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Local Perception of Drought Impacts in a Changing Climate: The Mega-Drought in Central Chile

Paulina Aldunce [1,2,3,*], Dámare Araya [1,2], Rodolfo Sapiain [2,4], Issa Ramos [2], Gloria Lillo [1,2], Anahí Urquiza [2,5] and René Garreaud [2,6]

1 Department of Environmental Science and Natural Resources, University of Chile, Av. Santa Rosa 11.315, La Pintana, Santiago 8820808, Región Metropolitana, Chile; damare.av@renare.uchile.cl (D.A.); glillo@renare.uchile.cl (G.L.)
2 Center for Climate and Resilience Research, CR2, Blanco Encalada 2002, 4○ Piso, Santiago 8370449, Región Metropolitana, Chile; rodolfo.sapiains@gmail.com (R.S.); Iramos.salgado@gmail.com (I.R.); anahi.urquiza.gomez@gmail.com (A.U.); rgarreau@dgf.uchile.cl (R.G.)
3 Center for Disaster Risk Reduction, University of Chile, Diagonal Paraguay 265, Santiago 8820808, Región Metropolitana, Chile
4 Department of Psychology, University of Chile, Av. Capitán Ignacio Carrera Pinto 1045, Ñuñoa, Santiago 7750000, Región Metropolitana, Chile
5 Department of Anthropology, University of Chile, Av. Capitán Ignacio Carrera Pinto 1045, Ñuñoa, Santiago 7750000, Región Metropolitana, Chile
6 Department of Geophysics, University of Chile, Blanco Encalada 2002, 4○ Piso, Santiago 8370449, Región Metropolitana, Chile
* Correspondence: paldunce@uchile.cl; Tel.: +56-9-5647-3360

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Abstract: Droughts are a recurrent and complex natural hazard whose frequency and magnitude are expected to increase with climate change. Despite the advances in responding and adapting to droughts (with the development of new policies, for example), droughts continue to cause serious impacts and suffering. Developing well-targeted public policies requires further research on adaptation. Specifically, understanding the public perception of drought can help to identify drivers of and barriers to adaptation and options. This research seeks to understand the public perception of drought in central Chile in order to inform adaptation-related policies and decision-making processes. This study focused on the Mega-drought, which was a protracted dry spell afflicting central Chile since 2010.

Keywords: perception; climate change impacts; drought; adaptation policy and practice; Chile

1. Introduction

Drought is a complex, natural hazard, with an onset that is often slow and difficult to detect, but with effects that can last for a long period of time and damage that can be widespread, resulting in significant economic losses, particularly in agriculture. While extended dry spells are often caused by natural climate variability, their intensity and frequency has increased in the past decades [1]. This trend is expected to continue during the 21st century as a result of climate change [2,3]. Droughts are affecting more people than any other socio-natural hazard in the world [4], and although in many cases the consequences of drought can be well predicted, preventive strategies are frequently insufficient to avoid serious impacts [5]. Failure to adapt to drought, especially in the context of a changing climate, causes and will continue to cause serious financial impacts for farmers, reducing employment in rural areas, affecting food availability and prices, driving a significant number of people into poverty, and triggering migration from rural to urban areas [6,7].

The study of public perception of drought can contribute to the successful implementation of drought adaptation strategies. An understanding of the public's sensitivity to and conceptualization of droughts and their effects, as well as public perception of the way droughts relate to climate change, has the potential to support the definition of what can be done, who is going to do it, who will benefit from this action, and how it will be evaluated [8–10]. Duinen, et al. ([8], p. 1082) describes two types of adaptation: private and public. Private adaptation is defined as individuals' behavioural responses to drought for the sake of private benefit, as defined by Duinen, et al. [8] who emphasize that private adaptation 'plays an important role in reducing vulnerability and enhances the performance of the agricultural sector as a whole'. Public adaptation includes the adaptive responses that are developed by governments that are 'often required to reinforce private initiatives and may include the provision of financial incentives, the removal of institutional barriers or the creation of awareness' [8]. Given the intimate relationship between public and private adaptation, in order to develop well-targeted public policies, further research is required to understand public perception and adaptation behaviour while recognizing current actions, willingness to incorporate new actions, barriers to behavioural changes, and ways to overcome these barriers and reinforce adaptive capacity [11–13]. A series of studies aiming to understand the factors that drive individuals to take actions to adapt to drought have concluded that people who perceive drought as a potential risk are more likely to incorporate adaptation strategies than those who do not [8,14–16]. Additionally, literature indicates that socioeconomic characteristics and resource constraints are the major determinants of drought adaptation, and that a shared understanding of drought allows public and private stakeholders to coordinate actions to cope with drought impacts [8,17–19].

