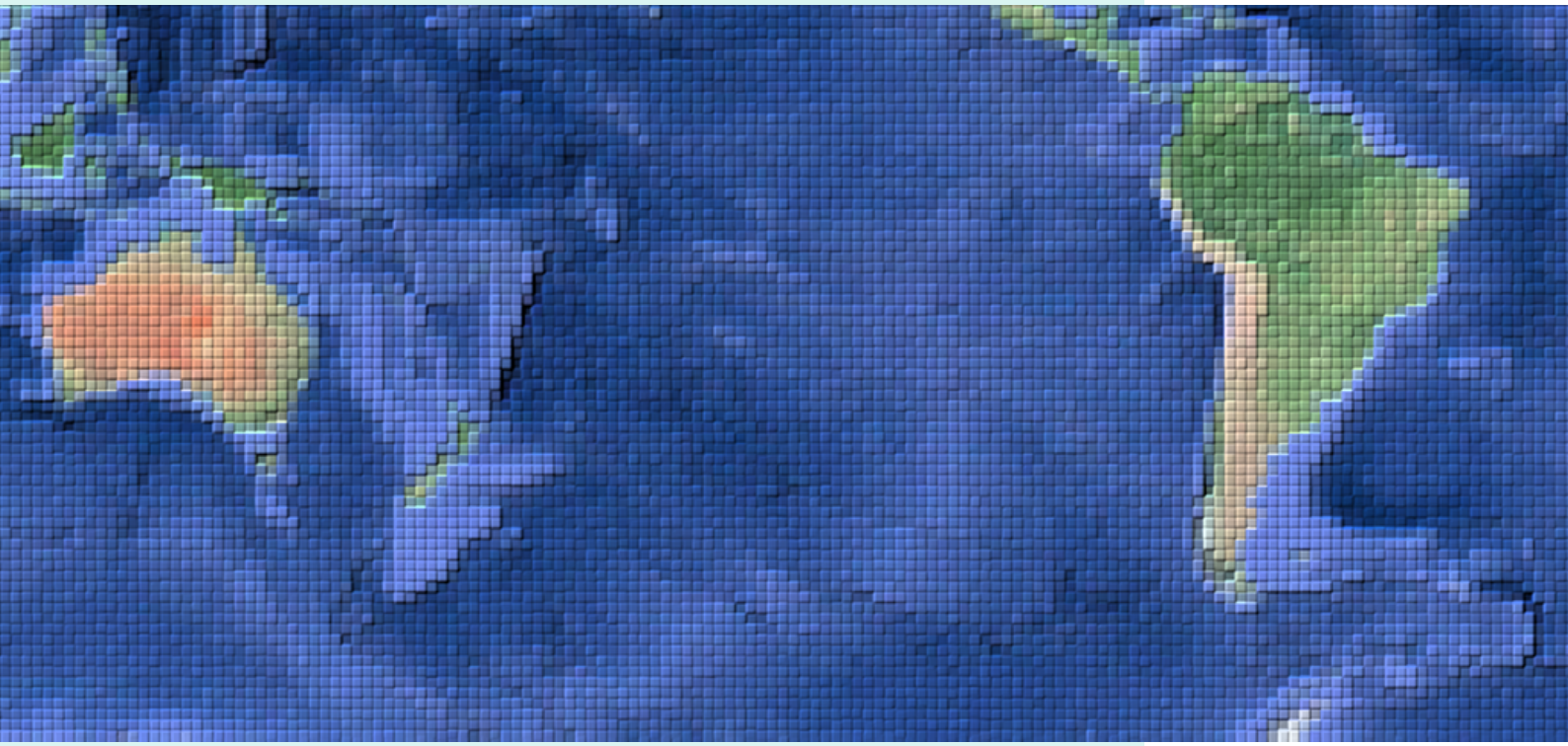

DIVERSITY FOR RESILIENT AGRICULTURE

THE CASE OF CHILE AND NEW ZEALAND

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WINDS OF CHANGE

