Winds of change project:
Wildfires in New Zealand and Chile

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Introduction

The Winds of Change (WoC) programme[1] aims to enhance the collaborative bi-national network between New Zealand and Chile. The programme focuses on investigating common climate change impacts on ecosystems and developing sustainable strategies in managing its associated risks. This report compiles general aspects of climate change's influence in the natural process of wildfires, how human activities interact with this phenomenon and potential collaboration among both countries in the risk management of fire events. The information is used as a primary source of infographics for the general public complementary to this document[2]. The report is divided into three topics. The first shows the relation between climate change and wildfires on a global scale. The second describes the wildfire situation in New Zealand and Chile. The third compares risk management strategies in both countries, resulting in direct collaboration from research and operational perspectives. Those provide a big picture of the wildfire challenge at different scales oriented to current and future researchers and risk management practitioners of wildfires. Hopefully, those products will generate a starting point for improvements in the bi-national collaborative network under the WoC umbrella.

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[1] For further information of WoC programme, see https://www.otago.ac.nz/administration/service_divisions/external-engagement/otago742957.html

[2] Infographics available in (link to infographics)

Wildfires challenge in the climate change context

Climate change is a sign of environmental unsustainability expressed in increasing global warming. Since the last ~100 years, the Earth's temperature has risen by 0.85°C (IPCC, 2014). Strong evidence of climate change has accumulated over time, primarily by measuring the atmosphere's human-induced CO2 concentrations (Paul, 2012). Since the first industrial revolution, economic growth and greenhouse gas emissions (GHG) have been closely related to human activities (IPCC, 2013). These refer to the global generation of energy in 25%, industry in 21%, transportation in 14%, agriculture, forestry, and other land uses in 24% by 2010, considered the basis for human economic development (IPCC, 2014). The evidence also shows how the increment of CO2 emissions diminish the atmosphere's capacity to reflect solar radiation, which is positively correlated with the global temperature increment (Ades, 2019; IPCC, 2018). The rising global temperature results in a variation of the Earth's hydrological cycle, resulting in the increment of extreme climatic events such as floods, tornadoes, heat waves, and drought. Those processes are associated with impacts on biodiversity and ecosystems, including species loss and extinction (IPCC, 2018; Paul, 2012). Global temperature increase also produces oceans' expansion by ice melting processes, where the average sea level is projected to rise 24 - 30 cm by 2065 and 40 - 60 cm by 2100 (IPCC, 2014). The rise sea level also impacted water availability (Barnett, 2003), the biogeophysical structure of coastal zones, and its subsistence resources (Nicholls, 2003). Moreover, the climate-related risk to health, livestock, and lifelines utilities is projected to increase for the next decades (IPCC, 2014; IPCC, 2018).

Wildfires are part of the natural system, influencing different Earth processes such as the carbon cycle, atmospheric chemistry, aerosols, and human activities. Global trends show that biomass burning has decreased during the last two millenniums, rising sharply between 1750 and 1870, and then declined abruptly (Marlon, 2008). However, the conditions that promote climate change phenomena may amplify potential fire impacts. Since 1950, increased the number of extreme events in terms of geographic extent, duration, frequency, intensity, severity associated with economic, social, and environmental impacts, especially in subtropical regions of the Southern Hemisphere and the European Mediterranean Basin, and Levant (Bowman, 2017). The conditions are ideal for bushfire propagation, primarily through some drivers as tropospheric instability and dryness coupled with surface weather conditions such as temperature, humidity, wind speed, and precipitation (Di Virgilio, 2019). Predictions of increased fire events under a global warming climate highlight the need for a more sustainable coexistence with fire (Doerr, 2016). In those terms, climate change is a global process, but communities and their local governments have to face its impacts (Crowley, 2008). Also, disasters are considered fundamentally local and primarily affect local people (Davies, 2015). Still, different experiences developing risk management plans for local communities may be useful for others with similar environmental conditions (Crowley, 2008; Davies, 2015).

