



SHORELINES – April 2007
(As presented to the Island Review)

Global Warming & Rising Seas Part II – The Holocene, Younger Dryas, Medieval Warming Period, Little Ice Age, and other odd words.

In last month's edition of *Shorelines*, we dove head first into the sometimes contentious issue of global climate change, most notably the relationship between "global warming" and rising sea levels. We established that greenhouse gases trap the sun's radiation causing global temperatures to rise and triggering continental ice packs (glaciers) to melt. The melting ice provides additional water to the world's oceans and hence causing sea level to rise. While this phenomenon is considered as the main driver regarding climate change and sea level movement, there are many other variables that also play an important role in this relationship including; dust from volcanic eruptions and air pollution, oceanic currents, solar activity, water evaporation from oceans, expansion and contraction of seawater, tectonic activity, land subsidence, isostatic rebound of land, and others.

Our primer on climate/sea level was precipitated by the February 2007 release of the Intergovernmental Panel on Climate Change's fourth report since 1988, which is considered as the gold star of everything climate and sea level. While much of the discussion regarding climate change is focused on the present, it is also interesting to review how climate has oscillated in the past and how these relatively minor hiccups in temperature have changed the direction of humankind.

We often lose sight that we are actually living in the larger timeframe known as the *Quaternary* geologic period that roughly started 1.8 million years ago and is signified by periodic episodes of interglacial and glacial activity (i.e., hot and cold global temperatures). While there is some debate regarding how many exact episodes of glaciation/interglaciation has occurred in the past 1.8 million years, we do know the last interglacial (time of warm temperatures) was roughly 125,000 years ago (peak). Climate subsequently took a downturn and into our last time period of widespread glaciation, which started ~70,000 years ago and bottomed out ~18,000 years ago. It is believed that sea level was at one time ~400 foot below where it is today! Climate subsequently began to warm and initiated our current interglacial event that we are still a part of. There is compelling evidence the current phase of warming that started ~18,000 years ago began rather slowly and spiked sharply upward near 11,500 years ago.

Actually, 11,500 years ago is the demarcation for the end of the *Pleistocene* Epoch and the beginning of the **Holocene** Epoch. The Pleistocene and Holocene Epochs simply comprise the larger Quaternary Period in the geologic timescale. These phonetics aside, we are living in the Holocene and things got very interesting just after the Holocene started 11,500 years ago.

The accompanying figure is a reconstructed climate curve for the Holocene (11,500 years ago to the present). Remember, this is *not* a sea-level curve because as mentioned above, there are many variables besides or in addition to climate that causes sea level to

rise and fall; however it might be useful to consider this climate curve as a loose proxy for sea-level movement. Also depicted on this figure are some well known climatic events associated with these relatively small-scale oscillations in temperature. These events are so well known that they have unique names and have possibly changed the course of history on a few occasions.