Since 2010, an uninterrupted sequence of dry years, with annual rainfall deficits from 25 to 45 per cent has affected central Chile (30–38 °S) [20]. Given its unprecedented duration and large spatial extent, this phenomenon is referred to as the Central Chile Mega-drought. The Mega-drought has concurred with the warmest decade on record for central Chile [21], a factor that has increased the drought's severity by increasing reservoir evaporation [20]. Boisier et al. [22] concluded that a quarter of this rainfall deficit is caused by climate change, prompting a reflection that the hydrological reality of Chile is moving toward more frequent and severe droughts [23,24]. There is therefore a call for authorities and communities in Chile to reinforce their actions in order to adapt to this new reality.

Central Chile concentrates 81.2 per cent of the country's population [25], and most of the agricultural production. The region has a Mediterranean-like climate with precipitation concentrated in winter: April to September [26]. Irrigation demands for agriculture during spring and summer are supplied by snow-melt river flow, water reservoirs, and groundwater [27]. Over 90 per cent of the human water demand in Chile is met by drinking water companies; these companies also use groundwater or snow and water reservoirs, with desalination not representing an important water source. Given this scenario, any reduction of rainfall constitutes a stressor for the system [24].

The Chilean government has made significant advances in terms of climate change and drought adaptation policies and policy instruments over the last decade [28]. Nevertheless, research on climate change and drought perception has not informed climate change policy, with few studies focusing on this issue [29–33]. This situation reveals not only a relevant gap in literature, but also a deficient bottom-up approach to public policy development. Results of the few existing studies show, for example, that changes in climate have been recognized by a majority of individuals, with signs such as a reduction of rain frequency and quantity being most frequently mentioned.

In the context of a dryer and warmer future climate scenario, understanding how different actors perceive drought and drought impacts is relevant to informing policy and decision-making. The recent protracted, extended central Chile Mega-drought, with a quarter of rainfall deficit attributed to climate change, offers a synopsis of the future and thus a novel opportunity to study drought perception in the context of a changing climate. This research seeks to explore the main drought impacts that are perceived at the local level by different stakeholders, the temporality in which these impacts were perceived and the main causes of drought identified by local actors. We aim to inform

theory and practice, contributing to the improve responses to drought in the context of anthropogenic climate change.

The article is organized into five sections. Following the present introduction, the second section describes methodology and the case study. The third section presents an analysis of interview results, and the fourth section discusses these results and their implications and is followed by a conclusion.

2. Materials and Methods

This exploratory study was conducted at the local level in six counties in central Chile during 2015, after five years of dry conditions in central Chile, where 55 interviews were conducted and a thematic analysis was performed. The selection of local sites was based on the following criteria:

(1) Sites affected by the Mega-drought.
(2) Sites presenting vulnerability to drought and agriculture as one of their primary activities (based on the amount of land used for agricultural activities and the relative employment generated by this sector).
(3) Sites differing geographically and socioeconomically, and representing rural and urban settings.
(4) Access for conducting interviews.

Six counties in two administrative regions of central Chile were selected, two in the Metropolitan Region: La Pintana and Paine; and four in the Aconcagua Valley: Los Andes, San Felipe, Santa María, Los Andes and Rinconada de Los Andes. The location of these sites is shown in Figure 1, and their basic demographic characterization is presented in Table 1. Agriculture constitutes one of the top three sources of employment for four of these counties, with the exceptions of La Pintana and Los Andes [34].