Wildfires distribution: New Zealand and Chile

The wildfire process has a heterogeneous global distribution controlled by three basic requirements: vegetative resources to burn, environmental conditions that promote combustion, and ignitions (Krawchuk, 2009). In New Zealand and Chile, environmental similarities have been identified, especially for the latitudes 37°S and 47°S, by analyzing the distribution of temperate rainforest and weather conditions of temperature and precipitation (Lusk, 2016). Those conditions of vegetative resources and weather create a common mechanism of vulnerability to fire in both countries (Kitzberger, 2016). In terms of ignitions, direct human influence is the main cause of fires for those nations. Fires events were low in New Zealand before occupation from the first Maori communities by ~700 years B.P., and European expeditions since 1642 AD (Perry, 2014; Ogden, 1998). The effect of Maori and European fire reduces forest cover from 85-90% to 25% (Perry, 2014). In Chile, the oldest archaeological records are dated from 11,500 years B.P. in Central Western Patagonia (~43°S - 49°S), which correlate with fire increment based on pollen and charcoal records (Méndez, 2016).

In Chile, precipitation started to decline in 1970 (~2.8% by decade) when local rain was influenced by large-circulation changes such as El Niño and La Niña (Boisier, 2016). This precipitation decline, coupled with the maximum registered temperatures, spatially correlates with burned areas of central Chile (Urrutia-Jalabert, 2018). Also, a significant drought phenomenon has occurred during the last decade between 30°S and 38°S., with an uninterrupted sequence of dry years since 2010. This “megadrought” event was unprecedented to the south of 35°S according to tree-ring reconstruction of regional precipitation (Garreud, 2017). Given these conditions, fire activity in Chile has increased since the '70s in overall events (~58%), the extension of burned areas (~100%), and longer fire seasons (~44%) in comparison to previous decades (Gonzalez, 2018). However, less than 1% of the fires are associated with natural causes, which indicates those events are almost entirely caused by humans (Urrutia-Jalabert, 2018).

A high vulnerability to fires is concentrated in the urban-wildland territory, also known as Wildland-Urban Territory (WUI), where ~60% of wildfires are focussed, also home to ~80% of the total Chilean population, mostly in poverty (Soto, 2013; (CR2), 2015). In New Zealand, the urban fringe is increasingly populated with holiday homes and farmland. Many of the new arrivals do not understand wildfire mitigation strategies (Langer & Wegner, 2018). Neither of these populations is easily accessible by firefighters. Both are at risk of fire.

Forest fires are used to clear the land for activities such as agriculture, livestock, real estate, forest plantations for firewood or cellulose production, among others. This has decreased the native forest cover in both countries, causing serious damage to ecosystems.

In Chile, land use changes have decreased the coverage of native forests, which are more resilient to fires than exotic forests and plantations. New, exotic species act as new fuel resources for fire events (Gonzalez, 2018). Exotic plantations have also impacted erosion, flooding, landslide, water availability, biodiversity, and increased zoonotic disease propagation because of the deforestation of native forests that promote resistant and resilient landscapes (Gonzalez, 2018; Altamirano, 2019).

New Zealand recently started to increase awareness about the impacts and implications of human-induced climate change. The country focused on biodiversity, conservation and risk management of natural hazards (McKim, 2016). Exotic plantations represent less than 6% of total forest in both countries, but these plantations account for 50% of burned land (Global Forest Watch, 2021).

Fire events recorded since 1985 show an increase in the number. The South Island saw a much more significant portion of area burnt (increase of ~85%) in the last years (FENZ & SCION, 2020). In New Zealand wildfires are relatively small, but are frequent compared to other countries, with around 4,100 wildfires burning 4.170 ha annually (Langer, 2017). As a direct comparison, the Chilean wildfires burned more than 63,988 ha on average during the 2006 and 2016 period ((C.R.)2, 2015).

Risk management of wildfires: New Zealand and Chile

A fundamental aspect of the risk management of wildfires is monitoring and forecast events. In the case of Chile, in 1993, a Wildfire Forecast System (WFS) known as KITRAL (meaning 'fire' in the Mapuche language) was developed. It is still operational, supporting management strategies by identifying risk areas (Castillo, 2014; Ubeda, 2016). In New Zealand, an automated Fire Weather Monitoring System (FWMS) was implemented in 2002, including current fire weather, fire danger, and fire behavior potential updated daily (Pearce, 2008). In terms of research, both countries have created organizations in charge of developing knowledge and methods to understand and predict wildfires. In Chile, since 2013, the Center for Climate and Resilience Research ((C.R.)2) funded by the National Commission for Scientific and Technological Research (CONICYT) has been active. Assembled researchers from the University of Chile, University of Concepcion, and the Austral University of Chile are central institutions ((C.R.)2, 2017). In New Zealand, since 2018, SCION is the Crown Research Institute (CRI) in charge of developing research, science, and technology for the forestry, wood, and wood-derived materials sectors (SCION, 2018).

