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THE 2001–2002 DROUGHT: VULNERABILITY AND ADAPTATION IN ALBERTA'S SPECIAL AREAS

JOHANNA WANDEL, GWEN YOUNG, AND BARRY SMIT

Abstract

Insights into vulnerability and adaptation of particular cases can be gained through examining management of past stresses. This paper uses the example of the 2001–2002 drought in Alberta's Special Areas to examine the exposure-sensitivities and adaptive strategies of stakeholders within the region. Not all stakeholders were equally affected, as the existence of a secure municipal water supply mitigated the impact of the drought for urban users. Among the agricultural community, dryland farmers faced particularly great challenges, though all producers, including those with access to irrigation, were negatively affected. Locally-based institutions, who have a long history of drought management, facilitated some drought management strategies.

Sommaire

L'étude de la gestion des stress auxquels une collectivité a été soumise dans le passé fournit des renseignements utiles à l'égard de la vulnérabilité et de l'adaptation. Cet article s'appuie sur la sècheresse de 2001–02 dans les zones spéciales de l'Alberta afin d'étudier la sensibilité des intervenants de la région par rapport aux divers facteurs de stress auxquels ils sont exposés et les stratégies évolutives déployées par ceux-ci. Certains intervenants furent plus touchés que d'autres. La présence d'un réseau municipal sûr d'approvisionnement en eau a atténué de façon substantielle les impacts de la sècheresse pour les habitants des régions urbaines. Chez les collectivités agricoles, les producteurs en régime d'aridoculture ont dû faire face à de particulièrement grands défis, bien que tous les producteurs, incluant ceux ayant accès à l'irrigation, furent touchés de façon négative. Les institutions locales, qui depuis longtemps travaillent sur la gestion relative à la sècheresse, ont favorisé l'établissement de stratégies de gestion en cas de sècheresse.

1. Introduction

Recurring persistent dry periods have been documented for the southern Canadian Prairies for over 400 years,[1] including the well-known case of the "dust bowl" years of the 1920s and 1930s.[2] While persistent dry periods invariably have had economic and social impacts on Prairie residents, recent drought events have not had the same catastrophic implications, including loss of livelihood and displacement, as earlier events. This is particularly notable in the case study presented in this paper, the Special Areas of southeastern Alberta. As a result of the droughts of the 20s and 30s, the majority of the land within the present-day Special Areas reverted to the Crown as tax recovery land; however, the drought of 2001–2002 had no similarly dramatic and visible impacts. This difference in impact is attributed to changes in differential vulnerability of this area of the southern Prairies.

The concept of "vulnerability," commonly defined as the degree and manner to which a system of interest is susceptible to and unable to cope with the adverse effects of climate, incorporates both the characteristics of the system of interest and the nature of the stimulus that acts upon it.[3] In the context of this paper, the system of interest is a study area in southern Alberta and the stimulus is a drought event. The implications of drought on southern Alberta reflect the region's physical landscape, the existing human land-use system, and the human and financial capital of its occupants. A region's vulnerability to a persistent dry period is thus related not only to a deviation from hydrological norms but also to the human use of and reliance on water and the available coping mechanisms to manage periods of insufficient moisture.

Under climate change models, it can be expected that drought stress and surface water availability shortages in the southern Prairies will increase due to increased temperatures and decreased snow pack.[4] Consequently, there is considerable interest in identifying the ways in which drought is managed in southern Alberta. This paper investigates the vulnerability of the case study of Alberta's Special Areas during the 2001–2002 drought. Impacts of and responses to the extended dry period are documented at the local level, and conclusions are drawn with respect to adaptation, adaptive capacity and vulnerability in the study region.

2. Vulnerability and Adaptation to Climate Change in Agriculture

The southern Prairies have experienced several multi-year drought episodes since the mid-1980s.[5] The most recent drought of 2001–2002 is estimated to have had a range of impacts on the Canadian economy, including agricultural production losses of $3.6 billion and negative or zero net farm income in Alberta and Saskatchewan for 2002.[6] There is a recognized need for a better understanding of agricultural adaptation to climate variability and change to improve farmer ability to cope with or manage periods of stress.[7]

Considerable research effort has estimated production and economic implications of changing climate normals for the agricultural sector at the macro scale.[8] However, there has been less research on how farmers experience actual climatic conditions, the implications of particular conditions, the management strategies available to respond to these and associated constraints, and opportunities for enhancing adaptive capacity.[9] There is also comparatively little information on what particular conditions pose problems, what has been done in response in the past, and what lessons these provide for what could be done in the future. Some of the few examples of actual experience of climatic conditions and associated risks, opportunities and management strategies were framed using the concepts of vulnerability and adaptation.[10]

Vulnerability can be conceptualized as reflective of exposure-sensitivity and adaptive capacity.[11] Exposure relates to how a system experiences an external stress such as a persistent dry period, while the system's sensitivity to the stress reflects its use of affected resources and is thus a function of livelihoods and occupancy characteristics. Adaptive capacity includes available adaptation tools and strategies and the ability of individuals and institutions within the system to implement these given financial, managerial, time and other constraints. Research in recent years has highlighted the need to consider climate-related stimuli in the context of other stresses.[12] Considerations of exposure-sensitivity and adaptive capacity necessarily include opportunities and constraints introduced by other non-climatic processes including falling cattle prices due to BSE outbreaks and labour shortages given the upswing in Alberta's economy.

Key insights for understanding how a system may be affected by and respond to a climatic stress in the future can be drawn from the ways in which the stress is currently managed or has been managed in the recent past. Documenting the impacts of and responses to the 2001–2002 drought in the Special Areas provides a basis for identifying what magnitude of moisture stress is manageable, and what conditions fall beyond the available adaptation strategies. An analysis of what stresses occurred, how these impacted individuals and how these were managed, allows an identification of what management strategies can be further strengthened so as to increase the ability to manage problematic conditions in the future.

