

# Integrative Risk Management for abrupt catastrophes destroying 10%-20% of global food supply

A. L. Ray Taylor<sup>1</sup>, David Denkenberger<sup>2</sup>, Joshua M. Pearce<sup>3</sup>

<sup>1</sup>Denkenberger Systemic Shock Group, UK. [ray@foodsystemshock.com](mailto:ray@foodsystemshock.com)

<sup>2</sup>Global Catastrophic Risks Institute, [GCRInstitute.org/integrated-assessment](http://GCRInstitute.org/integrated-assessment), USA [david.denkenberger@gmail.com](mailto:david.denkenberger@gmail.com)

<sup>3</sup>Department of Materials Science & Engineering, Michigan Technological University, Houghton, USA. E-mail: [pearce@mtu.edu](mailto:pearce@mtu.edu)

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## 1. INTRODUCTION (relevance for risk practitioners, developing countries and UN World Food Program)

In this decade, a Global Catastrophic Risk (GCR) or the effect of several extreme weather events could lead to multiple bread basket failure and a 10% global food deficit or worse (Denkenberger and Pearce, 2014). Lloyds of London recently published a scenario<sup>i</sup> describing a possible food system shock with global impact (GFSS). Research for the UK Foreign Office suggest that *due to extreme weather events alone* there is an 80% risk of this degree of shock in this century (Bailey et al., 2015). The reinsurance industry in the London and USA is now addressing many of these risks. GCRs from non-weather causes include so many quantifiable “low probability high impact” risks to the food-transport-energy nexus<sup>ii</sup> that in aggregate they have a greater than 1 in 10 probability of occurring in any given 10 year period (D C Denkenberger and Pearce, 2016). In addition, more than 5 shocks of less than 3% of global output can also be expected *with high confidence*. This is only from known extreme weather events, *so the total risk is greater* (3% is still very serious – the 2008 food price spike was linked to a loss of less than 0.2% and perhaps more a result of factors other than actual shortage). So it can be considered extremely likely that disaster risk reduction (DRR) staff and others involved with the Hyogo/Sendai framework and food, security, logistics, diplomacy, consulting or politics will be involved in preparedness for or responding to at least *two* such unprecedented global events in their lifetime. Awareness is also increasing concerning the specific and multiple vulnerabilities of regional and global transport systems<sup>iii</sup> For journalists or those who are skeptical about reinsurers or the predictability of individual events, it is possible to simply make this argument: “Make an allowance for stresses from climate/ population growth/ resource pressure, and for unknown risks, and then assume a normal or poisson distribution of shocks in any given century, and take account of the obvious likelihood that everyone will have to deal with at least one outlier or Black Swan event. Taken together, it is not hard to believe that most people alive today can expect with fair confidence to live through several food shocks worse than 2008 and at least one major global food system shock GFSS or, in the worst case, 'actual global famine' ”. This would put 100 million people at risk of starvation within months, and conceivably up to 2 billion deaths across Africa, Asia, the Middle East and the Americas within 2 years (Helfand, 2013).

“Sometimes the worst case *does* happen.” John Ewert, USGS



Pinatubo, a VEI 6 eruption *during* Typhoon Yunya.

June 15, 1991

“Climate impact was stronger than an El Nino event.”  
([USGS](http://USGS))

Note that VEI- 7 eruptions put 10 times more material into the atmosphere than Pinatubo, with correspondingly greater impacts on temperature and rainfall, putting harvests at risk globally.

In these scenarios, given no additional preparedness, the UN’s World Food Program and other major relief agencies would be completely unable to source sufficient food/logistics capacity for famine relief, which implies a need for alternate approaches, so very relevant for Sendai and SDG target 1.5 (resilience in developing countries).

Among known examples of GCRs are atypical crop pathogen, abrupt climate change, regional nuclear war, and level 7 volcanic eruption. In almost all of these, reinsurance and increased grain storage are not sufficient to prevent sustained food shortages, or

even viable and fundable given shipping constraints and other currently pressing global priorities such as already existing malnutrition, poverty and insecurities.

The Hyogo/Sendai Framework, does not *explicitly* address all non-climate global catastrophic risks (GCRs). Nevertheless, the Hyogo framework sections on regional and national actors and coordination provide a necessary foundation for effective preparedness, response and gap identification in relation to GCRs.

