Climate Change is Here:
Teachers' and Students' Perceptions about Education For It

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Abstract

Climate change is the greatest threat humans have ever faced. The unprecedented anthropogenic activity impacting on the environment is having catastrophic effects across the globe and could continue for thousands of years. Mitigation to prevent further environmental harm and adaptation to the already-changing conditions are essential strategies in addressing climate change and, therefore, education for these strategies is imperative. Educators have an opportunity to prepare our learners with the knowledge and skills they will need to combat the impacts and effects of climate change. Climate change education offers young people a chance to develop their knowledge, critical and creative thinking and problem-solving skills while building their resilience and adaptive capacity to act in this crisis. But are our young people getting these learning opportunities?

This was an interpretive study that focused on the perceptions of climate change and climate change education of students, teachers and leaders at a secondary school in the Waikato region of New Zealand. A mix of quantitative and qualitative data were gathered by using an on-line questionnaire and focus groups with students and semi-structured interviews with their teachers and leaders. The data were divided into four sections: beliefs, knowledge, attitudes and actions for both the student data and the teachers' and leaders' data, and were thematically analysed using NVivo.

The data clearly showed in this study that the students were worried about how climate change was going to affect their future lives and the lives of the people closest to them and most wanted to change their behaviour and take action to try and reduce the effects of a changing climate. In order to do this, the students wanted to learn more about climate change, raise their awareness, and the awareness in their community, so that everybody could be prepared for the changing climate. The findings indicated that the teachers all agreed that climate change education is important for students and wanted to know more about climate change so

they could inform their students about climate change through education. The leaders indicated that it is vital that the students' are thoroughly prepared for the changing climate and a change in behaviour, but they also felt that the teachers needed to be supported as well, and not just those teaching about climate change, but to make sure everyone is prepared for an uncertain future.

This study recommends the Ministry of Education to firstly, consider how climate change education can be made available to all children and young people, and then to provide guidance on how educators in schools and teacher education throughout New Zealand could teach about climate change to all our learners.

Acknowledgements

I would like to thank my supervisor, Associate Professor Chris Eames, for his inspiration, and his continuous support, patience and encouragement throughout this research project.

To the students, teachers and leaders that participated in this research and gave up their time to help me, I owe you a huge thank you, as you all made this a memorable journey.

Thank you to my family for all your support, encouragement and patience throughout this process, particularly my daughter Hannah as without your help, this study would not have been possible.

“Surely we have a responsibility to care for our planet.

The future of humanity and indeed all life on Earth, now depends on us”.

David Attenborough

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Chapter 1
Introduction

1.1 Overview of the chapter

This chapter is an introduction to my research. Within it, I discuss the motivation I had for undertaking this study. I justify why I chose the research question and outline the purpose and scope of the research. The chapter concludes with the structure of the thesis.

1.2. Motivation for the research

In the later years of the previous century, I worked on several dairy farms in the Waikato and Taranaki. During that time, I became increasingly concerned with how the environment was managed, and the impact farming and animal agriculture was having on the terrestrial landscape. However, changes were happening in the climate that I had never seen before. For example, on the 7th and 8th of March 1988, Cyclone Bola (an ex-tropical cyclone) ravaged the central and upper regions of the North Island and created a path of destruction from Taranaki, where it made landfall, through to Gisborne, which received the full force of the storm. At the time, I was working on a dairy farm southwest of New Plymouth and this powerful storm not only affected the farming season for many months, but it also changed the physical landscape dramatically, as there were a lot fewer trees across the region.

More recently, the increase in the summer temperatures, severe flooding in the Waikato region and a couple of years of drought made me realise that the climate was changing. As an Agriculture and Horticulture (Ag/Hort) teacher by now, I was privileged to be able to demonstrate how and why we should all look after our environment; ways we could be sustainable and use sustainable practices in farming, growing crops and in our gardens at home. As a Science teacher, I have taught the students about the science of climate change: how humans are influencing the climate, the effects that are changing the climate and what we could all do to reduce this impact on Earth. However, I believe that teaching students about climate change from a scientific perspective is not sufficient, as it does not express the whole issue. As well as being an educator, I also have a Bachelor of Social Science in Geography. Hence, I believe that climate change

education offers the students a multidisciplined, socioscientific approach that develops critical and creative thinking that can lead to action-taking.

I love teaching and enjoy interacting with the young people in our school, but I decided to take a break to inform my teaching practice and undertake a research project that would allow me to explore the perceptions of climate change within this secondary school. Stepping away from a busy workload has afforded me to become fully informed of the complex science that underpins the specific concepts of climate change. Further, this study has enlightened my thinking and made me realise that the teaching and learning of climate change must be relevant in the lives of the students, as well as revealing the unprecedented impact humans are having on the planet and the way the systems are being changed. I now have a much better understanding of how climate change education can empower young people to take informed and intentional action and help others to become aware of the issues and impacts of the changing climate.

1.3. Justification for the research

For as long as the Earth has been in existence, the climate has undergone changes in the global temperatures and gaseous composition of its atmosphere. However, it has only been in the past 150-200 years that human activities have contributed to climate change in ways never seen before (National Aeronautics and Space Administration, 2019). Moreover, the scientific community overwhelmingly agrees that anthropogenic events such as the unprecedented combustion of fossil fuels and carbon dioxide emissions have accelerated the accumulation of greenhouse gases in the atmosphere and led to a rise in global temperatures (Hoegh-Guldberg et al., 2018; Intergovernmental Panel on Climate Change, 2018; National Aeronautics and Space Administration, 2019).

The science and chemistry of climate change, global warming and climate science literacy is complex and can be difficult for teachers to teach and for students to learn about. However, if students are to be thoroughly prepared for the impacts and consequences of a world with a changing climate, are able to adapt to these changes and are empowered to make changes in their behaviour and the behaviour of others, then young people must have the opportunity to learn about climate change throughout their schooling. Learning about the weather, the climate and how this can affect our daily lives, as well as reducing pollution with the 3 R's (reuse, reduce and recycle) could begin in

early childhood education and at primary school. In the middle school (Years 7 to 10) the students could learn about what climate change is, how and why the climate is changing and actions they can do to reduce their impact on the planet. They could also be taught the science behind climate change and the effect that a changing climate will have on vulnerable people in their community or country, during these formative years with teachers scaffolding or eliminating the complex science, so it does not overwhelm the students. At NCEA Level 1-3, climate change education could be offered to the students as an interdisciplinary option or in a socioscientific framework, which is teaching across the science and social science curriculums, that is holistic, relevant and mindful.

A socioscientific, interdisciplinary approach uses an inquiry to develop transformative ways of thinking, which can lead to action-taking and attitudinal and behavioural changes, and is very suited to the teaching and learning of climate change, than just content alone (Dawson, 2015; Caranto & Pitpitunge, 2015; Saddler & Zeidler, 2005; Stevenson, Nicholls & Whitehouse, 2017; Vongalis-Macrow (2010). Further, McKeown and Hopkins (2010) describe climate change education as having two parts: *climate* involving the natural sciences and *change* or educating for change, which is an ideal platform for a socioscientific focus on climate change. Climate change education can empower learners by inspiring them to inform others about the effects of climate change, to think critically and creatively and take informed intentional action to effect real change. Educators that inspire and empower their learners and offer student-centred teaching methods can engage, challenge and enable their students to actively participate in actions to help mitigate or adapt to climate change (Monroe, Plate, Oxarart, Bowers & Chaves, 2017).

Climate change will affect local, national, international and indigenous communities, vulnerable and affluent people, ecosystems and habitats. Therefore, it is pertinent that climate change education encompasses the four fundamental principles of environmental education: environmental, economic, social, and cultural aspects (Ministry of Education, 2015a), which are crucial in understanding what effects climate change could have on the social structures as well as the economy and the Earth's physical systems. Further, climate change education also utilises a *system thinking approach* (sum of the parts

equals the whole), which is the process of examining and understanding the various components and interactions within a system such as the ecological system or the Earth's global systems. Labriole (2016) states that a "system thinking approach" enables both teachers and students to see the complex science of climate change, the impacts and the solutions, as a part of a bigger picture (para 9).

This study examined the perceptions of students, teachers and leaders and their understanding and experience about climate change and climate change education at a secondary school. I chose this level over younger children as I believe that secondary and post-secondary education must thoroughly prepare our young people for a future that will be full of challenges and uncertainties in a world with a changing climate. However, in order to be fully prepared, all our learners must know about climate change, and climate change education makes this possible.

1.4. Purpose of the research

The purpose of this interpretive thesis was to interpret and understand the perceptions of the students, teachers and the school leaders and the experiences they have about climate change and climate change education in the context of a secondary school in the Waikato region of New Zealand. The outcomes of this research could assist educators to inspire and empower learners to build resilience and adaptive capacity and enable them to take informed intentional action for climate change.

1.5. Research question

The research question that guided this study was:

- What are the perceptions of students', teachers' and leaders' in a secondary school in Aotearoa New Zealand about climate change and climate change education?

This question has been addressed by exploring students', teachers' and school leaders' perceptions of climate change and climate change education through a questionnaire, focus groups and semi-structured interviews. The data that was collected was analysed using Microsoft Excel, NVivo and a thematic approach.