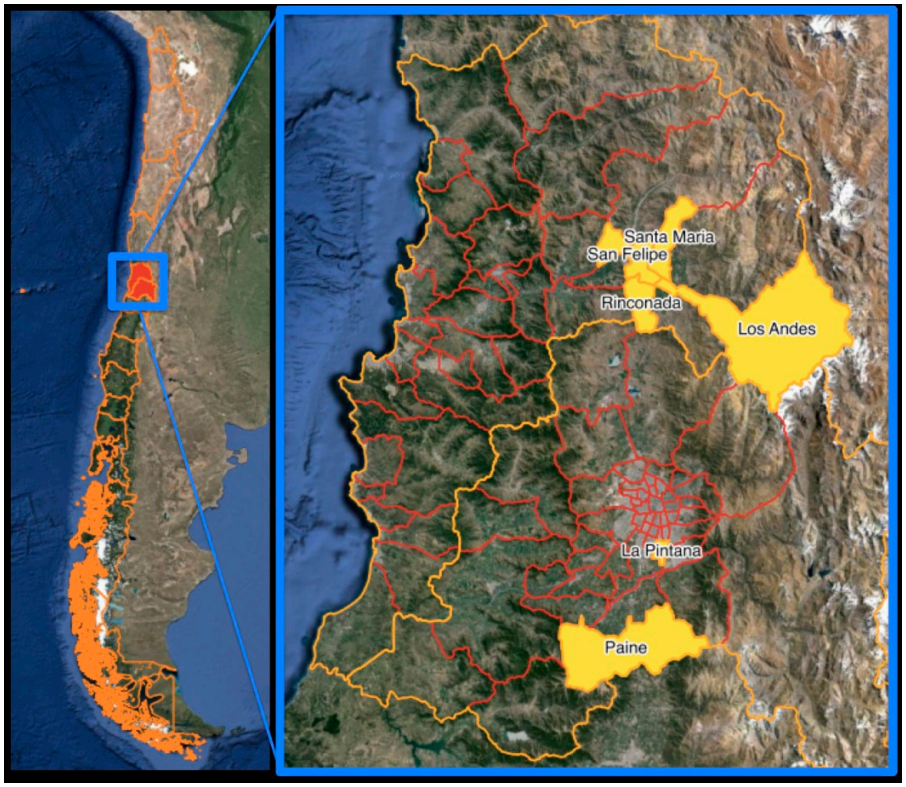

Figure 1. Study area. Source: Map based on geographical information from Biblioteca del Congreso Nacional BCN [35].

Table 1. County characterization.

County	Total Inhabitants	% of Urban Population	% of Land Used for Agroforestry	Main Sources of Employment (% of Working Force)
La Pintana	213.702	100.0	42.3	Construction (22.2) Public administration (11.8) Transport, storage and communications (11.7)
Paine	68.101	92.0	73.1	Commerce (25.4) Agroforestry (23.2) Transport, storage and communications (10.4)
Los Andes	68.401	63.2	60.0	Commerce (20.5) Construction (15.0) Real estate (13.7)
Rinconada de Los Andes	10.703	85.6	82.5	Hotels and Restaurants (60.0) Agroforestry (15.2) Commerce (6.8)
San Felipe	74.337	30.1	77.5	Agroforestry (29.0) Commerce (12.9) Non-metallic mining (11.9)
Santa María	15.836	63.4	96	Agroforestry (53.2) Commerce (24.2) Public administration (8.0)

Source: Compiled by the authors, based on information from [34].

Document review and expert consultation were performed for initial identification of key actors, with purposive and snowball sampling techniques being used to complement this selection. To ensure sample diversity, potential interviewees were organized according to the typology of actors proposed by Cornell et al. [36]: government organizations (local government and local government agencies), civil society and the private sector (e.g., agriculture, tourism, mining, and rural water sectors), and research and academic organizations. The focus of this study was on the individuals that are directly impacted by drought or directly related to the implementation of drought responses at the local level; representatives of academic organizations were therefore not included. A total of 55 semi-structured interviews were conducted between February and August of 2015, with 14 interviews being conducted between Paine and La Pintana and 41 interviews between the other four counties. Interviews lasted from 30 to 80 min and were conducted by two interviewers, with one asking the questions and the other taking notes. The characterization of interviewees is presented in Table 2.

Table 2. Characterization of interviewees.

	Actor Type [1]			Age Range				Gender		Urban or Rural		County [2]					
	CS	GO	PS	25–35	35–45	45–55	+55	M	F	U	R	LP	P	LA	R	SF	SM
Number of interviewees	10	16	29	5	18	18	14	41	14	27	28	5	9	10	11	12	8

[1] Actor type: Civil society (CS); Government organizations (GO); Private sector (PS); [2] Counties: La Pintana (LP), Paine (P), Los Andes (LA), Rinconada de Los Andes (RA), San Felipe (SF), and Santa María (SM).

Interviews were applied as the primary research method, given our goal of obtaining rich information. The study of drought perception in the context of a changing climate in Chile is still relatively new and therefore demands a deeper understanding and more detailed description than a survey could provide. Interview questions addressed changes in drought intensity (such as whether

interviewees perceived an increase, decrease or stability in drought severity), as well as perception of drought temporality and drought onset. Interviewees were also asked about their understanding and identification of drought causes, as well as their perception of drought impacts, both on interviewees themselves and on their natural and social environments.

Interviews were recorded and transcribed in NVivo 10. Thematic analysis was conducted to code and organize interview content in nodes. The first round of coding identified different topics that were discussed; these first hierarchy nodes were constructed based on questions asked during each interview regarding drought history, causes, and impacts (including impacts on the natural environment, water management, and productive sectors, as well as socio-economic impacts). Drought causes were an emergent node, which is a recurrent theme that is mentioned by interviewees but not asked as part of the interview.