FEBRURARY 2021

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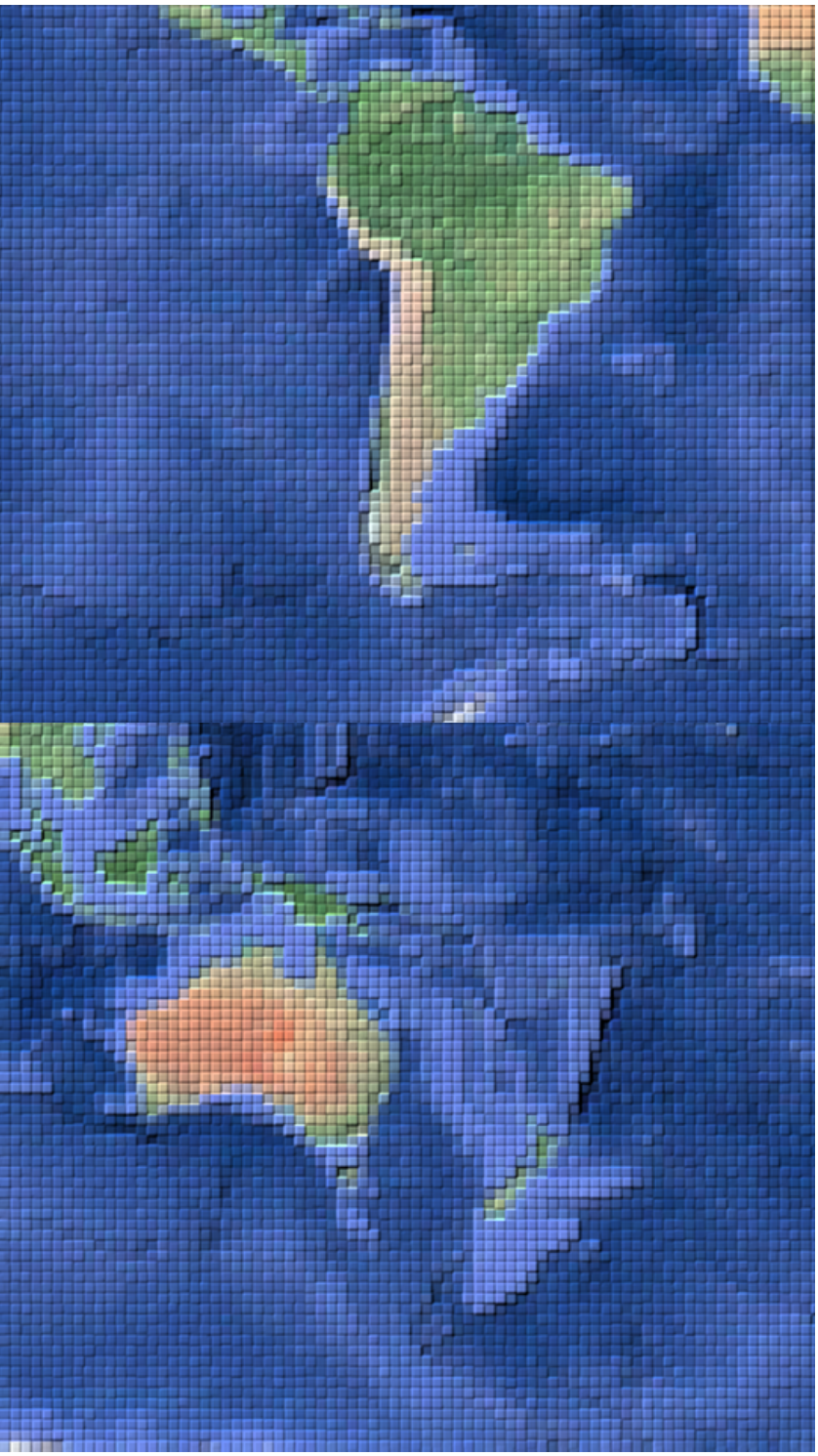
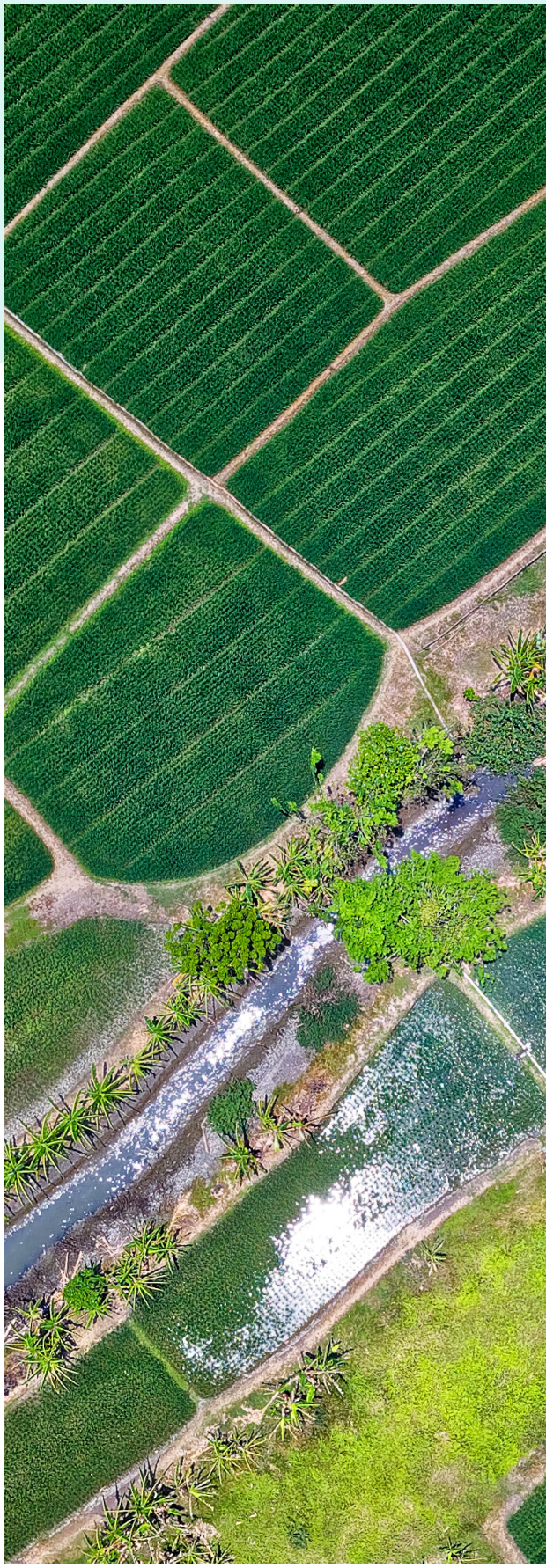


