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Geothics and Sustainability

Václav Němec
President, International Association for Geoethics (IAGETH)
CZ-100 00 Praha 10 -Strasnice, K Rybnickum 17

E-Mail: Vaclav Nemec <lidmila.nemcova@quick.cz>

Tel.: +420-274-811-801 (recorder)

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Abstract: The new scientific discipline of GEOETHICS since 1991 has brought to the attention various topics of Earth sciences needed to be discussed from a specific ethical point of view. Geoethical principles and geological factors are to be considered in any scenario of a “sustainable development”.

Keywords: geoethics, sustainability concept, unavoidable natural disasters, global warming and cooling, geoethical way of thinking and acting, new legal aspects, earthquakes predictions

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1. Introduction

The new scientific discipline of GEOETHICS in the course of its development during the last 20 years has made a considerable progress. To the originally preferred problems of protecting and moderating consumption of non renewable mineral resources of the Earth new priorities have been added, primarily concerning unavoidable natural disasters in connection with their presently increasing intensity. [1]

The International Declaration on Geoethics (issued at Pribram, 2011) includes indicators for further development of geoethics at the up-to-date level:
1) significance of geoethics in the context of facing extra-ordinary natural hazards and disasters in the course of recent years;

2) geoethical approach to needed new legal aspects (including insurance policy) and to an ethical way of thinking;
3) links of geoethics with new aspects of geosciences education;
4) inclusion of geoethical subjects into deontological codes;
5) liaison with mining engineers and their activities [for optimum use of mineral resources];
6) need of searching new priorities for the 3rd millennium fitting the World Millennium Goals;
7) links for incorporating geoethics into any activity related with the abiotic world.

2. New Geoethical Priorities

2.1. Unavoidable natural disasters and concept of sustainability

The actual attention and orientation of responsible activities of Earth scientists need to be focussed on natural disasters because of a needed forecasting as well as of suggesting appropriate measures for minimizing any potential expected damage. The future of our planet is determined not only by anthropogenic influences but also by unavoidable long term exogenous and endogenous natural processes, often with some hierarchical periodicity of significant change [2], usually accompanied by unavoidable natural disasters beyond any human control. The most significant of these events are often beyond the reach of any human memory.

Liaision of these topics with concepts of sustainability is evident. It is necessary for human kind, as well as for any further progress of its scientific background, to bring into consideration the necessity of intensifying contacts of the Earth sciences with other technical and humanistic scientific fields. Geoethics may have an important role in this process as well as in introducing other new scientific domains. In the light of this knowledge, it seems necessary to modify oversimplified ideas about the environment sustainability by an appropriate geoeducation and by a geoethical approach. Such a sustainability does not depend exclusively on human activities; on the other hand more intensified research is needed for achieving progress in deciphering algorithms of the long term processes of the Nature.

Every citizen of the planet needs to comprehend that the so-called ‘abiotic world’ also has its own dynamic evolution and that it is necessary to improve any forecasting and mitigation of serious catastrophes and climate changes which might and should be expected. (A simple illustrative example: any human effort is and forever will be unable to stop such a process where the Nature development plan is ready to replace a “dry land” by a see.)

At any responsible level of state authorities and self-governments as well as in any context of international co-operation, geoethics might be able to help in paving a better way for the needed understanding of nature by human kind. Geoethical principles (the planet Earth = absolute value of the life; principles of respect, interdependence, harmony and balance of interests, responsibility to future generations, prognosticating, precaution, riversibility, integration, frugality) [3] should be incorporated in the optimal way into the consciousness and life of the contemporaneous global society.

