“Corporate strategy and the weather: towards a corporate sustainability platform”

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Corporate strategy and the weather: towards a corporate sustainability platform

Abstract

The effect of weather and climate variation on complex manufacturing and the retail sector and their operations can be significant, unpredictable, and costly. This paper provides a novel conceptual framework for a sustainability platform for competitive advantage. It encompasses metrics of performance, business processes, and product and process innovation to encapsulate risk of weather conditions. A sustainable platform requires deep collaboration across the entire eco-system: the supply chain, the life cycle of production, processes, and managerial functions, and distribution end-points, including recycling and disposal. Sustainability platforms and their implications in practice are discussed.

Keywords: corporate strategy, weather, sustainability platform, climate change, structural transformation.
JEL Classification: M1, M14, M16, Q54, Q57.

"Climate is what you expect, weather is about what you get" (Robert A. Heinlein).

Introduction

It is now almost 40 years since Ed Bowman (Bowman, 1976) introduced the weather as a vital component in corporate strategy-making. His research highlighted weather as a surrogate for environmental factor, and a strategic signal of a vital risk factor in an unpredictable and less controllable environment domain. Today, weather, weather conditions, and the lingering impacts of climate change challenge conventional models of global supply chains, internal coordination of firms with multiple manufacturing locations, and global marketing outlets. Weather and weather-dependent variables now influence industries, supply chains, transportation and distribution gateways, and strategy itself, made more so by the levels of greenhouse gas and climate change. Do today's current models and frameworks of corporate strategy depict the new risks – weather, value chain shortages, financial, technological – of weather and climate change elements for high performance?

Weather, extreme weather conditions, and climate change are now vital policy issues for governments and, with a lag, for corporate strategy[1]. These issues are not new: the military and military planners have a long history of incorporating weather and climate issues to battle strategies (Moyer and Rowan, 2013; Metz et al., 2007). Indeed, military history is a catalogue of famous victories and defeats based on weather conditions, from Napoleon's and Hitler's invasion of Russia, to the Allies' 1944 landings at Normandy. Private sector industries, as well as public sector governments, have learned these risk elements from military planners and they bear testimony to how weather conditions – and seasonality – impact risk profiles for success and failure. For centuries, farmers and fishermen appreciate these weather issues, but it is only recently that managerial planners have fully understood the severity of extreme weather conditions and climate change on corporate strategy. Studies of extreme weather events, the establishment of a new journal, *Weather and Climate Extremes*, and the rising costs of weather damage and destruction are signs that weather is a vital topic for management.

Recent weather-related tragedies in numerous countries ranging from Russia and Britain to Sudan and the Philippines (severe floods, rain, draughts, and extreme temperatures costing billions in damages) illustrate the disruptive features of weather and climate-related crises. The 2011 floods in Thailand that forced Toyota to stop its operation, and the 2013 Sandy Hurricane in New England are two dramatic examples how the massive disruptions to global supply chains, the time-lines for delivery of products, and components, and slowdowns to meeting production orders impact corporate performance.

Globalization and the drivers of globalization – financial flows, technological and communication advances, investment policies and trade development – now intersect with weather and climate factors as sources of uncertainty, competitive response, and changing corporate awareness. Disruption risk, appreciation of supply chain uncertainties and deep operating disturbances from weather patterns – from severe hurricanes and floods to droughts and ice storms – are changing the mind-set of corporate executives. Insurance markets, as well as electrical utilities, global

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[1] Sun-Tzu's classic study of warfare lists five criteria for successful outcomes, and climate was second: "Climate is light and shadow, heat and cold, and the rotation of the seasons". See Ames, Sun-Tzu (1993). For a recent analysis, see Winston (2014).

exporters and shippers, and some governments (e.g., the state of Florida established a new agency to design methodologies and metrics for residential property)[2] appreciate the need for more pro-active adaptation strategies. In some areas of the private sector – agriculture and agribusiness, travel and tourism, air and ocean transportation, electricity producers, fashion, and food retailing – weather now influences product choices, market demands, technological threats, and risk uncertainties, because logistics and supply chains can be impacted within hours or days (Finos, 2012).

A study by an American science organization, the National Center for Atmospheric Research, examining 70 years of favorable and unfavorable weather, suggests a production gap of over 3 per cent of GNP, almost $500 billion. According to the U.S. Department of Commerce, almost one third – 30 per cent – of the U.S. GNP is directly or indirectly affected by the weather[2]. The effect of weather on complex manufacturing and the retail sector and their global supply chains can be disruptive, unpredictable, and costly. From agribusiness to transportation, construction to tourism and retail, weather is a central source of unpredictability and volatility. Accurate and timely weather intelligence is now central to corporate strategy-making and enables a more efficient and reliable supply chain, while improving the key metrics of customer service. However, while the real costs of hazardous disruptions and cost tradeoffs from bad weather may seem obvious, there is a lacuna of studies addressing weather patterns and corporate performance, as well as new frameworks and planning models that accept climate change and disruptive weather patterns as the 'new' normal.

New sustainable business practices, such as product, process and waste recycling, energy-saving, pollution-mitigation, and green innovation products (e.g. hybrid vehicles) are common both in advanced industrial countries, but increasingly in emerging markets, especially China. However, weather conditions now pose new challenges. Firms around the world are struggling to develop new tools and frameworks, based on multiple sources of data on weather impacts. In industries like agribusiness and global retailing (where companies source from multiple locations and have store outlets in numerous countries and cities) and transportation sectors like ocean shipping, airlines, and railways, companies are increasingly connecting the dots between risk management, enlightened sustainability, and extreme weather. Robust new models require new competencies and skill-sets for awareness, planning and adaptation, and new approaches to link external threats and opportunities to internal structures, flexible systems, and mitigation against weather risks and their impacts.

This paper addresses weather and climate-related issues (climate change describes patterns of weather over a long-term) on corporate strategy. It provides a novel conceptual framework for a sustainability enterprise platform for corporate positioning and competitive advantage. Climate issues now impose increased corporate risk. This sustainability platform requires a new corporate mind-set and an eco-system model involving supplier inputs and supply chain metrics, in-house manufacturing and production tools of deep collaboration, and output distribution and marketing outlets. Such a framework is necessary to deal with a core proposition, that frequent and continuing weather disruptions need new managerial frameworks of planning. The new challenges imposed by extreme weather patterns, disaster-relief and disruptions, and long-run climate change now require pro-active understanding and appreciation of new corporate risk, weather risk, and risk mitigation management. Both corporate strategy and tactical operations require superior industry and enterprise information metrics and intelligence analysis. They also need clear, forward-looking tools to link each stage of the eco-system value chain to weather.

1. Weather disruptions and climate change

Why weather-related issues are so central to manage corporate risk? What new calculations and capabilities are central to judge total costs, time losses, and disruption threats that impact the corporate bottom line and long run measures of effectiveness? What are the unintended costs of inaction? Conventional tools of flexible action, such as decentralized decision-making, open communications, and tools of redundancy, duplication, and excess capacity may be inadequate for extreme weather conditions. In theory, managers can anticipate demand patterns of product sales, forecasting of inventory needs and supply chain affects, and transportation and distribution based on weather conditions.