THE PROBLEM: FARMING IN THE FACE OF CLIMATE CHANGE



The consequences of climate change will be varied and complex. Although these possible impacts are relatively well known (increase in annual temperature, decrease in rainfall, extreme rainfall events, among others), the precision of climate predictions at local scales has more uncertainty. At the same time, there is a multiplicity of social, political, economic and cultural consequences of climate change. At a global scale, some of these include potential mass migration of human and non-human communities (from coastal or near-desert cities), degradation of cultivable land, higher energy demands for cooling or heating houses, and potential for a global economic crisis.

Regardless of these challenges, different geographical, economical and social contexts are creating unique opportunities to adapt to, mitigate and approach these physical changes. Despite the differences humanity has in these global contexts, one commonality that we all share is food, a physical sustenance. As the changes of the coming decades unfold, one certainty is that humanity will not only need to be fed, but food is required to be produced and consumed in a way that also provides us with social, cultural and economic sustenance.

Furthermore, global land use change - of which agriculture is a major driver- has strongly contributed to the loss of biodiversity. Humanity is reliant upon healthy functioning ecosystems for all the services they provide us. This includes food, fibre and other resources such as medicines, but also additional regulating, cultural and supporting services. Biodiversity is a critical part of ensuring these services are provided and therefore is a vital component of creating resilient ecosystems in the face of climate change. But current agriculture practices have intensified production at the expense of biodiversity, severely threatening ecosystem health and therefore our own food security.

Given this context, farms and food producers become a focal point for vulnerability to the physical and non-physical challenges of climate change, but also the front line for adaptation and hope. Developing and implementing technologies in agriculture to deal with climate change and biodiversity loss has become a billion dollar industry, yet there is the additional challenge of trying to be profitable in a changing economic context.

It is at this point where the concept of “diversity” can be considered a tool against climate change. Ecological biodiversity in farms could make local ecosystems more resilient to different extreme climate events like rainfalls or droughts with long term benefits for the stability of food production.

But equally, farms with a higher diversity of products or many production methodologies could be more prepared to deal with future markets and changes in legislation, with long term benefits for the social and economic stability of farming families and their communities.

"It is at this point where the concept of 'diversity' can be considered a tool against climate change"

Hence, when we think about the challenges of climate change, in all its complexity, we see that creating economic and social resilience is as critical as restoring biophysical systems. We cannot produce food with broken ecosystems, and we cannot transport, sell or access food with broken farmers, markets or distribution systems.

