

# AD 536: The Worst Year Ever and Our New Ragnarok

by

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## Preparation

Before beginning this case study:

- Listen to the following episode from *The Viking Age* podcast: “Eastern Way III: Catastrophe and Opportunity,” <<http://vikingagepodcast.com/catastrophe-and-opportunity>>
- Review the following webpage about day-to-day life in Old Norse culture: “Farms and Villages in the Viking Age,” <[http://www.hurstwic.org/history/articles/daily\\_living/text/Villages.htm](http://www.hurstwic.org/history/articles/daily_living/text/Villages.htm)>

## Part I – The Past

*Brothers will fight and kill each other, sisters' children will defile kinship. It is harsh in the world, whoredom rife  
—an axe age, a sword age—shields are riven—a wind age, a wolf age— before the world goes headlong.  
No man will have mercy on another.*

This apocalyptic passage of poetry (Dronke, 1997) describes the “Fimbulwinter” (the great winter) that will precede the final cataclysmic end of the world in Old Norse (think Vikings) mythology: Ragnarok. Does this mythical prediction of times to come have root in actual events from the past? Are we doomed to enter our own “axe age” as current anthropogenic (i.e., of human origin) climate change progresses? Hopefully this case study will help answer these questions.

In 536 AD there was a climatic event that changed normal weather patterns across the northern half of the planet for years. This event, known as the “Dust Veil,” dramatically reduced the amount of sunlight that reached the planet’s surface, causing dramatic reductions in agricultural output over summer months and exacerbating already harsh winter conditions in Iron Age northern latitude cultures. This event has been confirmed using multiple lines of evidence such as fossilized tree-ring data, historical narratives, glacial ice-cores and isotope analysis (Graslund & Price, 2012; Helama *et al.*, 2017; Gibbons, 2018). A reduction of 3-4<sup>o</sup> C has been estimated for that time period: a seemingly small, yet dramatic climatic shift.

There is evidence of the Dust Veil ranging from present-day Spain, and Middle-East to western North America as well as the aforementioned northern latitudes, with impacts lasting until 550 AD (Graslund & Price, 2012). The cause of this climatic disturbance was likely the result of major volcanic activity around present-day Iceland which sent a large dust plume into the upper atmosphere, reducing the amount of solar radiation that reached the surface of the earth (Helama *et al.*, 2017; Gibbons, 2018).

## Task

On the map below (Figure 1), outline the origin and approximate geographical area of influence of the Dust Veil event of the middle 550s.



Figure 1. Outline the origin and approximate geographical area of influence of the Dust Veil event of the middle 550s.

The changes in the planet's climate, from the Dust Veil, drove human populations to react to those climatic changes in dramatic ways. As the climate cooled, agricultural crops failed driving famine into Norse homes. An estimated 75% of occupied sites throughout ancient Sweden were abandoned after more than 1000 years of continuous use, with similar outcomes throughout the rest of Scandinavia. Norse populations not only declined, but how people lived in their environments changed as well; populated centers moved away from historically productive areas to areas on hilltops, and there was an increase in development of fortified ring-forts at the same time (Graslund & Price, 2012).

### Distribution of Excavated Prehistoric Settlements

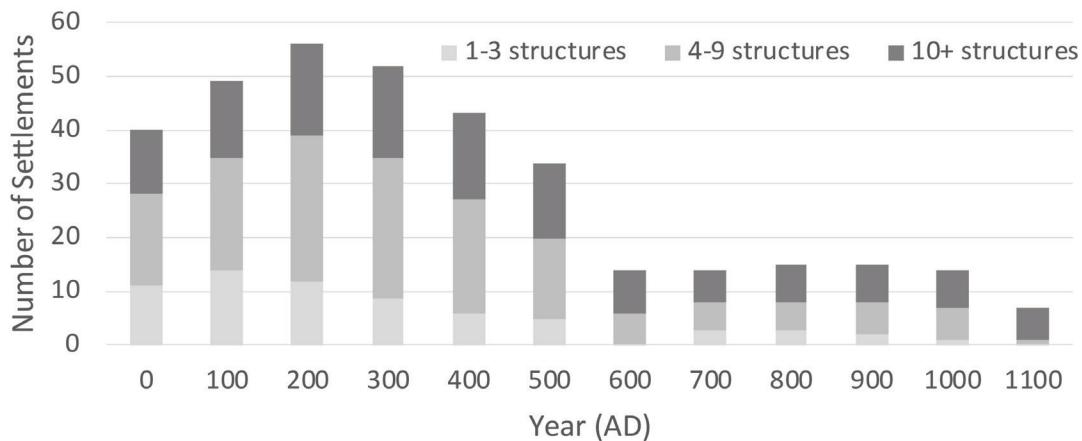


Figure 2. Chronological distribution of excavated prehistoric settlements. Data from: Graslund & Price, (2012).

### Questions

- Using the data presented in the graph above (Figure 2), describe the archaeological evidence of a reduction in settlements around the Dust Veil time period. Describe the changes in total numbers of settlements and what types of settlements people were living in.

