SOCIETY OF ACTUARIES®

July 2018

Environmental Sustainability

2017 Call for Essays

Contents

Insurance and Environmental Sustainability

James Jones
Krzysztof Ostaszewski

Sustainability, in a general sense, is the overall capacity to maintain a certain process or state indefinitely. Sustainability in nature is the capacity to continue, to endure. For human beings, sustainability is about the potential for long-term preservation of well-being, with ecological, economic, political and cultural dimensions. The issue of sustainability and human activity surfaced in the 1980s as developing countries began to experience adverse long-term consequences from short-term gains in their development. In 1987, the World Commission on Environment and Development (aka Brundtland Commission), coined the term *sustainable development* to mean "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainability in business is not just about being "green." It is about being fit for the future.

The field of sustainable development can be conceptually broken into three constituent parts: environmental sustainability, economic sustainability and sociopolitical sustainability. Debates about sustainability are typically constructed in these areas with the economics of energy production playing an increasingly prominent role. Issues of sustainability and long-term environmental risks are hotly debated, and often controversial as they involve some very fundamental issues in society such as:

- The rights of individuals to choose how they use the resources they purchase
- The long-term, but gradual sustainability risks to the Earth's ecosystem
- The shifting of costs of related to these risks, from one group of people to another, and from one generation to the next

In a democratic society, people have the inalienable right to the pursuit of happiness, as long as that pursuit is not harmful to others. The reality is that all economic activities have costs. Some are clearly visible, and some are uncertain and invisible costs. This is an issue throughout human history and throughout all types of economic activities. How can we, as a society, deal with uncertain costs that show up suddenly in the future, and show up in unexpected places? It seems irresponsible for a society to not consider those costs, how they affect members of society, and how to plan for these cost contingencies, even if they are uncertain. The reality is that the costs of one person's economic activity imposed on others are not always fully accounted for, with accounting for future costs being particularly problematic.

Much has been written, from the perspective of several disciplines, about the human bias for inaction when the risks we face are long term and the uncertainty transcends generations (Johnson and Levin, 2009). Research has even been conducted on overcoming biases to help reduce losses to natural catastrophes (Kunreuther, Meyer, and Michel-Keerjan, 2012). Examples of how this bias affects decision making include the failure of homeowners on the Atlantic and Gulf Coast to take steps to fortify their homes or even purchase hurricane survival kits (Goodnough, 2006). Flooding experts say Houston was unprepared for Hurricane Harvey because the city allowed developers to build new communities with little regard to flood protections.[1] Research (Johnson and Levin, 2009) places many of these causes into one of three categories of biases: psychological biases (positive illusions, attribution theory, prospect theory), organizational biases (agency factors, problem detection failures) and political biases (short-term constituent horizon, incumbency).

The Causes of Unsustainable Environmental Practices

Sustainability is about managing future economic, social and environmental risks and opportunities. Sustainability can be viewed as an extended level of

1 Justin Worland, "Why We Won't Be Ready for the Next Hurricane Harvey Either," Time, August 29, 2017, *http://time.com/4919224/hurricane-harvey-houston-policy/.*

risk management. Some of the documented causes of unsustainable practices include:

- Delayed signals in sustainability feedback loops
- Lack of transparency in assessing sustainability risk
- Misaligned interests that militate against sustainability
- Inability to regulate and legislate against unsustainable practices
- Lack of real financial accountability for future losses related to sustainability risks
- Lack of a risk-aware culture that supports sustainability
- Agency factors, which cause a diffusion of responsibility
- Inadequate assessment of true sustainability risk resulting from
    - Lack of imagination and understanding of "tail risks"
    - Silo approach to risk assessment
    - Lack of actuarial capacity

Private insurance, unencumbered by many of the biases and sustainability challenges can support sustainability in three key ways:

1. By addressing many of the causes of unsustainable behavior
2. By promoting sustainable insurance products and services
3. By investing with a sustainability perspective

The Unique Nature of Insurance as an Antidote to Unsustainable Behavior

Private insurance is, in fact, the only business whose purpose is to underwrite the risks associated with human progress. In order to properly underwrite the risks of economic activity, insurers must value future risks today. This makes insurance a natural ally when attempting to facilitate sustainable development.

So what is it about private insurance that makes it unique and able to respond to risks, like long-term sustainability risks, in ways that other businesses and government solutions do not? How is insurance less likely to be influenced by the biases that affect governments and individual firms?

First insurance by its very nature must objectively, accurately, rationally and properly account for the cost of risk. An important function for insurers is addressing tendency of insured parties to assume more risk than appropriate for the circumstance. This occurs when the risks are not well understood or measured. Insurance prices risk in a more transparent and objective manner than would occur if it were to be subjectively priced by entities or individuals who may have a financial interest in either the acceptance or rejection of the risk exposure.

Private insurance can enable insureds to assume more risk (rationally), which results in a commensurate increase in their economic output (and income), while not assuming more risk than is economically rational. The first line of defense of an insurance firm is underwriting working in conjunction with pricing of its products. Insurers can choose not to underwrite risks if the risks cannot be priced adequately. So insureds who choose to build in areas that are prone to hurricanes or wildfires can be refused, or nonrenewed, if the risks cannot be priced at actuarially sound rates (because of regulation or competition from underpriced government insurance). This objective pricing of risk function that insurance provides can address psychological biases, delayed feedback loops and a lack of transparency.

Furthermore, an insurance product does not just have a price; it also has a complex contract structure. It excludes certain losses; it included deductibles, copays, limits and so on. In fact, the insurance contract is something very unusual and unknown in other human endeavors: Flexible and often renegotiated property rights arrangement between the insured and the insurer. Insurance is not often thought of as a form of distribution of property rights for the outcome of a particular economic activity, but this is at the heart of insurance.

Perhaps one of the most overlooked features of private insurance is its ability to modify insureds behavior through credits and surcharges, as these may lead to insured's taking precautions to mitigate and prevent losses when incentivized through credits (or disincentivized through surcharges). Insureds who modify their homes (or buy homes that are modified), to be more resilient to hurricanes or wildfires, may do so if they receive credit for their efforts. Communities

that have taken efforts to become more resilient from flooding, hurricanes or wildfires, may be given ratings that are favorable to its residents. An insurer can alter behavior simply by changing the underwriting requirements. Compare this to legislative and regulatory effort that would require homeowners to do the exact same thing that insurers ask policyholders to do voluntarily to obtain insurance or insurance at a discounted rate. Other examples of insurer flexibility over regulatory action include underwriting liability risk associated with genetically modified foods, aerosolized nanotechnology products or hydraulic fracturing, based on a precautionary principle even when the scientific evidence has not proven conclusively any health risks. Insurer underwriting demands can influence communities and help create a more risk-aware culture.

Financial accountability for future uncertain losses due to sustainability risks is another cause of unsustainable behavior. A unique feature of the insurance business is its accounting methodology. Insurers use conservative statutory accounting that requires them to record future liabilities in the current accounting period, even if those liabilities are remote and uncertain. If individuals, businesses or governments do not have a legally recognized way of accounting for uncertain future losses (and then bringing those losses to the present risk-adjusted value), then those losses are unlikely to be considered in the present-day activities that contribute to future losses.

Even if funds for future liabilities were set up by businesses, the firms' investors would be unlikely to want to keep their capital tied up in low-earning, low-risk investments like those that insurers must keep. Government entities have their own challenges. Beside political biases against such funding (to be discussed later), many states have been precluded by law, until quite recently, from even setting aside "rainy day" funds.[2] As mentioned earlier, private insurance is required to account today for future uncertain losses and establish reserves to pay for future losses. Insurance can also do so in a way that has tax advantages.

Insurance, because of its purpose for indemnification of loss, does not have the same tax consequences as other forms of financing. The value of this is widely accepted and was established by the seminal Modigliani-Miller theorem (Modigliani and Miller, 1958; also Brealey and Myers, 2008). This theorem roughly says that the value of a firm created solely by finance must come from either a reduction of taxes, or bankruptcy costs, or agency costs. Assuming this theorem holds true, insurance enhances firm value through its tax treatment of loss payments (not being taxed), as well as its role in protecting against catastrophic losses (and thereby reducing the cost of bankruptcy), and inducing better risk management (reducing agency costs).