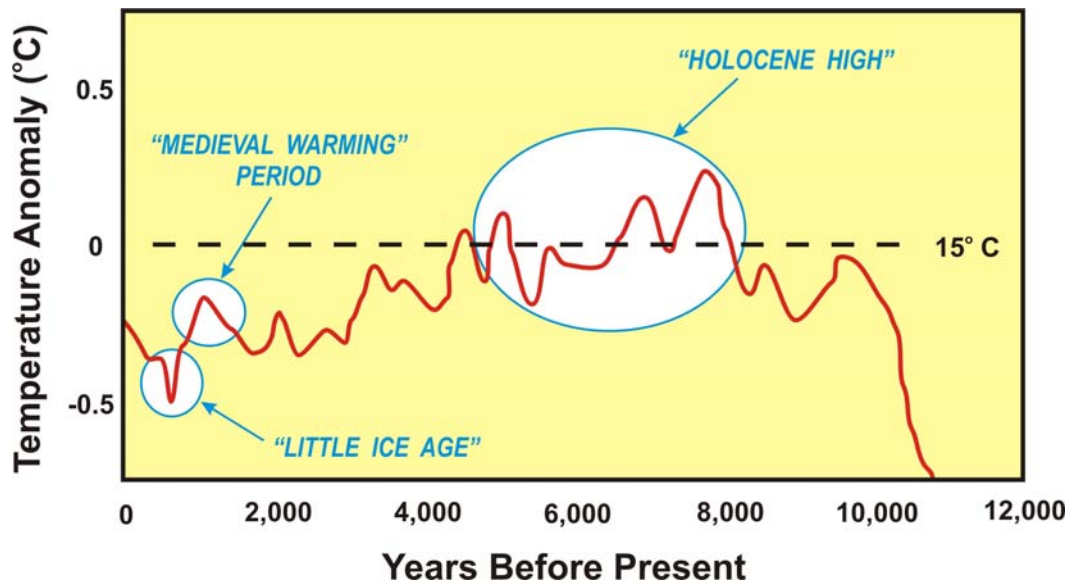


Fig. 1 – A Holocene climate curve depicting temperature changes over the last 11,500 years including some of the more well known climatic events. While global temperature trends may provide us a good proxy and often mimic sea-level changes, the correlation is by no means “one to one”.

First of all, the sharp increase in temperature nearly 11,500 years ago that initiated the Holocene was preceded by the “**Younger Dryas**” - a brief, abrupt cold spell that is believed to have occur roughly 12,700 to 11,500 years ago - a last gasp of the Pleistocene if you will. The Younger Dryas is named after an alpine/tundra wildflower, and the sharp rise in temperature signifying the end of the Younger Dryas is often linked to the dawn of agriculture (believed to be in the Middle East)!

This leads us to another climate event known as the “**Holocene High**” that generally extended between 9,000 – 5,000 years ago. Global temperature is reported to have been slightly higher than today and accordingly, sea level may have also been at higher levels than the present! Interestingly in order for island barriers to develop, shorelines and water depth need to remain essentially unchanged. By doing so, enough time elapses for waves to build the sand accumulations which eventually become barrier islands. If the available quantity of sand and/or the rate of sea level change oscillates dramatically, then barrier formation may never be completed. There is a great deal of concurrence that many of our barrier islands along the Atlantic coast formed roughly 3,000 years ago. This coincides with a time period just after the “Holocene High” where climate, and supposedly sea-level reached a plateau providing the conditions necessary for sand to accumulate and to be somewhat stranded as climate and possibly sea level dropped.



The next climate event, and our first one in historical context, is known as the **“Medieval Warming Period”** and occurred roughly 700 – 1,200 years ago, or 800-1300 AD. The impacts to Europe were most obvious and well documented, and the increase in temperature is credited to the colonization of Greenland by Erik the Red who was greeted to lush vegetation in southern Greenland with plenty of opportunities for farming, hunting, and trade. The warm climate also attributed to the Viking invasion of northern Europe. Although many factors play into wine-making, expansive vineyards reached northern Britain and other high latitude areas that are not cultivated today.

While climate may have helped the Vikings expand into northern Europe and Scandinavia, a drop in global temperature may have also caused their demise as the **“Little Ice Age”** ensued from roughly 1300 – 1850 AD (150 – 700 years ago). Scandinavian settlements vanished, possibly because of famine during the 15th Century when climatic conditions deteriorated, crops vanished, and contact with Europe was lost. The Little Ice Age also saw glaciers in the Swiss Alpine advance consuming villages in the process, disappearing crops and famine in Scotland, Finland, Sweden, and other high latitude countries, and fantastic freezes of the Thames River in England and New York Harbor. Although modifications by humans have changed the hydraulics of these water bodies since the 17th and 18th centuries, there is a little more than coincidence at play considering this is the last time these water bodies froze. A question that is currently being discussed is whether or not, or to what degree sea level rose or fell in response to the climate changes experienced during the Medieval Warming Period and Little Ice Age.

Where are we now? Actually we’re on a temperature upswing since the Little Ice Age ended – coincidentally at just about the same time the Industrial Revolution started. Much of our current phase of global warming can be attributed to natural forces, but we can’t ignore the human input in the form of increased greenhouse gases which is exacerbating this effect - a reality resoundingly echoed by the Intergovernmental Panel on Climate Change in February. The enviro-socio-economic solutions to reduce the human signature on global warming and rising seas will be very interesting to watch evolve and implement. Centuries from now, after we are all long gone, it will be just as interesting to see what our climate event will be known as in the history books. Who knows, maybe “the new millennium meltdown” or “the Holocene hot spell”.

Author’s note: For the sake of completeness, there is some line of thought that the Medieval Warming Period and Little Ice Age were more European-centric than global. The Intergovernmental Panel on Climate Change will likely address the regionalism or globalism of these events in their full report due later this year. Also, several sources of information were utilized to prepare this edition of *Shorelines*, and while these sources are not included here for logistical reasons, please do not hesitate to contact the Shore Protection Office directly for a list.