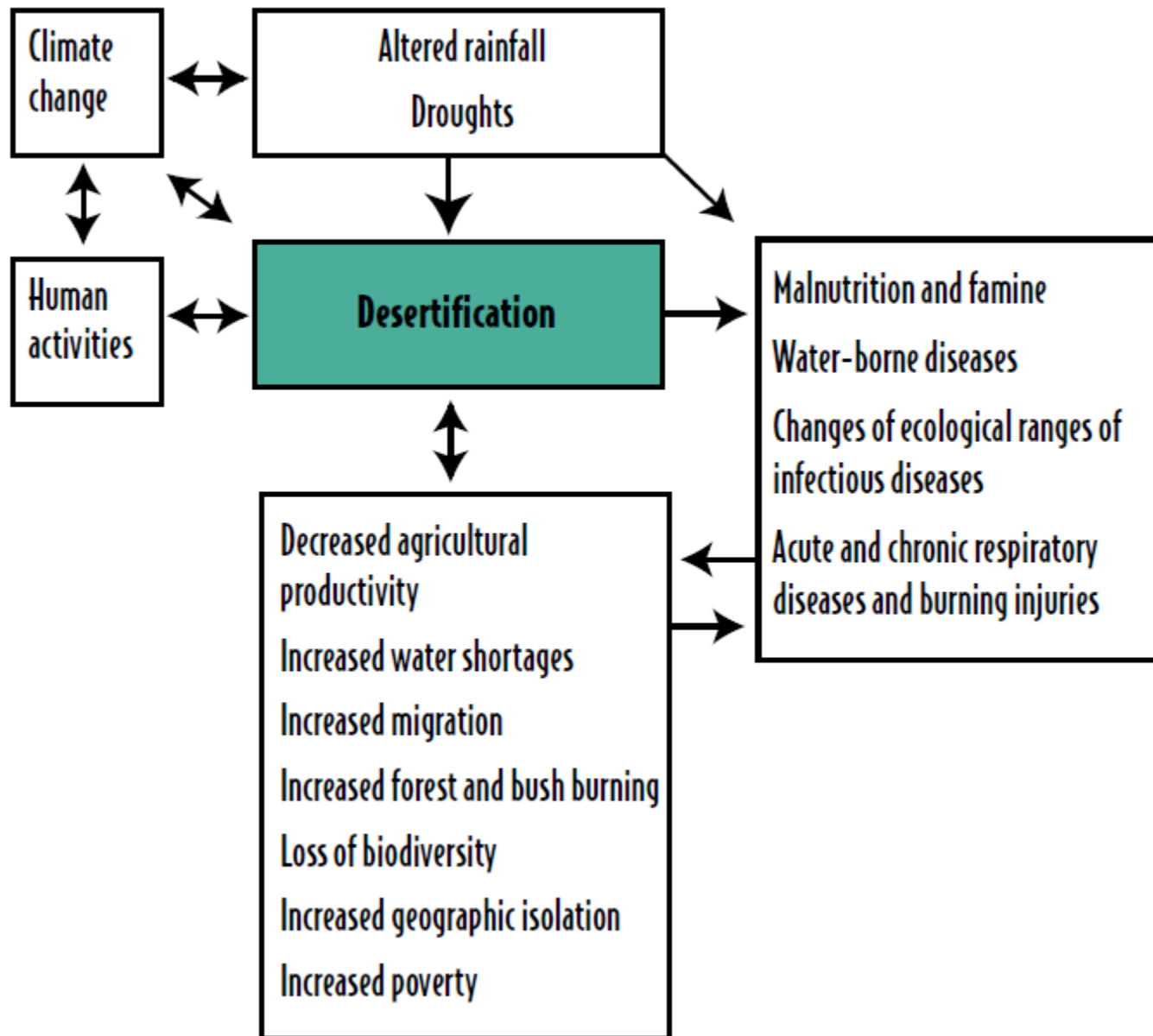
- Deforestation
- Overgrazing
- Arable Farming
- Bio-Industrial