Our goal is to support preparedness work, response planning and assessments of convertible/re-deployable capacity which would support national and regional DRR networks to save many lives in the event of any global catastrophic risk which affects multiple breadbaskets. (SDG target 11.5) Our particular concern is scenarios affecting populous developing nations, or scenarios where WFP and other major relief agencies were unable to source serious quantities of *any staples at all* from exporting nations or on open markets for a period of 2-24 months. (SDG target 13.1 resilience and adaptive capacity)

In our full paper we intend to address issues of climate/water stress, sovereignty, participatory planning, impacts on and leadership by women of the Global South, Amartya Sen's work, transport, distribution etc. Chatham House staff in London are among those looking at economic and diplomatic aspects of potential freight choke points in nexus shock scenarios (i.e. the food-energy-transport nexus, as defined by the Global Sustainability Institute, UK.)<sup>ii, iii</sup>

## 2. CATASTROPHIC RISKS and REGIONAL/GLOBAL FOOD SYSTEM VULNERABILITY

### *Duty of Care = Duty of Preparedness* (Sendai Priority Areas 1 & 2)

We are here discussing a large number of low probability high impact risks, mostly *not* climate related, though in most cases droughts/floods/heat stress/storm damage are likely to be pre-existing or complicating stressors. (Denkenberger and Pearce, 2015). In aggregate, these risks, *where known and quantifiable*, added to extreme weather risks have around a 10% probability of occurring per decade (Bailey et al., 2015; D C Denkenberger and Pearce, 2016). They don't all destroy crops immediately, but what *would* affect food prices immediately (and is in itself a hazard) despite the best efforts of the Rapid Response Forum, would be *media reports* of a projected global food deficit. The reinsurance industry (including Willis Re and a major US reinsurer) is now addressing these high impact risks<sup>iv</sup>. This means that some industries are being forced to show investors they have addressed these risks. There are historical precedents for this<sup>v</sup>. Taking as a given that lives matter more than money, we consider that some degree of preparedness is *also* a professional duty of care for governments, academics, funders, relevant private sector organisations and senior DRR professionals. Current learning in integrated risk management, especially at the regional level, can *and should* be scaled up to address such risks. IMF, World Bank, WWF, US Navy analysts, Mars, several foreign ministries (e.g. UK, USA), Mars Cargill and others are looking at aspects of this<sup>vi</sup>. The UK's recent EU referendum experience has recently shown how a lack of preparedness even for a predictable event with few physical impacts can cause economic trauma, so it is not hard to imagine that an unexpected event with major physical impacts on crops or transport systems would need good preparedness in place, including not only DRR professionals, but the whole range of integrative risk disciplines, also diplomats and media professionals (and their older colleagues and on-call lawyers, who can potentially act as an “institutional memory and prompt” during periods of crisis).

When considering shocks to the global food system, most current research focuses on scenarios which cut total global output by much less than 5%. A sub-group of the GCR research community looks specifically at “lifeboat scenarios” where 90%-100% of global output is hit. There is therefore an obvious gap in published literature for scenarios in the 5-20% and 20-90% ranges. These scenarios are both much more likely than 100% scenarios, and offer researchers much more scope to contribute to saving large numbers of lives. Now that many of the risks have been assessed quantitatively, and no longer form part of poorly thought through science fiction and distorted Hollywood alarmism, the lack of literature and preparedness is unconscionable and (perhaps legally?) negligent. We have a collective duty of care to redress this before we find ourselves struck by an impact we have no readiness for, at a time when front line staff and budgets are already overstressed responding to climate stress, conflict and refugees. Hoping that we are no longer alive “before or after the comet strikes” is not a sufficient response, now that we know that zero cost and low cost preparedness is possible.

