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Seasons, Stress, Salience, and Support for Cooperative Groundwater Management

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Background: Common property resources (CPR) are defined as resources where one person's use affects what is available to others (either now or in the future). One example of a CPR is a shared aquifer, where multiple users have access to the groundwater. Economic researchers have shown that with a CPR, there are economic benefits to regulating the use of the resource, and that well-designed regulation increases the sustainability of agricultural-based economies that rely on CPRs. Many such regulations exist, and examples include allocation limits in some of Nebraska's Natural Resources Districts and Kansas's Groundwater Management Districts, as well as groundwater fees in Colorado's San Luis Valley. However, there are a number of reasons that CPR users may not support regulation. These reasons include the associated short-term cost, financial constraints, a lack of trust that there will be long-term benefits, and time stress that prevents them from carefully considering all outcomes.

In a recent study (Suter et al., 2023), we examine the relationship between season, stress, salience, and support for groundwater management. In groundwater management, cooperation can be realized through policies that incentivize restraint in extraction to extend the life of the aquifer. While collective management is affected by the incentives faced by resource users, there remains incomplete knowledge about how cognitive processes affect collective management.

Existing research on the relationship between stress, salience, and cooperative behavior is limited, and much of it is from a developing country context. One challenge in determining the relationship between these various factors is that it is difficult to isolate individual preferences from stress or salience. For example, preferences for groundwater management may increase (or decrease) during relatively dry periods because water availability is a more immediate concern. Preferences may also change due to other types of stress, such as working long hours or increases in input prices. However, to measure these impacts, it is essential to collect information from the same individuals over time, in order to evaluate the relationship between changes in preferences and changes in stress or salience (issue prominence) *for the same individuals*.

Survey methods: To analyze the relationship between stress, salience, and support for groundwater management, we use a repeat survey with a staggered start. One benefit of this approach is that we can better capture changes in variables over time that may also change with the growing season. Another benefit is that we can control for individual omitted variables due to the panel structure of our data.

In Colorado, the survey invitations were sent to agricultural landowners in Kit Carson, Logan, Phillips, Sedgwick, Washington, and Yuma counties. In Nebraska,

invitations for the initial survey were sent to 503 irrigators in the Tri-Basin Natural Resource District (NRD) in April 2020 (wave 1) and an additional 503 invitations for the initial survey were sent in September 2020 (wave 2). The Tri-Basin NRD covers Gosper, Phelps, and Kearney counties in Nebraska. The initial survey invitations were sent out in two waves. Approximately half of the sample received the initial survey invitation in wave 1, which was sent in the spring of 2020. The other half of the sample was in wave 2 and received the initial survey invitation in the fall of 2020. The wave 1 respondents to the initial survey then received an invitation for the follow-up survey in fall 2020. The wave 2 respondents to the initial survey received the follow-up survey in the spring of 2021. Figure 1 provides a visual representation of the survey implementation. Staggering the timing of wave 1 and wave 2 better allows us to account for general changes in stressors and support for groundwater management over time separately from the impact of seasons.

We use several sets of attitudinal questions to determine the relationship between stress, season, salience, and support for groundwater management. The first set of questions ask about the frequency of concern regarding different external factors such as output prices, weather, and input prices. The second set of questions ask about the frequency of feelings of stress related to factors such as lack of control or working too many hours. The third set of questions asks about preferences for groundwater management policies. The variables 'Give up profit', 'Restriction', and 'Fee' are on a scale from 1 (= definitely no) to 5 (= definitely yes)and relate to support for giving up profit to ensure future groundwater availability, restrictions on annual groundwater use, and taxes on groundwater use.

Results: Table 1 shows the summary statistics for responses from the two waves. General demographic characteristics are similar between the waves, although the response rate from Colorado is higher (lower) than Nebraska in wave 2 (wave 1). Within-state characteristics were similar between the waves, but an overall smaller average farm size in wave 2 is consistent with more responses from Colorado producers.

