

RESEARCH LETTER

Shifting dry spells in Central Chile: Implications for agricultural water planning

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Abstract

Chile's agricultural production occurs in a highly variable Mediterranean climate and faces declining annual precipitation trends as well as growing competition from other uses. Water availability for agriculture depends on winter precipitation; however, a more even distribution of precipitation throughout the year would better support agricultural planning and management. We examine the occurrence, frequency, and trends of dry spells in Central Chile (32°–40° S) as a proxy for changes in the timing of dry-wet seasons, using a gridded daily precipitation dataset spanning the period from 1960 to 2021. Our results indicate a significant increase in dry spells (+1 event/decade), but shorter (−2 days/event), and a significant decrease in precipitation per wet spell (−2 mm/event/decade). Findings suggest that changes in dry spells should also be considered in planning and policy, as some regions may be experiencing water shortages due to shifts in timing and access, rather than simply having less water.

Plain Language Summary

Chile's agriculture occurs in a region with variable precipitation and temperature year-to-year. Water for farming mainly comes from winter precipitation, but better year-round distribution is needed for effective planning. We analyzed the occurrence of consecutive dry days during the fall-winter and spring-summer seasons. We found that there has been an increase in dry spells, as well as a decrease in precipitation volume per wet spell. Changes in dry spells should be considered in agricultural planning and policy, as some regions may face water shortages due to timing and access issues, in addition to reduced water availability.

1 | INTRODUCTION

Central Chile (32°–40° S) exhibits a Mediterranean climate characterized by wet, cold winters (April to September) and dry, warm summers (October to March) (Garreaud,

2009; Sarricolea et al., 2017). Climate exhibits significant natural variability at interannual to decadal scales due to the El Niño-Southern Oscillation and other large-scale climate processes (Boisier et al., 2016; Quintana & Aceituno, 2012; Valdés-Pineda et al., 2016, 2018). Most precipitation

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(70%–85%, April to September) occurs during winter and is stored in groundwater and mountain snowpacks, which farmers use during spring and summer. Precipitation amounts have declined due to an extensive and persistent drought since 2010, and lower precipitation amounts are expected to persist in the future due to climate change (Salazar et al., 2024). In addition to reduced water availability, the demand for water for agriculture, communities, and the environment is increasing (Álamos et al., 2024). Thus, the current situation frames an uncertain future for water availability.

Declines in precipitation have been extensively studied in terms of climate and anthropogenic drivers (Garreaud et al., 2020); economic, environmental, and social impacts (Garreaud et al., 2017; Vicuña et al., 2021); and feedback between water balance components (e.g., Baez-Villanueva et al., 2024). However, less attention has been paid to interannual precipitation indices. Changes in precipitation, such as intensity (Sangüesa et al., 2018; Sarricolea et al., 2019), amounts, and seasonal distribution (Garreaud et al., 2020; Trenberth et al., 2003), may lead to changes in water availability during the growing season due to reduced water storage during the previous season and lower summer precipitation. South of 37° S, agricultural activities have traditionally relied on summer precipitation to water crops and grasslands; however, the distribution of precipitation throughout the year has also shifted, with an increase in dry days during winter (Latoja et al., 2024).

Dry days and consecutive dry days (also known as dry spells [DS]) are key indicators of precipitation variability (IPCC, 2021; Polade et al., 2014; Seager et al., 2019; Zolina et al., 2013), as well as climate extremes (Breinl et al., 2020). Compound dry days, dry spells, and heat waves are important for agricultural water management (Hettiarachchi et al., 2022) as they impact irrigation scheduling, infrastructure, resource use, and expected yields (Meza et al., 2008; Meza et al., 2012; Mitter & Schmid, 2019).

As dry days and dry spells have been less studied, we use a gridded daily precipitation dataset to examine the occurrence, frequency, and trends of dry spells in Central Chile (32°–40° S) as a proxy for changes in the timing of dry-wet seasons from 1960 to 2021. Previously, Latoja et al. (2024) analyzed the occurrence of dry days without considering their consecutiveness, while Garreaud et al. (2025) analyzed the occurrence of dry spells at the annual scale. We aim to demonstrate that changes in precipitation distribution complement our understanding of coupled climate-agriculture processes, the need for improved water and agriculture-related information, and new infrastructure to cope with a warmer and drier future.

