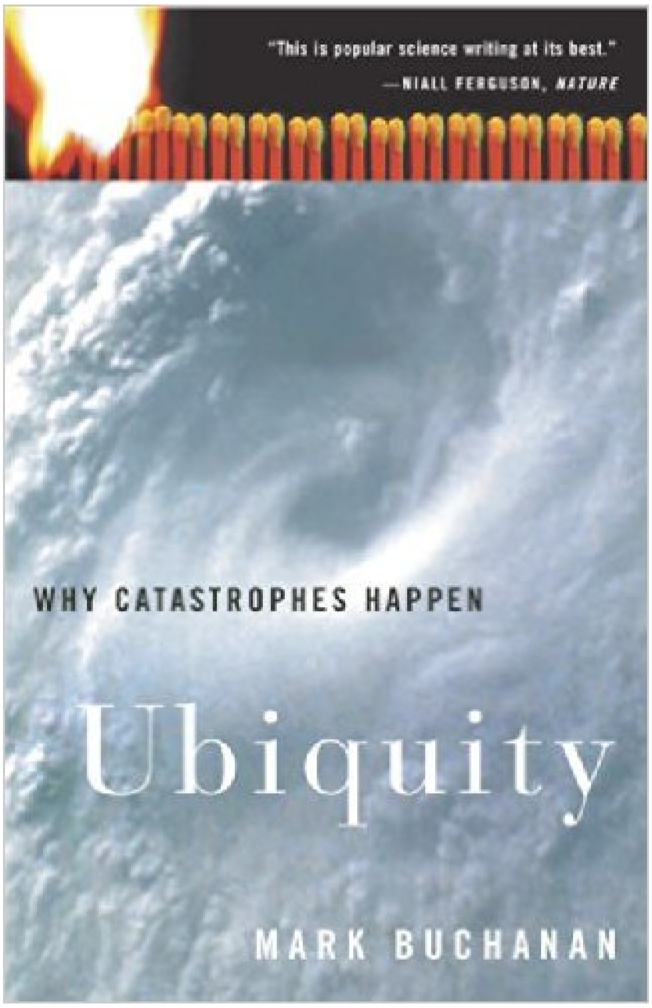
Ubiquity: Why Catastrophes Happen



Synopsis

Why do catastrophes happen? What sets off earthquakes, for example? What about mass extinctions of species? The outbreak of major wars? Massive traffic jams that seem to appear out of nowhere? Why does the stock market periodically suffer dramatic crashes? Why do some forest fires become superheated infernos that rage totally out of control? Experts have never been able to explain the causes of any of these disasters. Now scientists have discovered that these seemingly unrelated cataclysms, both natural and human, almost certainly all happen for one fundamental reason. More than that, there is not and never will be any way to predict them. Critically acclaimed science journalist Mark Buchanan tells the fascinating story of the discovery that there is a natural structure of instability woven into the fabric of our world. From humble beginnings studying the physics of sandpiles, scientists have learned that an astonishing range of thingsâ “Earthâ ™s crust, cars on a highway, the market for stocks, and the tightly woven networks of human societyâ “have a natural tendency to organize themselves into whatâ ™s called the â œcritical state,â • in which they are poised on what Buchanan describes as the â œknife-edge of instability.â • The more places scientists have looked for the critical state, the more places theyâ ™ve found it, and some believe that the pervasiveness of instability must now be seen as a fundamental feature of our world. Ubiquity is packed with stories of real-life catastrophes, such as the huge earthquake that in 1995 hit Kobe, Japan, killing 5,000 people; the forest fires that ravaged Yellowstone National Park in 1988; the stock market crash of 1987; the mass extinction that killed off the dinosaurs; and the outbreak of World War I. Combining literary flair with scientific rigor, Buchanan introduces the researchers who have pieced together the evidence of the critical state, explaining their ingenious work and unexpected insights in beautifully lucid prose. At the dawn of this new century, Buchanan reveals, we are witnessing the emergence of an extraordinarily powerful new field of science that will help us comprehend the bewildering and unruly rhythms that dominate our lives and may even lead to a true science of the dynamics of human culture and history. From the Hardcover edition.

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Customer Reviews

Who hasn’t wondered why catastrophes happen, and if they can be predicted or avoided? Economists and investors try to understand why markets crash, seismologists struggle to understand and predict great earthquakes, and historians speculate why empires crumble and global cataclysms such as the First and Second World Wars occur.Physicist and science journalist Mark Buchanan brings the science of what he calls "historical physics"--the study of systems that are far from equilibrium and, as he puts it poised "on the knife edge of instability" to bear on these questions.He describes a much-studied model of such catastrophe-prone systems, a simple sandpile. Build a sandpile by dropping one grain at a time on the top of the heap. It will eventually reach a critical state at which a grain can either make the pile a bit taller or start an avalanche, small or large. Scientists experimenting with real and virtual sandpiles have observed several important regularities:1. The time between avalanches is extremely variable, making it essentially impossible to predict when the next avalanche will occur.2. The size of avalanches is also extremely variable, making it essentially impossible to predict whether the next avalanche will be tiny or huge.3. A big avalanche doesn’t need a big cause; one grain can trigger a sandpile-flattening event.4. Avalanche sizes follow what mathematicians call a power law. What that means is that large events happen less frequently than small ones according to a fixed ratio. For sandpiles the frequency goes down by a factor of 2.14 for each doubling of avalanche size. For earthquakes the frequency goes down by a factor of four for each doubling of released energy.5.

This is not a hard book to read, but it is difficult to integrate into the way you look at the world. Mark Buchanan is a science writer who has worked on the editorial staff of Nature and as a features editor New Scientist. In this book he is writing about the development of a growing field of physics - complexity. Complexity is chaos in critical states. A critical state exists in a system that is not in equilibrium. You may have heard of the "butterfly effect". That is, there is a possibility that a butterfly flapping its wings in South America can cause a storm in Europe weeks later. However, that same butterfly can flap all in wants inside a closed balloon with no effects, other than maybe slightly increasing the temperature of the air in the balloon. The air inside the balloon is in equilibrium, even though the molecules exhibit chaotic behavior. The atmosphere is in a critical, i.e. non-equilibrium, state. A small perturbation somewhere can lead to very big changes.If the air inside the balloon is in equilibrium, its past, present and future are all the same. It has no "history". When things are in non-equilibrium, history matters since what happens now can never be washed away but affects the entire course of the future.The applications of this model extend from the piling of grains of sand in an hourglass to economics."Despite what scientists had previously believed, might the critical state in fact be quite common? Could riddling lines of instability of a logically equivalent sort run through the Earth's crust, for example, through forests and ecosystems, and perhaps even through the somewhat more abstract "fabric" of our economics?