Climate Change and Food Security

Backgrounder for

Communities Adapting to Climate Change
Phase II Communities
Rossland, Castlegar and Kaslo Area D

DRAFT
May 13, 2010

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1.0 Goal of Backgrounder

The goal of this backgrounder is to provide an initial review of the literature with respect to food security as it relates to climate change in the Rossland, Castlegar and Kaslo regions. It is intended to outline what we currently know with regard to food security, identify questions that require further research and provide a basis for each of the three Phase II communities undertaking the Columbia Basin Trust's Communities Adapting to Climate Change to complete local or regional vulnerability assessments with regard to food security.

This backgrounder is structured to follow a logical progression of questions: What do we mean by food security? How might climate change affect food systems in the region, taking into consideration that the majority of the food consumed within the region comes from outside the region? And finally what is our local, regional and/or provincial capacity for self-sufficiency in food systems?

The majority of food consumed in our region is sourced from around the world, with the average distance traveled for a single ingredient food item being 1500 miles and that for a multiple ingredient item being 2200 miles (Brynne, 2009). As a result, food security is a climate change adaptation issue area that must be considered on a global level.

For the purposes of this backgrounder, the region under discussion will be considered to include all of the municipalities between Grand Forks on the West and Creston on the East, ranging from the US border on the South to Nakusp and the Slocan Valley in the North. These boundaries are arbitrary at the moment and it is suggested that a clearer definition of the region from a food security perspective that takes into consideration realistic potential future food distribution routes and boundaries be developed.

This is intended to be a draft living document prepared to assist the Phase II Adapting to Climate Change Communities undertake vulnerability assessments with regard to food security. In many cases with respect to regional food security, there are more unknowns than knowns. This report reflects that state of knowledge. Information requests have been sent out as part of the preparation of this backgrounder. As new information becomes available and comments are received, this document will be updated.

2.0 Definition of Food Security

Food security is challenging to define and means different things to different people. Defining food security is bound up in what one considers to be human food needs. Human food needs can vary broadly depending on whether one is defining it based on a subsistence vegetarian diet or a traditional meat and grain based North American diet. The choice one makes with respect to what kind of diet is to be the basis for defining food security will have enormous implications for the degree to which a region can be considered food secure, and the types of measures and agricultural land base required for a region to be food secure.

Changing food consumption and preparation patterns may be all that is necessary to ensure food security in some circumstances (FAO, 2008).

Food security also relates not only to the food being available for consumption in a certain region, but also that it is available at prices that people can afford, which is affected both by the price of the food itself but also the level of employment income and unemployment in the region under consideration.

In a report for the Vancouver Food Policy Council, (Serecon Management Consulting et al., 2009), food security is defined as follows:

Food security is achieved when the structure and capacity of the food system is resilient and adaptive and can meet the food related human, cultural, economic, social and environmental needs of the individual and community.

The most commonly used and accepted definition of food security developed by the United Nations Food and Agricultural Organization (FAO) is:

"Food security exists when all people at all times have physical or economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996).

For a more local definition, the Kootenay Food Strategy Society defines food security on a community level. Note the greater emphasis on environmentally sound and socially just food production:

"A community enjoys food security when all people, at all times, have access to nutritious, safe, personally acceptable and culturally appropriate foods, produced in ways that are environmentally sound and socially just" (KFSS, nd).

The Food and Agricultural Organization (FAO) considers four dimensions to food security:

- *food availability* – the physical availability of the food in the region due to the overall ability of the agricultural system to meet demand;
- *food accessibility* – the economic accessibility of the food in the region for families based on their income or rights;
- *food stability* – the absence of seasonal shortfalls i.e. in the months before the next harvest or other temporary or permanent disruption in access to food;
- *food utilization* – the safety and nutrition of the food and the ability of the body to use the food (Schmidhuber and Tubiello, 2007; Bals et al., 2008; FAO, 2008).

As a result, the FAO sometimes adds to its definition of food security:

"To achieve food security, all four of its components must be adequate. These are availability, stability, accessibility and utilization." (Bals et al., 2008:43).

The concept of food security was initially developed to be analyzed on a global level based on the comparison of how much food can be produced globally versus global demand (Bals et al., 2008). It has since been extended to allow for consideration of food security on a national, regional, household and individual level and to focus also on accessibility of food, rather than just availability of food. Food security often relates just as much, if not more, to the ability of individuals to access food through monetary or non-monetary means, rather than the physical availability of food (Schmidhuber and Tubiello, 2007; FAO, 2008). It is often a socio-economic issue rather than an agro-climatic one.

It is critical to emphasize that food security differs from the viability of local agriculture as a result of climate change from an economic or social perspective. A region can be food secure through secure access to food from other regions in the complete absence of local agriculture. Thus climate change impacts that could negatively impact local agriculture might not affect a region's food security. However, one could argue that access to food from other regions will never be 100 percent secure and thus regional food sources are a critical element of regional food security. In addition, individual food production may be a fundamental element of household food security in some households. As a result, this paper will attempt to move from a global assessment of food security to a more regional and local one.

3.0 A Food Systems Lens

This paper will examine food security through a *food systems* lens. The FAO (2008) describes food systems as a holistic set of interacting processes including:

- food production,
- food processing and packaging,
- food distribution and retailing, and
- food consumption.

This section will explore how climate change will affect our food systems on a local, regional and global level both directly and indirectly.

Unlike many of the impacts of climate change, such as water and ecosystems, which can be more localized, it is critical to assess food security implications on a global, regional and local scale. The majority of our food comes from outside of our region. Thus the question of how that global and provincial food systems will be affected by climate change is a critical element of assessing regional food security. As the FAO (2008:xi) observes, "Climate change will affect food security through its impacts on all components of global, national and local food systems."

Food systems are highly complex and globalized. Any change affecting one or more aspects of the food production and distribution system could have significant ripple effects resulting if not in reduced food availability, increases in market prices. The FAO stresses that to evaluate the potential impacts of climate change on food security it is not enough to assess the impacts on domestic production. Factors such as the impacts of climate change on overall global food surpluses and the ability of countries and individuals to purchase those surpluses must also be considered.

4.0 Impacts of Climate Change on Food Systems

4.1 Overview

4.1.1 Direct and Indirect Impacts

Climate change will likely affect food systems:

- *directly* through its impacts on biophysical factors such as plant and animal growth and the physical infrastructure associated with food processing and distribution; and
- *indirectly* through its effects on human capital, and economic and sociopolitical structures (Schmidhuber and Tubiello, 2007).

This section will provide outline some of the potential direct and indirect impacts of climate change on food systems. Because there is more information available on the direct potential effects of climate change on food systems, that will be the focus of this section. However the indirect effects are highly interrelated and ultimately may be the primary threat to global and regional food systems.

Climate change will bring both impacts and opportunities with respect to global food systems. Food *production*, especially agriculture and fisheries, will be one of the key aspects of our food system affected by climate change. This is important because food production is how the food we consume is generated, but also because food production employs 36 percent of the world's population (FAO, 2008). Thus if people are no longer able to make a living producing food, their ability to have the capital to access food may also be affected thereby creating an indirect effect of climate change on food security. While the potential impacts of climate change on food production may be the most immediately obvious, the food processing, distribution and utilization aspects of our food system will also likely be directly impacted by climate change and are of equal importance.

4.1.2 Timing of Impacts

Some of the impacts of climate change on food systems will be felt more immediately and indeed are already being experienced in some part of the world, such as the impacts of extreme weather events, less predictable rainfall patterns and rising sea levels (FAO, 2008). Other climate change impacts will be longer term and potentially more gradual, such as changes in temperatures and precipitation (FAO, 2008). In addition, some climate change impacts will result in short term shortfalls and volatility, while others will result in longer term more likely permanent changes in overall global production capacity (Bals et al., 2008). Certain already vulnerable crops, people and food systems, particularly small-scale farmers living off of rain-fed crops in tropical areas, will likely be affected first, but over time, the distribution of vulnerability and risk will likely shift (FAO, 2008).