2 | METHODS

We utilize the CR2MET-gridded daily precipitation dataset, which spans from 1960 to 2021 (Boisier, 2023). CR2MET combines reanalyses from ERA5-Interim (ECMWF Reanaly-

Core Ideas

- Changes in the length and timing of dry and wet spells impact seasonal precipitation.
- Changes in dry spells introduce more uncertainty to agricultural planning in Central Chile.
- Dry spells analysis complements other annual precipitation deficit indices.

sis v5), topography, and NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) thermal images to provide a downscaled data set at $0.05 \times 0.05^\circ$ resolution (ca. 5 km) that is controlled against observational data from several government agencies (874 ground stations). CR2MET is the reference data set for daily precipitation and temperature in Chile.

For each grid cell (7076 in the spatial domain 32°–40° S), we record the number of consecutive dry days (dry spell's length, ℓ) to produce statistics of the number of dry spells per 6-month seasons (fall-winter, DS_w , from April to September and spring-summer, DS_s , October to March), per hydrological year (DS_y , April to March), and the mean length of dry spells per year (ℓ_m). A dry day occurs when the daily precipitation is less than a threshold, usually 1 mm. Threshold selection remains an open issue; however, previous results suggest that a threshold of 1 mm yields robust results (Latoja et al., 2024). For completeness's sake, we count the number of dry days (DD_w , DD_s) and wet days per season (WD_w , WD_s), and hydrological year (DD_y , WD_y), and mean precipitation volume per wet spell (VWS_y). We did not compute monthly dry spell indices, as several dry spells last more than 30 days, so $DD_y \approx \sum \ell_i$. We also calculated the amounts of monthly, seasonal, and annual precipitation.

We compare the mean anomalies of the dry spell indices for each decade since 1960 with the long-term mean for the period 1960–2020. The periods were chosen considering the strong decadal variability of the climate in Central Chile and historical grounds. The 1960s decade was one of the most impactful droughts (Garreaud et al., 2025), while the 1980s was one of the wettest decades (Quintana & Aceituno, 2012).

For each pixel, we calculate long-term linear monotonic trends (1960–2021) using Sen's slope and assess statistical significance with the nonparametric Mann–Kendall test ($p \leq 0.05$), indicating a trend exists (Wilks, 2005). For the statistical significance of anomalies, we use a t -test at $p \leq 0.05$.

3 | RESULTS

There is a spatial difference in dry spell events between the northern region (32°–38° S) and the southern region (38°–40° S), following a latitudinal and longitudinal gradient. From 32°