Documentations of vulnerability via examinations of exposure-sensitivities and adaptive strategies draw on a number of sources. Stakeholders themselves provide accounts of the ways in which they experience climatic (and other) stresses, how these have been managed in the past, possible unrealized opportunities, and speculations of impacts and adaptations in "what if" scenarios. The research for this paper is based in part on detailed narrative accounts of households, water managers, and agricultural producers of climatic and non-climatic stresses during both a "normal" year and the 2001–2002 drought, and the implications of cumulative persistent dry periods. Further data inputs are derived from key institutional informants, secondary source material, and climatic records to fully understand exposure-sensitivities and adaptive strategies and capacities.

3. Case Study: Alberta's Special Areas

3.1. Methodology

Under climate change, it can be expected that moisture stress and surface water availability shortages will increase in the southern Prairies. This paper draws on case study research to document how vulnerability and adaptation are experienced at the local level during one period of stress, the 2001–2002 drought. Data sources include published secondary source material, census and instrumental records, and interviews with key informants and stakeholders.

Forty-three interviews were conducted by two female interviewers with residents of the western portions of the Special Areas, Special Area 2 and the Town of Hanna, during a five-week period. Initial contact with the community was made via the local Agriculture Canada/Prairie Farm Rehabilitation Administration field office, and the researchers familiarized themselves with the local context through attendance at water managers association and irrigation committee meetings, as well as through key informant representatives from the federal government, regional administration, local government, the municipal water commission, and an environmental non-governmental organization. Further study participants were selected by the researchers in collaboration with local key informants using a stratified sampling frame to ensure that the range of agricultural enterprises present in the study area were included in the research. Table 1 outlines the agricultural producers, non-farm residents, and key informants who were consulted.

Interviews followed a semi-structured protocol based on an interview guide. Interviews ranged from 30 to 150 minutes in length. All interviews were audio recorded and subsequently transcribed. Interview data were analyzed with the help of qualitative data management software.[13]

3.2. The Context of the Special Areas

Alberta's Special Areas comprise a tract of 2,024,292 hectares (ha) north of the Red Deer River and just west of the Saskatchewan border between 50.6° and 53.3° north and 110° and 112.5° west (see Figure 1). The majority of the municipality falls within Palliser's Triangle, with soils primarily in the Brown (GA) and Dark Brown (GB) Chernozem soil groups.[14] Most of the area

KEY INFORMANTS	#
Mayor, Town of Hanna	1
Special Areas Board Chairman	1
Special Areas Board Past Chairman	1
Special Areas Bullpound Pasture Manager	1
Special Areas Ditchrider/Water Plant Operator	1
Henry Kroeger Water Plant Personnel	2
Agriculture Canada Field Staff	2
Ducks Unlimited Field Staff	1
Oil Industry Representatives	2
Crop Insurance Agent	1
Sheerness Generating Station Engineer	1
PARTICIPANTS	**#**
Non-farm Residents	6
Dryland Farmers (no livestock)	1
Dryland Farmers, Mixed Operation (cash crops and livestock)	8
Ranchers (no cash crops, no irrigation)	6
Ranchers (no cash crops, irrigation for pasture/feed)	6
Irrigated Farmers (crops and livestock mixed)	2
TOTAL INTERVIEWS	**43**

Table 1. Sample Description.

receives less than 250 mm precipitation per annum[15] with a gradual increase toward the north and north-west, where long-term precipitation averages reach as high as 400 mm per annum (Figure 1). Evaporation generally exceeds precipitation throughout the study area, and consequently Solonetzic[16] soil groupings are common in parts of the study area, including 30% or more of all land in the Special Area 2.

This region of Alberta is part of the dry mixed-grass natural grasslands, characterized by treeless prairie with shrubs and trees only in relatively moist areas such as coulees and river valleys. The area was settled beginning in 1909 in accordance with the Dominion Lands Act, which granted settlers title to one quarter section of land[17] under the condition that a fee was paid, a house built, and one-fifth of the land area was cultivated within three years. Population of the area increased from 75 in 1901 to 24,164 in 1916 and an all-time high of 29,689 in 1921. Consequently, substantial areas of native grasslands were plowed and wheat was established as the dominant crop.[18]

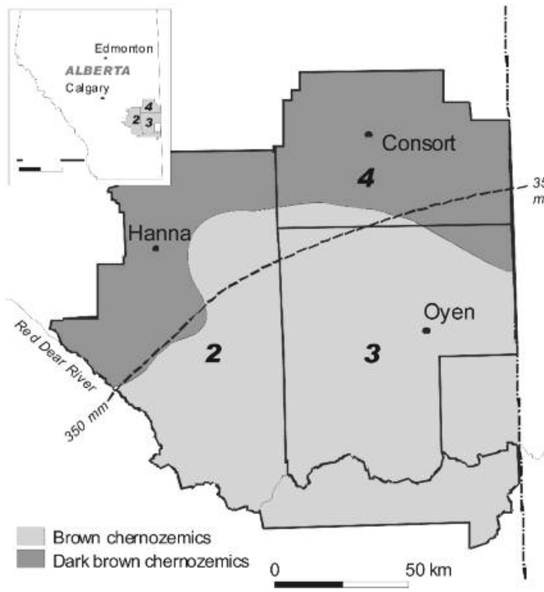

Figure 1. Alberta's Special Areas.

