CLIMATE-RELATED HAZARDS

A.V. Kislov
Moscow State University, Russia

A.N. Krenke
Institute of Geography, Russian Academy of Sciences, Russia

Keywords: atmosphere, atmospheric front, atmospheric whirls, cyclone, drought, dust storm, flood, forecast, frost, hot, human perception, insurance, legislation, mountains, planetary waves, precipitation, reservoir, river, scale, sea coast, snow fall, wind.

Contents

1. Introduction
2. Description and major types of climate-related natural hazards
3. Interdependence and scale of the various climate-related hazards
4. Comparative analysis of climate-related natural hazards
5. Human perception of climate-related hazards
6. Forecast and prediction of climate-related hazards
Glossary
Bibliography
Biographical Sketches

Summary

Natural hazards related to deficiency or excess of precipitation, with destructive winds and anomalous temperatures, are described. Moisture deficiency causes dry winds, dust storms and vegetation fires, and surplus moisture causes storms, river and lake floods, snowfalls and ice growth. Wind is a major danger presented by tropical and extra-tropical cyclones (especially wind-induced surges caused by wind and striking coastlines), spouts and tornadoes. Extreme frost and dangerous heat are related to anomalous temperatures. Other hazards such as breaching floods and ice-crusted ground are also described.

These hazards are classified by intensity and degree of manifestation, and their interactions (attraction or mutual exclusion) are described. Examples of series of natural hazards are presented. Their scope and methods of forecast are briefly characterized. Large-scale hazards such as droughts and anomalous spring floods are predicted within the framework of regular hydrometeorological forecasts. Smaller and short-term hazards such as rain floods, hurricanes and tornadoes are forecast either a) probabilistically (increased probability is indicated for specific regions), b) by tracking the whirlwinds that cause these hazards or c) by means of special hydrodynamic models, which are still insufficiently developed and lacking in data. Finally, various types of responses to natural hazards from individual peoples and society as a whole are described. These responses include hazard avoidance (e.g. emigration), reconciliation with hazards (including protection as the hazard appears) and precautionary protection and control (e.g. hail prevention).

1. Introduction

Climate-related hazards and temporal deviation of weather characteristics from the norm in a particular region and in a particular season, are dangerous to life and economic activity. Such anomalies may be considered as the normal parameters for other regions (e.g. 50-100 mm of precipitation per day can be a catastrophic event in the temporal zone but a normal one during the wet season in the tropics). However, anomalous hydrometerorological events, which greatly deviate from the norm and which are widely regarded as natural hazards (e.g. tornadoes with record wind velocity and pressure differences), are not uncommon.

Weather conditions which are unfavorable but normal for a particular area and season, such as Siberian frosts and long periods without precipitation in the deserts, cannot be regarded as natural hazards.

Difficult-to-forecast irregular anomalies are related to sharp changes in climatic system and result from its nonlinear nature. Relations between atmospheric anomalies and hydrological regime are most significant, e.g. the relations between precipitation and floods or winds and raised water levels.

The ratio of the intensity of an anomaly in relation to climatic variability can be a useful criterion in distinguishing natural hazards. It is generally agreed that extreme events are usually those exceeding one, one and a half or two standard deviations in long-term observational series. Under a normal distribution this corresponds to approximate recurrence of such events less than once in every six, twenty or fifty years.

Such criteria vary with different kinds of events. For example, the probability of floods in river flood plains exceeds once in every five years, so only hayfields and pasture are reasonable forms of land use. When the probability of floods is once in every 5 to 20 years, agricultural crops can be sown. Rural building is possible, where the probability of flooding is from once in every hundred years to once in the every twenty years. If the probability of flooding is less than once in every hundred years urban building can be permitted, and if the probability of floods is less than once in every 330 years, railways should be permitted.

The above described classification is useful when planning measures for flood protection and damage reduction in developed areas, or for organization of resettlement and transfer of communications.

