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NATURAL HAZARDS AND RISKS: THE VIEW FROM THE JUNCTION OF NATURAL AND SOCIAL SCIENCES

V. Vilímek, J. Spilková: *Natural hazards and risks: the view from the junction of natural and social sciences.* – Geografie–Sborník ČGS, 114, 4, pp. 332–349 (2009). – The current emphasis on the research of natural hazards and risks has been widely recognized and possible mitigation of their effects is of crucial importance for the whole society. While many international activities concerning the risk management emerged during the last two decades and the international cooperation proved necessary in this field, the realm of geography still remained split to a certain extent into the research activities in physical and in social geography. Nevertheless, there is an obvious need of the cooperation of these two domains of geography. The paper introduces the significant contributions of both natural and social sciences into the research of the natural hazards and risks and stresses that the knowledge gained in both of these disciplines constitute a solid complex that can be used and applied in a particular case of a natural disaster.
KEY WORDS: natural hazards – natural risks – vulnerability of society – behavioural geography.

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Introduction

Great attention was paid to natural hazards and risks already during the last decades of the 20th century, as was the case of the International Decade for Natural Disaster Reduction. At the beginning of the 21st century, a deep change concerning collective hazards exists. In general, hazards are nowadays more dispersed and new threats are emerging – e.g. terrorism (Massue 2005). Hazards could be classified at the first hierarchy according to their causes – natural, technological and social. Natural hazards and risks are being investigated, described and classified from different points of view. Papers published in Geosciences were mainly oriented at the natural essence of the process and its consequences, possibly to determine requirements to avoid future similar events (Bolt et al. 1975, Kukal 1982, Alexander 1993). Some publications are focused on the linkage with environmental issues (Burton et al. 1993, Kolejka 2003) and civil defence (e.g. Kuroiwa 2004). Nevertheless, predominantly general publications which would take into account the both aspects, i.e. natural causes and regional planning or natural causes and behavioural response, are not frequent.

The study of natural hazards and risks, their possible prediction and mitigation of their effects is a topic of crucial importance for the whole society. As the number of reported natural events increases and new threats from the natural and technological risks emerge, the society matures to be more concerned in both the theoretical and practical research in natural hazards and risks. Similarly, the concern arises as the effects of natural disasters are geographically uneven, clearly affecting the population of the most economically lagging regions, the population unprepared for these natural events, without the possibility to use various adjustments known from the developed countries. Last but not least, this paper intends to bridge the gap of the currently growing dualism in the field of geography. Natural hazards and their study from various points of view are the point of concurrence of both the natural and social sciences, leading into the sphere of applied science and applied geography. It is thus a topic once again showing the all-encompassing complexity of geography. The aim of this paper is therefore to remind this complexity and concurrence rather than foster current centrifugal research directions and stress the importance of international cooperation in the research of natural hazards and risks.

The first section of the paper introduces the main terms used in the research of natural hazards and risks and sets a terminological framework to the following sections. The second part stresses the crucial interest in the vulnerability of the society in general in the context of the International Decade for Natural Disaster Reduction. This activity reminds the need to prevent risks, to mitigate their effects and to protect the society from the natural and human made disasters at the largest possible extent. It discusses also the geographical unevenness of the harmful effects of such natural events for particular populations. The third section focuses on temporal and spatial aspects of the research in natural hazards and explains main concepts used in the natural science realm to grasp the knowledge of these natural events. The next section then turns to the social sciences and reveals how the natural hazard and risk issues may be approached from the viewpoint of these sciences. The final section of the paper discusses the international activities in natural hazards study and disaster reduction. Some concluding remarks are then sketched in the final section of the paper.

Definition of terms

At present, terms related to natural hazards and risks are more and more frequently used, especially in mass media, but they are not always used in compliance with their scientific meaning. Even in specialized literature, their conception is not always the same (Marandola, Hogan 2006). Natural hazards are generally considered to be processes of potential destruction of natural origin, which may lead to losses in human lives, injuries, economic or social damages and/or to the environment degradation. One of the first definitions of a natural hazard was presented by Burton and Kates (1964) as "(t)hose elements in the physical environment (which are) harmful to man and caused by forces extraneous to him". It is not easy for us to distinguish the purely natural component of the process from that caused by human beings. Natural hazards, even if their triggering factors could be of an anthropogenic origin, have their "roots" in natural environment and are controlled by natural processes (e.g. slope movement triggered by road construction). This is implemented e.g. in the definition by White (1973): "An interaction of people and nature governed by the co-existent state of adjustment of the human use system and the state of nature in the natural events system". According to Slaymaker (1996), hazard is commonly defined by geomorphologists as probability of a change of a given magnitude occurring within a specified time period in a given area. Geomorphic hazard results from any landform change that adversely affects the geomorphic stability of a site (Schumm 1988). Procházková (2004) defines hazard as potentially harmful process or situation which will occur, with a certain probability, during a defined time period in the studied territory.