4.1.3 Certainty of Impacts

There is a significant amount of uncertainty associated with forecasts of how climate change might affect food security (Bals et al., 2008). This uncertainty increases exponentially when making forecasts on a regional and local level. This is because of uncertainty with regard to how climate change will manifest on a regional and local level, but also due to uncertainty with regard to feedback loops and chaotic changes in the natural ecosystems upon which we depend for our food (Bals et al., 2008). Downscaling global climate models to local and regional levels continues to be challenging and highly uncertain. Even global models of climate change, particularly when they incorporate socioeconomic projections to develop emissions scenarios, are uncertain. As a result, most of the analysis with respect to food security presented in this paper is based on models that are at best highly uncertain (Schmidhuber and Tubiello, 2007). Thus, the potential impacts outlined below, and the final conclusions, are best guesses on a global scale, particularly with respect to the indirect impacts.

4.2 Direct Biophysical Impacts of Climate Change

Food systems will likely be directly affected by many aspects of climate change including increased CO2 concentration in the atmosphere, increased temperatures, reduced precipitation, new diseases and pests, more extreme events and rises in sea level.

4.2.1 Increased CO2 Concentrations in the Atmosphere

Increased CO2 concentrations in the atmosphere are a key element of climate change that could affect food security. Atmospheric CO2 concentrations are estimated to be approximately 379 ppm today and are projected to potentially rise to 550 ppm by 2100 under the IPCC Scenario B1 (the lowest future emissions scenario) and greater than 800 ppm in Scenario A1 (the business as usual scenario) (Schmidhuber and Tubiello, 2007).

Crops

Increases in carbon dioxide concentrations in the atmosphere cause plant stomata to narrow reducing water losses and decreasing water requirements associated with agriculture. In addition, increased CO2 concentrations could stimulate photosynthesis resulting in a fertilizing effect on many crops increasing biomass accumulation and final crop yields. It was initially thought that this would contribute significantly to increased crop yields (WBGU, 2007). However the effects of CO2 concentrations are influenced by many factors including the species, growth stage, competition, pests, fertilization and water availability (Schmidhuber and Tubiello, 2007; Bals et al., 2008). As result the degree of crop yield increase is highly uncertain. While greenhouse based experiments were positive, open field tests have found that closure of the plant stomata reduces photosynthesis increases (WGBU, 2007). Some types of crops, such as wheat, rice and soybeans could increase yields by up to 10 to 20 percent if atmospheric CO2 concentrations reach 550 ppm, but the projected increase for other crops is less than 10 percent (Schmidhuber and Tubiello, 2007; Bals et al., 2008) and little to none for millet and maize (WBGU, 2007). In addition, the nutritional quality of the crops produced in elevated CO2 conditions may not be any higher than that produced in current CO2 conditions, despite higher yields (Schmidhuber and Tubiello, 2007).

Fisheries

Increased CO2 concentrations in the atmosphere could cause an increase in ocean acidification which could severely impact the viability a wide range of coral reefs, planktonic and other benthic marine organisms that make their shells or skeletons from aragonite (Bals et al., 2008). This could have significant implications for marine food chains and the overall productivity of the oceans. Reefs are critical to marine fisheries production as they are breeding grounds for many species as well as habitat for juveniles.

4.2.2 Increased Temperatures

Increases in mean, maximum and minimum temperatures are forecast for most regions of the world as a result of climate change. These temperature increases will have impacts on plant and animal growth.

Crops

It is expected that in mid to high latitude (temperate) areas of the world, higher temperatures of up to 1 to 3° C could result in greater crop productivity, longer growing seasons, more growing degree days, and an expansion in the areas suitable for agriculture (Schneider et al., 2007; Bals et al., 2008; FAO 2008). The extent of these increases in crop yields is still uncertain, but more recent analyses are suggesting that they may be lower than initially expected (Bals et al., 2008). It is also expected that temperature increases will create the opportunity for different kinds of crops in temperate areas (FAO, 2008).

Low latitude (tropical) areas, where water availability is lower, are at risk of decreased crop yields at even 1 to 2° C of warming (Schneider et al., 2007; FAO 2008) as increases in temperature increase evapotranspiration and lower soil moisture levels (Bals et al., 2008). These processes will cause some cultivated areas to become unsuitable for cropping and some grasslands to become unsuitable for pasture (Bals et al., 2008). The extent of these declines in yields is still unknown, but some analyses suggest they could be severe (Bals et al., 2008).

It is expected increases in yields in temperate areas will offset decreases in yields in tropical areas and that as a result, that crop yields may increase globally with temperatures of up to 1 to 3° C (Schneider et al., 2007; FAO, 2008). However, larger temperature increases could have much more adverse effects. Most plants have a limit to the temperature increases they can tolerate. Grains for example can tolerate increases in temperature of about 1.5 to 3° C in tropical regions and 4.5 to 5° C in temperate regions (Bals et al., 2008).

Warmer days and nights could also affect plants in unexpected ways – i.e. temperatures rising to near the maximum earlier in the day. Even if the daily high is not significantly above historical levels, most plants close their leaf stomata and become dormant at only 2-3 degrees above their "working" temperature. If plants go dormant earlier in the day, time incrementally lost from the growing season. Other plants, such as nuts and fruits, require chill hours, or a number of hours below a certain temperature in the winter to undergo a required period of dormancy (CNRA, 2009).

Beyond 3° C of warming, crop yields in all regions of the world including temperate regions are projected to decline (Schneider et al., 2007). Temperature rises of 4° C are likely to have major negative impacts on global agriculture (WBGU, 2007).

In BC, because it is a temperate area of the world, climate change temperatures increases are expected to have little impact on crops in most regions of BC (Serecon Management Consulting, 2009).

Fisheries

Fisheries industries are likely to be significantly affected as climate change affects freshwater and marine ecosystems for fish (Schneider et al., 2007). It is projected that the temperatures of many lakes and rivers and marine ecosystems will rise (Bals et al., 2008). This will impact the composition, productivity and nature of these ecosystems, and therefore could have an impact on the types, abundance and seasonal availability fish and sea life as a food source (Bals et al., 2008; FAO, 2008; ESCAP, 2009). The impact of rising temperatures on fisheries is very difficult to predict, but there are many potential causes for concern (ESCAP, 2009).

In some cases, some species could experience a range, growth rate and population expansion due to higher temperatures, access to new areas of ocean due to the decrease in ice cover (Bals et al., 2008). However fish also have ranges of thermal tolerance and temperature increases in the wrong season could impact fish populations (Bals et al., 2008). Rising temperatures could affect breeding habitats and predator prey relationships in unpredictable ways (ESCAP, 2009).

Rising temperatures in lakes and rivers could also result in water quality problems, such as algal blooms, which would have impacts on fisheries, and aquaculture (Bals et al., 2008).

Temperature changes could also affect large ocean circulation systems and the vertical stability of the water column impacting nutrient availability for fish (Bals et al., 2008). Changes in the stability of the water column has already resulted in a decrease in marine and lake productivity in some areas (Bals et al., 2008).

Livestock

Higher temperatures will have implications for the quality and extent of rangeland for animals (Schneider et al., 2007). Livestock is sensitive to thermal stress even at limited temperature increases (Bals et al., 2008; CNRA, 2009). Higher temperatures can cause increased mortality and decreased productivity in livestock (CNRA, 2009). While the productivity of rangeland is expected to increase in temperate areas, it could decrease in arid or semiarid regions (Bals et al, 2008). At the same time, shorter and milder winters could result in increased livestock production at a lower cost by lower heating requirements for animals, reduced winter feeding, easier winter grazing, and less winter kill.