Criteria for distinguishing droughts vary in different countries. This fact complicates the comparison of drought catalogues in various regions. One of the approaches for distinguishing droughts includes the following characteristics: 15 days without precipitation, more than 30% decrease of precipitation over three weeks, 20% decrease in the monthly norm of precipitation with simultaneous growth of monthly average temperature by 1 ^{o}C, reduction of precipitation and reserves of soil moisture exceeding standard deviation and simultaneously the same positive deviation of the sum of mean daily temperatures above 10 ^{o}C (‘Ped’ criterion), more than a 50% reduction in the sum of soil moisture reserve, precipitation and evapotranspiration compared to the norm.

Finally, criteria based on various combinations of surface radiation intensity in different wavebands have been developed to forecast droughts from remote sensing.

The transition of meteorological parameters over the threshold value can be also a criterion for distinguishing natural hazards. For example, excess of moisture deficit over 20 hPa accompanied by wind with a velocity of over 3-5 m/sec., is usually considered to be a dry wind. As already mentioned, most of these criteria differ from region to region.

Finally, the danger which meteorological anomalies pose for a society depends on their readiness to be able to cope with them, e.g. the existence of dams affording protection from wind-induced and spring floods.

-
-
-

Bibliography

Avakyan A.B., 2000. Floods. Conception of their control. Izvestiya RAN, Seriya Geographicheskaya, No 5, p. 40-46 (Russian). [Data on the number of floods over the last 5-year periods and over the continents are presented. Recommendations on floodplain development are given]

Barry R.G., Chorley R.J., 1988. Atmosphere, weather and climate. London –New York, routledge (7th edition), 409 pp. [General climatology including natural hazards].

Chen Zhi Ming. 1996. Sequential analysis of China's hazards in geoscience. Geojournal, vol.38, No3, p. 259-263. [Casual succession of events related with natural hazards is described].

China Disasters Reduction Plan. 1999. *Action plan for mitigating the hazard damage is described.*

Comprehensive Risk assessment for Natural Hazards. WMO/TD. N995. 1999. [Recommendations on hazard risk assessment].

Dunn G.E., Miller B.I., 1969. Atlantic hurricanes. La Habana, Instituto de Meteorologia, 326 pp.

Heerdegen R.G., Rsier D.J., 1996. Does the hazards change with new legislation. The New Zeland experience. Geojournal, vol. 38, No3, p. 265-291. [The mechanism of evolution and recurrence of hurricanes in the Northern Atlantic].

Heerdegen R.G., Rosier D.J., 1996. Does the hazards change with new legislation. The New Zealand experience. Geojournal, vol.38, №3, p. 265-291. [Organization of the warning service and aid centers is described].

Krenke A.N., Chernavskaya M.M., 2000. Extreme climate phenomena over the Russian Plain during the Medieval warming and the Little Ice Age according to documentary records. Prace Geograiczne, zeszyt 107, Krakow, p. 79-83. [An analysis of dependence of climate-related hazards in the Russian plain on climatic epochs].

Myagkov S.M., 1995. Geography of the natural risk. M., MGU, 222 pp. (Russian). [Dependence of natural hazard risk on territory is assessed].

Natural hazards, local, national, global, 1974, ed. By G.F.White. New York, London, Toronto, 284 pp. [Scales of natural hazards and public responses are characterized for countries of varied economic status].

Natural risks assessment and management, 2000. The proceedings of All-Russia conference "Risk-2000". M., ANKIL, 488 pp. [Reports on hazard responses in Russia].

Osipov V.I. Natural disasters at the turn of the 21st century. Herald of the Russian Academy of Sciences. Moscow, Nauka/Interperiodika, 2001, vol. 71, №4, p. 291-303. [The facts on frequency of natural hazards round the world, over the continents and in Russia].

Parfit M., 1988. Living with the natural hazards. National geographic, vol.194, No1, July, p.2-39. [Popular paper on public response on natural hazards].