1.6. Scope of the research

The research data was collected from a small sample of secondary school students (14 to 18 year-olds), teachers and leaders at a secondary school in the Waikato region. The data was gathered using a questionnaire, focus groups and semi-structured interviews and analysed the beliefs, knowledge, attitudes and actions of the participants about climate change and climate change education.

1.7. The thesis structure

This thesis is divided into six chapters. Chapter two reviews the literature that encompasses the main concepts of this thesis, which is divided into two main sections: climate change and climate change education. The first part of the chapter begins by examining greenhouse gases, and their role in the climate system, as well as the greenhouse effect, and global warming. The next section reveals how human activities are affecting the climate and weather patterns due to the acceleration of atmospheric greenhouse gases and an increase in temperature. Finally, New Zealand's changing climate, mitigating and adapting to climate change and Māori environmental knowledge reveal how innovative problem-solving and solutions are being found through traditional and contemporary knowledge and wisdom.

The second part of the chapter explores the literature around the policy, philosophy and principles of climate change education, and the pedagogy reveals the strategies for teaching and learning about climate change. These include mitigation and adaptation, action competence, a socioscientific and a culturally responsive approach. Teaching climate change education is also examined, as are the outcomes for teaching and learning. The subsequent sections will explore secondary schooling (to inform this thesis), and what is known generally about the perceptions of students', teachers' and leaders' about climate change and climate change education.

In chapter three, the methodological basis for this research is described as is the approach taken for the selection of the participants, the data collection and the analysis. The research design is outlined. The methodological framework introduces the paradigm that guided the research, and the research methods and instruments used to collect the data are explained. Finally, the limitations

of the study, the trustworthiness and ethical considerations of the research are discussed.

In chapter four, the findings of the study are divided into three participant groups: the students, the teachers, and the leaders. In this section, I present and interpret the data from these three groups through beliefs, knowledge, attitudes and actions in relation to climate change and climate change education.

In chapter five, the research findings are discussed to highlight the main points that were interpreted in the study. The conclusions, implications and limitations that were drawn from the study are also considered as well as further research that is recommended.

Chapter 2

Literature Review

2.1 Overview of the chapter

This chapter presents the literature relevant to this research in four main sections. In section 2.2, climate science and its significance in New Zealand is explored. In the second section, the greenhouse effect, global warming; climate change and the human impact are examined, as well as mitigation and adaptation, and finally those most vulnerable to climate change and Māori environmental knowledge are explored. The third section examines the curriculum, philosophy, pedagogy and outcomes of climate change education. The fourth section considers secondary schooling in New Zealand and is followed by the way students, teachers and leaders perceive climate change and climate change education in Aotearoa New Zealand. The chapter concludes with a summary of the reviewed literature and its significance to the present study.

2.2 Climate science

In this section, aspects of climate science are explored, beginning with greenhouse gases and their contribution to the greenhouse effect and global warming. How these relate to New Zealand is included.

2.2.1 Greenhouse gases

Greenhouse gases are atmospheric gases that absorb infrared radiation from the Earth's surface. As these gases accumulate, radiated heat from the Earth gets trapped, warming the lower atmosphere, the oceans, and the land (Marshak, 2015; Withgott & Laposata, 2015). These complex molecules are a part of our climate system and include water vapour, oxygen, nitrogen, carbon dioxide, methane, nitrous oxide, inert gases and ozone and are extremely important for the health of the Earth's biosphere. Nitrogen and oxygen make up the highest proportion of the Earth's atmosphere at 78.8% and 20.95% respectively, but they do not absorb infrared energy. Therefore, they are not greenhouse gases (Nightingale, 2019). Of all the greenhouse gases water vapour occurs in the highest concentration in the atmosphere (Marshek, 2015; Pidwirny, 2006).

Nevertheless, to support life on Earth, greenhouse gases are essential. Plants, for example, utilise water vapour and carbon dioxide and release oxygen into the atmosphere during photosynthesis and respiration, the ozone layer protects the surface of the planet from harmful ultraviolet shortwave radiation, and nitrogen is released by lightning through precipitation and taken up by nitrogen-fixing bacteria (Armstrong, Krasny & Schuldt, 2018). Greenhouse gases are released naturally into the atmosphere by natural processes such as volcanic eruptions, the melting of the permafrost and emissions from our wetlands. Moreover, the levels of atmospheric emissions and concentrations also naturally change and fluctuate over time (Withgott & Laposata, 2015).

Since the industrial age, however, atmospheric greenhouse gases have accumulated rapidly due to anthropogenic (human-generated) activities such as transport, energy and agriculture. For instance, carbon dioxide in the atmosphere has risen from 280 parts per million in the late 1700s to 412 part per million in 2019, and atmospheric methane has risen sharply since 2007 with a record 1858 parts per billion in 2018 (Armstrong et al., 2018; Nisbet, Dlugokencky, & Bousquet, 2019; Withgott & Laposata, 2015). In New Zealand, NIWA's atmospheric monitoring station at Baring Head records the present carbon dioxide levels, and it is approximately 408.5 parts per million (National Institute of Water and Atmospheric Research, 2019).

2.2.2 New Zealand's greenhouse gas profile

Even though New Zealand is a small island nation and the total contributions to global emissions are relatively low, the greenhouse gas emission levels are higher per person than other industrialised countries (Ministry for the Environment, 2019). One reason for this is that a large proportion of the emissions are from methane and nitrous oxide, which are a consequence of intensive dairy and pastoral farming. According to Statistics New Zealand, land use for dairy farming increased by 42 per cent, from 1.8 million to 2.6 million hectares between 2002 and 2016.

Additionally, the Waikato had one of the most substantial increases in land area for dairying up 35 per cent over this period. In 2018, the Waikato region had 4,000 dairy herds and 1.5 million milking cows (Tikkisetty, 2019). Local research indicates that Waikato dairy farmers produce about one-third of New Zealand's total dairy production (The Waikato Plan, 2017). Research carried

out between 1995 and 2015 ascertains that by 2015 emissions had risen by 64 per cent with the majority of the increase coming from animal agriculture as methane emissions increased by 5 per cent, nitrous oxide (nitrogenous fertilisers and animal waste) increased by 51 per cent, and carbon dioxide increased by 78 per cent due to road transport emissions (Ministry for the Environment and Statistics New Zealand, 2017).

According to the Organisation for Economic Co-operation and Development (OCED), New Zealand has a unique emissions profile: with nearly half of its greenhouse gases coming from animal agriculture; methane emissions from ruminant animals and nitrous oxide from agricultural soils, animal waste and fertiliser. Furthermore, the contribution to agricultural emissions is placed highest in the OECD, which reflects the importance of this industry to the economy (Organisation for Economic Co-operation and Development, 2017).

Methane gas is a potent greenhouse gas and is produced in the gut of ruminant animals such as sheep and cattle by enteric fermentation (digestive process) and contributes to almost one-third of New Zealand's greenhouse gas emissions (Manaaki Whenua, 2019; Monteny, Bannink, & Chadwick, 2006; The University of Waikato, n.d.). Monteny et al. (2006) argue that dairy cows produce between 84 and 123kg of methane/per animal/per year as a result of rumen fermentation. However, according to scientists at AgResearch when a micro-meteorological technique (which measures paddock methane emissions) is used, the seasonal methane emission rates fluctuated between 284 and 427 grams/per day/per cow. This research is significant as New Zealand has an extensive methane emissions rate (0.6 tonnes per person per year), which is six times the global average (Manaaki Whenua, 2019).

Additionally, it has been claimed that the environment and the ecological services cannot sustain 6.4 million cows we have at present (Ministry for the Environment and Statistics New Zealand, 2018). Although methane and nitrous oxide gasses are more potent (able to trap more heat) than carbon dioxide (CO_2), the latter is more abundant in the atmosphere and a significant contributor to anthropogenic global warming (Withgott & Laposata, 2015).

In New Zealand, the two leading contributors to New Zealand's carbon dioxide emissions are the transport and energy sectors as shown in figures 2.1 and 2.2 - natural gas and coal-fired power stations (Ministry for the Environment

and Statistics New Zealand, 2019; Ministry for the Environment, 2019). Evidence collected at the Clean Air Monitoring Station at Baring Head near Wellington has shown that atmospheric concentrations of carbon dioxide in New Zealand increased by 23 per cent between 1972 and 2016 or 401 parts per million (Ministry for the Environment and Statistics New Zealand, 2017). According to the OECD, New Zealand leads the international research effort to reduce greenhouse gas emissions and water pollution from agriculture. However, New Zealand's "growth model has started to show its environmental limits" with increased greenhouse gas emissions, freshwater contamination and threats to biodiversity (Organisation for Economic Co-operation and Development, 2017, p.5). Furthermore, New Zealand's gross greenhouse gas emissions per capita remain among the fifth-highest amongst the industrialised countries, and in 2016, we ranked fourth-highest (Ministry for the Environment and Statistics New Zealand, 2019; Organisation Economic Cooperation and Development, 2017).