It is interesting to note that insurance offers an example of planning for future contingencies. Consider the example of hurricanes. Insurers can't ignore them even though they may or may not happen. If they do happen, their costs are very uncertain, and over time, the areas of human development change along with the patterns for hurricanes. They are arguably even more uncertain than retirement cost risks or environmental damage risks. Yet insurers do not just wait for them to happen and then count the deaths and losses. In addition to insurance contracts that cover most (but not all) of damages, they also build emergency responses from government entities. They deal with the great uncertainty of hurricanes, and set aside resources to manage the uncertainty in the form of insurance reserves.

Even if other noninsurance businesses decided to self-insure those future liabilities, they may be precluded by the tax code from including them in their financial statements unless there is a high degree of certainty about these future liabilities.[3] The accounting requirements for insurers are different. According to statutory accounting requirements, they must establish reserves and include those in their financial statements, based on the possibility of loss. Even losses that have only a one in 500-year chance of occurrence must be accounted for. Many sustainability challenges

2 "Fact Sheet: State Rainy Day Funds in 2017," PewTrusts.org, July 18, 2017, *http://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2017/07/state-rainy-day-funds-in-2017.*

3 Financial Accounting Standards Board, Statement of Financial Accounting Standards No. 5, FASB.org, March 1975, *http://www.fasb.org/cs/BlobServer?blobcol=urldata&blobtable=MungoBlobs&blobkey=id&blobwhere=1175820910926&blobheader=application/pdf.*

may be addressed better, if they are brought into the rigorous and yes, possibly costly, system of insurance accounting and risk management.

It is important to note that this means that insurance accounting methodology causes profits to be lower in current period, but higher in later periods (if they have properly evaluated and priced the risk). Each year insurers are required to reevaluate the risk and to either keep reserves funded, add to the reserves (take a charge) or release the reserves (take a profit). This means no bonuses for management for short-term activities (such as originating a loan); instead they are rewarded once it is firmly established that the profits are real. This helps address the "agency factor" and misaligned interests identified earlier in this paper as a cause of unsustainable practices.

Government policies can and have disabled the insurance mechanism and kept it from functioning properly. This is evidenced in government (in) action to societal risks such as flood risks because developers, mortgage companies and constituents of legislators lobby for insurance prices well below the actuarially indicated rate. The legislative flip-flop on the bipartisan Biggert-Waters Flood Insurance Reform Act of 2012 is a prime example of how political biases hinder efforts for environmental sustainability.[4] *Private* insurance can address political biases by being "the adult in the room." Insurers can offer the discipline required and oftentimes, the "political scapegoat" needed to shield legislators from political attacks to enable them to move forward with real reforms. If left unfettered, this feature of private insurance can be used productively to manage sustainability risks.

A more detailed discussion of how specifically private insurance addresses the causes of unsustainable practices is found later in this paper. The following section furthers the argument that private insurance is a natural ally to environmental sustainability by explaining the alignment between the nature, goals and methods of insurance with those of environmental sustainability.

Alignment of Insurance and Environmental Sustainability

The nature of private insurance aligns well with long-term efforts to mitigate sustainability risks. This is an important point as it enables insurers to justify stakeholders' actions to support and promote environmental sustainability. First, there is a financial alignment between insurance and financial sustainability (discussed in the following section), but there is even an alignment in the manner in which insurance and those promoting environmental sustainability operate. Those involved in managing private insurance align with the approach and goals of scientists, nonprofits and government agencies, who are trying to promote environmental sustainability, as follows:

- Both face future liabilities related to risks, including climate change, environmental degradation and unsustainable financing practices.
- Both use computer models to integrate the information and project its implications into the future.
- Both must consider risks that extend many generations into the future and adapt to socio-economic changes that may not have been expected.
- Both understand the importance of a risk-aware culture that seeks to embed risk management as a component in all critical decisions throughout the organization.
- Both seek to bring forward and make transparent the cost of future liabilities (in insurance this is statutory accounting; in sustainability it is costing of externalities).
- Both have specifically educated and trained people (both internal and external) who regularly review those changes in future liabilities and make adjustments to their projections.
- Both recognize that individual risks across the organization are interrelated and can create a combined exposure that differs from the sum of the individual risks.

4 Scott Gabriel Knowles, "Flood Zone Foolishness," *Slate*, March 23, 2014, *http://www.slate.com/articles/health_and_science/science/2014/03/biggert_waters_and_nfip_flood_insurance_should_be_strengthened.html.*

A specific illustration of this operational alignment can be found in the regulatory standard of insurers known as ORSA (Own Risk Solvency Assessment). In an operational way, the ORSA is part of the global process of enterprise risk management (ERM).[5] It is part of a cyclical and iterative system involving the board of directors, senior management, internal audit, internal control and all the employees of the company. It aims to provide a reasonable assurance on compliance with the strategy of the company against risks. ORSA requires insurance companies to issue their own assessment of their current and future risk through an internal risk self-assessment process, and it will allow regulators to form an enhanced view of an insurer's ability to withstand financial stress. It specifically requires insurers to promote and assess a risk culture that supports accountability in risk-based decision making.[6]

Alignment of Financial Interests of Insurers With Sustainability

In addition to the manner in which insurance and those seeking to promote environmental sustainability view future risks, there are natural alignments in financial interests of the insurance industry with the goal of sustainability. Consider just one aspect of environmental sustainability, climate change. Climate change affects insured losses through the severity and frequency of flooding, typhoons, hurricanes, tornados, hailstorms and wildfires.[7] Dust storms related to increasing droughts in many parts of the world have increased the hospital admissions for people suffering from respiratory illness[8] and increased related health insurance claims. The overall quality of life affects mortality and morbidity that must be considered in life insurance, annuities and health insurance. Insurer investments, for example, investments in municipal bonds where municipalities are affected by climate change, create a correlated risk on the asset side as well as the liability side of the balance sheet.

"LONG TAIL" RISKS AND THE LONG-TERM VIEW OF INSURERS PROMOTES SUSTAINABILITY

Sustainability risks have a temporal, decades-long component that challenges most businesses focused on quarterly returns or political officials focused on two- to six-year time horizons. Insurance by its nature is different. The main reason for this difference is that the very products insurers sell require them to fund liabilities into the future. The following describes the relationship between insurance and future liabilities.

Economic sustainability requires the ability to adapt to future uncertainty that may transcend several generations. The insurance industry through many of the "long tail" products it offers must be able to contemplate risks in the future and adapt to changes that were unforeseen, while maintaining financial viability. Examples of property/casualty insurance products that are long tail in nature include workers' compensation, product liability and environmental liability in property and casualty lines. The insurance industry in 2013 is still paying for asbestos claims arising from occurrences almost a century ago and more than 30 years after Johns Manville, the main manufacturer of asbestos, declared bankruptcy.[9]

Even shorter tails lines of business like property insurance must take into consideration longer- term trends. A common misconception is that property insurers have no risk to climate change because they write one-year contracts that can be either nonrenewed or repriced. This is a very shortsighted and unrealistic assumption. Although insurers can and do exit the property market in isolated circumstances if the business becomes unprofitable, the reality is that exiting property lines of business *en masse* in numerous locations exposed to climate change is not a viable option. Furthermore, like all other businesses, they still must have a place to allocate capital and this cannot be redeployed to other lines or locations easily, especially if competitor are attempting

5 "Enterprise Risk Management," Wikipedia, *http://en.wikipedia.org/wiki/Enterprise_Risk_Management.*

6 *https://digital.library.unt.edu/ark:/67531/metadc12027/m2/1/high_res_d/sap3-4-final-report-all.pdf. http://www.naic.org/cipr_topics/topic_climate_risk_disclosure.htm*

7 For a detailed discussion on climate change and the insurance industry, see Jim Jones, *http://sustainabilityriskmanagement.blogspot.com/*

8 W. W. Tam, T. W. Wong, A. H. Wong, and D. S. Hui, "Effect of Dust Storm Events on Daily Emergency Admissions for Respiratory Diseases," Respirology, 17, no. 1 (2012): 143–48, *http://www.ncbi.nlm.nih.gov/pubmed/22092966.*

9 "Johns Manville," Wikipedia, *http://en.wikipedia.org/wiki/Johns_Manville.*

to do the same. Global reinsurance industry pays careful attention to climate risks, and so direct insurance companies exposed to large catastrophic events risks.

