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Methods for mapping local food production capacity from agricultural statistics

Kathryn T. Morrison [a,*], Trisalyn A. Nelson [a,b], Aleck S. Ostry [c]

[a] Spatial Pattern Analysis and Research Laboratory, University of Victoria, Department of Geography, PO Box 3060, Victoria, BC, Canada V8W 3R4
[b] Lansdowne Research Chair of Spatial Sciences, University of Victoria, Canada
[c] Canada Research Chair, Michael Smith Foundation for Health Research Senior Scholar, University of Victoria, Canada

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ABSTRACT

Interest in local food security has increased in the last decade, stemming from concerns surrounding environmental sustainability, small scale agriculture, and community food security. Promotions for consumption of locally produced foods have come from activists, non-governmental organizations, as well as some academic and government research and policy makers. Methods to empirically assess the types and quantities of crops and animals produced locally (i.e., local food production capacity) are underdeveloped, hindering the ability of policy makers to effect innovative local food security policy. In this paper, we demonstrate methods to estimate local food production capacity using regularly gathered federal Agricultural Census and survey data for a Canadian province. The methods are generalizable to other provinces and nations. Operating at the sub-provincial scale of Local Health Area (LHA), our goal is to integrate census farmland and survey yield data to construct local food production estimates in each LHA. We also assess the stability of these surveyed agricultural yields over time to determine the temporal extent of data required for reasonable representation of product yields. We find that provincial yield data may be used to construct reasonable estimates of local scale food production, due to the high level of regionalization in productive farmland of each product in the province. However, many products exhibit significant yield variability over time, suggesting that, for some foods, local production capacity is a dynamic and variable concept. The methods developed will be useful for researchers and government officials alike, as well as a first step towards more advanced modeling of current local food capacity and future potential.

1. Introduction

In many developed nations consumers are increasingly concerned about the ability of large industrial food systems to supply safe, nutritious food in a way that is environmentally sustainable. The emergence of periodic food safety crises have alarmed the public; for example, Avian influenza, Bovine spongiform encephalopathy (“mad cow” disease), the recent outbreak of melamine contamination of milk in China and, outbreaks of Listeriosis at a Maple Leaf Foods Canadian processing plant (Joffe and Lee, 2004; Wilson and Keelan, 2008). Long food supply chains arising from the globalization of production and processing, with production often originating in politically unstable nations, may further undermine the reliability of timely, safe, and cost-effective food delivery.

Experts such as agricultural scientists and planners are increasingly required to consider and predict agricultural output based on local variation in fertilizer use, soil type, and weather conditions (Basso et al., 2001; Chakir, 2009; Rounsevell et al., 2003). Resource managers and disaster planners are also concerned with community agricultural self-reliance, should international trade in food products become stifled for environmental or political reasons (Feenstra, 1997). Demand for information on food production at various local scales has increased as concerns grow about the impact of climate change on food security (Olesen et al., 2007; Lobell et al., 2008; Lobell and Christopher, 2007). Agriculture is a globally significant land use, and has considerable impact on economic systems, the natural environment, and human health (Rounsevell et al., 2003). The availability of regional agricultural production estimates has not kept pace with information needs, particularly in methods to empirically estimate local food production capacity using the best available data. There is demand for regional agricultural production estimates that allow for mapping of the spatial variation in agricultural productivity.

The definition of “local” is subjective, and is most commonly defined based on Euclidian distance or, as is used in this paper, political boundaries. In the latter case, foods may be considered locally sourced if they are produced in the same state, province, or even country as the consumers. Given that Canada is a large country and British Columbia is a large province, this may not be

* Corresponding author. Tel.: +1 250 419 2712; fax: +1 250 721 6216.
E-mail addresses: ktm@uvic.ca (K.T. Morrison), trisalyn@uvic.ca (T.A. Nelson), ostry@uvic.ca (A.S. Ostry).

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a meaningful definition, therefore we operationalize smaller sub-provincial units as discussed further in Section 2.1.

The goal of this paper is to develop map-based methods to estimate local food production capacity. To meet this goal we assess both the spatial and temporal variability in food production in British Columbia (BC), Canada. In considering the spatial variability in food production, we map regional productive farmland. We also identify which agricultural yields remain relatively stable over time, and can be represented with a single year of data, versus those yields that vary temporally and may require multiple years of data for accurate representation. These methods can be expanded to other regions to determine the extent to which regional exploration of food production is possible with commonly available aggregate data.

BC is an important case study for understanding regional food production, as it is home to unique agriculture and nutrition policies directly related to local food production. In particular, the Agricultural Land Reserve (ALR) is a province-wide land preservation policy of nearly five million hectares of protected farmland that cannot be developed for non-agricultural purposes (Androkovich et al., 2008). Devoted to preservation of local food production capacity, the ALR should preserve capacity compared to other regions in Canada.

The popular book "100-mile Diet", which describes the attempt of a couple to eat a nutritious diet for an entire year using only foods accessible within 100 miles of their home, was a non-empirical attempt to determine if the food production system of south-western BC could supply their local needs; it could not (Smith and MacKinnon, 2007). The popularity of the book attests to strong interest in local foods. Finally, the new public health act passed in the province in 2007 has made the five Regional Health Authorities (RHAs) in the province responsible for local food security, so that policy makers concerned with the nutritional health of the province's population are beginning to focus on the health and sustainability of local agricultural and local food production systems (PHSA, 2010). In spite of interest and activism around local food security in BC, little research has been conducted to assess local agricultural capacity so that BC's capacity to meet local food demands is unknown.