Following thematic coding, open, analytical coding was performed to generate new categories (codes of second hierarchy in the tree node). Analytical coding is an inductive and interpretative exercise, where patterns are identified by juxtaposition, rather than by a prescribed or linear method of analysis [37,38].

3. Results

This section presents the main topics identified by interview analysis: drought history, causes, and impacts. Some illustrative quotes are presented within the text and complementary quotes are presented in supplemental material. To protect interviewees' identity, names were replaced by codes. A summary of interviewees' responses is included in Table 3.

Table 3. Frequency of interviewees' responses by topic.

Category	Sub-Category		Frequency [1]
History	Intensification	Increase	52
	Onset [2]	No answer	3
		2012	1
		2011	2
		2009–2010	10
		2007–2008	12
		2005–2006	3
		Previous to 2004	6
		Does not set a year	21
Causes [3]	Human activities/Demand		16
	Climate change		7
	Natural drought cycle		5
	Other origins		4
Impacts	Environmental		48
	On productive sectors		38
	On water management		27
	Socio-economic		19

[1] Total interviewees: 55; [2] Interviewers did not ask interviewees to identify a specific year of drought onset. Nevertheless, a majority of interviewees identified a specific date and these are presented; [3] This is considered an emergent category; no interview question aimed to determine interviewees' perception of the main drivers of the Mega-drought, but 27 informants clearly identified perceived causes.

3.1. Drought History, According to the Locals

All of the interviewees identified drought occurrence, and the vast majority (52/55) commented on its progressive intensification.

> "Well, I'm not that old but I can tell you that during the last seven years we have been in a constant and progressive drought." (Interviewee from private sector, San Felipe)

Interviewees mentioned two different periods of drought onset: 2007–2008 (12/34) and 2009–2010 (10/34). People who recognized drought intensification from 2007–2008 represented a primarily rural context from the Aconcagua Valley, were all over 45 years old, and worked in the agriculture and water supply sectors. Residents more closely related to the urban context, from Metropolitan Region and Aconcagua Valley, primarily recognized drought onset during the period 2009–2010.

3.2. The Blame Game: What Caused the Mega-Drought?

Although interviewers did not directly ask interviewees to identify perceived drought causes, this issue emerged repeatedly during interviews and the most frequent cause attributed to drought was human intervention (16 interviewees), and especially an increase in water demand resulting from an increased population and associated the change in land use for housing, coupled with the intensification of industrial and agricultural activities and inadequate water distribution. Glaciers deterioration due to human activities was also mentioned.

> "Yes, another thing is that in our area, all crops are irrigated with water from the Penco River, . . . but in that river there are some businessmen, upstream from us, who have water harvesting systems, . . . and they have stolen from us for years—in fact, they have been reported to the DGA—General Water Authority—, but they just pay the fine; they pay and keep stealing water." (Interviewee from civil society, Paine)

Natural climate variability was also mentioned as a cause (5), which implies an understanding of drought as part of a natural cycle. Some interviewees also mentioned climate change specifically (7), but only one explicitly recognized climate change as caused by anthropogenic factors. Few interviewees identified other origins (4), such as a desertification or the effects of the 2010 earthquake, which, as some interviewees explained, affected groundwater levels.

3.3. Impacts

In this section, the results of the analysis of drought impacts are presented and divided into four categories: environmental impacts (including landscape, flora and fauna); impacts on water management; impacts on productive sectors; and, socio-economic impacts.

3.3.1. Environmental Impacts

Interviewees identified impacts on the landscape as a whole and also changes in water bodies and plants and animal species. The most frequently identified impact was general landscape dryness (32), with some interviewees differentiating between drying of hill or meadow landscapes (9) and agricultural landscapes such as crop fields (6).

> "You can tell, because the Valley used to just be green and now almost half is dry. Everything is yellow—you can tell right away." (Interviewee from civil society, Santa María)

> "Well, I remember when I was a child, it was great, well, great and boring, because [it rained] then, fifteen days, day and night, and we had to lock ourselves in, and stay inside." (Interviewee from private sector, Paine)

Water bodies, including surface water, groundwater and snowpack, as well as rain, were frequently mentioned as elements that were impacted by the drought, and which have decreased in volume, extension, or frequency. Decrease of surface water was the most recognized impact (27/48), followed by the decrease of snow (11/48) and rain (5/48).

> " . . . The Copín Lagoon, 2450 meters high, which was a fantastic place about one kilometre long by 600 meters wide, [nowadays] is practically dry." (Interviewee from private sector, Santa María)

Some of the interviewees recognized a decrease in avifauna (including condors), catfish, mackerel, and frogs, and terrestrial species (mainly land mammals: nutria, guanacos, foxes, rabbits, *degúes*, hares), with an increase in some native flora (cacti and thorns). Interestingly, interviewees recognized changes in certain highly drought-resistant animal and plant species as indicators of intense drought; as a sign of how the impacts of drought has affected even those species that are prepared for dry conditions, reinforcing the perception of new and uncommon climatic conditions.

