CLASSIFICATION OF DISASTER IMPACTS ON SOCIAL AND ECONOMIC ACTIVITY

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1. Introduction

Natural disasters impact on social and economical activities breaking its stability and integrity, while social and economical activity impacts on natural environment disturbing its normal "functioning". Hence, it is necessary to obtain beforehand to the extent possible information on the character of such impacts, the conditions of their appearance and development as well as possible unfavourable results and measures to decrease the latter.

With a view to collecting and using materials on problem situations Decision Support Systems (**DSS**) are created. An important place in **DSS** is given to a knowledge base, that is a set of information related to impacts and possible ways of their decrease. **DSS** is based on subject knowledge built on original sources. In the organisation of **DSS** knowledge base, the goal is to create a subject area model that would allow conversion of original knowledge into the subject one, i.e. to be able to expand and update the knowledge base.

2. System analyses research object

2.1. Formalization of information

Nine types of environment and industrial objects relationships can be isolated. Schematic representation of them is given in **Fig. 1**. The last three schemes illustrate situations with a functional impact on environment or social and economical activity aimed at providing stability of social and economical activity with respect to disaster. In such a case classes 7-9 are also marked with time that they are related at the situation with natural environment (**Te**) and social and economical activity (**Tse**). In situation 7 (**Te** and **Tse** are crossed); in situation 8 (**Tse**- earlier than **Te**); in situation 9 (**Tse** - later than **Te**).

Analyses of environment and social and economical activity shows that types of relationships depend on availability, combination and direction of impacts as well as relation of impacts in time. The three last classes delineate such a character of environment and social and

economical activity relationship, to which it is necessary to tend to and for whose providing the systems like **DSS** are created.

Analysis of disaster allows to represent them in generalised, canonic and report forms [2]:

*a)As a result <**Natural Disaster** list>, caused by <**Disasters** list>, over the Territory <list of **Geographic objects**>, from <**Period** beginning> to <**Period** end> on <list of social and economical activity **Object**> take place < list **Impacts**>.*

*b)**Natural Disaster**: <list>; **Prerequisites**: <list>; **Geographic area**: <list>; **Period: (Season)**: <from ... <to...>>; **Object of impact**: <list>; **Consequences**:<list>.*

An example of true message is corresponding to such report [3]: "2-3 September 1986, over the territory of Semipalatinsk, East-Kazakh area, the frosts were observed up to -2° C in the air and up to -3° C on the soil. The reason was - passing of a cold front. Following the cyclone, anticyclone moved into central and eastern regions of the Republic causing the coolness. Over the territory of Golubovskaya, Tavricheskaya, and other areas vegetables and meloncrops had been completely annihilated, and fruit and berry crops- partially damaged. Agriculture had been greatly damaged".

Here **natural disasters** are given as frosts, **Prerequisites** - as messages about reasons. **Period** - 2-3, September, 1986, **Object** of **impact** - agriculture, **Consequences** - information about the fact, that over the **territory** of specific areas agriculture crops are annihilated and damaged. Analysing a great amount of messages about natural disasters for several years makes it possible to come to a certain conclusions on the structure and content of message alike.

2.2. Analysis results of the structure and content of disasters impacts

One message can contain simultaneously several natural disasters; some of them are complex (e.g. snow storm, strong wind + heavy snowfall).

The "reasons" mentioned in messages, can not be considered as such, strictly speaking, but serve as pre-conditions for natural disaster emergence; this being the case, an important role is given to conditions that led to natural disaster development.

Messages on natural disaster contain information about **the parameters of these phenomena's** (air temperature for frosts, speed for strong wind) and their values. The consequences of the hazard phenomenon are defined not only **by critical values** of the parameters, but also by conditions in which natural disasters are realised. That is depending on the conditions of impact, the disaster may be dangerous to different extent. Thus, flood,

characterised by the same level of water, can be a disaster for the settlements in the mouth of a river and for those at hills - of no danger.

Messages about natural disaster prerequisites contain information on **phenomenon** that caused natural disaster; **time** and **place** of its occurrence; **local conditions** and **consequences**.

Consequences are also situations, but with respect to social and economical activity they are characterised by coverage area, time of consequences and disaster conditions. Consequences can be current, delayed and remote in time.

Situations are characterised by different level of **spacial presentation** of situations prequisites occurrence of natural disaster and consequences. The **time aspect** is given through specific date, reference to climatologic, phenologic season, etc.

Messages about the object of impact can be implicit and follow from information about the consequences. The objects can be of different types: plants, building, constructions and such fields as traffic, agriculture, etc.