Humans are not separable from the world around them, and as such, the way we approach environmental issues should not compartmentalize them in such a way. For agriculture, the resilience that we seek in our systems is an opportunity to champion ecological biodiversity as a pathway to sustainability and production.

OUR AIM

Our aim will be looking at ways Chile and New Zealand are creating agricultural resilience (ecological, social and economic) through protecting and restoring biodiversity in farming landscapes.

As part of the inaugural Winds of Change programme, this project brings together young climate change leaders and researchers from Chile and New Zealand. Therefore these two countries are used as the case studies for this project. Chile and New Zealand are two countries with geographic, topographic and economic similarities, and are facing similar potential consequences of climate change.

Therefore, how is each country addressing the issues of food production and biodiversity loss? Contrasting the projects and ideas that each country has developed to deal with agricultural resilience and biodiversity can create an opportunity to learn from and share knowledge with each other.

SIMILARITIES BETWEEN CHILE AND NEW ZEALAND

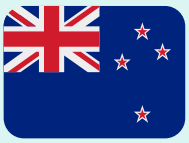
The first step to develop our aim will be to identify climate/environmental consequences of climate change that will impact both Chile and New Zealand. This way, we will understand the context in which agricultural solutions and technologies have been developed and the potential for successful initiatives to be translated between countries.

GEOGRAPHIC

Geographically, both countries are in the southern hemisphere, bordering the Pacific Ocean. Both are near to Antarctica and have high topography that includes high elevations (mountains over 3000 m.a.s.l). Long coastlines and a narrow shape are matched with the presence of mountain chains. As a result, both countries have many relatively small catchment areas, short rivers and landscapes with high slopes.

On the other hand, there are some principal differences between Chile and New Zealand. One is their size, Chile three times bigger than New Zealand. Chile also shares political borders with Perú, Bolivia and Argentina, whereas New Zealand is an island. Chile is located in a continent (South America), with a desert at its north border and a Mountain chain at its east border, while New Zealand is three main islands with its primary countain chain running the length of the South Island.

Despite their different location, both countries are geographically isolated, New Zealand by the ocean, and Chile by the Andes to east and the Pacific ocean to the west. This isolation contributes to the creation of similar ecosystem and ecological scenarios for both territories (Walrond 2005; Biblioteca Nacional de Chile 2018).



NEW ZEALAND

CHILE

MAPS NOT TO SCALE

CLIMATIC

Climatically, if we consider the climate classification of Kopper-Geiger (Geiger 1954), we could say that Chile has a higher diversity of climates than New Zealand, due the presence of arid desert and warm-summer-mediterranean-climate areas. However, they also share a lot of similarities. The most frequent New Zealand climates (Temperate-oceanic-climate in most of its territory and Tundra in high elevation areas), are also present in Chile. The Temperate-oceanic-climate is present in Chile at the same latitude as New Zealand, and Tundra climate is present in high elevation areas also (Beck et al. 2018).

While Temperate-oceanic-climate is characterized for having monthly averaging temperature between 0 ˚C and 18 ˚C, a warm summer and constant rainfall, Tundra is characterized for having an average temperature for every month below 10 ˚C. This way, both countries share climatic scenarios with particularly cold temperatures and constant rainfall.

Another similar climatic scenario to both countries is the influence of ENSO (El Niño-Southern Oscillation, also named El Niño and La Niña). ENSO phenomenon is an ocean-atmosphere intradecadal cycle that occurs on average every two to seven years. It directly impacts rainfall and temperature of both countries, determining drier or wetter seasons plus other climatological anomalies (Rutllant and Fuenzalida 1991; Mullan 1995).

El Niño and La Niña impact both countries differently: while El Niño determines wetter winters in Chile and more rain in the west coast of New Zealand, is associated with dryness in the east coast of New Zealand (Rutllant and Fuenzalida 1991; Mullan 1995). Despite these differences, this phenomenon determines whether both countries have annual changes in climate conditions but it is becoming more difficult to predict weather and other relevant changes in climatic conditions of the Pacific Ocean.