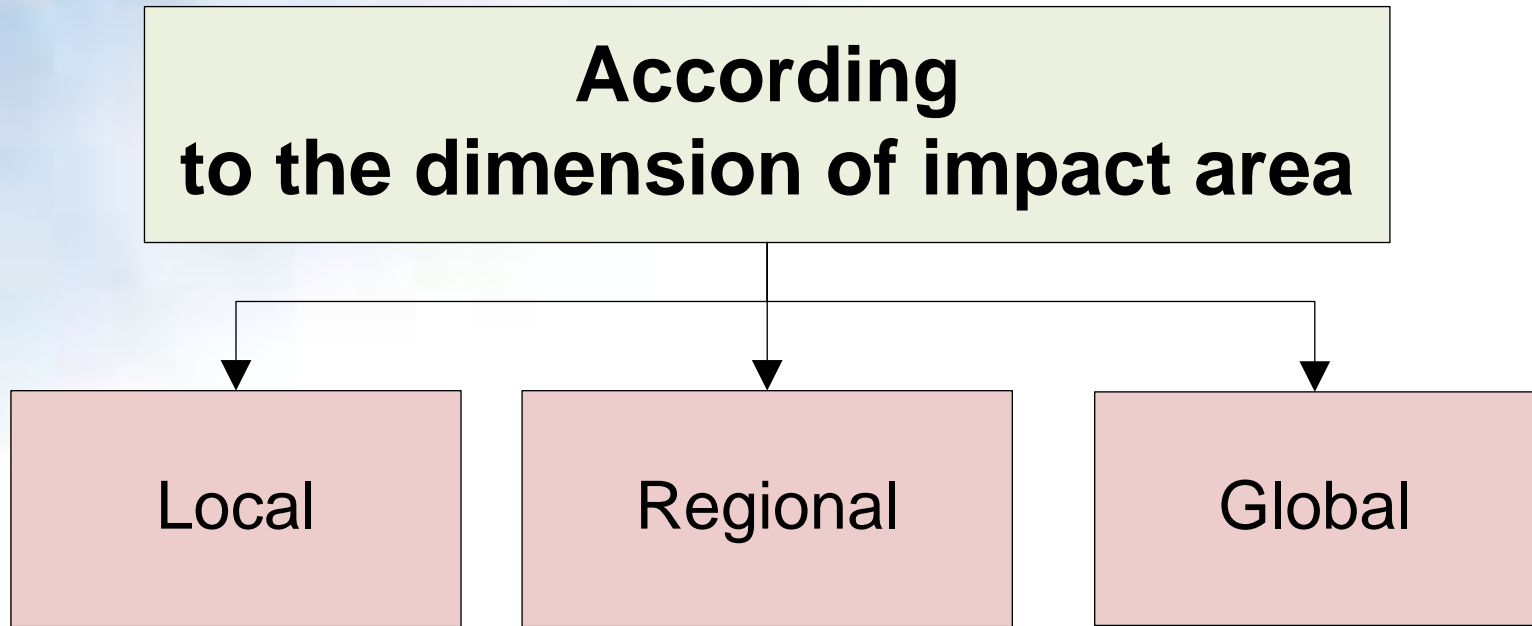
- [Lake Chad](#) in a 2001 satellite image, with the actual lake in blue. The lake has shrunk by 95% since the 1960s.

FIGURE 10: THE HEALTH IMPACTS OF DESERTIFICATION



Risk and hazard arrangement

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Differ in the space distribution, extent of material damage, number of victims and cause of origin.

Risk classification according to the dimension of impact area

Scale	Area distribution	The scale of damage, \$	Death number	Causes
Local	distributed within the limited territories	less than 10^5	up to 1000	engineering
Regional	covers the regions, have a tendency to extend	$10^5 - 10^8$	$10^2 - 10^4$	chemical, engineering, transport
Global	do not have any political or administrative borders			nuclear, military, space rocket complexes, collision with asteroids

Hungary toxic spill



WHAT IS RED SLUDGE?

A toxic spill of mining waste from an industrial plant in Hungary is the worst of its kind in the country's history

- Red sludge is a byproduct of the refining of bauxite into alumina, the basic material for manufacturing aluminum. Treated sludge is often stored in ponds where the water eventually evaporates, leaving behind a dried red clay-like soil.
- Alumina plants are scattered around the world, with the 12 largest concentrated in Australia, Brazil and China. The plant in Hungary ranks 53rd in the world in production, according to industry statistics.

- An estimated 1 million cubic metres of red-coloured sludge, a mixture of water and mining waste including toxic heavy metals like lead, cadmium, arsenic and chromium, spilled from the Ajkai Alumunia refinery about 160KM south-west of Budapest after a dam broke.

Toxic sludge

Hungary's government called the sludge flood an "ecological disaster" that could threaten the Danube and other key rivers.



SOURCE: ESRI

AP

A photograph of a wolf sitting on a rocky outcrop in a mountainous landscape. The wolf is facing left, looking towards the horizon. The background features rolling green hills, a dense forest of evergreen trees, and a clear blue sky. The overall scene is bright and scenic.

Thank you for your attention

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