2. Study area and data

2.1. Study area

BC is Canada's westernmost province, with a diverse, industrialized agricultural sector worth about $2.2 billion dollars per year (BCMAL, 2006). The province is divided into five Regional Health Authorities (RHAs), each responsible for providing medical care, nutritional health, and food security to their residents (Fig. 1). Each RHA disaggregates into a number of Local Health Areas (LHAs), with size (land area) inversely proportional to population. The 89

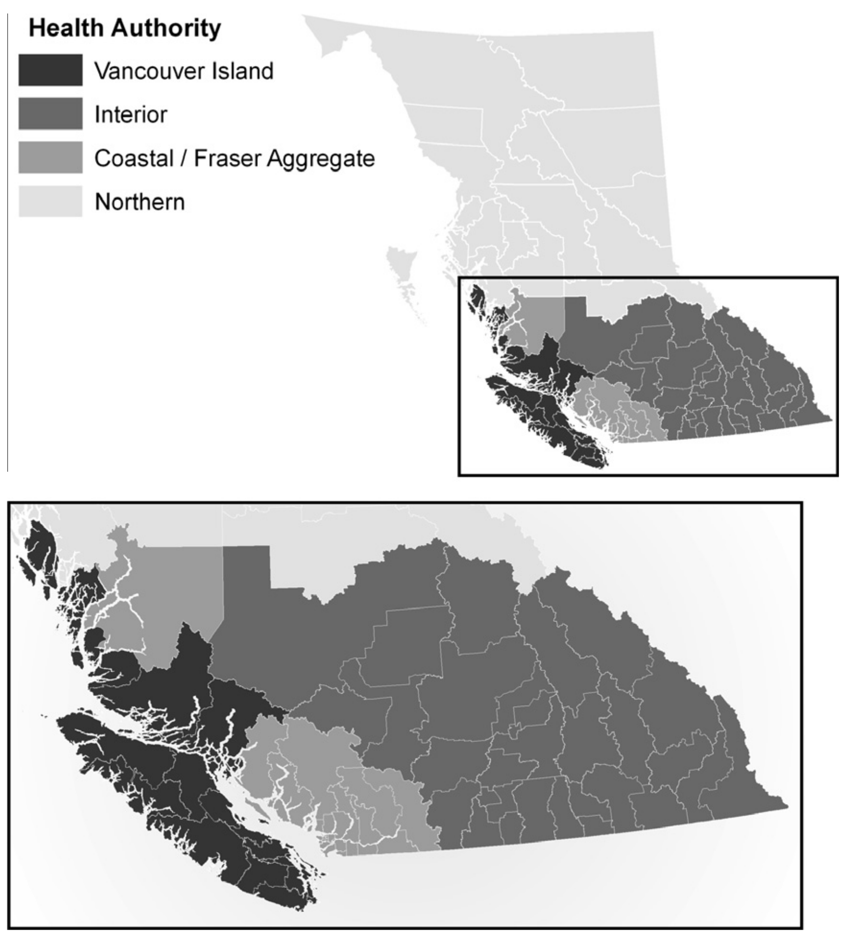

Fig. 1. Aggregated BC Regional Health Authorities. Local Health Areas are outlined in white. BC is shown in four regions based on the five RHAs; the Vancouver Coastal Health Authority and Fraser Health Authority have been aggregated in this figure because they make up a relatively homogeneous agricultural area in the province, which we also refer to as the "lower mainland." The fifth RHA, the Provincial Health Services Authority is not regionally based.

LHAs are a useful spatial unit for studying food systems as RHAs are responsible for promoting and ensuring the food security of their residents (PHSA, 2010).

2.2. Data

All data used in this paper are provided by Statistics Canada. Data from the Agricultural Census are provided at a custom spatial unit of LHA. Agricultural Census data provide information on the number of food production units in each region (e.g., number of animals, area of currently productive farmland). Data from the agricultural surveys are disseminated at the provincial scale with no sub-provincial data available. Census and sample survey data are collected by Statistics Canada from direct questionnaires provided from farm operators in Canada. Sample survey data are used by Statistics Canada to extrapolate estimates of provincial totals for the sampled variables, such as total food production for a given food product over 1 year. A description of data products follows.

2.2.1. Fruit, field vegetable, and potato surveys

The Statistics Canada Fruit and Vegetable Survey is conducted in Spring and Fall annually through stratified random sample survey of fruit and vegetable farms in Canada, with all large (>10 acres) farms surveyed (StatCan, 2010a). Farms growing only potatoes are generated through a specialized potato survey, that is similarly stratified, randomly sampling potato farms reporting a minimum of $1000 in sales. Annual totals of production and planted area for all fruits, vegetables, and potatoes are released by Statistics Canada each year (StatCan, 2010a,b).

2.2.2. Greenhouse vegetable survey

In BC, three main greenhouse vegetables (tomatoes, cucumbers, and peppers) are grown, and planted area and yield of each product are reported by Statistics Canada at the provincial scale (StatCan, 2010c). Data are collected by Statistics Canada in the Annual Greenhouse, Sod, and Nursery Survey which includes all greenhouse vegetable producing farms in the province. Greenhouse fruits are grown in negligible quantities in BC and are not considered in this paper (Adams, 2010). Since greenhouse area is reported as a single value in the Agricultural Census at the LHA scale, we calculate a weighted mean for "provincial average greenhouse vegetable yield" based on the proportion of total greenhouse area each product occupies in the total in BC, and each respective yield.

2.2.3. Grains and oilseed surveys

Grain data are available through Statistics Canada Field Crop Reporting Series, in which farms producing grains in all non-Atlantic provinces are stratified by farm size and randomly sampled, reporting area planted, harvested, and production weight (StatCan, 2010d). Crops grown in Peace River are reported separately from the remainder of BC and account for 90% of total grain production excluding forage corn.

A significant proportion of some grain crops (e.g., oats) are fed to livestock. The approximate proportion of livestock grain is removed from the production data, since it will not be available for human consumption. Livestock proportions are based on data from Statistics Canada Cereal and oilseeds review, where grain crops used for seed or livestock feed are separated from grains available for human consumption (StatCan, 2010e).

3. Methods

To enable mapping of data several adjustments were made. Here we outline adjustments and then demonstrate how adjusted data can be integrated and used to map productivity.