In Chile, the leading agencies facing fire emergencies are the National Emergency Office (ONEMI), the National Forest Corporation (CONAF), the Meteorological Direction of Chile (MeteoChile), and local firefighters companies, which are volunteers. In New Zealand, fire response is subscribed under the Fire and Emergency New Zealand (FENZ) act 2017. The FENZ combined urban and rural fire services into a single, integrated fire and emergency organization intending to reduce unwanted fires and their associated risks (DIA, 2017). The FENZ structure includes a national board working with different Local Advisory Committees (LAC), which provide a strong local perspective for developing emergency response strategies. The FENZ also has agreements with the Department of Conservation (DoC), the New Zealand Defence Force, and the Ministry of Education (DIA, 2017).

Recent events illustrate the impacts, costs, and management challenges in fire emergencies. In Chile, in the five days since April 16th, 2014, the Great Valparaiso Fire claimed 15 human lives, injured over 500 people, destroyed more than 2,900 homes, burned over 1,000 ha, and forced the evacuation of ~12,500 people (Raeszka, 2015). Also, multiple fires since January 18th and February 5th, in 2017, burned ~500,000 ha with associated costs of ~17 billion Chilean pesos (~23M USD) in management expenses (T13, 2017). One of the significant challenges in those events was the number of simultaneously active fires, which numbered as high as 120 during the emergencies in summer 2017 (T13, 2017). These events increased public awareness related to wildfires and their impacts on urban areas, which resulted in neighborhood associations adopting basic protocols in the face of such emergencies (Ubeda, 2016). In New Zealand, the Port Hills was affected by two fires in the same month of February 2017, burning over 1,600 ha. Nine homes were destroyed, and 450 households were evacuated (Langer, 2018; Squance, 2018). It took around two weeks to have the fire spreading under control, with one firefighter fatality and associated costs of ~8m USD in management operations (RNZ, 2017; Squance, 2018).

A fundamental risk facing both countries is the threat of wilding pines. Species of exotic pine, originally planted for timber, have reproduced beyond the boundaries of their farms and encroach upon native forest. By choking out native species, these invasive pines are able to occupy large swaths of land, and create dry, fire-ready environments (Edwards et. al, 2020). Finding a balance between their economic importance and critical fire risk remains a problem at the front of wildfire discussion. Solutions must appease people’s concern for safety while accounting for their financial investment. However, recent studies show that when wilding pines are visible from public spaces, their risk is appreciated and public approval for their removal increases, especially after a fire event (SCION, 2015).

All the events mentioned before, in both New Zealand and Chile, occurred in the Wildland-Urban Interface (WUI). Given the similarities among those countries, collaborative work for adaptation and operational strategies facing fires would be highly beneficial. Chile already has accumulated experience in the challenge ((C.R.)2, 2015), and New Zealand has been focused on the development of strategies based on local communities (DIA, 2017). As the Port Hills demonstrated, climate change is also changing the wildfire landscape in New Zealand, and the risk management was the key to avoiding very much more significant losses (Pearce, 2018). However, those operational strategies must include local communities and be prepared appropriately in case of multiple simultaneous events releasing stress in the organizational management system.

References

Ades, M., Adler, R., Aldeco, L. S., Alejandra, G., Alfaro, E. J., Aliaga-Nestares, V., … Veasey, S. W. (2019, January 1). State of the climate in 2018. *Bulletin of the American Meteorological Society*. American Meteorological Society. https://doi.org/10.1175/2019BAMSStateoftheClimate.1

Altamirano, A., Miranda, A., Aplin, P., Carrasco, J., Catalán, G., Cayuela, L., … Di Bella, C. (2019). Natural forests loss and tree plantations: Large-scale tree cover loss differentiation in a threatened biodiversity hotspot. Environmental Research Letters, 15(12). https://doi.org/10.1088/1748-9326/abca64

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(1), 413–421. https://doi.org/10.1002/2015GL067265

Barnett, T., Adam, J. & Lettenmaier, D. Potential impacts of a warming climate on water availability in snow-dominated regions. Nature 438, 303–309 (2005). https://doi.org/10.1038/nature04141

Bowman. (2017). 'Wildfire science is at a loss for comprehensive data'. July 31th, 2017. Accessed from https://www.nature.com/articles/d41586-018-05840-4