BIODIVERSITY LOSS

All these geographical and climatic similarities determine many other between both countries. For example, the high quantities of endemic species (Kier et al. 2009), or similar agricultural sectors which specialise in wine, fisheries, wood or fruit (Barton et al. 2007). However, land use change fuels the reduction of biodiversity. New Zealand has lost 63% of its total forest area, partly due to the introduction of Maori to the land, but more greatly due to the emergence of Europeans in the 1800's (Ewers et al, 2006). In Chile, 19% of its native forest in central zone has been lost just in the last 40 years due to forest transformation to shrublands, tree plantations and agriculture (Miranda et al, 2017). As such, the loss of biodiversity in both countries is dramatic.

80%

of native species in New Zealand are threatened (over 4000 species)

(Ministry for the Environment, 2019)

66%

of evaluated species in Chile are threatened (but only 5% of known Chilean species have been evaluated)

(Ministerio del Medio Ambiente, 2019)

CLIMATE CHANGE SCENARIOS

All climate change scenarios developed for New Zealand to the year 2090 predicted an increase of temperatures throughout its territory (between 0.7–3 ˚C). This included an increase between two and four times the frequency of "hot days" (maximum temperatures at least 25˚C), and a decrease of "cold nights" (minimum temperature ≤ 0 ˚C) under 50 m.a.s.l. (Ministry for the Environment 2018).

According rainfall predictions, the largest increases will be in the west of the South Island, mainly during winter. Conversely, the largest decreases will be in the east of the North Island and coastal Marlborough, rising the number of dry days per year. Moreover, for the entire country is expected an increase in the number of extreme precipitation events. Other predictions include stronger extreme daily winds and a larger reduction of relative humidity (see all detailed projections in the Ministry for the Environment 2018).

In the case of Chile, projections for the period of 2081–2100 predict an increase of temperatures throughout the Chilean territory. For example, under worst-case climate change scenarios, minimum and maximum temperature in winter might increase by about 4–8 ˚C, and maximum temperature in summer might increase about 2–6 ˚C.

Precipitation is projected to decrease by over 40% from the northern zone to the southern zone (between -23.3 and -45.4 Latitude) and might increase by 60% in the Altiplano regions (over -23.3 latitude, near to borders with Perú and Bolivia) as well as in the austral zone (below -45.4 Latitude, area closest to the Antarctic). There is also likely to be an increase in extreme precipitation events (see all detailed projection in Araya-Osses et al. 2020).

When we compare climate change prediction to both countries, we could conclude:

1. Climate change effects would be more severe in Chile than New Zealand in regard to the increase in maximum temperatures;

2. The east of the North Island and coastal Marlborough of New Zealand would be climatically similar that southern Chile (between -35– -45 Latitude) under climate change scenarios;

3. The west of the South Island would be climatically similar that austral Chile (below -45 Latitude) under climate change scenarios.

Considering these projections, we could assume that both countries may be forced to deal with increasing droughts in regions that currently have high precipitation and low temperatures. Both countries may also have to deal with an increase of floods in their southern areas as they experience an increase in extreme precipitation events.

HISTORICAL AND ECONOMIC SIMILARITIES

To finalize this section, it is also important to highlight that in addition to all these physical similarities, both countries also share economic and historical characteristics. New Zealand and Chile both share colonial histories. New Zealand was invaded by the British, and remains a part of the commonwealth, while Chile was invaded by Spanish, but gained independence in the 1800's.

The combination of colonial histories and the physical geographical similarities have meant that both countries have been set up to have strong primary industries that fuel export-orientated economies (Murray and Challies, 2004).

As a result, both countries also approached economic liberalisation across the later part of the 1900's to position themselves as key exporters in the modern global economy.

As such, the economic challenges Chile and New Zealand face in the free-market (Murray and Challies, 2004), but also then future changes and economic restructuring to markets in the context of climate change and changing diets could be similar as well.

This way, in this moment of human history, we have two countries with geographic, topographic, climatic, ecologic, economic, and historical similarities facing similar potential consequences of climate change.

STRATEGIES IN CONSERVATION AND AGRICULTURE

New Zealand and Chile have both recognised the issues that biodiversity loss and climate change present for farming. Despite the countries similarities, they have taken differing approaches to conservation and agricultural resilience. This section explores some of the current adaptation and mitigation strategies that each country has taken in previous decades.

NEW ZEALAND

In 2019, the Ministry for the Environment released its latest report on the state of native biodiversity in NZ. The report highlighted that native biodiversity is significantly threatened (MfE and Stats NZ, 2019). In farming areas, waterway pollution is attributed to excess nutrients, pathogens and sediment (ibid).

