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ORIGINAL PAPER

Soil and its influence on rural drought migration: insights from Depression-era Southwestern Saskatchewan, Canada

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Abstract This article investigates linkages between soil conditions, farm-level vulnerability, adaptation, and rural migration during periods of drought. It begins by reviewing existing literature on climate adaptation in agricultural populations and on relationships between soil and rural migration. This is followed by a detailed case study of rural migration patterns that emerged in the Swift Current district of Saskatchewan, Canada, during a period of extended droughts and severe economic conditions in the 1930s. Using a combination of secondary literature, interviews with surviving first-hand observers and GIS modeling, the study shows how the interacting effects of household indebtedness, social capital, government relief programs, and farm-level soil quality helped stimulate population loss in many rural townships across the study area. The study focuses particularly on the role played by differential soil quality across the Swift Current district and how farms situated on sandier soils were typically more sensitive and vulnerable to drought than those situated on clay soils. Higher-than-average rates of population loss were associated with townships containing areas of poorer quality agricultural soils, an association replicable using GIS software and existing soil and population datasets. The findings from the case study are discussed within the context of the broader existing literature, and suggestions are provided on future directions for research, planning, and modeling to assist planners and policymakers concerned with rural adaptation and migration.

Keywords Drought · Migration · Agricultural soils · Great plains · Great depression · Historical analogs · Climate change

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Introduction

Migration can occur during periods of drought, but not all droughts necessarily result in migration. This simple fact, observable in rural areas across the globe, opens a range of theoretical, conceptual, and empirical challenges for scholars and policymakers concerned with questions of environment and migration, particularly in an era of anthropogenic climate change. Although rural-to-urban migration rates in developing nations are growing, the majority of the world's population continues to live in rural areas, villages, and towns where livelihoods and well-being are tied closely to agriculture and other resource-based activities (Cohen 2003; Hunter 2005). Such activities are often inherently sensitive to climatic variability, and there is growing concern that anthropogenic climate change will exacerbate adverse climatic conditions and accelerate rural out-migration, especially in developing countries (UNHCR 2009; McLeman and Hunter 2010). The Intergovernmental Panel on Climate Change (IPCC) suggests that a number of regions may become more frequently exposed to severe drought conditions in coming decades (Parry et al. 2007). Well-known reports concerning the potential migration consequences of climate change tend to identify rural populations, especially those in drought-prone regions, as being at risk of distress migration in coming decades (e.g., CARE International 2009; Christian Aid 2007; Myers 2002).

Specialists have long recognized that migration in response to environmental conditions rarely emerges as a simple stimulus–response relationship, and drought-migration is no exception (Bates 2002; Curran 2002; Hugo 1996; Hunter 2005; Massey et al. 2010; McLeman and Smit 2006a; Tacoli 2009). If past experience is any indication, not all members of populations exposed to future climate change-related droughts will respond by migrating, except in the absolute worst-case scenario where there are no alternatives (Gutmann et al. 2005; Henry et al. 2004; McLeman and Hunter 2010; Meze-Hausken 2000). This is because within any given population, there is a high degree of variability in terms of the relative vulnerability and adaptive capacity of individuals and households to climate-related stresses like drought (McLeman and Smit 2006a). Vulnerability and adaptive capacity are products of complex interactions between environmental, cultural, socio-economic, and institutional processes interacting across multiple scales, and which are continually changing over time (Adger 2006, Smit and Wandel 2006). Anticipating migration outcomes in response to droughts consequently requires teasing apart the various processes and factors that contribute to the formation of vulnerability and understanding how they interact with one another to generate adaptive migration on a context-specific basis.

Direct and indirect studies of drought-related migration have been done in various regions, many of which may be used as learning analogs for developing insights into how future drought migration may unfold (e.g., de Haan et al. 2002; Deshingkar and Start 2003; Ezra and Kiros 2001; Findley 1994; Fratkin and Roth 1990; Gilbert and McLeman 2010; Gottschang 1987; Gutmann et al. 2005; Henry et al. 2004; McLeman 2006; Mortimore and Adams 2001; Roncoli et al. 2001; Swinton 1988; Thébaud and Batterbury 2001; Turton and Turton 1984). A factor that has featured in these and other studies, and which warrants further attention, is the role played by local soil conditions in the emergence of migration. Soil quality is an important determinant of the productivity of agricultural lands and as a result has an ongoing influence on rural livelihoods and incomes. Different types of soil respond differently to variations in temperature and precipitation (Tan 2009). Soil quality and availability can vary considerably over short distances and are highly responsive to land use practices. As a result, spatial variations in soil conditions may be an important contributor to differential patterns of household-level vulnerability and adaptation responses, including migration, during drought.

The present article explores the interconnectedness of soil quality, household adaptation, and drought migration, drawing upon an empirical study of migration patterns that emerged in the Swift Current district of Saskatchewan, Canada, during a period of severe drought and difficult socio-economic conditions in the 1930s. This agricultural district experienced a significant rate of population decline in the period 1931–1936 as farm families migrated elsewhere. While drought and economic conditions were almost uniformly difficult across the study area, the spatial distribution of households that migrated out of the area was neither uniform nor random. Rather, particular areas had higher rates of population loss than others, especially those in or near areas where soils were sandier. This relationship between soil and migration was identified through a combination of techniques including qualitative interviews with first-hand observers, review of historical documentation, and GIS-based modeling. The findings suggest how similar techniques might be used elsewhere to help identify populations that have a higher potential for migration as a result of future droughts.

This article begins by reviewing existing literature with respect to climate adaptation in agricultural populations and the linkages between soil and rural migration. The case study is then introduced, and its empirical findings are described and discussed within the context of the broader literature. The article concludes with suggestions on future directions for research, planning, and modeling to assist planners and policymakers on the allocation of resources to enhance rural adaptive capacity in coming years.

Interactions of drought, soil, and erosion in the shaping of rural vulnerability

The potential for human populations and systems to experience loss or harm due to climatic conditions or events is increasingly described by scientists in terms of *vulnerability*, which is in turn understood to be a function of three attributes: (1) the nature of the climatic stimulus to which a given population or system is exposed; (2) the sensitivity of the population or system to the given risk; and (3) the capacity of the population or system and its components to adapt to the exposure in question (Adger 2006; Parry et al. 2007). These three attributes, hereafter referred to simply as exposure, sensitivity and adaptive capacity, are so closely interconnected that in many circumstances, it may be difficult to identify and treat them as mutually exclusive variables (Smit and Wandel 2006; McLeman and Smit 2006b). In general, exposure and sensitivity are positively related to vulnerability (i.e., that as either of these attributes increases so, too, will vulnerability increase, and vice versa), whereas vulnerability is negatively related to adaptive capacity (i.e., increases in adaptive capacity reduce vulnerability, and vice versa) (Smit and Wandel 2006).

Given the important role that climate plays in agricultural productivity, it is regularly observed that rural livelihoods and incomes are inherently sensitive to extreme climatic conditions and events beyond expected normal ranges (Bryant et al. 2000; Gregory et al. 2005; Polsky and Easterling 2001; Sivakumar et al. 2005). The sensitivity of a given agricultural population to climate variability and change depends upon a variety of factors including, but not limited to, the type of production choices characteristic of participants within that system, the technologies employed, institutional arrangements, connections to markets, and prevailing environmental conditions in the area in question (Blaikie 1985; Bryant et al. 2000; Reid et al. 2007; Reilly et al. 2003). A variety of adaptation options may exist in any given agricultural system, many of which do not entail migration (Smit and Skinner 2002). Some are actions that take place at the household level, such as making changes to farm practices or diversifying household income by seeking off-farm employment. Others require the involvement of higher-level actors, such as the creation of crop insurance programs or the development of new crop varieties and agricultural technologies (Smit and Skinner 2002; McLeman et al. 2008).