Characteristics of impacts along with specific values, example, crops' losses by 70%"; contain general estimation - great damage for agriculture.

The functional processes (actions) in social and economical activity can be considered as objects of impacts (growing of plant, transportation of people, transmission of energy, information, etc.).

Consequences as a result of critical impact of natural disaster on objects is considered not only in the context of changes (collapse, disfunctioning of objects) destruction of bridges, loss of crops or component elements; water pipelines rupture, tearing off roofs) but in the context of changing properties of objects as well (reducing mechanical strength of materials, worsening of operating characteristics of instruments).

Natural disaster can have various **consequences** (both in character and scale) if the conditions disaster occur differ. The earthquakes in Spitak and California were of the same type and, though being of much alike, had quite different consequences. If the second one is considered regional distress, the first one - as regional disaster in terms of scale and character of consequences. The main difference was in social and economic prerequisites in which this phenomenon occurred.

The consequences can be current, delayed or remote as well as requisites can also be current and remote. Knowing prerequisites of anthropogenic or any other origin can make it possible to practically realise such a functional impact on social and economical activity or environment that will allow either to prevent or reduce the scale of impact.

Natural disaster can occur without fatal impacts if the object is not available within the area of its occurrence. In this connection we can speak of potentially dangerous or most heigly dangerous phenomenon, hence it is follows that a disaster may not occur. The task of providing the sustainable social and economic development in terms of potential danger is to

increase the resistance of objects to natural disasters: strengthen seismological resistance of (buildings) structures, wind resistance of high voltage transmission line.

Objects of impacts can be more accurately called as objects prone to dangerous impact of a certain disaster. Here we can speak of the universal feature of the object: "tolerance for external impacts". In terms of relationship of social and economical activity- environment the importance of this feature plays the same role as the critical characteristic of natural disaster (wind speed, precipitation amount, level of water rise).

2.3. Descriptions social and economical activity

Consider social and economical activity as a functional system in another plane: its major components - production, life endurance, consumption, wastes storage - impact an environment. The negative impact is felt throughout air, water and soil pollution resulted from developing economic and industrial production. Environmental impact on the processes and resources of production can be manifested as natural disasters along with hazardous impacts (e.g. acid rains) due to the man - made activity.

The conception of sustainable development in social and economic activity as well as in environment in the above given terms means that were is a limit for every type of natural resources consumption of which is to be regulated lest no harm could be done to natural environment suffers an irrevocable changes, it follows that information - ecological monitoring should be implemented.

There is some kind of resources in environment that do not directly participate in life endurance, but whose conservation provide sustainable relationship between social and economical activity and environment. Flora and fauna resources support biodiversity as the basis for life development on our planet. Brittle social and economical activity-environment balance can easily be disturbed if rain is combined with SO_2 emissions (acid rains) and also wind, being not strong though, can significantly enlarge the scale of soil pollution when toxic matters are thrown into the air.

Special attention in environment-social and economical activity relationship is payed to information fluxes - information on environment state, including data on natural disaster and natural resources state.

On the whole, social and economical activity and environment combination can be determined as human beings inhabitation; to make this human environment sustainable we should know norms of consumption of natural resources and limits of impacts for every type on environment. These "norms" and "limits" are to be the component of **DSS** knowledge base.

3. Classification of situations with natural disasters impact on social and economic activity

3.1. Phenomena in natural environment

We start classification with a sign "Natural environment sphere": atmospheric, hydrosphere, lithosphere phenomena's. With this in mind, we start considering natural disasters in this or that class taking as a basis the sphere in which they occur. Thus, tsunami by its origin refer to lithosphere (generated mainly on the sea bottom), but occur in hydrosphere, and, hence in our scheme we assign it to this class proper.

At last most important for our problem area is classification aspect character of dangerous interaction. The following phenomena should be emphasised here: anthropogenic (due to man - made activity) and natural (originated in nature). So phenomena of the last class, are the subject for consideration in situation of class 2.

Every phenomena is characterised by some certain parameters: wind speed, visual range, precipitation duration, waves height, etc. Thus, it is parameter **values** that are the factor determining natural phenomena as dangerous or, as it has already been mentioned more accurately - potentially dangerous. So, wind is determined as potentially dangerous if its speed exceeds certain **critical** value. In case of dangerous impact these characteristic play an important role and that's why are singled out in situation model as independent, though derivative component. The term "derivative" is used on purpose here, since with respect to our classification scheme **parameter** is a component of a phenomena.

The following aspects of parametrization are emphasised: **spatial** (wind direction, current direction, etc.); **intensity** (tendency, speed, etc.); **temporal** (duration, beginning; **practice** (of cloud forms, ice); **internal processes** (cloud water content, convection); **factors of interrelation** with other phenomena (extent of snow cover on the ice, depth of ice submerging, etc.).