> "The thorns are the toughest, they are more rustic one might say. [Now] they are dry..."
>
> (Interviewee from government (government personnel), Los Andes)

3.3.2. Impacts on Water Management

Half of all interviewees (27/55) identified drought impacts on water management. These impacts can be grouped into four categories: irrigation; drinking water supply; efficient water usage; and Rural Drinking Water Committees. These committees are in charge of providing drinking water in rural communities; they are usually composed of neighbours who organize themselves in order to build the infrastructure and operate one or more extraction wells, and distribute water among the members (neighbours) of the committee. As they are directly dependent on groundwater levels, they are prone to be affected by droughts. However, the level of affectation will also depend on the economic resources of the neighbours. In terms of irrigation, the impacts were associated with changes in irrigation practices, such as decreased frequency in the use of irrigation canals and the number of furrows irrigated in a crop field; scarcity of surface water for irrigation (related to the use of deep wells to complement surface water and the implementation of more efficient technologies); and, a difficulty in fulfilling water use rights.

> "Small farmers and land owners, and especially those at the end of the irrigation canals [are the most affected], because that is where [water] is delayed and you have to take turns to use the canal . . . ; there are people who get water only once every 15 or 30 days . . . "
> (Interviewee from civil society, Los Andes)

Regarding drinking water supply, respondents identified a lack or significant decrease of water levels in drinking wells, which translated into the need to use tanker trucks and to deepen wells; a decrease in water pressure; and, damaged plumbing systems resulting from increased air bubbles.

> " . . . [drought] is affecting drinking water in San Felipe. San Felipe uses deep wells, and there are wells in Tocornal. There is one well that is being deepened, but it has been deepened for two months and they still can't find a stable water level. San Felipe is in a critical situation regarding drinking water." (Interviewee from government (government personnel), San Felipe)

Few positive impacts of the drought on water management were identified (6/27), and included a change in behaviour, expressed as more efficient water use, and an increase in the implementation of more efficient irrigation technologies. Interviewees mentioned fines for the excessive use of drinking water and improvements in garden irrigation efficiency.

> "And in the case of drinking water, we try to restrict overuse by fining the people who use more water than average." (Interviewee from civil society, Paine)

Finally, one interviewee mentioned impacts on the economy of Rural Drinking Water Committees related to difficulties in covering expenses as a result of household level economic losses that were produced by the drought.

3.3.3. Impacts on Productive Sectors

Agriculture and tourism were the main productive sectors that were impacted by drought as indicated by interviewees. Among the agricultural impacts identified by 35 interviewees (16 of them from urban context), the most frequently mentioned were those related to a decrease in the quality and the quantity of food production; loss of crops and animals; reduction of irrigated land; decrease in the size of agricultural products; the impossibility of seeding on traditional dates; and, hydric stress in crops. These impacts have resulted in a decrease in farmers' incomes and an increase in irrigation costs. Also identified was a decrease in the demand for agricultural labour and difficulty compensating workers during traditional periods, and as a result a reduction of seasonal employment. This decrease in incomes has affected both large-scale farmers and small land or cattle owners, who in some cases have had to alter their activities.

> "From an agricultural point of view, at the farm where I work we have had to let more than 100 hectares go dry because there is not enough water." (Interviewee from private sector, San Felipe)

> "It affects all of us, many people who used to live on crops [from small farms] and did not have the production because of the lack of water, they have had to look for jobs in other places, ... they left their families, they went to work to the north, to the mining ... ." (Interviewee from private sector, Santa María)

Drought has also directly or indirectly affected public agencies' investments; for example, more monetary resources have been directed toward drinking water supply at the expense of the finance of other projects.

Regarding tourism, the main impact as identified by eight informants was an increase in costs for tourism operators (with the generation of artificial snow for area ski centres being the most notable). Also noted was a change in the demand for tourism services (8), as some places have lost their recreational appeal. For example, the ski season has shortened and some tourist centres that are dependent on water bodies that have dried can no longer support aquatic sports.

> " ... in fact, Portillo [a ski centre] wanted to open for the ski season on July 4th and they had to do it with ... artificial snow made with water from the Inca Lagoon; this it is not a good option because it [the artificial snow] only lasts a day!" (Interviewee from government (government personnel), Los Andes)

3.3.4. Socio-Economic Impacts

A total of 19 interviewees recognized socio-economic impacts affecting the labour and cost of living, quality of life, and social conflicts. Ten recognized an impact on labour, affecting workers from agriculture and commerce sectors and reducing their working days and recruitment. For people working in commerce, decreased incomes were observed, while people working in the public sector described how drought has altered the way they support and advise farmers, because of technical issues that are related to pesticides, seeding, or harvesting, have been replaced by problems resulting from water restrictions for which they are not fully prepared.