Seasonal demand forecast are typical in sectors like retailing, agriculture and fishing, energy and utilities, tourism and transport, fashion and

[2] See Dutton (2002). For a pioneering work on linking weather to demand planning, see Cawthorne (1998). For an analysis of transportation systems to extreme weather, see Doll et al. (2013).
[2] Dutton, op. cit. He defines risk as: *Risk* = (*Probability of Occurrence*) (*Cost of Occurrence*). For an overview of similar but more proactive strategies, see Long (2014).

construction. Firms that understand seasonality, like hotel chains, airlines, and retailers readily offer bargains during nasty winter storms. Similarly, retail outlets offer bargains and discount prices for lawn furniture, garden supplies, and golf equipment on the first warm days of summer. Food retailers understand how short-life product cycles and perishable goods require sophisticated weather conditions in their demand forecasts. Worldwide, as many as half a million people have died in weather disasters such as flooding and tropical cyclones since 2000 (Wilson, 2013). Not only do natural disasters lead to extreme financial losses, food shortages, and severe health problems, corporate financial collapses can be exacerbated by natural disasters.

Corporations have decades of experience in designing and fine-tuning simulation tools and other planning methods to forecast risk elements and corporate decisions in such areas as sales, market demand, redundant capacity, manpower, energy use, inventory and production, exchange rates and a host of applications applied to specific industries and business sectors. Weather is often included in supply chain forecasts. But these forecasts and simulation models include data mostly within a country or region, especially for sectors like retailing, with their seasonal demand needs, short life cycles, and perishable goods, or in agriculture, construction and transport. However, the availability of weather data from scientists, government officials (including the military), and private forecasters, the corporate community has better tools to design and develop simulation models of energy use, energy pricing, the production of greenhouse gases, and now, most controversially, long-term climate change.

In the U.S., but in other advanced countries as well, companies are increasingly turning to Atmospheric and Environmental Research (AER) for weather intelligence. With AER, supply chain executives can anticipate demand before it spikes and take effective action. Shipments can be accelerated or rerouted to avoid severe weather areas. Seasonal forecasts can drive decision-making about inventory levels. Companies can better predict customer traffic and store volume and react accordingly. Retailers and manufacturers can strive for product availability to avoid stockouts, and improved revenue turnover.

In the recent past, governments and private sector firms had a dearth of information on weather-related disasters, financial costs, risk measures, and time delays. Today, thanks to real-time data sources, tracking systems of weather patterns using sophisticated data models from satellites, there is a wealth of expertise educated in the atmospheric sciences, once confined to government weather departments. These trends plus a realization of why weather conditions are so vital to planning now allow private sector startups, new financial products like weather derivatives, and new corporate risk models (Carabello, 2009; Gall et al., 2009; Elsner et al., 2009 and Dischel, 2002)[1].

Weather-related issues are front and center for governments and managers in vital sectors like insurance, energy, agriculture, transportation, and retail, and leading multinationals. How can managers now employ better tools and managerial systems to shift from a short-term, reactive stance to a pro-active, forward planning perspective with considerations of models of redundancy, resilience, and risk mitigation? Weather impacts are real.

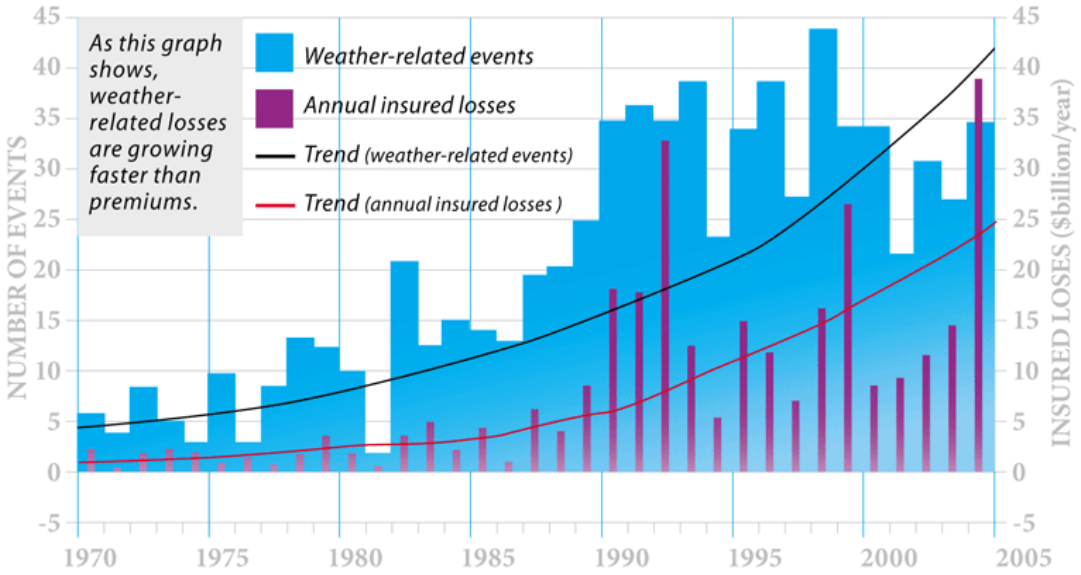
Munich Re, a global insurance firm based in Europe, documents global weather-related disasters, such as Typhoon Haiyan in the Philippines with 7,500 people died or lost and 4m made homeless to flooding in the state of Uttarakhand. India caused a death toll of 6,000, and cost insurance sector $45 in 2013 and $65 billion in 2012. The *OECD's Environmental Outlook To 2050 Report*[2] reinforces the need for corporate risk premium of passive strategies by outlining both the extent and number of severe floods, droughts and storms occurring in the risk premium of weather-related disasters globally over three decades, as shown in Figure 1.

Data from the Center for Research on the Epidemiology of Disasters, from 1980 to 2009, in what it calls weather-related disasters, storms nearly 45% floods accounted for over 40% and droughts 15%, impacting between 100 million and 200 million people a year, with economic costs (losses) amounting to between $50 billion and $100 billion annually. This report suggests that by 2050 more than 1.6 billion people (or nearly 20% of the world's population) and assets worth $45 trillion could be at risk from the impact of increased flooding, especially in big cities in Asia[3].

[1] Social media also promises to advance on-line access to weather conditions.

[2] See Munich Re (2013) Half-Year Natural Catastrophe Review (www.munichre.com/natcatservice/downloadcenter/em); OECD Outlook to 2050, www.oecd.org/env/cc/49082173.pdf. See also, Price Waterhouse Coopers, Too Late for 2 Degrees? London: November 2012.

[3] Wilson, op. cit. For background, see Begg et al. (2005).