Greenhouse gas emissions profile

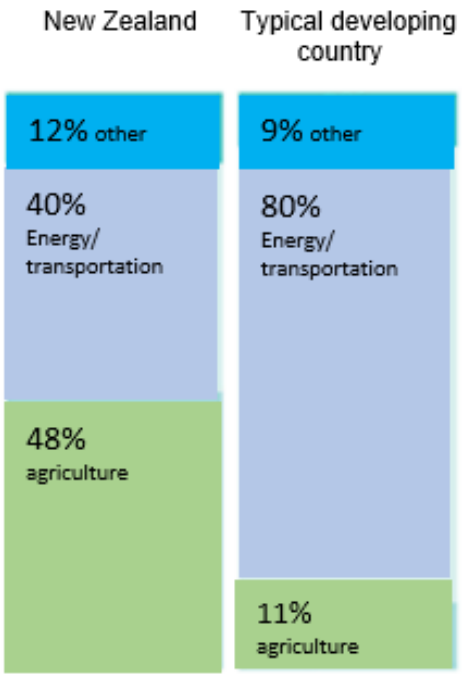

Figure 2.1. New Zealand's environmental profile (Ministry for the Environment, 2017)

New Zealand's emission profile, 2015

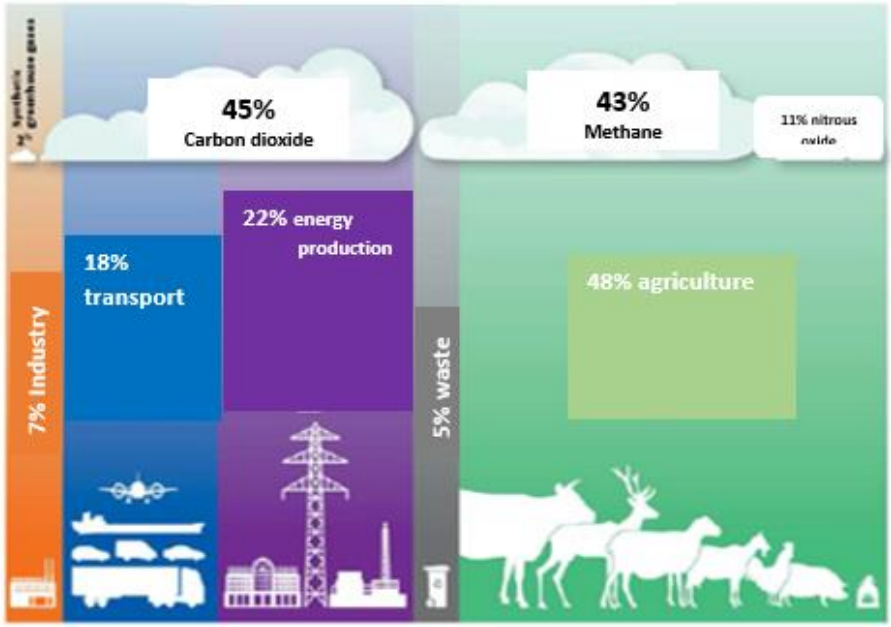

Figure 2.2. This diagram illustrates the sources and relative contribution of greenhouse gas emissions in New Zealand emissions in 2015. (Ministry for the Environment, 2017).

2.2.3 Global warming potential and CO2 equivalence

To identify how much each greenhouse gas will contribute to global warming or trap extra heat over a given time (usually 100 years), scientists estimate its *global warming potential* (GWP) comparative to carbon dioxide which has a GWP of 1. However, this is dependent on how effective the gas is at trapping heat and how long it stays in the atmosphere before breaking down. For example, a methane molecule breaks down quite quickly and stays in the atmosphere for about 12 years. However, methane is more potent i.e.it traps heat more efficiently than carbon dioxide, which has a much longer lifespan.

The carbon dioxide equivalent (CO_2e) uses GWP to convert a given amount of a greenhouse gas like methane, which has a GPW of 25 into an equivalent amount of carbon dioxide. For example, 1 kilogram of methane is equivalent to emitting 25 kilograms of carbon dioxide or 1 kilogram of nitrous oxide with a GWP of 298 is equivalent to emitting 298 kilograms of carbon dioxide (Ministry for the Environment and Statistics New Zealand, 2017; National Institute of Water and Atmospheric Research, 2016; Withgott & Laposata, 2015). In 2015, New Zealand's gross CO_2e per person was 12 per cent lower than in 2006, which is a decrease of 19.9 to 17.5 tonnes per person (Ministry for the Environment, 2019).

In the Waikato region, the per capita net CO_2 emissions are 50 per cent higher than the national average or 8,201,706 tonnes CO_2e, and the agricultural emissions are almost three times higher than the national average (75% compared with 49%). However, the forestry sector sequestrates about 41% of the Waikato's total gross emissions or 5,595,391 Tonnes CO_2e, which is more than double the national average. Additionally, over 90 per cent of the carbon sequestrated comes from rapidly growing exotic forests (Waikato Climate Action Now, 2019).

The composition of the New Zealand economy and the gross emissions each sector contributed to greenhouse gases, is shown in figure 2.3. However, land use, land-use changes and the forestry (LULUCF) sector represent a sink with a net removal value of -23,958.4kt CO_2e, which offset 29.6 per cent of New Zealand's gross emissions (Ministry for the Environment, 2019). The World Meteorological Organisation (WMO) (2018) define net emissions as sources minus removals by sinks, and these take into account the carbon dioxide absorbed by forests and then released once the trees are felled (Ministry for the Environment, 2017).

New Zealand's emission profile in 2017

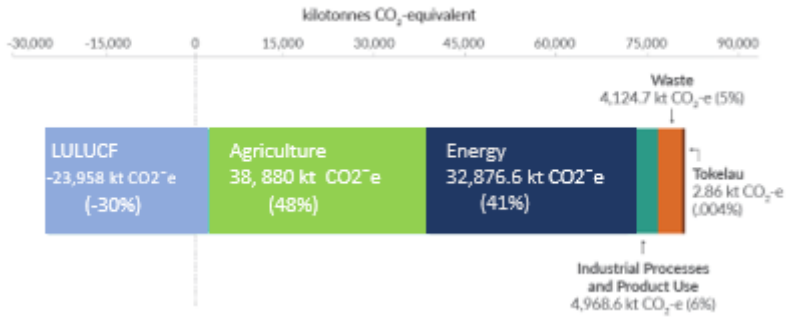

Figure 2.3. This bar chart illustrates the carbon dioxide equivalent (CO2e) in kilotonnes for agriculture and energy and their contribution to greenhouse emissions. (Ministry for the environment, 2019).

Additionally, in 2017 the energy sector emitted a total of 88.2 per cent carbon emissions to the atmosphere, of which transport and manufacturing/industries/construction was 43.8 per cent and 19.1 per cent respectively as shown in figure 2.4. Additionally, the agricultural sector produced both methane and nitrous oxide, which contributed 85.4 per cent and 95.3 per cent, respectively, due to enteric fermentation (Ministry for the Environment, 2019).

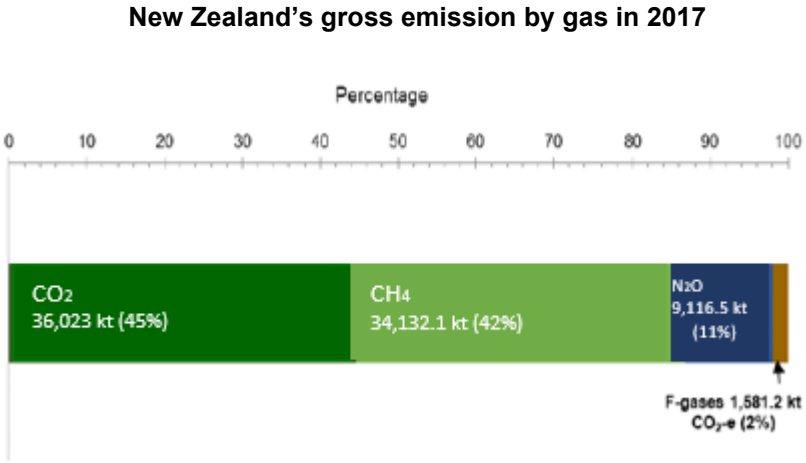

Figure 2.4. This bar chart represents the three principle gasses and the fluorinated gases (used in refrigerators, air-conditioners, foams and aerosol cans. (Ministry for the Environment, 2019).

2.2.4 The greenhouse effect

For life to exist on Earth, it must be the right distance from the sun, not too hot or too cold, defined by Astronomers as the *Goldilocks Effect* or the habitable zone of the Solar System (Marshak, 2015; Weaver, 2011). Therefore, to sustain life as we know it, several vital elements are required, i.e. liquid water, the sun, the exact distance to the surface of the Earth, and a thin atmosphere that contains essential greenhouse gases. The greenhouse effect can be compared to a glasshouse where a mixture of greenhouse gases act together like a pane of glass, and the sun's solar longwave radiation warms up the surface of the planet just as the sun warms up the walls, roof and air inside a glasshouse. However, greenhouse gasses can absorb some of the longwave radiation that would otherwise radiate back into space essentially trapping the heat in the atmosphere and this solar energy from the sun powers the climate systems (Armstrong et al., 2018; Ministry for the Environment, 2017; National Institute of Water and Atmospheric Research, 2016b); Ramanujan, 2005; Wratt & Renwick, 2007).

The Earth's atmosphere, clouds, land, and water together absorb about 70 per cent of the sun's radiation, and only 30 per cent of the longwave infrared radiation is reflected into space (Intergovernmental Panel on Climate Change 2007; Marshak, 2015). Therefore, to sustain life on Earth, a constant temperature range must be maintained. Additionally, the greenhouse gases that trap the radiant energy also act as an insulation layer, which surrounds the Earth, keeping the surface temperature warm, as shown in figure 2.5.