3.1. Data integration and disaggregation

3.1.1. Data suppression

When Census data are sparse, data are suppressed to protect the privacy of respondents. The Agricultural Census suppresses data there are fewer than 16 farms within a region LHA. Suppression is problematic for mapping as it masks spatial distributions. In BC in 2006, 49% of greenhouse vegetable area was located in regions with suppressed data. This is problematic as our calculations show that greenhouse vegetables makes up approximately 40% of the total vegetables grown in BC. Most suppression occurred in the Delta LHA, where 14 large operations reported greenhouse production, accounting for about 40% of BC's total greenhouse area (Shiell, 2010). Accounting for suppression in the Delta LHA reduces greenhouse vegetable data suppression from 49% to 7%.

3.1.2. Adjustments and waste factors

The amount of food available for consumption is typically less than actual amounts of production. In this paper we are interested in estimating the amount of food available for human consumption at the local scale, therefore it is desirable to estimate the food loss and waste that occurs in food production systems. We do this by accounting for waste that occurs on-farm, and waste that occurs between farm and consumer. On-farm waste is accounted for in Fruit and Vegetable Survey by reporting total and marketed production separately. The difference between total production and marketed production is the farm waste. In this paper, we calculate yield as marketed production per planted area to better estimate amounts of food available for consumption.

We then account for waste that inevitably occurs between "farm gate" and "human plate". The United States Department of Agriculture (USDA) estimates food waste in households, restaurants, and institutions, such as from food preparation, storage, spoilage, and plate loss (Kantor et al., 1997). Statistics Canada has adopted these waste factors, and applied them to their Food Statistics datasets to better estimate food consumed at the individual level (StatCan, 2007). Waste estimates are available for 47 of the 50 foods included in this paper. Products without waste estimates include mixed grains, canola, and raspberries. For mixed grains, we average the waste estimate for all other grain products. For Canola, the "vegetable oil" waste estimate is used. For raspberries, the "other fresh berries" waste estimate is used.

3.2. Mapping productive farmland

We mapped productive farmland in the province to allow us to visually assess clustering or dispersion of the farmland for each product. Units were normalized to enable data integration and reporting of results using standard food production units. The Agricultural Census reports *planted* area of all fruits, vegetables, and grains. This was converted to food production using yield (kilograms per planted hectare) as described below.

To determine provincial food production at a sub-provincial scale, we need an average agricultural yield. Yields are reported as a provincial average, calculated from the area of planted farmland in BC, and marketed provincial food production as follows:

$$Yield = \frac{food\ produced}{planted\ area} \tag{1}$$

Yield and *food produced* are available only as provincial averages. However, *planted area* is reported within each LHA as described above. We can calculate production for the *i*th region as follows:

$$Food\ producedi = yield * planted\ area_i \tag{2}$$

When mapping, special consideration must be paid to classification of the data into different categories (colors or shading). The farmland dataset is positively skewed, with most regions comprised of relatively little farmland and a small number of regions containing the vast majority of the farmland. While often used for data which are normally distributed, using a standard deviation method is useful for highlighting the extreme skewness is datasets when the goal of mapping is to highlight atypical values (Hutchinson, 2004). For each map, we calculated the average (mean) area of regional farmland, and then categorized regions as those which are 1.5–2.5 and 2.5+ standard deviations above the mean. Data less than 1.5 standard deviations above the mean are classified together and represent areas which contain little or no farmland in that category; because of the nature of the skewed data, no regions are more than 1.5 standard deviations below the mean.

We will calculate and present the results of a global Morans I statistic, which is an inferential method used to determine the presence or absence of spatial clustering in a dataset, testing against the null hypothesis of random spatial patterns (O'Sullivan and Unwin, 2003). Neighborhoods are constructed using first order polygon contiguity (adjacency).

3.3. Assessing temporal trends in agricultural yields

We assess the spatial distribution of productive farmland to determine if provincial averaged yields can be applied to local regions. Assessing the temporal variability of agricultural yields is also of interest. Weather patterns vary annually and impact food production.

To assess yields over time, we calculated annual yield and summary statistics for each product. A simple linear regression equation was constructed for this time span of each agricultural product, with yield (kilograms of food produced per hectare) regressed against time (years, 1986–2006). The derivative of the regression equation (the slope) represents a metric for assessing the strength and direction of change in yield over time, in kilo-