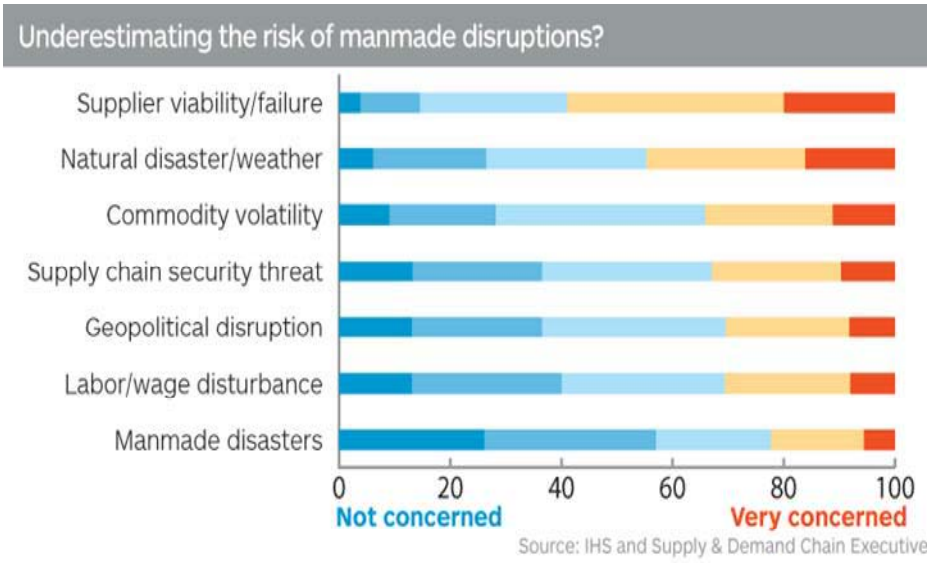


Source: "Financial Risks of Climate Change" (2005), Association of Business Insurers, Sigma database.

Fig. 1. Weather-related disasters and losses

Estimates of fatality rates, and economic losses as a percentage of GNP from weather-related factors, range from 0.1 per cent of GNP for high-income countries, 1 per cent for middle income countries, but as high as 8 per cent for small, island developing countries. Consequently, financial estimates vary widely, in part because the impacts go beyond mere economic and financial numbers – loss of lives, damage to cultural heritage artifacts, and destruction of ecosystem infrastructure assets, e.g. coral reefs and beaches, waterways and water supply and treatment facilities. Total losses are difficult to calculate, monetize and assess (Changnon, 2010).

The real impact of these weather-related disasters and organizational disruptions have been absent from organizational planning and models of risk forecasting, which often tend to be short term with financial and economic metrics only. However, this reactive, myopic mind-set may be changing. A recent survey of supply chain professional executives, reported in *Supply & Demand Chain Executive* magazine, asking respondents to identify levels of concern, placed supplier viability/failure first, and natural disaster/weather disruption second. Significantly, the category of manmade disasters scored last (see Figure 2).



Source: Long (2014).

Fig. 2. Survey of concerns of supply chain executives

In America, because of declining expenditures on core infrastructure, certain types of infrastructure are more at risk, e.g. most transportation systems like roads, bridges, highways, and tunnels; water drainage and electricity transmission systems; water pipelines and water treatment plants now estimated to be $2.3 trillion in deficit and $57 trillion world-wide (McMillan and Stalk, 2012)[1]. Cities and large urban areas are especially vulnerable to severe weather and climate conditions because of disruptions to complex communications networks and transportation interconnections like ports, rail and roads, or airports, highways and trucking. Disasters like Katrina in New Orleans and the 2012 New York storms illustrate societal dependence on water supplies, drainage and runoffs, traffic management, telecommunications, health care services and urban metro trains on electricity supply and the vital role of emergency services on all-weather roads and functioning bridges (Da Silva, 2010; Solecki et al., 2012). The weather-related disasters vastly increase the risk premiums for supply chain and work disruptions. Estimates of weather impacts on various sectors in the US demonstrate significant costs, as shown in Figure 1.

Table 1. Weather-sensitive impacts on the US industry

Industry sector	GDP	Weather-sensitive
Agriculture, forestry and fishing	135.8	135.8
Mining	127.1	109.6
Construction	463.6	463.6
Manufacturing	1,556.6	-
Transportation, public utilities	825.0	786.5
Wholesale trade	674.1	-
Retail trade	893.9	893.9
Finance, insurance, and real estate	1.936.2	379.1
Services: hotels, auto repair, etc.	2,164.6	241.2
Statistical discrepancy	-130.4	-
Total – private industry	8,656.5	3,029.6
Federal government	387.0	-
State and local government	829.5	829.5
Total GNP, 2000	9,872.9	3.859.1

Source: Adapted from Dutton, Table 2.
Note: Operations, Demands, or Price: 1987 SIC, Calculated for 2000.

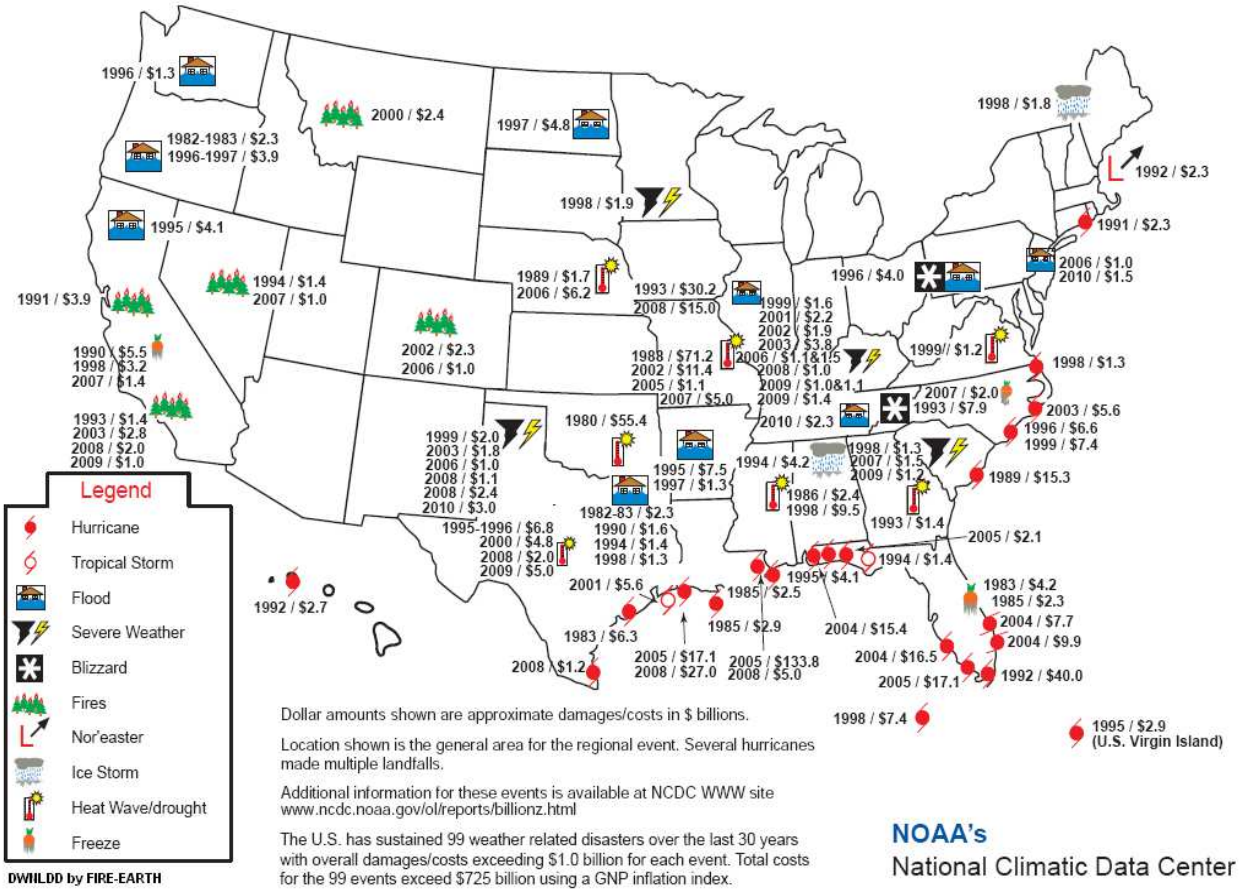
Weather patterns are more immediate and visible globally because data and images available via satellites and global positioning systems have improved so dramatically, and instantly distributed via the Internet, mobile phones, and TV weather channels. But other factors suggest new threats of weather-related disruptions. The rise of India and China, and the spread of globalization, linking countries, multinational companies, and parts and component makers via complex supply chains require management systems to consider novel elements of environmental and weather risk. The rapid diffusion globally of cars and trunks, extensive use of ICT and smart phone systems, and deregulation of air transport and more flights per day increase the level of greenhouse gas emissions. Alone and cumulatively, they add urgency to weather issues, emission levels, and weather-dependent production systems.