The potential for migration to emerge in rural populations experiencing drought is linked to underlying factors that influence exposure, sensitivity, and adaptive capacity. Soil is one such factor. Soil of a quality suitable for agricultural purposes is a critical eco-system service (Pimentel 2000; Millennium Ecosystem Assessment 2005). Soil erosion and degradation have a range of direct and indirect effects on livelihoods and economic well-being, not only at the rural household level, but also across local and state economies (Alfsen et al. 1996). Scholars have often sought to link the decline of ancient and classical civilizations and the abandonment of their rural hinterlands with soil erosion and/or nutrient depletion caused by agricultural practices and deforestation (Butzer 2005; Marsh 1864; Montgomery 2007; Perlin 2005). While historical cases of drought and land degradation have sometimes been used as warnings of the potential consequences of modern day environmental degradation (e.g. Diamond 2005), continuous cultivation over long periods of time does not inevitably lead to soil loss, land abandonment, and population decline. For example, slopes in Peru's Colca Valley, which have been in agricultural production for more than 1,500 years, show higher levels of key soil nutrients than uncultivated land in the region and are evidence of the potential effectiveness of traditional land stewardship and soil conservation measures (Dick et al. 1994).

That said, the past century has seen various examples of settlement abandonments and migrations attributable to or influenced by soil erosion and land degradation in dryland areas of Africa, Asia, the Middle East, and the Americas (see Leighton (2006) for a more detailed review of case studies). Overgrazing of grasslands by pastoralists' livestock, clearance of tropical forests and conversion to agricultural use, and expansion of agricultural production into marginal environments are some of the processes that cause declines in soil quality and availability and help lead to migration (Amacher et al. 1998; Bilsborrow and DeLargy 1991; Geist and Lambin 2004; Grove 1951; Trimble 1985; Westing 1994; Yan and Qian 2004; Zimmerer 1993). In some areas, high rates of natural population increase may become a further driver of soil erosion that in turn may stimulate migration (e.g. Repetto 1986). However, while it is generally held that soil erosion is less likely to emerge in rural areas with low population density [i.e., the "fewer people, less erosion" scenario (see Ovuka 2000; Preston et al. 1997)], some research from East Africa has suggested that population growth may encourage more careful land management practices in some areas [i.e., the "more people, less erosion" scenario (Tiffen et al. 1994)]. Rural out-migration may have a feedback effect on soil erosion in the places left behind; in Niger, high rates of soil erosion may be found on land where family members have moved away to work, a strategy that diversifies household income sources but leaves less labor available for land management (Warren et al. 2001). In short, it is evident that soil erosion and population change are dynamic, interconnected processes that have feedback effects on one another, but such interactions may not play out the same way in every setting.

Drought may exacerbate ongoing soil erosion, thereby heightening the potential for migration from vulnerable households. The U.S. "Dust Bowl" migration provides one of the better-studied examples. During the 1930s, hundreds of thousands of people migrated from drought-stricken rural areas of the U.S. Great Plains to the Pacific coast, with as many more relocating within the Great Plains region (Cunfer 2005; Gregory 1989; Gutmann et al. 2005). The combined effects of persistent drought conditions, collapsed commodity prices, government policies, high unemployment, and economic recession are widely seen as having contributed to the migration patterns that emerged during that era (McLeman 2006). Land management practices popular on dryland farms likely contributed to the widespread soil erosion and sky-darkening dust storms that gave the region and its migrants the "Dust Bowl" moniker (Hurt 1981; Lockeritz 1978; Worster 1979). Farmers were encouraged to plow their land often, in the belief this would make their soil better able to absorb precipitation, and to leave fallow land plowed and bare to prevent weeds from using soil nutrients. Some boosters of western agriculture, particularly land agents who profited from land sales and speculation, went so far as to actively promote the idea that "rain follows the plow" (i.e., that converting dry grassland to cropland would actually stimulate an increase in precipitation (Smith 1947)).

Using the conceptualization of vulnerability given above, changes in soil conditions due to erosion and poor land management can be said to have a significant influence on farm-level sensitivity to precipitation extremes. In addition to management practices and exogenous environmental factors like climate, the physical and chemical properties of the soil also influence the potential for erosion and agricultural crop failure at a given location (Bronick and Lal 2005; Greene and Hairsine 2004). A soil's potential ability to store moisture depends upon the relative amounts of sand, silt, clay, and organic material of which it is composed (Tan 2009). As compared with clay soils, where the electrical charge of the clay particle encourages the adhesion of water molecules and cations, sandy soils have a relatively poor capacity to store moisture and nutrients, and when exposed to shortfalls in precipitation and/or extreme heat can dry out quickly. On the other hand, the better drainage of sandier soils makes them less prone to waterlogging during heavy precipitation or following snowmelt than are heavy clay soils. Other things being equal, the risk of crop failure due to drought is more immediate on sandier soils. This risk may be offset in a variety of ways, including technological investments such as irrigation systems, growing drought-tolerant crop varieties, or through adjusting land management practices to minimize erosion and maximize nutrient and moisture retention (Smit and Skinner 2002). Where such adaptations are not implemented [or where their implementation is limited or precluded by socio-economic factors (McLeman et al. 2008)], it may be posited that a higher potential for out-migration in response to persistent or extreme drought conditions exists at those locations where soil-related sensitivity is high.

Methods

The relationship between soil, drought adaptation and migration is now discussed in greater detail using findings from an empirical case study of migration that occurred in the Swift Current district of southwestern Saskatchewan, Canada, during an extended period of drought in the 1930s. The practice of using of historical case studies as learning analogs from which to draw lessons about the human impacts of climatic events and conditions is well-established (Ford et al. 2010; Glantz 1991). The Swift Current case was selected for this study because it was known through secondary research to have been a site of drought-related migration (McGowan 1975). The population of the Swift Current district, which had grown steadily throughout the early decades of the twentieth century, fell by more than six percent between the years 1931 and 1936 (Fig. 1).

In particular, the study sought to understand why it was that some rural households in the district were able to adapt and remain on the land while other households left, and identify factors that may have distinguished the two groups. Using a methodological approach derived from grounded theory (Charmaz 2004), surviving first-hand witnesses still residing in the study area were identified with the initial assistance of museums in Swift Current and Herbert in the summer of 2009. In-depth, semi-structured interviews were conducted using mostly open-ended questions with some closed-ended ones to obtain information regarding 1930s migration patterns and factors that may have distinguished migrants from non-migrants. Interviewees were asked for assistance in identifying additional

Fig. 1 Population of the Swift Current district, 1926–1936. *Data source*: Dominion Bureau of Statistics (1936)

interviewees in a “snowball” recruitment approach. Twenty-five interviews were conducted in all and recorded via handwritten notes that were transcribed immediately following the interview into an electronic bibliographic database. This information was subsequently organized and coded in a spreadsheet using a preestablished framework designed to isolate and categorize contributory factors identified by interviewees. It was through these interviews that the possibility of an association between farm-level soil quality and migration was first brought to the attention of the authors.

Added to this same framework was information gathered from two sets of secondary data sources. The first of these consisted of records obtained from the Saskatchewan Archives in Regina, including provincial departmental reports on government-organized relocations of migrants from the district during the study period, and reports of provincial agriculture ministry officials on conditions in the study area during the droughts. A second set of secondary information was obtained by reviewing locally generated community history books, the latter existing for all the Rural Municipalities of the study area as a legacy of celebrations of Saskatchewan’s 50th and 75th anniversaries. These books are available through the Swift Current Museum and the Provincial Archives. Entries in local histories were visually scanned for references to conditions during the droughts and to movements of people in or out of the communities during the study period.

A third step was to create a GIS model containing population and land quality data for the study area, which was used as a tool to visualize the possibility of association between the quality of farmland and population change between 1931 and 1936. While soil was not the only factor that distinguished migrant from non-migrant households, the interviews, secondary information, and GIS model all suggested that spatial variations in soil quality likely had an influence on the migration patterns that emerged in the study area during the 1930s.

Location and geography of the study area

The study area is situated in southwestern Saskatchewan, Canada, with the city of Swift Current near its geographical center (Fig. 2). It is approximately 100 by 100 km and has two natural geographical boundaries, the northern one being the south branch of the Saskatchewan River and the western boundary being the eastern margins of the self-descriptive Great Sand Hills. The eastern boundary chosen for the study area is a north–south extension of the division between rural municipalities (RM) 164 and 165 (near the village of Morse), and the southern one, the east–west extension of the division between RMs 106 and 76 (just north of the towns of Cadillac and Ponteix). These boundaries capture the district of settlement historically served by the administrative and commercial center of Swift Current (McGowan 1975). While primarily a rural, agricultural population, during the 1930s the study area had a number of smaller towns and villages in addition to Swift Current that provided commercial services, many of which have since dwindled.

