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SUMMARY FOR DECISION-MAKERS

CLIMATE CHANGE ADAPTATION AND CANADA'S CROPS AND FOOD SUPPLY

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SUMMARY REPORT

CLIMATE CHANGE ADAPTATION AND CANADA'S CROPS AND FOOD SUPPLY

JULY 03, 2013

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Please note: The views expressed herein reflect solely those of the authors and do not necessarily represent the views of the Partners.

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EXECUTIVE SUMMARY

Serious water conservation measures must be put into place immediately to reduce the risk of water scarcity, and additional measures ... to ensure that water quality and allocation issues related to reduced supply can be effectively managed.

Climate change is causing significant and measurable increases in extreme weather events. Canada's agri-food sector (primary production and processing)[1] will require a variety of adaptation and risk reduction strategies, plans and on-the ground approaches if it is to respond efficiently and survive these challenges.

Fortunately programs are already available in Canada to address changes to growing conditions and weather-caused damages to crops and property, but the unpredictability, increased frequency, longer duration and overlapping impacts of extreme weather conditions raise concerns about the ongoing viability of affected food systems. What's missing is a guiding focus on long-term adaptation, which is designed to facilitate long term transitions and gives urgent attention to reducing the impacts of extreme weather. This focus needs to apply "triple loop" learning principles and other transformative decision strategies to:

1. Sustain the systems that support agri-food production by making them more resilient;
2. Avoid harmful and costly trade-offs while managing the impacts of unavoidable trade-offs; and,
3. Use adaptive management approaches to ensure intended relient results are achieved.

With these principles in mind, ACT reviewed Canada's and other countries' leading climate change adaptation and extreme weather risk reduction practices and proposes a transformative, nested set of strategies, action plans and implementation programs, and practices that employ these types of principles. ACT also looked for barriers that require attention, and pitfalls to be avoided, in particular with respect to overland flooding, and proposes an agenda for giving focused attention to the roles of government, the private insurance industry and stakeholders to achieve effective and affordable overland flooding risk reduction, relief and recovery.

This report also reviews impacts on "iconic" Canadian foods-salmon, beef, grains, maple syrup, and ice wine-as a way of illustrating the immediacy of these concerns in our country. For instance, declining stocks of Pacific salmon face warming ocean and fresh water habitats; the western beef industry faces water supply shortages; the grain industry faces increasing extreme weather damages and major overland floods and drought conditions; maple syrup production faces tree root damages from loss of snow cover coupled with freezing temperatures; and ice wine, a high-quality, high-value added product of BC's Okanagan Valley and Ontario's Niagara Peninsula, will be compromised by warming conditions.

1 Canadian agriculture and agri-food system is described as *"a complex integrated production and distribution chain of industries that supply food and beverages to both Canadian and international consumers. The component industries include agricultural input and service suppliers, primary agriculture, food processors (including beverage and tobacco processors), food retailers/wholesalers and foodservice establishments. The whole system is an integral part of the global economy. Imports enter and exports leave at each stage in the chain.* In this report, the primary focus is on primary agriculture, which together with input and processing comprise the statistically reported agri-food sector. See AAFC in the Citations and Reference section for sources.

As water is an essential resource in all aspects of life, social, economic and environmental, one of the most crucial ways to adapt to the growing number of negative consequences and costly feedbacks associated with climate change is to manage water effectively.

RECOMMENDATIONS

ACT recommends the preparation and implementation of:

- **Integrated water resource and agri-food sustainability strategies** to inform science-based and economically viable resource development, and plans and management actions.
- **Sustainable food production plans based on agri-climate zones** to achieve sustainable, multiple-benefits flows to avoid costly, underperforming, narrowly determined responses.
- **Effective integrated adaptation and risk reduction practices** rather than incomplete, inconsistent or contradictory uses of adaptation and risk reduction practices.

In order to build towards this, ACT further recommends that Agriculture and Agri-Foods Canada and its provincial and territorial partners and industry stakeholders give priority attention to climate change adaptation for the agri-food sector in Canada by:

- Preparing and reporting on case studies of recent and emerging challenges from flooding and droughts to frame a clearer focus on identifying and addressing farm-level vulnerability and risks.
- Developing and using scenario-based "robust decision making" approaches to disaster risk reduction strategies where regional climate events based on climate change projections are greater than or completely different from the historical record.
- Developing stronger and more collaborative disaster risk reduction programs involving the public and private sectors by moving towards risk-based and risk-reduction approaches to protection, relief and recovery programs that are now being used in other areas of the globe.
- Establishing integrated agriculture and agri-food, water, and biodiversity policies and programs involving comprehensive regional water management strategies at the basin, watershed and drainage levels to attain and sustain resilient food production and ecosystem health.

INTRODUCTION - A CALL TO ACTION

Greater resilience would mean that Canadians and their communities are better able to absorb, adapt to, or bounce back from various climate change impacts. (Fournier 2011)

Canada's climate is changing. Over the last 60 years, the country on average has warmed at twice the global rate; become wetter by about 12% with 20 days more rain a year; and experienced increasingly extreme floods, storms and droughts.[2]

But changes in climate are not uniformly distributed across the country. As reported in the review of climate change impacts on iconic Canadian foods in this report, warming of some areas is creating new agri-food development opportunities – for example, the expansion of canola cropping into new areas – however, in other areas climate changes are causing major crop and yield losses. Increasingly frequent and intense extreme weather is reducing productivity, destroying crops and damaging food supply chain infrastructure, putting agri-food economies and businesses at risk and increasing costs for producers, communities, consumers and taxpayers as a whole.

Maintaining existing, and developing new food production opportunities require intergovernmental attention to national and regional crop and food supply priorities. Canada's governments need to work together at all levels to anticipate and facilitate transitions involving changing food-growing conditions to bring new crops and/or new areas into production and to overcome or offset climate changes that reduce productivity. All levels and orders of government in Canada, and the private sector including the insurance industry need to collaborate to protect food supply chains from extreme weather damages and facilitate efficient recovery and business continuance mechanisms to ensure food security.