Without this layer of insulation or 'blanket', life on Earth would not exist as the temperature of the planet would reach -18ºC (Ministry for the Environment, 2017; Riebeek, 2010; Withgott & Laposata, 2015).

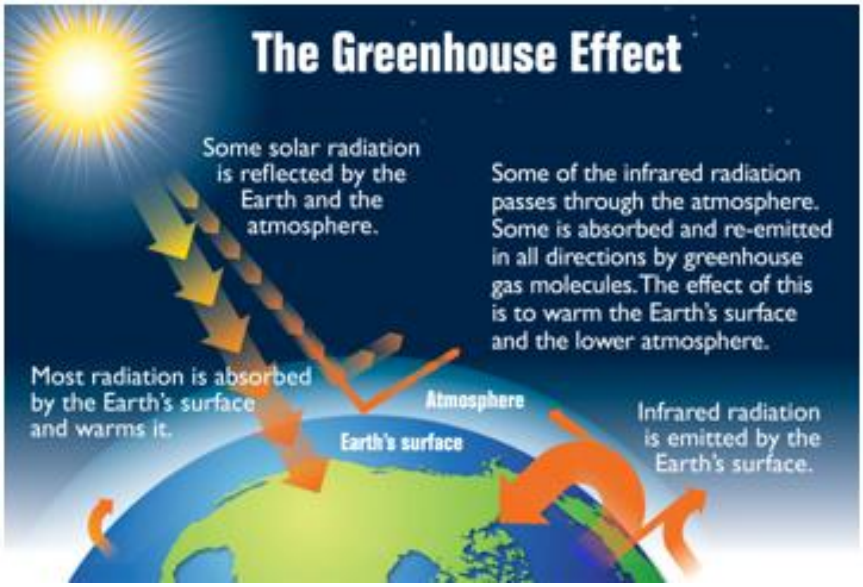

Figure 2.5. The greenhouse effect
(The United States Environmental Protection Agency, 2012)

2.2.5 The enhanced greenhouse effect

Research indicates that over the last 150 years, greenhouse gas levels in the atmosphere have risen due to anthropogenic activities. The extra radiated heat trapped near the Earth's surface and in the oceans is affecting global weather patterns as a result. This occurrence is known as the *enhanced greenhouse effect.* Climate scientists state that the Earth's climate *thermal* equilibrium has been disrupted due to the increased concentrations of greenhouse gases, which has led to an increase in the global average surface temperatures (Australian Academy of Science, 2015; National Aeronautics and Space Administration, 2017). Additionally, Wratt and Renwick (2007) argue that as human activity continues to contribute to the accumulation of greenhouse gases, particularly from the combustion of fossil fuels, increased amounts of infrared radiation will be absorbed. Consequently, the Earth's surface and the lower atmosphere will warm further until a balance of incoming and outgoing radiation is reached again.

2.2.6 Earth's energy budget

In essence, the Earth's energy budget is the balance between *incoming* shortwave radiation and *outgoing* longwave radiation from Earth. Therefore,

understanding the Earth's energy budget is essential, as this determines the global average temperature of the planet and how much energy stays and how much energy goes. For example, light surfaces such as ice and snow reflect incoming radiation, while dark surfaces such as water and forests absorb it (Martin, 2016; National Aeronautics and Space Administration, 2017). Further, the sunlight that is absorbed powers photosynthesis and stimulates evaporation, which melts the ice and snow and warms the Earth (Lindsey, 2009).

2.2.7 Global warming

Global warming and climate change are often thought of as the same thing but have distinctive differences. Global warming is the long-term heating of the Earth's climate system due to human activity, whereas climate change is the long-term change in the average weather patterns that define Earth's local, regional and global climate (National Aeronautics and Space Administration, 2019; Weart, 2008). It was during the 17th and 18th century that technological developments such as the invention of the combustion engine that powered the locomotives, large-scale manufacturing plants and farm machinery began to release carbon dioxide gas emissions into the atmosphere (Lerche, 2001; McLamb, 2011). Furthermore, the widespread, removal of carbon-absorbing forests and large-scale burning of fossil fuels was beginning to alter the climate systems like never before (Lerche, 2001). Withgott and Laposata (2015) concur that the launch of large-scale mechanisation and fossil fuel combustion for agriculture and industry were responsible for the early emissions of carbon dioxide in the atmosphere and the gradual warming of the planet. Henderson, Long, Berger, Russell, and Drewes (2017) argue that humans moved carbon from the lithosphere, where it remained undisturbed for millions of years, to the atmosphere, unleashing the accumulated energy of the carbon-rich deposits, known as fossil fuels. The stored energy that accumulated over millennia has taken only 230 years to be released and has increased the Earth's average surface temperature by 1ºC (Renwick, 2019).

These unrelenting anthropogenic activities have given way to a rapid rise in the global concentrations of carbon dioxide of more than 35 per cent above pre-industrial levels since the 1950's (Armstrong et al., 2018; Collins, Colman, Haywood, Manning, & Mote, 2007; Le Treut et al., 2007; Withgott & Laposata,

2015; Weaver, 2011; World Meteorological Organisation, 2018). Scientists can accurately pinpoint the cause of this increase by analysing the chemical signature of the carbon in the air. This analysis shows atmospheric carbon dioxide was at 324ppm in 1970 and has risen to 408.9 part per million (ppm) in 2019 (Renwick, 2019a). Additionally, methane, nitrous oxide and other gases were taken from the soil and air just above the ground (National Institute of Water and Atmospheric Research, 2016a; 2019; University of Waikato, 2018). The IPCC state that these anthropogenic activities are thought to have caused a temperature rise of 1.0°C above pre-industrial levels, and are predicted to be at 1.5°C between 2030 and 2052 and >2ºC by 2080 if the emissions continue to increase at the current rate (Intergovernmental Panel on Climate Change, 2018).

The significant rise of greenhouse gases in the atmosphere through anthropogenic emissions is contributing to the substantial increase in terrestrial and marine temperatures and is triggering widespread drought, wildfires, desertification, intense storms and flooding across the planet (Blunden & Arndt, 2019; McGlone & Walker, 2011; National Aeronautics and Space Administration, 2019). The accumulated research indicates that global warming is having, and will continue to have an adverse effect on the global climate for some time.

To sum up, climate change has become the pivotal event of our time, as it has and will continue to affect our lives, the lives of our children and their children for generations if we continue to burn fossil fuels as we have been doing now for the past 250 years. The literature indicates that the scientific community agree that human activity has caused the temperatures on Earth to increase and have predicted weather patterns and storms such as we have never experienced before.

2.3 Climate change

The scientific evidence is strong; our climate is changing at an unprecedented rate (Intergovernmental Panel on Climate Change, 2020; Ministry for the Environment, 2019a; National Aeronautics and Space Administration, 2019). Climate scientists studying global temperature anomalies argue that the period between 2014 to 2017 produced near-record temperatures in some parts of the world (National Oceanic and Atmospheric Administration, 2018; National

Aeronautics and Space Administration, 2019). The IPCC concur that the number of hot days and heatwaves are projected to increase and become more frequent in most land regions, which is likely to put further pressure on the already stressed biodiversity in these areas (Intergovernmental Panel on Climate Change, 2018). Although the occurrence of warming and cooling of global temperatures is a natural event in the Earth's history, the weather events that are taking place in 2019 are breaking climate records across the globe (National Oceanic and Atmospheric Administration, 2020). But some astronomers argue that natural climate change occurs when the planet receives more or less sunlight due to subtle shifts or wobbles in its orbit (Riebeek, 2010). Historical records dating back some 15,000 years indicate that the warming and cooling of the planet sometimes lasted thousands of years (Marshak, 2015).

To reveal the actual reality of climate change, climate scientists extrapolate the findings from extracting and examining ice cores from ancient atmospheres, sediment pollen and ancient tree rings. The ancient past provides evidence that abrupt changes in greenhouse gases may have been a possible cause and similar to what is happening in present times at an unprecedented rate (Marshak, 2015; Withgott & Laposata, 2015; Weaver, 2011).

2.3.1 The human impacts of climate change

Since the 1970's, many land regions around the world have been warming faster than the global temperature rise of 0.2ºC per decade (Intergovernmental Panel on Climate Change, 2018). As a result, over one-fifth of the global population are experiencing warming greater than 1.5 ºC, while the Arctic is warming up faster than any other region and is predicted to have ice-free summers by the middle of the twenty-first century (Intergovernmental Panel on Climate Change, 2018b; National Aeronautics and Space Administration, 2019; Rhodes, 2019; World Wide Fund for Nature, 2019).

This rapid rise in global warming has been brought about by anthropogenic emissions such as deforestation, intensive agriculture, soil cultivation, industry, transport and energy, and more recently the observable changes in the cryosphere (Earth's total ice and snow) and the thawing of the permafrost has exceeded historical climate scenarios (Intergovernmental Panel on Climate

Change, 2020; National Oceanic and Atmospheric Administration, 2019; United Nations Framework Convention on Climate Change, 2019; World Wide Fund for Nature, 2019). In order to stabilise the Earth's climate system, the upper regions of the oceans absorb a considerable amount of excess heat from the atmosphere, which is distributed through the world's oceans from the equator to the poles and back into the atmosphere through evaporation (National Oceanic and Atmospheric Administration, 2018; Withgott & Laposata, 2015).