Table 2 provides a summary of responses for the attitudinal variables. Across the two waves, respondents expressed the greatest concerns about commodity prices ('Output prices'), input prices ('Input prices'), and weather. The biggest differences across the two waves occurred for concerns related to weather and groundwater availability ('Groundwater availability'), which were both higher in wave 2 (fall of 2020). The summer of 2020 was characterized by severe drought, which put stress on water resources throughout the region.

To measure the relationship between the stress, salience, and groundwater support policies, we evaluate the change in the support for groundwater policies as a function of the change in attitudinal variables. Table 3 shows these results. Results that are statistically significant at standard levels are denoted with an asterisk. In each case, the estimate shows how a change in season or attitude affects the level of support for an annual groundwater use restriction (column 1) or a groundwater fee (column 2). For example, answering the survey in the fall reduces the support for a groundwater use restriction by 0.137 or support for a groundwater fee by 0.198 (these are reductions in support of about 4.7% or 8.6% relative to the average support level). An increase in output prices reduces support for a groundwater fee by 0.329 (about 14.3% relative to average support), likely due to increased financial stress. Increased concern over groundwater availability increases support for a groundwater fee by 0.215 (about 9.3% relative to average support). These results already incorporate any individual characteristics such as age, location, or farm size, which may affect support for groundwater conservation efforts.

We find that seasonality and changing concerns in variables that measure the salience of prices and weather are associated with preferences for groundwater management that may enhance or detract from collective action. Support for groundwater management is generally found to be lower in the fall compared to the spring. Additionally, increased concerns over output price changes are associated with less support for groundwater management, while concern over weather and groundwater scarcity is associated with greater support for groundwater management. This suggests

that the salience of specific factors may determine support for collective action related to groundwater conservation.

References:

Suter, Jordan, Todd Guilfoos, and Karina Schoengold. 2023 "Seasons, stress, salience, and support for cooperative groundwater management." Forthcoming in *Journal of the Agricultural and Applied Economics Association* (JAAEA), https://doi.org/10.1002/jaa2.78

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Figures:

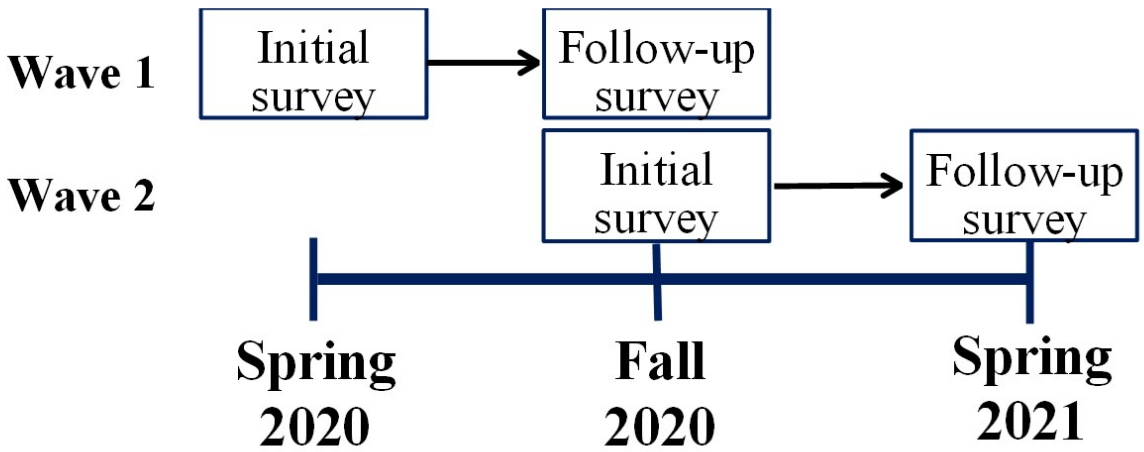

Figure 1: Overview of survey design, with initial and follow-up survey invitations sent in two waves.