A PARADIGM SHIFT TO "TRIPLE LOOP LEARNING"

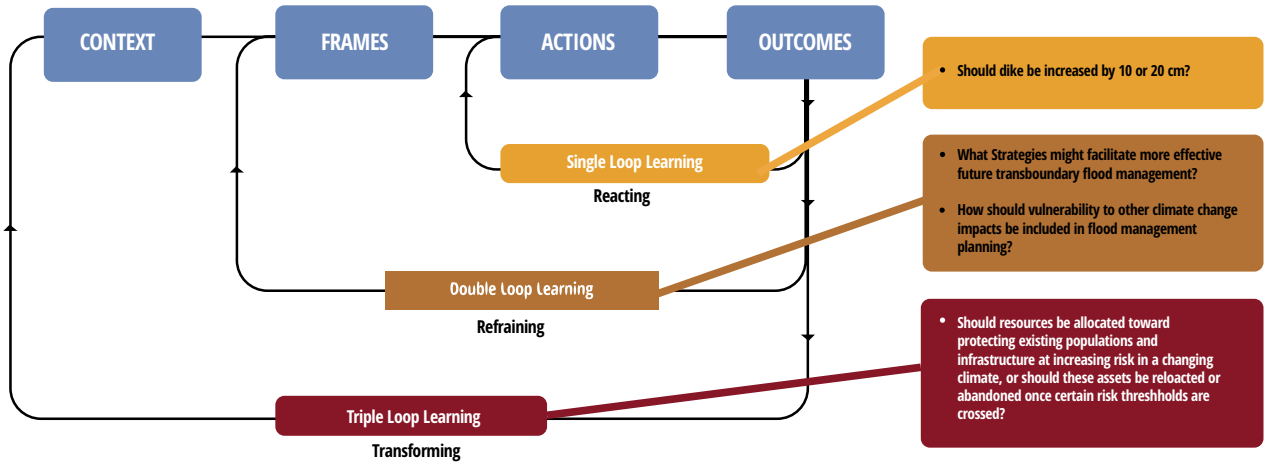
In order to bring about effective climate change adaptation, particularly in anticipation of extreme weather, a paradigm shift is needed. In its 2012 Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX), the International Panel on Climate Change (IPCC) described the need to move to a triple-loop learning approach in adapting to extreme weather events:

1. Reacting.
2. Reframing.
3. Transforming.

An example of a single loop approach would be to build an irrigation system that depends on a water supply that may not be available in the future for a variety of reasons, some or all of which were not considered. A double loop approach would be to build the irrigation system and use drought resistant seed varieties. A third loop approach would involve looking all potential influences on water supply and their interactions with changing climate and extreme weather conditions and other changing conditions, and planning accordingly. [3]

2 McBean et al, (June 2011).

3 For a generic description of the paradigm shift to triple loop learning and associated approaches, see Wang and Ahmed (2003) page 13-14



Learning loops: pathways, outcomes, and dynamics of single-, double-, and triple-loop learning and applications to flood management. Adapted from Argyris and Schon, 1978; Hargrove, 2002; Stenman et al, 2006; Folke et al, 2009; and Pahl-Wostl, 2009.

ACT suggests that the transformational third loop be renamed and elaborated as the "resilience" loop [4] (see box [5]), which can also be referred to as a complex adaptive systems approach.[6]

In practice, a paradigm shift to the third loop would require Canada's governments to form collaborative partnerships to prepare food supply chain and food security resilience strategies based on:

1. Assessments of climate change vulnerabilities and risks to crops and food supplies.
2. Determination of effective protection standards and practices (these are later elaborated as tools in this report).
3. Commitments to apply these tools to avoid extreme damages or, at least where applicable, limit or manage impacts to ensure a high degree of recoverability.

Experience has shown that paradigm shifts require a shared sense of urgency: creating a pathway from thinking differently to acting differently, and building the evidentiary case for and the capacity to move from reactive to resilient decision-making.

- **A shared sense of urgency**: Climate scientists report that "*by 2050, global average temperature could be between 1.4°C and 3°C warmer than it was just a couple of decades ago… That's substantially higher than estimates produced by other climate analyses, suggesting that Earth's climate could warm much more quickly than previously thought.*" [7] [8]Other sources of this type of information would include loss of stationarity in extreme weather event impacts, and scenario-based projections of future conditions.
- **Creating a pathway to move from thinking differently to acting differently**: This involves starting with invention, then innovation and after testing, early adoption, and then further testing followed by mainstream application. It is highly unlikely that untested approaches will be accepted as mainstream practices.

4 The National Academies, 2012 provide an in-depth approach to resilient communities in the United States.

5 Fournier 2011 Conference Board of Canada

6 Booher and Innes (2010) provide examples of paradigm shifts in relation to complex networks.

7 Sid Perkins on 25 March 2012, 1:05 PM "*Earth Warming Faster Than Expected. Science Now.*" http://news.sciencemag.org/sciencenow/2012/03/earth-warming-faster-than-expected.html?ref=em

8 The following announcement may in the years ahead be seen as the beginning of a paradigm shift in Canada's approach to disaster risk reduction. During the 2011 floods in Manitoba and Quebec, the Prime Minister "announced that the Government is also prepared to discuss a mitigation strategy that would apply to all provinces and territories to help enhance infrastructure to better withstand future floods." http://www.ipcc.ch/index.htm#.T3nvCnh0G2M (accessed March 29, 2012)

- **Building the evidentiary case for, and the capacity to move from, reactive to resilient decision-making:** This requires drawing on existing and emerging leading practices and applying these through case studies across Canada's regions.

Paradigm shifts are also typically supported by principles that help guide steps towards the new ways of thinking. For example, a shift to a transformative resilient approach would involve the following basic principles:

- Use a holistic approach to defining and sustaining the systems that support agri-food production.
- Avoid harmful and costly trade-offs while managing the impacts of unavoidable trade-offs.
- Monitor performance to ensure intended results are achieved, and where necessary, making adjustments to attain such results.

More detailed principles for agri-food climate adaptation and disaster risk reduction are provided in the form of a checklist on pages 17-18. The following sections provide definitions, and then the context, for introducing leading initiatives that can provide a foundation for, and mark the emergence of climate adaptive, resilient approaches to agriculture and agrifood economic development and food security planning.

FOOD SECURITY – DEFINITIONS, INFLUENCES AND STEPS

Food security is the starting point, and is ultimately the focus, of recommendations for this review of climate change adaptation impacts on crops and food supplies.

In 2003, the United Nations Food and Agricultural Organization (FAO) reported there were over 200 definitions of food security and selected the following to define both food security and food insecurity:

> *"**Food security** exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept to the family level, with individuals within households as the focus of concern.*
>
> ***Food insecurity** exists when people do not have adequate physical, social or economic access to food as defined above."* [9]

These basic definitions are expressions of success and failure, which depend on the ability of society to develop third-loop governance approaches that embrace the complexity of interactions among the following influences:

- Natural assets, including soils, water supplies, ecosystem goods and services and biodiversity that influence food growing conditions.
- Affordability, accessibility and cultural considerations (referred to in this report as "iconic foods") and their influence on food supply/market relationships and human health.
- Viability, or the ability to achieve and maintain a business case to produce and supply foods.
- Risks, including human conflicts, geological (non-climate) hazards, extreme weather events and food safety issues (biological and toxicity), all of which influence food production through to consumption.