Healthy marine ecosystems provide essential benefits like taking up carbon dioxide and removing pollutants (Ministry for the Environment and Statistics New Zealand, 2019a). The absorption of carbon dioxide and other greenhouse gases from the atmosphere into the oceans enables microscopic marine algae known as phytoplankton to capture the sunlight, convert it into chemical energy and produce oxygen through the process of photosynthesis. According to atmospheric and oceanic research, marine phytoplankton are responsible for 50 per cent of the oxygen on Earth (National Oceanic and Atmospheric Administration, 2018). Similarly, the oceans absorb up to fifty times more carbon than the atmosphere. However, the excessive absorption of carbon dioxide into the oceans is altering the pH of the seawater, making the water more acidic (National Oceanic and Atmospheric Administration, 2020a). This process is known as ocean acidification and is adversely affecting the ocean's organisms, particularly all the animals that have a shell and rely on calcium carbonate to make their shells stronger to protect themselves (Ministry for the Environment and Statistics New Zealand, 2017; National Institute of Water and Atmospheric Research, 2016d).

In addition to ocean acidification, the warming of the oceans alters the horizontal and vertical movement of ocean water currents and can have far-reaching effects on global and regional climates and weather patterns (Forest & Bird, 2019; Withgott & Laposata, 2015). The thermohaline *(thermo* – temperature - *haline* - salinity*)* circulation or the 'great oceanic current' is a continuous flow of seawater and strong ocean wind (National Oceanic and Atmospheric Administration, n.d.). Together these drive the warmer fresh surface water in the tropics, and the colder saltwater, into nutrient-rich deeper water at the poles where there is a significant amount of absorption of carbon

dioxide (Cheng et al., 2019; Intergovernmental Panel on Climate Change, 2001; Marshak, 2015; National Oceanic and Atmospheric Administration, 2020). However, even the deep water (between 500m and 2,000m) is warming every year, which could have significant implications for future iceberg thawing, a higher than the projected increase in sea-level rise and more intense storms such as hurricanes (National Institute of Water and Atmospheric Research, 2016; Withgott & Laposata, 2015). Disturbingly, research suggests that in 2018 new records were set for ocean heating, which is of concern to the scientific community as the increased temperature causes thermal expansion of water and a rise in sea levels, which exposes coastal freshwater supplies to mix with the saltwater (Cheng et al., 2019).

Through natural processes, the Earth's climate systems are continually changing, i.e. the pressure of the air, the sea temperature and the wind direction change from year to year. This variation in the climate cycle is a climate oscillation and the El Niño Southern Oscillation influence New Zealand's weather patterns every 2 to 7 years on average (Ministry for the Environment and Statistics New Zealand, 2017; National Institute of Water and Atmospheric Research, 2016e). El Niño and La Niña are opposite phases of naturally occurring global climate cycle, which results in increased westerly winds during the summer months, with more rain in the west and drought in the east; winter temperatures are warmer than usual in the Southeast and colder than usual in the Northwest respectively (National Institute of Water and Atmospheric Research, 2016e).

With the changing climate and warming seas, climate scientists predict that El Niño phases could become more intense in the future and areas and ecosystems already struggling with the effects of climate change, could be pushed to their limits (Ministry for the Environment and Statistics New Zealand, 2017). Consequently, the manipulation of the Earth's climate systems is being modified at an exceedingly rapid rate. The emissions from unprecedented combustion of fossil fuels are changing the global weather and oceanic patterns (The United States Environmental Protection Agency, 2019). The impact on the land and ocean ecosystems, and the biodiversity of life on Earth, are significantly affected by the rapidly changing climate (Withgott & Laposata, 2015). Land ecosystems are central to all human life: they provide air, water,

food for survival, and insulate us from natural forces such as flood and fire (Ministry for the Environment and Statistics New Zealand, 2018a).

Similarly, in the ocean, the warm-water coral reefs are dying due to bleaching caused by the water becoming too acidic and the increased warming of the oceans; migratory birds, insects and animals are affected due to changes in global temperatures and the relocation of food sources; while others are being pushed towards extinction. Further, global warming will cause the geographic redistribution of some organisms whose ecological range is limited by temperature (Boyes, Skamp & Stanisstreet, 2009; Ministry for the Environment, 2019a; Withgott & Laposata, 2015). Alarmingly, the modification of the Earth's physical and environmental systems have direct consequences on the biodiversity, as these systems begin to alter they may not change even if the greenhouse gas concentrations could be stabilised (Intergovernmental Panel on Climate Change, 2014b and 2018; Ministry for the Environment, 2017; Shepardson, Niyogi, Choi, & Charusombat, 2011; Withgott & Laposata, 2015).

2.3.2 New Zealand's changing climate

Human activities are influencing the climate systems due to the increased amounts of carbon dioxide equivalents in the atmosphere, driving up the temperatures on Earth. As a result, increased precipitation, widespread drought and extreme weather events are expected. In New Zealand, one-in-one hundred-year storms now happen every year, severe inundation from rivers and coastal flooding put coastal towns at risk, and prolonged droughts affect those who depend on the land for their livelihood (Intergovernmental Panel on Climate Change, 2018; Ministry for the Environment and Statistics New Zealand, 2018; National Institute of Water and Atmospheric Research, 2020). However, the effects of the changing climate vary from region to region depending on the topography, elevation, location relative to the coast and on the east or west coast of New Zealand.

New Zealand is an island nation with a substantial marine boundary, long coastline and economy based mainly on primary production and tourism. Although the country is vulnerable to the impacts of climate change, it is protected to some degree by the Southern Ocean (Eames, 2017; McLachlan, 2019; Ministry for the Environment and Statistics New Zealand, 2019). While

research has predicted that climate change will have a significant impact on the land with severe storms, increased precipitation and widespread drought, the acidity of the ocean surrounding New Zealand has increased by 27 per cent since pre-industrial times and could be 116 per cent by the end of the century (Forest & Bird, 2019; Hendy et al., 2018). Furthermore, since the beginning of the 20th century, New Zealand's average temperatures have risen by 1ºC; in 2016 the number of frost days decreased and the warm days (over 25ºC) increased, while the summer of 2019 brought prolonged drought to some regions and the heaviest rainfall on record to others (Ministry for the Environment and Statistics New Zealand, 2017; Noll, 2019).

The climate scientists suggest the change in the climate across the country, as shown in figure 2.6, is due to an increase in global temperatures. The consequences of this increase are warming oceans and changes in the polar regions (particularly Antarctica and Greenland); changes in land-use (converting forested land to pasture or urban development), and continuing anthropogenic greenhouse gas emissions in the atmosphere (Ministry for the Environment and Statistics New Zealand, 2017). NIWA's Meteorologist Ben Noll claims that New Zealand's climate data is a dramatic story of weather and climate extremes, with heatwave conditions, warming sea and ex-tropical cyclones, on-going drought and nationwide weather anomalies, such as tornadoes (National Institute of Water and Atmospheric Research, 2016b; 2019).

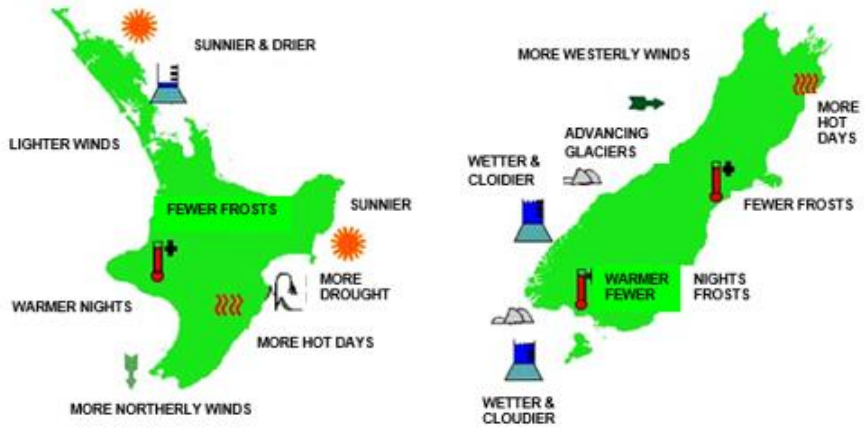

Figure 2.6. The climate in New Zealand has changed over the past 20 years (National Institute of Water and Atmospheric Research, 2016)

Further, the climate scientists have predicted that as the global temperature increases, so could the magnitude and frequency of extreme rainfall events, as a warmer atmosphere can hold more water (Ministry for the Environment and Statistics New Zealand, 2017). However, the shifting rainfall could also change the nature of droughts and may contribute to regional variations in drought conditions (Hendy et al., 2018). The OCED reports that meteorological droughts (atmospheric and weather) occur when less water is available than is required; socioeconomic and environmental droughts occur when an extreme event such as a water deficit has an impact on people, the economy and the environment (The Organization for Economic Cooperation and Development, 2017), which could have a severe effect on our economy (Hendy et al., 2018). Additionally, a report in 2018 indicated that the economic losses from droughts between 2007 and 2017 were $720 million (Frame et al., 2018 as cited in Hendy et al., 2018).