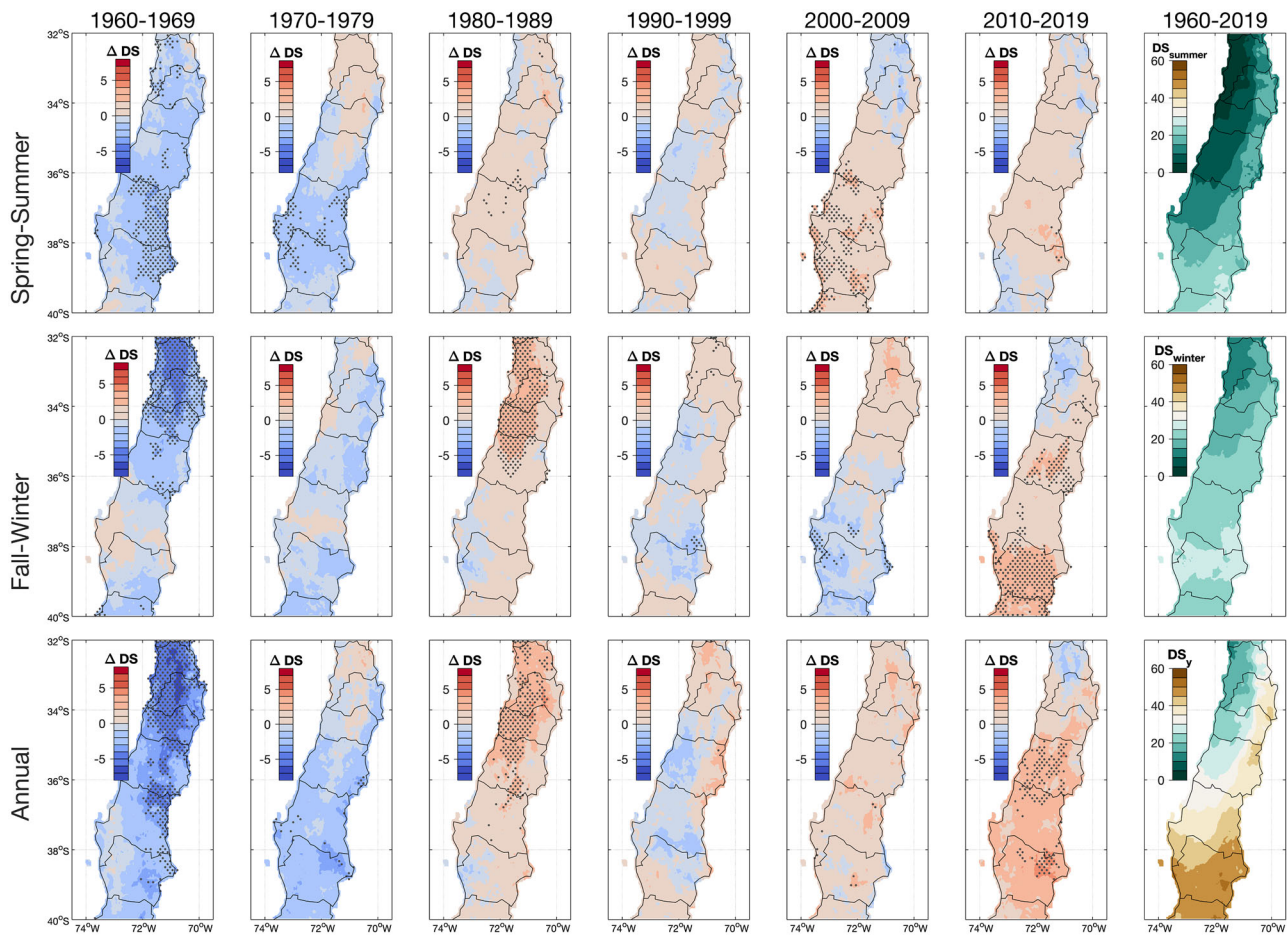


FIGURE 1 Interannual anomalies of dry spells averaged by decade per decade and hydrological ΔDD_y against the long-term mean (1960–2021) of DD_y (rightmost column). Positive (negative) anomalies indicate more (less) dry spells than the long-term mean. The bottom row shows the anomaly of annual aggregation, that is, the sum of dry spells during both seasons. Stippled areas indicate statistical significance at $p \leq 0.05$.

to 36° S, the long-term mean is 250–350 dry days per year, distributed in 20–40 dry spells. Longer dry spells occur during the spring-summer (up to 200 consecutive dry days). South of 36° S, there are 150–250 dry days, with more frequent dry spells, resulting in shorter dry periods (with a long-term average of approximately 7 days). During fall and winter, the number of dry spells is more homogeneous, as frontal systems cover most of Central Chile (Figure 1). During the spring-summer season, the Pacific Anticyclone blocks frontal systems north of 38° S, resulting in reduced precipitation, while south of 38° S, precipitation is less affected.

Dry spells per year change depending on the decade, and the magnitude and sign of anomalies vary depending on the season (Figure 1). Significant decadal differences are most pronounced during the fall and winter. Indeed, during the last decade, there occurred ca. 5 more dry spells during winter south of 38° S. Such differences between seasons show the importance of seasonal precipitation patterns in total yearly amounts. It is also worth noting that the conversion from dry spells to dry days depends on the mean length of dry spells and

the number of wet spells. Thus, more dry spells, but shorter, and more frequent wet spells confirm that precipitation is becoming increasingly intermittent in Central Chile.