A period of relatively abundant rainfall in south-eastern Alberta ended in 1916, and the area experienced eight successive years of low precipitation and poor harvests. Poor harvest and wind erosion led to many settlers being unable to meet tax obligations and subsequent out-migration with claimed land reverting to the Crown The region was closed to settlement under the Dominion Lands Act in the 1920s. The Special Areas Act of 1938 replaced regional government in this region with a crown agency which manages the remaining never claimed crown and tax recovery lands and set up a governance structure which is distinct from the rest of the southern Prairies.[19] Unlike the remainder of Alberta's counties and municipal districts, regional government falls directly under the authority of the Province. The Special Areas are under the direction of the Special Areas Board, which consists of the Chairman appointed by provincial cabinet and two board members which are nominated by the Special Areas Advisory Council and appointed by the provincial department of Municipal Affairs and Housing. The Special Areas Advisory Council itself has 13 elected members. The Special Areas Board has no set term of office, and thus administration of the Special Areas does not follow the three year election cycle of the remainder of the province.

The Special Areas administration administers agricultural land with a view to drought management via cropping and grazing leases, parkland and community pastures. In addition to public land administration, the Special Areas Board is responsible for roads, water management, emergency and protective services, agricultural and rural economic development, and conservation.

The governance framework established by the Special Areas Act and the Agricultural Service Board Act (1945) allows the Special Areas Board to devote resources to prevent and mitigate some of the impacts of drought. For example, the Special Areas Agricultural Service Board has undertaken exten-

YEAR	RURAL	URBAN	TOTAL
1941	11794	3325	15119
1946	9542	3504	13046
1951	8430	4076	12506
1956	8723	4657	13380
1961	8799	5256	14055
1966	7974	5354	13328
1971	7050	5250	12300
1976	5824	5182	11006
1981	6042	5535	11577
1986	6261	5850	12111
1991	6010	5835	11845
1996	5765	5725	11490
2001	5756	5703	11459
2006	5314	5526	10840

(Urban areas include the Towns of Hanna and Oyen, Villages of Consort, Cereal, Veteran, Youngstown, and Empress.)

Sources: data up to 1976 from Gregory P. Marchildon, "Institutional Adaptation to Drought and the Special Areas of Alberta, 1909–1939," *Prairie Forum,* vol. 32, no. 2 (2007): 263; data after 1976 from Alberta Municipal Affairs Statistics.

Table 2. Rural/Urban Population in the Special Areas, 1941–2006.

sive research into, and the promotion of, zero tillage initiatives to decrease wind erosion during dry periods, and has recommended particular mixes of native grasses for reseeding grazing leases. To generate research with particular relevance to the drought-prone Special Areas, the Agricultural Service Board established the Dryland Applied Research Association now known as the Chinook Applied Research Association.

The Special Areas currently have a population of 10,840, of which just over half live in towns and villages. The rural population of the Special Areas steadily decreased from a record of 26,031 in 1921 to 5,314 in 2006, while the urban population (in the towns of Hanna and Oyen and the villages Cereal, Consort, and Empress) increased until 1961, but has been slowly declining since.

Primary industries remain as the dominant source of employment within the Special Areas, accounting for 39% of all jobs. Table 3 illustrates the urban/rural difference in employment by sector, with agriculture as the dominant sector in the rural areas, and sales and service related occupations leading in towns and villages. Towns and villages are classic service centres for the rural population with a diversified wage base. The rural areas are still primarily agricultural areas by employment, though the oil and gas industry has gained some prominence in recent years. Currently 7% of all jobs within the Special Areas (for both rural and urban residents) are oil and gas related (extraction, service, manufacture of related lubricants, absorbents etc.) In addition, Sheerness Generating Station and the adjacent Luscar coal mine provide employment for over 100 people.

	TOTAL	RURAL	URBAN
Total employed	6,240	3,340	2,900
By sector (%)			
Management	6	1	12
Business/administration	10	8	13
Science related	2	1	2
Health	4	3	6
Education/government	5	4	6
Arts/recreation/sport	1	1	2
Sales/service	17	8	27
Trades	15	10	19
Primary (total)	39	62	13
Agriculture	36	59	10
Manufacturing/processing	3	3	2

Source: Census of Population, 2001.

Table 3. Employment by Sector.

3.3. Current Land Use in the Special Areas

Currently, 60% of the Special Areas is made up of public land (30% never-claimed crown lands and 30% tax recovery lands). Public land is primarily used as community pasture (6%) and leased (91%) under various terms, with the majority of the remainder designated as parkland. The most common arrangements are grazing leases, which are for 20 years, and 10-year cultivation leases, although there are also a number of small oil and gas development leases.

The 2001 Census of Agriculture data indicate that 96% of the total land area of the Special Areas was used for agriculture, with 73% of the public land area leased by individual producers for agriculture. Since the Dust Bowl years, the area tilled has decreased dramatically—in 2001, only 24% of the total farm area was under crops. Wheat remains the most common crop (52% of farmers reporting / 10% of the total farmland area), followed by alfalfa and alfalfa mixtures (43% reporting / 4% of land area), oats (36% reporting / 2% of farmland area), barley (25% reporting / 3% of land area), and tame hay (15% reporting / 1% of land area). Other crops reported by more than 100 of the 1,437 farmers but comprising less than 1% of the total farmland area are mixed grains, rye and canola.

Of the five leading field crops, four can be and are commonly used as livestock feed. Given that that the majority of the public land leased to farmers is classified as grazing leases, it is not surprising that 74% of all agricultural producers in the Special Areas report cattle. While there are a handful of dairy farms (16 total), the majority of the cattle producing enterprises are cow-calf operations, stocker operations, and feedlots. In many cases, cow-calf operations also function as stocker operations, and feedlots also include stocker operations.