The Waikato region is well known for its temperate climate with steady rainfall throughout the year, relatively high sunshine hours and strong northerly or westerly winds (particularly in the spring). Ex-tropical cyclones are not uncommon and may affect the region once or twice a year and usually bring heavy rain and strong easterly winds (Chappell, 2013). From time to time, the region can also experience severe drought conditions and widespread flooding events. However, the long-term predictions for the Waikato region indicate that drought could impact on the agricultural sector by 2070 (Wang, Li & Yin, 2015). Additionally, river flooding is predicted to increase by 8 to 16 per cent by the middle of the century due to the changes in the frequency and intensity of the extreme rainfall (Ministry for the Environment, 2010).

The northern Waikato region, for example, is expected to have the highest risk of exposure to extreme climatic events in the future, such as tropical cyclones and heavy rainfall, where rising floodwater may negatively impact the towns located next to the Waikato River, such as Huntly, Meremere and Mercer (Li, Storey, Ye & Bornman, 2010). In 1998, a regional flood occurred when record rainfall fell for over seven days and smaller storms over several weeks combined to inundate extensive areas of already saturated farmland and State Highway 1 at Rangiriri. In Huntly, seven families were evacuated from their homes and businesses were partially flooded when the Waikato River spilled

over its banks, damaging hundreds of hectares farmland in the process (Brenstrum, 1998; Monro, 1998). Averting large-scale flooding events can be challenging and could become more so with the rapidly changing climate (Ministry for the Environment, 2010).

Nevertheless, mitigating or managing the peak flow from the Waikato River into the Whangamarino wetland depends on the management of the flood control scheme and floodwater storage in the Waikare-Whangamarino storage reservoir managed by Environmental Waikato (Department of Conservation, 2007). Therefore, adapting to more frequent and extreme flooding events will be necessary as a warmer atmosphere increases the water-holding capacity of the air and rainfall which is likely to be more intense (Ministry for the environment, 2019b).

2.3.3 Mitigating and adapting to the impacts of climate change

The speed and the scale at which anthropogenic activities have altered the climate system for future generations is mostly unknown. The climate scientists maintain that certain aspects of the worst effects of climate change such as the loss of sheet ice and glaciers in Greenland and Antarctica, and the thawing of the permafrost in the cryosphere are coming close to becoming irreversible, which could influence the climate system for thousands or even millions of years (Intergovernmental Panel on Climate Change, 2018; Ministry for the Environment, 2017a; National Aeronautics and Space Administration, 2020b). Therefore, our only way forward is to mitigate or *reduce the source* of carbon emitted into the atmosphere and *enhance the sinks* that absorb the carbon to keep warming below 1.5ºC. By taking this measure, this could eventually bring about a sustainable balance or a *mitigation response* (Ogunseemi & Ibimilua, 2016). Mitigation measures focus on the interventions of reducing greenhouse gas concentrations or moving carbon out of the atmosphere, which in turn stabilises greenhouse gases and suspends many of the negative impacts of climate change. Adaptation responses reduce the vulnerability of natural and human systems to the effects of climate change through adjustments in social, ecological or economic systems (Anderson, 2012; United Nations Framework Convention on Climate Change, 2019; Intergovernmental Panel on Climate Change, 2018).

The goal of the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement of 2015 is to carry out efforts to limit global warming to 1.5ºC below pre-industrial levels by 2030, and net zero emissions by 2050 (Intergovernmental Panel on Climate Change, 2018a; 2018). In 2015, the UNFCCC initiated the agreement to limit the average temperature to below 1.5ºC, which would reduce the amount of global warming and other climatic changes New Zealand would experience (Ministry for the Environment and Statistics New Zealand, 2017; United Nations Framework Convention on Climate Change, 2015).

The New Zealand government signed, and later that year ratified the Paris agreement and then in 2016, made a commitment to reduce greenhouse gas emissions to 30 per cent below 2005 levels by 2030 (or 11 per cent below 1990 levels); this target reduction could be managed using a carbon budget (Sussams, 2018; United Nations Framework Convention on Climate Change, 2015; Organization for Economic Cooperation and Development, 2017). The size and risks New Zealand encounter from future climate change depends on what strategies our governments implement, such as the Zero Carbon Amendment Act (New Zealand Parliament, 2019), mitigating our greenhouse gas emissions, and how quickly other countries reduce their emissions from entering the atmosphere. In other words, the faster and more substantive the reduction, the lower the risk, and less lasting effects on the natural environment and people's lives (Ministry for the Environment and Statistics New Zealand, 2017).

In 2018, the IPCC cautioned that their climate models indicated with *high confidence* that *impacts and risks* associated with extreme weather events up to 1.5º signalled severe and widespread devastation (Intergovernmental Panel of Climate Change. 2018). Additionally, climate change will increase pressures on resources and add to the vulnerability of people and ecosystems, particularly water scarcity in the drier regions of New Zealand (Lawrence, Blackett, Cradock-Henry, Flood, Greenaway & Dunningham, 2016).

2.3.4 New Zealand's vulnerability to climate change

In New Zealand, potentially vulnerable people, such as poor communities, rural Māori, the young and the elderly may find coping with climate change difficult, which may be due to isolation or mobility issues and may need support

and guidance (Massey University, 2018). The IPCC argues that people who are socially, economically, culturally, politically, institutionally or otherwise marginalised are especially vulnerable to climate change (Intergovernmental Panel on Climate Change (2014a). As the number of New Zealanders living in poverty has risen over the last decade, the government and its agencies must make sure that people are able to cope and adapt to the impending consequences of a warming planet (Ministry for the Environment, 2018b). The Paris Agreement states that the goal for all developed and developing countries is to enhance adaptive capacity; strengthen resilience and reduce vulnerability in the light of the risks and impacts of climate change (United Nations Framework Convention on Climate Change, 2015a). Adaptive capacity is both a component of resilience and vulnerability (Cohen et al., 2016); and education is a critical component in adaptive capacity (Anderson, 2012).

The research indicated that although we have passed the symbolic threshold of 400 parts per million, it may have now become unattainable to reduce warming to pre-industrial levels (Ministry for the Environment and Statistics New Zealand, 2017). Therefore, developing resilience and being able to adapt to a warmer climate and cope with the consequences are essential in this uncertain age. Anderson (2010) notes that putting measures in place to reduce the vulnerability of natural and human systems through adjustments in the social, ecological and economic systems is essential.

Much of the biodiversity in New Zealand is unique and vulnerable to changes we make to the environment (Ministry for the Environment and Statistics New Zealand, 2019). Therefore, as part of the New Zealand government's commitment to carbon neutrality (zero net anthropogenic CO_2 emissions), procedures are being established to phase out fossil fuel use by 2050. New Zealand will also connect with a small group of countries that have established this goal, which includes France, Germany, Sweden (by 2045) and Norway (by 2030) (World Resources Institute, 2015; McLachlan, 2017; New Zealand Government, 2019).

2.3.5 Mitigating New Zealand's impacts of climate change

Mitigating or reducing our carbon emissions in the atmosphere and lowering global warming is vital for the health of the planet and the biodiversity that lives

here. Moreover, afforestation and reforestation projects such as expanding the forests, increase the amount of carbon dioxide taken out of the atmosphere as sequestration is central to New Zealand's mitigation efforts (Department of Conservation, 2011). Research indicates that our native and fast-growing exotic forests, known as *sinks,* use carbon dioxide through photosynthesis and then store it in their trunks, roots, branches, leaf litter and the surrounding soil. The stored carbon in a rapidly growing forest can offset or mitigate some of the greenhouse gas emissions New Zealand produces (Riebeek, 2010; Ministry for the Environment and Statistics New Zealand, 2019; Stephenson et al., 2014). Although more than twice as much carbon per hectare is stored in New Zealand's mature indigenous forests, the trees grow very slowly so contribute very little to offset greenhouse gas emissions (Ministry for the Environment and Statistics New Zealand, 2018). From 1990 to 2015, growing forests sequestered an average of 8.5 million tonnes of carbon from the atmosphere each year (Ministry for the Environment, 2017a).

A mitigating measure that the New Zealand Government is undertaking is afforestation and reforestation across the country by planting one billion trees before 2028 (Cabinet Economic Development Committee, 2018). The plan is to plant 10-25 million native trees each year by small community groups and local councils. To reach the government's billion tree target, an additional 230,000 to 430,000 hectares of new forests will be planted, which is over and above the 50 million trees, the forestry sector already plants each year (Bennet, 2019; Forestry New Zealand, 2020). Land changes will be utilised by regenerating native forests on unproductive pastoral beef, and sheep land, with carbon credits available to the farmer and other options, such as planting Manuka trees for honey and pine trees for cropping (Bennett, 2019).

The crucial element to keeping the source-sink balance is to reduce anthropogenic emissions (fossil fuels and deforestation) and increase removals (reforestation and afforestation). When we are able to bring emissions down to the level of removals, we will achieve balance or net zero CO_2 emissions (Johnston, 2020). Capturing and storing atmospheric carbon is another approach that removes carbon dioxide and other emissions from large emitters such as power stations and processing plants and stores it deep in the ground (Withgott & Laposata, 2015).

A key aspect of mitigating climate change is to reduce the release of greenhouse gas emissions that are warming our planet. The IPCC highlights that global emissions will need to peak by 2030 and rapidly decrease to net-zero by 2050 if we are to stay within the safety limits set down by the Paris Agreement (Global Environmental Facility, 2020; Intergovernmental Panel on Climate Change, 2018). Capturing the carbon and transporting it through pipelines and injected into porous rocks at least 800 metres deep in the ground or stored in long-term reservoirs deep in the ocean, reduces the carbon emissions from returning to the atmosphere (Ministry for the Environment and Statistics New Zealand, 2017; Haszeldine, 2009).

