CHAPTER 2

THE SETTING: BASELINE INFORMATION

IMPACTS

The IPCC 4th Assessment

The latest key findings of the IPCC regarding current research results on the state of climate change, its drivers and projections for the future include but are not limited to the following highlights (IPCC, 2007a):

- Warming of the climate system is now unequivocal;
- The rate of warming in the last century is historically high;
- The net effect of human activities since 1750 has been one of warming, due primarily to fossil fuel use, land-use change and agriculture;
- Most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely (greater than 90 percent) due to the observed increase in anthropogenic greenhouse gas emissions;
- Long-term changes in climate have already been observed, including changes in Arctic temperature and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and intensity of tropical cyclones;
- From 1900 to 2005, drying has been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia;
- More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics;
- Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the twenty-first century that will very likely be larger than those changes that were observed in the twentieth century;
- Projections for the twenty-first century include a greater chance that more areas will be affected by drought, that intense tropical cyclone activity will increase, that the incidence of extreme high sea levels will increase, and that heat waves and heavy precipitation events will be more frequent; and

- Even if greenhouse gas concentrations were to be stabilized, anthropogenic warming and sea-level rise would continue for centuries due to the timescales associated with climate processes and feedbacks.

The IPCC 4th Assessment and food security

This IPCC Assessment addresses food security by discussing the foreseeable impacts on agricultural productivity and production in different regions around the globe. The report's collective comments suggest that some areas will benefit from global warming, at least through a transitional period, though most areas will be adversely affected. Significantly, the assessment emphasizes that those areas that do benefit from global warming in the near to mid-term will eventually also suffer from declining productivity. Various parts of the assessment also reference changes in the hydrological cycle that will affect agriculture in general and food security specifically. Migrations forced by climate change (for example, excessive heat, increased evaporation rates, or prolonged drought-induced crop failures, or flood) will further burden the already stretched agricultural resources and food supplies of regions that have managed to sustain productivity.

While each region around the globe will have to develop its own adaptation, mitigation, prevention and response strategies, inhabitants of the African continent will likely be the most affected and most needful of resources, if they are to effectively respond to climate change:

> *Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability and change. The area suitable for agriculture, the length of the growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50 percent by 2020. (http://timeforchange.org)*

The IPCC's 4th Assessment is the culmination of a process that began over twenty years ago in the late 1980s. Preceded by the IPCC's 1st, 2nd and 3rd Assessments, the trends in greenhouse gas emissions and global warming's likely impacts as noted in the 4th report of the IPCC are consistent with trends that were reported in those earlier IPCC assessments, with each new assessment having further bolstered the evidence for human contributions to the naturally occurring greenhouse effect. Making a bad situation appear even worse is the evidence that the rates of several environmental changes, such as the melting of Arctic sea ice, have actually accelerated in recent years.

A climate change challenge for society: riding the variability curve

The 4th Assessment clearly played a key role in the sharp, step-like increase in concern over the climate change issue after its release in 2007, in many ways proving to be the "tipping point" for policy-makers worldwide who truly began to take more seriously the climate situation after its release. Recognition of the IPCC process with the awarding of the Nobel Peace Prize served to enhance the influence of the 4th Assessment, especially with the broader public. Concern over climate change has sparked an unprecedented "rush to action." Though deserving of such focus and concern, governments and other climate-, water- and weather-related scientific research and application funding agencies must beware, especially with regard to their response to this one climate change report, of the likelihood of "overshoot"; that is, agencies must beware of over-focusing on what has become the most popular and recognizable concept in climate reporting, "change," and risk neglecting other important, less reported climate factors – such as variability from season to season, year to year, and decade to decade – that have often not been record setting anomalies but have none-the-less had serious consequences for societies and ecosystems. After all, the broad notion of climate change includes variability in the set of such climate factors as temperature, which will change at different rates; changes in the expected flow of the seasons; and changes in the timings, intensities and locations of precipitation.

Concern about the potential occurrence of an abrupt climate change tends to draw attention away from possibly substantial transformations in the naturally occurring variability of our existing, relatively well-understood global climate regime. Societies, their institutions and the individuals that compose them have always struggled to understand and forecast variability on various time scales, especially the seasonal and inter-annual ones, either to take advantage of good climate conditions or to prepare for adverse ones. This can be referred to as an attempt by societies to "ride the climate variability curve." In any of the climate change scenarios set forth thus far, variability will continue; however, given that the future state of climate is uncertain, such variability may shift beyond the bounds of an anticipated range, resulting in unexpected climate scenarios. Precaution should be taken to compensate for possible upturns and downturns in climate variability in order to be better positioned to prevent or mitigate the impacts of these unknowns. The fisheries sector provides perhaps one of the most straightforward examples of this response to variability.

Fish populations vary from year to year, with some species exhibiting high variability in reproduction because of environmental factors combined with recruitment processes. A perfect fishery would, arguably, enable the fishing community to ride the seasonal variability curve's ups and downs; however, forecasts are not good enough to allow for such a perfect scenario, so fishing strategies must include a range of management options such as Maximum Sustainable Yield (MSY), optimal yield and safe yield. Maximum sustainable yield is an attempt to eke out the maximum level of fish catches possible. For this management strategy, however, the risk of over-fishing or of a collapse of the fish population is high due to fish population dynamics and populations' interactions with environmental variability. Optimal yields can be viewed as a compromise to split the difference between the risk-averse safe yield approach and the risk-taking MSY approach. Safe yields have the lowest probability of fishing pressures destroying fish populations, but it also provides the lowest level of potential catches. The management strategy for fisheries for a given place must reflect a level of caution (e.g. level of fishing effort), given the numerous uncertainties that can surround the exploitation of living marine resources.