Slaymaker (1996) classified "geomorphic hazards": endogenous (volcanism and neotectonics), exogenous (flood, karst collapse, snow avalanche, channel erosion, sedimentation, mass movement, jokulhlaup, tsunami and coastal erosion) and finally those induced by climate change or land-use change (desertification, permafrost, degradation, soil erosion, salinization and flood) – it means that anthropogenic influence is taken into consideration as well. Various types of natural hazards are mutually conditioned and interconnected. Some are even causally interdependent – like tsunami triggered by earthquakes (slope movement or volcanic eruptions). Others could influence each other – like volcanic eruption and earthquake. As to mutual relationship among natural hazards, see for instance Kukal (1982), or recently Coopey et al. eds. (2005).

When considering a natural hazard, it is always necessary to take into account the time. Alcántara-Ayala (2002) speaks about natural hazards in the sense that they represent events which are producing damage to physical and social spheres not only in the moment of their occurrence but on a long-term basis due to their associated consequences. Natural hazards are usually primary and social could be considered as secondary and might be even worse. Such example could be illustrated by Figure 1.

The extent of deviation from the so-called "normal state", to which individual components of the system of the environment are adapted in a long-term evolution, is important. "In fact we can define an extreme event as any manifestation in a geophysical system (lithosphere, hydrosphere, biosphere or atmosphere) which differs substantially or significantly from the mean" (Alexander 1993, p. 5). Nevertheless generally hold that lots of disasters are a natural process of landscape evolution in case of natural triggering factors. It is not necessarily always true that an extreme natural process must directly induce a natural disaster (Wisner et al. 2004), as it depends on the degree of its impact on the society and values created by it.

What is necessary to stress is the relationship between the natural process on one side and its impact on the human society on the other site and its vulnerability itself. Impacts of natural hazards are very different, when occurring in highly populated areas or in less populated ones. Humanity in general tries, with the help of scientific and technological process, to eliminate unfavourable impacts of the nature. Interventions into natural environment, intended not only to protect humans (!) are so intense that for instance Goudie (1983) states that during the last 125 years the "impact of environment upon mankind" changed gradually into the "humanity‘s impact on environment". Nevertheless the impacts of natural disasters are, in spite of internationally coordinated efforts, still destructive on the global scale (see Berz 1992, ISDR 2003, Juggle ed. 2005).

In such case, when lives are endangered directly or when values created by the human society are affected in any manner, we speak about natural risks. This risk thus follows from the interaction between an extreme process of natural origin and endangered elements and their vulnerability. The extent of the risk is thus given not only by the intensity degree of the natural process

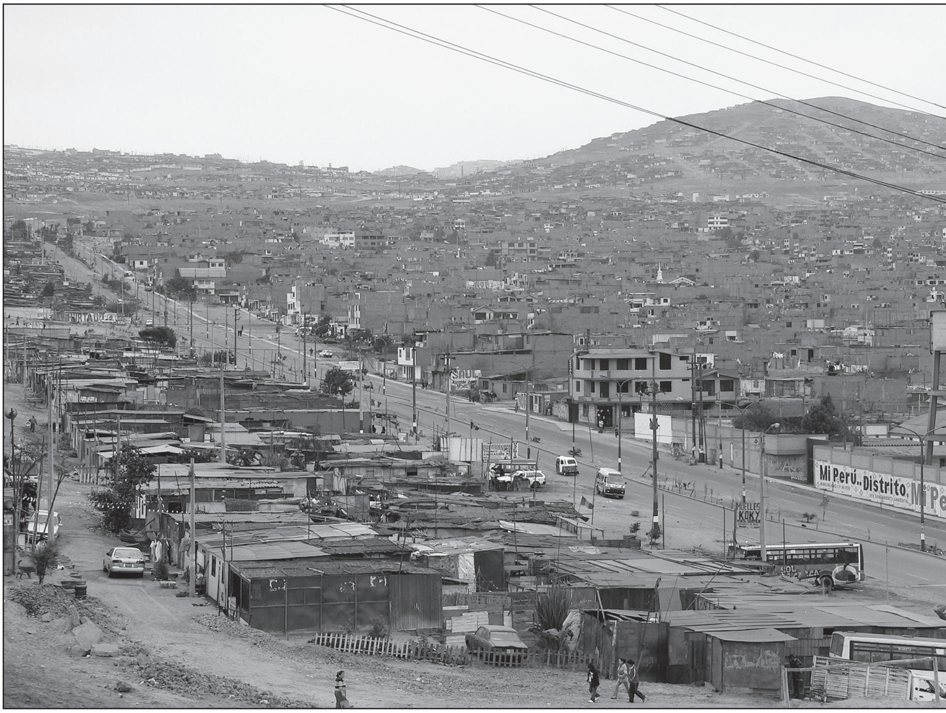

Fig. 1 – The suburbs of Lima with large shanty-towns. During last decades the city is spreading, however the conditions of living remain low, there are numerous problems with water, sanitation, increasing criminality and other psychopathological phenomena. Moreover, the area is in seismically active zone and in the case of an earthquake, the problems of the inhabitants would multiply enormously. Photo: V. Vilímek.

concerned but also by the population density or existing infrastructure. From the viewpoint of human society development, this is a quality variable not only in space but also in time. For example in many river basins, floods have formed a part of the landscape from the palaeogeographic point of view, and that without unfavourable impacts or even with beneficial effects. We need to evaluate floods adopting this point of view.