Food supply chain steps (activities) bring these influences into sharper focus, as they exist within the context of competing land and resource uses, which are subject to even wider-ranging environmental, social and economic issues than those listed above. These steps must be considered as we adapt to climate change, including: the primary production of food; packing; transportation of food to facilities that grade, package and ship to processors or markets; to processing; to initial through to final preparation of food for consumption; to distribution to local through to global markets; to marketing to wholesalers, retailers and food services; and finally to sales to consumers through the food service and retail sectors.

9 FAO (2003) page 28

Together, these definitions, influences and steps, and the complex linkages among them, provide the governance context for the climate change adaptation challenges faced by the agri-food sector and associated global, national, regional and local authorities, as they move from reactive, step by step lines of reasoning and responding to a more integrated consideration of sustainability, and on to whole system, synergistic, resilient, third loop-based approaches. [10]

A QUICK LOOK AT THE RISKS – FLOODING AND DROUGHTS

Canada's food producers, processers and manufacturers have already experienced economically disastrous impacts of extreme weather events. The following examples illustrate how the loss of production and the costs of disaster relief and recovery have affected the public as whole:

In 2000 and 2001 droughts across Canada resulted in a $3.6 billion drop in agricultural production. [11]

This drought period continued into 2004, and has recently been described as the worst drought in 800 years.[12] By comparison, the unprecedented 2011 Texas drought is estimated to cost $7.63 billion in the agricultural sector and another $669 million in the forestry sector.

Manitoba's 2011 floods are estimated to cost $936 million, with the provincial share estimated to be $491 million and anticipated federal costs estimated at $445 million.[13] That's just for one watershed. Only 13 years ago, the 1997 Red River Basin flood cost $4 billion for the US portion of the basin[14] and $1 billion in Manitoba for recovery, retro-fitting and new flood protection infrastructure for both urban and rural areas on the Red River Basin.[15] However, the recent floods saw unprecedented flooding of all the other rivers in Manitoba, illustrating the loss of stationarity.

The summer of 2012 saw massive droughts and heat stress in the US and southern Ontario with catastrophic impacts on corn and soybean crops, resulting in food price spikes and major losses for livestock farmers dependent on corn. A pork shortage was predicted for 2013. Early blossoming of Ontario fruit trees followed by killing frosts led to the loss of 80% of the region's apple crop.

- The Gross Domestic Product fell some $5.8 billion for 2001 and 2002, with the loss in 2002 more than $3.6 billion.
- Employment losses exceeded 41,000 jobs, including nearly 24,000 jobs in 2002.
- Net farm income was negative or zero for several provinces for the first time in 25 years in 2002.
- A negative net farm income occurred in PEI for 2001, in Saskatchewan for 2002, and a zero net farm income was reported for Alberta in 2002.
- Wheaton et al (2005)

10 Booher and Innes (2010)

11 AAFC. (2010-09-20). *Lessons Learned from the Canadian Drought Years 2001 and 2002. Synthesis Report* http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1326987176314&lang=eng (Accessed August 23, 2012). See also, Wheaton et al (2005). Statistics Canada records show that the accrued net income of farm operators from farm production during 1999 through 2004 was (in millions) 1, 819 (1999), 1,243 (2000), 1,675 (2001), 1,101 (2002), 1,439 (2003), 2,897 (2004). This data is included in *Table 9.2 Gross domestic product, income-based, 1996 to 2010* (Accessed on August 27, 2012http://www.statcan.gc.ca/pub/11-402-x/2011000/chap/econo/tbl/tbl02-eng.htm

12 The Globe and Mail. Monday July 30, 2012, page A5. See "Drought Research Initiative" at http://www.drinetwork.ca/index.php See Nature Geoscience (2012) doi:10.1038/ngeo1529

13 Texas A&M AgriLife. AgriLifeToday. 2012/03/21. "Updated 2011 Texas agricultural drought losses total $7.62 billion Commercial timber losses add another $669 million" http://agrilife.org/today/2012/03/21/updated-2011-texas-agricultural-drought-losses-total-7-62-billion/?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+AgrilifeToday+%28AgriLife+Today%29

14 Province of Manitoba. 2011.

15 Red River Basin Commission. September 30, 2011. Page 13

ON THE GROUND EXPERIENCE

Farming is highly vulnerable to climate change and extreme weather events and periods. One only needs to listen to a grain farmer who lives with the day-to-day and longer duration consequences of extreme weather: If it's too hot, too cold, too wet, too dry, too windy, raining too hard or hailing, and if there is too much wind- and water-borne soil erosion and too much sedimentation in water sources, crops may not be planted, they may not grow and they may not be harvestable. The yield may be reduced or there may not be any yield, and the farmer's bills won't get paid. Farmers are constantly balancing these and other production factors (plant diseases, pests, costs of inputs, e.g., seed, fuel, fertilizer, etc.; costs of land, buildings, structures, fences, machinery, equipment, insurance, etc.; and concerns about labour supply, aging and intergeneration transfer, etc.) against uncertain prices for their crops.

One could also listen to an orchardist, or a rancher, or a sugar bush operator, or others who produce the hundreds of different crops in Canada. Each has their own weather stories, and increasingly, their own tales of climate change-influenced extreme weather impacts.[16]

There are unprecedented, unpredictable, and damaging extreme events ahead, flooding being the most destructive with the added risks of floodwater-borne siltation, erosion and contamination, and, in coastal settings, ocean inundation with risks of plant-killing and soil productivity-destroying salination. Drought, especially over extended periods during a growing season and in some cases for years at a time, while not as immediately destructive, can lead to equally damaging business and economic impacts compared to shorter term and more localized flooding. Both hazards, simply stated, put farmers' livelihoods at serious risk and create widespread supply chain impacts. And both are predicted to increase in duration and severity.

Climate change and extreme weather challenges not only affect the production level, but create ripples through the entire food supply chain from producers, to packers, to processors, to manufacturers, to distributors, to restaurateurs, to retailers and finally to consumers. Impacts can include transportation costs, food safety (health), food trade, food marketing, and food affordability and accessibility issues, each with layers of influencing considerations. Factoring in the experience and prospect of climate change and extreme climate events creates added challenges; for example, if suppliers and consumers are linked by three-day delivery timelines and a flood knocks out the highway system, there will be physical and financial losses along the supply chain, and potential scarcity-induced food price increases and even shortages.

Taken together, Canada's food supply systems have complex sets of widespread vulnerabilities and risks in the development, adaptation and continuance of agriculture and agrifood economies and their role in food security. All of these contextual considerations need to be acknowledged when addressing climate change adaptation and disaster risk reduction in the agriculture and agri-food sector.