A perfect forecast of variability a season or two in advance would allow farmers and other stakeholders to prepare well in advance for shifts in climate conditions. Such preparations might include lowering stocking rates on rangelands if drought is forecast; more or less stringent controls on fishing limits; planting shorter season grain varieties or completely shifting to better suited crops, and so forth. Without such perfect forecasts, however, skills in the form of education and training combined with existing "ordinary" knowledge become necessary for effective management of climate-sensitive resources related to food security. Regardless, societies must not shortsightedly focus only on 'change' that might occur in an unspecified distant future, but must continuously improve their ability to cope with seasonal and inter-annual variability as well as decade-scale fluctuations as the climate warms, altering the climate variability that we have become accustomed to in our experiences of the recent past.

Does climate impacts history have a future?

Most people tend to value present-day events and knowledge more highly than past events and knowledge and possible futures. Economists call this discounting; one euro in the pocket now is worth more than the same euro in the same pocket several years from now, according to this economic principle, because, put simply, people have to survive the present in order to participate in the future. The problem with this standard for valuation is that a considerable amount of usable knowledge exists in the records and folk wisdom of people from the generations that preceded ours. Learning about how climate, water or weather anomalies affected food security in the past and how societies coped or failed to cope can provide usable insights into how to respond to similar or analogous impacts in the future.

The problem is that many people (researchers as well as policy-makers) tend to believe that such historical information has become outdated because of scientific, engineering, or technological progress and because lessons about coping with disasters were learned. As a result, historical climate-, water-, and weather-related impact information, even information about recent impacts, is often neglected, even though such information could often provide context and guidance for present and future planning. The impacts of anomalies on food security in the recent past, for example, will possibly produce similar impacts in the near term. While speculating about future impacts, therefore, these historical accounts must be exploited in developing adaptation strategies to cope with these issues at local to national levels.

ASPECTS OF VULNERABILITY

Ecosystem changes

Considerable attention has focused on the IPCC assessment process, which began in the late 1980s. What has been as important in a different way has been the recent release of the Millennium Ecosystem Assessment (MA). The website for the MA fully explains its origin and importance (MA, 2005; [http://www.millenniumassessment.org/en/About.aspx]), though an excerpt here is useful:

The Millennium Ecosystem Assessment (MA) was called for by the United Nations Secretary-General Kofi Annan in 2000. Initiated in 2001, the objective of the MA was to assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human welfare. The MA has involved the work of more than 1 360 experts worldwide. Their findings … provide a state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide (such as clean water, food, forest products, flood control, and natural resources) and the options to restore, conserve or enhance the sustainable use of ecosystems.

Given the central importance of ecosystems to societal well being, some key observations about the risks associated with "tampering" with the sustainable functioning of ecosystems are instructive.

About 25 years ago a schematic diagram, reproduced in Figure 1, presented an idealized picture of a food production system.

The figure suggests that weather affects only crop yields; however, even at that time weather's effect on many of the boxes in the graphic was well known. Weather's broader influence is suggested in another version of the graph (Figure 2), in which the box previously marked as "weather" is replaced by "drought."

In fact, lines in Figure 2 can be drawn from the drought box to many of the boxes in the diagram – even the "tastes" box – as humanitarian food imports of wheat or yellow corn, not being the staple of the food importing region, have even been known to distort local food preferences. This situation has led to arable land being removed from traditional crop cultivation and given to cultivation of non-traditional, climate-sensitive food crops.

In addition to what is already known or what will likely be the impact of episodes of extreme weather and climate on food production and, therefore, on food security, it is reasonable to speculate on the major impacts that might accompany global warming. In truth, such speculation has already been happening for several decades. The most legitimate assumption is that every box in the above graphic would be affected if the weather box were replaced by a "global warming" box.

Beyond serving as interesting illustrations of the point, these diagrams also underscore what has been called the Four Laws of Ecology and the basic belief that in nature "you can't change just one thing." Taking this law into account,

FIGURE 1

Schematic diagram idealizing a food production system (Glantz, 1987; originally published by the US Department of Agriculture in 1984 -"sub-Saharan Africa: outlook and situation report, Economic Research Service).