Extreme weather, climate change, and national disasters are now high on the public agenda internationally, as the recent triple storm in Japan illustrates – the 2011 earthquake, the tsunami, and the nuclear disaster at Fukushima – and show how they impact neighbouring states and supply chains globally. But other countries are affected as well by complex weather patterns, not only in places like China and Thailand with storms and earthquakes, but droughts, floods, snowfalls, and heat waves in Russia, or other forms of unusual weather storms in different parts of the world. The United Nation's 2011 *Global Assessment Report on Disaster Risk Reduction*[2] cites two million people killed in disasters from 1970-2011, and estimates for losses in Asia for 2011 were $366.1 billion.

As shown in Figure 3, the USA, the world's largest and most innovative economy but one of the most exposed to severe weather conditions, illustrates the geographically widespread impact of weather disasters that inflict damage to states, cities, industries, and firms and the regular disruptions on global supply chains, corporate production, and distribution outlets. Climate change is real: 2012 was the 9th-warmest year in history, and the ten hottest years in history occurred since 1998. President Barack Obama, in his second Inaugural Address in 2013, put a new priority on climate change. "Some may still deny the overwhelming judgment of science, but none can avoid the devastating impact of raging fires, and crippling drought, and more powerful storms."

[1] See also The Economist (2014).

[2] United Nations, The 2011 Global Assessment Report on Disaster Risk Reduction, www.unisdr.org/we/inform/.../19846. The Environmental Performance Index, compiled annually by researchers at America's Yale and Columbia University, ranks 178 countries on nine indicators, such as air quality, water and sanitation, biodiversity and habitat, agricultural subsidies and pesticide use, forestry and fisheries, and climate and energy emissions



Source: National Climatic Data Center (2011).

Fig. 3. Billion dollar weather disasters (1980-2010)

2. Corporate strategy and weather threats

Weather, Mark Train remarked, is akin to something that everybody complains about, like death and taxes. Long-term changes in weather patterns, including climate change, persist to many observers as a combination of part-science, part-mystery. Indeed, it remains a paradox that whilst organizations espouse change and innovation, managers fail to recognize how environmental conditions impact internal decision processes necessary to know, understand, and prepare for the future. Organizational failures in complex or extreme weather situations stems from strategic myopias and decision inertia that prevent learning, anticipation, and adaptation of environmental change. Climate change is a case in point. Writers and consultants have been talking about these issues for more than two generations – the first work on corporate social responsibility dates to 1953[1] – but the global conversation on weather and climate has changed dramatically in this century.

Globalization and the emergence of the BRIC countries, plus revolutionary communication tools, social media, and the Internet have played a major role. So too have inter-governmental initiatives like the Kyoto Accord and the global conference on climate change in Copenhagen (Giddens, 2011; Nordhaus, 2011). There are new, progressive voices from think tanks and policy institutes, and business groups, like the World Business Council for Sustainable Development. Activist NGOs, both with a pro-business bias and NGOs favoring government regulation and supervision have mobilized a network of young people who are very media savvy, such as Greenpeace, Friends of the Earth, and the World Wild Life Fund for Nature (and an advisor on climate issues to many global firms. The Climate Change Network, acting as an umbrella for some 365 NGOs, is a significant pressure group on governments and companies and serves as an information source to promote climate initiatives and is now linked to some university departments in Europe. Even the reality gaming industry is protruding into the debate, such as the computer game, World Without Oil.

[1] Bowen (1953). For a recent overview, see "Briefing: The Science of Climate Change: The Clouds of Unknowing", The Economist (March 20, 2010).

Many American firms have taken their environmental cues on climate change policy from industry associations and environmental groups like the Global Climate Coalition, formed to challenge the science of climate change, the Pew Center on Global Climate Change, and the Business Council for Sustainable Energy (Levy and Jones, 2012)[1]. Two groups, the Competitive Enterprise Institute, and the American Legislative Exchange Council, were leading lobbyists advancing restrictions on climate change policy initiatives at the state level, including fighting fuel efficiency standards for the auto sector.

The defensive and reactive positions of the U.S. corporations have shifted slowly. Leading business groups, including the U.S. Chamber of Commerce, began an intellectual transformation of the executive mindset. Wal-Mart, to cite a corporate example, working with domestic and international NGOs, initiated a number of measures for their global supply chain, including reductions to their carbon footprint, more sustainable products and packaging, and improved energy use[2], initiatives than have become the global standard for best practices in retailing. In Britain, a coalition of groups from finance, business, and academe established the Center for Enterprise, Markets, and Ethics at Oxford University. The Aspen Institute Business and Society program has initiated programs to change the mind set of leaders for the 21st century, including working with North American business schools on sustainability courses for MBA students, case writing, and short executive programs on sustainability issues. Michael Porter of Harvard and Mark Kramer of Stanford have given their stamp of approval to these sustainable efforts with their influential article, "Creating Shared Values" by expanding the traditional shareholder value model to society at large (Porter and Kramer, 2006; Arnold and Bustos, 2005).

More concretely, two issues have helped shift the global debate towards climate change initiatives, carbon emission policies and sustainability: oil and water[3]. They are inter-related and have a profound impact on global development and economic growth. Both oil and water reserves are not distributed evenly across the continents. Some countries have abundant sources, some have severe shortages. Few countries match Canada, with abundant availability of both energy (especially hydro, which is renewable) and fresh water. Japan, the world's third largest economy, has no readily available access to any raw materials, including oil, and functions with the highest energy prices, including electricity, of all the advanced industrial countries (O'Sullivan, 2013). The southwest part of the United States, sub-Saharan Africa, and the western part of China have severe shortages of rainfall, fresh water, and up-to-date water reservoirs.