The term risk is often used in different connections and contexts. It is used not only with regard to natural processes, but also in social, economic, security or environmental spheres (e.g. Dostál, Hampl 2007). According to these facts, its understanding, delimitation and usage are generally different in each of these spheres. But as it is necessary to have a clear definition for analysing, assessing and controlling risks, several methodological approaches have progressively developed (Langhammer, Vilímek 2006).

When speaking about natural risks, we have to consider natural hazards and associated risks, as consequent damage or loss of lives, property and services (Varnes et al. 1984). We must consider two different approaches, which are usually applied (Bolt et al. 1975). In the case of so-called relative risk, the degrees of intensity are compared within each other (e.g. low, medium, high). The question of probability of occurrence of the given natural process is not incorporated. The probabilistic risk is considered in the sense of the event occurrence probability in the given time interval and given place. Sometimes the probability of occurrence is bound up with a time window, like days, weeks, months or even years (e.g. Zvelebil, Moser 2001). It depends whether a short-, medium- or long-term prediction is set up. However, determining of the probabilistic risk is very complicated due to insufficient accurate information which would lead to the time classification.

Vulnerability of the society

The impact of natural hazards on society can be described from several points of view. Similarly, society can, to a certain degree, increase the risk character of natural processes. With growing population density on the Earth this relationship has been gaining importance. In general, the 21st century is considered as a period, when effects of different types of hazards begin to cumulate to a large extent. Under certain circumstances, e.g. a higher population density, financial and technological requirements on structures and globalization of society, also the relationship between natural and technological hazards gains importance. The so-called domino effect comes to force, when a certain type of natural disaster (e.g. earthquake) can condition a technological risk (e.g. escape of toxic substances). This may lead to a higher social tension, epidemics in the society, etc. For such hazard administrative borders are not barriers, therefore we progressively aim to create the global risk management.

Alcántara-Ayala (2002, p. 108) uses the terms natural vulnerability and human vulnerability to specify natural disaster: “When both types of vulnerability have the same coordinates in space and time, natural disaster can occur.” From the point of view of the development of human society, more precisely within the sphere of physical geography, men were repeatedly exposed to different types of natural hazards (according to the region). In dependence on the interaction between the natural sphere and humanity, the originally purely natural processes have been progressively changing into natural disasters. What vary during the time are the intensity of these events and the density of population in the given region. On one hand, people used natural resources and on the other hand they were forced to protect themselves from impacts of natural processes.

In the past, natural disasters were often perceived as exceptional events which were consequences of “God’s will” and which, once over, would not be a problem for the given region anymore. Now, natural disasters are more perceived as a response of natural environment on changing conditions (Burton 2005). In areas with a lower level of education, the original point of view still prevails and the population does not understand the consequences of the relationship cause – consequence. But what appears even in developed societies is the conviction that more sophisticated technologies will ensure an absolute protection and that we will be able for instance to entirely eliminate impacts of earthquakes, landslides, floods, etc. We should rather take into consideration, whether the localization of structures and communication is suitable with regard to possible natural hazards (Hladný 2007).

It is important to try to reduce and prevent possible risks. Within international cooperation (e.g. IDNDR – International Decade for Natural Disaster Reduction) emphasis was always put on the reduction of damages caused by natural disasters. But the stress put on prevention should be larger at all levels (international national, regional and local), because this is the way how to sensibly reduce the number of victims. The importance of prevention is proved for instance by Hladný (2007), who quotes in his paper the former UN Secretary General Kofi Annan that it is necessary to pass "from culture of reaction to culture of prevention". It is of course problematic to politically put through such relatively high costs, when it is not possible to safely determine the place and the time of a future natural disaster. The "culture of prevention" must first relay on better understanding of physical phenomena. The future development of both basic and applied research into geohazards is currently crucial. Although the strategy of prevention is general, individual application must take into account the local variability of natural environment.

The development of technological possibilities of the society and the development of knowledge of natural processes have influenced also the approaches intended to limit the impacts of natural disasters. In the 1960s natural disasters were still perceived as uncontrollable natural processes affecting the society and its functions (e.g. Fritz 1961), while during the following decade the link between extreme natural processes and vulnerability of the society were already well recognized (e.g. Westgate and O'Keefe 1976). At present, we speak directly about the balance/imbalance between the natural and the social systems (Alexander 1993).