A review of climate change and extreme weather event challenges for five of Canada's iconic foods follows. These foods are economically important in their regions and are keystone elements of Canada's culinary identity, and thus critical to our cultural and social sustainability. We then describe what Canadians are doing about these challenges, followed by a list of results-focused steps, which will ultimately determine whether or not Canadians become more dependent on external (equally if not more vulnerable) food sources or create resilient food production systems in all regions.

CLIMATE CHANGES AND AGRI-FOOD IN CANADA

In Canada, climate changes affecting precipitation and temperature patterns are creating a number of interlocking effects, including changes to agricultural production potential, invasion by new weeds and pests, an increase in the frequency and magnitude of precipitation and drought, and increases to landscape level effects such as wildfires, salination, and erosion.

16 Government of Manitoba, *Flood Fighting Manitoba*.

IMPACTS ON CANADA'S ICONIC FOODS

The summaries presented here are drawn from Newman's in-depth review in the accompanying Background Report on climate change impacts on selected iconic foods that Canadians cherish: BC salmon, Western Canadian beef, Prairie grains, Eastern ice wine and Quebecois maple syrup. This review also provides adaptation strategies for these foods.

This summary underlines the crop-specific influences of climate changes, highlighting the need for detailed vulnerability and risk assessments and adaptation strategies.

BC salmon are highly vulnerable to climate change, in particular high water temperatures and unpredictable stream flows. In the long term, warming conditions will likely shift the range of the species northward, which will challenge its ability to survive in new regions and with varying competition from other species. River and lakeshore habitat protection can help boost species resilience, and protecting BC's salmon will require a concerted effort to maintain or restore fish-bearing streams to proper functioning conditions. If salmon are to be maintained as BC's single most important cultural food product, we will need to re-organize our prioritization of salmon habitats, and may require them to be favored when resolving competing water uses such as energy production, other agricultural demands, or urban development.

Western Canadian beef production is likely to encounter higher costs for water due to hydrological shifts, and over the long-term may have to shift feeding regimes from grains to grass, or access water from northern basins. Shifting from grain to grass would require significant public relations efforts, as the resulting flavour differs from what is now considered the North American norm. Securing water supplies will require integrated watershed planning and management in local production areas.

Prairie grain production will need to adapt to drier conditions that could require a shift to grain and pulse intercropping. An increase in extreme events is also of concern to grain farmers due to devastation caused by floods. However, higher temperatures could boost yields, further increasing Canada's ability to act as a global breadbasket, at least in the medium-term.

Okanagan, BC and Niagara, Ontario ice wine production could rise along with general warming trends; however, winter temperatures may not remain cold enough for the freezing periods required, and the industry will face challenges posed by extreme weather such as hail or rain that is detrimental to fruit as well as vineyard infrastructure. It is worth noting here that vineyards provide a useful reserve of farmland if domestic food production needs to be raised.

Quebec maple syrup, as Canada's foremost iconic food, will likely see production decrease as temperatures rise, and the industry may have to shift northward, which will limit the role of syrup production as an early season cash crop for small farms in southern sections of the cropping region. The market for this high value crop continues to increase as Canadians search for healthier sugars. Protection of our maple capacity is also a matter of national culture.

Grains and beef are staple foods required for primary food security and a significant percentage of Canada's economy. Salmon is a high value food that represents primary food security for many First Nations and others in salmon-rich regions. Maple syrup plays a defining role in Canada's cultural identity; maple syrup and ice wine are both high value products that are processed locally. Losing these foods would damage cultural identity, undermine rural and national aspects of our economy. Many other such foods will face similar threats and challenges.

CLIMATE CHANGE IMPACTS ON FOODS IMPORTED TO CANADA

In addition to the foods briefly described above, Canadians import food from other regions, all of which are experiencing climate change induced limits on growing conditions.

While coffee, tea and chocolate – all projected to be impacted by climate change – do not present food security issues for Canadians, they will likely bring climate vulnerability home to the broader public and have widespread economic impacts, even more so where substitutes do not currently exist.

Imports of fruits, vegetables and nuts that contribute to Canada's food security will initially become more expensive, then more scarce, a prospect that warrants attention in the near term to enable Canada's producers to bring replacement and substitute crops into production where growing conditions support this due to warming conditions in Canada, or the increased use of technology (e.g., greenhouses) that would be made more feasible by the higher prices that will occur with declining availability of products from existing sources.

CLIMATE CHANGE POLICIES AND PROGRAMS FOR THE AGRI-FOOD SECTOR IN CANADA

Due to its size and resources, Canada is well placed to maintain a robust food industry in the face of shifting climate conditions. Ensuring the continuance of some products in their current localities and facilitating transitions to other products or regions where opportunities exist, as well as reducing extreme weather risks, will involve governance approaches capable of addressing complex social, economic and environmental interactions to achieve resilient outcomes. This will involve multi-faceted, multi-tiered, multi-sectoral, multi-jurisdictional, and multi-instrument planning.

The agri-food sector in Canada is co-managed by the federal, provincial and territorial governments through joint and individual policies and programs.[17] Climate change is addressed through sector-focused initiatives or as part of more broadly applied initiatives. Taken together, these contain the elements of a transformative triple loop approach, but in themselves they represent primarily single and in some cases double loop approaches. These more narrowly considered

17 Extreme weather conditions and their effects on individual farmers are the subject of the daily news, for example for corn producers, and tree fruit growers throughout the spring and summer of 2012.

approaches might carry risks of either creating unintended consequences, or of being affected by the decisions made in other sectors. The latter would include, for example, resource development that pollutes a water supply needed to introduce agri-foods in areas where climate change has improved growing conditions. By not looking ahead across a range of potentially changing conditions and land uses, this decision would preclude development of a future food supply.

The following points summarize extensive activity in Canada that directly or indirectly contributes to climate change adaptation and disaster risk reduction in the agri-foods sector:

- Climate change risk and adaptation research has been and is being done across Canada to prepare for changing growing conditions.
- There are examples of local through to basin approaches to climate extreme event risk identification, avoidance and management.
- Extreme weather-related business continuance and recovery programs are available.
- Economic development and transition support programs are available.
- Producers are accustomed to working with the weather, and are already obliged to think ahead in terms of varieties available and their strengths and weaknesses
- Climate models are available to assist producers' understanding of the changing and unprecedented weather extremes they have already begun to experience.

At this high level of generalization, it would appear that the agri-food sector and governments in Canada already have the experience, knowledge, skills and abilities to take advantage of emerging opportunities in the agri-food sector, take steps to avoid and manage the damage threatened by impacts on land- and water-based food systems, and contribute to the food security of Canadians and others.[18]

However, although there are examples of preparedness, there is no one comprehensive, forward-looking policy or program that provides sufficient certainty that Canada's food systems will be able to adapt to climate changes either to maintain existing agriculture and food economies, or support new agriculture and agrifood development. In the absence of such a policy or program, we face current and increasing risks and costs for post-event (reactive) recovery and restoration approaches to extreme weather damages.