2.2 Global warming and cooling in the geological history

Problems of global warning are vey frequently discussed because of their imminent impact on sustainability. But historical human records are incomplete without considering historical geological records (e.g. Fig.1). Only Earth and Planetary sciences are able to serve as mediators for any research needed in detecting the character and predictability of such phenomena as global warming and cooling. Let us remember the conclusion of the 33rd International Geological Congress in Oslo (2008): *Planet Earth has a superb archive of past climates which documents great climate variability throughout Earth's history. Today's changes should be seen in the context of these billions of years of natural change.*

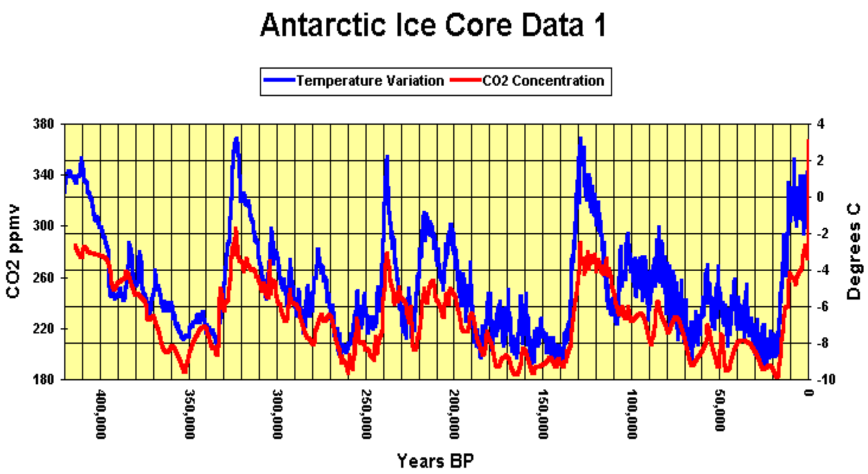

Figure 1. *Global temperature variation for the past 425,000 years*
The data derived from an analysis of ice cores taken at the Vostok station in Antarctica. The present is at the right. The horizontal 0 line represents the 1961–990 average global temperature. The numbers on the right show variation from that baseline in °C. - Image based on data from the National Oceanographic and Atmospheric Administration.

The same results can be summarized in case of regularly repeated periods of global warming and cooling as demonstrated in several symposia during the recent 34th International Geological Congress in Brisbane (August 2012) [4] :

Ninety five percent of the Cenozoic exhibited little to no bi-polar glaciation, in part due to high CO_2. Yet the lessons gleaned from this pre-icehouse climate archive with records of climatic warmth have not informed discussions of the future as much as they should. Contributions identifying key patterns and processes that caused, maintained, perturbed, and modulated pre-Quaternary greenhouse climate conditions were presented (symposium 3.5: *The silent majority: Cenozoic (Paleocene-Pliocene) records of climatic warmth*). - The Earth's severe global palaeoclimatic cycles, from global icehouse to greenhouse conditions, witnessed in the Neoproterozoic recur also throughout the Palaeozoic Era (as reported by the symposium 3.7: *Pre-Mesozoic climates and global change*). The polar areas have shown extreme variations in climate through Earth history from the onset of major glaciation during the Cenozoic to the present rapid changes in the Arctic and Antarctic Peninsula. These areas also are the regions where major processes influencing biogeochemical cycles and climate feedbacks are active. How the polar areas have responded to past changes gives important insights in how the planet will respond to future change (presented by the symposium 26.2: *Polar climate archives and their global significance*).

3. New Geoethically Interesting Phenomena (Selected Case Stories)

Three examples are presented below (technical data based on public informations).

3.1 Italy (2009): L´Aquila earthquake [5]

L´Aquila was largely destroyed by earthquakes in 1315, 1319, 1452, 1461, 1501, 1646, 1703 (until that time altogether about 3000 victims) and 1786 (about 6000 victims of this event only). The city was rebuilt and remained stable until October 2008, when tremors began again. From January 1 through April 5, 2009, 304 additional tremors were reported. Giampaolo Giuliani from the Italian National Institute of Astrophysics predicted a major earthquake on Italian television a month before, after measuring increased levels of radon emitted from the ground. He was accused of being alarmist by the Director of the Civil Defense, Guido Bertolaso, and forced to remove his findings from the Internet. He was also reported to police a week before the main quake for "causing fear" among the local population when he predicted an earthquake was imminent in Sulmona about 50 km from L'Aquila, on 30 March, after a 4° quake happened (later Sulmona only suffered minor damages by the 6 April earthquake). Enzo Boschi, the head of the National Institute of Geophysics and Volcanology declared: *Every time there is an earthquake there are people who claim to have predicted it. As far as I know nobody predicted this earth-quake with precision. It is not possible to predict earthquakes.*