Wild Plants and Animals

Higher temperatures will also likely lead to ecosystem movements towards the poles in the case of some of the world’s ecosystems. This is already being observed. Since not all plants and animals will be equally successful at migrating, the dominance of certain species will change. This expected to result in species extinctions, reductions in biodiversity and ecosystem change (Bals et al., 2008), which could have implications for populations that depend on forest ecosystems for their food security.

Food Infrastructure

Higher temperatures could have both positive and negative implications for food distribution. New arctic shipping routes could be opened up and transportation disruptions due to winter conditions could be reduced. At the same, time transportation disruptions due to increased wildfires, which will be discussed further in the extreme events section, and the overheating of vehicles could have negative implications for food security.

4.2.3 Changes in Precipitation

It is expected that as a result of climate change, wet areas in the world, particularly temperate regions, could become wetter and dry areas in the tropics could become drier (FAO, 2008). In addition, the timing of precipitation will likely shift resulting in earlier spring runoffs and dryer summers in some areas of the world. The intensity of rainstorms could increase and precipitation could become more variable and unpredictable in its timing.

Crops and Livestock

Since 80 percent of total global agricultural land is rain fed, changes in precipitation patterns could have a very significant effect on global food security (Bals et al., 2008). Temperature increases combined with reduced precipitation in some parts of the world will likely result in the loss of arable land in some areas, particularly tropical parts of the world, due to decreased soil moisture, increased aridity, increased salinity and groundwater depletion (Bals et al., 2008). Reduced overall water supply will limit opportunities to maintain or extend these cultivated and pasture areas through the use of irrigation. Soil erosion due to decreased soil moisture and increased extreme wind and water events is considered to be a major risk (WBGU, 2007). Grassland productivity in semi-arid and arid regions in tropical and sub-tropical parts of the world could decline by 40 to 90 percent by 2020 (WFP et al., 2009).

Reduced availability of good quality water overall, or at certain times of the year, for crops and livestock will likely negatively affect food supplies in many parts of the world (FAO, 2008). Water shortages could lead to water rationing and higher water costs, which could negatively affect agriculture (Serecon Management Consulting, 2009).

Moreover, even if overall precipitation for a particular region is not decreased, the tendency for this precipitation to be concentrated into more intense rain events, and for more winter precipitation to fall as rain, thereby changing the timing of peak stream and river flows could have negative implications for agriculture that will be challenging to predict. If peak river flows occur before the water is needed for agriculture, different strategies will have to be employed to capture that water. If rain does not come at the right time, or occurs more intensely for fewer days, crops will be affected, and the types of crops that can be successfully grown may change (Bals et al., 2008). In South Asia and parts of Africa, the timing of monsoon related rainfall events is key for the success of local agriculture. If this timing is affected by climate change, crop productivity or survival could be affected. More intense rain events could adversely affect the quality of surface and ground water, damage crops or lead to soil erosion (Bals et al., 2008).

Fisheries

Aquaculture could be negatively affected by the reduction in water availability for inland fish production (Bals et al., 2008), which could have a significant effect on food security in certain parts of the world that depend on fish protein (FAO, 2008).

4.2.4 Pests and Diseases

Most studies on global agriculture and climate change have not yet analyzed the spread of pests and diseases in detail (Schneider et al., 2007). Nevertheless it is generally acknowledged that the incidence and distribution of pests and diseases will change as a result of climate change (Bals et al., 2008; FAO, 2008). Pests and diseases can be considered a spin off effect of the main climate related changes associated with climate change including increases in temperature and changes in precipitation.

Crops and Livestock

Higher temperatures are likely to lead to increased earlier spring insect activity, insect outbreaks and the proliferation of some species (Bals et al., 2008). Higher winter temperatures will increase the ability of some pest populations to survive the winter (Schmidhuber and Tubiello, 2007), and the northern migration of some pest species (CNRA, 2009). Weather extremes could also promote pest and disease outbreaks. Invasive plants could also become more problematic in agriculture (WBGU, 2007).

The increase in animal and crop diseases is considered to be one of the key likely climate change impacts on agriculture in BC (Serecon Management Consulting, 2009). The significant decline in animal and plant diversity in our food, due to genetic modification and selective breeding (Serecon Management Consulting, 2009) makes us more vulnerable to diseases and pests. The expansion of the mountain pine beetle in BC in part as a result of warming trends is an example of how pest activity can be increased by climate change.

Fisheries

Temperature increases in lakes and oceans can also result in the spread of pathogens (Bals et al., 2008). For example warmer oceans may contribute to the increased incidence of human shellfish and reef-fish poisoning (ciguatera) and the expansion of the disease towards the poles (Schmidhuber and Tubiello, 2007).

Food Safety and Human Diseases

The expansion of food safety and human diseases, such as salmonella and malaria, also affects food security because it can impact the food utilization component of food security. If because of disease, humans cannot utilize the food available, hunger can be compounded and eventually result in a decline of labour to produce the food compounding food security issues (Schmidhuber and Tubiello, 2007). Increases in temperature as a result of climate change are expected to increase the incidence of salmonella poisoning and diarrhoeal disease (Schmidhuber and Tubiello, 2007). Extreme rainfall events and flooding can increase the risks of water-borne diseases such as cholera, which are considered relevant to food security in the sense that they affect population's capacity for food utilization (Schmidhuber and Tubiello, 2007).

4.2.5 More Extreme Events

Extreme climate change events such as storms, cyclones, hailstorms, drought, flooding, heat waves could have unpredictable impacts on food systems (Schmidhuber and Tubiello, 2007). These events are already increasing with an average of 500 weather related disasters per year compared with 120 in the 1980s with a six times increase in the number of floods (FAO, 2008) and are predicted to continue to increase significantly as a result of climate change (Bals et al., 2008). Extreme events are not new phenomena in agriculture, particularly in certain parts of the world, but they are expected to increase in frequency and the areas subject to extreme events are likely to expand (Schmidhuber and Tubiello, 2007). Most studies on global agriculture have not yet considered the impacts of changes in extreme events (Schneider et al., 2007) and yet the possible implications are significant.

Crops and Livestock

Drought in Australia in 2006 already resulted in a decrease in grain yields from 25 million tones to less than 10 million tones (Bals et al., 2008). Heat waves could cause crop failure and/or reduced yields and livestock death due to heat stress (Bals et al., 2008). Heat waves in Europe in 2003 reduced crop yields by 25 to 36 percent (Bals et al., 2008). Wildfires and flooding could wipe out entire crops. Even short term heat waves could have significant effects on certain crops if they occur at specific developmental stages for the crop, such as flowering (Bals et al., 2008). The impacts of droughts and floods could be most severe in semiarid and subhumid areas, in which populations are already subject to chronic instability in food production (Schmidhuber and Tubiello, 2007).

In addition to wiping out already planted crops, causing short-term shortfalls and affecting the stability of food security, extreme events can also have longer-term implications for global food security. For example, flooding can reduce the overall fertility of cropland by washing away fertile soil and soil organisms causing long term declines in crop yields. (Bals et al., 2008). Wind and storms could damage coral reefs, which are critical for fish production, and forest ecosystems (Bals et al., 2008).

Winter floods and summer droughts are considered to be a climate change impact that will affect BC agriculture in some regions, although the Fraser Valley is expected to be more or less unaffected (Serecon Management Consulting, 2009).

Food Infrastructure

In addition, as the frequency and intensity of weather events increases, there is an increased risk of temporary disruptions or longer-term damage to food production and distribution infrastructure from storms, flooding or wildfire (ESCAP, 2009). The damage to food distribution infrastructure, such as roads, bridges or ports in particular, could have impacts on food security (FAO, 2008). The longer our food chains, the greater the risks associated with transportation disruptions (FAO, 2008). Unlike Canada, some countries, such as Switzerland, have a six-month food stockpile for their citizens (Brynne, 2009). Given that most Canadian households no longer stock up food for the winter and most North American grocery stores only have three days food in stock (Brynne, 2009), transportation disruptions of longer than three days could have serious implications in some communities.