The research into different types of natural processes is carried on by different methods. Considering rock falls it is positive that the improving communication and monitoring methods enable to successfully manage risks and to introduce early warning systems (e.g. in sandstone landscape of the Bohemian Switzerland National Park, Czechia; Zvelebil et al. 2005). Shallow landslides and earth flows were studied in Outer Western Carpathians (east of Vsetín city, Czech Republic) in order to introduce SINMAP model for landslide susceptibility (Klimeš 2008).

In the case of hydro-meteorological phenomena, a significant progress was registered mainly thanks to the possibility to use satellites and to model processes with a catastrophic course (Blöschl, Grayson 2002; Řičicová, Krejčí 2002). Not only has the precision of estimated intensities increased, but also the timing of occurrence of the given phenomena. Nevertheless the success in reduction of natural hazards is not only the question of scientific progress and technological possibilities, but it is given by a whole complex of political, socio-economical and environmental dimensions (Hamilton 2005).

The experience in flood research from 1997 and 2002 in Czechia enables us to evaluate individual manifestations of human activities in landscape, like changes in land-use, large-scale drainage, stream regulation or modifications in floodplain (Langhammer, Vilímek 2006). Other cases of flash-floods offered an excellent opportunity to examine geomorphological manifestations of these natural phenomena (Fig. 2). The interpretation of causes of flash flood in the Olešenský brook drainage area (Vilímek, Šercl 2006) revealed that main reason for the disaster was an extraordinary rainfall episode and man-made influences were only secondary in importance or of local effects (e.g. unsuitable plants on fields with high inclination, obstacles for flowing like low bridges). A complex overview of historical and recent floods in the Czech Lands was published by Brázdil et al. (2005) and of natural extremes for Moravia and Silesia by Brázdil, Kirchner et al. (2007).

A number of developing countries are situated in zones of natural hazards. As indicated for instance by Anderson and Decker (1992), 80 % of volcanic activities are bound to the Circum-Pacific Volcanic Belt. Alcántara-Ayala (2002) states that Asia and Latin America manifest the highest density of floods

Fig. 2 – During flash flood along the Olešenský potok Brook on June 10, 2004 large amount of material was transported from fields into forest areas. Slopes with maize fields were easily affected by soil erosion during intensive rainfall. Photo: V. Vilímek.

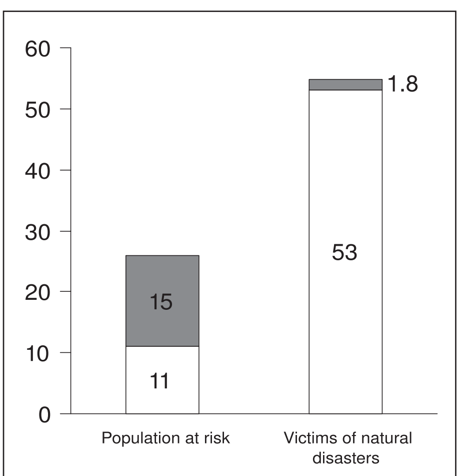

Fig. 3 – The contrast between the percentage of population at risk (left) and the victims of disasters (right) in the world. Dark – developed countries, light – developing countries.

connected with hurricanes, cyclones, tropical storms, typhoons and monsoons. Natural disasters affect also the developed countries, nevertheless in case of the developing countries the unfavourable impacts are doubled, because natural hazards are aggravated by a higher degree of vulnerability of their society. The reasons are technical, economical, organisational, but also social and political. According to the UNDP (United Nations Development Programme) data, only 11 % of the total number of people at risk in the world lives in the poorest developing countries, but 53 % of victims of natural disasters is in these countries. On the contrary, in the economically most developed countries only 15 % of population is exposed to natural hazards, but they represent only 1.8 % of victims of disasters (Fig. 3). Alexander

(1993) estimates that the portion of developing countries on the total number of victims of natural disasters can be even 95 %.

Natural hazards and risks in the light of time and space

Both space and time are categories closely connected with natural hazards and risks, although there is no causal relation. An uneven distribution of different types of natural hazards on the Earth is given by the geophysical character of these events. Also human vulnerability includes the factor of space – geographical distribution. On the background of the linear time scale we can register individual natural disasters, look for links between frequency and magnitude. Time, as an important factor, is present also in risk management. In general, these categories (space and time) can undergo dynamical changes and have therefore an unsubstitutable part in studying natural hazards and risks. Slaymaker (1996) categorized different types of natural hazards into groups: "high magnitude and low frequency", "low magnitude and high frequency" events with a transitional category "continuous".

For survival of certain communities on the Earth with regard to the variability of climate, prediction forecast and modelling of natural processes gain on importance (e.g. Benešová, Matějíček 2007; Kliment, Langhammer 2007). In spite of all research and increasing technological possibilities, during natural disasters we have often to rely mostly on reducing risk and its impacts. Some processes, as volcanic activities, are relatively easily predictable; although not with a sufficient precision as to time and intensity of eruptions (localisation is relatively easier). On the contrary, prevision of earthquakes is very difficult as to their place, time and intensity). Also floods are non predictable in a longer time perspective. In dependence on fallen or approaching precipitations we can model imminent floods, but only several days or hours in advance. Several approaches exist in the field of flood modelling (e.g. Beven 1996, 2001; Jeníček 2007). Conclusions published by National Research Council (1995) make it clear that certain partial successes in prediction of the impact of climate on natural hazards were registered in connection with the research into the variability of climate on the Earth. An example thereof is the annual prediction of the occurrence of the El Niño phenomenon. Communities dependent upon farming or fishing can, to a certain degree, prepare themselves for the coming situation. On the other hand, certain types of natural disasters are unavoidable, as landslides (Vilímek et al. 2000) or floods.