Castillo Soto, M., & Garfias Salinas, R. (2014). Estudio del comportamiento del fuego mediante simulación de incendios forestales en Chile. Geographicalia, (58), 81. https://doi.org/10.26754/ojs_geoph/geoph.201058818

(CR)2. (2015). Report to the Nation. The 2010-2015 mega-drought: A lesson for the future. Informe a La Nación, (November), 28. Retrieved from www.cr2.cl/megasequia

(CR)2. (2017). Memoria 2013 - 2017. Retrieved from http://www.cr2.cl/wp-content/uploads/2017/10/memoriacr2_2017.pdf

Crowley, CM (2008). The Climate Challenge: Thinking Globally, Changing Locally, Proceedings of Tasmanian Local Government Conference 2008, 18-20 June 2008, Launceston E.J.

Davies, T. (2015). Developing resilience to naturally triggered disasters. Environment Systems and Decisions, 35(2), 237–251. https://doi.org/10.1007/s10669-015-9545-6

DIA. (2017). Fire and Emergency New Zealand Act 2017. Department of Internal Affairs New-Zealand (July), 138. Retrieved from https://fireandemergency.nz/hazardous-substances/emergency-response-plans/%0Ahttps://fireandemergency.nz/assets/Documents/About-FENZ/Key-documents/FENZ-Blueprint-2017-20-Final-v2017-11-30.pdf

Di Virgilio, G., Evans, J. P., Blake, S. A. P., Armstrong, M., Dowdy, A. J., Sharples, J., & McRae, R. (2019). Climate Change Increases the Potential for Extreme Wildfires. Geophysical Research Letters, 46(14), 8517–8526. https://doi.org/10.1029/2019GL083699

Doerr, S., & Santin, C. (2016). Global trends in wildfire-perceptions and realities in a changing world. Geophysical Research Abstracts, 19, 2017–17979.

Edwards, P., Stahlmann-Brown, P., & Thomas, S. (2020). Pernicious pests and public perceptions: Wilding conifers in Aotearoa New Zealand. Land Use Policy. np. https://doi.org/10.1016/j.landusepol.2020.104759

FENZ & SCION. (2020). New Zealand Wildfire Season Summary 2019/2020 wildfire season (updated July 2020). (July), 30. Retrieved from https://www.ruralfireresearch.co.nz/__data/assets/pdf_file/0006/73959/FireSeasonWrap_2019-20.pdf

Garreaud, R. D., Alvarez-Garreton, C., Barichivich, J., Pablo Boisier, J., Christie, D., Galleguillos, M., … Zambrano-Bigiarini, M. (2017). The 2010-2015 megadrought in central Chile: Impacts on regional hydroclimate and vegetation. Hydrology and Earth System Sciences, 21(12), 6307–6327. https://doi.org/10.5194/hess-21-6307-2017

Global Forest Watch. (2021). New Zealand Forests. Web. https://www.globalforestwatch.org/

González, M. E., Gómez-González, S., Lara, A., Garreaud, R., & Díaz-Hormazábal, I. (2018). The 2010–2015 Megadrought and its influence on the fire regime in central and south-central Chile. Ecosphere, 9(8). https://doi.org/10.1002/ecs2.2300

IPCC (2018) Global warming of 1.5°C: an IPCC special report on the impacts of global warming of 1.5 C above pre-industrial levels and related global greenhouse gas emission pathways, Geneva.

IPCC (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Kitzberger, T., Perry, G. L. W., Paritsis, J., Gowda, J. H., Tepley, A. J., Holz, A., & Veblen, T. T. (2016). Fire–vegetation feedbacks and alternative states: common mechanisms of temperate forest vulnerability to fire in southern South America and New Zealand. New Zealand Journal of Botany, 54(2), 247–272. https://doi.org/10.1080/0028825X.2016.1151903

Krawchuk, M. A., Moritz, M. A., Parisien, M. A., Van Dorn, J., & Hayhoe, K. (2009). Global pyrogeography: The current and future distribution of wildfire. PLoS ONE, 4(4). https://doi.org/10.1371/journal.pone.0005102

Langer, E. R., & Wegner, S. (2018). Wildfire risk awareness, perception and preparedness in the urban fringe in Aotearoa/New Zealand: Public responses to the 2017 Port Hills wildfire. Australasian Journal of Disaster and Trauma Studies, 22, 75-84.