2. Think about what life would have been like for people in 536 AD Scandinavia. In what specific ways could a rapid and sustained cooling of the climate alter their:
  - a. Food production practices?
  
  - b. Social structure?
  
3. Why were populations more strongly affected by the Dust Veil in northern latitudes than those closer to the equator?

## Part II – The Present

Current climate change models predict a 3-4<sup>o</sup> C temperature increase in the near future due to anthropogenic carbon dioxide inputs into the atmosphere; primarily through the burning of fossil fuels. The effect on the globe is predicted to cover a much broader geographical area and persist for a much longer time than the Dust Veil of the mid-500's.

The 30 year average global temperature from the middle of the 20th century provides a reasonable base value from which to extrapolate short and long term climatic changes. Using the 1951-1980 average global temperature (<https://climate.nasa.gov/vital-signs/global-temperature/>.) as the “zero” point, it is possible to track global temperature change over time.

### Tasks

1. Use Figure 3 below to graph the data in Table 1 to visualize temperature data from 1880–2017.
2. Predictions based on current climate change models range from 2.5 to 10<sup>o</sup> C increases in global temperature over the next century (<https://climate.nasa.gov/effects/>). Extrapolate the low and high range temperature change predictions on your graph above (use the 2100 date).

Table 1. Temperature data.

Year	Temperature Deviation (°C)
1880	-0.19
1890	-0.37
1900	-0.09
1910	-0.44
1920	-0.25
1930	-0.15
1940	0.11
1950	-0.19
1960	-0.02
1970	0.03
1980	0.27
1990	0.44
2000	0.4
2010	0.7
2017	0.9

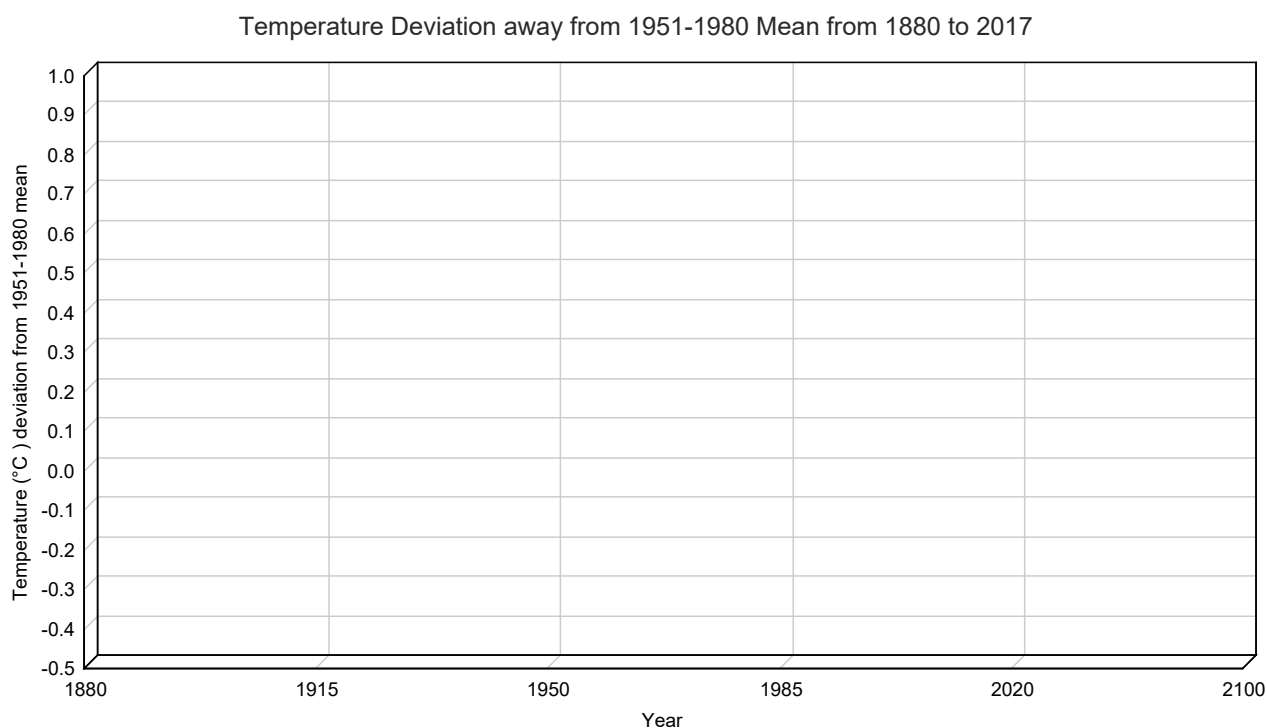


Figure 3. Temperature deviation away from 1951–1980 mean from 1880 to 2017.

### Question

1. During the last ice age (the Pleistocene epoch; think woolly mammoths), temperatures were estimated to be 5 to 9 °C cooler than today (<https://climate.nasa.gov/effects/>). Broadly speaking, how were polar latitudes ecosystems on earth different under this temperature regime than today? Why?