Adaptation and mitigation methods to climate change and biodiversity loss are discussed in terms of reformative action within the current system. These focus predominantly on technological fixes or reactive environmental management to agri-food pollution. For example, local measures such as pushing for 'best practice' riparian planting to reduce nutrient pollution from run-off into waterways, industry-led research into reducing methane emissions from cows, considerations for carbon accounting that includes agricultural emissions, or reserving sections of land for 'preservation'.

While fertilizers (particularly nitrates) are of hot topics in the public realm due to their links to the public and political campaigns for 'swimmable rivers' and concerns of nitrate pollution in drinking water in some regions, other agri-chemicals and their impact on the environment are not at the foreground of issues in the media.

In this context, some existing efforts to conserve/protect biodiversity or manage farm landscapes are:

FARM ENVIRONMENT PLANS (FEP)

Every farm has to have a FEP with their local council to show how they are reducing their impact on the environment. Some industry bodies for example, Beef+Lamb NZ, or supply chain companies or exporters require a separate FEP, or audit to verify environmental standards are met.

The effectiveness of the plan and audits to create positive environmental outcomes can differ based on who is involved and the motives of the farmer, and the extent to which the FEP/auditing process is created collaboratively between regulators and farmers.

NATIONAL POLICY STATEMENTS (NPS)

NPS are are created under the Resource Management Act (1991) and are used to guide decision-making at national, regional and district levels. New Zealand has many NPS, including for indigenous biodiversity and for freshwater management (indicating they are generally managed separately).

However, historically, NPS are not enforceable pieces of legislation and instead more of a guide to good management desired by government bodies.

REGIONAL BIODIVESITY STRATEGIES AOR ACTION PLANS

Many regional and district councils across New Zealand have biodiversity strategies or action plans that inform the vision for local wildlife habitat and conservation practices.

PREDATOR FREE NEW ZEALAND 2050

Predator Free NZ is a national initiative to eradicate introduced predators such as possums, rats and stoats by 2050. To achieve this a variety of formal and informal groups such as government funded Department of Conservation or local community groups undertake conservation work that involves trapping and killing of these pests.

Protecting native birds is often considered a priority in such conservation efforts, often rendering the necessity and benefits of the work to protect other native wildlife such as reptiles, fish or plants. It is often debated in political circles whether the goal of predator free can be achieved by 2050.

LOCAL GROUPS AND OTHER INFORMAL WORK

Biodiversity conservation and reduction of environmental harm on farms is also completed through a lot of informal environmental networks in New Zealand. This can be anything from local catchment groups in rural areas to community tree planting. Collectively, informal work plays a large role in conservation in New Zealand.

INDEPENDENT ORGANISATIONS

CASE STUDY: QUEEN ELIZABETH II NATIONAL TRUST

Works with landowners to designate parts of their land (usually steep gullies or less productive areas to be reforested/restored and then protected as covenants. These covenants are permanent and so the land is protected even if it is sold to a new owner.

These are exclusionary-based protection methods as stock, development, harvesting etc. is restricted or prohibited within the covenants (recreation, hunting allowed).

Nearly ½ of all QEII covenants in New Zealand are on sheep and beef farms, showing high farmer uptake of the conservation method.

It is important for conservation to occur in agricultural production spaces that private and public land. For farmers, there is an increasing social pressure for environmental standards to be raised and met so that ecological health is not harmed in the process of food production. This is also met with increasingly similar expectations from international markets (Maseyk et al 2019). New Zealand must meet these pressures while also adapting to climatic changes that will make farming in many places across the country more difficult.

Maseyk et al (2019) notes that improving indigenous biodiversity management on-farms can create opportunities to meet wider social, economic issues in farming businesses as well as the urgency of creating farm resilience to climate extremes.

They note however, that the existing approaches to protecting and managing biodiversity on private land "has failed to resonate beyond the protection of fragments by individual farmers" such as we see with the QEII covenants, and as such it "is not at the level needed to influence the transformative change required to meet goals for the conservation of New Zealand's indigenous biodiversity" as set by national biodiversity strategies or public aspirations (Maseyk et al 2019, pg. 2).

CHILE

In Chile, agriculture is the second most important primary economic activity after mining, contributing 7.3% of GDP, The most important is the production of fruits, vegetables, wheat, milk and meat (ODEPA, 2017). However, monocultures dominate the Chilean agricultural region. For example, water was used for the monocultural production of avocado in Petorca, Valparaiso region(Budds, 2004).