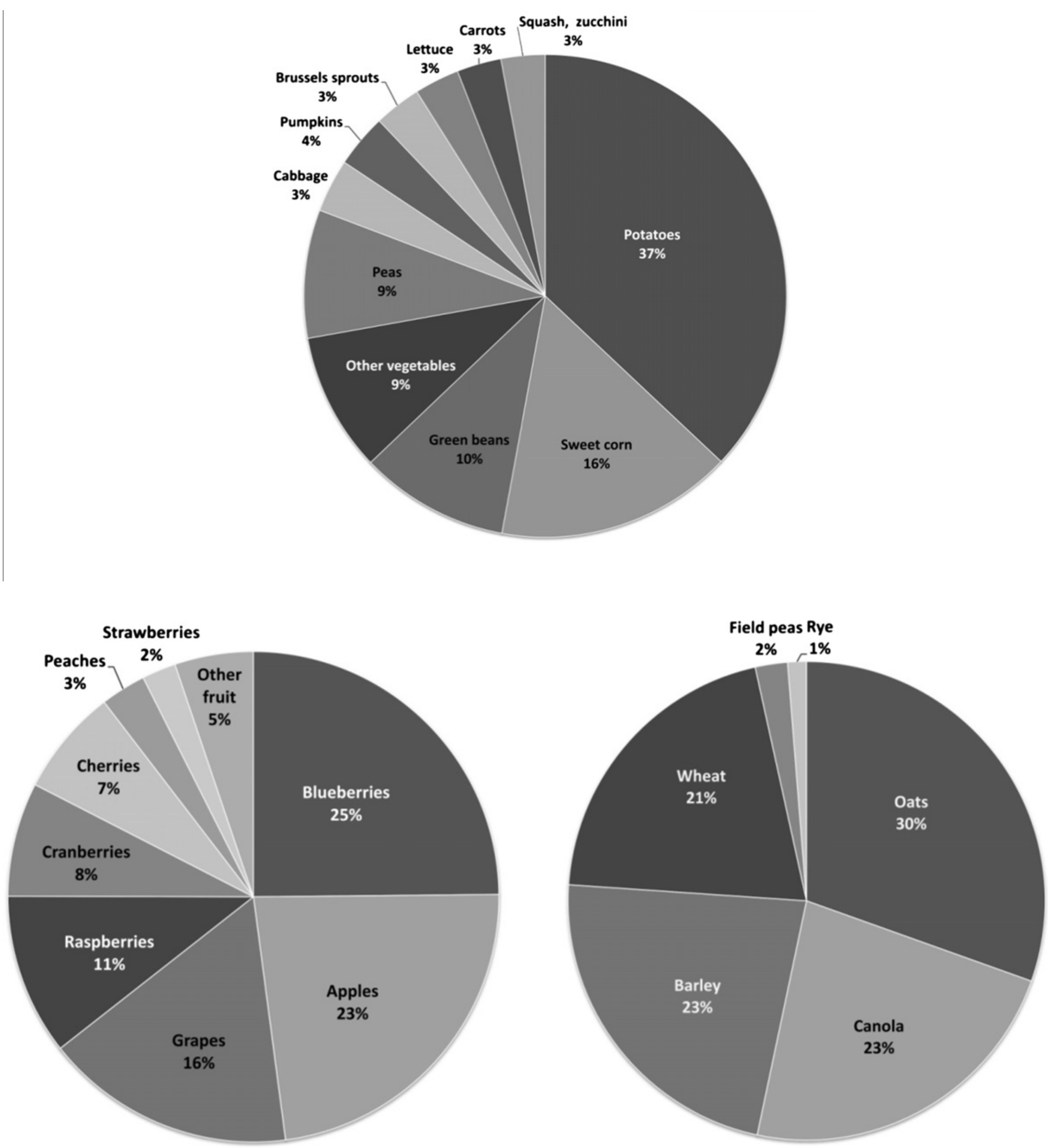

Fig. 2. Farmland allocated to produce fruits, field-grown vegetables, and grains in British Columbia, 2006.

grams per year. The magnitude of the slope is proportional to the magnitude of the yield, and the coefficient of variation (CV) is a useful normalized statistic to compare change over time between products. The slope indicates the net change during the entire time series, while the CV indicates the amount of change each year. A *t*-test was used to determine if the slope differs significantly from zero (in other words, testing the significance of the regression model), indicating whether the slope has changed significantly over time. We also report the coefficient of determination (R^2) value which likewise represents whether there has been a significant change in slope over time, and how well a linear model explains the relationship yield and time. A lower (but significant) R^2 may indicate that yield has changed significantly but in a nonlinear fashion, exhibiting considerable variability over time. We use simple linear regression model as an exploratory tool, therefore we are not concerned with the predictive ability of these models and do not perform model diagnostics. Allowing for exponential and logarithmic relationships between yield and time did not improve model fit for these data and would have complicated the interpretation of the slope parameter, therefore were not included in this

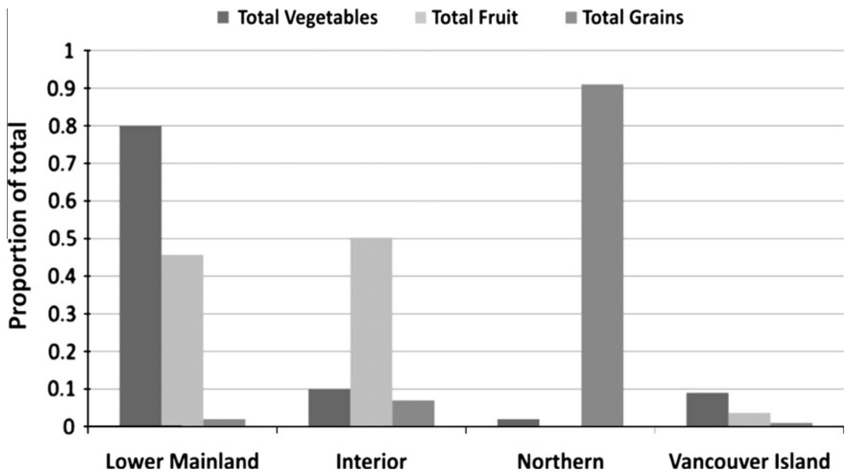

Fig. 3. Regional distribution of farmland in BC. Lower mainland includes Fraser and Vancouver Coastal Health Authorities.