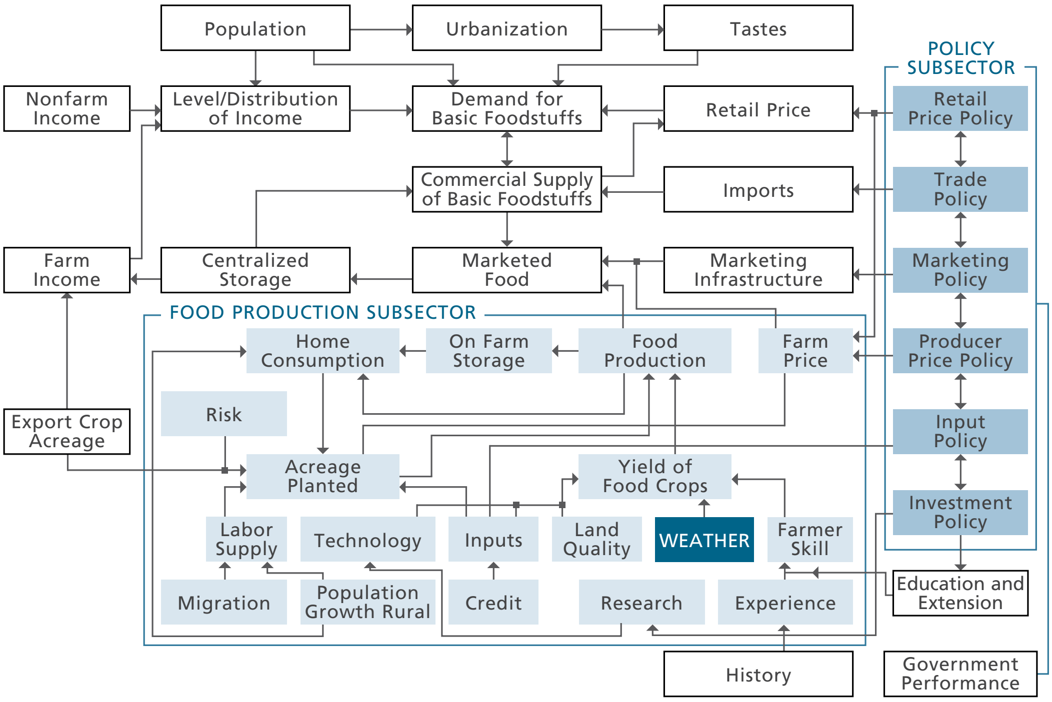
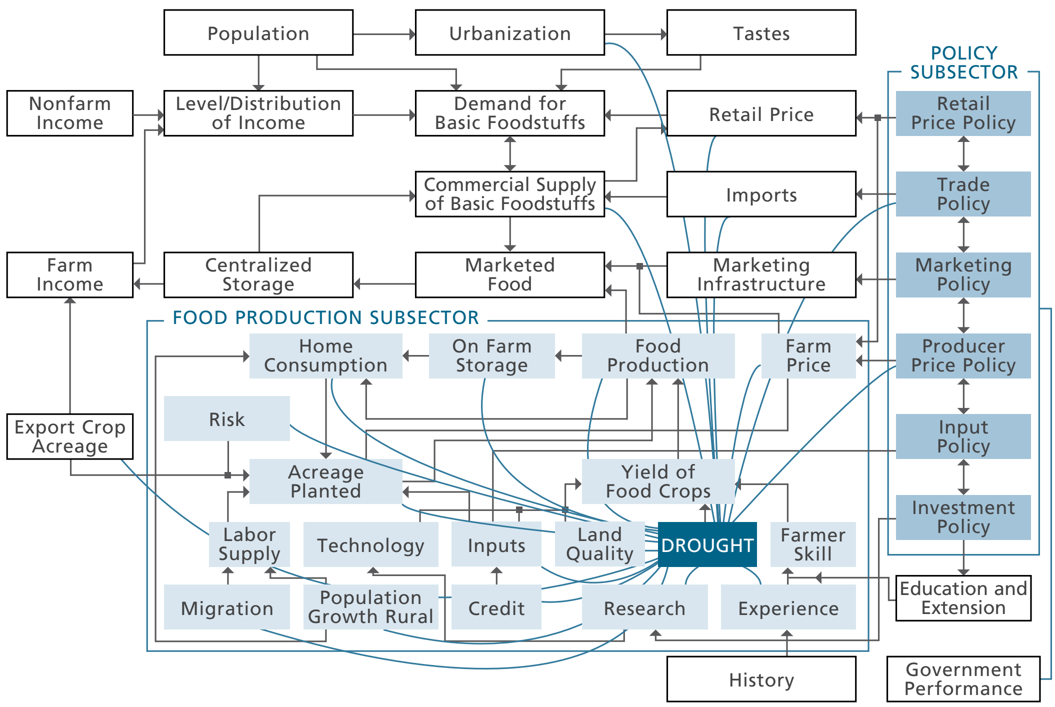


FIGURE 2

Schematic diagram in which 'drought' replaces 'weather' as the affecting parameter



a key issue for governments is that of ensuring that billions of people around the globe with little purchasing power have access to and receive adequate nutrition (i.e. food security at the household level), while preserving the planet's biodiversity, which is at the root of the sustainability of life on earth. While the interactions and values involved in this issue are complex, complexity, like uncertainty, cannot be used as an excuse for inaction or used to exclude elements of civil society from participating in planning for the climate change future.

One way societies can attend to the complexities of these ecosystemic issues is by paying attention to the value (and pervasiveness) of "usable" ordinary knowledge." Lindblom (1979) referred to "ordinary knowledge" as:

> *knowledge that does not owe its origin, testing, degree of verification, and truth status to current distinctive [research] techniques but rather to common sense, casual empiricism, or thoughtful speculation and analysis. It is highly fallible, but we shall call it knowledge, even if it is false. As in the case of scientific knowledge whether it is true or false, knowledge is knowledge to anyone who takes it as a basis for some commitment or action…For social problem solving, we suggest people will always depend heavily on "ordinary knowledge."*

As the saying goes, "knowledge is power. Sharing knowledge is empowering"; the task of researchers and policy providers, therefore, is to assure the correctness of the knowledge base that is passed on to individuals in society. Their task is also to become empowered by learning from local knowledge that had been garnered through trail and error over long periods of time.

The conclusion of the Millennium Assessment about societal well-being and ecosystems goods and services suggests that in order for ecosystems to have value or merit protection from destruction they must provide tangible goods and services to society. A provocative, new understanding emerges, however, when the two ideas central to the MA conclusion are rearranged to read as follows: in order for human goods and services to have value or merit protection they must provide tangible benefits for ecosystems' well-being. In other words, human activities must be pursued with the sustained well-being of ecosystems as a key objective. Although composed of the same two ideas, these converse notions for the new millennium and a changing climate would yield very different outcomes for both societies and ecosystems.