UNDERWRITING, LOSS CONTROL AND THE PROMOTION OF SUSTAINABLE PRODUCTS

The insurance industry promotes sustainability through underwriting requirements that require certain loss control measures, incentives (premium discounts) for sustainable products, and development of insurance products for sustainable business operations.

For example, in wildfire-prone areas of the western United States, insurers have responded to climate change not just by using the tools of underwriting (and refusing to insure homes in wildfire-prone areas or rate them according to their true higher risk), but some insurers have worked to increase the resiliency to these risks also by making inspections and requiring insureds to undertake specific loss control measures that make them and their entire area communities safer.[10]

The insurance industry also provides incentives to insureds to promote sustainable products and services such as LEED certified buildings,[11] hurricane-resistant construction design and materials[12] and hybrid cars.[13] Insurers collaborated with the Climate Action Reserve (CAR) to mitigate the risk of invalidation for ozone-depleting substances (ODS) and livestock offsets bound for California's compliance market. This helped address a challenge to developing the market, which is concerned about the potential for an invalidation of offset credits despite their best efforts to comply. This could one day help promote the market for carbon trading.[14]

Recently, the industry has developed expertise specific to sustainability and a related goal of resilience. Building homes that are less vulnerable to winds and fires means fewer homes ending up with their debris in landfills. Making homes more resilient to hazards like wind, hail and fire is the goal of the insurance-industry-sponsored Insurance Institute for Business and Home Safety (IBHS). IBHS is an industry-sponsored research facility whose mission is to use research to identify and promote ways to strengthen homes, businesses and communities against natural and man-made disasters.

This is an example of how the insurance industry fills a void that government legislatures and regulators cannot because funding for such research must take place in the crucible of the political world where constituents have a shorter-term view of financial priorities that may not align well with long-term sustainability.

The following discussion describes in more detail the sustainability challenges related to organizational biases, misaligned interests, and agency factors.

Organizational Biases and the Failure of Risks Management

Why would risk management as practiced by a business firm be different from the way that insurers assess, price, and manage risk? One reason is simply the type of expertise and methodology for risk assessment employed. Although most large firms have risk management functions, they do not always identify and assess future-oriented risk properly. Douglas Hubbard, a risk management consultant and author of the book *The Failure of Risk Management*, tells of an all too common story in which highly trained, engineering experts could develop sophisticated products and implement detailed processes for producing the products, but

10 Solutions to the Rising Costs of Fighting Fires in the Wildland-Urban Interface Headwaters Economics, Bozeman, Montana Section 7 pp-45-49. December, 2009 published online: *www.headwaterseconomics.org/wildfire.php.*

11 *https://www.insurancequotes.com/insurance-tips/green-houses-may-get-home-insurance-discounts.*

12 "Florida Wind Insurance Savings Calculator," *FloridaDisaster.org, http://www.floridadisaster.org/wisc/.*

13 "Get the Most out of Your Car Insurance—for Less," Travelers.com, *https://www.travelers.com/personal-insurance/auto-insurance/discounts-advantages/hybrid-auto.aspx.*

14 Gloria Gonzalez, "CAR, Insurer Parhelion Join Forces to Cover California Offset Invalidation Risk," *Forest Trends*, May 30, 2013. *http://www.ecosystemmarketplace.com/pages/dynamic/article.page.php?page_id=9753&.*

were at a loss as to how to assess risk. In his book he observes, "These highly trained scientists and engineers developed a risk management approach with no more scientific rigor to it than that of an ancient shaman reading goat entrails to determine where to hunt."[15] Hubbard concludes that the failure of risk management is commonplace in corporations.

Notably Hubbard identifies actuaries employed by insurers as one of the "four horsemen" of risk management and makes an important point that insurance products are assessed by actuaries and that this may be one key distinction as to why insurance is different. To further prove his point he notes that actuaries, whose work functioned well in the insurance operations of AIG, were excluded from the AIG review process of assessing the risk for their now infamous credit default swaps (CDS). The CDS instruments were deemed not to be insurance and therefore not requiring actuarial review. However, this product, which ended with disastrous consequence, was reviewed and approved by the other three of the "four horsemen": quants, economists and management consultants.

One of the commonly identified causes in both Hubbard's book and research into this issue is that there is a "systematic, underestimation of real risk," overconfidence and overreliance on "risk scoring" by managers in a firm. There are also deeply rooted organizational biases like agency factors due to senior management placing their own personal interests over those of the organization (Booth and Schulz, 2004).

The environmental disaster of BP's Deepwater Horizon's Macondo well provides both lessons for and warning about reliance on a firm's own internal risk management assessment and illustrates the fundamental problem of why environmental risk management by individual firms may be inadequate. BP was self-insured.[16] Following this catastrophic environmental disaster, numerous studies were conducted and reports written on this risk management failure. One study, the Deepwater Horizon Study Group formed by the Center for Catastrophic Risk Management, clearly underscores the agency issue when risk is managed internally and provides a strong argument for independent risk assessment and pricing. The group's 2010 investigative report reads, "There were multiple opportunities to properly assess the likelihoods and consequences of organizational decisions (i.e., risk assessment and management) that were ostensibly driven by the management's desire to "close the competitive gap" and improve bottom-line performance. Consequently, although there were multiple chances to do the right things in the right ways at the right times, management's perspective failed to recognize and accept its own fallibilities despite a record of recent accidents in the United States and a series of promises to change BP's safety culture."[17]

It would be a mistake and a glaring lack of awareness of modern risk management failures to assume that this kind of senior management influence over the assessment risk is unique to BP. Truthfully answering there fundamental questions can help assess the capability of internal risk management to function properly in managing long-term environmental sustainability risks. The three questions that need to be answered are:

1. Is the management of an individual firm capable of identifying, assessing and managing long-term systemic sustainability risks based on information only available to the firm?

2. Does management believe that long-term environmental sustainability is in the best interest of the owners?

3. Does management exert influence over the assessment and reporting of risks to the board when the potential upside of taking the risk works in their own self-interest?

15 Douglas Hubbard, *The Failure of Risk Management* (Hoboken, NJ: Wiley Press, 2009), p. 14.

16 With a 65% interest in the Deepwater Horizon joint venture, BP says it is self-insured. BP's captive (Jupiter Insurance Ltd) has $6 billion in capital, but does not purchase outside reinsurance protection. Jupiter's per occurrence limit on physical damage and business interruption is $700 million and is not expected to cover environmental cleanup cost *https://www.iii.org/sites/default/files/docs/pdf/Deepwater-0901101.pdf*

17 Deepwater Horizon Study Group, Final Report on the Investigation of the Macondo Well Blowout Disaster, March 1, 2011, *http://ccrm.berkeley.edu/pdfs_papers/bea_pdfs/dhsgfinalreport-march2011-tag.pdf.*

How would insurance help with this risk management challenge? First, the insurer bases its risk analysis not only on the firm's experience but also on other firms with similar risks in the same industry. This information not only helps in pricing the risk but also in underwriting the risk. One of the critical components of underwriting is the application process. For long-term sustainability risks, application is very detailed: it is developed based on the experience of numerous experts in the area being underwritten (i.e., oil and gas, pharmaceutical, environmental liability). This application can even serve as a "teaching tool" for the businesses. The questions asked often involve how the firm measures its risk. It is not unusual for a firm to change its business practices in order to be able to obtain insurance coverages. In addition, good risk management is incentivized through premium discounts, and poor risk management is penalized through premium surcharges. In effect, the insurer underwriting tool becomes a risk management tool for the firm. This tool is updated regularly by the insurer based on new data. Insurers also have the ability to spread out the costs of experts among numerous insured businesses, whereas individual firms may not be able to afford that expertise.

The upside financial gain of a firm's project, like the Macondo well or the AIG CDS, and potential gain for management, are not considered by the underwriting and actuarial function in pricing the risk. Thus the independence of the risk assessment should lead to greater transparency in assessing long-term environmental sustainability risks.

In some parts of the world, law requires this analysis, or by convention through a specific risk committee, that is part of the board. As of 2010 sustainability risk reporting was mandatory in 134 countries and included in the laws of corporate governance and the management of publicly held companies.[18] In such countries, firms are required to make informed assessments about the longer-term sustainability of a company and demonstrate that it is operating as a responsible corporate citizen. For example, South Africa's 2009 King III report[19] recommends that organizations produce an integrated report in place of an annual financial report and a separate sustainability report, and that companies create sustainability reports according to the Global Reporting Initiative's "Sustainability Reporting Guidelines."[20] However, as mentioned earlier, these political solutions are subject to political biases and can change from one election to the next.