Climate change, extreme weather patterns, and the rising insurance costs and environmental risks – as high as $20 billion in 2013, according to Swiss Re's estimates – now initiate new thinking on the impacts of industry location, product line positioning, and corporate branding, with profound implications for governments and large firms. Public policy and market forces now converge, regardless of political ideology. As Keys and Malnight (Keys and Malnight, 2009) emphasize, 44 of the largest economies in the world are multinational firms, and traditional separation of the public and private sector is no longer adequate to address these complex policy issues[4]. However, despite adaptive organizational structural mechanisms like strategic business units, organizational networks, and bureaucratic integration tools like budgets, overlapping decision models, and kaizen learning, internal processes and organizational inertia remain a barrier to adaptive behavior, short-term myopias, and decision attention to weather and climate challenges.

Weather elements, climate change, and sustainable practices are not universally accepted. Many senior executives remain recalcitrant towards this mind-set of sustainable management and the new requirements of weather impacts. Some firms are in denial. Why? March and Simon (1958) address this point as follows: 'the routines of attention allocation tend to give priority to those things that are immediate, specific, operational, and doable; they tend to ignore things that are distant, general, and difficult to translate into action'. Or put differently, 'organizations and the people in them deal with ambiguity by avoiding it' (Cyert and March, 1963). Weather now require scarce executive attention time.

3. Weather as a strategic threat

Bowman's initial studies (Bowman and Haire, 1975) examined the evaluation of external conditions like the weather as a signal of environmental threats and

[1] See also, Climate Change and the Emergence of New Organizational Landscapes (2012).

[2] www.triplepundit.com/...rice-walmart-green-supply-chain-best-practices. See also Senge (1997).

[3] Both water and oil have been the causus belli of many military conflicts over the centuries, and they are highly interconnected, one needed to extract the other. For a recent analysis, see Gautier (2013).

[4] A new framework for firms is ISO26000, a guideline for socially responsible principles, now being adopted by many countries, and includes seven principles of social responsibility: Accountability, Transparency, Ethical Behavior, Respect for Stakeholders interests, Respect for the rule of law, Respect for international norms of behavior, and Respect for human rights.

opportunities. More specifically, this research, using annual reports of successful and unsuccessful firms, questioned whether managers had, in their streams of decisions, "a sensible integration of the goals of the firm, the nature and competences of the firm, and the perceived opportunities and risks in the environment". Given the impacts of global weather conditions, are firms and top leadership spending scarce strategic time and effort to focus on high risk environmental threats?

Business theory suggests organizational leadership requires industry positioning in niche products and markets with high returns and high market share (Porter, 1985). Internal capabilities and exploiting engineering processes via knowledge competencies (Nonaka et al., 2010), combine with explicit and tacit knowledge, allow firms to create sustainable but comprehensive cost value. For reasons already noted, environmental uncertainty from weather patterns is profound. New models of learning and frameworks for early warning system and flexible planning are required, not only because of disruptive forces of globalization, technology, and a range of wicked problems[1] but because weather and climate change inflict hazards and destruction, unpredictable distortions of routines, and organizational turbulence to corporate planning, forecasting, and appropriate responses.

Weather and climate variation shift interdependencies within the firm. They reduce internal integration and coordination of sub-units, and more disruptive conditions with specific functions, departments, and hierarchical levels. Weather issues challenge established decision protocols of conventional routines and activities, lesson capacities to make innovative decisions, and opens possibilities for profound organizational drift, managerial myopia and decision inertia (O'Reilly and Tushman, 2004). Budgets, strategic plans, established decision routines, and other bureaucratic mechanisms that integrate and coordinate workflows demand new mechanisms of learning, adaptation, and performance trade-offs. Weather and climate-related events threaten these orchestrated control systems in loosely-coupled systems, or disrupt the sequential information-processing and workflow of tightly-coupled organizations. In both cases, traditional dependencies with suppliers (inputs) and customers (outputs) become suspended, broken, and difficult to restore. Risk levels can climb quickly and even precipitously.

This brief discourse on organizational responses to weather make the difference between weather conditions as a point of reference and climate change only a measure of time: a short period like weeks or a season, or a very long period, measured in decades or centuries. Recent academic research suggests that studies of weather, climate change, and long term impacts are extremely controversial, and many industries but especially the oil and gas sector, display mixed signals towards government initiatives[2].

As depicted in Figure 4, corporate executives can have different approaches to weather and climate change. The reasons vary. The salience of real costs of emissions output, the availability of alternative energy feedstock, the history of technological innovation activity, the record of management's prior experience to environmental threats from severe weather conditions influence decision choices. Pro-active strategies of risk management and risk mitigation are shown in corporate examples where innovation strategies are real, and internal capabilities are mobilized to address weather threats ex ante. In other cases, management takes a defensive and reactive strategy, addressing the problems ex-post. Often a defensive stance may even entail a denial of climate science and leads to competing from a position of weakness.

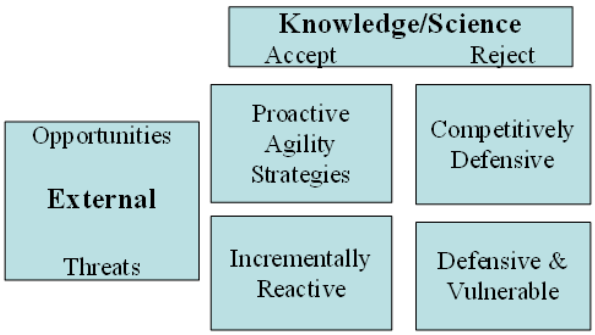


Fig. 4. Strategic approach to weather and climate

The corporate impacts may be indirect, like rising energy prices, electricity blackouts, and water shortages. But the impacts may be more direct and costly: supply and inventory outages, disrupted order delivery, and shocks to time-based managerial practices (Stalk, 1988; Stalk and Hout, 1991). Clearly, not all organizations recognize changes in the external environment, including impacts of disruptive technologies (Christensen, 1997) or even minor environmental disruptions that can accelerate quickly and lead to a spiral of decisions with disastrous consequences (Stalk, ibid., p. 3). The weather and climate change are two issues with profound implications for corporate behaviors. They impact not only the flow of goods, services, information channels, but also cycle times and in-

[1] McMillan and Overall, op. cit.; on the complicated legal and constitutional issues in the US, see Lazarus (2009).

[2] Giddens, op. cit; see also Aguinis and Glavas (2012) and Chouinard et al. (2011).

process inventory of the production system. To quote one leading authority (Stalk, ibid., p. 3), "sustaining the rate of improvement and the accompanying benefits necessitates a philosophical change. Top management must shift its focus from cost to time and its objective from control and functional optimization to providing resources to compare time throughout the organization".

4. Towards a sustainability platform

This section deals with a forward-looking conceptual framework for a sustainability platform. It incorporates treats of weather conditions, and draws on concepts in the organizational literature on social capital, network models of organizations, and novel ways to create new forms of collective intellectual capital. It addresses a core hypothesis: the higher collaboration of the eco-system participants, the higher the corporate performance. Given the impacts of extreme weather conditions and climate change, top management leadership needs to go well beyond a minimalist and passive response to threats of wealther, climate change, and narrow corporate welfare.

