










CHAPTER 14

Chaos Theory And Biospheric “Surprises”




 **CHAOS THEORY POSITS THAT COMPLEX, NON-LINEAR NATURAL SYSTEMS FOLLOW UNIVERSAL LAWS BUT ARE SO SENSITIVE THAT SMALL, INITIAL CHANGES CAN PRODUCE UNEXPECTED RESULTS THAT APPEAR RANDOM.**

-  **The Biosphere is a complex, non-linear natural system that functions as a single, self-regulating entity.¹**
-  **Small changes in the Biosphere can lead to passing the tipping points that signal irreversible changes.**
-  **Because the initial changes appear small, they may be disregarded or even missed entirely.**
-  **The “butterfly effect” posits that a tiny difference in initial conditions becomes amplified exponentially in the Biosphere and a major difference in trajectory may result.**





 **“WE ARE QUITE LITERALLY, IN A NEW WORLD, A MUCH MORE PECULIAR PLACE THAN IT SEEMED A FEW CENTURIES BACK, HARDER TO MAKE SENSE OF, RISKIER TO SPECULATE ABOUT, AND ALIVE WITH INFORMATION WHICH IS BECOMING MORE ACCESSIBLE AND BEWILDERING AT THE SAME TIME. IT SOMETIMES SEEMS THAT THERE IS NOT JUST MORE TO BE LEARNED, BUT THERE IS EVERYTHING TO BE LEARNED.”¹, p. x**

-  **What is humankind’s response to this concept that Earth is now a “new world”? Most people deny that massive changes are occurring, and they attack the bearers of “bad news” (i.e., scientists).**
-  **“Gaia theory forces a planetary perspective. It is the health of the planet that matters, not that of some individual species of organisms.”¹, p. xvii**
-  **“The health of the Earth is most threatened by change in natural ecosystems.”¹, p. xvii**

THE SHIFT IN OCEANIC pH FROM WEAKLY ALKALINE TO WEAKLY ACIDIC IS A “SMALL” CHANGE WORTH REVERSING SINCE THE OCEANS COVER APPROXIMATELY 70% OF EARTH’S SURFACE.




-  **The cause of pH change in the oceans, i.e., anthropogenic carbon dioxide emissions, has a pronounced effect in the Arctic since carbon dioxide is more soluble in cold water.**
-  **The pH “is likely to reach corrosive levels in less than 10 years. The water will then start to dissolve the shells of mussels and other shellfish and cause major disruption to the food chain.”²**
-  **Further acidification of the world’s oceans should be stopped through the major reduction of anthropogenic greenhouse gas emissions.**


“THE WORLD’S CORAL REEFS COULD BE WIPED OUT BY 2050 UNLESS URGENT ACTION IS TAKEN.”³





-  **Coral reefs are ecological “hot spots” with a diverse array of unique species.**
-  **Coral reefs process huge amounts of nutrients and energy, but occupy only a comparatively small space in the world’s oceans.**
-  **Multiple stresses act on coral reefs — “global warming; ocean acidification blamed on carbon dioxide pollution; shipping, overfishing, coastal development and agricultural runoff.”³**
-  **“... hundreds of millions of people depend on [coral reefs] for a living,” including both food and recreation.³**




“... A LARGE DISPARITY [EXISTS] IN AGRICULTURAL VULNERABILITY TO CLIMATE CHANGE BETWEEN DEVELOPED AND DEVELOPING COUNTRIES.”⁴

-  **The disparity has only worsened due to exponential human population growth and droughts, floods, wheat rust, and so on.**
-  **As chaos theory indicates, small initial changes can produce unexpected results that appear random.**
-  **When coping with multiple, interactive crises, developing policy on worst case scenarios is prudent, at least until predictive models based on interactive crises become available.**





 **“AMPHIBIAN DECLINES AROUND THE WORLD HAVE FORCED MANY SPECIES TO THE BRINK OF EXTINCTION, ARE MUCH MORE COMPLEX THAN REALIZED AND HAVE MULTIPLE CAUSES THAT ARE STILL NOT FULLY UNDERSTOOD.”⁵**


-  **“An enormous rate of change has occurred in the last 100 years, and amphibians are not evolving fast enough to keep up with it.”⁶**
-  **Amphibians are “one of Earth’s great survivors – evolving about 400 million years ago.”⁵ *Homo sapiens* evolved about 200,000 years ago.**
-  **If frogs cannot evolve rapidly enough, what are humankind’s chances?**
-  **Humans should be deeply concerned when one of the great survivors is facing extinction.**




 **“LOCAL EXTINCTION RATES OF AMERICAN PIKAS HAVE INCREASED NEARLY FIVE-FOLD IN THE LAST 10 YEARS, AND THE RATE AT WHICH THE CLIMATE-SENSITIVE SPECIES IS MOVING UP MOUNTAIN SLOPES HAS INCREASED 11-FOLD SINCE THE 20TH CENTURY.”⁷**

- 🌐 **When the pikas reach the top of the mountain, they have nowhere to go.**
- 🌐 **Humans have a similar situation — when sea level rise threatens low-lying islands (e.g., The Maldives) – since sovereign nations are not eager to welcome environmental refugees.**
- 🌐 **“The study’s most novel scientific contribution was that the factors apparently driving the local-extinction process were strongly different during the 20th Century than during 1999-2008, . . . knowledge of *past* population dynamics of a particular species may not always help researchers predict how and why distributions change in the *future*. That is, the rules of the ‘extinction game’ seem to be shifting.”⁷**

SCIENTIFIC RESEARCH MIGHT BE ABLE TO PROVIDE MEASUREMENTS FOR EFFECTS THAT CANNOT BE MEASURED NOW, BUT WILL THE SCIENTIFIC INFORMATION BE IGNORED?⁸

-  **Scientific predictive models can be used to take preventative measures before the risk becomes a reality.**
-  **Non-scientific misinformation presented as truth (i.e., fact) by special interest groups protecting their profits will probably lead to catastrophes.**
-  **Ignoring scientific information about global climate change places all of humanity at a huge risk — a risk that could be substantially reduced by enlightened use of scientific information.**
-  **Ignorance can be costly.**

 **“WHERE CHAOS BEGINS, CLASSICAL SCIENCE STOPS. FOR AS LONG AS THE WORLD HAS HAD PHYSICISTS INQUIRING INTO THE LAWS OF NATURE, IT HAS SUFFERED A SPECIAL IGNORANCE ABOUT DISORDER IN THE ATMOSPHERE, IN THE TURBULENT SEA, IN THE FLUCTUATIONS OF WILDLIFE POPULATIONS, IN THE OSCILLATIONS OF THE HEART AND BRAIN. THE IRREGULAR SIDE OF NATURE, THE DISCONTINUOUS AND ERRATIC SIDE — THESE HAVE BEEN PUZZLES TO SCIENCE, OR WORSE, MONSTROSITIES.”⁹, p. 3**

-  **Global systems will remain an enigma for many decades to come, but humankind’s survival requires an understanding of how they function.**
-  **Such endeavors will take scientists outside of their “comfort zone” of specialization.**
-  **Success requires that the assault on scientists and their evidence cease.**

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