The Swift Current district is situated within the Canadian Prairies, which are the northern extension of the North American Great Plains mixed grassland ecosystem that stretches southward to Texas. The semi-arid landscape of the Swift Current

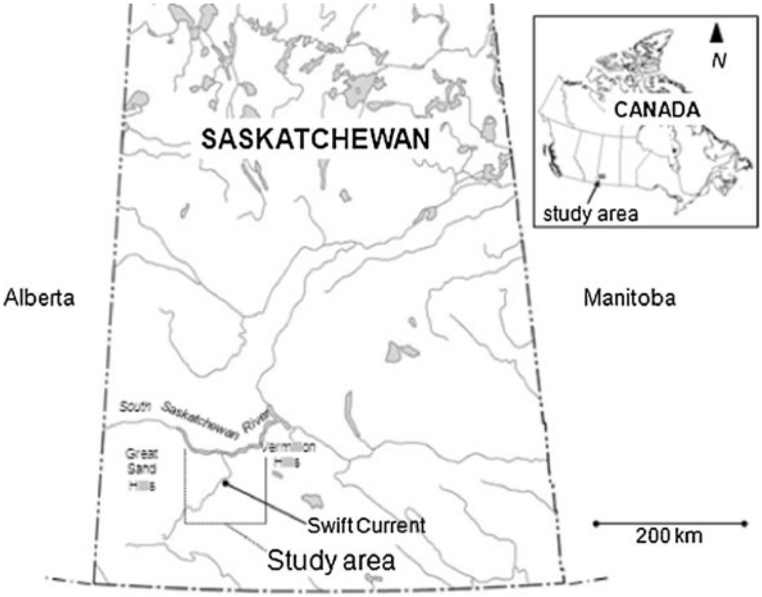

Fig. 2 Location of the study area

district rests on a gently undulating glaciated plateau, with elevations ranging from approximately 750–975 m above sea level (Acton et al. 1998). The south branch of the Saskatchewan River occupies a wide and deep valley and forms a natural barrier to travel northward from Swift Current. During the 1930s, it ran wild and was crossed by way of a ferry at the hamlet of Saskatchewan Landing; today, the river is dammed and a fixed bridge crosses the reservoir (Lake Diefenbaker) near the site of the original ferry. Across the study area, a number of smaller watercourses have cut deep coulees into the plains. Prior to European arrival in the nineteenth century, the natural vegetation was dominated by mixed perennial short-grasses that in turn supported a population of millions of bison (*Bison bison*), a key livelihood resource for the region's aboriginal groups (known collectively in Canada as First Nations).

Brown chernozemic soils characteristic of Canadian Prairie grasslands are commonly found throughout much of the study area, but at local scales, soil conditions are quite variable (Acton et al. 1998). Chernozemic soils are rich in organic material, range up to a meter in depth, and have a good ability to store moisture—important attributes in a semi-arid agricultural region (Toth et al. 2009). However, there are also many soil deposits high in sand throughout the study area, especially in the western and northern parts. These spatial differences in soil quality are reflected in the Canada Land Inventory (CLI), a system by which the agricultural potential of Canadian land is ranked. The seven CLI classes range from Class 1, where there are no significant limitations on productivity, to Class 7 lands that have little or no ability to support cultivation or pasture. Classes 2 through 6 are present in the study area, with class 3 (moderately severe limitations and/or special

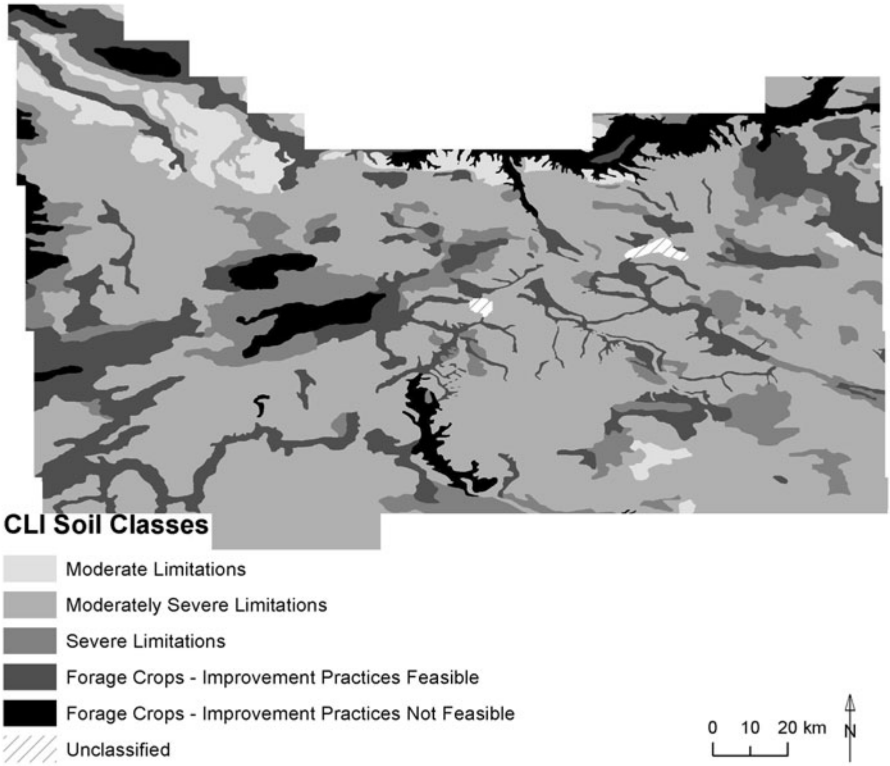

Fig. 3 Agricultural potential of Swift Current district lands. *Data source*: Natural Resources Canada (2011). *Note*: CLI Class 1 (No significant limitations), Class 7 (No capability for arable culture or permanent pasture), and Class 8 (Organic soils) are not present within the area of interest

conservation practices required, often because of moisture limitations) being the most predominant class (Fig. 3).

The study area is semi-arid and has a large intraannual temperature range. Southwestern Saskatchewan and southeastern Alberta are known colloquially as Palliser's Triangle, after Captain John Palliser, who surveyed the region in 1857 and described it as being too arid for crop cultivation (Eisler 2006). Reconstructed paleoclimate data show that extended periods of little or no precipitation are a recurrent, long-term feature of the Canadian Prairies (Sauchyn et al. 2003). Low levels of precipitation are a particular characteristic of the Swift Current district (Fig. 4). The hottest and coldest temperatures recorded at Swift Current are 38.9°C (in August 1961) and minus 42°C (in December 1983). There is an annual average of 118 frost-free days (Government of Saskatchewan 2011).

Historical settlement patterns in study area

Although southwestern Saskatchewan (particularly the Cypress Hills southwest of the study area) was a popular place of habitation for the Cree First Nation, most of

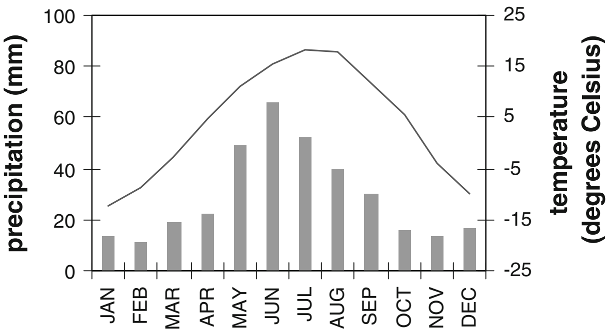

Fig. 4 Monthly precipitation and temperature averages, Swift Current, Saskatchewan. *Data source*: Environment Canada (2011)

the region's aboriginal population was relocated elsewhere following the 1874 Qu'Appelle Treaty (officially known as Treaty Number 4) between the Government of Canada and the Saulteaux and Cree Nations (Tobias 1983). This was followed by an influx of non-aboriginal settlers beginning in the 1880s with the construction of the Canadian Pacific Railway. The location of the present-day city of Swift Current was selected as a main railway town site because of the year-round presence of water in Swift Current Creek (McGowan 1975). In the last two decades of the nineteenth century, agriculture in the Swift Current district (then part of the Territory of Assiniboia) consisted primarily of commercial ranching of cattle that were grazed on lands leased from the federal government (Evans 1979). Early attempts at establishing family farms (known as *homesteads*) were few, and the commonly held view being that the area was too dry and too far from markets to make crop production viable (McGowan 1975). Although agricultural settlement expanded rapidly across other parts of the Canadian Prairies, the government land agency closed its Swift Current office between 1896 and 1901 for lack of settlement activity in the area (McGowan 1975).

