NEST Pathfinder

E2-C2

TACKLING COMPLEXITY IN SCIENCE

Extreme events can't be predicted with traditional statistical methods.

Making sense of extreme events

Earthquakes, floods, storms, riots and stock-market crashes have one thing in common: they cannot be successfully described by conventional statistical methods. Such 'extreme events' are the focus of E2-C2, a 17-partner NEST project trying to understand, and perhaps predict, some of these unexpected and damaging occurrences. Among other things, the project will look at the social and economic effects of impending climate change and even attempt to forecast crime waves in major urban centres.

The earthquake and tsunami that ravaged many communities around the Indian Ocean in December 2004 were typical of what are called extreme events. They came as a complete surprise, even though the area was well known as an earthquake zone and the underlying geophysical mechanisms were well understood. Other extreme events include floods, storms, droughts and landslides. Not all such events have natural causes: stock-market crashes, bridge collapses, crime waves and terrorist attacks are of human origin but share many of the same characteristics. A third group of events – possible catastrophic effects of climate change on the economy – have both natural and human origins.

What they have in common is that they are not well described by conventional statistical methods. Mathematical models of geophysical, climatic or socio-economic systems may have some success in describing their normal state or gradual changes but are not able to predict sudden, extreme events. And, what is more, these events do seem to be more common than conventional statistical analyses would suggest.

Interconnected hazards

The E2-C2 project, part of a wider NEST PATHFINDER initiative on complexity in science, will take a new look at both natural and socio-economic hazards and the connections between them. The 17 partners from nine countries will attempt to predict extreme events and also examine their consequences.

The first task will be to improve the statistical theories used to model extreme events. Conventional statistical methods are very poor at describing events that happen infrequently, so a team will devise new methods of analysis and prediction, and test them against a variety of historical records.

The second line of research will look at extreme climatic events in Europe that arise from the way in which greenhouse-gas emissions and volcanic eruptions interact with natural climate variability. Partners will use atmospheric models to simulate the effects of global warming on the North Atlantic and Western Europe, and historical and geological records from the Campania region of Italy to investigate connections between volcanic eruptions and climatic extremes.

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E2-C2

AT A GLANCE

Official title
Extreme events: Causes and consequences

Coordinator
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Partners

- *France: Laboratoire des Sciences du Climat et de l' Environnement, joint institute of Centre National de la Recherche Scientifique (CNRS) and Comissariat à l' Energie Atomique (CEA)*
- *France: Société de Mathématiques Appliquées et de Sciences Humaines*
- *France: Centre International de Recherches sur l' Environnement et le Développement*
- *Germany: Meteorological Institute, Universität Hamburg*
- *Germany: Interdisciplinary Centre for Dynamics of Complex Systems, Universität Potsdam*
- *UK: King's College London*
- *Italy: Physics Department, Università degli Studi di Roma "La Sapienza"*
- *Belgium: Physics Department, Université de Liège*
- *Belgium: Institut Royal Météorologique de Belgique*
- *Russia: International Institute of Earthquake Prediction Theory and Mathematical Geophysics, Russian Academy of Sciences*
- *Italy: Istituto di Ricerca per la Protezione Idrogeologica, Consiglio Nazionale delle Ricerche (CNR)*
- *Italy: Dipartimento di Fisica Generale, Università degli Studi di Torino*
- *Romania: Institute of Geodynamics of the Romanian Academy*
- *USA: Institute of Geophysics & Planetary Physics, University of California at Los Angeles*
- *France: Institut de Physique du Globe de Paris*
- *Luxembourg: Centre d' Etudes de Populations, de Pauvreté et de Politiques Socio-Economiques*

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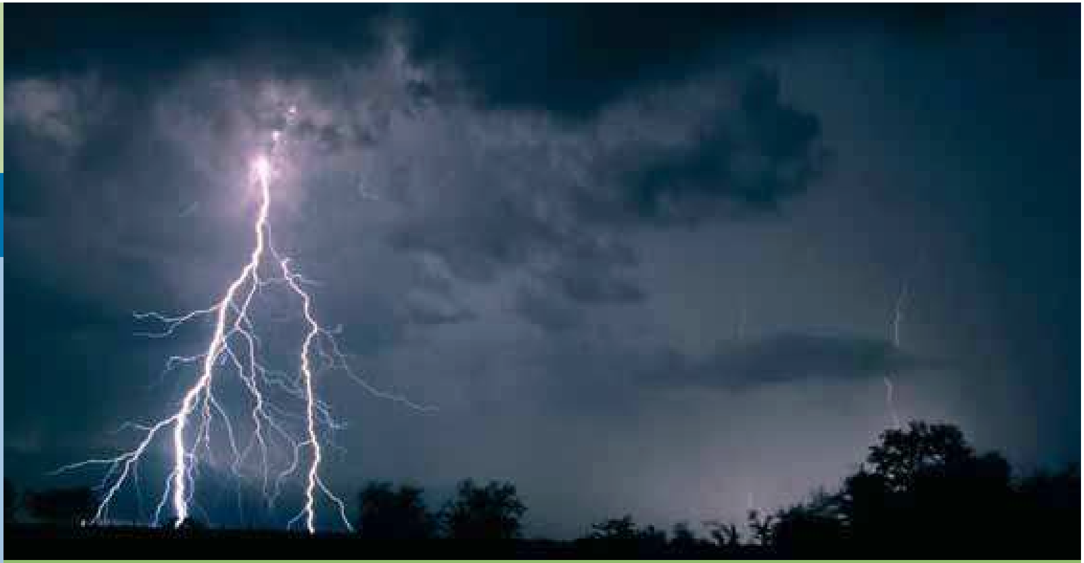

Better understanding of extreme events will help prepare communities better to deal with them.

Can a climatic extreme cause a reversal in the economic cycle? This is one of several questions on the relationship between climate and the economy that will be addressed by the third research group. Conventional long-term economic models are unable to cope with short-lived events such as the winter storms of 1999 or even the summer heat-wave of 2003. Therefore this group will aim at developing novel, fully integrated, dynamic models of the coupled climate-economy system.

Emergency planning

One reason why we need to understand extreme events is so that we can prepare for them in the design of buildings, control of land use and emergency planning. In each case, we need to know how often and how big any events are likely to be. Another task will be to look for evidence that extreme events are not random, but that one event may increase the likelihood of another. The team will look at records of strong winds, rogue waves, forest fires, hydrological extremes and landslides. They will attempt to simulate such events and develop methods for forecasting them.

The Carpathian Mountains in Romania are known for their major earthquakes, and another group will take on the goal of developing an earthquake prediction system for the Vrancea region, one of the world's best natural laboratories for studying earthquakes and landslides.

Finally, in perhaps the most ambitious activity in the E2-C2 project, a group will attempt to create a 'socio-economic barometer' to monitor conditions in major urban centres and provide day-by-day forecasts for impending crises such as crime waves, outbreaks of mass violence and surges in terrorist activity.

All these extreme events share a common characteristic: the bigger the event the less likely it is to happen, but the greater the social and economic costs if it does. It is too soon to say how successful the E2-C2 project will be, but any progress towards understanding and anticipating the unexpected is bound to pay off in the long run.

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SIXTH FRAMEWORK PROGRAMME