Figure 1. *Nuns walk past the ruins*

Predicting earthquakes based on radon emissions has been studied by scientists since the 1970s, but enthusiasm for it had faded due to inconsistent results. Italy's National Commission for Prediction and Prevention of Major Risks met in L'Aquila for one hour on March 31, 2009, to assess the earthquake swarms. Accordingly to the minutes, Enzo Boschi was asked if they were precursors to an earthquake resembling the one in 1703. He replied: *"It is unlikely that an earthquake like the one in 1703 could occur in the short term, but the possibility cannot be totally excluded.*" On April 6, 2009, a 6.3 magnitude earthquake struck Aquila and nearby towns, killing 308 people and injuring more than 1,500. The quake also destroyed roughly 20,000 buildings, temporarily displacing another 65,000 people. In July 2010, prosecutor Fabio Picuti charged the Commission members with manslaughter and negligence for failing to warn the public of the impending risk. The trial has implications for scientists, engineers, administrators, and legal systems far beyond Italy's borders. After Picuti made the charges public in June 2010, Alan Leshner, executive publisher of *Science*, sent an open letter of protest to Italian President Giorgio Napolitano on behalf of the American Association for the Advancement of Science. He wrote that the *"charges against these scientists are both unfair and naïve….There is no accepted scientific method for earthquake prediction that can be reliably used to warn citizens of an impending disaster."* The American Geophysical Union and thousands of other scientists also objected. Picuti reportedly responded: *"I'm not crazy. I know they can't predict earthquakes. The basis of the charges is not that they didn't predict the earthquake. As functionaries of the state, they had certain duties imposed by law: to evaluate and characterise the risks that were present in Aquila." (Source: Max Rossi/Reuters).* The verdict has been expected for November 2012.

3.1.1 Conclusions to the case

It is evident that at least two geoethical problems connected with this case should be solved also from a legal point of view demanding new up-to-date internationally acceptable definitions and protections in respective laws:
a) new legal limits for „false alarms" and reasonable risk and danger levels should be established;
b) avoiding underestimation of „incompetent" scientists.

Let us remember that any real effective development of the science – especially when laws of the Earth deelopment are to be discovered – cannot follow too strictly "democratic principles"; usually singular researchers arrive with new experiences and discoveries trying to get – step by step – a support of a minority unless a general consensus is achieved. This way should be followed in case of the still until now proclaimed "absolute" impossibility of any earthquake prediction.

Another practical geoethical recommendation and message should be remembered to scientists as well as to the population. Reciprocal respect should be based also on the use of a reciprocally understandable language. The obligation of scientists is to use the complete verity with clearly defined words.

3.2 Iceland (2010): eruption of Eyjafjallajokull [6]

Eyjafjallajokull barely compares to major eruptions like Mount St. Helens in 1980, which released 1.5 million metric tons of sulfur dioxide into the atmosphere, or the catastrophe of Krakatoa in Indonesia in 1883, which killed more than 40,000 people and was felt around the world. During Eyjafjallajokull, by contrast, there have been no deaths, and just 800 people living near the volcano had to be evacuated. But Eyjafjallajokull's eruption had a major impact on the world, as its 7-mile-high plume of volcanic gases and silicate ash has spread across much of Europe (see Figure 3) bringing air travel across the continent to a near standstill.