By the early 1900s, new homesteading lands had become scarce in more accessible and less climatically extreme parts of the Canadian Prairies and American Great Plains, and farm settlers began moving into Palliser's Triangle. Many of these families came from the Dakotas and other northern U.S. plains states, where land prices and tenancy rates had roughly quadrupled in the last decade of the nineteenth century (Widdis 2009). In the Swift Current district, population densities that in 1901 had been no more than two persons to the square mile[1] jumped to between 10 and 20 persons per square mile by 1911 in the best farming areas and averaged between two and five persons per square mile for the district as a whole (Murchie et al. 1936). The federal government encouraged the influx of settlers by allowing ranchers' grazing leases to expire and the land to be taken over by farmers (McGowan 1975). Strong commodity prices helped encourage crop farming; the

[1] One mile = approximately 2.6 km. Imperial measurements are used in this paper to reflect the standard unit of measurement in use during the study period.

price of wheat, for example, having grown by almost one-third between 1897 and 1901 (Morton 1938).

The location and selection of homesteading lands were shaped by the Dominion Land Survey, a system by which the Prairies were surveyed in the 1870s and organized into a grid of "townships", each 36 square miles and which were in turn subdivided into square, 640 acre "sections" (Martin 1973). Under the Dominion Lands Act of 1872, the head of a family could claim an unoccupied 160-acre "quarter-section" of land for ten dollars and gain legal title to it by planting crops, building a shelter and residing there for three years (Thompson 1998). Not all land was available for homesteading; blocks of land were reserved within each township for use or sale by the Canadian Pacific Railway and the Hudson Bay Company, with smaller areas set aside for churches and schools. Exceptions were also made in some areas to account for preestablished settlements of Métis (people of mixed French and aboriginal ancestry). Aspects of the land title acquisition process were modified over subsequent decades, but the basic spatial pattern and emphasis on facilitating agricultural settlement remained intact (Martin 1973). In the study area, sections adjacent to the Swift Current Creek, along the railway and in areas just south of the Saskatchewan River, were the first to be taken up by family farmers, with settlement spreading outward from there (McGowan 1975).

The early agricultural settlers of the Swift Current district came from multiple cultural backgrounds, and members of particular groups often tended to settle in particular areas (Fig. 5). For example, many migrants from southern Manitoba's German-speaking Mennonite communities established farms in the eastern portion of the study area, and particular blocks of land southeast of Swift Current town were reserved exclusively for their settlement through successful lobbying of the federal interior ministry (Schroeder and Huebert 1996). Migrants from the U.S., many of

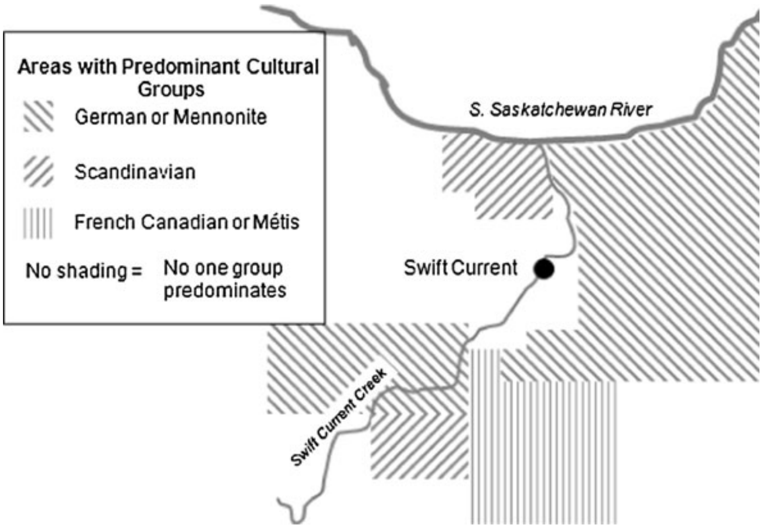

Fig. 5 Areas with high concentrations of particular cultural groups. *Data source*: Fung (2000)

Scandinavian origin, settled farms to the northwest of Swift Current, while French-speaking migrants of Quebecois and Métis origin settled in the south (Fung 2000). The central part of the region around the town of Swift Current was a heterogeneous mix of migrants arriving from eastern Canada, the U.S., and Europe (Fung 2000).

With the exception of the Mennonite reserve blocks, where settlers clustered their homes to create hamlets or villages reminiscent of rural central Europe, the spatial pattern of agricultural settlement reflected the Dominion Land survey system. Family operated farms were distributed in a checkerboard fashion along section roads a mile apart, with four quarter-section farms facing onto each mile of road. A church, a school, and perhaps a general store would be found at important crossroads. Main villages and towns that provided key agricultural services, such as mills, farm supply stores, and buyers of grain and livestock, were located along the railroads.

Farm-level sensitivity to drought

By the beginning of the 1930s, the majority of land in the Swift Current district was in agricultural production, with family operated, mixed-production farms being the predominant agricultural unit (Murchie et al. 1936; McGowan 1975). Farm-level production choices tended to be fairly similar notwithstanding the different cultural origins of farmers. Wheat was the predominant cash crop, with a mix of other cereals also being cultivated. Most farms kept a small number of cattle, chickens, and hogs. While ranching had been an important land use activity in the early decades of settlement, severe winter conditions in 1906–1907 led to widespread loss of livestock and helped spur the conversion of remaining grazing lands to wheat farming (Evans 1979). With a province-wide boom in wheat production in the 1920s, the Saskatchewan economy became increasingly centered on wheat export, with government policy and the province’s physical infrastructure dedicated to furthering that expansion (Marchildon 2005). The economic fortunes of farmers in the study area were tightly bound to revenues generated from wheat sales, leaving them highly exposed to fluctuations in global market prices for wheat and to the inherent variability in regional precipitation patterns.

The degree of exposure of individual farms to climatic risks varied across the Swift Current district. In the early years of homesteading, land with sandy loam soils had been attractive to settlers because they were easier to break with horse or ox-drawn plows than the heavier clay “gumbo” soils.[2] In years with average precipitation or better, sandy loam soils could be highly productive, and there was lower risk of waterlogging during periods of heavy precipitation. However, sandy soils suffered the disadvantage of being unable to store large amounts of moisture from spring melts, making them more susceptible to drying out in summers with high maximum temperatures and low precipitation. This sensitivity was exacerbated by the cropping techniques common of the day. Farmers practiced mechanical summer fallowing, whereby land was periodically taken out of rotation during the

[2] Gumbo being a type of thick soup, interviewees routinely used this word to describe clay-rich soils that take on a gumbo-like consistency in heavy rainfall or snowmelt.

summer and plowed, in the belief this would help conserve soil moisture, make more nutrients available for crop plants, and keep down weeds. Farmers also removed straw stubble from their land after harvest to use for animal feed. These practices have since been found to facilitate wind erosion and to be ineffective in maintaining soil moisture or nutrients in semi-arid areas (Derksen et al. 1994).