3.4. The 2001–2002 Drought in the Special Areas

The extent of the early 21st century droughts in the Canadian Prairies is well documented.[20] Based on the Palmer Drought Severity Index, the Special Areas suffered a drought in both 2001 and 2002.[21]

This case study is focused on exposure-sensitivities and adaptations at the producer scale in the Special Areas. Consequently, moisture availability is considered in light of farm operations, that is, consideration of moisture is needed and what other sources are available at critical times. Both crop production and ranching are particularly sensitive to early growing season (April-June) moisture shortages, since crops and tame pastures require rain to germinate and establish themselves.[22] Furthermore, if there is insufficient precipitation during the late growing season (July-September), crops wither and lose their value. Native prairie grass retains its nutritive value during droughts so long as it is well established. Impacts on native species are particularly severe if there is little soil moisture at the beginning of the growing season, and this is related to the previous year's conditions and, most importantly, to snowfall in the early part of the calendar year. Figure 2 illustrates the particularly low early and late season growing

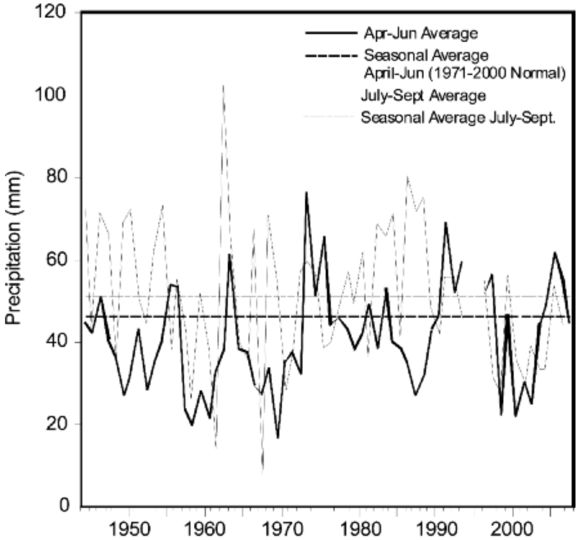

Figure 2. Early and Late Growing Season Precipitation at Coronation.

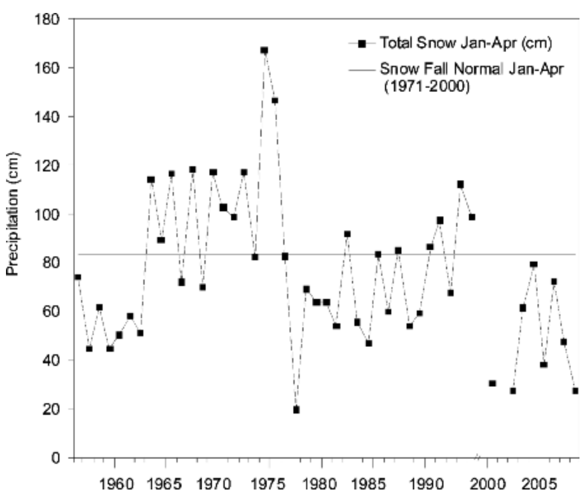

Figure 3. January-April Snowfall at Coronation.

seasons for 2000–2002 inclusive, and Figure 3 shows that snowfall was less than one third of the long-term seasonal average in the spring of 2001 and considerably below normal in 2002.

Moisture stress in the Special Areas was compounded by grasshopper outbreaks in 2002. Grasshopper populations are particularly high after two to three years of hot, dry summers and snow-free falls.[23] Conversely, wet and cool springs provide conditions which curtail grasshopper hatching, and serve to stop an outbreak.[24] Conditions during 2001–2002 provided the basis for record numbers of grasshoppers in 2002, and set the stage for another year of outbreaks if the spring of 2003 was dry.[25] Grasshoppers denude areas of all vegetation, including crops and tame and native grasses. Given the low precipitation values throughout the growing season that year, little regrowth was possible and thus both crop farmers and livestock producers relying on grazing and feed production were affected.

3.5. Water Use, Exposures, and Adaptation in the Special Areas

Water for household, industrial, and farm use in the Special Areas comes from three sources: groundwater, precipitation and associated spring run-off, and surface water via the Red Deer River and small-scale diversion projects. Water uses include household and drinking water, stock water for livestock, irrigation, recreation, and industrial uses for thermal power generation and in oil and gas drilling.

3.5.1. Industrial Water Use

The largest single industrial water user in the Special Areas is the Sheerness Generating Station. ATCO Power built Sheerness Thermal Generating Plant in 1986. The plant, which was originally designed to produce 380 megawatts (MW) of electricity, was expanded in 1990 to boost the coal-fired plant to 760 MW. Thermal generating stations produce electricity by heating water in large boilers to create steam, the steam spins turbines, and the turbines create electricity. The Sheerness plant was built next to its coal supply, the adjacent Luscar mine. Water is required both for thermal generation, and for cooling. To meet this need, ATCO built a raw water pipeline from the Red Deer River to the plant at the time of construction (see Figure 4).