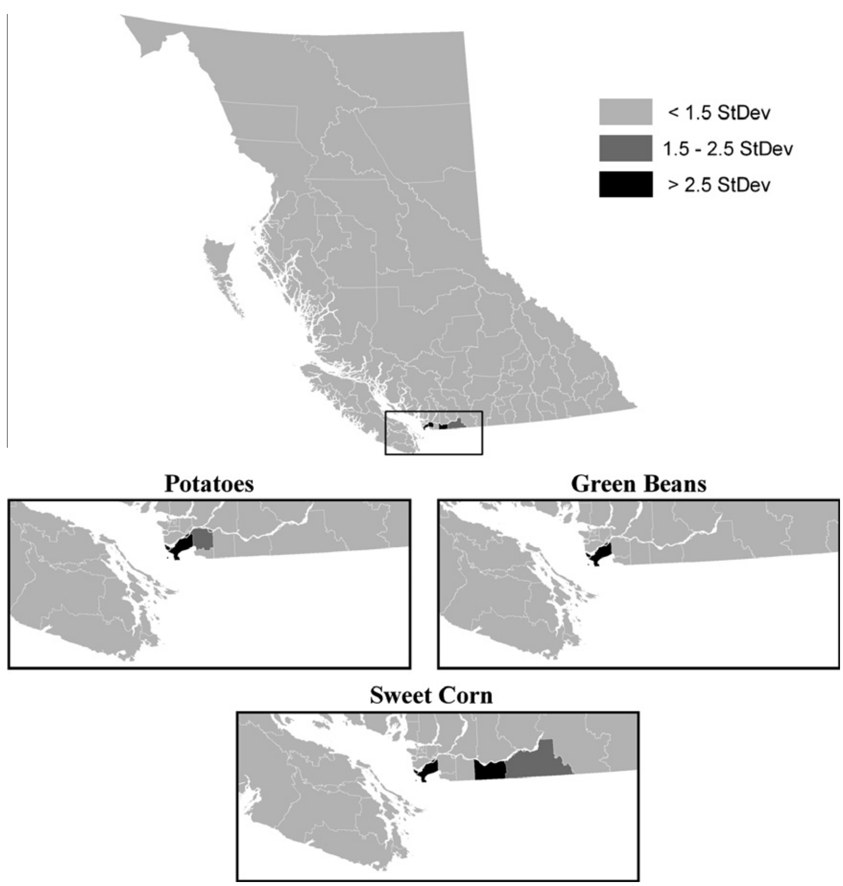

Fig. 4. Vegetable farmland in BC, 2006. Does not include greenhouse grown vegetables.

paper. Assessing the temporal variation in agricultural yield will guide the decision in whether to use a single year (e.g., 2006) or time series average yield to construct the most meaningful estimates and maps of food productions.

4. Results

4.1. Mapping productive farmland

We present figures showing the proportion of each food group individual products comprise (Fig. 2). We also present maps of the three most abundant products for fruit, vegetables, and grains, based on the proportion of total farmland they comprise in their food group (Figs. 4–6).

Figs. 3–6 show the distribution of farmland on a food group basis and for the primary three products within each food group. Farmland is present in all regions of the province, but when broken down, each food group clearly shows a high level of regionalization. For fruits, vegetables, and grains, the spatial distribution of farmland is highly significantly clustered with $p < 0.01$ in each case (vegetables: Moran's $I = 0.1856$, $Z = 3.94$; fruits: Moran's $I = 0.2378$, $Z = 4.72$; grains: Moran's $I = 0.221$, $Z = 4.90$).

Of 9060 hectares of vegetable farmland, potatoes, sweet corn, and green beans comprise 63% of all vegetable farmland. The production of blueberries, apples, and grapes comprises 64% of fruit farmland. Oats, Canola and barley production comprise 76% of grain farmland (Fig. 2). The spatial distributions are shown in Figs. 3–6. More than three quarters of all vegetable farmland is located in the lower mainland, where the primary vegetables are produced almost exclusively. Fruit farmland is evenly distributed between the lower mainland and the Interior RHA Okanagan region (Fig. 3). However, each fruit or berry is largely isolated to one RHA; blueberries are the primary fruit produced in BC, grown in the lower mainland, while apple orchards and grape vineyards are located in the Okanagan (Fig. 5). Significant grain production is essentially isolated to the Northern RHA Peace River region (Fig. 6). Clearly, while productive farmland is distributed throughout the province, food production is highly regionalized by food group and food type.

4.2. Temporal variability agricultural yields

Some agricultural products show a relatively negligible change in yield over time, with a small coefficient of variation and slope close to zero (e.g., cauliflower). Other products experience substantial changes over time (Table 1). For example, radishes, lettuce, and sweet corn have large, significant negative slopes and relatively large CVs, suggesting that their yields have decreased significantly since 1986. Products with an insignificant slope but relatively large CV show more variation over time, but the net change during the entire time series is relatively small. Conversely, products with a significant slope but smaller CV show a more substantial but steady net change over time.

While several key vegetables have significantly changing yields (e.g., sweet corn), most fruits have experienced insignificant increases in average yield. Only peaches have increased significantly since 1986, with considerably inter-annual variability. Consistency in CV suggests that most fruits tend to exhibit less variability in yield between growing seasons while vegetable yields are more variable over time. Oats, field peas, and rye have significantly decreasing yields, while other grain yields have gone relatively unchanged. (Table 1).

