Reflective Disequilibrium

Friday, May 11, 2012

What to eat during impact winter?

A number of possible global catastrophic risks seem like they would do their worst damage by disrupting food production. Some examples include nuclear winter, asteroid impacts, and supervolcanoes. In addition to directly laying waste to significant areas, such events would cast ash, dust, or other materials into the atmosphere. Temperatures would fall and solar radiation for primary producers would be reduced, causing agricultural failures and wreaking havoc on wilderness ecologies. It seems clear that feasible events of this sort could cost hundreds of millions or even billions of lives. But would even extreme events actually bring about would they cause human extinction or constitute an existential risk?

There are several sources of evidence we can bring to bear on the question. We can apply the "outside view" and consider the species, including hominids and primates, that have survived past volcanic and asteroid impacts. We can examine current supplies of food sources that could provide for humans during a period of impaired solar radiation. And we can look at past and present social behavior that bears on the distribution of food and recovery from period of severe famine. In the aggregate, it seems to me that humanity would survive one of these severe food disruptions, despite terrible quantities of death and misery.

This post will take a first-pass look at existing food sources that could be drawn upon during a "year without the Sun," or something close to it.

Grain stockpiles

The United Nations Food and Agriculture Organization produces Food Outlook, which reports (see "Cereal Market Summary") world production of some 2.3 billion tons of cereals, with stockpiles fluctuating around 22% of annual production, or about 80 days of consumption at current rates. The food statistics below will mostly be drawn from the same source.

However, only about 46% of cereal consumption was by humans in the data, with 34% going to animal feed, and the remainder applied to other uses such as planting seed, biofuels, industry, and spoilage. If food was diverted from these purposes as much as possible, by slaughtering livestock and ceasing biofuel production, grain stocks might be stretched to close to half a year's global consumption.

Livestock slaughter

Livestock producing milk, meat, eggs, and so forth typically consume multiple calories in feed for each calorie of animal product provided for human consumption, in addition to other costs. So in a world with a severe rise in food prices or tight non-price rationing of food reserves, they would likely be slaughtered both to save feed, as noted above, and to consume the existing supply. Annual (non-fish) meat production is about 300 million tons, and milk production around 700 million tons. However milk has about a fifth of the energy density of wheat flour (water content), while meat is closer to cereals in energy density.

The age of slaughter for egg-laying chickens, meat chickens, pigs, dairy cattle, and beef cattle vary from less than a year to several years, but it seems that slaughtering the standing population of livestock might provide a year's production, a quantity of food comparable to global cereal stocks.

Intensive fishing
The FAO reports about 90 million tons of annual wild fish capture and 60 million tons of aquaculture. The aquaculture often involves providing feed. Many wild fisheries have suffered from overfishing, but in the event of nuclear winter or impact winter it would make sense to catch as much as possible before stocks collapsed from reduced solar radiation and thus aquatic primary production. Not to mention the need to survive until agriculture rebounds.

Processed and preserved foods
Agricultural statistics cover stockpiles of raw ingredients, but not processed goods including the inventories of food retailers and food stored in private homes. My understanding is that retailers are fairly effective in minimizing inventories, so that these would provide only a small number of weeks.

Body fat reserves
Humans have survived for years in conditions of famine, in concentration camps, and other conditions where caloric intake was cut by more than half from normal levels. While those who have already suffered from malnutrition and starvation would be far less resilient, much of the world's population is overweight and well-nourished, with fat reserves that could substitute for most calories for weeks or months. However, low food rations would reduce productivity, including at agricultural and other essential jobs for survival.

Wild land animals
Populations such as buffalo, caribou, wildebeest, kangaroo, rabbits, squirrels, pigeons, and so forth would likely be slaughtered as well, although the accessible biomass would likely be substantially smaller than livestock supplies.

Decay organisms
Dead animals and forests would provide food for fungi, termites, and similar creatures. Termites in particular are widely used for human consumption, and could make good use of dead unburned forests.

Electric light agriculture
Insofar as some sources of electricity remain they could be used to enable greenhouse agriculture. Large power plants would be relatively likely to be disrupted by a catastrophe, and fuel for generators might be wasted, but smaller systems such as windmills and geothermal energy systems might provide sustained power which could not be consumed all at once. This would be energetically very inefficient, so seems fairly niche.

Chemosynthesis of food
[Added. I am indebted to Dave Denkenberger for this point.] Annual production of fossil fuels dwarfs foodstuffs in energy content, and these could be converted into food through the use of chemosynthetic microorganisms or chemical processes.

Theory and practice
Taking these stocks together, they could plausibly keep the majority of the population alive for a "year without agriculture," and with appropriate preservation could sustain smaller populations for much longer, assuming the stockpiles were effectively harvested and distributed to maximize the number of surviving people.

However, the nuclear destruction of cities, or the non-agricultural effects of volcanoes and asteroids, would probably not be conducive to such an orderly scenario. Disaster would directly kill essential workers, disrupt transportation of food and supplies, and directly destroy various stockpiles. Also, social conflict and collapse could greatly worsen the situation, as I'll discuss in a follow-up.

Posted by Carl at Friday, May 11, 2012
Labels: agriculture, collapse, existential risk, global catastrophic risk

4 comments:

Jesper Östman said...

How is the 1-year assumption justified and how likely does it seem (compared to longer periods) given all-out nuclear war? Wikipedia mentions research implying periods of several years without agriculture.

Sunday, June 03, 2012 8:36:00 AM

Dave Denkenberger said...

I have done a significant amount of work on this concept - please e-mail David.Denkenberger@Gmail.com to discuss. Thanks.

Monday, June 18, 2012 9:51:00 PM

Steamboat Lion said...

I explored this scenario recently in a novel (Newton's Ark) and came to similar conclusions about the likely amounts and sources of food supplies. I was less sanguine about the outcomes mostly due to econoic and social collapse getting in the way of maximising and protecting food stores.

Monday, November 05, 2012 2:40:00 PM

Carl said...

Thanks for the pointer to your book, it looks interesting. I agree that social collapse and infighting drive a wedge between the technically feasible and practical.

Monday, November 05, 2012 3:44:00 PM

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