## Part III – The Future

### Questions

1. If global ecosystems functioned differently under long-term colder regimes (as in glaciation events seen during the Pleistocene) and human systems were rapidly altered under short-term temperature changes (as in the Dust Veil event), is it reasonable to predict major alterations in the functioning of global ecosystems and of human interactions as well due to current anthropogenic climate change? Give some potential examples. (Review list of 10 Key Findings from Karl *et al.* 2009, at the end of the case.)
2. List three major climatically driven “natural disasters” that have made national or international news headlines over the past 10 years. How may anthropogenic climate change have impacted these events?
3. Observed warming of winter temperatures as well as increases in severity of hurricanes and drought conditions in the Southwestern United States are projected as a result of climate change (Karl *et al.*, 2009). What impacts might we expect to see in the below geographical areas with regards to agriculture, urban/industrial infrastructure and water availability? What are some other ways you might expect to see impacts?

Midwestern U.S.

Agriculture:

Urban/industrial infrastructure:

Water availability:

Other:

Southwestern U.S.

Agriculture:

Urban/industrial infrastructure:

Water availability:

Other:

Gulf Coast/Southeastern U.S.

Agriculture:

Urban/industrial infrastructure:

Water availability:

Other:

Northeast U.S.

Agriculture:

Urban/industrial infrastructure:

Water availability:

Other:

Northwest U.S.

Agriculture::

Urban/industrial infrastructure:

Water availability:

Other:

Where you live (if it is not listed above):

4. Discussions surrounding anthropogenic climate change are often couched in apocalyptic terms (indeed this very case study began with such a theme) but this is a challenge that we, as a species, are capable of addressing. Our technology got us into this mess, and modification and sustainable use of technology can get us out. List five ways that large human systems (e.g., agriculture, power generation, urbanization, etc.) can be modified to lessen their impact with regards to climate change.

A.

B.

C.

D.

E.

5. List five ways that you as an individual can modify your resource usage to lessen your personal impact on climate change.

A.

B.

C.

D.

E.

6. Extrapolate these changes by 8–10 billion to see the impact that we, as individuals, can have on global systems.

## Key Findings from Karl *et al.* (2009), p. 12.

1. *Global warming is unequivocal and primarily human-induced.*  
Global temperature has increased over the past 50 years. This observed increase is due primarily to human induced emissions of heat-trapping gases.
2. *Climate changes are underway in the United States and are projected to grow.*  
Climate-related changes are already observed in the United States and its coastal waters. These include increases in heavy downpours, rising temperature and sea level, rapidly retreating glaciers, thawing permafrost, lengthening growing seasons, lengthening ice-free seasons in the ocean and on lakes and rivers, earlier snowmelt, and alterations in river flows. These changes are projected to grow.
3. *Widespread climate-related impacts are occurring now and are expected to increase.*  
Climate changes are already affecting water, energy, transportation, agriculture, ecosystems, and health. These impacts are different from region to region and will grow under projected climate change.
4. *Climate change will stress water resources.*  
Water is an issue in every region, but the nature of the potential impacts varies. Drought, related to reduced precipitation, increased evaporation, and increased water loss from plants, is an important issue in many regions, especially in the West. Floods and water quality problems are likely to be amplified by climate change in most regions. Declines in mountain snowpack are important in the West and Alaska where snowpack provides vital natural water storage.
5. *Crop and livestock production will be increasingly challenged.*  
Many crops show positive responses to elevated carbon dioxide and low levels of warming, but higher levels of warming often negatively affect growth and yields. Increased pests, water stress, diseases, and weather extremes will pose adaptation challenges for crop and livestock production.
6. *Coastal areas are at increasing risk from sea-level rise and storm surge.*  
Sea-level rise and storm surge place many U.S. coastal areas at increasing risk of erosion and flooding, especially along the Atlantic and Gulf Coasts, Pacific Islands, and parts of Alaska. Energy and transportation infrastructure and other property in coastal areas are very likely to be adversely affected.
7. *Risks to human health will increase.*  
Harmful health impacts of climate change are related to increasing heat stress, waterborne diseases, poor air quality, extreme weather events, and diseases transmitted by insects and rodents. Reduced cold stress provides some benefits. Robust public health infrastructure can reduce the potential for negative impacts.
8. *Climate change will interact with many social and environmental stresses.*  
Climate change will combine with pollution, population growth, overuse of resources, urbanization, and other social, economic, and environmental stresses to create larger impacts than from any of these factors alone.
9. *Thresholds will be crossed, leading to large changes in climate and ecosystems.*  
There are a variety of thresholds in the climate system and ecosystems. These thresholds determine, for example, the presence of sea ice and permafrost, and the survival of species, from fish to insect pests, with implications for society. With further climate change, the crossing of additional thresholds is expected.
10. *Future climate change and its impacts depend on choices made today.*  
The amount and rate of future climate change depend primarily on current and future human-caused emissions of heat-trapping gases and airborne particles. Responses involve reducing emissions to limit future warming, and adapting to the changes that are unavoidable.

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