Damage to other non-food related infrastructure from extreme events, such as power and water supply infrastructure, could also have implications for food systems.

4.2.6 Rising Sea Levels

In the 20th century, sea level has already risen by 15 to 20 cm due in part to melting glaciers and polar ice, as well as rising temperatures in the oceans (thermal expansion) (WBGU, 2007). There is significant uncertainty with regard to how much sea level could rise, but current projections suggest a sea level rise of about half a metre by 2100 can be expected and that it could possibly be significantly higher (WBGU, 2007).

Crops and Fisheries

Although rising sea levels will not affect this region directly, it could affect other food producing regions in the world and therefore overall global food supplies through the loss and salinization of arable land, as well as the salinization of irrigation water (FAO, 2008; ESCAP, 2009). Contamination of arable land through greater exposure to wastewater is also a possibility (ESCAP, 2009).

Highly productive estuaries and freshwater fisheries systems could also be lost or damaged and sources of freshwater for agriculture could be reduced due to salt-water intrusion (Bals et al., 2008).

Food Infrastructure
Sea level rises could also have significant negative implications for port infrastructure, which is critical for global food distribution.

4.2.7 More Seasonal Weather Variability

It is highly likely that there will be greater variability in seasonal weather patterns as a result of climate change (Bals et al., 2008). This variability could have significant implications for food security.

Crops
Increases in seasonal weather variability will result in changes in the start and end of the growing season and less predictability for growers (FAO, 2008). Already the timing of most spring events, such as leaf unfolding and egg-laying, has shifted to be earlier in the season (Bals et al., 2008). While this could be positive in some locations and in some years by extending the growing season, it could also have negative effects, such as greater risk of tree fruit crop loss due to late and unexpected frosts, or a disconnect from when there is sufficient rainfall to support agriculture (Bals et al., 2008).

The predictability of rainfall patterns will also decline, presenting challenges for farmers to know what crops to plant and whether there will be sufficient rainfall. This is critical as 60 percent of the global harvest is produced on rain fed land (Bals et al., 2008).

4.2.8 Overall Outlook

Initial projections of the impacts of climate change on food security by the Food and Agricultural Organization (FAO) and other organizations suggest that on a biophysical level climate change is *not* expected to decrease global food security over the next century (Schmidhuber and Tubiello, 2007; Bals et al., 2008).

According to the mainstream literature, food availability is not projected to decrease on a global level to 2080 and is expected to be sufficient to meet the needs of the growing global population, due to increases in overall crop yields due to the CO2 fertilization effect, and due to increases in agricultural production in some regions of the world, due to increased temperatures and precipitation to offset decreases in regions of the world. Even if the expected CO2 fertilization effect, which will boost crop productivity, is discounted, food availability over the next century is projected to be sufficient to meet the needs of the global population (Schmidhuber and Tubiello, 2007). The total land and prime land areas in the world available for agriculture are expected to remain unchanged as a result of climate change at current levels of 2,600 million and 2,000 million hectares respectively (Schmidhuber and Tubiello, 2007). Some researchers suggest that only half of the world's agricultural land is currently being farmed, suggesting that there is considerable extra capacity (WBGU, 2007). This figure should be confirmed.

Nevertheless there will be critical shifts in the capacity if different countries and regions to produce food. It is expected that as a result of climate change, overall agricultural food production and crop yields will increase in high latitude temperate areas, decrease in the low latitudes and be mixed in the mid-latitudes. The declines in some low latitude areas could be significant with agricultural productivity in Central and South Asia projected to decline by 5 to 30 percent by 2050 (ESCAP, 2009). Potential cropland at higher latitudes in developed countries will increase by 160 million ha and potential cropland at lower latitudes in developing countries will decrease by 110 million ha (Schmidhuber and Tubiello, 2007). Moreover, the quality of land in developing countries will decline by an even greater amount with a loss of 135 million ha of prime land offset by an increase of about 20 million ha of moderately suitable land (Schmidhuber and Tubiello, 2007). The greatest losses of cropland are likely to be in Africa, while the greatest expansion of cropland are likely to be in Russia and Central Asia (Schmidhuber and Tubiello, 2007).

As a result, as with most climate change impacts, the impacts on food security are expected to fall disproportionately on *developing countries*, not only because their agriculture and livestock production may be most affected by changes in climate, but also because their economies, including the percentage of people employed, depend to a greater extent on primary food production, and they are the least able to purchase higher priced imported foods (Bals et al., 2008). Thus the negative impacts of climate change on food security will be most felt where food insecurity is already high and the reliance of developing countries on food imports will increase. In particular sub-Saharan Africa is considered to be the most likely to be the most food insecure region in the world as a result of climate change, both because of the direct impacts of climate change on food production will fall disproportionately on Africa, but also due to the indirect effects of income loss from agriculture (Schmidhuber and Tubiello, 2007). Capacity to adapt is a critical element of food security and developing nations often have less adaptation capacity than developed countries.

Developed countries may not be immune to food security impacts associated with climate change, particularly the short-term effects of extreme events, but they will likely experience them to a much lesser extent than developing countries. The overall percentage of undernourished people in the world is projected to decline in the next century, due primarily to projections of socioeconomic growth, rises in real income and stabilization of population growth (Schmidhuber and Tubiello, 2007). Climate change *is* projected to have a negative impact on food security – that is, the number of undernourished people is projected be greater than it would be in a non-climate change scenario, but its likely effects are considered to be small, and offset by the socioeconomic and population growth developments that will reduce the overall percentage of people that are undernourished in the world (Schmidhuber and Tubiello, 2007).

<u>Thus it is projected that on a biophysical level, the ultimate impact of climate change on food security will likely be that global food markets will provide sufficient food for those with purchasing power, while those without an adequate income who cannot produce enough of their own food will become food insecure (Bals et al., 2008).</u>

It is critical to note, however, that this relatively optimistic outlook does not account for the indirect impacts of climate change on food security (Section 4.3), and critical cautionary notes regarding non-linearity, extreme events and tipping points (Section 4.4), which will be discussed in the next two sections. This optimistic outlook also does not take into account the implications of non-climate change events and factors for food security, which will also be considered in Section 5.

4.3 Indirect Impacts of Climate Change

Climate change will have implications for human capital and economic and sociopolitical structures. These implications could in turn have indirect effects on our food systems that exceed the direct biophysical impacts. These indirect effects of climate change on our food systems, such as greater migration, poverty, civil unrest and resource-based conflicts have significant potential to negatively impact food security on global, national and regional levels (FAO, 2008).

Unlike the direct biophysical effects of climate change on food systems, which have significant implications for the availability of food, the indirect impacts of climate change also have significant potential to impact the accessibility of food. Accessibility refers to the ability of individuals, communities and countries to purchase sufficient quantities and qualities of food (Schmidhuber and Tubiello, 2007). A key element of improving global food security over the last thirty years has been an improvement in the accessibility of food through increases in the real incomes in many developing countries (Schmidhuber and Tubiello, 2007). Climate change impacts that affect the ability of households, regions and countries to access food from a socioeconomic perspective will have significant implications for food security.

The potential for civil unrest and conflict as well as general income level effects arising from climate change have not been very well addressed in the climate change food security literature. The food security and climate change literature tends to be dominated by fairly scientific analyses of the physical impacts of climate changes on food production. In addition, many analyses of climate change impacts are sectoral, focusing on specific ecosystems or events, and considering only the implications of climate change, rather than considering cumulative effects or examining the potential responses of populations to multiple concurrent threats.