From this point of view, zoning is important. One of possible approaches is to determine the risk in the given area as "a function of the cumulative severity of damage from earthquakes, floods ad so on, irrespective of the frequency of occurrence of these event" (Bolt et al. 1975). In this case, time is not included as one of the factors influencing the given process. The second possible methodological approach is to take into account the frequency of natural hazards occurrence. This enables to compare scarcely repeating events of catastrophic impact with much frequently occurring events of a lower intensity. In such cases the probability of occurrence in a given locality/region is related to the period of 100 or 1,000 years. According to the principle of mutual relationship magnitude – frequency as it was described by Wolman and Miller (1960), the quantity of work performed (as sum of catastrophic events) is equal to the multiple of magnitude and frequency of occurrence of the event. According to Alexander (1993) the most extreme events occur too rarely to be of a greater significance and, at the same time, the most frequent are events of such a low magnitude that even their cumulative value is not significant.

In case of very frequently occurring events with a low intensity we can state that there exist certain threshold levels which must be exceeded for that the given event would have some impacts – e.g. a visible erosional-accumulational development of a valley occurs only during floods exceeding a certain flow. A slope will get unstable only after exceeding a certain quantity of rainfall sums, etc. On the other hand, the most extreme types of natural hazards, although occurring only very rarely, can have such impact on the landscape that they will be identifiable even after a longer time (as they have a great erosion capacity and transport immense quantity of material). For instance huge prehistoric rock falls from Huascarán can be documented even nowadays (e.g. Plafker, Ericksen 1978). Huge rock falls (again prehistoric) in the area of Machu Picchu can be also documented in the relief (e.g. Vilímek et al., 2005, 2007). Nevertheless, it is difficult to forecast such events.

From the perspective of forecasts and in general also of impacts on human society, very important are natural hazards of mean intensity occurring with a mean frequency: society is able to be prepared to face them and they represent a sufficiently high risk to be taken into consideration.

An important factor for prediction is the regularity of occurrence of such events. This is however problematic. In some types of natural hazards (as earthquakes) the theory is that accumulated tension must be released – either in shorter periods or once in a longer period with a higher intensity. This would be true only on condition of a uniform increase of tension. For instance, the movement of lithospheric plates should be uniform. The question also is, whether we have a sufficiently long time series to eliminate incidental events. In this case information from documentary evidence can be useful (e.g. Brázdil, Kirchner et al. 2007). Brázdil et al. (2005) give series of historical floods based on documentary evidence for the Vltava, Labe, Ohře, Morava and Odra rivers. Elleder (2007) uses the example of historical floods in Labe and Vltava basins to show that frequency of historical records is a function of time, with an increasing tendency (from last decades / centuries we have usually larger sets of data). More recent historical records are in general also more credible.

In the case of prehistoric events, geomorphologic research can be useful – from a record in relief we are able to identify events anterior to human memory. As an example we can give the present prediction models of volcanic activities of Popocatépetl based on sedimentologically and archeologically well documented series of eruptions of this volcano during the last 22,000 years (Sheridan et al. 2001). But even this is not sufficient in case of Popocatépetl and possible threat to Mexico City agglomeration, because eruption of the highest intensity occurred only once during the 22,000 years, which is statistically insignificant. The role of geomorphology in the research into natural hazards and risks is well documented for instance by Alcántara-Ayala (2002), and that both with regard to volcanic activities and hydro-meteorological events as well as to slope movements. He also takes into consideration different methodological approaches. The position of geomorphologic research with the large spectrum of interdisciplinary research (e.g. slope movements caused by extreme rainfall) is dealt with by Rosenfeld (1994).

Social sciences and the natural risks: behavioural and psychological responses

Mitigation of risks is connected with the question to which degree is the population aware of natural hazards occurrence in the given region and how they are able to adapt themselves to this situation. The period between two natural disasters is good for adaptation of population to the given natural process. Nevertheless, if extreme events occur with a low frequency, although they are usually periodical in the given area, local population mostly loses its capacity of adaptation. In the past, the disaster often passed to legends and tales after some time (or it was forgotten). For the society, natural disasters are important not only for their physical substance and causes, but also from the perspective of their forecasting and management, frequency of their occurrence, speed of their setting on and their duration, their destructive potential and their proper impacts (Alexander 1993). To fully understand their impacts on human societies means to take into consideration also the adaptability of a group of population and measures to mitigate damages. For social sciences, the human aspect and social impacts of natural disasters are more important than the event of purely natural character itself (Hewitt 1983).