Since 1980, more dry spells have occurred during spring-summer and fall-winter seasons. Significant changes have occurred during the last decade south of 36° S during the fall and winter seasons. While some decades (e.g., 1960–1969) show fewer dry spells in both seasons, the period 2000–2009 shows fewer dry spells during fall-winter and more dry spells (nonsignificant) during spring-summer. The last decade shows positive anomalies in both seasons. Additionally, since 2010, there has been a 10% increase in dry days south of 36° S in both seasons and annually, with varying significance in space (Figure S1).

Trends in dry spells and wet spells show highly impacted regions in Central Chile (Figure 2 shows linear trends per pixel). At the annual scale (i.e., the sum of dry spells during both 6-month seasons), trends for the number of dry spells are significant in a large portion of the study region, while the length of the dry spells shows a slight decreasing trend,

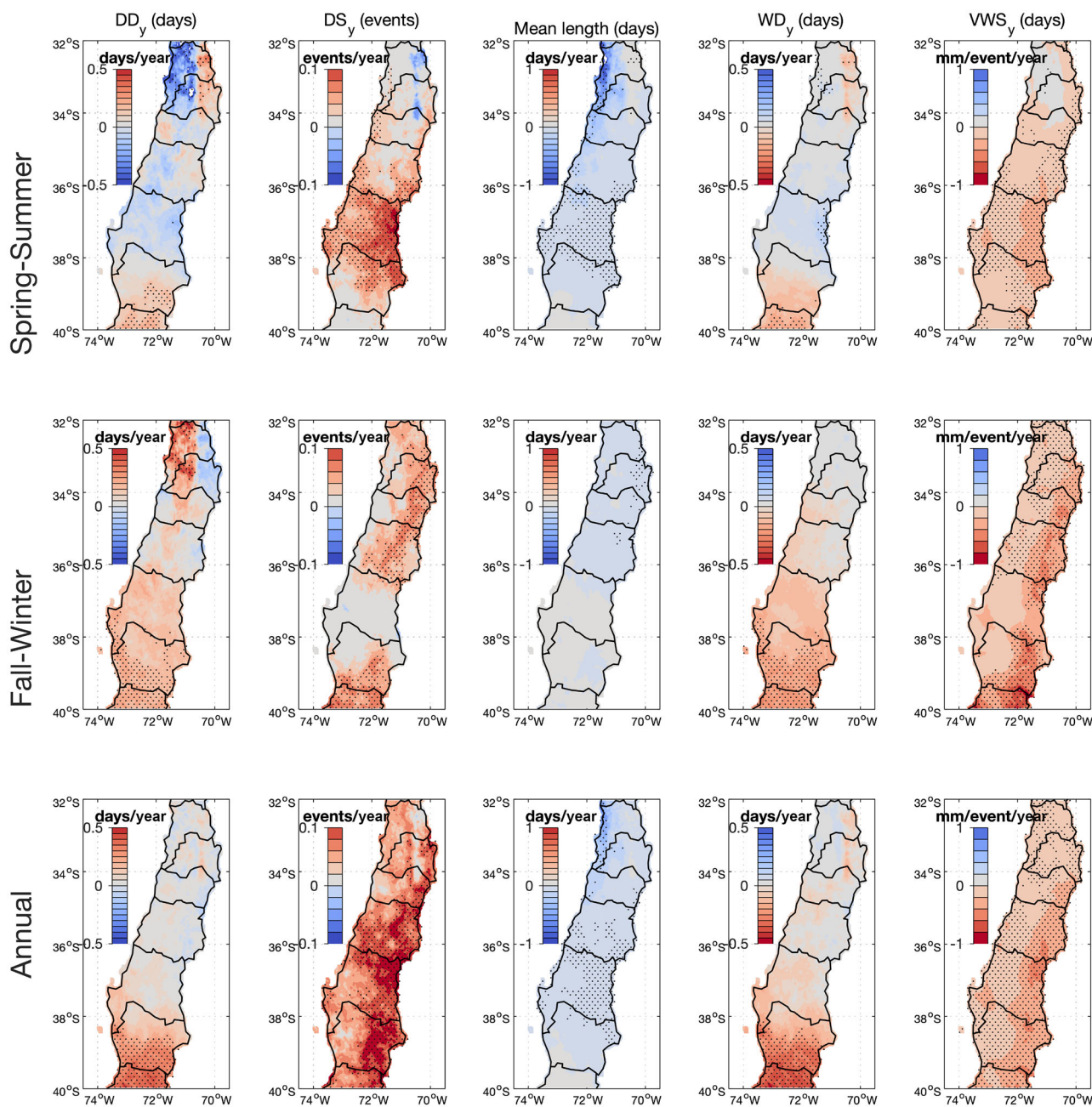


FIGURE 2 Linear trends (Sens' slope) for dry days (DD_y), dry spells (DS_y), mean length of dry spells, wet days (WD_y), and mean volume per wet spell (VWS_y). Stippled areas are statistically significant using the Mann–Kendall test ($p \leq 0.05$).

which is significant in the 35° – 38° S range. Most of the spatial domain exhibits a positive trend in terms of dry days and dry spells per year, with a significant trend observed south of 36° S for dry days (0.5 days per year) and south of 34° S for the number of dry spells (0.1 events per year). The mean length of dry spells exhibits a negative trend (shorter spells), which is significant during spring and summer in the 36° – 38° S region. The number of dry spells and their mean length provide insights into intraseasonal variability, as dry days occur in dry spells of varying lengths. Consequently, the ratio of

dry spells to wet spells also varies, as well as the frequency distribution of ℓ_i .

Furthermore, the number of dry spells lasting longer than 14 days exhibits a slight, nonsignificant trend (Figure S2). The decreasing trend in annual precipitation concurs with negative trends in wet days (significant south of 38° S) and fewer precipitation volumes per wet spell, which are significant for most of the spatial domain. As expected, wet spells and dry spells exhibit similar trends and spatial patterns, but the main result is the decreasing trend in precipitation volume

per wet spell during both seasons. Thus, dry spells are being interrupted by low-volume precipitation events.

4 | DISCUSSION