Table 1: Summary statistics for respondent characteristics to the initial survey

	Wave 1 (Spring 2020)			Wave 2 (Fall 2020)		
Statistic	N	Mean	St. Dev	N	Mean	St. Dev
Colorado resident (Y/N)	122	0.574	0.497	83	0.843	0.366
Male (Y/N)	122	0.836	0.372	83	0.783	0.415
College degree (Y/N)	122	0.369	0.484	83	0.422	0.497
Expect kids farm (Y/N)	122	0.664	0.474	83	0.566	0.499
Age	122	57.508	13.014	83	59.735	13.555
Irrigated acres	122	529.785	796.277	83	332.012	718.531
Dryland acres	122	667.852	1,327.85	83	625.916	1,002.01
Irrigated acres (insured)	122	498.687	815.645	83	309.398	715.748
Dryland acres (insured)	122	568.542	1,252.82	83	601.991	1,046.88
Acres rented from others	122	605.437	1,181.49	83	357.759	663.7
Acres rented to others	122	290.367	1,312.31	83	198.422	595.066
Wells operated	122	4.033	5.918	83	2.349	4.875
Wells owned	122	2.5	3.864	83	1.711	3.881
Own/operate well (Y/N)	122	0.623	0.487	83	0.458	0.501
Has groundwater use restriction (Y/N)	122	0.303	0.462	83	0.289	0.456

Table 2: Summary statistics for stress-related and groundwater management preference variables from the initial survey

		Variable	Wave 1 (Spring 2020)			Wave 2 (Fall 2020)		
	Statistic	Range	N	Mean	St. Dev	N	Mean	St. Dev
Recent concerns [1 = very concerned, 4 = not concerned]	Work hours	1 – 4	122	1.836	1.023	83	1.735	0.925
	Weather	1 – 4	122	2.705	0.951	83	3.566	0.702
	Debt	1 – 4	122	2.557	1.076	83	2.386	1.069
	Commodity prices	1 – 4	122	3.574	0.749	83	3.518	0.739
	Input prices	1 – 4	122	3.082	0.896	83	3.096	0.905
	Groundwater availability	1 – 4	122	2.189	1.031	83	2.566	1.061
	Health	1 – 4	122	2.787	0.973	83	2.687	0.987
Recent feelings [1 = never, 5 = often]	No control	1 – 5	122	3.361	1.129	83	3.193	1.152
	Upset	1 – 5	122	2.697	0.852	83	2.687	0.854
	Nervous	1 – 5	122	3.213	1.054	83	2.892	1
	Time pressure	1 – 5	122	3.049	0.961	83	2.771	1.004
Groundwater concerns and support for management policy [1 = definitely no, 5 = definitely yes]	Give up profit	1 – 5	122	2.828	0.959	83	2.747	1.01
	Restriction	1 – 5	122	2.992	1.139	83	2.88	1.224
	Fee	1 – 5	122	2.361	1.158	83	2.253	1.091

Table 3: Impact of changes in seasons and attitudes on support for groundwater conservation policy

Dependent variable: Support for groundwater conservation policy				
	Restriction		Fee	
Explanatory variables: season and attitudes	(1)		(2)	
Fall (0/1)	−0.137		-0.198	*
	(0.114)		(0.100)	
Work hours	0.192	*	−0.073	
	(0.107)		(0.094)	
Weather	0.040		−0.026	
	(0.106)		(0.094)	
Debt	0.107		0.073	
	(0.115)		(0.101)	
Output prices	0.052		−0.329	***
	(0.124)		(0.109)	
Input prices	0.008		−0.051	
	(0.125)		(0.11)	
Groundwater availability	−0.017		0.215	**
	(0.113)		(0.099)	
Health	−0.043		0.100	
	(0.099)		(0.087)	
Respondent fixed effects	Yes		Yes	
Note: *p < 0.1, **p < 0.05, ***p<0.01. Standard errors are in parentheses.				

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