So far, there has been no effective national public dialogue designed to gauge support for the status quo, which currently consists of standing by to pay for the costs resulting from climate-driven storms, floods and drought impacts on Canada's food supplies and associated damages to supply chain infrastructure. Continuing this status quo means accepting more uncertainty, inadequate preparation and the prospect of higher costs for damages and for food with substantially increased risk of hardship for Canadian consumers and producers, as well as missed opportunities in new agri-food markets.

Depending on the extent of climate damages, their costs, and their impact on food security, public concerns may quickly escalate from commentaries such as this report to society-wide actions in response to a perceived breach of an as-yet-unstated social contract between citizens and their governments that meeting citizens' food needs is one of government's highest priorities. Other jurisdictions in the United States, Australia and Europe, as well as some leading examples in Canada, provide examples of ways in which we might proceed; bringing these into mainstream practice in Canada calls for the triple loop paradigm shift described previously in this report.

FOOD SECURITY AND WATER

There is a need to effectively integrate water management as a first order consideration in determining whether or not crops and foods are produced and reach consumers. This has already been noted as a future concern in relation to beef production in western Canada. Corn production losses in the summer of 2012 resulting from heat stress combined with

18 An overview of these policies and programs is included in the Background Report.

dry conditions are a current example. More specific information on the extent of the water supply challenges can be found in the *ACT Crops & Food Supply Background Report* and ACT's 2011 report on Water Governance.

Secure water supplies are, like food, essential. Water is a natural resource that supports lives and livelihoods. It is part of properly functioning ecosystems that support wild food production. Water–based landscapes (wetlands, riparian areas, floodplains and estuaries), surface water bodies (rivers, streams and lakes) and groundwater are highly interrelated with terrestrial landscapes. What happens on the land impacts the water, and what impacts water affects human health and well-being.

To restate points made earlier, if there is too much or too little water, crops and food production are limited accordingly. Unseasonal icy conditions damage crops. Extreme rainfall on ice and snow results in flooding. Extreme summer storms create flash floods that wash out infrastructure and erode soils. Droughts can reduce yield and destroy crops over vast areas, and are a precursor condition for wildfires as well as the harbinger of desertification.

In recognition of this water/food nexus, the paradigm shift and the governance framework we propose in this report must both include and go beyond crops and food supply considerations. There is a need for integrated water/agriculture climate change adaptation strategies, such as that proposed by the Food and Agriculture Organization, which involves the following ten steps for each agri-climate zone [19](see box below). Note that steps 1 to 3 involve all land uses and steps 4 to 10 focus on agriculture, and in context, other land uses.

1. Define climate change impacts on water resources availability.
2. Define (account for) current water resources use, and projected use for current development goals.
3. Determine climate change impacts on future water availability and implications for future allocations.
4. Define the production status and potential of current agricultural (cropping) systems under selected climate change scenarios.
5. Examine the water and land-use implications of alternative combinations of agricultural development activities, incorporating rainfed agriculture; irrigated agriculture; agroforestry; rangeland; and integrated mixed farming.
6. Match options to likely scale and nature of farming in the future in recognition of current and likely levels of urban migration and remaining rural population.
7. Evaluate mitigation options for synergy, practicality and cost effectiveness.
8. Define resources and adaptations needed to maintain current levels of output and productivity.
9. Define resources and adaptations required to meet future demands.
10. Assess impacts on eco-systems and on the sustainability of the existing or proposed farming system.
11. Cost alternatives.
12. Prioritize options.

FAO 2010

19 For instance, as supplies of fresh produce are affected by increased arid conditions due to the climate shifts in the southern US, we will need to rely more heavily on the hothouse industry such as that in BC, or if climate shifts are favourable, on new crop opportunities in Canada.

FOOD SECURITY – FINANCIAL RESILIENCE AT THE SITE AND OPERATIONS LEVEL

Along with the high-level strategic attention to issues described above, there is a corresponding need to focus on the sensible (i.e., practical, effective) integrated use of, and improvements to, existing "tools."[20] We recommend development of the following tools:

1. Provision of public information on food supply chain extreme weather, risk avoidance and management practices to enable producers and others to take steps that are in their own interest.[21]
2. Resource management policies and practices, including ongoing innovation and use of more resilient crops and farm soil and water management practices.
3. Land use zoning and development standards designed to keep development out of harm's way, and where that is not possible, to increase its resilience.
4. Engineered and natural systems that create floodproof infrastructure, and ongoing management to protect development and crop production from inundation and erosion.
5. Reference/risk-based insurance and disaster relief, recovery and restoration programs. (In this context, reference-based means applying the knowledge about climate change/extreme weather vulnerabilities and risks to the design of public and private sector and joint public/private sector policies, plans, programs and practices.

ACT's work to date on these types of approaches points to the need for early, in-depth attention to resilience to climate change impacts, particularly with respect to overland flooding of buildings and structures. We acknowledge the importance of the role of crop insurance and related programs in agri-food business continuance, and these are described in the *Background Report*; however, we propose that priority attention is given to overland flood perils because private insurance is not currently available for homes, and while available for businesses, is rarely purchased by them. As a result, when overland flooding results in property damage in Canada, federal, provincial, territorial arrangements that are paid for by taxpayers fund relief, recovery and restoration efforts, and in some cases, re-development to a higher standard of protection. Also in some cases following major flood disasters - the Red River floods in Manitoba are prime examples - federal, provincial/territorial and local government funding is used for major flood protection and flood control infrastructure and services.

This reliance on publicly-funded flood disaster risk reduction, relief and recovery in Canada prompted ACT to review approaches and experience elsewhere. In the United Kingdom, concerns about coastal flooding have resulted in a public-private partnership involving the use of tools noted above.[22] In the United States, there are problems with the federal and state approaches to public sector flood insurance related to the ineffective use of zoning and development controls and to the administration of programs.[23]

20 FAO 2010

21 In considering these urgent matters, ACT acknowledges that adaptation to climate changes to growing conditions will involve continued senior government and private sector support for growing condition resilience of food sources, for example by focusing on these as innovation priorities. AAFC. (2010). *The Way Forward*.

22 AAFC (2001)

23 UK 2011 and 2012

BUILDING ON EXPERIENCE – A REVIEW OF LEADING INITIATIVES

The following examples of double loop and triple loop approaches, with the latter noted - and others included in the Background Report - can be used to help design adaptation approaches to achieve agri-food viability, resilience and sustainability in Canada. In some of the cases described below, very brief descriptions are provided, while more detail is provided in the Background Report. Readers are also encouraged to access sources listed in the Citations and References section.