It is well-established that precipitation deficits respond to changes in regional hydroclimatic processes. However, our understanding of the seasonal changes is less clear. The changes and interplay between the occurrence and length of dry spells suggest changes in the pace of precipitation during relevant seasons, especially in areas where summer precipitation complements irrigation volumes. Natural ecosystems would adapt their productivity to incoming precipitation and temperature regimes in the long term (Eagleson, 2005). Still, agrosystems must plan and manage resources to offset those changes at annual and seasonal timescales (Gavilán et al., 2019; Holzapfel et al., 2020; Kuschel-Otárola, Rivera, et al., 2020; Kuschel-Otárola, Schütze, et al., 2020). Thus, changes in the seasonality of precipitation, measured as, for instance, dry and wet spells, should also be considered in planning and policy, as some regions may experience water shortages due to changes in timing and access, rather than simply having less water. Moreover, decadal variability challenges policy-making and agricultural planning (Núñez et al., 2013, 2014) at medium-range timescales. We advise planners and policymakers to use interannual and seasonal indices, such as seasonality, and annual water scarcity indicators.

Despite the significant increase in dry days and dry spells in some areas, the mean length of dry spells shows less variability. Hence, the frequency of dry spells of different lengths must change. Thus, we argue for a change in the frequency distribution of dry days and dry spells, as well as the sequence of dry and wet spells. Additionally, irrigation scheduling and planning depend on the intermittency and volume of precipitation. Rainfed crops may suffer losses due to more dry spells and decreasing volumes of precipitation per wet spells. Therefore, farmers should consider alternative crops or invest in irrigation systems. For instance, if design and operation criteria rely on a low probability of dry spells longer than 7 days, any regime shift will challenge the current infrastructure.

Although CR2MET is widely used for hydroclimatic studies in Chile, we acknowledge that dry day indices may vary depending on the gridded product. Thus, there is a need to compare trends and significance across other available products. Moreover, we detect changes in dry spells, but the attribution of those changes is out of the scope of this paper. However, changes in large-scale sea level pressure, sea surface temperature, and zonal winds affect the number of precipitation events and yearly precipitation (Garreaud et al., 2025; Latoja et al., 2024), and 25% of the precipitation deficit is attributed to anthropogenic forcing (Garreaud et al., 2025).