BOX 1

A PRECAUTIONARY NOTE ON DEFINITIONS

Discussions about climate variability, climate change, climate extremes and the impacts of each on societies and ecosystems are filled with such terms as coping, capacity of response, vulnerability, resilience, adaptive capacity, sensitivity, adaptation, mitigation and - rarely these days – prevention. An important (troublesome, actually) problem with the concepts typically used in climate change discourse was, however, analyzed by Latin American researcher Gallopin (2006). He noted the following:

The terms vulnerability, resilience, and adaptive capacity are relevant in the biophysical realm as well as in the social realm. In addition to being terms in colloquial language, they are widely used by the life sciences and social sciences, not only with different foci but often with different meanings…Sometimes the concepts are used interchangeably or as polar opposites… This plurality of definitions is possibly functional to the needs of the different disciplinary fields… but sometimes it may also become a hindrance to the understanding and communication across disciplines.

Gallopin (2006) went on to "attempt to highlight the fundamental attributes of the three concepts and to identify the conceptual linkages between them." Still, the reality is that popular usage of these terms and other synonyms will rule the day, regardless of how hard academic researchers seek to clarify their meaning [NB: it is important to note that the UNFCCC and the IPCC do not use the same definition of such a central concept as "adaptation" [(Pielke, 2003; www.climateadaptation.net/docs/papers/pielke.pdf)]. This is the situation with which researchers and decision makers will have to live and, more importantly, of which they must continuously be aware.

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A FARMER IN THE MOUNTAINOUS AREA OF THE VALLEY OF GUILIN IN GUANGXI, CHINA

Mountains are early indicators of climate change. Extreme events are likely to become more common and more intense in mountain areas, threatening the livelihoods of both mountain people and those who depend on mountain areas for water, food and other resources.

Vulnerability patterns

Global statistics, like statistical averages, are useful for a wide range of purposes. For example, researchers talk in terms of the global average temperature having increased by 0.74 ºC since the beginning of the 1900s. This is doubtless a useful piece of information to alert people that the global atmosphere is on a warming trajectory; however, it only represents a *global* average of regionally warmer and cooler locations worldwide. Yet, national policy-makers need regional and local information in order to make policy decisions relevant to their citizens and their country's climate-related hazards. The same problem exists with demographic statistics. Global averages and global rankings using vulnerability indices for food security, for example, are useful for some purposes but may not be useful for national policy-making purposes associated with climate change-related adaptation, mitigation and prevention. National policy-making, on the other hand, requires country-specific information, such as demographics as who and which regions are most at risk to climate variability and extremes, much of which is already available but may not be readily accessible or in a centralized location.

As argued elsewhere, who is vulnerable to climate variability and extreme climate, water and weather events is generally known, and this knowledge can be directly correlated to the most likely victims of climate change. However, a breakdown provided by socio-economic and livelihoods groups, by geographic area, by farming systems or by sub-sectors will further help policy-makers to identify at-risk groups. Of special relevance is the state of the world's crop diversity, as it plays a major part in adaptation to climate change for livelihood measures.

Vulnerability is generally defined as a function of risk and exposure. Vulnerability with regard to climate change implies that people are exposed to aspects of climate that are changing in ways that will either generate or increase risk, which generally implies a potential loss of something valued. For food security, the risk is of poorer nutrition or reduced access to food supplies than would be expected under "normal" climate conditions. The capacity to cope with the risky situations under a given exposure to hazards (both natural and human induced) also shapes the pattern of vulnerability. As often is the case this capacity is weak in the part of the world that suffer from food insecurity either intermittently or chronically.

Resiliency patterns

Resilience, which has several definitions but generally refers to the ability of a society to "bounce back" after suffering an adverse impact, is sometimes viewed as the opposite of vulnerability, but it really isn't. The impression that these are opposing terms derives from the mistaken idea that resilience entails a fundamental robustness, whereas vulnerability suggests fragility. However, is the ability to 'bounce back' to a condition that was unsustainable or unsound to begin with really the resiliency societies or groups should strive for after an adverse impact? Does such a situation really demonstrate a fundamental robustness? Or is true robustness of a people represented by their ability to 'bounce back' from adversity to an improved condition over the one that had previously existed?

Resiliency viewed as the ability to "spring back" from and successfully adapts to adversity, is also used to indicate a characteristic of resistance to future negative events as commonly referred in human stress related psychology and strategies at personal, organizational and leadership levels in business and management field. The IPCC (2007a) defines "resilience" as the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change. Resiliency can also be defined by a capacity to cope successfully in the face of significant future risk. Mapping such a capacity to cope in a country is as important as mapping vulnerabilities to climate variability, extremes and change because such baseline data facilitates an understanding among planners and policy-makers of where risk is most critical.

As described on a management oriented website (AlphaThink Consulting, 2003), resiliency maps are already undertaken for individuals.

> *Essi Systems' Resiliency Map will help you explore your resiliency demands, assets and current levels of functioning. The Resiliency Map pinpoints your strengths and vulnerabilities, detects areas of caution and strain, and helps you chart new strategies for enhancing personal health and overall performance.*
> *[http://alphathink.com/Frame-944278-servicespage944278.html?refresh=1193338038490]*

Such narrow-scale mapping could be used to evaluate a household, village, region or country's ability to recover to near "normal" or improved food security conditions following an adverse impact.