CANADA/UNITED STATES:

The Red River Basin Commission

At the basin scale, the work of the Red River Basin Commission in southern Manitoba and neighbouring states is notable.

CANADA:

Landscape and Infrastructure Resilience in Saskatchewan

Saskatchewan's Rural Municipality of Corman's Landscape and Infrastructure Resiliency Assessment (LIRA) Manual provides a sub-basin/watershed/drainage area approach to assessment and adaptive management/ risk reduction approaches.

Agriculture land use and management assessments and integrated water management plans in Manitoba

Agriculture and Agrifood Canada (AAFC) and Manitoba's Ministry of Agriculture are preparing watershed-based Agricultural Land Use and Management (ALUM)[24] reports to inform the preparation of Integrated Water Management Plans (IWMP) by Manitoba's Conservation Districts:[25] collaborative organizations at the watershed scale that also provide leading best practice examples.

Environmental Farm Plans

At the farm level in Canada, the Agriculture and Agri-Food Canada/Provincial Environmental Farm Plan approach has been an effective platform for addressing environmental issues, and could be expanded for the delivery of site-scale climate adaptation and extreme climate event planning and development measures. Case studies in British Columbia will provide direction on next steps at the regional and farm levels. [26]

UNITED STATES:

The US Department of the Interior

The Secretary of the Interior - with reference to a legislated mandate and requirement - has established the *Interior's Plan for a Coordinated, Science-Based Response to Climate Impacts on Our Land, Water, and Wildlife Resource*.[27] This has guided the preparation of recent integrated river basin water management strategies to ensure that agricultural, domestic, and wildlife water needs as well as those for flood protection and

24 Sparks, (March 2010)

25 AFFC. Agri-Environment Services Branch (AESB) and Manitoba Agriculture Food and Rural Initiatives (MAFRI). (April 18th, 2011).

26 Information on these districts can be accessed through http://www.gov.mb.ca/waterstewardship/iwmp/index.html (Accessed September 4, 2012) and information on specific IWMP activities can be accessed through district websites.

27 Crawford and McNair, (2012)

hydroelectric power generation will be addressed. The recent publication of the Yakima River Basin Integrated Watershed Resources Management Plan is part of this USDOI initiative.[28]

Although not overtly designed as a triple loop transformative approach, the USDOI system has most of the elements of such an approach.

The California Water Plan and Robust Decision Making

The California Water Plan (CWP), administered through the California Department of Water Resources, is a leading example of planning for climate change adaptation for agriculture.[29] Updated every five years, with a recent update in 2009 (CWP 2009) and subsequent changes planned for 2013 (CWP 2013), the CWP offers a "collaborative planning framework for elected officials, agencies, tribes, water and resource managers, businesses, academia, stakeholders, and the public to develop findings and recommendations and make informed decisions for California's water future."[30] It provides the most current available information on the status and trends of water resources, supplies and demands under several future scenarios as well as potential management options to achieve critical objectives.

While CWP 2009 relied on scenarios to project likely future conditions, CWP 2013 is expected to provide a framework for management decisions in an uncertain future based on i) potential threats; ii) expected outcomes of different management options; and iii) tradeoffs between options.[31] This approach is intended to accommodate multiple potential future conditions with significant uncertainty using a ***Robust Decision Making*** approach [32] and may offer new options for managing water resources in a changing climate.

California's county level "spatially-explicit" approaches

The California Energy Commission's California Climate Change Center (CCCC) has recognized the importance of developing public awareness of biophysical and socioeconomic factors that contribute to agricultural vulnerability and resilience in order to establish public support for climate change mitigation and adaptation.[33] To provide the public with necessary information to understand these conditions, the CCCC has developed a spatially explicit vulnerability index based on 22 climate, crop, land use and socio-economic variables. [34]

The index has been used to identify priority regions for adaptation based on high vulnerability to climate change. However, the research team noted the need for a place-based approach to identifying underlying causes of vulnerability and relevant approaches to adaptation based on regional characteristics.

28 See www.doi.gov/csc/upload/Detailed-LCC-and-CSC-Information.pdf (Accessed September 4, 2012)
29 The Yakima River Basin is wholly within the State of Washington and is part of the larger Columbia River Basin. For report see: U.S. Department of the Interior, March 2012
30 California Water Plan website: http://www.waterplan.water.ca.gov/.
31 California Department of Water Resources (2012) California Water Plan. http://www.waterplan.water.ca.gov/
32 Groves, D., Bloom, E., and Joyce, B. (2011) A Decision Framework for the 2013 California Water Plan. Presentation at the SWAN meeting, May 13, 2011.http://www.waterplan.water.ca.gov/docs/meeting_materials/swan/2011-0513/CWP_2013-RAND_DECISION_FRAMEWORK-2011.05.12.pdf
33 Groves *et al.* (2012).
34 Jackson, L. et al (2012a)

A place-based study was conducted for Yolo County to assess future crop acreages and associated hydrological conditions under climate change, current levels of agricultural greenhouse gas emissions, farmers' current perspectives on climate change and willingness to adopt mitigation and adaptation strategies and future urban growth scenarios.[35]

Studies of potential climate change impacts, adaptation options, and contributors to vulnerability and resilience (i.e. socio-economic, infrastructure, community services and natural resources) have also been conducted for Fresno County.[36] These efforts indicate progress toward adaptation at the state and regional levels.

These California examples include triple loop learning approaches.

AUSTRALIA'S TOP-DOWN AND BOTTOM-UP APPROACHES:

Policy reform – top down

The most recent stage in the evolution of Australia's approach to climate change adaptation-oriented governance is the current study being undertaken by the Productivity Commission of the Australian Government to assess the role of regulation and policy barriers to effective climate change adaptation. The study will examine the costs and benefits of various policy options, including a business-as-usual approach; evaluate the role of markets in adaptation, including insurance markets; and assess non-market mechanisms, such as government intervention.[37] Policies will include those that can be implemented at each level of government. The project is intended to assist the COAG to advance climate change adaptation through policy approaches that demonstrate the highest net benefits of implementation. The results of the study will be released in September 2012.[38]

The report, Barriers to Effective Climate Change Adaptation, was released in draft in April 2012. Recommendations include the following:[39]

> *Policy reforms that would help people, firms and governments deal with current climate variability and extreme weather events should be prioritised. These 'no-regret' or 'low-regret' reforms would deliver benefits and build adaptive capacity for responding effectively to future impacts. Examples include:*
>
> - *Reducing perverse incentives in tax, transfer and regulatory arrangements that impede the mobility of labour and capital.*
> - *Improving information on climate risks by increasing the quality and availability of natural hazard mapping.*
> - *Clarifying the roles, responsibilities and legal liability of local governments, and improving their capacity to manage climate risks.*
> - *Improving emergency management arrangements.*
> - *Avoiding regulatory distortions in insurance markets.*

35 Jackson, L. et al (2012a)
36 Jackson, L. et al (2012b)
37 Moser, S.C. and J. Ekstrom, (2012)
38 Australian Government, Productivity Commission (2012)
39 Australian Government, Productivity Commission (2012)

The case for implementing reforms now to address barriers to adaptation to uncertain future climate trends is less clear.