Further research on climate attribution and the propagation of dry spells into agricultural systems would also better support agricultural water management at finer temporal and regional scales. Indeed, Álamos et al. (2024) and Álvarez-Garretón et al. (2021) have pioneered the attribution of decreasing streamflow and water availability at annual and watershed scales. The impacts of detected changes in agricultural water management require intensive fieldwork to capture farmers' perceptions and the measures they take. Capturing farmers' perceptions of current and future climate conditions would enable planners to design and implement effective mitigation and adaptation policies. Indeed, the number of government subsidies for implementing pressurized irrigation systems has increased, as has the number of requests for groundwater rights (Barria et al., 2019). It also opens questions regarding the change in precipitation seasonality and volatility.

5 | CONCLUSIONS

The seasonal distribution of wet and dry spells, as well as the mean volume of precipitation per wet spell, has changed in Central Chile, thereby affecting seasonal precipitation. Dry spells have increased since 2000 south of 36° S, but there are differences in anomalies depending on the season (positives in the wet season 2000–2009, and negatives for 2010–2019). Such changes are important for planning, as that region largely depends upon summer precipitation to complement irrigation from surface and gravitational irrigation systems.

More frequent but shorter dry spells and more frequent but less volume per wet spell influence water availability and the pace of precipitation. We advise that seasonal indices would benefit annual-scale measures of water deficit.

AUTHOR CONTRIBUTIONS

Daniela Latoja: Conceptualization; data curation; formal analysis. **Diego Rivera:** Conceptualization; formal analysis; funding acquisition; investigation; validation; visualization; writing—original draft. **Mario Lillo:** Formal analysis; visualization; writing—review and editing. **Álex Godoy-Faúndez:** Conceptualization; formal analysis; visualization; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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REFERENCES

