TIPPING POINT

Scientists test early warning systems to predict critical transition

Studying greenhouse-icehouse transition using NOAA data

Putting to test the new technology, these scientists are using the technique working on data related to greenhouse-icehouse transition with the help of data procured from National Oceanic and Atmospheric Administration (NOAA), US Department of Commerce. Greenhouse-icehouse transition occurred 34 million years ago when the earth's long lasting tropical state in which most recent life forms evolved, shifted abruptly and irreversibly to a cooler state with icecaps. They are also working on data generated from mathematical models of gene expression.

Rijke Tube experiment

Scientists used Rijke Tube, which converts heat into sound, to design the physical system and carry out the experiment. This physical system resembles many natural systems qualitatively. The tipping that is observed in natural systems can be captured and analysed in detail using this physical system.

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IN a path-breaking research, aerospace scientists and mathematicians of IIT Madras and IIT Ropar have tested early warning systems (EWS) that can predict critical transition (tipping point) of natural systems such as ecological systems, climatic systems or even financial markets.

Scientists claim that before a catastrophic event takes place, the system gives indication of the upcoming state-shift, which they call early warning signals. "If we can early detect the signals pattern before they hit a tipping point, then initiating appropriate management strategies to prevent a forthcoming catastrophe becomes easier. For instance, we would start seeing a lot of variability in the climate in an extreme way, seeing many records being broken, as a threshold for climatic change is approaching. We will start running often into hottest summers, coldest winters, wettest rains and driest droughts. Once Sahara desert was having thick vegetation; now it's a desert which meant a critical transition occurred," said RI Sujith of Department of Aerospace Engineering, IIT-M, told the *Express*.

Over the years, many early warning measures have been developed to successfully detect critical transitions observed in complex systems. However, these measures are often tested in mathematical models and not in real physical systems. Therefore, controlled laboratory-scale experiments are necessary to verify the robustness of the early warning measures in physical systems. Such testing is very critical to establish the reliability and robustness of EWS. This study is unique in the sense that it provides experimental evidence for the viability of the early warning measures using a controlled laboratory experiment.

"This is the first experimental evidence in a physical system such as fluid flow system. Further, it is one of the pioneering studies which consider the effect of fluctuations on the effectiveness of these early warning measures. From an engineering perspective, the benefits of this study are worth millions as it can help the big industries like gas-turbine companies," Sujith said and added that their research paper was published in *Scientific Reports (Nature)*.

Partha Sharathi Dutta of Department of Mathematics, IIT Ropar told *Express* that it is an exciting area of research, but the success of it depends on amount of data available. "We have taken into consideration the uncertainties and the continuous changes that take place in complex systems and still achieved 80% success rate."

To a query, the expert said how fast a catastrophe can be predicted is being probed. It's important to give enough time for governments to take preventive action.