> "Now I go to visit and I find that plants do not even have pests or diseases or any problem, and that is because they do not have water; then I fall short of technical recommendations because I have to tell them 'Decrease your irrigated land because there is no water' .... What recommendation can I give if the problem is that they don't have water?" (Interviewee from government (government personnel), Rinconada de Los Andes)

Ten interviewees also recognized impacts on the cost of living, which they relate to the increase in the cost of basic services, such as water, electricity, and food.

> " . . . in my personal life and in the community [the drought] is reflected mainly in the cost of vegetables." (Interviewee from civil society, Los Andes)

Private actors who identified socioeconomic impacts were mostly farmers (10) whose livelihood and cost of living is more directly affected by drought. The private sector is expected to be the most affected by drought, with incomes being directly dependent on changes in the environment.

Some interviewees (7) mentioned that drought had affected their forms of recreation; for example, by changing the natural spaces that they visit (such as rivers, springs, lagoons, and hills) or by presenting difficulties in filling and using swimming pools.

> "Of course that quality of life is lost, because, as I told you, back in the day we used to swim in that spring; we had a great time when we were kids." (Interviewee from private sector, Paine)

Quality of life is also impacted through impacts on physical health; for example, a decrease of precipitation in areas close to mining sites can provoke respiratory diseases as a result of increased particulate matter in the air. Mental health is also affected, with stress and worry resulting from current and future lack of water and from changes to daily routines, and melancholy resulting from changes to surroundings or the loss of natural places of personal importance.

> " . . . and in the quality of life, because . . . our ancestors bought [this land] with the idea that the family would have a different life, a healthy life, a natural environment, and [all that] is dying because of water scarcity . . . ; it has affected the family life and the economic life." (Interviewee from private sector, La Pintana)

Another important social impact is the conflicts emerging as a result of drought, as identified by 12 interviewees. Water scarcity has prompted migration as well as conflict between neighbours, water users and service providers. Disagreements result, for example, surrounding the price of water or the coordination of irrigation shifts. An increase in bribery allegations, water theft, and violence between people who share the same territory was also mentioned. Differences in terms of the nature of impacts can be observed between rural and urban contexts; for example, bribery was mentioned by rural interviewees, while migration from a rural to urban context was mentioned by urban dwellers.

Three interviewees identified positive impacts in response to the drought related to a renewed motivation to take care of the environment resulting in a greater participation in environmental activities, the use of renewable energies, and changes in common behaviours to promote efficient water use.

4. Discussion

The following section discusses the most relevant findings of this investigation and follows the same order in which the results were presented.

4.1. History

The presence of drought was recognized by all of the interviewees and its intensification was frequently mentioned; this indicates that the severity of the Mega-drought described by bio-physical literature as the most severe on record [20] has indeed been experienced as such by interviewees. Time series of annual precipitation in Los Andes City (the closest meteorological station to the four counties of the Aconcagua Valley) and Quinta Normal (closest station to La Pintana and Paine) are presented in Figure 2. Long-term mean precipitation is shown by the horizontal lines and the current Mega-drought period is highlighted by the grey bar. The stars and circles at the bottom indicate the onset of the Mega-drought, as indicated by interviewees; many of these points coincide with the meteorologically identified onset of the drought in 2010. Many interviewees also indicated 2007–2008 as the drought's onset, and this has two possible explanations. First, the year 2007 was as dry as the

Mega-drought years. Second, the tipping point for a meteorological 'dry year' is declared when a 30 per cent decrease in rain is observed, but this does not mean that individuals cannot perceive a year as drier than normal even if a 30 per cent decrease is not observed.

Also interesting to observe is that rural residents noticed the presence of drought before urban dwellers. This can be explained as rural interviewees may have a stronger bond with the natural environment and agricultural activities, where the impacts of droughts are more evident than in cities.