Within the frames of the above given scheme, classification of disaster phenomena is made and within some specific type of phenomena it is possible to separate its characteristics (according) to different levels. Thus, we can make out variety of precipitation, clouds types (as phenomenon), etc.

3.2. Social and economic activity

Social and economical activity being an object of unintentional impact on the part of disaster, is at the same time functional system with its components and relations between them that form an entire structure.

First of all, disaster - prone objects can be divided according to the activity sector: industry, gas and oil production and oil refining; transport, civil engineering, etc. within each sector the traditional branch classification takes place. An industry, for example, includes metallurgy, mechanical engineering, chemical and technological industry, etc. Agriculture embraces cattle production, field cropping, etc.

We emphasise such field of activity (untraditional so far) as information whose subject is production, obtaining of information (particularly about environment state) and its purposive use (for decision-making).

Social and economical activity combines three classes that can be isolated in a way: "production systems"(metallurgy, agriculture, etc.), **consumption systems** (of goods, services, energy) and **life assurance** (water-, gas-, electricity - supply), etc.

As for their functioning, social and economical activity objects can be divided into following classes or types: materials, matters, products, constructions, fields and radiation; buildings and constructions, mineral resources, plots (lands used for economic purposes); plants, animals, man, enterprises (organisations, agencies) settlements. In the given context of our subject we shall include information in this list as object of activity for example in informational sphere, energy - as object of production, consumption, life assurance. These can be breakdown into such groups as: technosphere, biosphere, geosphere, sociosphere.

The following aspects of disaster - prone **objects classification** is based on the description of natural disaster situations used in practice. The following is meant: components of constructions, plants, etc. as functional units. Reasoning from that the class buildings and constructions comprises living houses, production and service buildings, study centres, stock - breeding farm, theatres, storage's, etc.; Main roads- high ways, railroads, street cars road, etc. As for morphological systems of the components, they are divided into the following types: construction elements (foundation, walls, ceilings, roofing's, stairs), supplied instruments, etc.

The aspect of **functional role** is also considered with regard to social and economical activity. Disaster - prone object can be presented not only by material objects or by such branch on the whole, but also by functional process in social and economical activity. That is why it is quite natural the system of material objects should be considered along with the system of functional impacts (process actions) on original objects during the processes of social and economic activity: generation of current, fields, radiation's); cultivation (soil); growing (plants), breeding (poultry, cattle); purification (of water, air, raw materials); dressing (mineral resources); harvesting; discharge / loading (materials, products); transmission (energy, information); transportation of materials, articles), public conveyance; management, servicing; storage, warehousing. We can see that the elements of the system of functional impacts are combined with the elements of material objects.

3.3. Object features within social and economical activity and critical impacts

Features of objects can be subdivided into **functional and morphological**. The last ones reflect the object structure and under functional - its interrelation with other object is meant. Changing in functional signs under the impact of natural disaster is not due to change in object as a whole matter. Changing in morphological features touches the object proper. Upper level of classification is represented by the types: chemical, mechanical, thermal physics, electrical, magnetical, optical, biological, acoustical, combustible, related to radiation.

Depending on its nature each material object involved in social and economical activity can be characterised with some properties (frost-, moisture-, and wind - resistance). But it is more expedient to isolate them into a separate type since apart from being functional properties they have a function of compatibility norms with dangerous phenomena.

One more aspect of properties classification can be emphasised with respect to social and economical activity: service properties, users' properties, storage properties, providing life assurance. This aspect of determining properties is independent from the previous one and this property of resistance, chemical, can be of several types at a time.

From the above it is follows that all unfavourable impacts of natural disaster on social and economical activity elements can be drawn to the following types: worsening (loosing) the property of an object or a functional process; emergence of the new (unfavourable) property of on object or process; discontinuity (suspension) of process; emergence of the new object or phenomenon; destruction (disappearance) of an object.

In terminology, related to our problem area, impact is often identified with consequences. To avoid that we should call the elements of the last list impact type, and their specific values (crops falling, wire breakage, dike crush) - **consequences** proper. The difference should be made between **direct** consequences (e.g. crops soaking), and **indirect** (e.g. crops decrease due to soaking). In natural disaster information the consequences are often given as impact, unfavourable conditions, etc. To the list of such type of consequences the element uncertain should be added.