Rates and processes of change

Regarding adaptation to global warming's impacts on agriculture, fisheries, forestry, health, public safety, and food security, some of the most important factors are the expected changes to the rates at which various key aspects of climate change – rainfall, temperature, relative humidity, cloudiness – and at which evapotranspiration, the process by which moisture is exchanged between the atmosphere and vegetation and soils, occurs. If the rates change incrementally and societies are aware of those changes, those societies may be able to adjust human activities accordingly. Within limits, some ecosystems will likely also be able to adjust to incremental changes. If, however, the rates of change are too rapid to be viable for adjustments like shifting agricultural practices, changing crop rotations, developing new fodder regimes for livestock as grasslands dry out, then societies will be unable to escape with minimal impacts to their climate-sensitive activities and to the ecosystems on which those activities depend.

Virtual water and ghost acres

All reports on the hydrologic cycle suggest that the cycle will intensify as the atmosphere warms, with some suggesting that the cycle could yield about 15 percent more precipitation per annum. At this point, however, conjectures based on global circulation model output are little more than speculation and educated guessing, not yet reliable enough to predict with any accuracy where the precipitation would fall, how it might fall, or when it will fall. Paradoxically, these reports also suggest that water scarcity in the next couple of decades is highly probable, with extreme shortages already appearing in various locations around the globe. As changes to the global water cycle become more pressing, policy-makers will have to scrutinize more closely where their limited water supplies are going and what they are being used for. The concepts of virtual water will become more and more relevant as these cycles continue to change.

Virtual water is calculated in terms of the water that is used to grow crops that are exported to (or imported by) other countries. According to the concept, water used to grow flowers in Kenya, for example, is actually calculated as supplemental water supplies of the countries that import those flowers. In this manner, Kenya's water resources are not being used for its domestic food and energy needs. As another example, a country that imports wheat instead of producing it on its own soil is, in essence, borrowing water supplies from another country's water supply that had been used to produce the wheat. Governments around the world must reevaluate both their water and food balance demands and supplies in terms of 'virtual water'. Understanding the notion of 'virtual water' can enable a government to better understand where its finite water resources are being consumed and for what purposes.

Similarly, the concept of ghost acres (or ghost hectares) was developed several decades ago. It was used to explain that food imports by Country a relied for those imports on the agricultural lands of Country B. In the same way, the "Green Revolution" also provided ghost acres in that the use of fertilizers and irrigation enhanced agricultural productivity and overall production from beyond what the land might have been able to provide in its natural state (Lang and Heasman, 2004). The notion of ghost acres has also been applied to protein taken from the sea, which serves to supplement the protein produced on the land. A country such as Japan, for example, would require several times more farmland than it has in order to produce an equivalent amount of protein to replace the amount it takes from the sea. The notion of ghost acres also applies to a country's food imports as well.

Global warming and disappearing seasons (as we've come to expect them)

The disappearance or even the change in the overall characteristics of a season (i.e., seasonality) should concern everyone. What else might change, related to changes in the seasonality to which people have become accustomed to in their regions? For example, over the past decade, the ice on various lakes in the northern central United States was no longer strong enough to support ice fishermen and their equipment.

For years, the expected patterns of the seasons have been shifting almost imperceptibly. Those seemingly small changes have, over time, however, accumulated to become more and more visible, leading to seasonal flows in different locations around the globe that societies have been accustomed to. Winters have, in general, become drier and warmer in many regions, and spring rains now come less predictably, both in timing, in frequency and in intensity. Multiyear droughts in Australia and the southeastern United States have generated concern about the "aridification" or the drying out of these regions.

The disappearance or even substantial changes in the overall characteristics of the four seasons as they are expected should concern everyone. The problem is that over the past few decades, winters have in general become drier and warmer in many regions. Rainy seasons have become less so, not abruptly but incrementally over time. Both industrialized as well as developing economies and economies in transition live by the expected flow of the seasons, so no country will escape changes in seasonality with a warming atmosphere. Such changes will affect human settlements worldwide in ways that most communities are just beginning to consider. For example, researchers predict chronic water shortages worldwide (as in the Eastern Congo), a shifting boundary between rangeland and farmland, recurrent and prolonged drought (as in various parts of sub-Saharan Africa, Australia and Southeast US), a potential increase in the number and frequency of famines and perhaps a shift in their locations, and a shortening or lengthening of local and regional hazards related to climate, water, and weather. Adaptation strategies need to focus on this high priority aspect of climate change.

An aspect of the consequences in terms of food security, specifically, of the impacts of global warming includes but is not limited to the following: changes in the growing seasons' length as well as the timing and amount of precipitation; changes in the snowfall season, the runoff season, the rainy season, the timing of flood recession farming, the hunting season, the fishing season, the water season, changes in the timing of outbreaks and increases in vector-borne diseases, rice farming following the replacement of saline water intrusion in rivers by freshwater after onset of rains (e.g. Mekong River), extended seasonal food crisis because of long-lasting drought conditions (e.g. "*Monga*" in Bangladesh), and so forth. Speculation about the foreseeable impacts of changes in seasonality is virtually boundless.

CHILDREN IN THE MOUNTAINS OF PERU

The world's population is young, with nearly 2.2 billion people under the age of 18. Children and young people have enthusiasm, imagination and abundant energy to undertake local actions to manage climate risks.

APPROACHES TO IMPACT ASSESSMENTS

Forecasting by analogy: The future is here for those who wish to see it

Many of the adverse climate-change-related environmental scenarios people have discussed, especially regarding the consequences of future human interactions with various types of ecosystems, from deserts (i.e. desertification) to mountain slopes (i.e. deforestation), have already been occurring for decades. Such scenarios should, therefore, no longer be viewed as speculation because the impacts of those changes have already been demonstrated, if not within one country, then within another. Even where there is a paucity of data for one particular area, the results of similar modifications to the natural environment have already been tracked and tested in other areas, yielding results that have demonstrated these modifications as being either good or bad for the environment, for society, or for both. Such correlations are at the heart of "forecasting by analogy."