- *For reforms with low up-front costs and potentially large but distant benefits some preparatory action could be worthwhile. The case is stronger for reforms that would deliver benefits under a range of climate change scenarios. For instance: producing and disseminating localised (downscaled) climate projections designing flexible planning regulation to respond to uncertain climate change impacts developing approaches to managing risks to existing settlements.*
- *Where measures have high up-front costs, there is likely to be a benefit to the community in deferring action until better information becomes available.*

Regional strategies – bottom up

Governing authorities within individual basins, such as the largely agricultural Corangamite basin in the state of Victoria, have launched their own initiatives to manage natural resources under multiple pressures including changing climatic conditions, growing populations, and habitat degradation.

In 2012, the Corangamite Catchment Management Authority (CCMA) published its Regional Catchment Strategy 2012-2018 and encouraged feedback from the public through review of the document, open houses, workshops, listening posts, and online forums before finalization.[40] The CCMA developed the draft Strategy through partnership with the national, state, and local governments as well as local communities, aboriginal groups, and industry representatives but recognized from the outset that, since nearly 78% of land within the basin is privately owned,[41] public engagement and feedback would be critical for successful implementation.

The CCMA Regional Catchment Strategy 2012-2018 establishes a 50-year vision, priority assets, 20-year objectives, and six-year strategic actions for managing resources within the basin. A map of management "hot spots", which represent clusters of high-value agricultural lands, aquifers, coastal areas, marine areas, rivers and floodplains, terrestrial habitat, threatened flora and fauna, and wetlands is also included to guide actions. With respect to agriculture, the Regional Catchment Strategy 2012-2018 highlights the social and economic values offered by agriculture in the basin, its role in supporting other natural resource sectors, and the opportunity that agricultural landowners possess to contribute to achieving environmental goals. The draft document draws from existing legislation and policies at the national and state levels to establish management priorities and establish strategic actions.

These Australian examples include triple loop learning approaches.

FRAMING A GOVERNANCE APPROACH TO CLIMATE ADAPTATION AND DISASTER RISK REDUCTION FOR CANADA'S AGRI-FOOD SECTOR

Going forward, society as a whole needs to come together to protect our ability to produce food and feed people. This requires the design and use of the best possible governance approaches to the resilient adaptation to climate changes and to the avoidance and management of extreme weather impacts on food security. To do less is folly.

40 Australia Productivity Commission (2012)
41 Corangamite Catchment Management Authority (2012)

Resilience can be achieved by building on these leading examples and preparing high-level through to on-the-ground strategies based on the identification and analysis of existing agriculture (and other resource) capabilities. In the post-stationarity era this will involve using scenario-based approaches to establishing climate change adaptation and disaster risk reduction standards.[42] [43]

Moving to a resilient approach will need to be facilitated by the expression of and adherence to open governance and other value-based operational principles, which will keep attention focused on achieving intended sustainable outcomes in ways that will avoid unintended and unmanageable trade-offs.[44]

Looking back to narrowly considered single loop decision-making, no one chose to use fossil fuels for the purposes of creating climate change. The resultant impacts are the unintended consequences, the negative externalities and the collateral damages of the linearly decided and otherwise beneficial economic and social development uses of fossil fuels.

Looking ahead, global society is now experiencing disruptive, damaging and in some cases catastrophic climate change impacts affecting all aspects of human endeavour, including potentially disastrous threats to food supplies.

> "Scenarios are not predictions. They describe alternative plausible yet very different future conditions, and are used to explore uncertainties that a community has little control over and form the basis for "Robust Decision Making."
>
> Adapted from Groves et al (2012)

To achieve equitable access to nutritious food, our governance systems must identify and pursue initiatives that synergistically (socially, economically and environmentally) focus on achieving food security outcomes in relation to:

- Agri-climate zone shifts (growing conditions).
- Protection of naturally functioning ecosystems for wild foods and biodiversity - our natural assets.
- Avoidance and management of extreme weather impacts on food supply chains.
- Incorporation of GHG mitigation (reduction, sequestration and offset) practices. [45]

START WITH THE END IN MIND – A PARADIGM SHIFT

It is relatively easy to call for complex adaptive systems approaches to governance, but bringing these into effect takes unprecedented commitments and years of effort. At this stage, knowing what such an approach could deliver is presented as a starting point. Here is a checklist of key considerations and related principles and approaches - some readers may wish to consider these as goals - to help initiate discussions on the design of a climate change adaptation governance system for agri-foods in Canada:

1. Food security and secure water supplies for food are societal necessities—not options.
2. Food security requires and is supported by sustainable environmental, social, and economic systems.
3. Climate change adaptation and disaster risk reduction approaches receive priority attention—an unfortunate, but realistic acknowledgment that greenhouse gas emissions are not being effectively curtailed or offset, thus accelerating global warming and causing increased food supply chain vulnerabilities and societal well-being vulnerabilities and risks.
4. Effective climate change adaptation and disaster risk reduction standards and approaches must be based on the use of best available atmospheric and hydrogeological science combined with historic and traditional ecological knowledge, as well as archeological, paleobiological and surficial geological (soil profiles) records.

42 Stationarity based standards of protection which use the most extreme event experiences for ratings will not be sufficient to protect agriculture and agri-food production in the decades ahead, as even at current GHG concentrations, weather extremes are breaking records seemingly on a daily basis.

43 Groves et al, (May 2011)

44 Examples of the use of such principles in strategic planning can be found in Australia example in Ryan et al, (2010) and in North America in Red River Basin Commission, (May 2005).

45 For current AAFC direction see: http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1188220105158&lang=eng

5. Where extreme weather events and periods are exceeding coping ranges and are no longer predictable using stationarity approaches, scenario-based vulnerability assessments are used to help establish planning and design standards.
6. Risk avoidance and management options are considered with reference to a pro-active *"no-regrets"* or *"low-regrets"* and *"safety margin"* policies.
7. Adaptation strategies are designed to reduce, offset and sequester GHG emissions where possible, to reduce runaway climate change impacts.
8. The use of both natural assets and engineered technology are considered when designing approaches to avoid and manage flood vulnerabilities and risks.
9. Food security is not the only high priority societal necessity that requires a "no unmanaged trade-offs" approach. However, it is inextricably linked to all that involve:
   a. Ecosystem features and functions as well as environmental health.
   b. Referenced-based financial risk management.
   c. Community and livelihood continuity.
10. Adaptation and disaster risk reduction options are evaluated with reference to multiple accounts benefit cost analysis.
11. Multiple economic, social and environmental benefit flows with synergistic outcomes are sought and achieved.
12. Decision-making is open and accountable.