Insurer Risk Management Compared to Firm Level Risk Management

Table 1 compares how individual firm risk management compares to insurer risk management. The purpose of this comparison is not to suggest that individual firms can never do adequate risk management or to suggest that insurers always offer a superior solution. That is clearly not true. The purpose is to illustrate how risk management practices compare and in doing so, explain why challenges in understanding risk management coupled with inappropriate incentives encouraging short-term thinking may militate against firms in assessing and managing sustainability risk.

Again, this analysis does not mean the firm risk managers can't or don't equip the firm's senior management with risk management tools and information to make good decisions. This is probably more likely to occur if the risk manager is part of senior management such as a chief risk officer.[21] The challenge is internalizing the cost of the long-term sustainability risks as part of a core business function in the absence of a specific law that requires this. A firm faces many, often overwhelming influences, that militate toward underestimating (or ignoring) future liabilities associated with long-term environmental sustainability where the harmful negative consequences cannot be readily assessed for the individual firm, and the downside consequences may be paid for those other than the decision makers (i.e., the overall society in the case of many environmental losses.)

18 *Carrots and Sticks: Sustainability Reporting Policies Worldwide—Today's Best Practice Tomorrow's Trends*, 2013 ed., *GlobalReporting.org, https://www.globalreporting.org/resourcelibrary/Carrots-and-Sticks.pdf.*

19 *Corporate and Commercial/King Report on Governance for South Africa—2009*, Institute of Directors in South Africa, *http://www.library.up.ac.za/law/docs/king111report.pdf.*

20 *https://www.globalreporting.org/resourcelibrary/G3.1-Guidelines-Incl-Technical-Protocol.pdf.*

Table 1: Comparison of Risk Management of Individual Firm to Insurer

Risk Dimension	Traditional Risk Management at an Organization	Insurer Risk Management
Risk identification and assessment	Based on firm's own data experience	Based on industry experience, and data from numerous businesses in the same industry.
Legal financial responsibility for future losses associated with business sustainability risks	Firm managers not legally responsible for paying for risk (other than losing job) Owners responsible for paying for future risk to the extent corporation has financial means to pay for loss. Otherwise firm declares bankruptcy and society pays for loss.	Insurer is responsible for paying for risks well into the future and required by law to have the funds to do so. Guaranty funds exist in each state in the event that an insurer cannot pay claims.
Decision making on future risks	Decision to undertake a project is based on likelihood of profitable outcome. Risks are assessed related to short-term profitability goals.	Decision to underwrite depends on likelihood and severity of loss and insurer's ability to price risk, including future losses related to project
Risk assessment and pricing expertise	Risk assessment and pricing of risk is not typically a core function of firm and may lack expert analysis	Assessment and pricing of risk is core function of an insurer. Actuarial staff and underwriters have expertise (oftentimes combined with experience in the industry in which the risk is underwritten)
Funds available to pay for future by unknown, and uncertain losses related to sustainability risks	Firm is not required or even recommended to set aside funds for future unknown and uncertain losses.	Insurers required by law to set aside funds (reserves) to pay for future losses, and have financial regulators who audit the reserves for adequacy based on expected loss of overall portfolio of risks

Conclusion

Insurance is a unique product with unique functions that make it suitable to address long-term risks such as those related to environmental sustainability. Furthermore, the insurance industry is standing downstream from many of the risks related to unsustainable practices, especially those that contribute to climate change. For this reason, the industry is aligned well with sustainability. The industry has the ability to set actuarially sound rates, set aside reserves, and set aside funds to pay uncertain future losses for claims that may be made even decades in the future. The insurance industry promotes sustainability through market signals via the manner in which it underwrites and prices risks. The insurance industry is not as captive to public opinion as political officials are, and can make decisions that promote sustainability in a more timely and efficient manner. The industry can overcome some of the agency factors that influence the judgment of managers of individual business firms. The industry can promote sustainable behavior through discounts, surcharges and product offerings. Finally, insurers can use their significant investment influence to reduce holdings in organizations engaged in unsustainable practices, and to increase holdings in those organizations that promote sustainability.

James Jones, is executive director of the Katie School of Insurance and Financial Services at Illinois State University in Normal, Illinois.

Krzysztof Ostaszewski, FSA, CERA, MAAA, is the actuarial program director at Illinois State University in Normal, Illinois.

21 Firms appoint CROs to reduce information asymmetry regarding the firm's current and expected risk profile. A. Liebenberg and R. Hoy, *Risk Management and Insurance Review*, 6, no. 1 (2003): 37–52.

References

Booth, Peter, and Axel Schulz. 2004. "The Impact of an Ethical Environment on Managers' Project Evaluation Judgments Under Agency Problem Conditions" University of Melborne.

Accounting, Organizations and Society Volume 29, Issues 5–6, July–August 2004, Pages 473-488 *https://www.sciencedirect.com/science/article/pii/S0361368203000126*

Bovenberg, Lans, Casper van Ewijk, and Ed Westerhout (eds). 2012. *The Future of Multi-Pillar Pensions.* Cambridge: Cambridge University Press.

Brealey, Richard, A. Stewart, and C. Myers. 2008. *Principles of Corporate Finance*. 9th ed. Boston, Massachusetts: McGraw-Hill/Irwin.

Cabeza-Gutes, M. 1996. The concept of weak sustainability. *Ecological Economics* 17:147–56.

Goodnough, Abby. As hurricane season looms, states aim to scare. *New York Times*, May 31, 2006.

Hubbard, Douglas. 2009. *The Failure of Risk Management: Why It's Broken and How to Fix It.* International Monetary Fund. 2012. The Financial Impact of Longevity Risk, Chapter 4 in *Global Financial Stability Survey*, April 2012 edition, *http://www.imf.org/External/Pubs/FT/GFSR/2012/01/pdf/c4.pdf*

Johnson, Dominic, and Simon Levin. December 2009. The tragedy of cognition: psychological biases and environmental inaction. *Current Science* 97, no. 11.

Kunreuther, H., R. Meyer, and E. Michel-Keerjan. 2012. Overcoming decision biases to reduce losses from natural catastrophes. In *Behavioral Foundations of Policy*, E. Shafir (ed.), Princeton: Princeton University Press, pp. 398-493.

Liedtke, Patrick M., and Kai-Uwe Schanz (eds). 2012. *Addressing the Challenge of Global Ageing—Funding Issues and Insurance Solutions*, The Geneva Association, Geneva Report No. 6, *https://www.genevaassociation.org/media/201020/GA-2012-Geneva_report[6].pdf* (accessed May 29, 2018).

Ma, Eva, Michael Guinery, Peter McCarthy, and Rick Shaw. 2012. Australian floods and their impact on insurance. *Geneva Reports*, no. 5:81.

Madhavan, Guruprasad, Barbara Oakley, David Green, David Koon, and Penny Low (eds.). 2012. *Practicing Sustainability*. New York: Springer.

Modigliani, Franco, and Merton Miller. 1958. The cost of capital, corporation finance and the theory of investment. *American Economic Review* 48, no. 3:261–297.

Niehoerser, Falk (ed). June 2013. Warming of the oceans and implications for the (Re) insurance industry, *Geneva Association Report, https://www.genevaassociation.org/media/616661/GA2013-Warming_of_the_Oceans.pdf*

Stahel, Walter. June 2012. Climate risk and the principles for sustainable insurance. *The General Assembly Review*, The Geneva Association, *https://www.genevaassociation.org/media/496500/GA2012_The_General_Assembly_Review_2012.pdf* (accessed May 29, 2018).

Stern, D. I. 1997. The capital theory approach to sustainability: a critical appraisal. *Journal of Economic Issues* 31, no. 1:145–73.

Justus Wesseler & Jock Anderson (2010) Risk and uncertainty in environmental and resource economics: Insights from an international conference at Wageningen, June 2002, Risk, Decision and Policy, 9:2, 107-128, DOI: 10.1080/14664530490464761

Was Malthus Right, but Early?

Max J. Rudolph

Thomas Malthus wrote *An Essay on the Principle of Population* (1798), where he claimed that population would grow faster than food production. This was not long after Adam Smith's *The Wealth of Nations*, American independence, and the French revolution. Malthusian theory has been discussed ever since. While some belittle the arguments, theories aren't actively debated for over 200 years unless there are valid disagreements that need to be addressed.