An organizational platform has knowledge-based characterictics, such as features of social capital high network configurations, cognitive dimensions like knowledge codes and protocols, and relational (trust, shared goals and obligations). Some features vary – e.g. customer preferences, regional variations, and regulatory requirements. In the main, strategic platforms center on knowledge: for example, how Toyota structures its lean production around engineering systems, Microsoft with its operating system, or to retailers like Wal-Mart, Canadian Tire and IKEA in global logistics.

This framework, set out in Table 2, has three main characteristics or elements: an ecosystem of collaborate partners, design architecture, and a knowledge and intellectual capital base. The organizational ecosystem encompassing three levels of collaborative sub-systems: sustainable supply chains of Tier I and Tier II suppliers, each with their own suppliers and customers, with benchmarks of performance, such as price, quality, delivery time, and time lines for product design. The second characteristic, organizational design includes not only the appropriate level of attention activities and decision-support system, but a sustainable configuration of internal business processes that extend across all levels of the network's value chain. Such involvement of Tier 1 and Tier 2 suppliers and sustainable distribution and transportation suppliers must include deep decision collaboration on performance benchmarks, optimizing the network performance outcomes to sustain the rates of learning and knowledge creation. It is hypothesized that firms with a sustainability platform will achieve superior long-term performance.

The sustainable platform framework combines three elements: supply chain inputs, internal business processes, and output distribution. They are seen as an integrated total ecosystem, combining deep decision collaboration and joint benchmarks of performance and effectiveness. The sustainability platform, where corporate risks are reduced by spreading the learning tools across the entire organizational ecosystem, represents a proactive corporate philosophy that, like total quality management, reflects the bias of *Kaizen*, or continuous improvement. Past performance is a guide to future improvements and higher goal aspirations.

A platform model requires not only high levels of corporate commitment, including the CEO and board governance participation and support, but a set of metrics for sustainable performance at all levels, vertically and horizontally. A sustainability platform framework also goes beyond conventional cost accounting metrics. Process measures, such as time, training, and talent metrics, are vital components to assure operability and integration within the total ecosystem organization. This conceptual platform framework differs dramatically from conventional product-market architecture. It requires novel tools of collaborative design, talent expertise, supply chain collaboration, and technical standards, including life cycle analysis, that impact the entire organizational ecosystem.

An organizational platform is a strategic design that configures people, technology, and coordination processes that combine the tightly-coupled rules features of machine bureaucracy (i.e., exploitation) with highly flexible, loosely-coupled organic features of exploration. Variability coordination is, however, not a trivial activity. A successful platform strategy can have hugely profitable advantages, even a winner take-all outcome, and also a large reputation advantage[1]. Platform organizations capture commonalities between products (or services) through an ecosystem. It combines capabilities, intense interaction processes, and complementary products. An ecosystem organization has multiple network ties, shared performance benchmarks, and collaborative decision-making and experience create collective knowledge capital and superior outcomes, based on external threats, including weather conditions.

[1] Gower (2009). For background on social capital and liks to collaborative decision-making, see Nahapiet and Ghoshal (1998).

Platforms function as an extended network value chain under a generic umbrella, including parts and component suppliers and output distributors tailored to meet specific customer needs with variants within flexible structures to deal with weather disruptions[1]. Platform organizations exhibit flexible, mass customization model with high variety, speed, reduced lead time, and high reliability (Cusumano, 2010). Platform organizations demand intense levels of human resource interaction and training, deep collaborative decision-making, and long planning horizons across the organizational network. Precise knowledge of cost elements, including process variables like waiting times, delays, safety, weather conditions and forecasts, and social impacts of consumer acceptance (or rejection) must be recognized and measured for the entire eco-system, not discrete phases or parts. If these conditions are met, a proprietary platform is very difficult to replicate. However, in the absence of extreme conditions of training, expertise, risk management and a culture of learning and intelligence, platform models can also fail precipitously[2].

Each of the elements in the framework in Table 2 involves interactions and feedback not only for the platform organization but all members of the organizational network or eco-system. Each requires tests of agreed performance goals, and learning processes that calibrate and improve with time. Further, a proper information system take into account new metrics, involving time, emissions, delays, real-time feedback, potential social costs, and risk mitigation. Too often in the recent past, companies have operated in an environment when they can pass corporate risk factors to the public sector, by refusing to pay for cleanups (e.g. in mining), overuse of water from public lands, or needless restrictions to recycling practices.

Table 2. A conceptual framework for a sustainability platform

Supply chain integration	Business processes	Transport & distribution
♦ Sustainable metrics of Tier I and Tier II suppliers. ♦ Benchmarking metrics – speed, reliability & sustainability. ♦ IT tools for data analysis. ♦ Scenario analysis and backcasting tools. ♦ Organizational barriers to supply chain sustainability, training, regulations & executive commitment. ♦ Deep collaboration across the entire supply chain.	♦ Sustainable metrics for value chain. ♦ Design issues for recycling, reuse. ♦ Internal processes for process innovations and products. ♦ Water and energy efficiency. ♦ Preventive technologies and processes for fuel emissions & waste. ♦ Social audits of suppliers & distributors on work practices, safety, and quality. ♦ Green service levels and capacity indicators. ♦ Risk analysis and risk mitigation processes.	♦ Sustainable metrics for transportation and distribution. ♦ Sustainable capacity planning and inter-modal transport 'right-sizing'. ♦ Time-dependent cost efficiency metrics of reliability and customer service. ♦ Complete life cycle cost analysis. ♦ Crisis management tools and systems. ♦ Strategic partnerships for scale and learning. ♦ Reputation-enhancing measures for transportation & delivery.

Platform organizations have complex decision structures, with the need to integrate multiple goals and standards of operating performance. A sustainability platform, linking networks of suppliers and customers, is a new tool to gain competitive advantage (Cusomano, op. cit; Rao and Holt, 2005; Vom Brocke, Seidel and Ecker, 2012). The proposed conceptual framework for a sustainability platform links eco-system organi-zational features, robust environmental scanning, and network dimensions that reinforces open systems thinking of inputs, thru-puts, and outputs to weather conditions and climate change. It has special applications for firms in primary industries like oil and gas, mining, or agribusiness, because these sectors require associated infrastructure requirements (such as electricity grids, water systems, pipelines, and roadways). These sectors illustrate the real, long-term costs of reactive strategies, such as political protests, government indecision, and even loss of financial and investment support. It may take years to realize the full costs of inaction and reactive strategies. Platforms organizations differ from stand alone organizations, such as in vertically-integrated organizations, by their network features of shared dependencies, information coordination, and high performance benchmarks.[2]

Wal-Mart provides a dramatic example of how a retail firms can use some elements of a sustainability platform, which already has a world-class platform in logistics. In 2005, Walmart, Inc. announced new sustainability goals by reducing the use of nonrenewable energy, increase energy efficiency, and reduce waste. Wal-Mart's subsidiary in Mexico, Walmart de Mexico y Centroamerica ("Walmex"), developed three broad targets by 2025: (1) 100% renewable energy; (2) creating zero waste; and (3) merchandize products that sustain people and the environment. In 2010, Walmex designed a five-year sustainable strategic plan: using 50% renewable energy; recycling or reusing 80% of residual materials generated by operations; reusing 60% of the water used in stores; expanding the supply of sustainable products; and training and

[1] As Dyer notes, "A tightly integrated production network, dedicating supplier assets to the customer, will virtually always outperform a loosely-coupled production network". See Dyer (1994).