OPEN GOVERNANCE PRINCIPLES

Decision-makers ensure their accountability and avoid unintended consequences by:

- Being transparent, inclusive and collaborative.
- Being informed by multi-disciplinary, multi-interest and multi-jurisdictionalperspectives.
- Pursuing cost-and performance-effective public, private, civil society and individual approaches separately or together.
- Preparing and publishing stated performance planning and management strategies, and monitoring and reporting results.
- Engaging in the highest standards of administrative fairness.
- Providing for and being subject to publically reported arm's length performance audits and reviews.
- Improving their effectiveness with reference to internal and external reviews.

CONCLUSIONS

Serious water conservation measures must be put into place immediately to reduce the risk of water scarcity, and additional measures ... to ensure that water quality and allocation issues related to reduced supply can be effectively managed.

Successful climate change adaptation for crops and food supply will ultimately be measured in terms of economically viable, resilient and sustainable crops and food supply systems, as well as in terms of food security. It will ultimately require transformative policies, programs and practices that build resilience into the agri-food sector supply chain. Over the next five years, much can be accomplished by consolidating many of the leading initiatives and practices previously outlined in this document, and as set out below.

A GOVERNANCE FRAMEWORK FOR ACTION

Exemplary action-focused climate change adaptation and disaster risk reduction approaches have been developed in many countries, Canada included. By drawing on these best practices we propose a three-tier governance framework to enable Canadians to adapt their food supply chains to climate change and reduce and/or manage extreme weather impacts.

Use of the proposed framework will identify where new and emerging growing conditions will maintain existing production, or create new food production opportunities. Realistically, it will also need to inform decisions to take some areas out of food production to reduce economic and financial exposure where climate changes no longer support food production and/or where repetitive extreme weather conditions create increasingly unaffordable crop loses and property damage. In these situations, use of the framework will inform economic transition initiatives to assist individuals, families and communities that are no longer sustained by food production.

With reference to the triple loop learning principles listed on page 4, ACT proposes three levels of action:

- **Integrated water resource and agri-food sustainability strategies** to provide the context for planning and implementing resilient outcomes.
- **Agri-climate zone sustainable food production plans** that to achieve sustainable, multiple benefits flows and avoid costly, underperforming, narrowly responsive approaches.
- **Implementation of effective adaptation and risk reduction practices** rather than incomplete, inconsistent or contradictory uses of adaptation and risk reduction tools.

1) Integrated water resource and agri-food sustainability strategies.

This level would describe, prioritize and provide support for basin- through watershed-scale integrated water resource management assessments, strategies and actions for environmental/ecosystem, agricultural, and domestic/industrial water and hydro-electric power supply accounts, as well as flood water retention and control works.

This would involve the establishment of high-level, broad scale intergovernmental collaboratives.

As water is an essential resource in all aspects of life, social, economic and environmental, one of the most crucial ways to adapt to the growing number of negative consequences and costly feedbacks associated with climate change is to manage water effectively.

Multi-stakeholder civil society collaborative organizations would be established to "host" the dialogues necessary at key stages, for example the preparation of terms of reference, the review of assessments and plans, the preparation and selection of recommendations to governing organizations, monitoring and reporting on performance and advising on course adjustments as necessary.

2) Agri-climate zone food production plans.

Agri-climate zone plans would use the results from above and the findings from climate change assessments and extreme weather scenarios. Food production-potential plans and practices, including measures for avoiding and managing the impacts of extreme weather, would be prepared at the irrigation and/or drainage area scales and along food supply chains.

This would engage regional and local authorities and advisory bodies, which would be extensions of the higher-level collaboratives.

3) Implementation of agri/water climate change adaptation and disaster risk reduction actions.

These would include the fullest range and most effective use of farm practices, regulatory, infrastructure and financial "tools" that are needed to implement the high level strategies through site scale plans and practices.

Given the technical nature of these fields, technical advisory bodies would be established with representatives from business, industry, government and research and development/academic organizations. Their role would be to address the effective use of existing approaches and development of innovative approaches to deal with "wicked" problems[46] such as financing business continuance in the face of repetitive extreme weather disruptions and damages.

Where applicable, greenhouse gas reduction and mitigation measures would be built into area/site development and operational plans and practices.

46 "Wicked problem" is a phrase originally used in social planning to describe a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize. The term 'wicked' is used, not in the sense of evil, but rather its resistant to resolution. Moreover, because of complex interdependencies, the effort to solve one aspect of a wicked problem may reveal or create other problems." Source: http://en.wikipedia.org/wiki/Wicked_problem Retrieved July 29, 2012. This type of problem can also be referred to as a "tough" problem requiring dialogue. See Kahane (2005 and 2010) and the REOS proposal at: http://reokstners.com/sites/default/files/Climate-Working-Group-IUCN-Interviews.pdf Accessed July 29, 2012. Such problems are the focus of complex adaptive systems approaches, for example see Booher and Innes (2010).

ACTIONS

In each of the above levels there are details that need attention. Getting to the stage of actually being able to deliver results will require focused dialogue involving directly affected organizations. This journey needs to be mapped out by using agenda-setting ACT briefing notes. One of the highest priorities is to bring public and private insurers together to ensure that effective new tools are developed to accommodate the increase in damage arising from climatic extreme events for both food production and its supply chains.

The following specific actions are proposed:

- Within the next three months, a task force with representatives from the agri-foods sector, private insurance industry, federal and provincial governments and academia should be struck to respond to ACT's findings, conclusions, suggestions and recommendations.

Given the broad scope of the recommendations offered in this report, and the limited opportunity to engage stakeholders in its preparation, ACT recommends that they be further considered by governments, the agri-foods industry, and academia, as well as approached incrementally by the groups identified as actors.

To assist this process, ACT proposes to strike a task force with representatives from the agri-foods sector, private insurance industry, federal and provincial governments and academia to respond to ACT's findings, conclusions, suggestions and recommendations by early 2014.

- As a first priority, ACT will arrange a workshop with this task force designed to develop an agenda for a major conference, likely in 2014, on the topic of public and private collaboration in overland flooding disaster risk reduction in Canada as well as the overall economic impacts of climate change and relative costs associated with adaptation.

- The task force should then prepare for and convene a national forum in 2016 involving Agriculture and Agri-Food Canada and other federal departments, with provincial and territorial partners and sector stakeholders, to establish transformative policies and programs to ensure that food producers across the country have the tools to deal with increasing variability and higher impacts of climate events and more permanent climate shifts across the country.

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