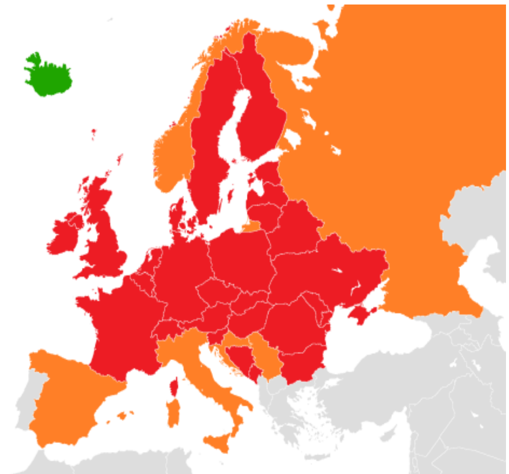

Figure 3. *Airspace completely (red) or partially (orange) closed to air traffic*

Delays and cancellations hit airports from Toronto to Tokyo, and the problems had cost the global air-travel industry an estimated $200 million a day.

Still, the havoc caused by Eyjafjallajokull is a reminder that in our globalized, interconnected world, it's less the sheer power of a natural disaster than where and when it happens — and how prepared we are to respond. Eyjafjallajokull was at the right place at the right time to wreak maximum havoc on air travel. (Even relatively small amounts of volcanic ash high in the air can clog sensitive jet engines, shutting down ventilation and causing the machinery to melt down and fail.) If the volcano had erupted in the years before air travel became common, it wouldn't have caused trouble for anyone but the people of Iceland.

3.2.1 Conclusions to the case

Let us emphasize a new experience: because of the increased sensibility of the new technology even a relatively small natural disaster may cause unexpected problems of an unexpected range (no more limited to an adjacent local area).

3.3 Japan (2011): 2011 earthquake off the Pacific coast of Tōhoku [7]

This often referred earthquake is also known as the 2011 Töhoku earthquake, the Great East Japan Earthquake, and the 3.11 Earthquake, was a magnitude 9.0 (M_w) undersea megathrust earthquake off the coast of Japan that occurred on 11 March 2011, with the epicenter approximately 70 kilometres east of the Oshika Peninsula of Tōhoku and the hypocenter at an underwater depth of approximately 32 km. It was the most powerful known earthquake ever to have hit Japan.

On 12 September 2012, a Japanese National Police Agency report confirmed 15,870 deaths, 6,114 injured, and 2,814 people missing across twenty prefectures, as well as 129,225 buildings totally collapsed, with a further 254,204 buildings 'half collapsed', and another 691,766 buildings partially damaged. The earthquake and tsunami also caused extensive and severe structural damage in north-eastern Japan, including heavy damage to roads and railways as well as fires in many areas, and a dam collapse. Japanese Prime Minister Naoto Kan said, *"In the 65 years after the end of World War II, this is the toughest and the most difficult crisis for Japan."* Around 4.4 million households in northeastern Japan were left without electricity and 1.5 million without water.