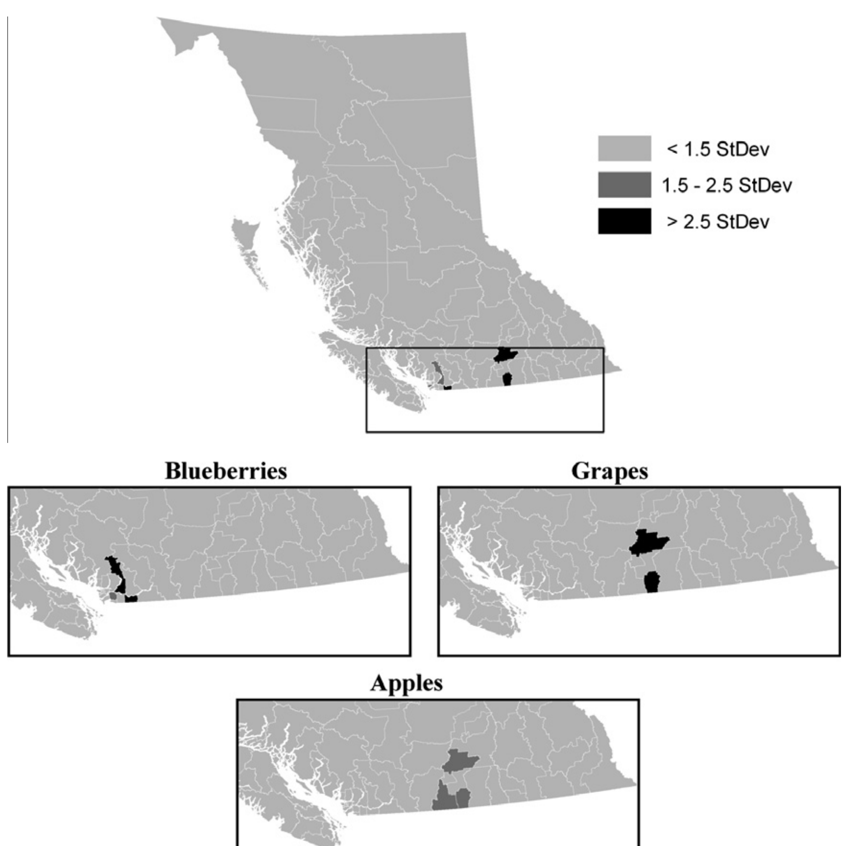

Fig. 5. Fruit farmland in BC, 2006.

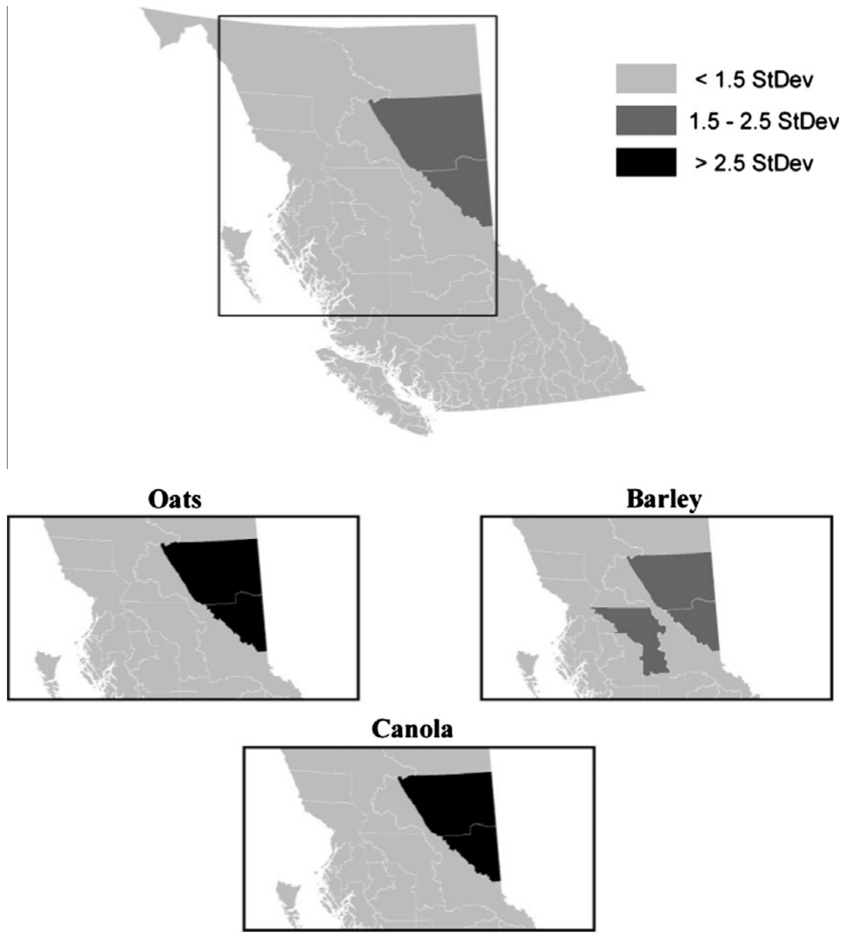

Fig. 6. Grain and oilseed farmland in BC, 2006.

Table 1
Summary statistics for agricultural yield in BC, 1986–2006. Products with a statistically significant slope, ($p < 0.05$), indicating significant change over time, are shown. All R^2 values are significant ($p < 0.05$).

	Min	Max	Mean	Cv	Slope (kg/year)	R^2
Radishes	5910	38,507	17,078	0.53	−838.88	0.32
Lettuce	15,735	30,220	24,079	0.18	−550.10	0.60
Corn	7787	14,745	10,842	0.19	−245.75	0.56
Asparagus	806	2057	1361	0.29	31.88	0.25
Peppers	5780	13,699	8971	0.25	203.22	0.32
Beets	10,216	23,640	16,450	0.24	281.17	0.18
Peaches	7072	10,817	8864	0.12	204.18	0.43
Oats	841	2723	1589	0.3	−34.35	0.21
Mixed grains	750	3167	1740	0.46	−67.85	0.27
All rye	425	2375	1476	0.45	−77.36	0.33

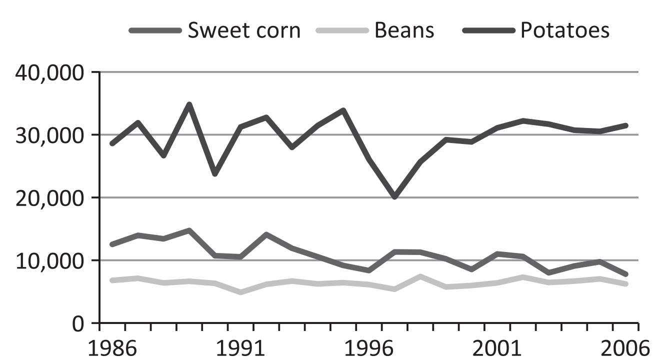

Fig. 7. Field vegetable yields in BC, 1986–2006, kilograms per planted hectare.

Since 1986, peaks and troughs in agricultural yields have often occurred across all products simultaneously. For example, the four primary vegetables grown in BC exhibit a highly similar pattern, where the change in yield over time varies similarly (Fig. 7), and the same is true for oat and barley yields (Fig. 8).