The rural population's high degree of exposure to commodity prices and climatic conditions was revealed in the 1930s. The 1929 stock market crash and ensuing global economic collapse caused the already declining market prices for wheat to fall by more than half between the 1928 and 1930 harvests (Fig. 6). By 1932, per capita incomes across Saskatchewan had fallen by 72% (Marchildon 2005, 56). The capital value of Saskatchewan farms and their equipment fell continuously from 1926 until World War II (Smith 1992). By 1933, nearly half of automobiles registered in rural Saskatchewan had been taken off the road, and gasoline consumption had fallen by more than half (Smith 1992, 242). Interviewees were able to illustrate the extent of the economic impacts of that period using local examples. One interviewee who farmed near the village of Morse reported receiving only 18 cents a bushel for wheat in the harvest of 1929, which hit his household particularly hard since he had married just the year before. Another recalled selling his cattle at $5 to $7 each in the 1930s, which was hardly worth the cost and effort of taking them to market. Successive years of depressed prices left farmers impoverished across the study area; as one interviewee whose family farmed 10 km north of Swift Current described it, "not one of us was better than anyone else". The economic contraction also meant that off-farm employment became particularly scarce, leaving farm families few alternative income opportunities. Although times were hard for farmers, conditions in urban areas were possibly more miserable. One respondent, who had worked as a teenager in Saskatoon for a period during the 1930s, described the extreme poverty in which he saw poorer urban residents living, in shacks with dirt floors, and their children visibly malnourished. The same interviewee noted that as hard as conditions were for farmers at the onset of the

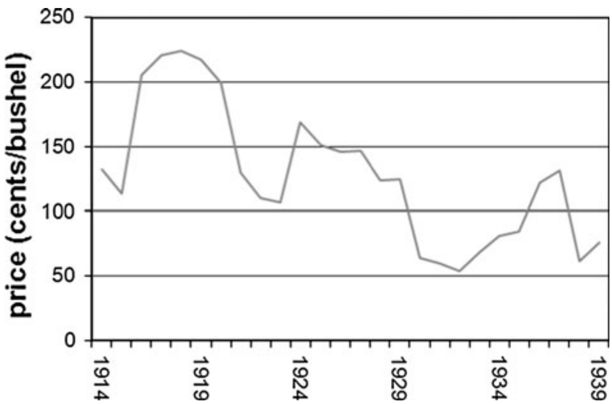

Fig. 6 Wholesale price for western Canadian spring wheat, 1914–1939. *Data source*: Statistics Canada (2011)

Depression, at least most were able to feed their families and subsist off their own production.

At the same time as the economic collapse took hold, prolonged drought conditions emerged throughout southwestern Saskatchewan. While the exact amount of precipitation necessary to produce a successful wheat harvest varied according to local soil conditions, topography, and temperatures, the Thatcher and Marquis varieties of wheat commonly grown by farmers during the 1930s generally required a minimum of between fifteen and twenty inches of annual precipitation (380–510 cm) (Magness et al. 1971). Irrigation was not commonly practiced on Swift Current district farms in the 1930s. Non-irrigated crops in that district were (and are) heavily dependent on moisture stored in the soil from snowmelt, given the relatively hot and dry summertime conditions that cause evapotranspiration rates to exceed precipitation. This meant that crops were often being grown under conditions of stress even in non-drought years (Robertson 1974, Staple and Lehane 1954). Particularly important was the availability of soil moisture during the period from May through early July, when seed heads form and develop on wheat (Robertson 1974).

The minimum annual amount of precipitation needed for successful wheat production was received only six times in the period between 1928 and 1939 (Fig. 7). Conditions were particularly severe in years when low summer precipitation and high summer maximum temperatures coincided (Fig. 8). Wheat production plummeted throughout southwestern Saskatchewan during the 1930s, with 13 of 25 interviewees stating unprompted that 1937 was an especially bad year, consistent with Fig. 9. Crop losses meant farmers not only lost their main source of

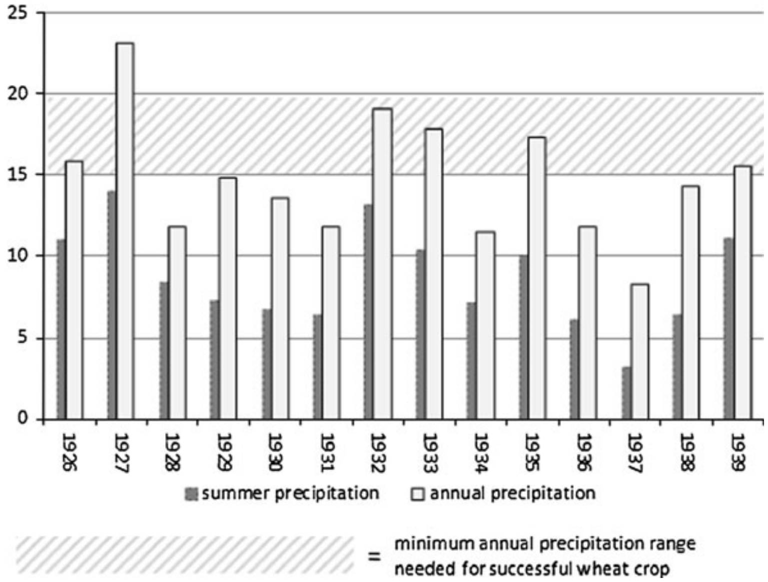

Fig. 7 Precipitation recorded at Swift Current, Saskatchewan, 1926–1939. *Data source*: Environment Canada (2011)

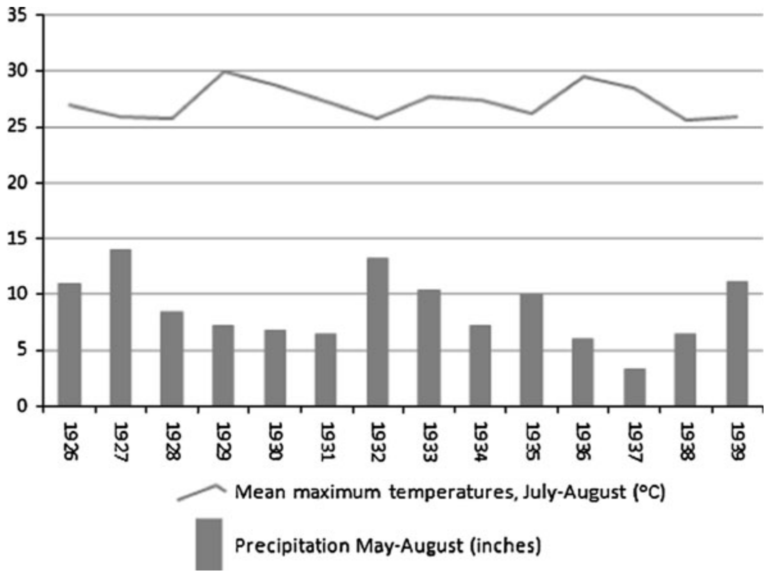

Fig. 8 Comparison of mean summer maximum temperatures and summer precipitation at Swift Current, 1926–1939. *Data source*: Environment Canada (2011)

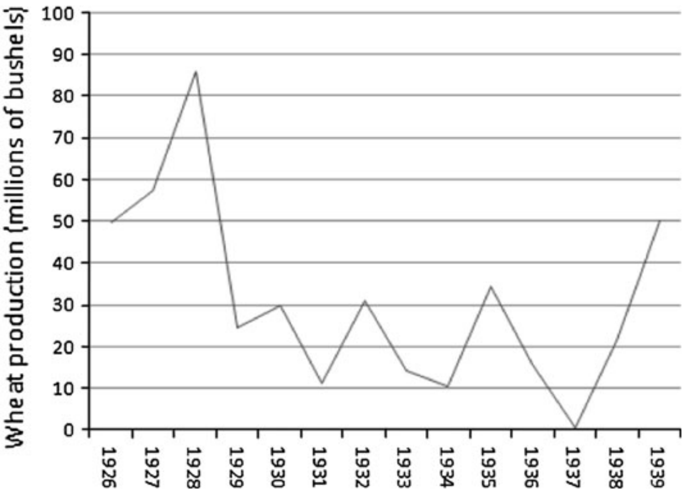

Fig. 9 Wheat production in south-central Saskatchewan. *Data source*: Government of Saskatchewan, Department of Agriculture, 1940. Wheat production statistics for Saskatchewan Crop District 3 (South Central), page 81. Regina

cash income in some years, but also were unable to produce enough seed for the following year or produce sufficient fodder for their livestock. Twenty interviewees described how the population of insect pests exploded as drought conditions persisted, including large infestations of grasshoppers (various *Melanoplus*) and army worms (*Mamestra configurata*) that devoured crops, stripped trees of their leaves, and consumed any surviving green material; potato bugs (*Leptinotarsa decemlineata*) that plagued household vegetable gardens; and saw flies (*Cephus cinctus*), which lay their eggs in the stalk of wheat plants and whose hatching larvae cause them to topple.