The deforestation of mountain slopes, for example, will likely yield results in remaining forested mountain areas that are similar to those that have been witnessed in areas where such degradation has already taken place; in other words, the experiment of mountain slope deforestation has already been performed and the results are in hand, at least as far as the long-term impacts on the natural environment are concerned. When similar approaches to mountain forest management are attempted anew in a similar topographical setting elsewhere on the globe, therefore, similar results – soil erosion, rapid rainfall runoff, lower soil moisture recharge, sediment loading of streams, dams and reservoirs, and faster snowmelt in the spring – should be expected.

Prolonged dry spells and especially severe droughts expose inappropriate land use practices of farmers and herders; that is, practices that are inappropriate during periods of moisture stress but that are hidden or tolerated by nature during periods of favorable rainfall. A similar situation is likely to occur with regard to climate change, as the various characteristics of climate intensify or shift to locations where they had not before been witnessed. Policy-makers and individuals alike need to be alert to subtle changes in the environment or in the human interface with climate-sensitive ecosystems. It is also important to be aware that severe droughts can expose sustainable land management practices. The process of forecasting by analogy is valid when considering scenarios for other ecosystems, like the destruction of mangrove forests for the development of shrimp ponds or the irrigation of soils in arid areas without putting proper drainage facilities in place.

While some governments have made sustainable changes to their environments, others have not. The point is that "new" scientific assessments of potential environmental impacts for each and every human interaction with the environment are often not necessary because the impacts of most human-induced environmental changes have already been sufficiently demonstrated. The truth is that calls for new environmental impact assessments are sometimes used as delaying tactics by those who will benefit, often for corporate, political, or personal gain, from their proposed changes to the environment. The bottom line is that the future environmental impacts of some of these new activities already exist somewhere on the globe, if only we would choose to see those inevitable futures and take proactive action accordingly.

Making hotspots visible

"Hotspots" has become a popular term in recent years, increasingly being used to draw attention to particularly calamitous situations in ecosystems around the world. The term also has social contexts, by positively highlighting such concepts as cultural hotspots, skiing hotspots, tourist hotspots, scuba hotspots, and so forth. "Hotspots" is, in this manner, a somewhat awkward notion, because it evokes a location or an activity or a situation that is beyond the usual or out of the ordinary, but whose specific meaning, which is accentuated as either very positive or very negative as a function of the term itself, is wholly dependent on its context in any usage.

For our purposes, "Hotspots" can be defined as locations or activities of interest to a group or organization where human interactions with the environment are considered to be adverse to the sustainability of an ecosystem or those human activities that are dependent upon it. It is a segment along a continuum of environmental change. For FAO in particular, "Hotspots" refers to adverse aspects of the interface between agricultural activities and environmental processes. These definitions are purposely rather broad to enable points of entry into an FAO-wide hotspots programme for activities related to agriculture, forests, fisheries, food security and nutrition (Glantz, 2003 [ftp://ftp.fao.org/docrep/fao/006/y5086E/y5086E00.pdf]).

Some might consider the recent surge in the use of the term “hotspots” to be a new environment-related fad; regardless of how it is viewed, however, the concept can be used to identify situations that, if left unattended, could prove harmful, both to the environment and to those dependent on it. The reality is that every country needs to prioritize its hazards in terms of the likelihood of their occurrence and the severity of their impacts on the people, infrastructure and ecosystems. No country, rich or poor, industrial or agrarian, capitalist or socialist, can address at once all of its “areas at risk” of hazards by putting into place adaptation mechanisms to protect them, so adaptation measures in most cases have to be implemented “in parts,” with the highest priorities given to the protection of those areas of greatest concern to both the government and civil society.

One of the truly global “hotspot” aspects of climate change is sea level rise. All island nations as well as low-lying coastal areas are at high risk of suffering from this aspect of climate change. Unlike shifts in rainfall or changes in seasonal characteristics, a rising sea level yields only losers. And the options available to individuals and governments, on local to national scales, to adapt to this aspect of climate change are few and costly – retreat from the low-lying coastal areas, re-enforce coastal barriers to the sea and its surges, voluntary or forced abandonment of the at-risk area.

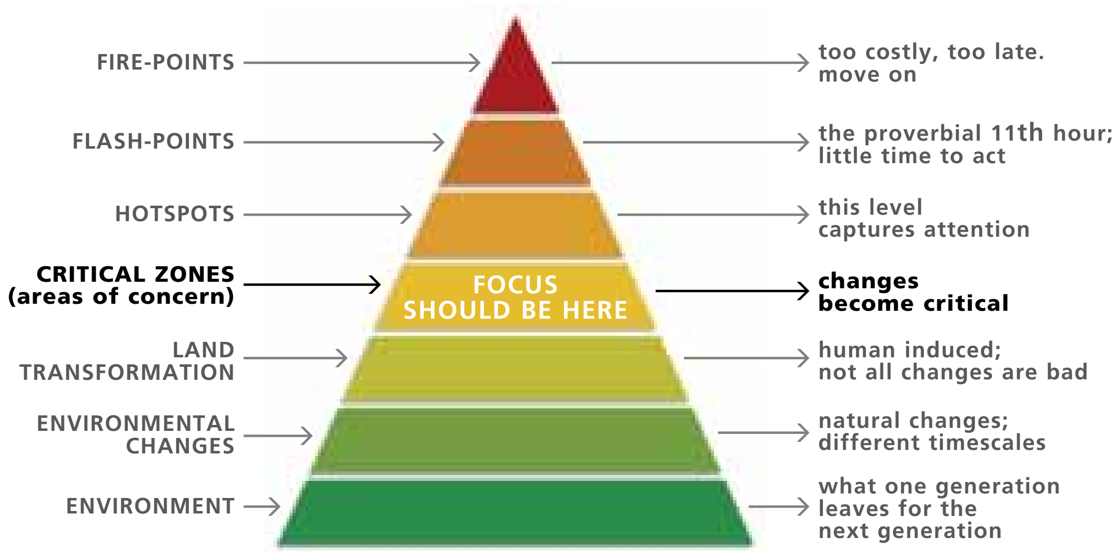
Another foreseeable hotspot to expect in mid-latitude regions around the globe is the emergence of tropical vector-borne diseases. Mosquitoes, for example, do not respect political borders and can easily spread pole-ward away from the equator into regions where the parasites they carry had not been present before. Infectious diseases such as malaria and dengue fever have always been seen as tropical or developing country problems, but they will increasingly become a concern to industrialized countries in the mid-latitudes as the temperature of the atmosphere rises.

