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Black Swans and Probability: Predicting Rare Events

During his *Hot Science – Cool Talks* outreach lecture on the University of Texas Campus, Dr. David Orr presented the audience an illustration of a very important principle underlying all of science, and the prediction of Black Swan Events. Many patterns and observable aspects of nature (such as someone's height, body temperature, or hurricane intensity) follow what is known as a "Normal distribution", which is based on something called a "Gaussian function" that looks like a bell-shaped curve. This curve describes the probability of occurrence for a given phenomena. Do not let the funny symbols on the bottom of the graph intimidate you! Rather, observe that the percentage brackets show that the majority of measured values are concentrated around a "central" number, or an average.

What this means is that most observations or measurements of something in nature reflect a similar value. The probability of observing values that are far higher or lower than the average (the outer right and left "wings" of the bell curve) is far lower than observing something closer to the average (or the middle "hump" of the curve. Most swans are white. The probability of encountering a black swan is very low, and would be described by the outer most wings of the bell curve as a quantity.

As a metaphor, *black swans are rare events that are difficult to predict and influence populations and systems.* They are, however, often related to changes in ecological systems or weather events that impact human populations negatively. One of Dr. Orr's messages is that the earth's climate is being destabilized as a result of increased temperatures caused by greenhouse gasses. This destabilization ineffect can be considered to causing a *positive shift in the bell curve that describes damaging weather such as hurricane or drought intensity. That is, the entire probability curve for these events is shifting to the right towards higher intensity values.* The probability of encountering intense, damaging weather is increased because our Earth's climate favors more extreme weather. This has very serious implications for human economies, cultures, and loss of life.

It should be noted that while predictions have been made for more severe whether such as increased hurricane intensity and frequency, the probability of observing environmental black swans such as these is often misinterpreted. Many residents along coastal areas of the United States can often be overheard saying "we haven't had a hurricane hit our area in a while; we're due for one and I think this year it will happen". While the overall pattern of storm frequency over a several year period may be observed to increase, this does not mean that chances favor the occurrence of a storm in an area that has not seen one in a set of years. That is not how variability or the degree to which observations of a given phenomenon differs from an "average" value. A coastal region may suffer strikes from multiple severe hurricanes in one season, and then encounter mild weather without intense hurricanes for multiple years. This has been observed in the Gulf of Mexico over the past 20 years. However, the fact remains that the overall probability of encountering storms described as having a "rare and severe intensity" in the U.S. future is increased due to climate destabilization from greenhouse gasses (GHGs).



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Sources

- "Black Swans & the U.S. Future: Building Sustainable & Resilient Societies" by Dr. David W. Orr, Professor of Environmental Studies and Politics, Oberlin College. *Hot Science – Cool Talks*, Friday, September 14, 2012. The University of Texas at Austin.
 - Webpage Containing Presentation, and Lecture Webcast: <u>http://www.esi.utexas.edu/k-12-a-the-community/hot-science-cool-talks/black-swans-a-the-us-future-creating-sustainable-a-resilient-societies</u>
- "Normal Distribution" Wikipedia: <u>http://en.wikipedia.org/wiki/Normal_distribution</u>