5. Discussion

Productive farmland is distributed throughout the province, but production is highly regionalized. On a food group basis (e.g., fruit or vegetables) farmland is isolated to small regions. On an individual product basis (e.g., blueberries) the geographic extent of farmland is even smaller. Though yields are presented as a provincial

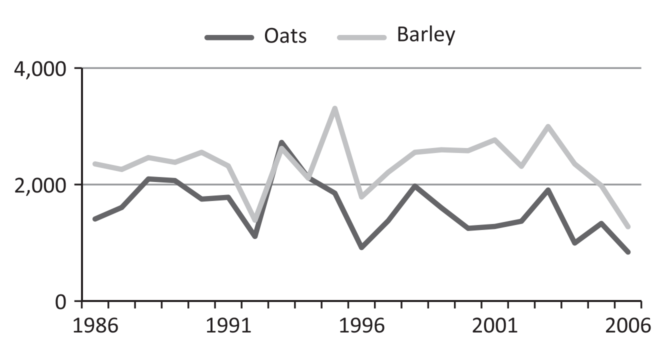

Fig. 8. Oat and barley yields in BC, 1986–2006, kilograms per planted hectare.

average, based on provincial production data, the provincial average yield represents a regional yield when production is geographically isolated. Extreme regionalization of farmland has implications for production analysis and food security. Regionalization impacts local scale food security by limiting nutritional variety and the feasibility of a local diet (Guptill and Wilkins, 2002).

Viewed comprehensively, maps show patterns that may not have been obvious from aspatial analysis. Total farmland in BC is distributed throughout the province; because oilseeds and grains are produced in greater amounts than fruits and vegetables, analyzing and mapping total farmland would have given unfair weight to grains. If researchers and regional health officials are interested in knowing what foods are available in their areas, it is important disaggregate data into nutrient-based food groups so nutritional variety can be assessed. Mapping regionalization in BC agricultural products demonstrates that no regions have sufficient agricultural variety to meet nutritional needs with a local diet at the scale of LHA.

Temporal analysis indicates that some agricultural yields have substantial annual variation likely related to year-to-year weather patterns that impact amounts of rainfall and sunlight hours (Rounsevell et al., 2003). Products grown within a relatively small geographic region tend to exhibit similar patterns over time. For example, oats, canola and barley are grown primarily in the Peace River region and have common temporal trends in yield that are likely attributed to weather. Poor weather from 1997 to 2000 reduced yield and gross production of many vegetable products. Warmer weather in 2001 increased production and yield of most crops (BCMAFF, 2003). Temperature increases with higher than average precipitation in the Fraser Valley in 2005 could explain the increase in yield of many products that year.

Temporal trends in berry and tree fruit yields, most grown in the Fraser Valley and Okanagan, may reflect unusually cool growing seasons in the years prior to 1997, followed by the warmer temperatures in the following years, with a particularly good growing season in 2003. Yields in most berries and tree fruits were lower in the late 1990's and higher than average after 2000 (StatCan, 2004). As well, in BC older fruit trees have been slowly replaced with new high-yield dwarf stock. Apples are susceptible to changes in heat and humidity; hot and dry growing seasons will cause a spike in yield whereas a cooler or more humid growing season will decreased productivity substantially (StatCan, 2000).

Grain yields have varied over time more than field vegetables and fruits, exhibiting similar temporal yield fluctuations as they are grown in the same region and are subject to the same weather conditions (Fig. 8). Agricultural yields of fruits, vegetables, and grains in BC exhibit considerable variability over time. Using a single year's yield is reasonable if the research goal is to construct a snapshot of local food capacity.

If a general view of local food capacity or future prediction is required then using a time series average yield will make the final estimate less reflective of weather-driven annual variability. This is particularly important if products are abundant or produced over a board geographic area. For example, green beans and peas together make up 34% of vegetable farmland in BC, and both yields have increased considerably over time. Apples, grapes, and peaches account for 41% of fruit farmland, and peach yields have increased significantly over time (Table 1). Temporal variation in these products could significantly impact the final food production estimate in an LHA.

6. Conclusion

This paper presented a method for estimating regional food production in BC with census and survey data and assesses spatial and temporal variability in food production. The absolute quantity of food produced in each region can be estimated as the product of farmland devoted to growing that product from the Agricultural Census, multiplied by the average provincial yield for the product from the appropriate federal survey product. Given the high level of regionalization in BC agriculture, this is methodologically sound. Constructing these estimates of regional food production has not previously been possible using available datasets. As well, assessment of yield stability over time has not been incorporated into any local food security research in the province (Vancouver Food Policy Council, 2009).

Health officials and policy makers are increasingly recognizing that healthy eating at a population level does not only depend on public nutrition education; the underlying structure of food production systems, and how foods are processed, distributed, and sold will ultimately determine what foods people consume. Health officials require access to research and data which describe the food production systems and food availability in their regions, which currently is lacking at any local scale. The lack of supportive data and research indicate a need for methods development in this area (BCMAL, 2006, 2008; Peters, 2009).

The methods applied here are transferable to other provinces in Canada, as Agricultural Census and survey data are available. If farmland is highly regionalized, isolated to relatively small regions on a per-product basis, then provincial average yields can be applied to local farmland area data. The importance of this step will depend on the size of the region. Reported values for area of productive farmland are available from the Agricultural Census in a variety of sub-provincial spatial units. The methods in this paper would also be adaptable to other countries, contingent on data availability and the farmland distribution as described above. In some countries, if soils and climates are fairly homogeneous, then nationally aggregated yields may suitable. National average yields are often available for common crops from the United Nations Food and Agriculture Organization (UNFAO, 2010).