However, in Chile, an alternative model of agricultural production called agroecology has developed alongside industrial agriculture. Agroecology is based in practices that are environmentally, socially and economically responsible and is grounded in the concept of sustainable development (FAO, n.d.). Agroecology also incorporates a socio-political discourse that supports contemporary agrarian social movements which seek the transformation of the current social, economic and political system as pathway to global unsustainability (Rosset and Martínez-Torres 2012).

"Agroecology is based in practices that are environmentally, socially and economically responsible"

The term agroecology emerged in the early 1980's when some non-governmental organizations (NGOs) began to work directly with rural communities and urban residents. However, many of the practices are embedded in or share similarities with indigenous agricultural practices.

Because agroecological practices contribute to the sustainability of agroecosystems and natural resource management in rural areas (Gutiérrez, Aguilera and González, 2008), they not only became a key part of peasant, and small-holder farming movements, but also are beginning to be incorporated in the framework of some national agrarian development policies.

Farms with an agroecological productive approach are characterized by pluriactivity, that is, by presenting mostly the development of complementary economic activities as integral parts of agricultural activity - making traditional handicrafts and food. In Chile, through agroecological plans that have been promoted by the INDAP (Chilean Institute of Agricultural Development, acronym in spanish) rural tourism has also been promoted.

For example, Chile has seen the development of fairs such as Expo Mundo Rural and local certifications such as the Manos Campesinas Seal (shorturl.at/moD39). These activities contribute to revitalizing peasant economies that bring their products to new consumers. However, this is not without controversy, as it promotes practices that tend to folklorize ancient rituals and traditions for commercial and market purposes.

In Chile and other countries around the world, The farming techniques based in biodiversity and heterogeneity is little because of the lack of ecological guidelines that farmers can apply, Also, the large-scale industrial farming can cause ecosystem loss.

Most farmers still do not practice agroecology and instead continue to use unsustainable models of production. The State also has not yet adopted agroecology decisively as an agrarian policy.

CONTRASTING CHILEAN AND NEW ZEALAND CONTEXTS

When contrasting New Zealand and Chilean agriculture, we see some differences in approaches. In New Zealand, a land-sparing approach is common. This is where intensive farming and conservation are designated into separate spaces. areas of land are 'set aside' for biodiversity in order to protect it from spaces that humans use. The QEII National Trust is a key example of this land sparing approach.

In contrast, Chilean agroecology has traditionally maintained a land-sharing approach, which favors conservation and farming in the same space. However, as the application of agroecology is not mandatory in Chile, while some small farms use agroecology to improve their food sovereignty and on-farm biodiversity, most large farms continue to use harmful industrial practices.

Therefore, despite these different approaches, each country is still facing massive declines in biodiversity.

BIODIVERSITY LOSS CONTINUES:

IN NEW ZEALAND

90% *of seabirds*

76% *of freshwater fish*

84% *of reptiles*

46% *of vascular plants*

ARE CLASSIFIED AS THREATENED OR AT RISK OF EXTINCTION

MINISTRY FOR ENVIRONEMNT AND STATS NZ, 2019

IN CHILE

75% *of invertebrates*

83% *of fishes*

71% *of amphibians*

72% *of plants*

ARE CLASSIFIED AS THREATENED

MINISTERIO DEL MEDIO AMBIENTE, 2019

DOING AGRICULTURE DIFFERENTLY:

LEADING THE WAY TO A BETTER FUTURE

What are the ways in which people in each country are working differently to resolve these issues and restore biodiversity AND create resilience in agriculture?

There are organisations, community groups, business and individuals from both countries which are taking a different approach to these issues of resilience.

Often these groups are taking a more holistic view that integrates biodiversity conservation efforts into the heart of agriculture and acknowledges the benefits of a mosaic of land-sparing and land-sharing approaches (Kremen, 2015). Landscape variety with native and agriculture structure can improve the richness and abundance of birds within agroecological systems by expanding the ecological niches and providing habitat for native birds (Muñoz-Sáez et al., 2017)

CASES FROM NEW ZEALAND

FARMING & NATURE CONSERVATION (FNC)

This is an initiative created through and funded by National Science Challenges - Biological Heritage in partnership with Beef + Lamb NZ. The aim is to help primary production and nature biodiversity work together.