Lusk, C. H., Jimenez-Castillo, M., Aragón, R., Easdale, T. A., Poorter, L., Hinojosa, L. F., & Mason, N. W. H. (2016). Testing for functional convergence of temperate rainforest tree assemblages in Chile and New Zealand. New Zealand Journal of Botany, 54(2), 175–203. https://doi.org/10.1080/0028825X.2016.1143019

Marlon, J. R., Bartlein, P. J., Carcaillet, C., Gavin, D. G., Harrison, S. P., Higuera, P. E., … Prentice, I. C. (2008). Climate and human influences on global biomass burning over the past two millennia. *Nature Geoscience*, *1*(10), 697–702. https://doi.org/10.1038/ngeo313

McKim, L. (2016). Climate Change Impacts and Implications for New Zealand to 2100 A systematic review of recent research Implications for policy and management, and tools to support adaptation decision making in New Zealand. 59. Retrieved from https://www.deepsouthchallenge.co.nz/sites/default/files/2017-02/CCII-RA4-Review-of-recent-research.pdf

Méndez, C., de Porras, M. E., Maldonado, A., Reyes, O., Delaunay, A. N., & García, J. L. (2016). Human effects in Holocene fire dynamics of Central Western Patagonia (~44° S, Chile). Frontiers in Ecology and Evolution, 4(AUG), 1–19. https://doi.org/10.3389/fevo.2016.00100

Nicholls, R. (2003) Case study on sea-level rise impacts. OECD Workshop on the Benefits of Climate Policy: Improving Information for Policy Makers. Paris. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.552.4668&rep=rep1&type=pdf

Ogden, J., Basher, L., & McGlone, M. (1998). Fire, forest regeneration and links with early human habitation: Evidence from New Zealand. Annals of Botany, 81(6), 687–696. https://doi.org/10.1006/anbo.1998.0637

Paul, B. K. (2012). Global Warming and Climate Change: An Observation. Journal of Geography & Natural Disasters, 02(03), 4172. https://doi.org/10.4172/2167-0587.1000e109

Pearce, H. G., & Clifford, V. (2008). Fire weather and climate of New Zealand. New Zealand Journal of Forestry, 53(3), 13–18.

Pearce, H. G. (2018). The 2017 port hills wildfires-a window into New Zealand's fire future? Australasian Journal of Disaster and Trauma Studies, 22(Special Issue), 35–50.

Perry, G., Wilmshurst, J., & McGlone, M. (2014). Ecology and long-term history of fire in New Zealand. New Zealand Journal of Ecology, 38(2), 157-176. Retrieved January 22, 2021, from http://www.jstor.org/stable/24060795

Reszka, P., & Fuentes, A. (2015). The Great Valparaiso Fire and Fire Safety Management in Chile. Fire Technology, 51(4), 753–758. https://doi.org/10.1007/s10694-014-0427-0

RNZ. (2017). 'Port Hills fire bill reaches $7.9m'. July 6th, 2017. Accessed from https://www.rnz.co.nz/news/national/334606/port-hills-fire-bill-reaches-7-point-9m

SCION. (2015). Contributors: Manaaki Whenua Landcare Research, New Zealand Forest Research Institute Ltd. (Scion), & Aardwolf Research and Consulting. Evaluating the (non-market) impacts of wilding conifers on cultural values. Prepared for: The Department of Conservation Te Papa Atawhai.

SCION. (2018). Right tree, right place, right purpose. Scion strategy to 2030. Rotorua, New Zealand.

Soto, M. E. C., Molina-Martínez, J. R., Rodríguez y Silva, F., & Alvear, G. H. J. (2013). A territorial fire vulnerability model for Mediterranean ecosystems in South America. Ecological Informatics, 13, 106–113. https://doi.org/10.1016/j.ecoinf.2012.06.004

T13. (2017). 'Conaf: Incendios forestales tuvieron un costo de $17 mil millones'. February 18th, 2017. Accessed from https://www.t13.cl/noticia/nacional/conaf-incendios-forestales-tuvieron-costo-17-mil-millones

Úbeda, X., & Sarricolea, P. (2016). Wildfires in Chile: A review. Global and Planetary Change, 146, 152–161. https://doi.org/10.1016/j.gloplacha.2016.10.004

Urrutia-Jalabert, R., González, M. E., González-Reyes, Á., Lara, A., & Garreaud, R. (2018). Climate variability and forest fires in central and south-central Chile. Ecosphere, 9(4). https://doi.org/10.1002/ecs2.2171