- Álamos, N., Álvarez-Garretón, C., Muñoz, A., & González-Reyes, A. (2024). The influence of human activities on streamflow reductions during the megadrought in central Chile. *Hydrology and Earth System Sciences*, 28, 2483–2503. <https://doi.org/10.5194/hess-28-2483-2024>
- Álvarez-Garretón, C., Boisier, J. P., Garreaud, R., Seibert, J., & Vis, M. (2021). Progressive water deficits during multiyear droughts in basins with long hydrological memory in Chile. *Hydrology and Earth System Sciences*, 25, 429–446. <https://doi.org/10.5194/hess-25-429-2021>
- Baez-Villanueva, O. M., Zambrano-Bigiarini, M., Miralles, D. G., Beck, H. E., Siegmund, J. F., Alvarez-Garretón, C., Verbist, K., Garreaud, R., Boisier, J. P., & Galleguillos, M. (2024). On the timescale of drought indices for monitoring streamflow drought considering catchment hydrological regimes. *Hydrology and Earth System Sciences*, 28, 1415–1439. <https://doi.org/10.5194/hess-28-1415-2024>
- Barria, P., Rojas, M., Moraga, P., Muñoz, A., Bozkurt, D., & Alvarez-Garretón, C. (2019). Anthropocene and streamflow: Long-term perspective of streamflow variability and water rights. *Elementa: Science of the Anthropocene*, 7, 2. <https://doi.org/10.1525/elementa.340>
- Boisier, J. P. (2023). *CR2MET: A high-resolution precipitation and temperature dataset for 1960–2021 in continental Chile*. Zenodo. <https://doi.org/10.5281/zenodo.7529682>
- Boisier, J. P., Rondanelli, R., Garreaud, R. D., & Muñoz, F. (2016). Anthropogenic and natural contributions to the Southeast Pacific precipitation decline and recent megadrought in central Chile. *Geophysical Research Letters*, 43, 413–421. <https://doi.org/10.1002/2015GL067265>
- Breil, K., Di Baldassarre, G., Mazzoleni, M., Lun, D., & Vico, G. (2020). Extreme dry and wet spells face changes in their duration and timing. *Environmental Research Letters*, 15, 074040. <https://doi.org/10.1088/1748-9326/ab7d05>
- Eagleson, P. (2005). *Ecohydrology*. Cambridge University Press.
- Garreaud, R., Alvarez-Garretón, C., Barichivich, J., Boisier, J., Christie, D., Galleguillos, M., LeQuesne, C., McPhee, J., & Zambrano-Bigiarini, M. (2017). The 2010–2015 megadrought in central Chile: Impacts on regional hydroclimate and vegetation. *Hydrology and Earth System Sciences*, 21, 6307–6327. <https://doi.org/10.5194/hess-21-6307-2017>
- Garreaud, R., Boisier, J. P., Álvarez-Garretón, C., Christie, D., Carrasco-Escalf, T., Vergara, I., Chávez, R. O., Aldunce, P., Camus, P., Suazo-Álvarez, M., Masiokas, M., Castro, G., Muñoz, A., Zambrano-Bigiarini, M., Fuster, R., & Godoy, L. (2025). Hyperdroughts in central Chile: Drivers, impacts, and projections. *EGU sphere*, 2025, 1–31.
- Garreaud, R. D. (2009). The Andes climate and weather. *Advances in geosciences*, 22, 3–11. <https://doi.org/10.5194/adgeo-22-3-2009>
- Garreaud, R. D., Boisier, J. P., Rondanelli, R., Montecinos, A., Sepúlveda, H. H., & Veloso-Aguila, D. (2020). The Central Chile mega-drought (2010–2018): A climate dynamics perspective. *International Journal of Climatology*, 40, 421–439. <https://doi.org/10.1002/joc.6219>
- Gavilán, V., Lillo-Saavedra, M., Holzapfel, E., Rivera, D., & García-Pedrero, A. (2019). Seasonal crop water balance using harmonized Landsat-8 and Sentinel-2 time series data. *Water*, 11, 2236. <https://doi.org/10.3390/w11112236>
- Hettiarachchi, S., Wasko, C., & Sharma, A. (2022). Do longer dry spells associated with warmer years compound the stress on global water resources? *Earth's Future*, 10, e2021EF002392. <https://doi.org/10.1029/2021EF002392>
- Holzapfel, E., Lillo-Saavedra, M., Rivera, D., Gavilán, V., García-Pedrero, A., & Gonzalo-Martín, C. (2020). A satellite-based ex post analysis of water management in a blueberry orchard. *Computers and Electronics in Agriculture*, 176, 105635. <https://doi.org/10.1016/j.compag.2020.105635>
- IPCC. (2021). *Climate change 2021: The physical science basis. Contribution of working group I to the sixth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- Kuschel-Otárola, M., Rivera, D., Holzapfel, E., Schütze, N., Neumann, P., & Godoy-Faúndez, A. (2020). Simulation of water use efficiency of crops under different irrigation strategies. *Water*, 12, 2930. <https://doi.org/10.3390/w12102930>
- Kuschel-Otárola, M., Schütze, N., Holzapfel, E., Godoy-Faúndez, A., Mialyk, O., & Rivera, D. (2020). Estimation of yield response factor for each growth stage under local conditions using Aquacrop-OS. *Water*, 12, 1080. <https://doi.org/10.3390/w12041080>
- Latoja, D., Lillo-Saavedra, M., Gonzalo-Martín, C., Godoy-Faúndez, A., Somos-Valenzuela, M., & Rivera, D. (2024). Decadal variability of dry days in central Chile. *Earth Systems and Environment*, 9(2), 1117–1134.
- Meza, F. J., Hansen, J. W., & Osgood, D. (2008). Economic value of seasonal climate forecasts for agriculture: Review of ex-ante assessments and recommendations for future research. *Journal of Applied Meteorology and Climatology*, 47, 1269–1286. <https://doi.org/10.1175/2007JAMC1540.1>
- Meza, F. J., Wilks, D. S., Gurovich, L., & Bambach, N. (2012). Impacts of climate change on irrigated agriculture in the Maipo basin, Chile: Reliability of water rights and changes in the demand for irrigation. *Journal of Water Resources Planning and Management*, 138, 421–430. [https://doi.org/10.1061/\(ASCE\)WR.1943-5452.0000216](https://doi.org/10.1061/(ASCE)WR.1943-5452.0000216)
- Mitter, H., & Schmid, E. (2019). Computing the economic value of climate information for water stress management exemplified by crop production in Austria. *Agricultural Water Management*, 221, 430–448. <https://doi.org/10.1016/j.agwat.2019.04.005>
- Núñez, J., Rivera, D., Oyarzún, R., & Arumí, J. (2013). Influence of Pacific Ocean multidecadal variability on the distributional properties of hydrological variables in north-central Chile. *Journal of Hydrology*, 501, 227–240.
- Núñez, J., Rivera, D., Oyarzún, R., & Arumí, J. (2014). On the use of standardized drought indices under decadal climate variability: Critical assessment and drought policy implications. *Journal of Hydrology*, 517, 458–470.
- Polade, S. D., Pierce, D. W., Cayan, D. R., Gershunov, A., & Dettinger, M. D. (2014). The key role of dry days in changing regional climate and precipitation regimes. *Scientific Reports*, 4, 4364. <https://doi.org/10.1038/srep04364>