Intake pumps on the Red Deer River can only divert water during the ice-free period (April-October). Water is pumped to the Sheerness Cooling Pond. The plant then withdraws water from the pond for its own fire water system, for treatment which in turn produces potable water and demineralized water for equipment cooling and the boiler, for the condenser and for general service. In 2005, ATCO diverted a total of 19,324 megaliters (ML) from the Red Deer River. Of that, 1,933 ML were withdrawn from various pipeline tap-offs before

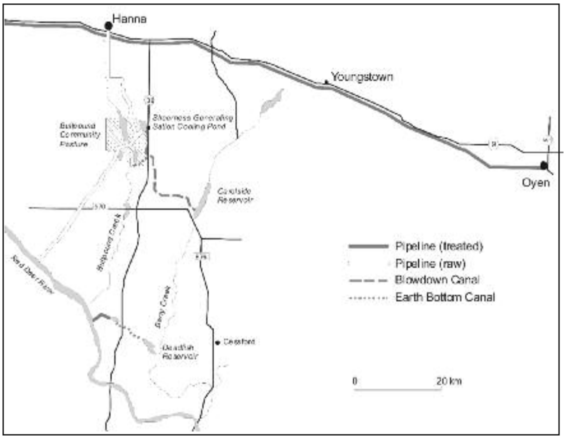

Figure 4. Surface Water Delivery in the Special Areas.

reaching the Cooling Pond. 17,391 ML entered the cooling pond. The largest consumptive water use at this stage was evaporation (9,213 ML), which was only partially offset by precipitation (1,239 ML). 221 ML were consumed by the generating plant.[26] The largest portion of the water, once it had served its cooling functions, was released via the Blowdown Canal (Figure 4).

Since ATCO can only pump during ice-free months, the cooling pond serves as long-term storage. However, it is constructed larger than needed for the plant alone and serves as a recreational facility for the Special Areas population. Similarly, water releases via the Blowdown Canal are higher in volume than the plant needs for operation as part of ATCO's agreement with Special Areas to contribute to irrigation (see below). The determining factor for pumping from the Red Deer River is turbidity, and turbidity increases with precipitation. Thus, so long as there is sufficient water in the Red Deer River to meet ATCO's water license requirements without compromising inter-provincial allocation, the generally temporary disruption in pumping caused by turbidity is the only limiting factor. To date, the Red Deer River is not over-allocated, and there has never been too little flow for ATCO to pump, and low precipitation actually facilitates pumping through low turbidity. Consequently, ATCO power was not greatly affected by the droughts beyond less rainfall input into the cooling pond and thus slightly higher pumping volumes.

The oil and gas industry represents the other large industrial water use. Water is used in both drilling and "fracing" (a process which fractures layers of formations to gain access to further deposits). While the oil and gas sector is allocated just over 7% of Alberta's total water licensing (and 1.1% of all groundwater allocations), this allocation is not currently used in full.[27] Actual water use in the oil industry at the municipal scale is not well documented. Key informants note that drilling often uses untreated, highly saline groundwater. A local oil industry support company supplies treated water for fracing using municipal water as an input supply. An industry informant noted that treated water is expensive, and companies commonly source slough and dugout waters as close to the drilling site as possible. In some cases, the oil companies will pump Red Deer River water.

3.5.2. Municipal Water

Since the 1980s, the Towns of Hanna and Oyen and the Highway 9 corridor have been supplied with treated water via the Henry Kroeger Regional Water Services Commission. The Commission operates a treatment plant in Hanna which is supplied via raw water pipeline from the Town of Hanna reservoir near the Sheerness Generating Station (see Figure 4). This reservoir is filled by a tap-off from the ATCO raw water pipeline. The Commission can only fill the town reservoir if ATCO is pumping, which in turn depends on the generating station's needs and turbidity at the intake on the river. Pumping is limited to the summer months (April to October), meaning that the Commission needs to store a minimum of five months' worth of water in the reservoir.

The Hanna Reservoir was recently expanded and currently has a capacity of 913,000 cubic meters. In 2005, the Henry Kroeger water treatment plant diverted 1,006,000 cubic meters with an output of 833,023 cubic meters of treated water.[28] In 2005, 55% of the treated water was consumed during the spring and summer (April to September), though this figure is higher during particularly dry years due to lawn and tree watering among municipal water users. Given that current annual demand for water is less than the total storage capacity in the reservoir, the supply is considered secure. Similarly, the plant is rated at a maximum capacity of 7,500 cubic meters per day. The plant manager estimates that the Henry Kroeger treatment plant, including its supply, is operating at only 50% of its total capacity.[29]

In the event of a power failure, the plant's generators are insufficient to continue treating water. A plant technician estimates that the plant's storage of treated water, the "clear well," can hold approximately one day's worth of winter demand—the same volume would be exhausted over approximately eight daytime hours in the summer. Thus, the municipal water supply is exposed to anything which disrupts the continuous operation of the plant such as interruption of electrical power supply, major maintenance operations, or a failure in the raw water pipe from the Hanna Reservoir. The Henry Kroeger Regional Water Services Commission is currently planning to expand the clear well to address this. In addition, the three main clients of the plant (the Town of Hanna, and the pipelines running east and west) maintain their own storage facilities which can serve as a buffer in these situations. Smaller clients use coin operated treated water tank filling stations which access the pipelines in various locations. So far, end users have always been able to access water since the plant has been in operation, though there have been multiple instances where water treatment was halted for more than 24 hours and backup storage reservoirs had to be used.

In addition to the Henry Kroeger plant, there are smaller municipal water plants in the Special Areas. For example, the Cessford treatment plant serves a school and under 30 households. It stores a year's worth of water in two dugouts adjacent to the plant. The dugouts are recharged in the spring from the Carolside Reservoir (see Figure 4 for the location of canals and reservoirs), which in turn is recharged via a canal originating in the Sheerness cooling pond. While the dugouts have never been empty in the spring, these small plants have very limited capacity and could not accommodate large users.

The exposure-sensitivities in municipal water supplies are currently not related to precipitation given that municipal water primarily originates in the Red Deer River, which in turn originates in the Rocky Mountains and is heavily influenced by accumulated snowpack. Currently, the Red Deer River has greater capacity than is needed for existing water licenses, even during dry years. Consequently, the only additional stresses placed on the municipal water system during the 2001–2002 drought related to increased consumption. Given the high capacity of the system relative to use, higher consumption was easily met using existing resources.