Repeated years of drought, combined with farmers' penchant for plowing and leaving land bare when fallow in the summer, led to widespread topsoil loss due to wind erosion. One interviewee reported losing six inches of topsoil from his land—essentially, the depth to which he typically plowed. Drifting sand that buried crops and fences became commonplace. Choking black dust storms occurred frequently—in some years as often as several times per week—and of which every interviewee had very clear recollections. Children often wore kerchiefs over their faces when going to school and would be sent home early whenever a dust storm was approaching, for the risk of getting lost in the storm was great. One interviewee recalled a neighboring family whose child died after getting lost in a dust storm. Her own family kept a rope tied between the house and barn, to which family members would cling whenever moving through the yard in wind and dust, so as to prevent wandering off. Dust infiltrated the homes, requiring that plates be set upside down on the dining table until the moment they were ready for use. One interviewee remembered how she had to be careful opening her eyes in the morning, for a thick layer of dust sometimes caked them while sleeping.

Among all the descriptions of dust storms, insect infestations and crop failures, one interviewee stood apart in stating there was never a crop failure on the land his family managed. The farm in question was a large one situated in a unique location and was owned by an absentee landlord. The farm consisted of three sections of flat bottomland into which drained several long coulees that flooded every spring. The land consisted of heavy, black gumbo that did not dry out even in the hottest summers. The greatest environmental risk to crop failure on that particular farm was flooding, and in 1936, the land on this farm was too wet to even plant—this when crops on other farms in the region were failing from drought. Even in 1937, the worst year in the region for drought, the interviewee reported this particular farm yielded an average of 40 bushels an acre. While this was an especially unique case, all interviewees agreed with the suggestion that crop yields were generally higher and the risk of crop failure lower on farms where the soils tended toward gumbo.

Adaptation

Interviewees were questioned about the ways in which they and other farmers adapted to the combined effects of drought and economic collapse. While all interviewees agreed that times were very hard for all during that period, interveiwees' families were able to subsist on their own production and with the help of neighbors, with 19 of 25 describing various ways they were able to do so. The first adaptations described by interviewees tended to be substitutions of home-produced products for purchased ones, such as hunting rabbits (*Lepus townsendii*) to supplement food supplies, making one's own clothing and furniture, and intensifying production and preserving of vegetables from the household garden. One interviewee admitted that his family netted fish illegally at night in the local creek and preserved them for winter use. Women from most farms would regularly take eggs, cream, and butter into the village store for barter or sale, and one interviewee recalled her family selling fresh vegetables to people who came out from the city in search of affordable food. Three interviewees whose families owned stores described how barter became common as cash became increasingly scarce; one of these interviewees described how his father stocked an entire barn with the livestock he had accepted as barter.

Twelve interviewees described how farmers unable to grow or purchase enough hay began feeding Russian thistle (*Salsola kali*) to their cattle, which was not only less nutritious, but also had a laxative effect on the animals, making barns and barnyards particularly messy. One interviewee recalled having seen groups of barefooted and gloveless farm children being sent to vacant scrubland to cut and make large piles of the thorny thistles to be later transported home by wagon. Another described collecting animal manure to be dried for fuel because his family ran out of money to purchase coal and wood. This practice is familiar to rural poor on other continents still today, but was not common in Saskatchewan prior to the droughts. The iconic "Bennett Buggy"—a horse-drawn automobile named after the Canadian Prime Minister of the time—was a common site on area roads according to three interviewees, consistent with the aforementioned statistics of a steep province-wide decline in automobile registrations.

Other adaptations involved drawing more heavily on social capital bound in the networks and connections present in extended family networks and between neighbors. The sharing of resources and pooling of labor to undertake farm chores that in past years would have been done by a hired employee were common examples (mentioned by 16 interviewees). One interviewee described how his father and uncles pooled their money to buy a tractor in the early 1930s, which they then took turns using. Those who had extra hay or straw to share with neighbors did so. Five interviewees told of being members of "beef rings" or "hog rings", a system whereby neighbors would take turns slaughtering an animal and sharing the meat with others on a rotating monthly basis, thereby ensuring all would have a steady supply of fresh meat—an important innovation in a time when many farms did not yet have electricity to power refrigerators. Being on good terms with other members of the community was important to obtaining credit from local merchants, particularly since bank loans were virtually impossible to obtain. For those who remained in the community, it was a point of honor to repay one's credit, no matter how long it took; one interviewee described how in 1953 his father received repayment for credit taken out in 1930. Merchants suffered losses as those who owed them money left the district; another interviewee reported seeing his father in the 1950s destroy boxes of papers pertaining to unpaid accounts from the 1930s.

Turning to government for assistance became a common means of adaptation, which left the provincial government heavily in debt (Marchildon 2005). Sixteen interviewees spoke of various aspects of government "relief" as it was then known, which was directed by the Saskatchewan Relief Commission and took on a variety of forms. Distribution of money and supplies to households was typically organized at the local level. Major funding came from federal and provincial sources, although some local municipalities also contributed from their own modest resources. For example, the town of Herbert provided clothing, eggs, meat, and small cash payments to families in need. The town also established its own currency, “Herbert dollars”, that could be used locally to settle debts or pay for goods and services at local businesses, their value guaranteed by the town office (Town of Herbert 1988). Interviewees from the Morse and Swift Current municipalities recalled their families receiving relief cash payments that could be used to buy groceries, clothing, and coal, with the expectation that the money would be paid back at a later date. Five interviewees from different parts of the study area described visiting their local rural municipal offices to collect canned goods, meat, potatoes, and other provisions that had been brought in for free distribution, with the amount of supplies given depending on the size of each family.

Twelve interviewees described “relief trains” arriving from eastern Canada carrying loads of hay and barrels of apples. One amusing anecdote shared by several interviewees concerned the dried, salted codfish that occasionally arrived on relief trains, a common food in Atlantic Canada but one that was alien to most Prairie farmers. The joke at the time was that the cod made fine roofing shingles until rain fell. One interviewee’s father had been responsible for relief distribution in his municipality and had distributed seed grain in addition to hay, food, and clothing. His father also had to guarantee payment for medical services on behalf of farmers receiving relief. This interviewee suggested that families in good stead with local government officials might have received more relief than others. The rural municipality of Rush Lake had a communal “hay flat” where needy families would be allocated 20 acres on which they could cut hay. One interviewee reported receiving a government-subsidized job at the age of 14, where a local farmer agreed to pay him $5 for doing a winter of chores and the government would match it with another $5.

Adaptive migration

Of particular interest in this study was to investigate the factors that distinguished families who adapted by migrating away from the study area from those who did not. All interviewees recalled observing migrants leaving the district. The most common destinations were to the north, in the Aspen Parkland of central Saskatchewan, a zone of transition from Prairie grassland to boreal forest and characterized by the many stands of aspen trees (*Populus tremuloides*) (Bailey and Wroe 1974). There, new land was still available for homesteading, although the nature of agriculture was considerably different than in the Swift Current district. In the Parkland, precipitation and surface water were not scarce, but the growing season was considerably cooler and shorter. In addition, homesteading land often had to be cleared of forest cover before it could be put into agricultural production.

The most common Parkland destinations known to interviewees were Meadow Lake, Foam Lake, and Carrot River, all accessed by traveling north out of the Swift Current district. Nine interviewees described the migration of relatives or family members; fourteen interviewees described the migration of friends or neighbors. For example, one interviewee described how a cousin whose land was “dry and windy and their soil blew away" drove his cattle across the Saskatchewan River and 400+ kilometers overland to Meadow Lake. A different interviewee described an uncle and other relatives who left their farms near Morse in 1931, taking with them their cattle and hay racks. Another interviewee had an uncle who left his farm north of the town of Swift Current that same year for Shelbrook in the Parkland. This interviewee's own father travelled to Shelbrook to look for land but "came back disgusted because of how much work had to be done to break the land" and saying that those who went north had to "grub among the stumps". Another interviewee reported that her sister and her husband left their farm near Eastend to join those clearing stumps in the Parkland. Three interviewees reported having friends and relatives leaving for British Columbia, also a popular destination for Saskatchewan migrants.