- Quintana, J., & Aceituno, P. (2012). Changes in the rainfall regime along the extratropical west coast of South America (Chile): 30–43° S. *Atmósfera*, 25, 1–22.
- Salazar, Á., Thatcher, M., Goubanova, K., Bernal, P., Gutiérrez, J., & Squeo, F. (2024). CMIP6 precipitation and temperature projections for Chile. *Climate Dynamics*, 62, 2475–2498. <https://doi.org/10.1007/s00382-023-07034-9>
- Sangüesa, C., Pizarro, R., Ibañez, A., Pino, J., Rivera, D., García-Chevesich, P., & Ingram, B. (2018). Spatial and temporal analysis of rainfall concentration using the Gini index and PCI. *Water*, 10, 112.
- Sarricolea, P., Herrera-Ossandon, M., & Meseguer-Ruiz, Ó. (2017). Climatic regionalisation of continental Chile. *Journal of Maps*, 13, 66–73. <https://doi.org/10.1080/17445647.2016.1259592>
- Sarricolea, P., Meseguer-Ruiz, Ó., Serrano-Notivol, R., Soto, M. V., & Martín-Vide, J. (2019). Trends of daily precipitation concentration in central-southern Chile. *Atmospheric Research*, 215, 85–98. <https://doi.org/10.1016/j.atmosres.2018.09.005>
- Seager, R., Osborn, T. J., Kushnir, Y., Simpson, I. R., Nakamura, J., & Liu, H. (2019). Climate variability and change of Mediterranean-type climates. *Journal of Climate*, 32, 2887–2915. <https://doi.org/10.1175/JCLI-D-18-0472.1>
- Trenberth, K. E., Dai, A., Rasmussen, R. M., & Parsons, D. B. (2003). The changing character of precipitation. *Bulletin of the American Meteorological Society*, 84(9), 1205–1218. <https://doi.org/10.1175/BAMS-84-9-1205>
- Valdés-Pineda, R., Cañón, J., & Valdés, J. B. (2018). Multi-decadal 40-to 60-year cycles of precipitation variability in Chile (South America) and their relationship to the AMO and PDO signals. *Journal of Hydrology*, 556, 1153–1170. <https://doi.org/10.1016/j.jhydrol.2017.01.031>
- Valdés-Pineda, R., Valdes, J. B., Diaz, H. F., & Pizarro-Tapia, R. (2016). Analysis of spatio-temporal changes in annual and seasonal precipitation variability in South America-Chile and related ocean–atmosphere circulation patterns. *International Journal of Climatology*, 36, 2979–3001. <https://doi.org/10.1002/joc.4532>
- Vicuña, S., Vargas, X., Boisier, J. P., Mendoza, P. A., Gómez, T., Vásquez, N., & Cepeda, J. (2021). Impacts of climate change on water resources in Chile. In B. Fernández & J. Gironás (Eds.), *Water resources of chile* (pp. 347–363). Springer.
- Wilks, D. S. (2005). *Statistical methods in the atmospheric sciences. International geophysics*. Elsevier Science.
- Zolina, O., Simmer, C., Belyaev, K., Gulev, S. K., & Koltermann, P. (2013). Changes in the duration of European wet and dry spells during the last 60 years. *Journal of Climate*, 26, 2022–2047. <https://doi.org/10.1175/JCLI-D-11-00498.1>

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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