The six non-farm residents consulted for this research were all connected to Henry Kroeger water. Their recollection of the 2001–2002 drought focused on the unpleasantness of the grasshopper infestation. One non-farm resident noted that her water bill went up substantially with increased consumption as she chose to water her yard trees. None of the residents decreased water consumption during this time.

The stability of the municipal water supply and the unused capacity for further supply are considered one of the key selling points for attracting business to Hanna by its mayor. He noted that a secure municipal water supply is "obviously very important for rural communities to survive. If you don't have quality water, it's difficult to bring in industry or any kind of residency of that nature"[30] and the Henry Kroeger plant put the Town of Hanna "in a position because of this to build for more lifestyle which of course encompasses quality of water, encompasses industry that needs volumes of water . . . (it puts) us in a position as a community to continue to look forward to economic growth."[31]

Due to the combination of the ATCO pipeline and the Henry Kroeger system, droughts are completely mitigated for urban residents and Hanna businesses. For urban water users, water is provided by the tap, and the tap has never run dry and is not expected to do so considering the reserve capacity built into the system.

3.5.3. Groundwater

There are an estimated 8,000 water wells accessing the groundwater resources under the Special Areas.[32] Close to 90% of these wells were completed for household and stock watering; the remaining wells serve uses such as irrigation, municipal water supply (for towns and villages not on the Henry Kroeger pipeline), industrial use and observation.

Well depth ranges from 0.6 to 260 meters, and just under half of the wells draw water from surficial deposits with the majority under 30 meters.[33] The balance of the wells consists of bedrock water wells, and most of these are located in the north and west of the Special Areas. Surficial wells are generally high in dissolved iron content, while bedrock water wells carry a very high average sodium load.[34] The Guidelines for Canadian Drinking Water set maximum recommended dissolved solids limits for sodium, sulfate, chloride, and fluoride. Water quality, on average, exceeds federal guidelines for sulfate and sodium.[35]

Twenty-three rural farm residents participated in the research. Twenty-one of these used one or more wells on the property. Of the 19 agricultural producers who had wells, five used well water only for stock watering and hauled their drinking water, either bottled water, or water obtained with a water truck at a tank filling station. An additional two users were close enough to the Highway 9 treated water pipeline corridor to access this water for household use, though they used dugout and well water for stock.

The 2001–2002 drought had no observable impact on either flow rates or water quality in the wells of the producers consulted for this study. However, groundwater is always an issue of concern in the Special Areas as a result of poor quality and insufficient supply. This past stress meant that reliance on groundwater for drinking and stock water is already low, and residents already have numerous coping mechanisms in place to mitigate further quality and quantity decreases. In some cases, these coping strategies such as hauling water presented short-term adaptations to surface water shortages as well.

3.5.4. Precipitation and Spring Runoff

Both cash crop and livestock producers are highly dependent on precipitation. In the words of one producer, "our biggest limiting factor in this country is water."[36] Furthermore, the timing of precipitation events matters. Key times of year are the early growing season (April-June, germination and initial growth) and the late growing season (July-September, continued growth and maturation). In addition, the snowfall in the early part of the calendar year (January-March) matters as this is the source of spring runoff, which is important for soil moisture and dugout recharge. Figures 2 and 3 illustrate that all three of these seasonal parameters were well below the long-term averages during the drought.

Good spring runoff is important for cattle producers for grass growth and stock watering. Local spring snowmelt is important for both soil moisture and dugout recharge. With little spring runoff, dugouts will not fully recharge, and ranchers can run into stock water shortages on grazing parcels later in the year. Adequate moisture is required during the spring for grass to establish itself and get some good growth. During the drought, there was inadequate grass growth for both feed production and standing in pastures. Ranchers and mixed farmers reported difficulties meeting their feed supplies.

Most cattle producers routinely carry feed supplies from year to year, and "reserve" native grass pastures for contingency use through rotational grazing. However, prior to the drought, most ranchers only carried one year's worth of stockpiled hay. These supplies were insufficient. Six producers reported decreasing herd size to cope with less available feed and three others increased their pasture acreages. Since native grasses are more drought tolerant and retain their nutritive value even during extreme dry events once they have established themselves, three livestock producers have actively begun to reseed native grasses since the drought. Nine out of 12 ranchers reported carrying pasture insurance to offset the costs of purchasing more feed supplies. Finally, four of the eight mixed farmers realized that their cash crops would not bring them any profit, and turned cattle onto those fields to at least use the crops for feed.

Crop farmers felt similar impacts as livestock producers. The spring of 2001 was considered adequate for germination and crop establishment. However, cash crops require continued moisture availability to mature. One producer noted that "we start praying through the end of June."[37] Without early growing season moisture or sustained moisture throughout the growing season, yields and crop quality decrease. For crop farmers, this meant either taking an income hit or drawing on crop insurance.[38] Most mixed farmers and dryland farmers reported that they had decreased their areas under crops and some had increased the ranching aspects of their operation. Dryland farmers commonly reported increasing the area under zero tillage to control wind erosion.

In 2002 feed supplies and reserves were already low, and cash crops were severely impacted by the compounding stress of the grasshopper epidemic. One mixed farmer explained, "drought you can deal with. You know you can maybe save grass here and there, and you know we saved some here and two days later the grasshoppers went through and there's nothing. What you have kinda stockpiled you may as well say is gone."[39] For farmers who were hardest hit, this "double whammy" of drought and grasshoppers meant having to import feed, in many cases from out of province. Ontario farmers sent hay to the southern Prairies during this time, though Special Areas farmers felt that these shipments were of low quality.