One interviewee from the western part of the study area, toward the Great Sand Hills, reported that many of his neighbors left during the droughts, with one family walking away with nothing more than personal items, leaving behind their furniture and dishes. Another interviewee who lived south of the town of Swift Current reported that the children from fourteen families left his school during the 1930s as their parents moved north to start new homesteads in the Carrot River district. Some migrants drove their tractors north. One interviewee's family farm was situated along the Battleford Trail, the main overland route running north out of the study area. His family's pond was a common stopping point for the many migrant households. Many neighbors living to the east of his farm also left for northern destinations. Another interviewee whose family farm sat near the junction of a main road and a railway recalled migrant families on the road with all their worldly possessions loaded on horse-drawn hay racks and saw possession-less, work-seeking young men riding on top of passing trains. An interviewee from the Herbert area recalled how auctions of people's farms and possessions would go on day after day during the mid-1930s. The year 1931 is remembered in Herbert as the year of "the Exodus", when two-dozen families moved away (Town of Herbert 1988). Town of Herbert records indicate the town council assisted at least three of those families in relocating to the Meadow Lake area by paying on their behalf homesteading fees for new farms (Town of Herbert 1988). Given that the town had a population of 1,009 in 1931 (Dominion Bureau of Statistics 1936, Census of Saskatchewan p. 400), it can be appreciated how the departure of so many families in one year could be perceived as an exodus.

Four interviewees said they believed the provincial government provided direct relocation assistance to some migrants, but having not migrated themselves, they were not certain of the specifics. Oblique references were also found to provincial rail assistance programs in local histories. A search was later made at the provincial archives in Regina for details of such programs. There, handwritten records were found, made by officials overseeing the relocation of families and their effects from the drought-stricken regions and paid for by the provincial government (Saskatchewan Archives Board [Department of Agriculture Records] 1935). Under the Re-establishment Assistance program, migrants were provided with rail cars for their livestock and possessions and could relocate anywhere they chose within Saskatchewan, to other provinces, or even to the US. As an example, Fig. 10 shows

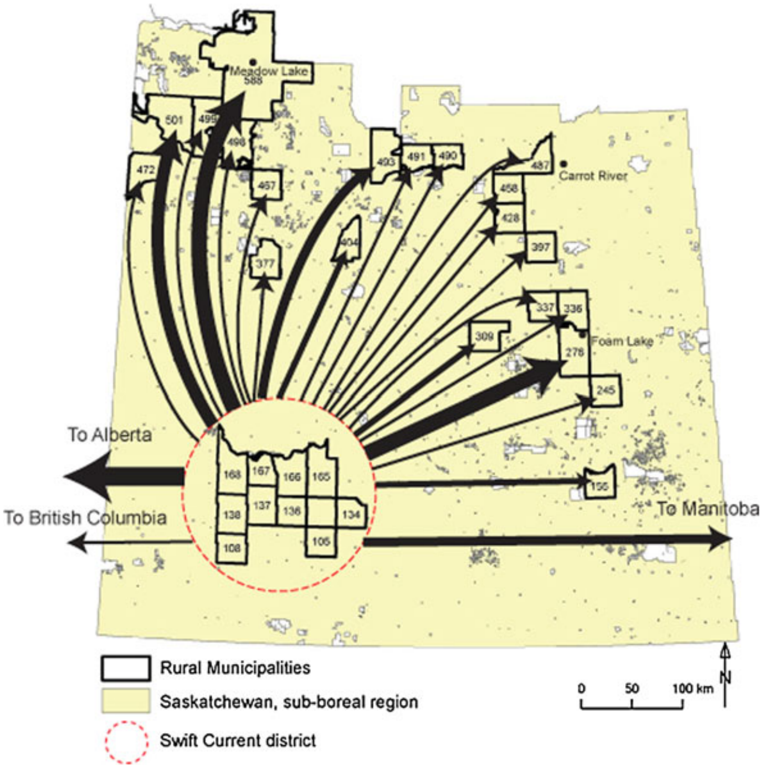

Fig. 10 Destinations of migrants relocating from Swift Current district with assistance from provincial rail-passage program, 1934. *Note*: Thickness of arrow is proportional to the number of families relocated. *Data source*: Saskatchewan Archives Board [Department of Agriculture records] (1935)

Table 1 Rural municipality of origin of government-assisted migrants, 1934

RM of origin	Name of origin	No. of families moved by government	RM of origin	Name of origin	No. of families moved by government
105	Whiska Creek	3	138	Webb	5
108	Bone Creek	3	165	Morse	5
134	Shamrock	2	166	Excelsior	17
136	Coulee	2	167	Sask Landing	3
137	Swift Current	3	168	Riverside	4

Data source: Saskatchewan Archives Board [Department of Agriculture records] (1935)

the destinations of migrants who left the study area in 1934 under this program. Again, this information is consistent with the anecdotal information provided by interviewees that destinations in the Parkland were the most popular among migrants. Table 1 breaks down the assisted migrants by Rural Municipality (RM) of origin as recorded in the official records. It shows that a disproportionate number of assisted migrants left from the RM of Excelsior in 1934, the rural area stretching south from the Saskatchewan River, with the town of Herbert situated at its southeast corner. The archived records did not reveal reasons why this RM had such high rates of assisted resettlement that year, and we are presently able to only speculate why.

Two interviewees had actually participated in the northward migration to the Parkland, although without government assistance. One accompanied her father, who had decided to quit farming altogether because of drought-related crop failures and seek railroad work in the north. She was by that time an adult and soon returned back to the Swift Current district on her own, unsatisfied with her own prospects in the Parkland. Another, younger, interviewee migrated northward with his parents in 1932 when their farm ran out of well water. His family earned a living in the north cutting lumber and vegetable gardening; he returned to the Swift Current district as an adult.

When asked what factors distinguished migrants from non-migrants, interviewee answers clustered around two themes. One was debt, its effects described by twelve interviewees. Many of those who left were said to owe large amounts of money on their property taxes and/or on mortgages. Interviewees did not recall anyone being forcibly evicted from their lands by the government for failure to pay outstanding taxes, but believed that indebted people eventually left their farms of their own volition. One interviewee recalled how in 1940 his neighbor offered to sell him a large farm with good buildings, which had been in the family since the original homestead, for $3,400, the amount still owing to the bank. This interviewee's father discouraged him from buying that farm, and indeed, the next owner also went on to lose the farm because of unpaid debt.

A second theme, which ultimately became the genesis for this article, was that in many parts of the district, the soil was simply too sandy to retain moisture for a sufficient length of time during dry periods, and twelve interviewees stated that those who migrated had had farms on such land. Related to this was a suggestion by two interviewees that migrants may also have had poor groundwater supplies. Interviewees whose families remained on their farms throughout the drought invariably reported that their farms had had good soil with a significant percentage of clay, and good wells.

To further gauge the accuracy of interviewees' observations with respect to soil and migration, we later entered township level population data for the census years 1931 and 1936 and Canada Land Inventory (CLI) information for the study area into an ArcGIS database. As shown earlier in Fig. 2, soils in the study area range from classes 2 through 6, with class 3 (moderately severe limitations and/or special conservation practices required, often because of moisture limitations) being the most common class. Soils in classes 4 through 6 have severe limitations on productivity or may be suitable only for forage. We consequently aggregated the CLI categories into two groups for analytical purposes: categories 2–3 in one and categories 4–6 in the other. These two groups are reflected in the background layer on Fig. 11.