The analyses that do consider social implications rely on the IPCC SRES (Special Report on Emissions Scenarios) development paths, which do not forecast significant breakdown of economic and sociopolitical structures. All of the IPCC SRES (Special Report on Emissions Scenarios) development paths envision a world of economic growth and rising real incomes in most parts of most developing countries (Schmidhuber and Tubiello, 2007). Modeling based on these scenarios suggests that food prices will rise moderately in part due to climate change and its direct impacts on food production and distribution, but also due to other exogenous factors. Nevertheless, real incomes are projected to keep pace, and while some regions are expected to continue to have food security issues and undernourished populations, the overall percentage of undernourished people in the world is projected to decline from current percentage levels (Schmidhuber and Tubiello, 2007).

However, human economic, social and political systems are highly complex and the potential climate change impacts to spin off into larger socio-political or socio-economic breakdown need to be considered with respect to regional food security (WBGU, 2007; Dyer, 2009). Countries at war, undergoing mass migrations due to sea level rise, or severely impoverished may not be able to produce food for export even if the climate conditions are conducive to growing food.

The German Advisory Council on Global Change (WBGU) has undertaken a comprehensive survey of the potential conflict constellations associated with climate change and stresses that climate change will overstretch many societies' adaptive capacities unless serious action is taken (WBGU, 2007). In particular, they stress the potential conflict constellations around the degradation of freshwater resources, a potential decline in global food production, increases in storm and flood disasters and environmentally induced migration (WBGU, 2007).

Moreover, extreme events such as war or mass migration are not necessary to cause declines in food security. There is little disagreement that climate change will likely have the most significant impacts on the poorest nations and populations of the world both biophysically and socio-economically (Stern, 2006; ESCAP, 2009). These nations and populations are already the most vulnerable and have the least adaptive capacity. While Stern (2006) suggested that most nations would experience GDP losses, GDP losses in some smaller African countries could be as high as 30 percent (WBGU, 2007). Moreover although the total global amount of viable agricultural land may be increased or remain the same as a result of climate change, the expected regional shifts in the locations of those lands could have more significant impacts than expected. The loss of agricultural lands in some areas will mean economic ruin for the farmers who own those lands. Those economically ruined farmers are unlikely to shift their operations elsewhere, particularly if the new viable agricultural land lies across borders or continents. The true viability of the new biophysically viable agricultural lands depends on having farmers to farm it, which is a less than certain proposition.

While developed countries in Europe and North American may initially experience only minimal impacts on food security arising from the direct impacts of climate change on agriculture and fisheries, the indirect effects of larger structural changes to agriculture markets, global conflict and migration could affect developed countries (WBGU, 2007). This is an area that requires further study and consideration.

4.4 Non-Linear Effects, Extreme Events and Tipping Points

While the general outlook in the literature for food systems on a global level is optimistic, these analyses are based on examining changes that are in general highly predictable and gradual and continuous (WBGU, 2007). The cumulative effects of all of the changes expected from climate change or increases in global mean temperatures exceeding 3° C may be more than the system can handle.

It is quite possible that climate change may proceed in unexpected non-linear ways, with surprising tipping points and thresholds that have large implications for global and regional food security (Bals et al., 2008). When critical thresholds, or tipping points are crossed runaway changes can be triggered that are impossible to bring under control (WBGU, 2007). Non-linear processes have occurred in earth's history – ice shields have abruptly melted and ocean streams have stalled (Bals et al., 2008). Sometimes small disruptions in systems are sufficient to generate fundamental changes.

While agricultural systems are often monocultures, they are still complex ecosystems and with the costs of inputs that simplify these ecosystems, such as fertilizers and energy rising, and therefore potentially becoming less utilized, they may become even more complex. Marine and freshwater fisheries are highly complex ecosystems. Ocean circulation and weather systems are equally complex. The WBGU (2007) suggests that non-linear phenomena such as weakening of the North Atlantic current, changes in atmospheric circulation that results in monsoon transformation, which account for 90 percent of annual precipitation in some regions, and instability of continental ice sheets leading to sea level rise of several metres are possible and would have far reaching consequences for global food security.

Moreover it was repeatedly emphasized in the literature that projections for food systems is optimistic, unless warming trends exceed 3° C. All of the models that provide a relatively optimistic overall outlook for food security generally assume mean climate change of 3° C or less, and do *not* consider the possibility of major abrupt climate or socioeconomic change, or a *significant* increase in the number of extreme events (Schmidhuber and Tubiello, 2007). Given that the potential impact of extreme events is being increasingly recognized as possibly the most serious climate change related issue for food security, potentially offsetting the potentially positive effects of moderate increases in temperature (Bals et al., 2008), this is a very significant shortcoming.

In addition, the models that provide the optimistic outlooks for food security outlined above are based on SRES models assuming future socioeconomic growth, and FAO models regarding future food production through extensive expansive of irrigation, that are highly uncertain. In addition the models that analyze overall food production in a climate change scenario have many important exclusions, such as the implications of food safety and food borne diseases, the implications of sea level rise and extreme events (Schmidhuber and Tubiello, 2007). The potential for these impacts are mentioned as qualitative considerations, as they are in the analysis above, but are not explicitly incorporated into the models of future food availability and accessibility (Schmidhuber and Tubiello, 2007).

5.0 Non-Climate Change Events/Factors

In addition to climate change, to properly assess a region's food security it is critical to consider some of the non-climate events and changes that are affecting and will affect food production and distribution over the next few decades. While it is beyond the scope of this backgrounder to examine these events and factors in detail, they require some mention as it is possible and likely that some of these events and factors will exacerbate or be exacerbated by climate change impacts and contribute to the overall regional vulnerability of our food systems. Given some of these trends, it is possible that even in a non-climate change scenario that global food production might be insufficient to meet food needs in the next few decades.

Some of these key factors include:

5.1.1 Increased Input Costs

Increasing energy and input costs (decline in supply, decrease in hydroelectric production capacity, regulated carbon economy) and increasing energy demand in all parts of the world could have a significant effect on global agriculture (Bals et al., 2008). Food production, processing and distribution are all highly energy intensive. It is estimated that producing one calorie of food requires 10 calories of fossil fuels, leading some researchers to suggest that we are literally eating fossil fuels (Pfiefer, 2006). Many of our gains in food production in the last century have been based largely on increases in the use of fossil fuel inputs, especially fossil-fuel based fertilizer (Pfiefer, 2006). If fossil fuel prices increase over the next several decades, which they are projected to as a result of declines in global oil production due to peak oil, so too will the costs of food production, processing and distribution (Pfiefer, 2006), and if fossil fuels reach a point whereby they are significantly less available, overall global food production could decline significantly.

Food distribution systems, which rely heavily on fossil fuel dependent modes of transport, such as trucks and planes, will also be dramatically affected if energy prices increase and will result in higher food prices and potentially reduced food security.

The costs of other agricultural inputs are also increasing including fertilizer and pesticide costs, in part because of increasing energy costs but also because of depletion and therefore increasing prices of certain other inputs. Water costs may also increase in the future as a result of increasing water demand due to lifestyle changes and urbanization in many countries (Bals et al., 2008).

5.1.2 Population Increase

The global population is projected to continue to increase (from 6.5 billion people to 9 billion people in 2050) and the population of many countries and regions of the world including British Columbia is expected to increase. Food insecurity already exists on a global level for many populations (FAO, 2008) with 850 million people, mostly in developing countries, chronically hungry or malnourished (Bals et al., 2008). At the moment this is primarily an access issue. Sufficient food is available but these people do not have adequate income to access it (Bals et al., 2008). The global food security situation has improved dramatically over the last thirty years, largely due to improvements in food accessibility with lower food prices and significant income growth in developing countries (Schmidhuber and Tubiello, 2007). Nevertheless, with increased global population, even if food production and distribution are unaffected by climate change, greater demand will require increases in food production to meet food security needs (Bals et al., 2008). This is projected to occur and it is forecast that the number and/or percentage of undernourished people in the world will decline by 2080 even considering the effects of climate change (Schmidhuber and Tubiello, 2007).