The low snow cover during the drought years had implications beyond soil moisture for ranchers. Although many have access to wells on the home farm quarter, cattle spend the majority of the year out in pasture. Grazing is generally rotational, meaning that stock water supplies must be available throughout the pasture areas. This is met via dugout construction. Dugouts are generally recharged during the spring snowmelt, and supply enough water for an entire snow-free season. However, during the drought, low snowfall meant that dugouts were only partially recharged. With successive dry years, dugouts become further drawn down. Agriculture Canada data indicate that dugouts in the Special Areas were generally dry by September 2002. [40]

Livestock producers responded to low stock water levels in a number of ways. Reductions in herd size by culling older cows without replacing these with younger animals reduced some of the demand. Some ranchers hauled stock water, an expensive and labour-intensive undertaking, while others kept their herds close to more secure water supplies and hauled feed. Dugout improvements, which include fencing off the dugout and pumping water on demand via nose pumps, help preserve water quality in the dugout and allow a larger proportion of the volume to be used for stock watering. The local Agriculture Canada (PFRA) field office had actively promoted dugout improvements over the previous decade, and several ranchers reported that these improvements helped them manage their dugout levels during the drought. In addition, some ranchers had introduced non-precipitation dugout recharge. Seven farmers had either already or have since installed shallow pipelines for dugout recharge or stock water troughs. This is an option only if there is a secure water supply in reasonable proximity, and this was provided in some cases by the Blowdown Canal, in others by good wells on the home quarter.

Managing stock water needs during the drought placed an additional management and labour burden onto livestock farmers. Producers needed to consider their possible stock water supplies, and adjust rotations and herd sizes accordingly or, in the worst case scenario, resort to cost-prohibitive water hauling.

3.5.5. Irrigated Farming

The Special Areas do not contain irrigation projects on the scale of the southern Alberta Irrigation Districts. However, the Berry and Deadfish Creek watersheds in the southern portion of Special Area 2 provide some irrigation opportunities. The Special Areas Board maintains reservoirs on both creeks (the Carolside Reservoir on Berry Creek and the Deadfish Reservoir on Deadfish Creek). There are currently 26 irrigators in the Special Areas irrigation project. Of these, 11 are along the Blowdown Canal or on Berry Creek above its confluence with Deadfish Creek, five are on Deadfish Creek above the confluence, and ten are between the confluence and the Red Deer River. The Blowdown Canal is important as natural runoff into Carolside Reservoir and in most years equals evaporation from the reservoir, which is also used for recreation and thus is kept at a minimum level, and thus little if any water would have been available for irrigation during the drought without the ATCO contribution of almost 10,000 ML. The Deadfish Reservoir is filled via intake pumps on the Red Deer River.

Farmers who have irrigation agreements were affected by the drought in two ways: their own irrigation requirements increased due to poor natural precipitation. In the words of one producer, "the rain helps with irrigation, cause I don't care what anybody says, rain is way better than any irrigation, you can pump and pump it seems like irrigation wont go as good . . . even about three inches of rain just makes a load of difference with production."[41] Without precipitation, irrigators had their pumps running continuously and irrigation water supplies were insufficient. All of the irrigators included in this research were either mixed farmers or ranchers, and used irrigation for only a small portion of their farm enterprise. In many cases, irrigation was used to produce secure feed supplies. However, when water supplies ran low during the drought, all farmers were asked to reduce their water use and were threatened that they would be cut off completely if they did not comply. This meant that those who had relied on irrigation as a drought management strategy could not entirely meet their needs in this way. Furthermore, irrigators noted that the fuel costs of pumping water to pivots were too high for this to be feasible in successive drought years. A logical adaptation during the drought would have been to use more irrigation water, but this was limited by a lack of availability.

Since the drought, Alberta Environment has upgraded the pumping capacity for the Deadfish Reservoir to provide more secure water supplies. The 15 irrigators who are located on Deadfish Creek or below the confluence of Deadfish and Berry Creeks have access to more secure irrigation supplies, but this capacity upgrade does not improve the situation for the 11 producers above the confluence.

4. Discussion and Conclusions

The Special Areas include urban non-farm residents and businesses, industry and agricultural producers. These groups had differential exposure-sensitivity to drought given the ways in which they rely on water and the means in which they secure water supplies. The drought was primarily an inconvenience for non-farm residents and businesses. Agricultural production, on the other hand, was severely impacted and required adaptation.

Agricultural producers in the Special Areas are accustomed to managing dry periods. The 2001–2002 drought was problematic because successive dry years resulted in cumulative effects: soil moisture continued to decrease, dugouts were not substantially recharged during the entire drought, and feed reserves were exhausted. Furthermore, the compounding stress of the grasshopper epidemic meant that even those who had planned for shortages found their reserves ruined. However, this drought episode, while it created management challenges and resulted in financial impacts for many producers, did not have nearly the same impacts as the catastrophic results of the Dust Bowl years which led to the establishment of the Special Areas. Relative to the earlier periods, farmers were far less vulnerable during the most recent drought episode.

Reasons for this decreased vulnerability can be noted by examining the exposure-sensitivities and adaptive capacities of agricultural producers in the Special Areas. While all of the producers were exposed and sensitive to drought in that it had substantial impacts for their operations, this exposure-sensitivity was much lower than during the 1930s when most farmers were cash cropping much smaller parcels and dependent on crop growth. Cash cropping requires breaking the native prairie sod, leaving it far more exposed to drying and wind erosion, and eliminates the relatively more drought-resilient native prairie grass. Furthermore, the small parcel size during the 1930s meant that a much larger population had to be sustained on the same land base, and the carrying capacity of the land may have simply been exceeded during this time. Furthermore, crop farmers have changed their farming practices beyond increasing parcel size. A local PFRA employee notes that "farming practices have changed a lot since the 30s and moisture, rainfall is probably the same—it's probably the farming practices that are a lot better."[42] This theme is echoed by another respondent, who explains the role of minimum or zero tillage in cropping: " . . . in the 30s . . . you know, you'd see these clouds of dust. We didn't get those clouds of dust this time around. And largely in part because they were taking the straw off."[43]