## 2. PRAGMATIC SOLUTIONS

### *Cheaper than storage, better than refugees*

The kind of operation conducted by the US military and civil marine to avert a famine in India in 1965<sup>vii</sup> (when there was more than a few months' warning) would be a tremendous challenge for any merchant fleet currently available, even with several months warning. So, for similar or worse or more sudden scenarios, advance work is needed to determine what *could* be done, by whom, and what other options there are for worst case scenarios (other than conventional deliveries of food aid by WFP and others). Without stress tests, apparently quite minor problems become very significant: for example, as of March 2016, there are no ports in South Africa where sufficient silt has been dredged to enable the docking of major relief supplies, meaning that even media reports alone of corn harvest failure could cause a crisis, not just in South Africa itself but across the whole of southern

Africa. In most cases, these GCRs (combined with choke points/limitations on distribution) can *not* be protected against simply by increased grain storage, especially if North America is affected by the GCR (as the US and Canada supply so much grain to WFP and others). However, recent work on catastrophic risks, risk mitigation, ramp-up rates and alternate foods suggests that these scenarios, *given good preparedness and prompt decisions nationally and multilaterally*, could, given prompt decisions, play out much more favourably, probably at very low cost per life saved (D C Denkenberger and Pearce, 2016). In one of the very worst (and very unlikely) scenarios, a VEI 8 eruption, there would be a 5 year winter, but even here, Baum, Denkenberger and Pearce have shown how, with “cooperation between continents”, enough food could be produced to feed 10 billion people and also some populations of large mammals (Baum et al., 2016). A small but clear example is that biofuel plants could be quickly converted to produce food. A key intervention would be making protein from natural gas via bacteria, a technology already in use in fish farming. There are even historic precedents relevant to the urban context which we have space only to list: (a) the nationwide introduction of building regulations reduced US fire-deaths massively and this elimination of a “local catastrophic risk” and was forced *by reinsurers* (b) in the UK during World War 2, there was a massive increase in domestic food production (c) during US prohibition, breweries were converted to produce carbonated beverages and baked goods. In an emergency, a brewery is a giant biological plant with chemistry that can produce carbohydrate and much else from a variety of inputs. In Africa, many women brew at home, so scale here is adaptable - many traditional survival strategies could become very valuable across multiple regions with similar climate/soil/human resources.

### Research gaps

Risk and consequence	Research is needed to establish likely starvation and malnutrition rates with a range of scenarios. (This has been done for nuclear war scenarios and human epidemics, but for little else (David C Denkenberger and Pearce, 2016))
Industry/ technologies	What are the ramp up rates in both conventional and alternate food production, and also in distribution, and what could be done in advance to increase them? Which technologies currently available but not in extensive and widespread use, would become useful and affordable with a severe food deficit?
Legislation	Would legislation (e.g. to ensure rapid convertibility of biofuels plants to safe human food production) be helpful?
Strategic studies	What stress tests be conducted to identify hazardous and critical choke points have been done, and what others are needed? In >10% GCRs, or extreme catastrophes affecting 30%-90% of harvests on just 1-3 continents, could preparedness work on affected <i>and</i> unaffected continents make the difference between a billion casualties and tens of thousands? Would some regions need to rely on traditional resilience and/ or organised migration and/ or specialised support teams?
Politics/ communication/ emotion	Would, in reality, the US or another industrial power assemble a coalition of cooperators, and if so, what advance work would ensure the Global South would be fully included? What led to non-cooperative choices in the 2008 food price spike, and what led to cooperation in the following food price crisis? There is no published response plan for any global shock impacting >10% of global food supply, and little for anything over 5% – is there perhaps a good reason why not? What has been the effect of communication on these topics to date? Why? Are there lessons from swine flu and Ebola about alarmism vs complacency, emotions and speed of response? Can responses to global catastrophic events be prepared effectively in advance at multi-lateral levels? Can they be drilled? If not, can they usefully be simulated or stress tested or prepared using scenario planning exercises? Does the reality of the internet, and the reality that most over 20s don't yet see its full potential, mean that we under-estimate national and global response capacities?
Global media & response	Is there a useful role for media work in presenting a case for pragmatic GCR preparedness? Could the media inform public and politicians about preparedness and cooperation options in a helpful or unhelpful way now, in the 2020s, <i>or in the event of a catastrophe</i> ? Would advance training be necessary, and who should receive it? What would make the difference between helpful and unhelpful, defining helpful as leading to inter-continental cooperation and unhelpful as encouraging escalating conflict or beggar-thy-neighbour? Will more communication and media attention to these topics enhance and support cooperative action, or, as in examples of early-warning, could it lead to buck-passing, and what determines the difference? And how will social media, the internet and virtual reality change everything in these scenarios?
Economics	What is the value of research on these topics compared to climate adaptation, income generation in least developed countries, etc?