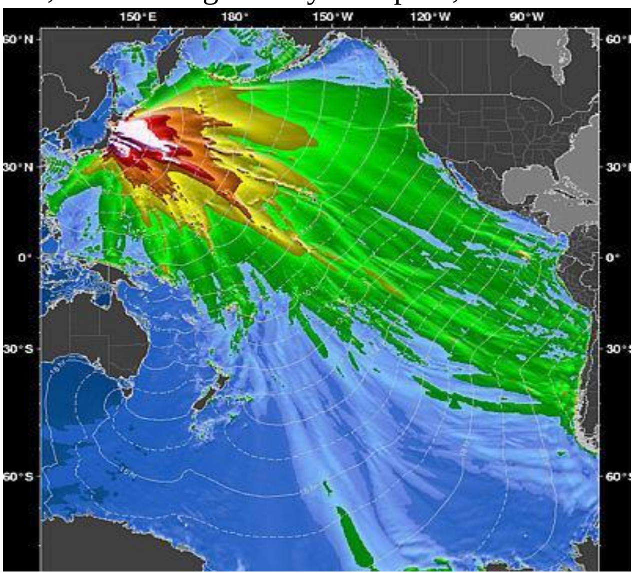

Figure 4. Animation of tsunami wave diffusion in the Pacific Ocean

The tsunami caused a number of nuclear accidents, primarily the level 7 meltdowns at three reactors in the Fukushima Daiichi Nuclear Power Plant complex, and the associated evacuation zones affecting hundreds of thousands of residents. Many electrical generators were taken down, and at least three nuclear reactors suffered explosions due to hydrogen gas that had built up within their outer containment buildings after cooling system failure. Residents within a 20 km radius of the Fukushima Daiichi Nuclear Power Plant and a 10 km radius of the Fukushima Daini Nuclear Power Plant were evacuated. In addition, the U.S. recommended that its citizens evacuate up to 80 km of the plant.

3.3.1 Conclusions to the case

Accordingly to the personal experiences of the author Japan is among the top countries in the world (if not the only one) – well prepared for big seismic events. Whereas the proper earthquake with the magnitude of 9.0 has caused minimum of deaths (incomparably lower than tragic events from 1923) the tsunami in a substantial way has broken any known record. The existing anti-tsunami measures were not appropriate to what really had to be expected in a short time distance.

4. Conclusions

It is necessary to find appropriate structures which would make it possible to incorporate geoethical principles in the optimal way into the consciousness and the daily life of the global society. All efforts of not only Earth and Planetary scientists, ecologists and pedagogues but also of managers, leaders, politicians and statesmen at any level should respect – in the sense of geoethics – their own responsibility for the fate of our planet and of all its inhabitants including the future generations.

As to the final social, cultural, economic and environmental consequences for sustainability it is necessary to seek new priorities emphasizing more and more the solidarity of human kind. The needed geoethical way of thinking should be based on generally accepted moral and ethical principles achieved by mankind by various ways and experiences (in spite of some current contrary trends). Geological factors need to be reflected and respected in any concept of environmental sustainability. People have to live in a coexistence with the Nature trying to permanently improve any knowledge of its behaviour and predictability.

Acknowledgments

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Conflict of Interest

The author declares no conflict of interest.

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Note

1. Regularity of Structural Patterns (excerpt from: Němec, V. (2006): *Geoethical dimension of the geological risk assessment.* - 5th European Congress on Regional Geoscientific Cartography, vol. 1, 408-410, Barcelona (Spain) – B-31.042-2006/1)

Many natural phenomena both in space and in time have a periodical and hierarchical character. Many tectonic phenomena are controlled by special laws and they have their own characteristic features. They occur in regular structural patterns, i. e. in systems of zones which may repeat themselves at equal distances. A hierarchical character of the spacing is also evident. Many geological phenomena connected with inundations in the geological history can be further studied and evaluated in order to make more precise prediction of possible occurrences of such potential dangers in the future.

The author started to develop an original model of regular structural patterns in 1970. The improved version assumes that in the course of geological time the earth crust conserves at any point a tendency to its decomposition into hierarchically organized blocks separated by disjunctive boundaries (sutures, lineaments, joints etc.) corresponding to critical latitudes, meridians and diagonals. These decomposed systems should be always related to the respective successive palaeopoles. Any further positive progress of learning regular structural patterns may help to decipher the algorithms of the Nature. Many specific features are to be taken into account: changes of the poles position, inherited structures, transformations of crustal blocks (tectonic plates), etc. Geometric regularities are probably of the equal importance as various other geological criteria used for deciphering the tectonic history of the earth crust. They have to be taken into consideration in any serious effort to construct appropriate reliable models of basement tectonics. Their practical importance for improving reliability of any prediction of natural hazards like earthquakes or volcanic activities is evident. New models are to be elaborated with a strong liaison to cartographers.