[2] The classic study is Vaughan (1996).

involving suppliers and partners in sustainability. Similar sustainable life cycle tools are applied at firms like 3M, but these are too often exceptions to best practices (Salvado et al., 2013).

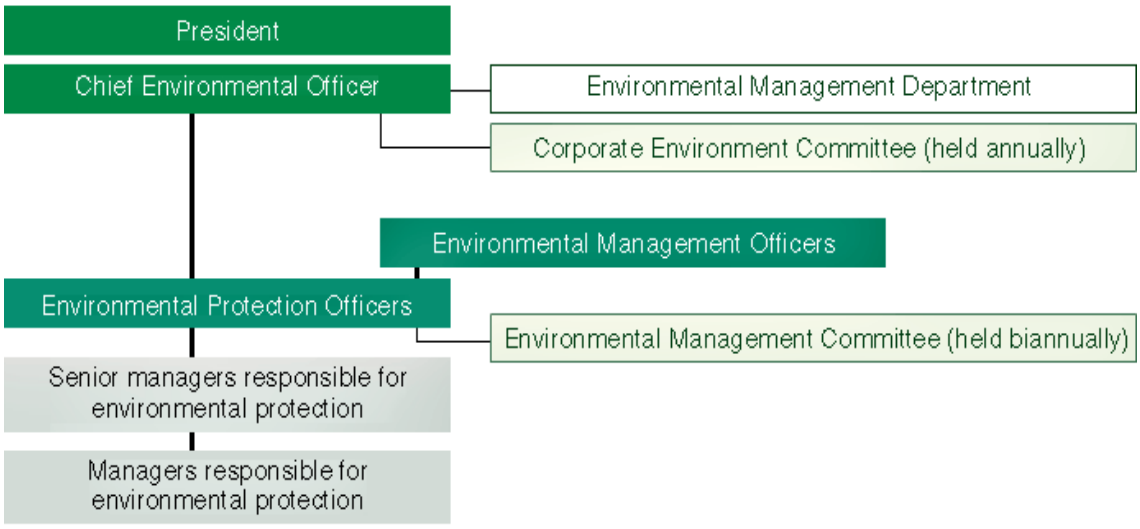
However, firms need to go beyond input metrics of sourcing, procurement, logistics, and supply chains. Platform organizations need to address two imperatives in their internal operations to address extreme weather, severe disruptions, and potential conflicts with stakeholders. The first is a highly flexible organizational structure that allows measures to cope with environmental uncertainty, continuous internal decision scutiny, and the capabilities and skills-sets for unantipated crisis reponse – characteristics of an ambidexterous organization (O'Reilly and Tushman, op. cit.; McMillan and Stalk, Jr., 2014). Platform organizations also require substantial investments in intellectual assets, both to stretch the knowhow and technical capabilites of the firm, and to experiment, modify, and improve metrics of performance, including from weather conditions and alignments with stakeholders (Nonaka et al., op. cit., Cusumano, op. cit., Jaikumar, 1986). Both require the total commitment of network members and top management. Like quality management practices, sustainability platforms cannot be an organizational slogan, or be delegated to lower levels. Even worse, lt cannot be a statement of strategic intent without concrete action plans at all levels, thus minimizing the deadening hand of bureaucratic intertia.

To cite an example of past managerial myopias, consider the case twenty years ago when Japanese firms were slow to accept sustainable initiatives (Hayami et al., 1997; McMillan, 1995) but reacted quickly to stricter environmental regulations arising from the Minamata crisis, a crippling disease arising from mercury contaminents released into Minamata Bay. The Minamata tragedy, caused by the discharge of organic mercury compounds, was made worse by the refusal of cooperation by the firm involved, Shin-Nippon Chisso Hiryo KK. It became a public relations disaster for Japanese industry generally and the polluting firm, rechristened as Chisso Corporation, was forced to pay over $3 billion in compensation payments. This crisis led to strict new regulations on the use of mercury in Japan, but also to an international agreement, the Minimata Convention on Mercury, now ratified by 50 countries.

Slowly, Japanese firms instituted proactive sustainable practices and high level commitments by industry groups, *Keiretsus*, and major corporations like Toyota Corporation. Sustainable management practices were duplicated, and even improved by other Asian firms that benchmark against leading Japanese companies. Weather and climate change issues are now central to their corporate planning, notably in the transportation sectors like automobiles and shipping, where Japanese firms have become global benchmarks for sustainable practices. As illustrated in Figure 5, leading firms take sustainable practices seriously, especially be senior management. Kawasaki Heavy Industry Group (KHI)[1], now issues annual reports on their sustainable activities and ecological planning. Like many Japanese industrial groups, KHI is positioned as a global manufacturing enterprise that covers a vast product range from aircrafts and satellites to shipbuilding and bullet trains. Starting in 2003, KHI established its environmental *Vision 2010.* Each year, it publishes its environmental management activities plan, contributing to "a low-carbon society", "a recycling-oriented society", and "a society to coexist with nature" (Kawasaki Heavy Industries, 2012).

Against a backdrop of changing public sentiments and national consciousness towards waste, pollution, and climate change and sustainability, many leading Asian multinationals, including Toyota and Nissan in the Japanese car sector, Korea's Samsung and Japan's Toshiba in the LED light bulb sector, China Suntech, Yingli Solar, and Japan's Sharp Solar also navigated through the waves of eco-production values and shifted their business strategies to sustainable business practices. Top management and the CEO take personal responsibility for all aspects of sustainability performance, so there is no attempt to sidestep or delegate sustainable actions. These roles and activity are reinforced and reflected in the organizational chart (see Figure 5). Such sustainable work processes are becoming global benchmarks for best practice firms and demonstrate the need to involve a much wider network model of suppliers, sub-suppliers, distributors and leading customers into the planning process to gain competitive advantage.

[1] Kawasaki Heavy Industries (2012). KHI Group CSR Report 2012 (Environmental Report). http://www.khi.co.jp/english/csr/report/index.html.



Source: Kawasaki Industries, Annual Report (2011).

Fig. 5. Organizational structure at Kawasaki Heave Industries

Conclusion

Corporate strategy has always been a bet on the future, a calculation how decisions today provide sustainable competitive advantages in future time periods. For this reason, weather, weather-related events, and climate change, are now central concerns for corporate strategy. Even elementary cost analysis and risk management require fundamental reevaluation of traditional tools and metrics to fully appreciate the total costs, risks, and accountability metrics for practices impacting the value chain, external supply chain systems, and transportation and distribution networks. Proactive responses to weather and climate change also require a new executive mind-set, away from outright denial, meek acceptance and passive action plans.