Malthus argued that population grows exponentially, food production linearly, and that "poor laws" designed to aid those in poverty create poor incentives. Population can self-correct, with overcrowding increasing the likelihood and impact of natural occurrences like floods and earthquakes. Human populations can also be inundated by famines and viruses that create mass kill-offs. Family-planning techniques that reduce the number of babies will also ease the pressure on population growth through later marriages, self-restraint and various methods that reduce reproduction. Offsetting factors that expand population are increasing life expectancies through improved health care and sanitation. More drastic voluntary measures enter the realm of science fiction, with humans being killed at a certain age à la *Logan's Run*, using religion or cult status to gain acceptance.

Malthus has not been proven correct, so naysayers say he was wrong. A closer look argues that he did not anticipate a number of positive scientific achievements that accelerated food production nor improvements in management of human fertility. Have these factors only delayed the inevitable? Will his arguments eventually be proven right? Scenario planning can help us answer these questions.

Historical Review

Malthus could have written his paper today, with the argument generalized away from exponential versus linear growth to focus on faster growth of population relative to food production and impacted by climate change. Much has happened in the meantime that Malthus did not anticipate. What have we learned, and how might his theory be updated?

ECOSYSTEM

Historically, humans would discover something that works and exploit it to the extent possible. The Earth is an ecosystem, with humans the dominant species. While it is possible that a virus or bacteria could serve to maintain a balance between human population and living space, no animal has evolved to challenge humans.

When I attended Michigan Technological University, Dr. Rolf Peterson visited our statistics class. He led a study of the ecosystem between wolves and moose on Isle Royale, a national park located on Lake Superior. Mammals arrive as new entrants to the island only when the lake freezes over, which happens rarely. This gives scientists a chance to study the cycle of predator and prey; some years the wolf population expands and kills more moose, followed by periods when the lack of food causes the wolf population to shrink.

As food supply decreases, predators limit reproduction and die of starvation. When it increases, the opposite occurs. In the long run, every species must play by these rules. Humans have no such balancing factor in the short term. We do what we want until resources are depleted. In the movie *Downsizing* by Alexander Payne, a technique is developed to shrink humans to limit resource use. When they determine that not enough of the population is following through, the developers become survivalists, entering a cave where they will live underground for a millennium until the Earth has had time to cleanse itself. An organism with no limits imposed on it has the ability to destroy itself.

RATCHETS AND PIVOTS—IT WORKS UNTIL IT DOESN'T

In her book *The Big Ratchet: How Humanity Thrives in the Face of Natural Crisis—a Biography of an Ingenious Species*,[1] author Ruth DeFries presents a history of food production. The human species finds something that works, expands it until it becomes destructive and then pivots, or ratchets, to a new method. Then the cycle repeats. This is how humans have avoided a Malthusian trap. We rely on science developing radical solutions to problems. One misstep or slow pivot may be all it takes to trigger catastrophe. Considering scenarios, especially qualitatively, builds resiliency and encourages adaptability.

Much of the food we consume comes either directly or indirectly from plants. We eat plants and eat things that eat plants, as part of a complex food chain. As energy is extracted by plants from the soil, there is a need to replace those nutrients for future generations. Each ratchet the author describes is an updated version of this process, increasing yields and supporting further population growth. Humanity extends a cycle by settling new areas and increasing population until, just before the hatchet falls and makes the current process unsustainable, a new pivot is made that avoids the pitfalls of the prior method. We saw this strategy play out in the past when Europeans came to the New World, and again now as futurists like Elon Musk talk of inhabiting Mars. These are not efforts to make current practices sustainable, but efforts to find new places to live where we can continue as before. While not as glamorous, funding basic science designed to capture carbon from the atmosphere and oceans may be a scenario that better increases long-term survivability.

As humans evolved, our brains grew in size, we developed opposable thumbs, and we figured out how to control fire. We developed tools and language. We built on this knowledge (despite periods where past learnings were repressed), learning to grow more food with fewer farmers. Much of this improvement is based on experimentation. Often breakthroughs come from accidental occurrences, but they would not be possible if experiments weren't being done.

The Earth has a built-in recycling process. For example, water and carbon circulates between land, ocean, deep beneath the surface, and in the atmosphere. It is a self-correcting cycle that regulates the climate over long periods of time. DeFries calls it the "foundation for human civilization." The planet can temporarily be moved out of balance, but not permanently. Human impact that defines the Anthropocene epoch has taken the Earth's ecosystem out of balance. Scenarios, both positive and negative, can help explore future paths.

The oil, natural gas and coal that exist deep in the ground started mostly as leafy plants grown while converting the sun's energy. Many millions of years of life, death and erosion resulted in carbon being taken out of the air and captured underground. As we extract and burn fossil fuels, imbalances create toxins in the atmosphere and oceans, impacting weather and climate. These rapid changes create a lack of harmony in the ecosystem, with species becoming extinct and reducing biodiversity. A new pivot is needed.

Early Pivots: 3.5 Billion Years Ago

Single-celled organisms appeared, followed 2 billion years later by those using photosynthesis. This built up oxygen in the atmosphere, created the ozone layer and replaced early bacteria with air-breathing animal forms.

Next Pivot: 1.5 Billion Years Ago

Sexual reproduction allowed quicker evolution and easier adaptation. Several hatchets fell as the environment rapidly changed, for various reasons. There have been at least five occurrences where at least 96 percent of species went extinct.

Farming Pivot

Humans, like other living things, pass on their genes to the next generation. We teach succeeding generations what we have learned. Man started out as a forager, but the rich abundance of the Fertile Crescent region led to farming and cities. Scientists now study how man's influence has taken the "garden of Eden" to a desert state as a possible precursor for the planet.

Settled Life Pivot

Over 6,000 years ago animal power was added to supplement human labor, and 3,000 years ago crop rotation was developed in China. Human waste was collected from city dwellers to use as fertilizer, returning nutrients to the soil.

1 Ruth DeFries, *The Big Ratchet: How Humanity Thrives in the Face of Natural Crisis—A Biography of an Ingenious Species* (New York: Basic Books, 2014).

14th-Century Pivot
Changing climate and wars led to famines and plague in Europe. During the agricultural revolution (followed by the industrial revolution) crop rotation, enhanced tools, better seeds and livestock improvements led to a food surplus.

Columbus Pivot
Using the trade winds to cross the Atlantic, a general homogenization between species began. Ships traveling west carried animals and seeds, and those on the return trip carried crops and gold. Diseases mostly traveled west, as the domestication of animals that led to jumps between species and built-up immunity was much further along in the Old World. Native American populations were decimated by diseases such as smallpox. Africans had greater resistance to these diseases, encouraging the slave trade.

Late 18th-Century Pivot
Drought, war and inflation led to Malthus' warning that "the power of population is indefinitely greater than the power in the Earth to produce subsistence for man." Cities had built up, with flush toilets and sewers improving sanitation, yet the phosphorus and nitrogen cycles were breaking down and soils were degrading. The next hatchet was getting ready to fall.

Guano Pivot
Bird droppings in South America provided rich nitrogen and phosphorus to the Incas, and by the mid-1800s mining techniques were allowing guano to be shipped to North America and Europe.

Chemical Pivot
The next pivot extracted nitrogen from the air as ammonia using heat derived from coal. The Germans improved the process during World War I as part of the war effort to make explosives. Sources of phosphorus were also developed during this period. Over time, runoff into lakes created algal blooms that destroyed everything else as they blocked sunlight and sucked up oxygen. It was during this period that the great dust bowls of America, when a severe drought followed a period of perfect climate for growing crops, led to improvements in crop rotation and other techniques that increased stability of agricultural production.