Conservation International (CI) has produced an interactive map that identifies biodiversity (biological and soil) hotspots – in this context the term is wholly negative, referring to locations at risk to biodiversity loss – around the world by continent. Interestingly, the notion of “bright spots” was introduced on the same map, identified as areas where the degradation of soils has either been arrested or reversed.

[http://web.biodiversityhotspots.org/xp/Hotspots/hotspots_by_region/]

FIGURE 3

Hotspots Pyramid showing an idealized progression of environmental change



The hotspots pyramid and adaptation Areas of Concern (AOC)

Figure 3 can be referred to as a hotspots pyramid. A glimpse of the pyramid shows, in graphic form, a simplified progression of environmental changes (forests, irrigated lands, rainfed cultivated areas, fisheries, etc.) that can result from environmental interactions with human activities. Assume, for example, a swath of land in a pristine state. As humans move in, they begin to transform the land. Cultivators prepare it for food production, and herders graze their livestock on its grasses. Notably, not every such interaction between agriculture/herding and the environment is a negative, non-zero sum one, where either agriculture wins or the environment wins and the other loses. If developed sustainably, both agriculture and the environment can prevail in a sustainable way.

As unsustainable transformations to the land accumulate and the land becomes exhausted from overuse, however, cultivators and herders increasingly move into marginal areas with poorer soils and more erratic rainfall in an attempt to maintain or even increase production. Changes in the land become much more pronounced but are not seen to be of crisis proportion by policy-makers who are busy dealing with other, more urgent socio-economic problems, especially since, at least in the short term, the cultivators and the herders are able to maintain production levels by encroaching further and further onto more and more marginal tracts. At this point, this once pristine swath enters a critical zone. The changes that have accumulated have brought the ecosystem to the brink of collapse.

Hotspots are locations of degradation of either the managed or the unmanaged environment. They indicate situations when mitigative action remains possible at relatively higher costs and appear before conditions deteriorate further to the flashpoint stage, the proverbial 11^{th} hour when actions to restore environmental quality before long-term, irreversible destruction occurs. The Flashpoint stage offers a brief, last window of opportunity for policy-makers to react before environmental collapse becomes inevitable; when (if) they do choose to react, however, the necessary measures for recovery will prove extremely costly in terms of time, money and political capital. Firepoints indicate that environmental conditions have collapsed – it's too late for policy making, as the degradation has overwhelmed all chances for recovery, and exhausted fields, for example, have to be abandoned for generations to come.

Typically, only when a swath of land (or section of the sea) has been labeled a Hotspot, indicating that a crisis situation has emerged, does it begin to receive the serious attention of local officials and the national media. Such reactions are decidedly ill-timed, however, as more proactive attendance to foreseeable and developing crises would prove beneficial to all stakeholders, and especially to the environment itself. The fact is that policy-makers should focus not on Hotspots but on Critical Zones (Areas of Concern) because at this stage of the continuum (represented graphically in the Hotspots Pyramid) not only does enough scientific evidence of degradation exist but so does enough lead time to proactively implement relatively low cost yet highly effective measures to arrest or reverse the devastation and avoid the negative consequences (again, both socially and environmentally) that accompany passage into the Hotspots stage. Indeed, Areas of Concern merit considerable attention as indicators of adverse change and as a focus for policy discussion and execution.

Policy-makers do not have to wait for Hotspots to appear before they take preventative action they can respond when early warning observers, who are key participants in a comprehensive early warning system, alert them of an emerging Areas of Concern. The primary objective of a focus on food-security-related hotspots is to avoid creating them where they do not yet exist. Most such changes to the environment by human activities are of the slow onset but accumulating kind. The hotspots pyramid can be used to discuss changes in agricultural activities and in the tendency to slide from a state of food security toward one of food insecurity.

Creeping environmental change

Quick-onset changes in climate and the environment are easy to see but difficult to cope with. Slow-onset changes, on the other hand, are difficult to see and even more difficult to cope with, at least in a timely way. Crop failure due to drought occurs over a short time and is obvious to the observer. Decline in crop yield, however, is more readily detected over a longer time period. Governments in general tend to have considerable difficulty dealing with slow-onset, low grade but cumulative changes to the environment. The same holds true for similar creeping changes in both managed and unmanaged ecosystems as well as for changes in various aspects of climate, including subtle changes in temperature, rainfall, inter-annual variability, record-setting anomalies and so forth. Governments need to spend more attention coping with creeping changes in climate, water and weather because those incremental creeping changes eventually accumulate, leading to crises at some time in the future. For example, "famine" can be viewed as either an event or a process. Perceived as an event, famine is usually identified, on the one hand, in terms of the number of people forced to seek food in refugee camps. As a process, on the other hand, famine is identified by indicators of progress (change) that constitute subtle indicators along the path toward famine, such as increased sales of personal property (e.g. jewelry or cooking pots), the drastic forced thinning of herds and unfavorable market behavior of land, livestock, credit and water each of which works against the scarce resources of poor farmers and herders.