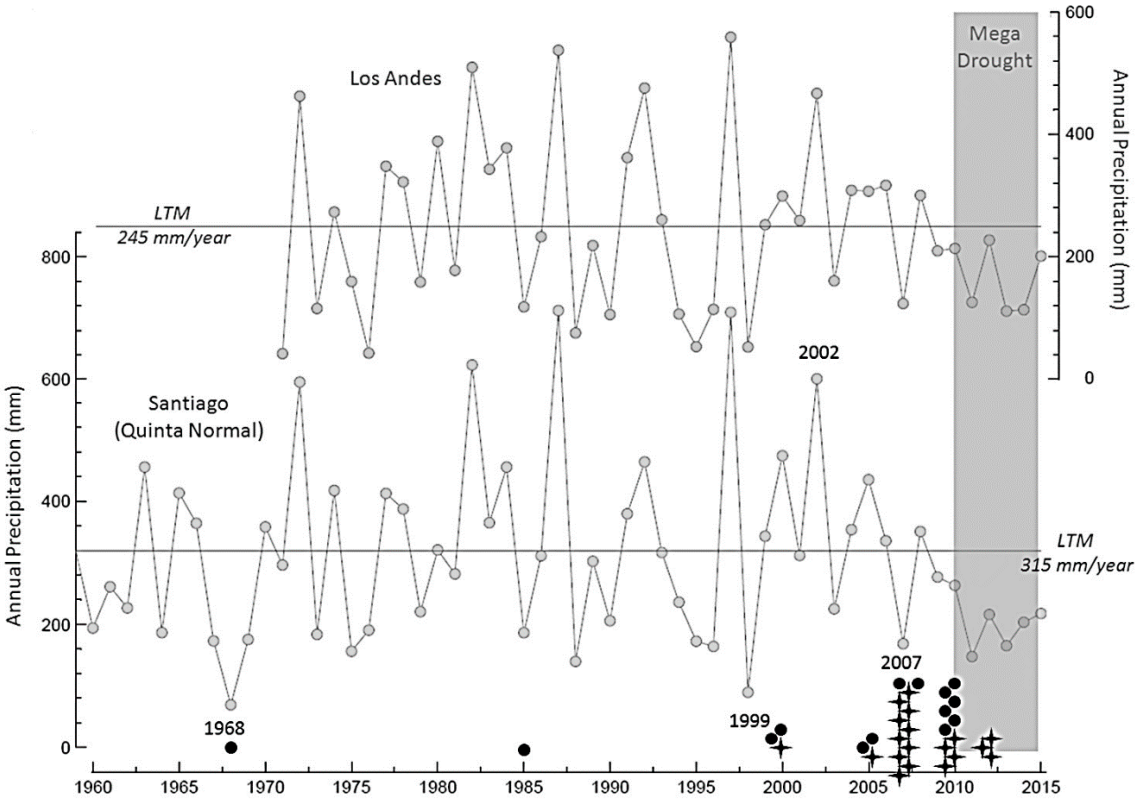

Figure 2. Annual precipitation for Los Andes and Quinta Normal meteorological stations. Stars indicate responses from rural interviewees and circles urban interviewees. Source: Based on precipitation data from DGA-Los Andes and DMC-Quinta Normal, extracted from the CR2 Climatic Explorer ([39], 2016).

4.2. Causes

The study results of the recognition of more intense water demand for human use as the main cause of drought concurs with relevant literature [5,11,31,33,40], where climate change and natural variability are identified as secondary causes. This suggests that drought is mainly framed as a management issue and that, as many other studies point out, the existing water management model should be reviewed [41–43]. The Water Code (The Chilean Water Code was introduced in 1981 and later amended in 2005. Its most important feature is the introduction of Water Use Rights (WUR), aiming to favor the establishment of a water market. These WUR are independent from land ownership, they are granted for life and can be freely and unrestrictedly traded as any other real estate.) in Chile allows the private use of water through the assignation of 'water rights', leaving water use (efficient or otherwise) to be determined by trading on the water market. Due to the lack of accurate hydrological information when the code came into effect, most of the water basins in Chile were overexploited (with more water rights assigned than water available), and the Water Code does not present efficient ways to regulate or prevent conflicts resulting from water scarcity—a situation that faces even more pressure in the face of drought and climate change.

Regarding climate change and its connection to drought, the literature suggests that even though people recognize many climate-related problems, these are not always linked specifically to climate change [31,33]. Despite Boisier et al. [22] study, assigning 25 per cent of the Mega-drought to climate change, this understanding is not easy to transfer to a non-scientific community, especially when droughts are a normal or known climatic condition in a given territory. Policy makers must therefore take responsibility for understanding and addressing the ways climate change will alter drought frequency and intensity.

The few interviewees who recognized climate change as a cause of drought were mainly between the ages of 35 and 55 and came from an urban context. Their understanding may be attributed or related to higher levels of formal education, and this difference may be important to consider when formulating adaptation strategies, especially when considering that these strategies are primarily targeted to rural areas. As presented by Habiba et al. [40], the perception of climate change varies with age, educational level, urban and rural context, and livelihood, therefore an inappropriate or misguided approach can affect the credibility of government initiatives. However, this is a field that demands much more research in the Chilean context [44].