Geographical region as an element in the given situation is of great importance, since it more than often predetermines the case of natural disaster emergence of some certain type (e.g. snow avalanche tails in mountains) and possible consequences resulted from natural disaster (e.g. erosion of tilled layer as a result of steppe storm). This concept is true to Northern Hemisphere, subtropics, mountain areas as well as to settlements, transport sites (airport, seaport, etc.). In factographic knowledge base, there can be specific values, such as Kustanai area, mouth of the river Volga, etc.

Consider briefly classification scheme for **geographical region**, which can be given in the context of the following types of geosystems: **global** (system elements Northern Hemisphere, Arctic); **continental** (Europe, Atlantic Oceans); **administrative and political; productive and economic; branch; geophysical** (climatic zones, subtropics, area of tundra land, sea basin, lowland, coast; river). Knowledge base for geographical region can contain specific values for any level of classification system (e.g. Barents sea basin, Caspian coast, etc.). The same elements characterise geographical sphere of critical relationships between environment and social and economical activity and it is not necessary that in one and the same situation one element, say settlement, appeared to occur in geographical region and social and economic activity.

4. Model of problem fields for a case of natural disaster impact on social and economical activity

The main elements in this situation are two blocks: **potentially dangerous situation** and **situation of dangerous impact**. Potentially dangerous situation includes (in the general case), apart from chronological and geographical characteristics, situations proper which generate disaster components, potentially dangerous disaster - prone object. The last can be represented by any element of social and economical activity from specific branch (agriculture, transportation's) to the type of specific object (sea-port, cereal crop, aircraft flight). Potentially dangerous situation are named in accordance with names of components generating them (frosts at melon plantation, town shower, sea-port flooding, heavy snowfall problems for public services, etc.). Base elements of potentially dangerous situation can (or can not) have characteristics of their own: conditions for disaster emergency (comprehensive characteristic), critical disaster characteristics (these are the parameters attributing to the character of impact) and norms of compatibility of potentially highly dangerous impact with disaster.

A special place among disaster and potentially dangerous situation on the whole is given to disaster prerequisites. It is natural that every potentially dangerous situation can be related to several geographical objects and time characteristics.

Socially dangerous impact is somewhat limited with respect to potentially dangerous situation. To be more exact, each copy of potentially dangerous situations can be related to several copies of socially dangerous impact. It corresponds to the fact that, practically, under disaster impact on specific field of social and economical activity, several types of impacts can be emphasised. More over, it is true to the model of subject knowledge when one of potentially dangerous situation types is related to many types of impacts connected with different components of the object of impact.

Socially dangerous impact relating to specific type of potentially dangerous situation (e.g. flooding in the sea-port) can comprise different in their structure variants of limited socially dangerous impact: one type of impact - several types of impact objects; one type of impact - one object of impact -several types of dangerous impact; several types of impact - one/several objects of impacts; most various combinations, leading to various structures to such situation.

Each copy of socially dangerous impact can be characterised when necessary: by socially dangerous impact conditions, geographic area of certain type of an impact object and a certain time characteristic. In case each specific impact, related to socially dangerous impact, is to be given in accordance with its values of conditions, geographical and time characteristics, several socially dangerous impact copies should be made up. This is true for all attributes of situations. Situation with delayed consequences can be practically related with every socially dangerous impact. So, if potentially dangerous situation - flooding over agricultural lands, socially dangerous impact - serial crops soaking, than situation with delayed consequences can have the following type: harvest loss (time: vegetational period; Geography: river's flood - plain). Situation with delayed consequences is generally identical to socially dangerous impact situations, but it also may be a case, when only a kind of impact is pointed out: harvest loss.

Note, that the model assumes incomplete variants of structures for all types of situations interrelated, i.e. an absence of conditions, prerequisites, time and geographical characteristics. That means, that an expert updating the knowledge base, makes a decision by his own regarding these or that attributes of situations. The same way the model assumes free distribution of geographical and time characteristics among situations of different level.

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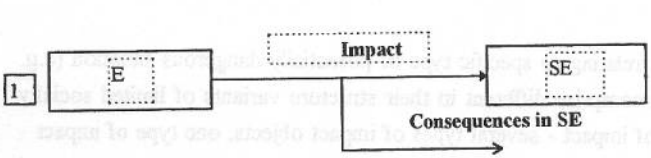
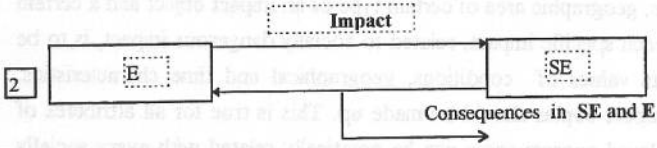
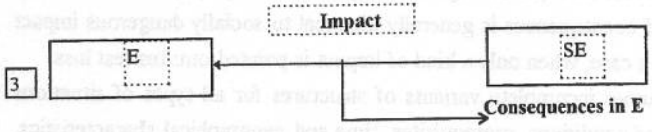