The 4th Law of Ecology states that there is no "free lunch" (see section 3.1), and this law holds true when it comes to neglecting creeping environmental changes, regardless of cause, whether natural or human-induced. Creeping changes, by their very nature, accumulate and eventually become major changes, which usually materialize in environmental crises that interact with – if not create – other creeping environmental changes.

For example, deforestation of mountain slopes can lead to soil erosion and increased runoff during heavy rains, intensifying the turbidity loads of rivers and streams. This silt continues to build up until it settles in reservoirs and behind dams, decreasing their utility and shortening their expected lifespan. This situation, in turn, reduces the amount of water that the dam or reservoir can provide to downstream users, while the increased runoff can lead to more serious and more frequent flooding of settlements and cultivated areas.

Global warming as a creeping environmental change

Climate has been changing slowly since the early 1900s. This is an accepted scientific fact; by the year 2000, the global average temperature had increased by 0.74°C. For three-quarters of the twentieth century, these changes were noted with little fanfare, and scientists could not even determine with a degree of certainty why the climate was changing. In the mid-1970s, however, convincing evidence that is now considered reliable for the likely human-induced cause of changes in global climate – the increasing levels of greenhouse gas emissions into the atmosphere – began to accumulate.

In retrospect, those responsible for food security in their countries and at the global level have for some time now been engaged in food-security-related decision making under uncertainty. For the most part, they did so in the distant to near past by responding to seasonal and inter-annual forecasts. More recently, however, their decisions have been made under a different set of conditions: They now know that certain human activities are in part responsible for enhancing the naturally occurring greenhouse effect; they now know that global temperatures are reaching levels not seen in tens of thousands of years; they now know that global warming will likely bring impacts that have not been witnessed in human history; and they now know that these physical changes are taking place at a time when nearly 7 billion people are dependent on the earth's limited resources for their lives and livelihoods.

The climate has been changing slowly for some time now (creeping along incrementally but cumulatively), and policy-makers and especially local farmers and herders have been coping unwittingly with the changes in food production and food security over this period. They must not panic now as they prepare for changes in the near and mid term in order at the least to maintain current food security or even to enhance it.

The future is arriving earlier than expected: 2020 is the new 2050

For the past decade or so, the public, which includes everyone, even scientists and policy-makers, has been informed by science media reporting about the buildup of greenhouse gases (GHGs) in the atmosphere. One of many effects of this buildup is global warming, which will increasingly intensify if societies continue on a "business as usual" path choosing not to alter their patterns of energy consumption and land use. Such scientific findings continue to serve as an early warning about foreseeable changes in the global climate patterns and the impacts of those changes on ecosystems and societies.

Based on the available data, scientists have developed scenarios that, in general, have focused on those climate changes and their impacts that might plausibly be expected to occur in 2050 or 2100, if all of the science is proven correct. While such processes of change are relatively well understood with regard to the state of climate science today, many of the rates of these processes of change are barely discernible over short time frames to the naked eye—and sometimes even to the instruments that measure such changes.

Reports are now coming in from scientists and are being repeated in the media worldwide that the rates of change for a wide range of ecological and social climate-impact factors are actually faster than had been predicted just a few years ago. As an example, the most visible rate of environmental change has to do with the accelerated disappearance of ice cover in the Arctic. Using sophisticated computer models, scientists had projected a certain percentage loss in sea ice cover in the Arctic by the year 2020; however, the disappearance of sea ice, based on actual measurements, had already reached those projected levels by 2007—13 years earlier!

The rapidity of the Arctic meltdown (and that of the Greenland ice cover as well) has sparked concern about rates of change in various ecosystems from the equator to the poles. Around the world, levels and impacts of warming that had been projected to arise many, many decades into the future are emerging now before our eyes. In other words, "the future is arriving earlier than expected." Such indications necessitate the shifting forward of consideration of the timeline suggested by climate change impact scenarios. This might help to show how quick the impacts might become visible in highly exposed climate- and water-sensitive sectors like agriculture.

The scenarios for 2100, while interesting to planners at some level, are of much less concern to most decision makers than are scenarios more proximate to our contemporary time of life and governance. If science is going to be relevant to most policy-makers today, then its projections must also include time scales that are far closer to the present than those a century away. Therefore, 2020, in the minds of those who are concerned with societal responses to a “dangerous” climate change and in light of accelerating rates of change, must be seen as the new 2050. Not only does 2020 become the new 2050, but the impacts projected for 2100, for example, may now plausibly arrive as early as 2050. Clearly, the climate is changing, and apparently far faster than we had expected.

The problem is that because the physical and ecological mechanisms involved in these processes continually seem to translate to shorter and shorter timeframes for what once were distantly projected impacts, these accelerated environmental changes will continue to create a major dilemma in thinking about and acting on these impacts, since both the physical and ecological rates of change will occur far faster than the rates at which institutional bureaucracies are designed to cope effectively. A further problem is that because the focus of the past decades has been on adapting and mitigating to future impacts, the concept of prevention seems to have been abandoned.

A RICE FARMER IN THE FLOOD PLAINS OF BANGLADESH

Smallholder subsistence farmers in Bangladesh depend on temporary transient livelihood activities after natural disasters. The rice field often turns into fish ponds.