Furthermore, farmers currently have a much higher adaptive capacity. In large part this is due to the fact that almost all of the farmers currently in the Special Areas are the descendants of those who successfully weathered earlier drought epidemics. These producers are the product of a long line of successful drought managers, and this expertise is highly developed in the Special Areas. Earlier, less severe, drought episodes in the 1980s and 1990s meant that farmers with relatively low adaptive capacity had already left the industry and remaining farmers already had contingency plans. In the words of the past Special Areas Board Chairman:

> The experience from the 30s was carried over in a lot of the old timers and the people of the area they have adapted to drought. we get periodic droughts. Not like it was in the 30s, but we still get them. I mean, we're only one day rain away from drought at any time in this country.
>
> I mean, we could end up coming into a drought so easy in a year. But the people are more apt to be able to handle it. PFRA was a big pusher on dugouts and this type of thing and so people have water available in most cases. There's now a lot of water being piped around the country. We've got shallow pipes for filling cobs and dugouts and this type of thing.[44]

Adaptive capacity includes access to resources and capital. Water is one of the most important resources in the Special Areas. However, the importance of non-agricultural income sources including off-farm work and oil and gas leases cannot be discounted. In several instances, producers chose to farm as a way of life, but earned greater income from the oil and gas wells located on their owned or leased lands. Many of the common adaptation strategies required absorbing an income loss or using capital to meet feed needs, and this would not have been feasible for many without additional income.

Locally-based institutions play a significant role in managing drought in the Special Areas. The ATCO pipelines and Henry Kroeger Regional Water Services Commission mean that municipalities and those who have access to tap-offs from pipelines have guaranteed water supplies (though at a cost). One local institution which in the past played a large role in increasing adaptive capacity was the local Agriculture and Agri-Food Canada Prairie Farm Rehabilitation Administration (AAFC-PFRA) field office, which was instrumental in dugout design and improvements. Unfortunately, AAFC-PFRA has drastically reduced its field presence—during the time of this research the Hanna field office only had three staff members for all programs combined.

The Special Areas Board maintains community pastures to alleviate some of the stress on owned and leased parcels and manages the Carolside-Deadfish irrigation project. The Board maintains rental equipment for minimum tillage and constructing shallow water pipelines. While other municipalities provide some of these services, the governance structure of the Special Areas in particular facilitates long-term planning for increased adaptive capacity. Despite the fact that it is a creature of the provincial government, the Special Areas Board is not subject to regular provincial election cycles, nor does it need to engage in programs which are designed to appeal to voters. The current Special Areas Board Chairman notes:

> I think we tend to think in longer term things. We don't, we're not like, the government's all on a year to year cycle . . . we have a long-term plan for a lot of things . . . we just tend to think in terms of longer term. And we're not trying to go back and get money from the government every year, and if we don't spend it, we're not making stupid expenditures. We can carry (a fiscal surplus) over and that's allowed us to be really flexible.
>
> You get in a crisis situation, you do crisis-management. But after you're done crisis, like the time right now, we don't need the water right now. The time to build it is now. The time to build water storage is now because we have run-off. Get the hole in the ground, so you can catch the water because in the drought it's not coming. After a drought, you come out of it and you say, what can we do different?[45]

Finally, it should be noted that the drought had one net positive benefit for cattle producers in the Special Areas. In the fall of 2001, the first case of Bovine Spongiform Encephalopathy (BSE, or colloquially known as mad cow disease) was found in Alberta. Since cattle producers in the Special Areas had already responded to the drought by reducing their stocking rates (and in most cases, this meant selling older cattle), they had sold cattle at a time before cattle prices plunged. Furthermore, the average age of remaining herds were substantially younger than is normally the case. When the United States cattle market re-opened to Canadian beef, only cattle less than 12 months in age were acceptable. As a direct result of adaptations undertaken in response to the 2001–2002 drought, Special Areas cattle producers were in a better position to survive this compounding stress than their counterparts in less drought-stricken areas.

The case of the 2001–2002 drought in the Special Areas of Alberta highlights a number of key themes in vulnerability research. First, vulnerability is not experienced equally by all members of a community or residents of a region, even if they are subject to the same climatic stress. Dryland farmers were more exposed to this drought event than other producers, and town residents were merely inconvenienced. Second, a climatic stress such as a drought cannot be seen in isolation of other stresses and opportunities. There were those compounding impacts which were not precipitation related but nevertheless related to the drought (e.g., grasshoppers) but also stresses which were unrelated to climate (e.g., cattle price changes as a result of BSE and opportunities for non-farm income due to the oil and gas sector). Third, adaptation occurs at individual levels but is frequently facilitated by institutions. For example, many producers chose to improve their dugouts or implement shallow pipelines, but federal and provincial organizations such as the PFRA and the Special Areas Board contributed expertise and equipment for these projects. Fourth, previous climatic stresses build adaptive capacity for future stresses. This region was in a very good position to manage drought given its management of recurring persistent dry periods since it was settled, and this most recent drought event prompted even higher adaptive capacity through strategic adaptations such as the construction of shallow pipelines or carrying greater feed reserves. Finally, climatic stresses such as a dry season need to be considered in a cumulative sense: one dry year, while unfortunate, is not a disaster in this region. Two to three dry years begin to approach the limits to regular management strategies as feed reserves are exhausted and dugouts run dry, and it is questionable whether even an area as highly adapted to persistent dry periods as the Special Areas would be able to maintain agricultural productivity during a longer event.

Endnotes

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