The study of the natural hazards and their perception belongs to a distinguished area of behavioral geography. The field of behavioral geography enjoyed its boom in the sixties and seventies of the 20th century when the academia and geographers expressed disfavor with the model-centered, qualitative, understanding of the natural and social phenomena, and when the researchers aimed to place the human individual into the focus of the science's concern. Behavioral geography in this context focuses at the human spatial behavior and its underlying psychological factors. In case of natural risks, the perception of a risk and its consequential experience, response to it, and the process of decision-making at the moment of the disaster's strike were in the center of research interest. Authors as White (1964), Dagg (1965), Saarinen (1966), Burton et al. (1968), Kates (1971) aimed to describe the role of perception in the human adjustment to natural risks. Kates (1971, p. 438) defined this research paradigm as focusing on (i) assessing the extent of human occupancy in hazard zones, (ii) identifying the full range of possible human adjustment to the hazard; (iii) studying how men perceive and estimate the occurrence of the hazard; (iv) describing the process of adoption of damage reducing adjustments in the social context and (v) estimating the optimal set of adjustments in terms of anticipated social consequences. This agenda outlined already at the beginning of the seventies seems indubitably up-to-date even for today's research in the natural hazards and risks, covering the basic problems and assumptions. The behavioral paradigm attempted to ask various questions: How do people react with potentially dangerous or unfavorable spaces? What is the role of experience with the disaster, what is the role of individual's personality in coping with hazards in the one's closest environment?

It is obvious that individual's perception of the hazard is influenced by the one's own experience with the hazard, the extent to which one is sensitive to the characteristics of a natural event and the personality of the perceiver. As stated above, the magnitude, duration and frequency are important characteristics of the natural event. At the personal level, however, the intensity of an experience, its recency and frequency seems to be fundamental (Kates 1971). From the personality's attributes, it is mainly the extent to which one believes he or she can control the fate, different sensation of nature and personal tolerance to accept even perturbating information. The appraisal of a risk may be also influenced by risk understanding, credibility of the source of information, the methods of information distribution and many other variables emerging from the situational context. Wartofsky (1983, p. 131) states that a risk is often defined in relation to perceived values and, in the same manner, Lazarus and Falkman (1966) also reminded that appraisal of the natural threat contributes to the decision to act and adjust. Fridgen (1994, p. 104) concludes that "…the appraisal of risk is often altered by past experiences that affect judgment… two individuals appraising the same risk are differently affected by a past experience that resulted in a loss of health or reputation for one of them". The factual information about the particular risk situation may represent the most influential variable in the decision making only to a limited extent. In the final effect, there is a considerable difference in the perception of particular hazards and in the ability to implement the right adjustments to it, but the behavioral studies manifest that people living in hazardous areas are often showing a higher level of adjustment knowledge in sense of their environmental fit, technical feasibility, economic gainfulness and social conformity.

The risk assessment can be also addressed as a clearly social or cultural issue, as shown in the study of Douglas (1985) which explains some of the underlying factors in the relationship between social influences and risk perception. In fact, the study area of natural hazards and their perception may be linked also with the field of philosophy, where Edwards (1954) reminds that the goal of every human performance is to seek pleasure and avoid pain, thus to seek the maximum positive utility of every action. The concept of moral responsibility is related to the study of risk appraisal and perception as well (Van Liere, Dunlap 1978), focusing on the issues of awareness of consequences of human actions (in the case of mainly the technological hazards) and thus a ascription of responsibility. This research direction led into current interest in various non-governmental organizations concerned in the environment and its protection (Friends of Earth, Greenpeace etc.) and in the more general question of environmental ethics or even environmental justice (Taylor 2000, Bullard 1993 etc.).

The possible impacts of natural disasters on human behavior and mental health are subject to research also in the field of environmental psychology. It is assumed that natural disasters result in serious stress leading to psychological and emotional problems, whereas other research suggest that psychological effects diminish quickly after the event is over (Rubonis, Bickman 1991). Natural disasters have diverse outcomes also when it comes to the community response. Erikson (1976) states, that the disaster may have long-term effects in the sense of the community destruction, and loss of a sense of community or belonging. On the other hand, some studies have found that effects of a disaster may be more positive, resulting in increased social cohesiveness as victims creates local groups and help others to cope with the stress situation (Bell et al. 2001). As the effects may vary from disaster case to another, their impact may differ also according to a specific age or social group. The burden hypothesis (Thompson et al. 1993) indicates that the most profound impact of a disaster will be posed on the middle-aged caregivers who, due to their abilities and state of health and mental condition tend to support the disadvantaged groups during the strike of a disaster (children, elderly, handicapped etc.). Diverse impacts are recognized also in the terms of so called primary disaster victims (those in the epicenters of the natural events, directly threatened of affected) and secondary disaster victims (who are not directly affected, but whose property is destroyed, people with friends or family who are primary victims, people living nearby the disaster location etc.). A special group can be distinguished also in the rescue end recovery workers who work at the site of the disaster, usually under difficult conditions for long hours under considerable pressure on them (Bell et al. 2001).