4.3. Impacts

Drought not only impacts the economy of a territory; it also challenges the life systems of people living in it, according to the study results. Therefore, drought is a socio-environmental problem and should be addressed as such. This requires a transformation not only of productive sectors, but also of social systems, a transformation that should be targeted as a long-term, sustainable adaptation to a new climatic reality [45,46].

The results of this study resonates with those described by Finucane and Peterson [47], which argue that human relationships are highly affected by extreme circumstances, such as drought, when diverse social impacts emerge or intensify. Moreover, as described by Udmale, et al. [7], social impacts such as population migration, health impacts, hopelessness and sense of loss, and conflicts between water users are all potential impacts of drought, all of the impacts identified in our study. Additionally other impacts have been acknowledged in our research, such as an increased cost of living and the loss of recreational spaces and, as a result, social impacts similar to those described by Udmale et al. [7]. This understanding reveals the relevance of social aspects within adaptation processes and the need to integrate social considerations with public policy development. The vulnerability of human and social systems is exacerbated by drought conditions, and it is essential to develop adaptation actions with attention to social capital, trust, and social participation that support social cohesion.

With regard to productive sectors, the results of our study are similar to those presented by Ogalleh et al. [6], Olmos-Martínez et al. [9], and Udmale et al. [7], with drought impacts focused mainly on agriculture and, to a lesser extent, other economic activities such as tourism. As is widely presented in the literature, the impacts of droughts on agriculture experienced around the world [5–7,9,13,40], and in Chile in particular [31–33,48,49], are more or less similar, recurrent, and well understood—and, therefore, are relatively easy to predict. That is why preventive actions and actions to reduce vulnerability in the early stages of drought can and should be taken, such as the promotion of water efficient agricultural practices or the adaptation of new technologies. Regarding tourism, one impact that is mentioned was an increase in costs for operators—for example, the cost of generating artificial snow for ski centres. This example reflects the low degree of preparation and adaptation to the new climatic conditions of the territory as an action that, as described by [46], does require cultural change and cannot be considered a "sustainable adaptation". A different type of tourism based on rural traditions might be more effective and less vulnerable to the new climatic conditions.

Advancing adaptation strategies requires joint construction with local communities. Locally generated information and knowledge provided by diverse actors, as in this study, is vital to inform adaptation policy and supporting and improving existing actions in a way that considers the

specific realities and the physical and geographical conditions of each context. Developing strategies to reinforce adaptive capacity in a specific territory is fundamental; climatic conditions change and productive sectors must be able to change along with these conditions. Existing actions focus primarily on infrastructure (actions taken to cope with drought can be reviewed in Aldunce et al. [50]), and seek to satisfy current necessities but lack long-term perspective.

5. Conclusions

Research is needed to understand public perception of drought and its socio-cultural impacts in the context of a changing climate in Chile. This investigation demonstrates that drought is a social construct attributed to various causes. The results of this study are relevant because they illustrate a general recognition of drought and confirm that people identify drought onset similarly to meteorological information, based on the recognition of impacts on personal and social lives, productive sectors, water management systems, and the environment. This shows that this is a socio-environmental issue, exacerbated by climate change, which affects the entire living system of a territory and, therefore, public and private actions should be taken to reduce vulnerability and improve adaptation.

The fact that people recognize the drought, its intensification and set a date to its beginning that correspond to meteorological information, provide a common ground to join efforts to advance in adaptation, for example by facilitating communication. Additionally, understanding that human activities represent the primary cause of drought allows for policy makers to target adaptation actions and efforts toward increasing the public's awareness and understanding of climate change.

Further efforts are needed to identify and articulate the individual and social impacts of drought, in order to inform policies and strategies that address the wide spectrum of impacts. Adaptation requires integrative solutions and can be enhanced if national and regional policies integrate elements that are already implemented at the local level, and in this way allow for decision makers to have a better understanding of local vulnerabilities and the potential to improve resilience. This study generates knowledge that is relevant to informing theory, policy, and practice.

Further research should seek to complement these results. An important consideration for future investigation should be the sample's size and composition, and the inclusion of new criteria, such as diverse geographical/climate context, cultural backgrounds, ethnical origin and gender differences, and the integration of the scientific and innovation sectors. Efforts should also be made to recognize impacts in highly or exclusively urban areas; most of the urban interviewees included in this study had close connections to rural surroundings, while urban areas that do not have such proximity to rural context may present other impacts.

It would be also interesting to contrast the results of this investigation with different climatic realities, especially with territories with high precipitation or where drought is not common, or where it is assumed that the impacts and causality of climate change will be more obvious. In this regard, the city of Valdivia in Chile has experienced a great rain deficit in the county and presents an interesting case study.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/9/11/2053/s1, Table S1: Complementary quotes.

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