Pielke R.A.Jr. and Pielke R.A. Sr., 1997. Hurricanes, their nature and impact on society. John Willey and Sons. [Origin, manifestations and public responses to hurricanes are described].

Vasiliev A.A., Belinskiy O.N., Alekseeva A.A. at al. 1999. The unfavorable weather forecast and possibility of its improvement. In: 70 years of the Russia Hydrometeocenter. Sankt Peterburg, Hydrometeoizdat, p. 190-200. [Recommendations on forecasting meteorological hazards are presented].

Yokohama Strategy and Plan of Action for a Safer World. Guidelines for Natural Disaster Reduction. Yokohama, Japan, 23-27 May, 1994. United Nations. New York and Geneva, 1995. [Collected reports on mitigation of hazard damage].

Biographical Sketches

Alexandr Victorovich Kislov was born on 14 September 1953 in Moscow, Russia. In 1970 he entered the Geographical Faculty of Moscow State University and graduated from it in 1975 as a specialist in climatology and meteorology. From 1975 to 1978 he was a post-graduate student of the same University and in 1978 he received his PhD for the thesis "Distribution of Solar Radiation over the Tropical Zone". From he has been affiliated to the same University, as a junior researcher until 1981, assistant until 1989, docent until 1995 and professor since 1995. In 1993 he received the degree of Doc. Habilitat for his thesis about the genesis of global climate fluctuation in the Late Pleistocene and Holocene. In 1985 he received the title of Professor. He has a full time lecture courses at Moscow University and several post-graduate students have received PhDs under his supervision. His main interest has been climate theory, mainly using global and regional climate models, for example modeling of water balance in the Caspian Sea basin and the climatically induced evolution of permafrost over Jamal peninsula. He has part-time affiliation to the Laboratory of Climatology in the Institute of Geography.

He is a member of the International Working Group in Paleoclimate Modeling (PMIP), and he took part in a number of scientific conferences in different parts of the world, as well as in several field experiments. He has published four books and 67 original papers.

Alexandr Nikolaevich Krenke was born on 8 October 1931 in Moscow, Russia. He entered the Geographical Faculty of Moscow State University in 1949, and graduated in 1954 specialising in geography-hydrology. Until the end of 1956 he had a fellowship as a junior researcher in the Biological Research Station "Borok" on the Volga River, investigating currents in the reservoirs.

In December 1956 he joined the Glaciology Department of the Institute of Geography, Russian (than USSR) Academy of Sciences, and took part in the 26 month (1957 -59) wintering party on Franz-Joseph Land. He studied mass-balance and interrelations between climate and glaciation. In 1964 he received a PhD on this topic. He studied several glacier surges in the Pamirs and Caucasus, both theoretically and practically, giving advice to decision-making bodies. From 1965 to 1974 he was responsible for the national programme of ice, water and heat balances in glaciated basins for the International Hydrological Decade, and was leader of the corresponding expedition to the Caucasus. In 1980 he received a Doc. Habilitat degree for his second thesis "Mass-exchange of the glacier systems of the territory of USSR", which was published as a book in 1982. He was one of the main editors and authors of the World Atlas of Snow and Ice Resources, was involved in the preparation of the Arctic Atlas.

Since 1983 he has been head of the Laboratory of Climatology at the same Institute. Its main topics are the role of land surface in climate formation and changes and the history of climate in the last millennium. In 1985 he was appointed Professor, and gave occasional courses in several universities. Twenty-one post graduate students have received their PhD degrees under his supervision.

He was the scientific leader of two international field experiments KUREX-88 and KUREX-91, mainly dealing with snow-climate interrelations. He took part in the World Atlas of Natural Resources and is currently involved with the Atlas of Hazards in Russia. In 1997 he spent nine months in the National Snow and Ice Data Centre at Colorado University, as a grantee of the Fulbright Program. He has been a member of several international working groups and committees. He is currently a member of the Sustainable Management of Hydrological Processes Working Group in the International Geographical Union. He is author or co-author of eight books and about 200 papers.