Despite the fact that this paper does not focus on the technological disasters and hazards, one interesting outcome of the environmental psychology studies should be mentioned. It is the fact that human-made (technological) disasters may differ in the way how they affect mood and behavior from the natural ones. Research evidence (Gleser et al. 1981; Lifton, Olson 1976; Tichener, Kapp 1976) shows that when the disasters are human made, the rage tends to be worse, the psychological distress tend to be longer than in some natural disasters (floods) and the victims seek to focus their anger on the culprit of the disaster. However, the questions of the psychological effects of a disaster at this point may reach the area of clinical medicine and clinical psychology, revealing another interesting science field related to natural disasters, which is not, however, within the scope of this paper.

Concluding remarks

The paper attempted to present the natural hazard and risk research area as a vivid discipline linking the existing knowledge and theoretical framework of both the natural sciences and social sciences in a logic, integral manner. Whereas physical geography measures the scope, magnitude and frequency of the disasters and aims to provide a good predictions or forecasts, social sciences focus at the perception of the possible risk and at the behavioural response to a particular natural event and its possible effects on individuals or communities. We supposed that papers in physical geography should be crowned by issues in risk evaluation and not only by relying on the analysis of physical-geographical features or description of landforms or processes. Currently papers dealing with social hazards should optimally stem from a detailed recognition of physical-geographical setting. After the evaluation of a particular hazard from the physical point of view a consequent, behavioural and cognitive evaluation, follows. This phase focuses on the understanding of the risk, credibility of information sources, the method of information spreading, and many other situational variables, which are under the study of social and behavioural sciences.

In sum, we can conclude with the recommendations for a complex geographic research agenda according to the spirit of Kates's (1971) fundamental work. In the process of adjustment to natural hazards, geographers of all specializations play their crucial role in:

– modification of the natural systems (physical geography)
– modification of the human use of the natural system (social geography, environmental psychology)
– emergency adjustments (applied geography).

The knowledge reached in both of these science branches, however, constitute a solid complex that may be used and applied in a particular case of a natural disaster. Since the complex of the application of the achieved knowledge encompass the prediction of risks, their understanding and measurement, the adjustments to the event and the mitigation of its effects, there is a certain need of all the mentioned disciplines of natural and social sciences in the applied natural risks research.

An example of ongoing common research could be the analysis and synthesis of preception in the community endangered periodically by natural disasters. Local investigation using questionnaires was realized in selected areas under risk and data are in the process of evaluation. The focus of this research is to gain the knowledge about awareness of natural hazards among people and evaluate it with our background of real hazardous processes – both recent and potential. This pilot study, realised by joint efforts by the Department of Physical Geography and Geoecology and the Department of Social Geography and Regional Development at the Faculty of Science, Charles University in Prague, thus shows an example of research on the threshold of natural and social sciences by combining the study of individual risk of every particular inhabitant with the perception of the menace on the environment and, finally, the perception of possible control of the risk. This may be a crucial concern as the evaluation of the seriousness of the risk influences the decision making of the people.

It is obvious that a complex research in this area must be strengthened by international cooperation, since the effects of a natural disasters are far from influence only a limited part of Earth's surface or a separate community. There are no administrative boundaries for natural disasters and there must be no administrative or politic boundaries for the joint effort in the basic and applied research of them. The International Strategy for Disaster Reduction should provide a solid framework for the necessary international cooperation within the field.

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Shrnutí

PŘÍRODNÍ OHROŽENÍ A RIZIKA: VZTAH MEZI PŘÍRODNÍMI A SPOLEČENSKÝMI VĚDAMI

Přírodní ohrožení a rizika hrála v posledních desetiletích minulého století důležitou roli ve společnosti v mnoha státech světa (viz např. Mezinárodní dekáda za snížení výskytu přírodních katastrof). Počátek 21. století je obdobím, kdy se začíná mluvit o tzv. hromadném ohrožení (*collective hazard*). Ohrožení, obecně pojato, vůči kterému jsme dnes jako spolenost vystavováni, je více rozptýleno z hlediska příčin. Nové hrozby se objevují stále, např. terorismus (Massue, 2005). Klasifikace ohrožení je podle příčin dána základním rozdělením na přírodní, technologická a sociální.

Přírodní ohrožení a rizika jsou zkoumána, popisována a klasifikována z různých úhlů pohledů několika vědních disciplín. Publikace v oborech geografie či geologie jsou většinou orientovány na přírodní podstatu procesů a jejich následky; případně s návrhy opatření jež zabraňují opakování daného jevu (Bolt et al. 1975, Kukal 1982, Alexandr 1993). V poslední době se objevují publikace s širším výstupem, a to ve spojení s environmentálními změnami přírodního prostředí (Burton et al. 1993, Kolejka 2003) či s ohledem na civilní obranu (např. Kuroiwa 2004). Publikace, které by zohlednily současně a vyváženě přírodní aspekty a možnosti regionálního plánování nejsou naopak časté, a to i v geografii. Stejně tak spolupráce odborníků z oblasti fyzické a sociální geografie na studiu přírodních ohrožení a rizik je zanedbatelná.