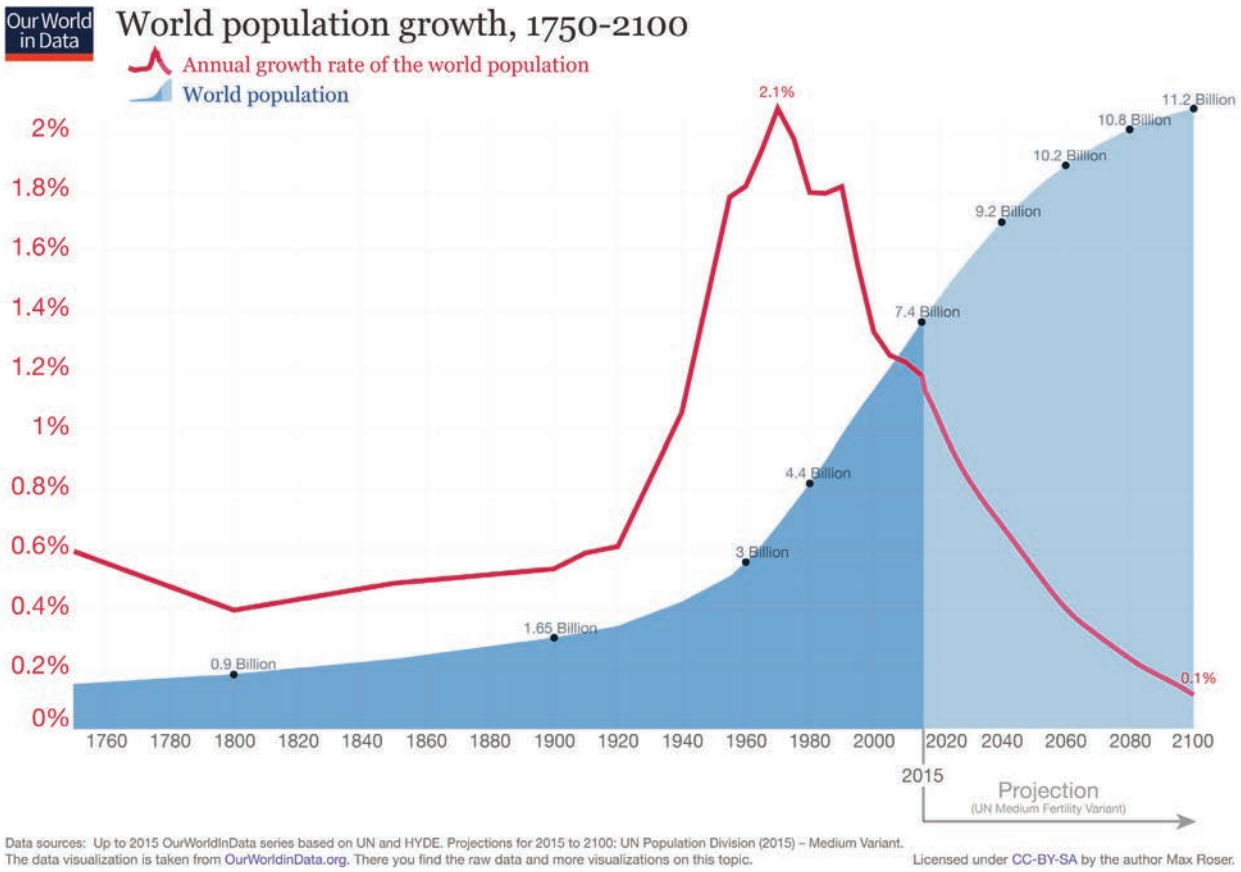
Monoculture Pivot
Hybrid seeds, using the double-cross method, increased yields while decreasing the diversity of crops. This led to the next hatchet, where unintended consequences allowed pests to defeat the defenses of a focused species. Failed solutions like DDT pesticides followed.

Green Revolution Pivot
Led by Norman Borlaug (Nobel Peace Prize 1970), breeders devised ways to defeat pests and bacteria using increasingly complex techniques that manipulated genes. First wheat rust was (temporarily) defeated, and then other crops were modified. Large-scale monoculture farming using aquifers in unsustainable ways became widespread. This left regional crops to die out, with their broad defense structures eradicated and the ecosystem's resiliency reduced. Eventually a seed bank was implemented, but much had already been lost. This is important to understand, because pests and bacteria continue to evolve. All solutions are short-term. Efforts are underway to cross breed back in some of the traits lost from these efforts. DNA-driven techniques allow pesticides to go after bugs or bacteria while having no impact on the crops themselves.

Genetic engineering and biotechnology have pros and cons, with concerns about incentives for the private sector offset by populations that need to eat. Each pivot has unintended consequences that must be identified and addressed in future (temporary) solutions.

Urbanite Pivot
More than half the world's population now live in cities, with many facets of life now manipulated that previously evolved naturally. There are three things needed for the planet to remain habitable: a stable climate, a recycling apparatus and diversity of life. Each is threatened today. In addition to burning of fossil fuels by industry and individuals, greenhouse gases from agriculture come from fertilizer production, manure and the stomachs of cows. Forest-clearing wildfires release carbon that has recently been removed from the atmosphere, and volcanos periodically release both carbon and sulfur. The process to extract nitrogen from the air currently has no counter that returns it. Sewage systems do not return phosphorus to the soil. Resiliency has been lost and the ecosystem is more fragile. In the best of times it will be difficult for governments to agree on a solution. Wartime conditions may compound and accelerate many of the issues discussed here, potentially leading to an unsustainable spiral.

Figure 1: World Population Growth, 1750–2100



Going Forward

The DeFries book guesses at some future pivots. In the past the sole problem was deemed to be a shortage of food. Now many diets are unhealthy, and obesity threatens to unwind the mortality improvements made as sanitation improved and cigarette smoking decreased during the last century (disruptions could also occur as cures for cancer or cell regeneration techniques move forward). Some city dwellers are participating in the solution, with rooftop gardens and human waste recovery efforts. Farmers are using technology to manage water use and fertilizer. Less wasteful habits in the developed world and improving storage in the developing world would help. We currently grow enough food to feed the Earth's population, but recent growth is problematic if extrapolated. As shown in Figure 1[2], since the beginning of the Industrial Revolution the human population has grown quickly, from about 1 billion by 1850 to over 7.5 billion today.[3]

Much of this growth has been in developing countries where there is less management of population, food supply and economies. Food that costs more than a family can pay is useless, as is food that sits in ports and feeds rodents rather than being distributed.

The good news is that, across the last two generations, agricultural production growth has outpaced population growth.[4] Malthus' arguments should be adjusted to show a reversal of his exponential

2 The data visualization is taken from OurWorldinData.org (*https://ourworldindata.org/wp-content/uploads/2013/05/updated-World-Population-Growth-1750-2100.png*).

3 "Not Even World War III Will Stop Unsustainable Human Population Growth. The 'Fix' Lies With Lowering Impact," ZME Science (last modified August 19, 2015), *https://www.zmescience.com/science/unsustainable-human-population-growth-0534/*.

4 Mark Willis, "Allotments—A Vital Community Resource, Part I," *Cowling Allotment Group* (November 28, 2011), *http://cowlingallotmentgroup.blogspot.co.uk/2011_11_01_archive.html*.

population and linear food production growth. But this does not mean there are not risks moving forward, mostly driven by climate change. Considering scenarios that are not a continuation of the recent past will build resiliency and reduce fragility of the ecosystem.

New agricultural options will be created as extreme northern and southern latitudes warm, providing opportunities to introduce better methods. But there will also be surprises, some of which can be anticipated and some which cannot. Already we see glaciers melting. As regions thaw, not only will frozen tundra disappear, but the winds that drive our weather systems will likely weaken. We already see storms that sit over one area (e.g., hurricane Harvey in Houston in 2017) for longer periods, and multiple storms follow the same path while moisture is lacking nearby.

Oceans are increasingly acidic, hurricanes stronger, and tornados more prevalent and further north. Higher ocean levels will doom those living in low-lying areas, including population hubs like Miami and Jakarta, or much of the country of Bangladesh. Fracking near coastlines will accelerate the problem as these areas sink in response.

Recent actions by U.S. government agencies under the Trump administration not only do not address the issue but might accelerate the end result[5] A widespread war would be fought using fossil fuels. Little effort will be made to worry about the environment during a conflict. In a way this would be similar to the extreme toll taken on the world's youth during the influenza pandemic that coincided with World War I. Such an event may be what Neil Howe describes in *The Fourth Turning*,[6] finally convincing everyone that something needs to be done. Hopefully it will not already be too late. This is why I prefer to look at carbon capture ideas rather than dwell on a carbon tax. I believe it is already too late, unfortunately, for a financial solution alone to solve climate change.

Scenarios that include the impacts of higher sea levels on investment returns and other assumptions should be included in any new product developed. This doesn't mean everything has to be quantified, but will lead to a greater ability to identify marginal impacts from an event.