Through local food production estimates, presented here, we can construct baseline estimates of local scale food self-sufficiency, assuming that regional food consumption can be estimated. Contrasting food production and food consumption at a local scale would provide an empirical assessment of local food self-sufficiency, which is not currently available in BC, or described extensively in the food security or agricultural literature. More sophisticated modeling could be incorporated, such as forecasting of future agricultural self-sufficiency, based on demographic changes (aging, population growth, or urbanization) or agricultural changes (due to climate or land use change). This research is a first step towards a more sophisticated analysis of local diets and regional decision making. The methods presented in this paper do not allow for a theoretical estimate of productivity in regions where crops are not currently grown, since these yield data would only reflect yields in the localized production regions. More sophisticated modeling of predicted yield and further research into the spatial stability in agricultural yields based on regional characteristics (such a soil and climate) would help quantify the level of regionalization required to justify the use of aggregate yield data. Local foods recommendations will only be effective when local agricultural systems can meet current or increased demand for agricultural products. Understanding the current state of local scale agriculture is a first step towards aligning agricultural and nutritional goals.

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References

Adams, D., 2010. Account Executive, Statistics Canada Account Executive. Personal Communication, July 2010.

Androkovich, R., Desjardins, I., Tarzwell, G., Tsigaris, P., 2008. Land preservation in British Columbia: an empirical analysis of the factors underlying public support and willingness to pay. Journal of Agricultural and Applied Economics 4, 999–1013.

Basso, B., Ritchie, J.T., Pierce, F.J., Braga, R.P., Jones, J.W., 2001. Spatial validation of crop models for precision agriculture. Agricultural Systems 68, 97–117.

BC Ministry of Agriculture, Food, and Fisheries (BCMAFF), 2003. An Overview of the BC Field Vegetable Industry. Industry Competitiveness Branch, pp. 1–14.

BC Ministry of Agriculture and Lands (BCMAL), 2006. BC Food Self Reliance Report. Government of British Columbia, Vancouver, pp. 1–18.

BC Ministry of Agriculture and Lands (BCMAL), 2008. The BC Agriculture Plan: Growing a Healthy Future for BC Families. Government of British Columbia, Vancouver, pp. 1–48.

Chakir, R., 2009. Spatial downscaling of agricultural land-use data: an econometric approach using cross entropy. Land Economics 85, 238–251.

Feenstra, G., 1997. Local food systems and sustainable communities. American Journal of Alternative Agriculture 12, 28–36.

Guptill, A., Wilkins, J.L., 2002. Buying into the food system: trends in food retailing in the US and implications for local foods. Agriculture and Human Values 19, 39–51.

Hutchinson, S., 2004. Inside ArcView GIS 8.3. Thomson Delmar Learning, Canada.

Joffe, H., Lee, L., 2004. Social representation of a food risk: the Hong Kong Avian bird flu epidemic. Journal of Health Psychology 9, 517–533.

Kantor, L., Lipton, K., Manchester, A., Oliveria, V., 1997. Estimating and addressing America's food losses. Food Review, 2–12.

Lobell, D., Christopher, F., 2007. Global scale climate–crop yield relationships and the impacts of recent warming. Environmental Research Letters 2, 1–7.

Lobell, D.B., Burke, M.B., Tebaldi, C., Mastrandrea, M.D., Falcon, W.P., Naylor, R.L., 2008. Prioritizing climate change adaptation needs for food security in 2030. Science 319, 607–610.

Olesen, J., Carter, T., Díaz-Ambrona, C., Fronzek, S., Heidmann, T., Hickler, T., Holt, T., Minguez, M., Morales, P., Palutikof, J., Quemada, M., Ruiz-Ramos, M., Rubæk, G., Sau, F., Smith, B., Sykes, M., 2007. Uncertainties in projected impacts of climate change on European agriculture and terrestrial ecosystems based on scenarios from regional climate models. Climatic Change 81, 123–143.

O'Sullivan, D., Unwin, D., 2003. Geographic Information Analysis, first ed. Wiley & Sons, New Jersey.

Peters, C.J., 2009. Mapping potential foodsheds in New York State: a spatial model for evaluating the capacity to localize food production. Renewable Agriculture and Food Systems 24, 72–84.

Provincial Health Services Authority, 2010. 2009–2010 Annual Progress Update: Core Public Health Programs, pp. 1–10.

Rounsevell, M.D.A., Annetts, J.E., Audsley, E., Mayr, T., Reginster, I., 2003. Modelling the spatial distribution of agricultural land use at the regional scale. Agriculture, Ecosystems & Environment 95, 465–479.

Shiell, J., 2010. Market Analysis, BC Vegetable Marketing Commission. Personal Communication, August 2010. <http://www.bcveg.com>.

Smith, A., Mackinnon, J.B., 2007. The 100-Mile Diet: A Year of Local Eating. Random House, Toronto.

Statistics Canada, 2000. Fruit and Vegetable Production Report. Catalogue 22-003-XIB 68, pp. 1–46.

Statistics Canada, 2004. Fruit and Vegetable Production Report. Catalogue 22-003-XIB 72, pp. 1–41.

Statistics Canada, 2007. A Description of the Supply-demand Based Food and Nutrition data Produced by the Agriculture Division, Statistics Canada.

Statistics Canada, 2010a. Fruit & Vegetable Survey: Definitions, Data Sources and Methods. Survey No. 3407.

Statistics Canada, 2010b. Potato Area and Yield Survey: Definitions, Data Sources and Methods. Survey No. 3446.

Statistics Canada, 2010c. Greenhouse, Sod and Nursery Survey: Definitions, Data Sources and Methods. Survey No. 3416.

Statistics Canada, 2010d. Field Crop Reporting Series: Definitions, Data Sources & Methods.

Statistics Canada, 2010e. Cereals and Oilseeds Review. Catalogue No. 22-007-XWE 33, pp. 1–64.

United Nations Food and Agriculture Association, 2010. Food and Agriculture Statistics: Production Data. <http://faostat.fao.org/> (accessed 18.05.10).

Vancouver Food Policy Council, 2009. Food Secure Vancouver Baseline Report.

Wilson, K., Keelan, J., 2008. Learning from Listeria: the autonomy of the Public Health Agency of Canada. Canadian Medical Association Journal 179, 877–879.