Nejen přírodní ale i technologická ohrožení jsou hojně rozšířena po světě a nevyhnutelně dochází k dominovému efektu. Nicméně ta skutečnost, že se do popředí zájmu dostávají jiné typy ohrožení, ještě zdaleka neznamená, že přírodní formy ohrožení by mohly být opomíjeny. S postupujícím hospodářským rozvojem jednotlivých států a s růstem celosvětové populace se stává eliminace přírodních ohrožení stále dražší záležitostí. Globální klimatické změny mohou navíc současnou situaci ještě zhoršit.

V tomto kontextu je studium přírodních ohrožení a rizik, jejich případná predikce a zmírnění jejich dopadů tématem klíčové důležitosti pro celou společnost. S rostoucím počtem zaznamenaných událostí a nových hrozeb přírodních i technologických rizik společnost dospívá k většímu teoretickému i praktickému zájmu o výzkum v oblasti přírodních ohrožení a rizik. Obdobně se zvyšuje zájem o tuto problematiku i díky geograficky velmi nerovnoměrnému rozložení přírodních katastrof, které zjevně postihují populace v ekonomicky nejslabších regionech, tj. populace nepřipravené na obdobné události, bez možností využít různých opatření známých z rozvinutých zemí.

V neposlední řadě se tento článek také snaží překlenout rostoucí problém dualismu v současné geografii. Přírodní rizika a jejich studium je z mnoha úhlů pohledu na křižovatce jak přírodních, tak sociálních věd, a ústí navíc k aplikování vědeckých poznatků, tj. k aplikované geografii. Jedná se tedy o téma, které ukázkově vystihuje komplexitu zájmů oboru geografie. Úkolem tohoto článku je tedy připomenout tuto komplexitu a spojitosti, spíše než přispívat k současným odstředivým tendencím ve výzkumu, a nakonec také vyzdvihnout význam mezinárodní spolupráce ve výzkumu přírodních ohrožení a rizik.

První část článku seznamuje čtenáře s hlavními termíny používanými ve výzkumu přírodních ohrožení a rizik a teoreticky rámuje následující subkapitoly. Druhá část článku připomíná klíčovou problematiku zranitelnosti lidské společnosti, a tudíž potřebu předcházet rizikům, mírnit jejich dopady a chránit společnost před přírodními a technologickými katastrofami v největším možném rozsahu. Diskutuje také geografickou nerovnoměrnost dopadů takovýchto přírodních události pro různé populace. Třetí část se soustředí na časoprostorové aspekty výzkumu přírodních ohrožení a vysvětluje hlavní koncepty používané v přírodních vědách k vysvětlení těchto jevů. Následující část se pak věnuje sociálním vědám a ukazuje, jak mohou být přírodní ohrožení a rizika nahlížena také z pozice sociálních věd. Na závěr článku jsou prezentovány některé úvahy o interdisciplinaritě představené problematiky a významu přírodních a sociálních věd v souvisejícím výzkumu, tj. nezastupitelné roli fyzické i sociální geografie v moderním výzkumu přírodních ohrožení a rizik.

Je zřejmé, že bude nutno podporovat komplexní výzkum a mezinárodní spolupráci v této oblasti. Dopady přírodních katastrof zdaleka ovlivní pouze izolovanou část zemského povrchu či izolovanou komunitu. Pro přírodní katastrofy neexistují žádné administrativní hranice, takové hranice tedy nemohou existovat ani pro společné úsilí v základním a aplikovaném výzkumu těchto jevů.

Obr. 1 – Chudinské čtvrti v okrajové části Limy se v posledních desetiletích rychle rozrostly, nicméně životní podmínky zůstaly na velmi nízké úrovni. Problémy s pitnou vodou, kanalizací, zvýšenou kriminalitou sužují obyvatelstvo. Navíc je celá oblast seismicky aktivní a v případě výskytu silnějšího zemětřesení se všechny předešlé problémy budou násobit. Foto: V. Vilímek.

Obr. 2 – Během tzv. bleskové povodně na Olešenském potoce (10. 6. 2004) bylo transportováno z polí velké množství sedimentů i do lesních porostů. Během intenzivních dešťů byla erodována pole nevhodně osázená kukuřicí. Foto: V. Vilímek.

Obr. 3 – Kontrast mezi podílem populace v ohrožení a oběťmi přírodních katastrof ve světě. Osa x – podíl obyvatel ohrožených přírodními katastrofami na světové populaci (v %), levý sloupec – obyvatelstvo v ohrožení, pravý sloupec – oběti přírodních katastrof; ve sloupci tmavě – rozvinuté země, světle – rozvojové země.

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