Around the world, corporations are dealing with environmental issues, social responsible behavior, corruption, and business ethics, but with huge variations by country, industry, region, because the rules, formal and informal, differ widely. The current mantra, Corporate Social Responsibility (CSR), widely touted in business schools, has become code of acceptable practice. CSR is acceptably ambiguous to allow firms to be selective in actual performance tactics, but allows the slogan as part of the reputation-enhancing PR campaigns. Many NGOs, corporate activists, and union representatives gain legitimacy for their political campaigns by adopting the 1987 Brundtland Report, the UN Commission on Development and the Environment, an inflexion point for both public policy and corporate behavior.

The vision of environmental sustainability in the Brundtland Report has become main stream thinking for business groups, and allows an alignment of corporate interests with public attitudes and expectations[1]. The sustainability platform outlined in this paper goes much further, regardless of the public policy choices that encumber corporate actions, such as a carbon tax, a carbon-trading scheme already adopted by some jurisdictions, or direct government regulations, such as higher fuel standards for the automobile sector. A sustainability platform is more than a corporate activity – it is a set of bold measures involving the entire ecosystem of corporate inputs, thru-puts, and outputs.

The core hypothesis of this paper is that a sustainability platform framework with produce better long term results than past, standalone corporate practices. Network organizations and ecosystems models now extend beyond high technology firms, using the Internet and advanced software, to build new products, services, and applications. Primary sectors like mining, oil and gas, and even organizations associated with infrastructure, like ocean ports, pipeline firms, electricity generation and energy utilities, and airports increasing belong to an almost 'invisible' eco-system. New networks involve NGOs, security forces, and a range of frustrated stakeholders not beholden to traditional corporate performance and accountability measures. They can ignore the elements outline in Table 2 at their long-term performance peril.

Corporate researchers need to address these weather-based performance issues. Case studies, qualitative

[1] According to a recent report (January 24, 2013), *Sustainability Nears a Tipping Point*, undertaken by *Sloan Management Review* and Boston Consulting Group, sustainable plans are central to over two-thirds of 2800 company participants, up from 55 per cent a year ago. The leading firms, 31 per cent, called Harvesters, are changing their business models and initiating policies to reduce carbon emissions and energy consumption and investing in clean technologies.

methods, and longitudinal comparisons are necessary. Today, professional schools debate the merits of managerial factors that focus on investors and shareholder value. Other governance models, like the Triple Bottom Line, where firms and managers provide shareholder money to charities, NGOs, and business schools, are widespread. Practices adopted as Corporate Social Responsibility have become acceptable and legitimate activity, in part as a stigma to reduce their carbon footprint, reduce waste, and publicize their sustainable practices. But CSR remain controversial. Research teams need to address and reconcile such concepts and theories and avoid a narrow disciple focus, which must include historical analysis and single case studies. Too often tests of outcomes and performance are seen as the dependent variable of organizational theories and causal model with management strategies as the independent variables. Weather, climate change, and weather conditions now force new methods and theories, including second order consequences that may defy conventional approaches, simplistic feedback loops, philosophies, and viewpoints.

The sustainability platform encompasses new metrics of behavior. They include new product and process technological innovation, and deep corporate collaboration across the entire system, from the supply chain to the life cycle of products, processes, services, and end-functions, including recycling and disposal. The sustainability platform is but one measure to deal with weather and climate change. It also requires a different mind-set. As the corporate world struggles with conflicting signals of the activist green movement, and the real concerns of the global scientific community, an acute insight comes from the pen of Victor Hugo: "greater than the thread of mighty armies is an idea whose time has come".

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Appendix. Corporate strategy and climate change

In the post-war period, the United States was not only the largest economy, the largest energy user, but the world's biggest polluter, with lax regulations and a passive legal system on polluters. Europe, less committed politically to market-based systems of environmental regulation, enacted various laws, and in 2001, France pioneered a law forcing public corporations to disclose their CSR activities, unwittingly allowing public agencies, academics, and NGOs to rate and evaluate corporations on a series of sustainable benchmarks.

By most standards, the industrialized Western economies – Europe and North America – have been in denial about climate change, despite the scientific views of academic bodies and institutions, and most national governments. There remains immense public skepticism, especially in the United States, with journalists, and many political parties (notably the U.S. Republican Party). Yet one of America's leading military officers, Admiral Samuel J. Locklear III, cites climate change as the biggest threat to US Security in the Pacific theatre (Binder, 2013), ranging from Hawaii to India. Even tacit acceptance that the earth is steadily warming, partly because of the emission of greenhouse gases to the atmosphere, means no serious initiatives can change the trends without actions of developing countries, especially India and China, with 40 per cent of the world's population (Mattoo and Subramanian, 2012).

The impacts of global warming are more serious for developing countries than the industrialized West (with superior technological capabilities and a capacity to bear financial burdens of climate change), because tropical and subtropical lands are more sensitive to global warming than cold or temperate zones. Estimates by economist William Cline found that a rise of 2.5% in global temperatures would cut agricultural productivity by 6% in America but by 38% in India (Cline, 2011). Similar studies show the same impacts on maize production in the United States and China (Li et al., 2011). How will the emerging markets react, defensively as in the industrialized world, or proactively?

China is the world's largest emitter of green house gases (over 50 per cent of its energy comes from coal), contributing about a quarter of global emissions, while India accounts for 83% of the worldwide increase in carbon emissions in 2000-11, mainly due to coal-fired power stations to fuel their race for economic growth. Two authors estimate that if the two countries were to reduce emissions by 30% by 2020, manufacturing output would fall by 6-7% and their manufactured exports by even more (Mattoo and Subramanian, op. cit.).

Both countries have made a Faustian bargain with their populations: in return for high growth, necessitated by so many rural people moving to the cities for jobs, increasing dirty fuel consumption leads to severe pollution and rising emissions. Sticking to the same levels of fuel consumption as Western economies experienced, rising by 200 per cent, means a zero-sum tradeoff of an equal amount by the rich West to limit the rise in global temperature by 2 per cent, Such a tradeoff is politically unacceptable to the Western democracies, hence the political stalemate.

Various proposals have been made for a tax on carbon emissions, starting with a proposed $16-per-ton charge on carbon dioxide, setting it to rise by 4 percent annually (Morris, 2013). In the US, a carbon tax, like a consumption tax (or value added tax) is unlikely in the current era of political gridlock. Yet other jurisdictions have implemented one, but with variations: the Scandinavian nations, the Netherlands, Germany, the United Kingdom, and Australia, plus three Canadian provinces – Alberta and Quebec in 2007, and British Columbia in 2008. California has recently initiated a cap-and-trade system, which auctions carbon permits to companies.

Conventional wisdom has suggested a carbon tax is politically unfeasible in countries with oil and coal reserves. Proposals to collect the tax from upstream fuel producers like coal producers, oil companies and certain industries with big sources of CO_2, such as cement makers, government would avoid a large bureaucracy found in countries with a consumption tax (although a regressive tax), it can be offset by credits for low income families and has the advantage of being impossible to avoid. Government and corporate strategies now converge to face global climate change.