The New Zealand government looked into this technology some time ago. However, no decisions have been made about using this model in the near future (CSSNZ Partnership, 2011). The IPCC argues that although carbon dioxide capture and storage (CCS) technologies are used by the fossil fuel extraction and refining industries, they have not been applied to a significant fossil fuel power plant (Intergovernmental Panel on Climate Change, 2014). However, there is some doubt that the use of carbon dioxide removal techniques may work effectively in large industrial operations and therefore runs the risk of being less practical, effective and economical than first thought (Intergovernmental Panel on Climate Change, 2018a, FAQ 2.1)

The Huntly power station in the northern Waikato is a thermal powered station that uses coal, gas and both simultaneously as fuel. In 2016, Genesis Energy reversed its decision to stop burning coal by 2018. However, this decision was welcomed by some of the residents in the town as they had seen first-hand the effects of Solid Energy's closures as families seek food to feed their families (Pullar-Strecker & Wallace, 2016). Genesis Energy Chief executive Marc England justified that the coal burnt in Huntly created fewer emissions than the steel industry or Fonterra's coal-powered boilers used to dry raw milk into milk powder (Pullar-Strecker, 2019).

Although, in 2018, Genesis Energy announced that they would no longer be using coal to generate electricity except in exceptional circumstances (when water in the hydro lakes was low, which happened twice in 2018) from 2025 and will stop using coal from 2030 (Frykberg, 2018). Amanda Larsson, Greenpeace activist, argued that New Zealand had the technology and

resources to do without coal, gas or any other fossil fuel, but leadership from industry was lacking; she called for more initiative in wind and solar energy (Frykberg, 2018). Thus, decarbonising (reducing the carbon gas emissions) electricity generation is a crucial component of cost-effective mitigation strategies.

Unlike power generation, the use of fossil fuels in manufacturing plants such as Fonterra is being phased out. Current research indicates that New Zealand's biggest dairy cooperative has reversed a decision to build more coal boilers and will now invest in more sustainable options. This decision followed the release of an advertisement, which indicated that Fonterra was burning half a million tonnes of coal every year in the production of milk powder (Finnie, 2019). Moreover, Fonterra will look at either biomass fuel (wood and wood processing waste) plants or electricity moving forward, as well as replacing coal with electricity in its Otago factory; reducing greenhouse gas emissions by thirty per cent across all its plants by 2030 and achieve net zero by 2050. Genesis Energy and Fonterra are the two principal coal users in New Zealand (Hutching, 2019).

The damaging effects of atmospheric carbon dioxide are widely documented. Therefore, transport companies and industries need to reduce their carbon footprint or, greenhouse gas emissions to slow down the warming of the planet and switch to low carbon energy sources (World Meteorological Organisation, 2018). While the scientific community deliberate over the changing climate, Mātauranga Māori presents a unique perspective for mitigating and adapting to the impacts and risks of climate change (Goodall, 2019).

2.3.6 Māori environmental knowledge

Māori ways of thinking and understanding the environment are defined by their cultural, spiritual and holistic connection to the sky, and with the land and ocean as well as the long association Māori have had with its resources (King, Goff & Skipper, 2007). Similarly, the literature indicates that indigenous cultures across the world have a collective knowledge of land and sky and are excellent observers and interpreters of change in the environment (Etchart, 2017; Raygorodetsky, 2011). Further, Māori have an intricate, holistic world view, and an interconnected relationship with the environment, which is helping scientists tackle climate change across New Zealand (King, Goff &

Skipper, 2007). This unique ideology is based on *Mātauranga* Māori, or the knowledge, comprehension, and understanding of everything visible and invisible in the universe (Goodall, 2019) and *Mātauranga taiao* or the cumulative body of knowledge, practices and beliefs (King, Goff & Skipper, 2007). In a contemporary Aotearoa, these definitions encompass the historical, local and traditional knowledge; systems of knowledge transfer and storage and the goals, aspirations and issues from an indigenous perspective (Manaaka Whenua Landcare Research, n.d.).

Further, this precious knowledge base has developed over thousands of years and includes the concepts of kaitiakitanga (preservation) and mauri (life force). Skipper and Iti (2017) maintain that the kaitiakitanga is based on traditional Māori world views and should be the guide for how the environment and its resources are looked after and regarded as taonga (precious). Kaitiakitanga includes the conservation, replenishment and sustainability of the environment. The role of the *kaitiaki* (guardian) is essential to Māori as they watch over and protect the environment and is central in maintaining utu (or balance). At the same time, the *mauri* provides life, energy and protection to all living things and is a link to the spiritual world (The University of Waikato, 2017). Additionally, Tunks (1997) argues that regardless of what harm has been caused "'as kaitiaki, we have absolute liability for our effects upon the environment" (p.81).

However, like many other indigenous peoples, Māori are very aware of the impacts of climate change, and how vulnerable some Māori are will depend on where they and their marae are located in Aotearoa New Zealand. Many coastal iwi and hapū have marae and burial sites (urupā), essential to the identity and well-being of their people, situated in vulnerable areas (Ministry for the Environment and Statistics New Zealand, 2019, p. 101). Dr Daren King, a NIWA research scientist, has worked with numerous marae across New Zealand and believes that science and Mātauranga Māori traditional knowledge can help Māori develop their own innovative plans to adapt to climate change (Parahi, 2018; National Institute of Water and Atmospheric Research, 2018). Further, the IPCC concur that education and local indigenous knowledge can accelerate the wide-scale behaviour changes needed to address climate change (Intergovernmental Panel of Climate Change, 2014).

Recently, eight Māori-led science research projects have been funded by *Vision Mātauranga* and the Deep South Challenge around New Zealand. Among other things, they are investing in adaptation strategies for Māori communities and business to help strengthen the connections and knowledge among Māori and the broader science community (Goodall, 2019). Further, Dr Maria Bargh, a Senior Lecturer at Victoria University, argues that Māori as Treaty of Waitangi partners must be included in the decision-making process such as the 2019 Zero Carbon Amendment Act and the Climate Change Commission. Bargh (2019) maintains that Māori have their own science, Mātauranga Māori and know how to be kaitiaki and respect the bush, waterways and whenua (Husband, 2019). Additionally, iwi from around the country have set up the National Māori Climate Network and say Aotearoa New Zealand should declare an environmental and climate emergency just as the British parliament have done, as this highlights the severity and urgency of the problem (Dunlop, 2019; McLachlan, 2019). Furthermore, secondary schools that have high populations of Māori would benefit from learning about traditional Māori ways and examine the ideas the students bring into the classroom, which is a reason to consider this knowledge.

2.3.7 Climate change summary

For life to exist on Earth, it must be neither too hot nor too cold. This is made possible by a thin atmosphere that contains atmospheric greenhouse gases. These gases absorb infrared radiation and trap radiated heat, which in turn warms the oceans, land, lower atmosphere and surface of the planet. However, since the industrial revolution, deforestation, large-scale mechanisation, burning fossil fuels and anthropogenic activity has led to a rapid increased in concentrations of carbon dioxide in the atmosphere, and the temperature on the planet has risen sharply. This rise in temperature of almost 1ºC above pre-industrial levels is changing the climate and affecting the biodiversity in the oceans and across the globe as weather patterns fluctuate and extreme storms, intense flooding and prolonged droughts become the norm. Humanity began the acceleration of the carbon emissions 230 years ago, and the damage that has been caused will take thousands of years to stabilise.

Scientific research signifies that reducing or mitigating carbon emissions and atmospheric greenhouses gases that are heating the planet and altering the climate systems is our only way to keep the global temperature at 1.5ºC. The Māori worldview of Mātauranga Māori (knowledge and wisdom), the concept of kaitiakitanga (guardian of the environment) and the environmental mamae (hurt and damage to the environment) incorporates an intergenerational, holistic approach for mitigating and adapting to the impacts and risks of climate change. By sharing historical, local and traditional knowledge with contemporary scientists, innovative solutions are being found to solve environmental mamae. However, adapting to the impacts and risks of a changing climate, developing resilience and adaptive capacity to reduce vulnerability and taking informed and intentional action to change behaviour, is our only alternative. Climate change education is a crucial response to the changing climate and uncertain future for everyone across the world.

2.4 Climate change education

Climate change education is gaining impetus around the world. The literature indicates that educators have either incorporated climate change education into their curriculum or are deciding on the most effective way to provide children and young people with the knowledge and skills to help prepare them for an uncertain future (Anderson, 2010). Therefore, educating our learners about climate change is critical if we are to make sure they have the knowledge and skills needed to adapt to the change. Preparedness requires approaches that effectively elevate the student's awareness; develops resilience and adaptive capacity; promotes critical and creative thinking skills, and encourages young people to take informed and intentional action to become agents of change. Moreover, establishing multidisciplinary climate change literacy requires implementing climate change education as part of our daily communications; as knowledge alone is insufficient to change behaviour (United Nations Climate Change Learning Partnership, 2013).

Therefore, in order to understand what climate change education is and could be, the following sections explore the policy, philosophy, pedagogy, teacher education, culturally responsive pedagogies, teacher education and finally, the outcomes for the students. The key ideas that underpin climate change education are education for mitigation and adaptation knowledge, beliefs,

attitudes and meaningful action-taking associated with climate change.