5.1.3 Dietary Shifts

Changes to a more meat, dairy and cereal centered diet in many countries, such as China and India has and will continue to increase requirements for cropland globally (Bals et al., 2008). Meat consumption has doubled globally in the last 25 years (Bals et al., 2008). If this trend continues and a meat, dairy and cereal centered diet are adopted globally, global production of some crops may have to double to meet demand (Bals et al., 2008).

5.1.4 Loss of Arable Land

Arable land is being lost and degraded around the world (possibly as much as 0.5 percent annually) due to a number of factors (Bals et al., 2008). Urbanization of farmland in both developed and developing countries including Canada is a key trend leading to not only loss of farmland but also the contamination of adjacent farmland (Bals et al., 2008; Serecon Management Consulting, 2009). This trend is predicted to continue in developed countries shifting greater reliance for food production on developing countries (WBGU, 2007). There is also a trend towards the increased use of agricultural production land for biofuels crops. This trend will be driven partly by increases in oil prices, but also by the desire to reduce GHG emissions in the transport sector (Bals et al., 2008). Diversion of cropland to non-food crops will likely reduce global food production. Analyses of the implications of biofuels for food security have been both positive and negative (Schmidhuber and Tubiello, 2007).

This is already a critical problem in British Columbia whereby the Fraser Valley is one of our most agricultural productive areas, but is subject to significant pressures from urbanization (Vancouver Sun, 2007).

5.1.5 Shifts in Agriculture

Many shifts in the way agriculture is organized and undertaken serve to make it a more vulnerable system to potential climate change disruptions. For example, the oncentration of a significant portion of global food production and distribution in hands of a small number of multi-nationals (Brynne, 2009), the decline in farm incomes (farmers receive only a tiny portion of the revenues from consumer spending on food) making farming a relatively unattractive profession and therefore the subsequent decline in global and regional farming skills and knowledge (Brynne, 2009).

On a global level, long-term food production projections from the FAO are optimistic, despite all of these non-climate change factors (WBGU, 2007). For example, the annual growth rate for world cereal production is projected to increase from 1 percent to 1.4 percent by 2015, eventually falling to 1.2 percent over the long-term (WBGU, 2007). However, these projections and conclusions are not completely supported by ongoing trends. Food demand is currently outstripping production and as a result reserves for some major crops have been declining (Bals et al., 2008). Food prices, particularly for cereals, have already been increasing around the world and may continue to do so (Bals et al., 2008). This could be offset slightly by higher food prices driving more investment in agriculture (Bals et al., 2008).

6.0 Capacity for Regional Food Self-Sufficiency

This section examines food security from a regional and provincial perspective to address the question:

If climate and non-climate changes significantly disrupt the global food systems that serve our region, can we produce all of our food needs within in the region (Grand Forks to Creston) or within the province?

Experts do not currently believe that BC or the Columbia Basin can produce all of its required food on a year round basis (MAL, 2006; Brynne, 2009; Serecon Management Consulting, 2009). Moura Quayle, former Dean of the University of British Columbia Faculty of Land and Food Systems, has said with regard to BC:

"it's unlikely we'll ever get all our food from local sources, but more small-scale agriculture would provide a balance to the current agricultural model, and a mixed food supply system may give us more choices in the future" (Somerton, 2008:2).

However it has been stated that conclusion is based on the current composition of BC's population and the limited capacity of some components of the agricultural system.

It is believed that 100 years ago, the Kootenay region was a net exporter of food (Future of Food, 2007). Moreover even mountainous communities, such as Rossland, were believed to be relatively food self-sufficient at the turn of the century.

This section will review the basis for conclusions regarding self-sufficiency and raise some questions regarding the extent to which self-sufficiency can be achieved. It will examine potential for regional or provincial food self-sufficiency from a biophysical growing capacity, social growing capacity and a processing and distribution capacity perspective.

6.1 Biophysical Capacity for Food Production

This section will review the regional biophysical capacity for food production with respect to the availability of land and water for growing, current food production levels, the potential implications of climate change on regional food production and options for shifting diets.

6.1.1 Land and Water for Growing

Canada's productive land mass is estimated to be 6 percent (Brynne, 2009). In BC only 5 percent of the land base is suitable for growing crops (Curran, 2007). Prime farmland (Classes 1 – 3 of the Canada Land Inventory), also called 'dependable' agricultural land, comprises less than 1 percent of the land base (948,600 ha) and is primarily concentrated near urban areas in the Lower Mainland and Okanagan (Hofmann, 2001; Curran, 2007). To put this into context 25 percent of Saskatchewan is suitable for growing crops (Hofmann, 2001).

There are 63,924 hectares of Agricultural Land Reserve (ALR) land in the Central Kootenay and 53,443 hectares of ALR land in Kootenay Boundary (Penfold, 2009). The total area of farms in 2006 was 27,338 hectares (67,554 acres) in the Central Kootenay, representing 48 percent of ALR land and 53,260 hectares of farms (131,260) in the Kootenay Boundary, representing 103 percent of ALR land (Penfold, 2009). Approximately one third of the ALR in the region is lower quality agricultural classifications (i.e. lower than class 1-3) land and therefore limited in its productive capacity (Brynne, 2009).

The BC Ministry of Agriculture and Lands (MAL) indicates that given the production technology available in BC today, 0.524 hectares (1.3 acres) of farmland are required to produce healthy food sufficient for one person annually (MAL, 2006). The guidelines utilized for healthy food were those set out in the Canada's Food Guide to Healthy Eating (MAL, 2006).

According to the Ministry to produce a healthy diet for all British Columbians, farmers would need 2.15 million ha of farmland, of which 10 percent (215,000 ha) would need to be irrigated, for economic fruit, vegetable and dairy production (MAL, 2006). Currently there are about 189,000 ha of farmland in BC with access to irrigation, 88,000 of which is currently irrigated for dairy, fruit and vegetable production (MAL, 2006). However given projected population growth, by the year 2025 farmers would need to have 2.78 million ha in production of which 281,000 would need access to irrigation (MAL, 2006).

Extending this analysis to the Central Kootenay and Kootenay Boundary Regional Districts (the Regional Districts whose boundaries most closely coincide with the "region" under discussion in this paper, one finds that *at the 2006 combined population* of the two Regional Districts of 86,625 people (Central Kootenay – 55,883 ha, Kootenay Boundary 30,742 ha) (Penfold, 2009) that 45,392 ha of farmland would be required to support the existing population, of which 4540 ha would have to be irrigated.

This total amount is far less than the existing ALR land of 117,367 ha within the region, and in farms in the region 80,598 ha, but far exceeds the amount of land currently in crops in the region (under 18,027 ha) (Penfold, 2009). This is a back of the envelope calculation that does not take into consideration what percentage of the ALR or farmland is arable, the kinds of crops that can be produced on the arable land, and how much is irrigated or has the potential to be irrigated in the region. BC government agrologists have stated that water will be an extremely limiting factor for any agricultural production outside the Fraser Valley (Vancouver Sun, 2007). Theoretically, at the right price, and the water is available, much of the land would be capable of being irrigated, if the market forces were such that if the production of certain crops became more profitable. More information is required regarding the amount of class 1-3 land in the region. It is also not clear whether the Ministry of Agriculture calculation of 0.524 ha of land per person per year is an average for the province, or if it primarily for the Lower Mainland, based on Lower Mainland growing seasons, which will be longer than those in this region.

6.1.2 Current Food Production

British Columbia farmers currently produce 48 percent of the food that is consumed in BC (MAL, 2006; Brynne, 2009). If healthy diet considerations are incorporated, BC produces only 34 percent of the food its citizens would need (MAL, 2006). In the Columbia Basin, local production is considered to be an even smaller percentage of the food consumed (Brynne, 2009). Moreover, given projected population increases on a provincial level, unless provincial production is increased the percentage of food consumed in BC that is produced on a provincial level will drop.