### FURTHER STEPS: Integral Global Catastrophic Risk Management and Sendai Framework / SDGs

In the middle of a chaotic environmental or military crisis in 2018, 2028 or 2038, politicians, diplomats and civil servants will already be dealing urgently with a host of immediate negative consequences, and international negotiation or conflict, and worried or angry domestic populations and (perhaps most challenging of all) distressed family members and ambitious or maverick colleagues. In such an environment (which may include financial collapse or breakdown of trading systems) it is unrealistic to expect them to think and plan months ahead to ensure the recovery of food systems, especially if this requires mobilising resources which haven't been previously identified, assessed, tested and (ideally) researched and drilled over a period of 3 years. The situation would be much better if industry, academics, DRR planners and logistics/ food/ agriculture/ freight/ energy/ consulting companies, etc had already (i.e. during 2016-2019) looked at what production could be ramped up (or converted or created, where, how quickly) and how quickly food could be moved to where needed, without needing or expecting politicians to be able to focus on this and give a clear lead in the initial days and weeks – they will have enough to deal with already, and intelligent choices by industry, NGOs, cities, towns and media leadership may make the difference between a difficult but valuable struggle, and global panic or despair and folly.

We recognize that this all needs to be set in the context of duties, responsibilities, entitlements and capabilities at state and community levels. So, our goal is to encourage work now which can help the DRR community and others save many lives in the event of a >10% shock, secondary to a global catastrophic event, a global catastrophic disaster risk response (GC-DRR?!)

As I write this I hear in the background on the BBC World Service radio an account of the Mount Pinatubo eruption (from which I took the USGS quote about how the worst sometimes *does* happen). Although this was “only” a VEI level 6 eruption, it happened at the same time as a typhoon, and caused an almost 1F drop in global average surface temperatures. In 2008 and again in 2011, two individuals were able to persuade governments of Japan and Ukraine respectively to release food onto markets, preventing sustained high prices and so stopping a long uptick in malnutrition-related deaths. In a more extreme scenario, with an actual global deficit (which was not the situation in these two cases) it would not be possible to prevent mass starvation in this way.

We propose:

1. INTEGRATIVE DIALOGUE (*Sendai Priority Areas 1, 2*): publications and an online seminar series or e-symposium to bridge the gap between two very distinct communities of researchers, practitioners, policy makers and funders:

DRR                      - // -                      GCR \*  
disaster risk reduction                      global catastrophic risk

2. EXPERTISE (*Sendai 1, 4*): creation of a combined GCR-DRR web-gallery of expert advisers, companies, consultancies, departments and faculties. (E.g. in some scenarios there is a huge increase in UV light, so need fast-growing UV-resistant crops.)

3. STRATEGY (*Sendai 2, 4*): convene a joint DRR-GCR working group *and/or* lean project to collect recommendations on *priority preparedness work* from DRR & GCR professionals, aimed at specific industries, universities, funders and governments.

4. INTEGRATION (*Sendai 1*): formally recommending the initiation of seminar series at “integrating schools” (e.g. Oxford University's Martin School & FHI, CSER Cambridge, University of Western Cape/Pretoria, FLI Boston, GSR Princeton and others in strategic locations such as Cornell, Beijing, Stanford/Berkeley Tokyo/Hyogo/Seoul, Colombo/Trivandrum/Dacca, Wellington, St Petersburg, Buenos Aires, etc) .... with an initial focus on this theme which has struck a chord at Cornell: “*scope for re-deploying existing research and applications (other than storage) in the case of a global systemic shock or catastrophic event*”.

5. INDUSTRY (*Sendai 3*): assessments of convertible capacity and rapid ramp up potential, country by country, in both conventional and alternate food production and distribution. Specifically, GRF, WFP *and* Rapid Response Forum to invite governments and industry bodies to assess their potential “GCR ramp up rates” in conventional and alternate food production, adjusted for seasonality, as well as deployable and convertible shipping capacity and ability to create agricultural or engineering recovery teams, and to consider a range of national response and preparedness options for a 10% or 20% global GFSS.