OTHER FACTORS

With each surge in population a new hatchet has led to a pivot allowing population to continue its growth. If a new pivot does not become available, this leaves us to ponder the alternatives to controlling population—natural disasters, war and disease. Let's hope the scientists can keep up.

Drought

Warmer temperatures and drought lead directly to food shortages. In the United States, as shown in Figure 2, on page 18 the current drought monitor shows much of the country in at least a short-term drought.

Dry conditions have also contributed to an increased number of wildfires in California, Montana and the southeast United States as the fire season becomes both longer and more intense. Underground aquifers can provide water for crops and human use, but may not be sustainable over the long run as they become depleted.

The opposite is also true—weather extremes are tied to climate change as the Actuaries Climate Index, found at *http://actuariesclimateindex.org/home*, shows. Extremes of temperature, rainfall, consecutive dry days, wind and sea level all contribute to stresses for both humans and our food sources.

Acidic Oceans

It appears that oceans have acted as a sink to delay carbon buildup in the atmosphere, but this causes problems for shellfish and coral reefs. It also stresses other sea life, impacting biodiversity. This provides arguments for those choosing to "lie with statistics," misleading the public about climate change by focusing solely on the carbon buildup in the atmosphere and delaying solutions.

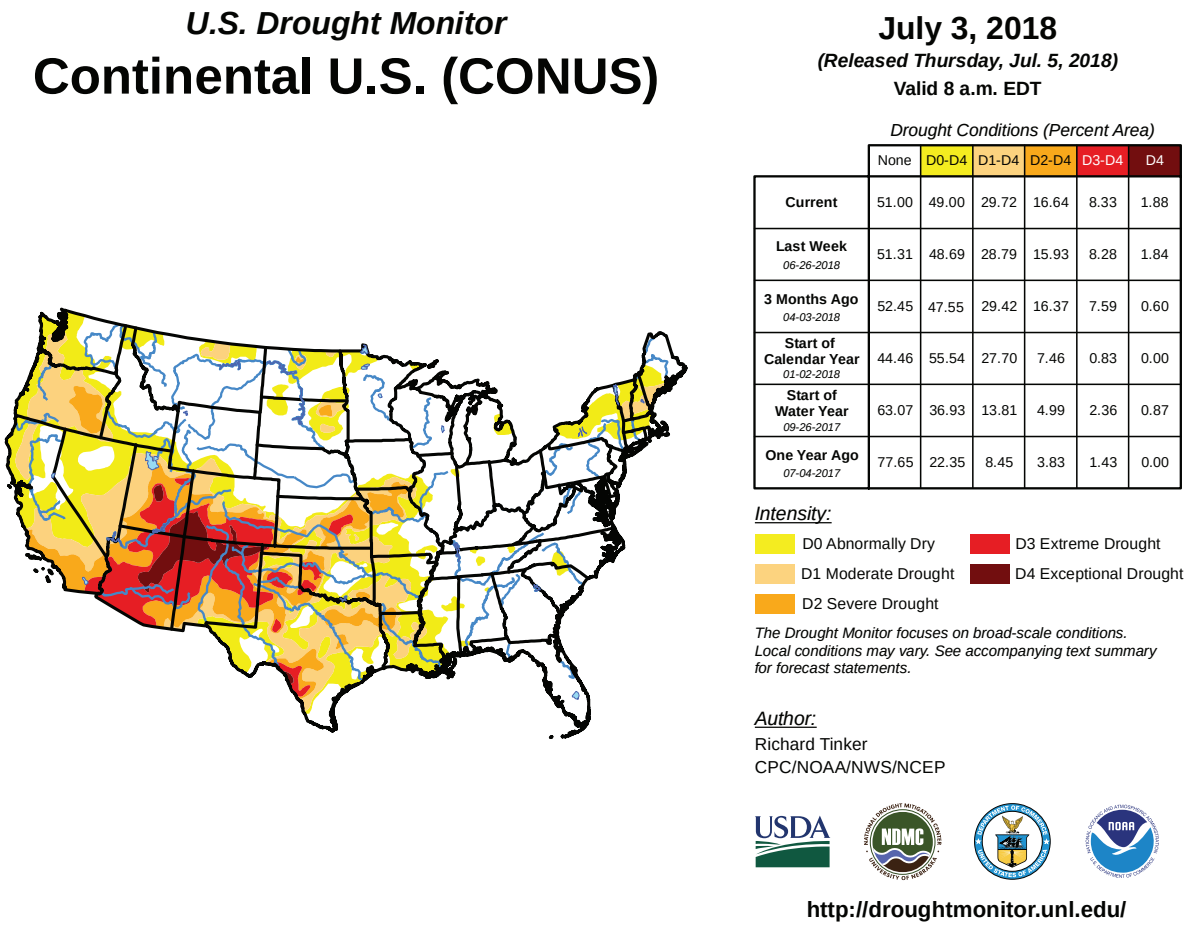
Economic Challenges

Volatile growth patterns, high inflation, deflation and other economic variables cause stresses that make it hard for businesses to prosper. Whether prices are

5 *Vanity Fair magazine* has published a number of Michael Lewis articles that reflect lessened attention provided to the Department of Energy and USDA, *https://www.vanityfair.com/contributor/michael-lewis*.

6 William Strauss and Neil Howe. *The Fourth Turning: An American Prophecy* (New York: Broadway Books,1997).

Figure 2: U.S. Drought Monitor, July 3, 2018



Source: Chris Fenimore, U.S. Drought Monitor (March 20, 2018), *http://droughtmonitor.unl.edu/.*

too high for consumers to pay or changes to climate eliminate jobs, a strong and stable economy is important for a sustainable future.

Disease

Historically, disease has been a limiting factor for human population. Illnesses like plague and influenza strike periodically, and some groups deal with endemic diseases like malaria on a regular basis. Health care has made great advances in the past century, but it remains to be seen if these changes are permanent. For example, resistance to antibiotic treatments has increased as bacteria have evolved stronger than ever. If these lifesaving drugs are no longer effective, who will be willing to risk injury that potentially results in death? Viruses that today seem like no big deal will once again become life threatening, and elective surgeries like knee replacement become less prevalent. Long frozen bacteria are being released in the Arctic that humans may have no resistance against. Spillover effects, where humans encroach on previously unexplored areas, allow diseases to jump species as has occurred with HIV (chimpanzees), novel influenza (birds) and Ebola (bats).

Previous Extinctions

In *The Sixth Extinction: An Unnatural History*,[8] a Pulitzer Prize winner written by New Yorker staff writer Elizabeth Kolbert, five historical mass extinctions are described.

7 The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC-UNL.

8 Elizabeth Kolbert, *The Sixth Extinction* (New York: Henry Holt and Co., 2014).

Many occurred because the rate of change was too fast for the ecosystem to evolve. We appear to have entered a sixth during what is now called the Anthropocene period, an epoch defined by human impact on the Earth. This extinction has been caused mainly by our unsustainable release of carbon through the use of fossil fuels.

Agriculture

Food production has changed over the years. Humans were once nomads, living off what they could find in one area before moving on. Initially evolving from Africa, we gradually filled the Earth in a zone surrounding the equator before spreading to the open areas north and south. When Europeans "discovered" America this provided more space for them to spread into, with spillover diseases that previously jumped from livestock to farmers (e.g., smallpox) being carried to the new world.

Population Growth

Attempts at worldwide coordination of anything, whether it be carbon emissions or population, are hard with incentives varying across the planet. Developed economies point to the growth in developing economies and say they need to slow down; developing economies point to current levels and wonder why they can't participate? Developing economies typically lack a broad-based insurance industry, losing out on an economic incentive to manage risk. When natural disasters occur the human cost is high but the insured cost is often low.

Malthus May Yet Have His Day

No question on my annual emerging risk survey has created so much consternation from respondents as the one about limited resources and the likelihood that we could face choices in the future. Many of the risk managers seem to feel that science will always keep ahead of these issues. Many doctors argued that pandemics were a thing of the past when I wrote about pandemic influenza 15 years ago.

A book by David Quammen, *Spillover: Animal Infections and the Next Human Pandemic*,[9] details the increased likelihood that benign infections in host animals will jump to humans (called zoonosis) given our encroachment on their natural ranges and evolving ecosystems. *Guns, Germs, and Steel*,[10] the Pulitzer Prize winner written by Jared Diamond, showed how access to weapons and metals, along with close contact with domesticated animals (building up immunity to disease) gave the Europeans great advantages, especially against those in the Americas. Humility about our knowledge is a requirement for sustainability.