In some areas BC is fairly self-sufficient, including the production of chicken, eggs and dairy, and there is significant provincial sufficiency in the production of vegetables, beef, fish and fruit (Serecon Management Consulting, 2009). However in some areas it is not self-sufficient at all, such as in the production of grains (14 percent self sufficient) and oils (10 percent self sufficient) (MAL, 2006).

Within the Columbia Basin, all agricultural production is small-scale (Brynne, 2009). Because of their size, these operations do not at the moment have the capacity for investments in things such as mechanization that would increase their production and reduce their costs (Brynne, 2009). Regional farmers face many barriers including low returns on their products, and huge challenges getting their products into major grocery chains (Brynne, 2009). The total land *in crops* in the Central Kootenay and Kootenay Boundary Regional Districts is significantly lower than the total farm land –11,434 hectares for Central Kootenay and 6,593 hectares for Kootenay Boundary and that Tame Hay/Fodder and Alfalfa represent over 50 percent of cropland in production in both Regional Districts (over 75 percent in Kootenay Boundary) (Penfold, 2009). Roughly half of the region's farmland lies fallow on a regular basis (Brynne, 2009).

Table 1 outlines the crops that the Kootenay Organic Growers Society currently lists as available seasonally in the region:

Table 1: Crops grown in Kootenays

• apples	• celery	• lettuce	• radish
• apricots	• chard	• melons	• raspberries
• arugula	• cherries	• mizuna	• rutabaga
• asparagus	• collards	• mushrooms	• salad greens
• beans	• corn	• onions	• spinach
• beets	• cucumbers	• parsnips	• sprouts
• blueberries	• dandelion	• squash	• strawberries
• bok choy	• eggplant	• peaches	• sunchokes
• broccoli	• garlic	• pears	• tomatoes
• burdock root	• grapes	• peas	• zucchini
• cabbage	• herbs	• peppers	•
• carrots	• kale	• potatoes	•
• cauliflower	• leeks	• plums	•

(KOGS, nd)

To this list, the Kootenay Local Agricultural Society would add mustard and artichokes. Note also that in many cases multiple varieties of the crop can be grown. Clearly this list provides little context with regard to how much of each of these crops can be grown or precisely where. Inventories of what can be grown in the region and a more detailed analysis of the region's carrying capacity need to be done. Grains are not listed in Table one and regional capacity for grain production could be a limiting factor in regional food self-sufficiency. Grains are grown in Grand Forks and Creston and efforts are being made to foster an expansion in grain production through the Local Grain Revolution in which residents purchase shares in grain crops in advance of planting to provide farmers with stability and assurance of markets.

Both Regional Districts are expected to produce Regional Agriculture Plans in the next year to provide some of this information. In addition, as part of their Adapting to Climate Change project, Area D (Kaslo) is conducting a North Kootenay Lake Foodshed survey of farmers to determine what farmers grow and how much of it they grow.

Nevertheless, some food items upon which most households depend (i.e. salt) are only available in certain locations may not be available within our region. These items would have to be purchased with cash (FAO, 2008). Similarly many fruits that we currently consume in BC cannot be grown economically in BC, such as avocadoes, citrus fruit, and bananas (MAL, 2006).

6.1.3 Local Impacts of Climate Change and Non-Climate Change Factors

Production in this region will also be affected by all of the biophysical impacts of climate change outlined in Section 4.0 of this backgrounder, with the exception of sea-level rise. While the region is in a temperate zone and therefore many of the impacts of climate change may be positive, including increased crop yields due to higher temperatures, greater rainfall and CO2 fertilization, some impacts will also likely be negative, such as those associated with extreme events and pests and diseases. The indirect effects of climate change on political, economic and social systems are extremely challenging to predict but could have significant impacts.

The non-climate change factors will also have significant implications for local food production. Increases in energy prices will likely be one of the largest factors affecting the amount of food that could be grown in the region.

6.1.4 Offsetting Issues and Dietary Shifts

There are factors however that would allow for food self-sufficiency at lower production levels. For example, it is estimated that 50 percent of the food produced is wasted (Serecon Management Consulting, 2009). Greater efficiency in food management and waste reduction could allow for food security at a lower production rate.

There are also significant opportunities with regard to shifting our diets. There is the potential to shift away from a meat-centered diet, shift to the consumption of potatoes instead of grains, and shift to a more game based diet. Changes in diet would significantly alter the amount and type of agricultural land required to support a population. The lower the consumption of meat, the more effectively agricultural land and cereal production can be utilized to ensure food security (WBGU, 2007). There is a five-fold difference in the acreage requirements between the diets incorporating the least amount of fat and meat (but still some meat, to make use of forage land that cannot be utilized for crops) (0.2 ha/0.5 acres per person per year) and those with the least amount of fat and greatest amount of meat (0.77 ha/1.9 acres per person per year) (Peters et al., 2008). The 0.2 ha per year estimate is less than the 0.524 estimate from the Ministry of Agriculture and Lands and a back of the envelope calculation based on the regions current population levels would result in agricultural land requirements in the region of 17,325 ha to support our population.

6.2 Social Capacity

The biophysical capacity to grow crops and raise livestock is not the only consideration in determining the potential for regional food self-sufficiency. The social capacity to grow food is also a critical component of food self-sufficiency. If individuals or farmers do not have access to land, skills to grow food or the appropriate incentives to grow food, achieving regional food self-sufficiency may be challenging.

6.2.1 Number of Farmers and Food Producers

There has been a considerable de-skilling of the population, both nationally and regionally around food production in the last century (Brynne, 2009).

Currently, given global food markets and the large amounts of food that are available at very low prices, achieving reasonable economic returns through local food production is very challenging. Average farm sales were below $60,000 in both Central Kootenay and Kootenay Boundary Regional Districts (Penfold, 2009). The average net return for farms in the region is extremely low ($5,422 in Central Kootenay and $1,680 in Kootenay Boundary) (Penfold, 2009). At those net returns, there is simply no incentive now for farmers to expand their crops or new farmers to enter the market. Thus the number of people engaged in farming in the population has declined dramatically over the last century. In 2006, there were 29,870 farm operators in BC, comprising 0.7 percent of the population (Statistics Canada, nd). To be classified as a farm operator, the farmer has to be producing an agricultural product for sale. Moreover, over half of those farm operators in BC have off-farm jobs or businesses (Statistics Canada, nd). In the region, there were 1445 farm operators (855 in Central Kootenay and 590 in Kootenay Boundary) (Penfold, 2009).

It is very challenging to get numbers on the number of backyard farmers or gardeners producing food in the region or the quantity of food they produce. Detailed surveys would have to be undertaken in each of the region areas. At the height of the US Victory Garden program in the US, only 40 percent of US vegetable needs were produced in backyard gardens (Brynne, 2009) raising concerns that in less favourable climate such as Canada, we could not produce sufficient food to be regionally self-sufficient. It is not clear, however whether this shortfall was because there was insufficient land planted, insufficient skill or interest in food production by backyard farmers (and therefore could be overcome with sufficient commercial producers), or an inability to grow the range of crops required due to climatic or arable land challenges.

If climate change were to make agriculture more profitable in the region there is the potential that there would be sufficient interest by existing and new farm operators to promote regional self-sufficiency. However, the years of low farm returns, and general decline in farming and backyard gardening skills will also mitigate against increased food self-sufficiency. If climate change related impacts on global food security occurred in a gradual fashion, these skills could technically be reacquired. However if global changes were sudden and unexpected it could be challenging to reestablish these skills in a timely manner.

6.2.2 Skill Preservation and Revival

There has been a significant revival in interest in local food production as a result of concerns regarding peak oil, climate change and the overall environmental impacts of global agriculture. This has resulted in the establishment of a multitude of local groups such as the

Kootenay Food Strategy Society, the Kootenay Local Agricultural Society, the Kootenay Organic Growers Society, and Rossland REAL food specifically geared to promoting local food production and preserving and enhancing local food production skills. Initiatives, such as the Castlegar and Rossland Community Gardens, the Kootenay Grain Community Supported Agriculture, the Kootenay Mountain Grown label, as well as the Kaslo Food Charter are also intended to foster regional food security through local growing.