6. RESPONSE PLANNING (*Sendai 2*): appropriate response planning and preparedness at national, academic, GRF and (if possible and not counter-productive) at regional/global levels (not forgetting, for both rich and poor countries, traditional subsistence & survival practices, bachelor crops, scope for organised migration to areas with viable aquifers, etc)

COORDINATION – NO. We specifically *do not* propose creating a new supra-national body or committee, as the existence or convening of such a body at any time would likely become an amplifier or secondary cause of instability – better, we currently suspect, to strengthen *existing* capacities and organizations, including media legal staff, who can remind news teams about the resource pack held by in-house science editors and producers for use in the event of a major catastrophe, famine or cataclysm.

### Conclusion

Being well-prepared globally, by sector and regionally can reduce the likelihood of panic export bans and other self-defeating options in the future, and build current self-interested trust/cooperation between countries, continents and industries. We have proposed next steps for the DRR community, GRF, academics, governments and private sector. Taken together, these steps can prevent 100 million-2 billion starvation and malnutrition deaths in the lifetime of younger readers of this paper at GRF Davos in 2016. The role of the Global Risk Forum as a whole may be to convince industry, large consultancies and at least one scientific

body to take on this work (namely, practical preparedness for shocks affecting 10%-20% of global harvests) in a focused and coordinated way.<sup>viii</sup>

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viii **Abstract:**

Lloyds of London and others have demonstrated how a global systemic shock and multiple bread basket failure in the near future could lead to starvation deaths or war. *We show how such scenarios are both likely and preventable.*

Research for the UK's Foreign Office suggest that there is an 80% risk of systemic shock cutting ~10% of agricultural output in this century caused by *known* extreme weather risks alone. The largest reinsurers and the Nexus Shock Network are now addressing these risks. There are *in addition* abrupt and known non-weather “low probability high impact” risks which could lead to a similar or greater global food deficit. These “Global

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Catastrophic Risks” collectively have ~1 in 10 probability of occurring per decade. With the possible exceptions of China, USA and South Korea, current resilience, financial systems and relief capacity are designed to mitigate only limited food price increases (such as in 2008 which was caused by impacts totalling <1% of global output) and not an abrupt 2-10% shock or worse, where without more preparedness it could be expected that governments, even with support from WFP and other major relief agencies, would be unable to source and distribute enough food to prevent food riots and government collapses. Without *both* internationals (industry, IMF, markets, Rapid Response Forum, UN insurers, disaster professionals, etc) *and* nationals (governments, broadcasters, private sector logistics, agriculture, etc.) having extraordinary stop-gap famine preparedness measures ready and stress tested, the run-up in global food prices would likely be much more severe than 2007-8 and last for months or years, leading to mass refugee flows, perhaps in unexpected directions. So food shortage and distribution problems or conflict could cause “actual global famine”, with widespread economic collapses, potentially putting 100 million people at risk of starvation and within 2 year conceivably up to 2 billion deaths across Africa, Asia, the Middle East and the Americas (Helfand, 2013).

As a duty of care, current learning in *integrative risk management can and should be scaled up* to address such risks through the UN Sendai process, building on the Hyogo framework. The IMF, World Bank, Chatham House and several governments (e.g. UK and USA) are looking at specific aspects of this, leaving many gaps, especially in relation to Africa, Asia and the Americas where (e.g.) Nigeria, Brazil and India have additional challenges such as distribution and total population.

We explore some possible responses, preparedness options, research gaps and usefulness of “alternate foods” such as quick diversion of modified biofuels to edible oils/carbs and innovative uses of residues, waste, leaves, woody matter, methane and bacteria. These options together with distribution readiness would dramatically reduce mortality in a global catastrophic risk event. Food secure continents attract more sustained investment. Some of the preparedness options and alternate foods have further present time benefits, making them more easily fundable. Being well-prepared globally can reduce the likelihood of panic export bans and other self-defeating options in the future, and build present time trust/cooperation between countries, continents and industries, preventing beggar-thy-neighbour scenarios.

We make suggestions for the Hyogo / Sendai framework and to the risk and disaster communities for (1) immediately doable preparedness actions with high value and low cost per life saved, and (2) initial assessments and research (3) integration and knowledge exchange opportunities (4) funding strategies and financial sustainability.