There are other changes coming, and some are already here. Fresh water shortages challenge population growth and drive regional conflicts. Climate change has led to increased volatility of harvests and weather patterns.

Omaha, Nebraska, where I live, over a two-year period experienced both flooding (due to heavy precipitation upstream on the Missouri River) and drought. The warm winter of 2011–2012 generated little snowfall and led to an early growing season. The corn crop was knee high by Memorial Day, but limited moisture after that destroyed the expected bounty. Various crops are becoming susceptible again to bugs and disease for the first time in decades. Antibiotics are moving closer to the end of their ability to evade the constant evolution of many bacteria. At some point the most dangerous place in your community will become your local hospital. The use of vaccines has created unintended consequences as disease reenters a region with no immunity to it or with a few who refused to take the vaccine, allowing the disease to reestablish a stronghold. Resources are not unlimited and science is neither infallible nor quick.

Evolution can also generate solutions. The lodgepole pine, decimated by the bark beetle and fuel for wildfires in the American west, has recently evolved to create a sap that traps the beetle.[11]

RESOURCE DEPLETION

Many emerging risks interact with population growth. Fresh water, energy, and minerals are important to growing economies, yet many countries do not control their own supplies of everything they need. This traditionally has led to regional conflict and could easily do so again.

9 David Quammen, *Spillover: Animal Infections and the Next Human Pandemic* (New York: W. W. Norton & Company, 2012).
10 Jared Diamond, *Guns, Germs, and Steel: The Fates of Human Societies* (New York: W. W. Norton & Company, 1997).
11 Zach St. George. *How California's Giant Sequoias Tell The Story of Americans' Conflicted Relationship With Nature.* Smithsonian, April 2018, p. 9.

POOR LAWS

Malthus argued that the poor laws, designed to help those living in poverty, created perverse incentives that actually made the situation worse. Charles Dickens appears to refer to this in *A Christmas Carol* (1843) when Scrooge says that he does not intend to donate funds for idle people. When the solicitor argues that many would rather die, he replies that "they had better do it, and decrease the surplus population." The Malthusian argument is that providing food to those who cannot otherwise afford it only encourages them to have families and add more people that must also be fed by others, creating a population spiral. It is a form of moral hazard.

WAR

During war time, everything else becomes unimportant. A large enough conflict could make climate change irreversible as fossil fuels are used without limit to power the war machines. Population growth could be reduced significantly, either through direct casualties or through a simultaneous pandemic.

One of the goals of German leaders during World War II, in concert with their Aryan supremacy ideology and discussed at length in *Black Earth*[12] (by Timothy Snyder), was to gain access to Ukrainian farmland. Psychology was used by both invading armies, German and Russian, to turn the people against each other and eradicate certain groups, primarily intellectuals, leaders, Jews and certain other minorities. Through eugenics using characteristics chosen by the victors, breeding would be limited to the smart and/or rich. This was all part of a multistage German model to avoid Malthusian overpopulation.

Why Might Malthus Be Proven Wrong?

DEMOGRAPHICS

Since Malthus' time, demographics have integrated with sanitation and health care to create a much older population. A newborn can now expect to live over 80 years in many parts of the world. While methods to control unwanted reproduction have slowed population growth, the primary drivers seem to be economic growth and reduced infant mortality. Parents have more children when many are expected to die before they can work. As more live, there is less need for so many.

Movement between countries, whether voluntary or forced, also impacts population. This can be direct, as when one group attempts genocide on another, or indirect as when an aging country with low fertility needs service workers. Japan has chosen to develop robots for this need rather than allow immigration from other areas, with long-term repercussions.

When supply and demand are allowed to incent movement, this reduces the downside of immigration, but more effort needs to be taken to mesh new cultures into a region. There will be bumps in the road, but efforts taken will help groups assimilate.

MISSED BY MALTHUS

Malthus looked at the world as he knew it. He did not anticipate changes that have led to advances in agricultural output. He also did not think through the higher order impacts of his what-if analysis. He tended to focus on exponential growth of population versus linear growth of food production. Creating multiple scenarios would have helped him. Agribusiness has used improvements in fertilizer and genetic developments, leading to fewer farmers feeding more people while using less land.

Larger populations historically have meant that more land was used for people to live on. Areas have been cleared and wild areas encroached on. Continents have been "discovered" and filled. Spillover diseases occur when species are closely mixed. Prior pandemics formed in this way include smallpox, Ebola and plague. Influenza continues to evolve through its reservoir and host species, creating periodic pandemics and annual outbreaks that mainly impact the young and old. Current travel practices increase the likelihood of new pandemics rapidly spreading throughout the world, with growing concerns about bioterrorism. Social Security may be underfunded, but is only a severe pandemic away from health. It is not a business plan that should be relied on.

How do you tell if a certain resource, like the sun, is cycling normally or if something new has occurred? This is a great challenge for scientists, not only to separate the signal from the noise, but to communicate the differences clearly to the general population. Lack of data is used against scientists because they do a poor

12 Timothy Snyder, *Black Earth: The Holocaust as History and Warning* (New York: Tim Duggan Books, 2015).

job communicating their message. Science deniers tend to assign little value to future events, arguing that it doesn't matter what they do today. They believe that it will all work out.

Those who discount the future are really relying on those they ridicule, who continue to look for pivots they can implement before the hatchet strikes.

REGULATIONS

One way a dominant species can remain sustainable is through self-regulation. By devising an accounting system that creates a fee/tax for things like resource depletion and pollution, humans could attempt to stabilize today's imbalances. This is much easier where one party rules, like in China, than in a democracy. It is difficult to change a ship's course quickly when culture requires debate and consensus. Unfortunately, in the United States, the government is currently moving in the opposite direction and dismantling environmental safeguards.

The Earth is a complex adaptive system. As population grows humans need more food, but land becomes scarce. Clear cutting of trees reduces the planet's ability to stabilize carbon, increasing spillover risk and other secondary climate impacts. There are no easy solutions.

The Role of Actuaries

The actuarial profession is defined by its ability to discount contingent events and place a value on the financial results. We are rare in that we have studied a wide range of topics, including finance, investments, life expectancy, health care and demographics. This makes actuaries well placed to straddle the fence between theoretical and practical solutions in a field like climate change. This is especially true when insurance risk mechanisms are considered. Climate survival requires long time horizons to increase resiliency.

While population growth could accelerate relative to food supply, the greater challenge is for the human impact on Earth to be sustainable. Oceans are rising, with two billion at risk in their coastal homes. Ocean stocks are being depleted, with dead zones and dying coral reefs found around the world. Fresh water shortages are causing regional conflicts at a time when displaced immigrants are not welcome elsewhere due to perceived economic hardship. Trends toward inequality have ushered in a new gilded age, where lobbyists seem to have more sway than voters.

We must first qualitatively assess the impact of scenarios before quantifying them. The future is uncertain. Techniques that we try may not work. We continue to learn about the ecosystem. We waste a third of the food we grow, yet many remain hungry. We build McMansions despite techniques being available that make urban planning more sustainable. We need a sustainability pivot soon, or we will be challenged with both a food and population hatchet. This could result from reaching a carbon tipping point with rising temperatures and acidity, a virulent pandemic, or a regional conflict over resources that expands into a broader war.

The debate continues, but it reminds me of Pascal's Wager (Is there a God? If there isn't a God, it is not a big deal to believe. But if there is a God, the downside to not believing is big.). There is no downside to preparation for climate change using scenario planning. If it does not occur, then everyone is better off. But if climate change is real, preparation for a pivot can defeat Malthus once again.

Max J. Rudolph, FSA, CFA, CERA, MAAA, is the owner of Rudolph Financial Consulting LLC. He can be reached at *max.rudolph@rudolph-financial.com*.

13 Eric R. Holley, Adam J. Liska, Michael Hayes, Max Rudolph, Geoffrey C. Friesen, and Donald E. Wilhite, *Climate Change: Feedbacks via Insurance*, Water for Food, Daugherty Global Institute at the University of Nebraska, *http://waterforfood.nebraska.edu/wp-content/uploads/2016/06/Holley.pdf* (accessed May 28, 2018).