6.2.3 Cost of Food Production

To achieve regional food security, region residents must also be able to afford to purchase the food produced in the region. This might be problematic if climate change has significant regional economic impacts and if local production requires an increase in prices. Thus food must not only be produced locally, but it must be produced economically. However, Canadians currently spend less than 10 percent of their disposable income on food (Brynne, 2009). Thus there is a certain degree of latitude in the extent to which prices could rise. Nevertheless, this is an area that requires significant further study.

6.3 Processing and Distribution Capacity

The question of whether the food produced could be processed and distributed within the region must also be addressed.

6.3.1 Fruit, Vegetable and Grain Processing

The region currently has no freezing or canning facilities. Grain milling can be done on a small scale in Creston, Nelson and Grand Forks (Pride of the Valley milling), but also can be undertaken through home milling. Packaging is done on a small scale by local farmers such as those selling under the Kootenay Mountain Grown label. This is an area that requires further research to determine food processing capacity on a regional and provincial level.

6.3.2 Animal Product Processing

Local meat processing and egg sales are seriously constrained by government regulation. Under BC legislation passed in 2004, all meat for human consumption must come from a provincially or federally licensed slaughter facility, or abattoir (Stueck, 2010). Many small abattoirs closed their operations due to the costs associated with getting licenced. As a result, there is no licensed facility to kill or butcher animals for commercial sale within the region. Locally raised animals have to be trucked to a butchering facility and then trucked back in order to be commercially sold. Efforts to establish a local abattoir have thus far been unsuccessful due to the inability to find an appropriate location. A Kootenay Mobile Poultry Abattoir, that processes as many as 500 chickens a day, based out of Cranbrook, was established in 2009, and a second unit is under consideration due to demand (Stueck, 2010).

Local eggs also cannot be sold (except at the farmer’s place of residence or in a farmer’s market) unless they are graded and marked in accordance with the Canada Agricultural Products Act (Zwicker, 2010). There are two licensed egg-grading stations in the area in Creston and in Rock Creek (Zwicker, 2010).

6.3.3 Distribution Channels

Current distribution channels are also problematic. Many of the food items sold in multi-national grocery store chains, such as Safeway, even if grown locally, are often transported to a central warehouse, which can be in a different province, and then back to the grocery store, adding many unnecessary kilometers to their travel (Brynne, 2009). These transportation channels, and the policies of the grocers, or the ownership of the grocery stores, would have to be reoriented to have regional food self-sufficiency. While independent grocers in the region, such as the Kootenay Country Store Co-operative and Ferarro Foods, are often highly supportive of local producers and will allow direct transport of foods from the producer to the grocery store, these independent grocers are becoming increasingly uncommon (Brynne, 2009).

The majority of local transport is currently by truck. If oil costs rise, this could become too costly. Climate change events, such as floods or snowstorms could also result in serious disruption in food distribution for local food products distributed by truck, just as they could for global food products. Through initiatives such the Local Grain Revolution, alternative methods of food distribution, in this case by sailboat, are being explored. However these efforts will need to be increased significantly to achieve regional food security.

7.0 Summary Points

Food Security Definitions

- On a regional level, food security has been defined by the Kootenay Food Strategy Society as follows:

"A community enjoys food security when all people, at all times, have access to nutritious, safe, personally acceptable and culturally appropriate foods, produced in ways that are environmentally sound and socially just" (KFSS, nd).

- There are four dimensions to food security – food availability, food accessibility, food stability and food utilization. To achieve food security all for dimensions must be in place.

- Food security must be considered through a food systems lens, which considers food production, food processing and packaging, food distribution and retailing and food consumption.

Impacts of Climate Change on Food Security

- Climate change will impact food systems both directly through it biophysical impacts on plant and animal growth, and indirectly through its effects on human capital, economic and political structures.

- The timing of climate change impacts will vary, with some impacts being experienced now, others occurring more gradually, and yet others being sudden and unexpected.

- Global models assessing the impacts of climate change in general and the impacts of climate change on food systems are subject to a high degree of uncertainty.

- The biophysical impacts of climate change on food security are expected to be both positive and negative. For example:
    - CO2 fertilization will likely lead to slight increases in crop productivity but declines in ocean productivity due to acidification
    - Higher temperatures will likely result in longer growing seasons and increased crop productivity in high latitude regions and crop losses and declines in productivity in mid and low latitude regions
    - Temperature changes will have unpredictable effects in lakes and oceans
    - Declines in precipitation will likely have significant impacts in reducing arable land and increasing aridity in mid and low latitude regions
    - Pest and disease distributions will likely change and could expand in some regions
    - Extreme events, such as flooding, storms and drought, could cause crop failure and cut off food transportation lines
    - Rising sea levels will eliminate and salinize arable land in some coastal regions

- On a global scale, the direct biophysical impacts of climate change on food systems are not expected to reduce overall global agricultural production as long as temperature increases do not exceed 3° C.

- The biophysical impacts of climate change on food systems will cause regional shifts in agricultural production with the higher latitude temperate regions of the world experiencing increases in agricultural production, and the lower latitude tropical regions of the world experiencing degreases in agricultural production.

- Global food security is not expected to be impacted significantly by climate change on a biophysical level, however developing nations are expected to have to start importing more of their food.

- Current analyses of climate change and food security do not sufficiently account for indirect impacts of climate change on socioeconomic and geopolitical structures, or for non-linear effects. These indirect and non-linear effects could lead to unpredictable and serious impacts on global food security.

- All of the models that provide a relatively optimistic overall outlook for food security generally assume mean climate change of 3° C or less, and do *not* consider the possibility of major abrupt climate or socioeconomic change, or a *significant* increase in the number of extreme events.

- Although they are beyond the scope of this backgrounder, many non-climate change events and factors including increased input costs, global population increases and loss of arable land will have implications for global and regional food security and need to be considered in any regional vulnerability assessment for food security.

Potential for Regional Food Self-Sufficiency

- Experts have suggested that BC could not be self-sufficient in food production. However it is believed that the Kootenay region was a net food exporter 100 years ago.

- In BC only 5 percent of the land base is suitable for growing crops. There are 117,367 ha of ALR land within the Regional Districts of Central Kootenay and Kootenay Boundary, and 80,598 ha in farms. A third of the ALR land in the region is considered of lower and limited quality for crop production.

- The BC Ministry of Agriculture and Lands (MAL) indicates that given the production technology available in BC today, 0.524 hectares (1.3 acres) of farmland are required to produce healthy food sufficient for one person annually. Estimates based on a less meat-centered diet suggest that 0.2 hectares of land per person annually is required.

- Using the Ministry of Agriculture and Lands formula and the 2006 population of the Central Kootenay and Kootenay Boundary Regional Districts, 45,392 ha of farmland would be required to support the existing population, of which 4540 ha would have to be irrigated. This is less than the current amount of ALR land in the region.

- BC currently produces 48 percent of its food and is fairly self-sufficient in the production of chickens, eggs, dairy, vegetables, fish and fruit. Regional food production is believed to be lower than 48 percent. The total area in crops in the region is 18,027 ha, many of which are hay/fodder and alfalfa crops.

- A wide variety of vegetable, fruit and grain crops can be grown in the region. Detailed production inventories, including the total amounts produced, and total amounts that could be produced are required to accurately assess the potential for regional food self-sufficiency.

- There has been considerable de-skilling of the regional population with respect to food production due to the low economic returns from farming and the loss of interest in backyard gardening. A considerable number of regional organizations are now working on revitalizing food production skills and promoting local food production.

- The regional capacity for food processing and distribution requires further assessment and faces many barriers due to provincial legislation and licensing requirements as well as the purchasing policies of many major grocery store chains.

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