The initiative is supported by the Tindall Foundation - they are working to create a 'Farming with Biodiversity' website that gives farmers information about protecting, maintaining and restoring indigenous biodiversity on farms. Having a comprehensive platform for farmers to go to get reliable and up-to-date information about the best ways to create positive spaces for biodiversity on their farm helps to simplify the challenges and provides access to solutions.

As part of the initiative, there is the creation of the Living Laboratory Project. The project is using small scale blocks of land to experiment with best outcomes on restoring biodiversity while also farming. These trial blocks can then go on to inform larger biodiversity restoration projects on farms
See https://www.farmingnatureconservation.org/ for more details about how this initiative progresses.

QUORUM SENSE

A farmer-led community group that is providing resources, education and a platform for knowledge sharing about regenerative farming practices.

Regenerative farming is a holistic approach to farming where focusing on soil health, diversity and context-specific practices allow farmers to begin to restore ecosystem function on their farm. This has outcomes for better production, reduced farming costs, and positive impacts of farmer wellbeing.

Learn more at:
https://www.quorumsense.org.nz/

ATA REGENERATIVE

Consulting company that helps companies/communities take regenerative, holistic approaches to their business (especially farms). Their work involves guiding people is a values based approach to decision-making for positive system outcomes.

Learn more at https://ata.land/

CENTRO DE EDUCACIÓN Y TECNOLOGÍA

Currently, several institutions throughout Chile carry out different dissemination and extension activities in agroecology. For example, the CET in Yumbel receives about 7000 people annually in its agroecological demonstration center.

CET (Centro de Educación y Tecnología) , a nongovernmental organisation (NGO) that since the 1980s have been encouraging small farmers to use agro-ecological activities that boost their self-sufficiency and food sovereignty. Althought in Chile there is an enormous progress of agroecology , which has mostly benefited small farmers, large-scale farmers do not accept these techniques . After more than 30 years, two of the four CET demonstration centers are still active, in Yumbel and Chiloé, to which they have been added demonstration farms and plots of agroecological farmers, which act as important "agroecological lighthouses".

In the case of Chiloé, the obtaining and development of FAO's SIPAM Chiloé project is remarkable and a great achievement for the CET. The SIPAM project's main objective is "the dynamic conservation of the traditional systems of the island and the strengthening of conservation of biodiversity and local knowledge" (http: // www.sipam.procode.cl).

For more information on the work of CET, see https://www.corporacioncet.cl

UNIVERSITY RESEARCHERS

Four universities present active and consolidated research and have extension groups in agroecology (**USACh, UFRO, UCM, UNAP**). Researchers are increasingly arguing that the restoration of the landscape scale is important to reverse the damage caused to biodiversity and human well-being by anthropogenic ecosystem degradation (Rey Benayas and Bullock 2012; Jones et al. 2018).

PUBLIC POLICY AND PRIVATE COMPANIES

As such, this research is beginning to influence agricultural policies. It is noteworthy that some public institutions such as **INDAP, INIA and CONADI** have recently established research and development programs or lines that incorporate agroecology.

Similarly, some large agricultural companies are beginning to tap into agroecological practices too. Large organic producers such as **Viñas Emiliana** and other vineyards, and producers of berries such as **Hortifrut SA**, have made efforts to incorporate an agroecological base in their designs and management. In doing so, they are seeking to transcend the input substitution that characterizes production organic export in Chile.

CONCLUSION

In the context of a changing climate, it is clear that we need diversity in how we think about creating resilient systems. We need both land-sparing and land-sharing approaches so that we have biodiverse farms that will be more physically resilient to extreme climatic events. But we also need farms with a higher diversity of products or production methods, so they also have economic and social resilience. Farms of the future must be more prepared to deal with future markets, legislation and other changes that will happen as our societies and ecosystems adapt to climate change.

"Whether it is big organizations, or small-scale farms, creating a healthy future is a team effort"

Whether it is big organizations, or small-scale farms, creating a healthy future is a team effort and countries like Chile and New Zealand can learn from each other as they tackle these major challenges of the future.

It is important that the small scale initiative that we see taking place in New Zealand and Chile receive support so that they can continue to create positive change in agricultural sectors.

As such, diversity should be perceived as a tool against climate change and agricultural pollution. The resilience it creates will be the key to improving food security, saving biodiversity, and facing the world's next economic challenges.

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THIS REPORT WAS PRODUCED AS PART OF THE WINDS OF CHANGE PROGRAMME 2021

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