There are 174 townships in the study area, 160 of which intersect areas of category 4–6 lands and 45 where the majority of land is category 4–6. Category 2–3

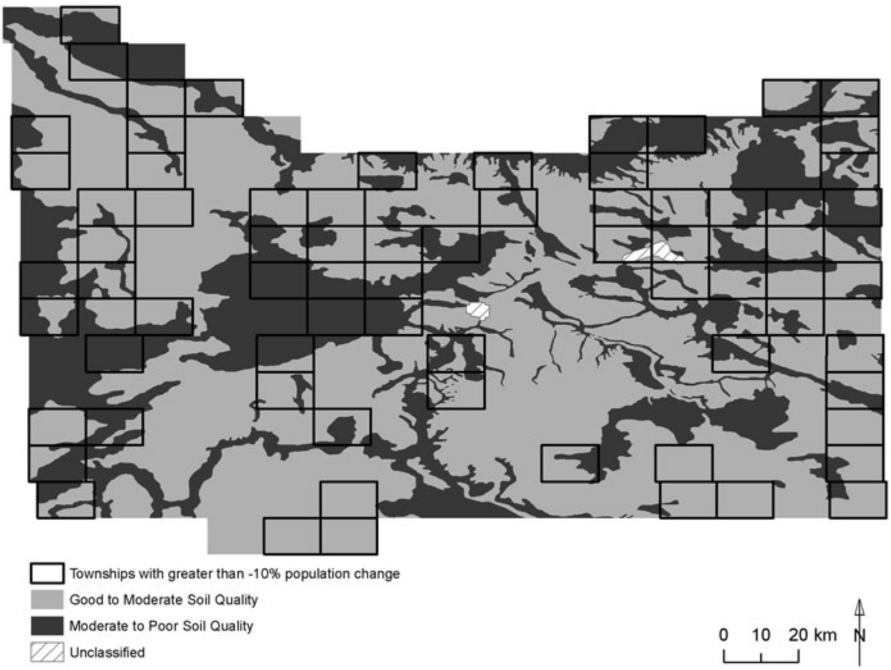

Fig. 11 Comparison of agricultural land classifications with population loss > 10% at the township level. *Note*: CLI Class 1 (No significant limitations), Class 7 (No capability for arable culture or permanent pasture), and Class 8 (Organic soils) are not present within the area of interest

lands predominate in 129 townships. Of the 174 townships that in total make up the study area, 120 (69%) lost population between 1931 and 1936 (Dominion Bureau of Statistics 1936). Of the 129 townships where category 2–3 lands predominate, 86 (67%) lost population. Of the 45 townships where category 4–6 soils predominate, 34 lost population (76%). The total population loss of townships intersecting category 4–6 land was 2,153. The total population loss from townships where category 4–6 land predominates was 685; the total loss from townships with no category 4–6 land was 240. These figures are consistent with the possibility of a general association between poorer land quality and higher rates of population loss during the study period. We can not be more conclusive because the model does not track population change at subtownship levels. It is possible, for example, that in townships where better category land dominates, population loss may have been higher in sections with poorer soil.

An indirect way of further checking for an association is to assume that if soil does influence drought migration, then townships with highest rates of population loss might be expected to have a high intersection rate with poorer quality land. To test this idea, we selected only those townships that lost 10% or more of their population during the study period and superimposed their boundaries on the land classification information (Fig. 11). Of these 72 townships that appear in Fig. 11, all but four intersect areas of category 4–6 land. Twenty-two of the townships shown here are among the 45 where category 4–6 land predominates, a capture rate of 49%. The remaining 50 shown here are drawn from the 129 where category 2–3 soils predominate, a capture rate of 39%. Such patterns are again consistent with the suggestion that higher rates of out-migration were associated with areas of poorer quality soils, but we again reiterate that they are not proof of a causal relationship. Even were it possible to demonstrate that the observed population trends were statistically correlated to land quality, it is also very clear from the other data gathered during this project that other factors were also at work. We also note that half of townships with large areas of poorer quality land did not have above-average rates of population loss. There are a variety of possible explanations for this, a simple one being that some areas of poor soils were sparsely populated from the outset of the study period, their lands having attracted fewer farm settlers in the first instance. In short, soil conditions probably contributed to but did not dictate migration outcomes. Migration in this case study occurred within the context of broader drought adaptation processes, and outcomes witnessed during the study period did not occur independent of preceding human-environment interactions in the district.

Discussion and conclusions

The use of historical analogs as a means of understanding vulnerability and adaptation to adverse climatic conditions is a well-established methodological practice (Ford et al. 2010; Glantz 1991). The case study presented here provides a number of insights into factors that shaped the adaptation of rural households in the Swift Current district to the combined effects of unusually difficult environmental and economic conditions, insights that may be useful for those concerned about future adaptation and migration in response to drought. The case highlights the importance and interaction of four particular sets of factors—social capital, indebtedness, government relief, and soil quality—in shaping household adaptation. The observations with respect to indebtedness, social capital, and government relief are consistent with other studies of Depression-era drought adaptation and migration on the Prairies (e.g., Gilbert and McLeman 2010; Gray 1967; Marchildon 2005; Marchildon et al. 2008). The Swift Current case adds additional details, from the importance of beef rings to the guaranteeing of medical treatments by relief officers, which may not have been captured in previous scholarly accounts, and which enhance our overall picture of the diversity of adaptive responses employed by rural families. We focus the remainder of our discussion of this case study on linking findings regarding the influence of soil on migration back to the earlier literature review.

Every farm family in the Swift Current district was confronted with collapsed commodity prices throughout the 1930s and had to adapt in some way. Employment prospects outside the agricultural sector were bleak. Climatic conditions were also equally harsh across the study area throughout the decade. In other words, and in keeping with the language used in present-day global change research, farm-level *exposure* to adverse conditions was more or less the same in terms of severity and duration across the study area. The situation of being exposed to coincident environmental and economic adversity, also described as “double exposure”, is not unique to this case study and has been identified as being particularly prevalent in many rural areas of the developing world today (O’Brien & Leichenko 2000).

In terms of their *sensitivity* to this double exposure, farms in the district were similar in a number of ways. Most farms were family operated, of similar size and capital value, and heavily reliant on the wheat crop for cash income. Farm level management practices were generally similar, and irrigation was not practiced. Two factors, however, distinguished individual farm-level sensitivity to the combined effects of drought and economic hardship, these being the relative amount of household debt and the quality of a given farm’s soil and groundwater. While soil erosion has been referred to as a migration driver in a number of studies and descriptions of Depression-era migration elsewhere on the Great Plains, it was the specific reference of interviewees to distinctions between sandy land and gumbo land that led us to pursue this question and to investigate the soil-migration association using the GIS model. Although the majority of rural townships in the district experienced population decline between 1931 and 1936, townships with acreages of poor or middling-quality agricultural soils had a higher rate of representation among those with above-average rates of decline. Farms situated on sandy land appear to have had a higher degree of sensitivity to drought, thereby elevating their family operators’ vulnerability relative to other farm families in otherwise similar circumstances. Consequently, as the rural population adapted to year upon year of hardship, the adaptation option of migrating elsewhere would have had the most attraction for the more highly vulnerable families working poorer quality land.

While the quality of soil was an important factor that helped distinguish migrants from non-migrants, it was also clearly not the only one. Good soil was in itself no guarantee of surviving the drought without migrating, and those who stayed on the land relied on a diverse mixture of adaptive strategies that entailed a heavy reliance on extended family and social networks. Farms situated on good quality soils also experienced drifting sand, dust storms, and insect infestations that resulted in low crop yields and made farm life difficult. Farmers working with good soils were just as prone to using techniques that contributed to soil erosion and desiccation as were farmers working poorer land, but were fortunate in that the presence of clay made their soils relatively more productive during drought conditions in spite of their farming techniques.

While the findings relate to a particular time and place, they provide useful suggestions for future research by those concerned with the potential for anthropogenic climate change to displace rural populations in coming decades. Other things being equal, farms on sandier soils are more likely to be sensitive to precipitation shortfalls and extreme heat events than farms situated on soils with greater moisture-retention capacity. Identification of such areas today is straightforward and can be a first step in helping policymakers, planners, farm operators, and their dependent communities recognize and assess adaptation needs and opportunities and potentially avoid crisis situations where distress migration might ensue. Soil maps have long existed for many regions and countries, even many developing ones, and are increasingly available in digitized form. However, these have not always been included in exercises that identify and map rural population vulnerability to climate change. Using GIS, soil inventories may be combined with downscaled regional climate models, crop yield forecast models and socio-economic datasets to identify at relatively fine resolutions those rural populations with a high potential for out-migration during extended precipitation shortfalls and extreme heat events.

Finally, despite the hard-earned lessons of the past, soil conservation and management do not always command the same degree of public attention as do other global environmental challenges. They should. They also warrant additional attention by scholars interested in environment and migration. There is opportunity here for researchers and public policymakers to better understand the role of environment in rural population dynamics and to enhance our ability to anticipate and plan for future rural population movements through renewed interest in the study of soils, their wise management, and their role in shaping rural household vulnerability.

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