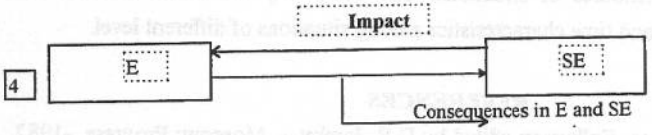
Break up, worsening the environmental conditions (E) as a result of disaster impacts on social and economic activity (SE)



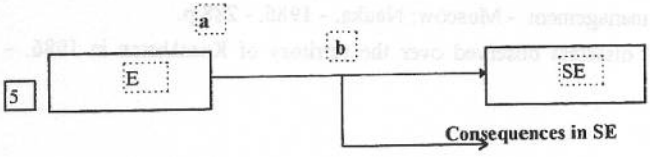
Impacts (caused by disaster) of toxic wastes storage; soil, water and air pollution



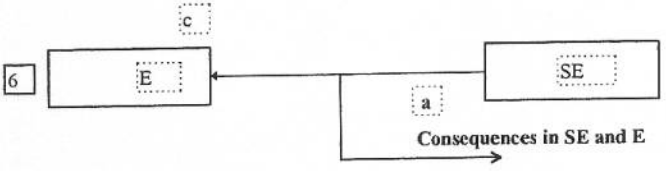
Natural environment pollution with waste products



Unpremeditated pollution of production, water and air, causing disease of people



Effect of secondary impact:
a - heavy showers
b - cause flooding, inundation of living houses



Effect of secondary impact:
a - industrial accident resulted in breakdown of refinement system
c - air pollution

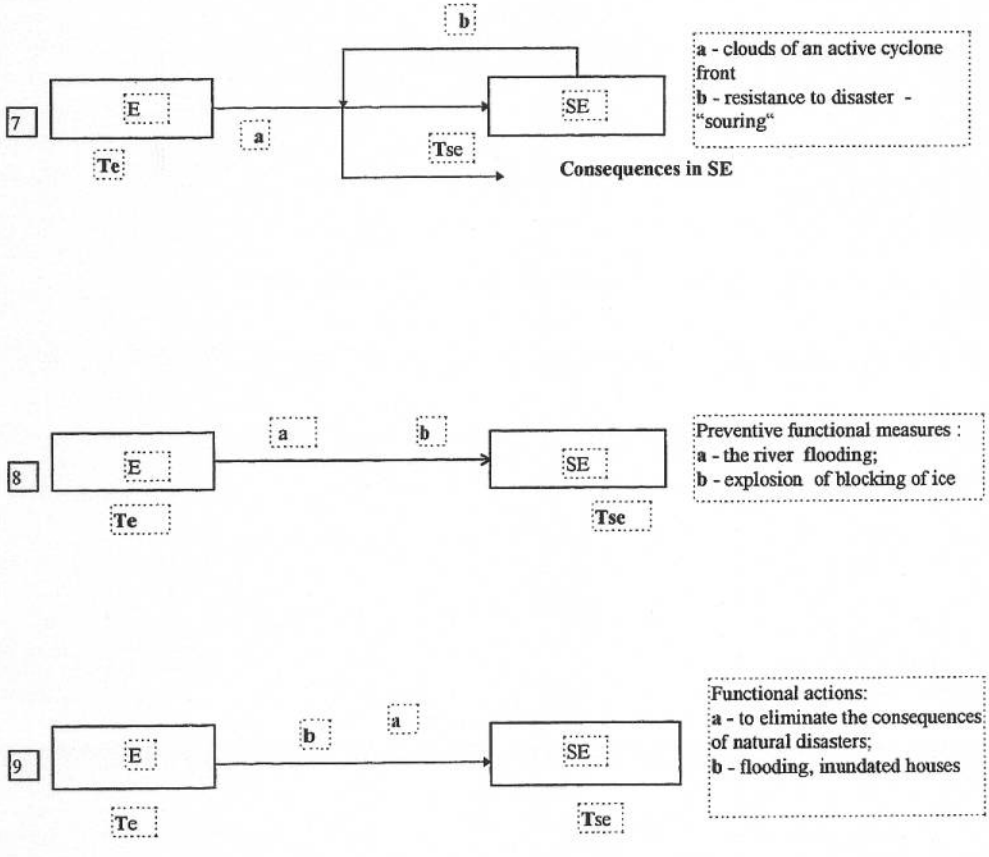


Fig. 1. Example of relationship between environmental and social - economical activity