2.4.1 Policy

The 2015 Paris Agreement is the latest defining collective understanding about how to respond to climate change by mitigating, adapting and taking action through climate change education. Article 6 of the United Nations Framework Convention on Climate Change states that governments should “promote, develop and implement educational, training and public awareness programmes on climate change and its effects” (United Nations Climate Change Learning Partnership, 2013, p.4). Additionally, the Director-General Irina Bokova of UNESCO stated that “change happens through education because education brings the skills and values that youth need to successfully manage the energy and climate revolution” (United Nations Educational, Scientific and Cultural Organisation, 2019).

These landmark agreements state that education is essential to all learners for enhancing their capacity-building and awareness around the issues of climate change (United Nations Framework Convention on Climate Change, 2015) and governments all over the world are responding in their own way. So how is education dealing with climate change in New Zealand?

In New Zealand, we have been responding primarily through the Zero Carbon Bill. However, the Zero Carbon Act does not explicitly mention education, as it is mostly about regulation, a form of backdoor educating targeting community response. In terms of formal education the New Zealand Curriculum states that our learners must develop a love of life-long learning; be able to think critically and creatively, problem-solve and make meaningful changes to their behaviours and attitudes in this uncertain climatic world (Ministry of Education, 2007).

Climate change education gives our learners (and teachers) the knowledge and skills they need to become active participants and the determination to make a difference. Eames (2017) argues that although the New Zealand Curriculum does not explicitly refer to climate change education, there are particular achievement objectives that could be taught across the curriculum to develop a basic understanding of climate literacy, the science behind a changing climate and how people may be affected by climate change. Furthermore, the recent introduction of the Level 4 teaching resource and

learning programme: *Climate Change: Prepare Today, Live Well Tomorrow,* could provide teachers with sufficient knowledge of the complex concepts as well as an increased awareness and an understanding of the responses to and impacts of climate change (Ministry of Education, 2020). To sum up, in a world with a changing climate that is unpredictable and full of uncertainties, making sure our young people are thoroughly prepared and educated in relevant learning areas is crucial.

2.4.2 Curriculum

Climate change education is critical in developing knowledge about the environmental, economic, social, and cultural aspects of climate change. It enables learners to take informed and intentional action, as well as acting to mitigate, which are fundamental principles in action competence. It is a multidisciplinary, holistic approach to learning that develops the varied knowledge, skills, attitudes and beliefs that are essential to empowering the students to become agents of change. Caranto and Pitpitunge (2015) point out that the complex science of climate change requires an interdisciplinary approach, especially when thinking about mitigating climate change impacts, the implications of the environmental, economic, political, social and cultural policies and adaptive strategies. Therefore, to understand the process of climate change, and the importance of mitigation and adaptation, learners need to have the knowledge to be able to comprehend the urgency of the problem and what actions we need to undertake to reduce the effects of climate change.

Climate change education examines students' and teachers' attitudes and beliefs towards climate change, their intention to take action and their ideas about action. This informed and intentional action is empowering. Eames et al. (2006) argue that "actions are consciously taken and targeted since they are intentions based on experience" (p.8). Moreover, research suggests that education is a critical driver in tackling the issues of climate change, as it empowers and motivates young people to become agents of change (United Nations, 2019). Furthermore, Anderson (2012) suggests that climate change education provides teachers with the opportunity to become well versed in climate and environmental science, systems and processes that may make a difference. However, students also need to understand the role of greenhouse

gases, how a warming climate can alter the climate systems, that mitigation and adaptation are responses to climate change, and climate change education can encourage students to become engaged in the conversation occurring around the world about what their future will look and feel like.

Climate change education shares key concepts and principles with environmental education, in particular, knowledge, attitudes and behavioural change, which are all linked together. Birdsall (2010) argues that in order to empower students to take action, students need to have the knowledge about how the changing climate is having an impact on the environment as well as positive attitudes and values. Therefore, when considering climate change education, the curriculum leaders must utilise strategies that empower the students to take action, instead of disempowering them. Creating a supportive learning environment where students feel autonomous in the decisions that they make is more likely to result in a productive experience with a continued response than one, where students are not invested in the action, and their interest will be short-lived. Christiana Figures, Executive Secretary of the UNFCCC agrees that climate change is a crucial part of the school curricula; however, it needs to be embedded in the DNA of the educational concepts to be a success for the learners (United Nations Framework Convention on Climate Change, 2015).

2.4.3 Pedagogies

Climate change education requires pedagogies that will inspire young people to become active change agents; provide opportunities to engage and empower them, by imparting knowledge and skills through a holistic, integrated formal education. Eames et al., (2006) argue that a teacher pedagogy is more than what teachers do; it also refers to the values, aims and the philosophy of education. Monroe, Oxarart and Plate (2013) claim that teachers have a responsibility to help young people explore the challenges of the future, and climate change education provides a variety of opportunities to do so. Therefore, climate change education must focus on making the learning relevant and meaningful for our learners, that fosters critical thinking and problem solving and can apply the learning to their own lives (Anderson, 2010).

Moreover, educators that inspire and empower their learners, deliver student-centred teaching methods that engage, challenge and enable their students to

actively participate in actions to help mitigate or adapt to climate change (Monroe et al., 2017). Although climate science and global warming can be disempowering, teachers that employ appropriate teaching methods such as flipped classrooms, deliberate discussion, interactions with scientists and participation in the science can increase students' awareness, understanding and motivation in the subject as they realise how significant climate change really is (Monroe et al., 2017; Vongalis-Macrow, 2010). Finally, Vaughter (2016) claims that effective climate change education requires not only a commitment to teach and learn but also a commitment to act, as knowledge alone is insufficient to change behaviour and change can be made by mitigating and adapting to climate change.

Socioscientific approach

A socioscientific approach to teaching and learning embraces an integrated issues-based programme that utilises an inquiry to tackle highly complex issues. Vongalis-Macrow (2010) acknowledges that socioscientific issues such as climate change require specificity, in terms of knowledge and pedagogy, so teaching about climate change may require equally specific pedagogy. Stevenson et al. (2017) concur that climate change is more than just a scientific phenomenon; it is a complex socioscientific issue, which requires more than just teaching the subject matter. Further, Sadler, Barba and Scott (2007) note that a socioscientific inquiry can provide a sound context for positioning relevant scientific content and processes as well as offering a societal perspective and a broader contextual framework for students to learn about the changing climate.

Culturally responsive pedagogy

A culturally responsive pedagogy is based on being receptive to the needs of the learners and embracing the students' cultural diversity (Ministry of Education, 2019a). Therefore, preparing Māori and non-Māori students for a changing climate and an uncertain future needs to be facilitated in an environment that embraces *Ako* and *Mātauranga Māori* knowledge and wisdom, as this can inform young people and their whānau about mitigating and adapting to climate change in a way they can understand. Vaioleti and Morrison (2018) claim that climate change education is a transformative agent

which requires learners to embrace both the holistic and scientific approaches in order to make behavioural changes in their lives.

2.4.4 Mitigation and adaptation strategies

If teachers are to raise the students' awareness and preparedness for an uncertain future, the learner must receive the relevant knowledge and skills they will need to cope with the changing climate. Mitigation and adaptation strategies enable students to think laterally to solve problems, build resilience to take decisive action and adaptive capacity to respond in a crisis (Anderson, 2012). Eames (2017) claims that education is the foundation of change through mitigation and adaptation and Stevenson et al. (2017) maintain that the "teachers must encourage students to think critically and creatively about approaches to climate change mitigation and adaptation and develop their capacity to respond with meaningful actions" (p. 67). Additionally, Anderson (2012) points out that in order to equip learners with knowledge, skills and attitudes to deal with future uncertainties, enhancing teachers' knowledge and their capacities to strengthen learners' capacity for critical thinking is essential.

The scientific consensus across the world is that climate change is happening, and there is no time to lose in preparing everyone to adapt to the impacts of climate change (Intergovernmental Panel on Climate Change, Morton, 2017, Sharma, 2017). Therefore, to be effectual, climate change education must focus the learning on mitigation and adaptive capacity, so students' can individually and collectively make informed choices about the actions they want to be involved in (Anderson, 2010; Henderson et al., 2017). Moreover, Anderson (2012) notes that evidence shows education interventions are most successful when they focus on local and tangible aspects of climate change and environmental education, especially those that can be addressed by an individual's taking action. Additionally, Henderson et al., (2017) concur that across the globe education is assisting humanity in mitigating and adapting to climate change as these strategies provide knowledge and skills, taking intentional action and making behavioural change (Anderson, 2010; Drewes, Henderson & Mouza, 2018).

2.4.5 Action competence and action-taking

Climate change education utilises mitigation and adaptation strategies that are essential in addressing the impacts of climate change. Recognising the

importance of these strategies will enable the learner to acquire the knowledge and skills that will deepen their understanding of the issues and impacts of climate change. Jensen and Schnack (1997) defined action competence as the “ability to act” (p.163). By taking meaningful action, the learner may be able to relate to the problem to their own lives, as well as giving the learning context, with teachers learning alongside the students. As a result, the students who take action, develop action competence. In other words, action competence is learning about environmental and climate change issues; planning; taking informed action and finding solutions (Ministry of Education, 2015). Furthermore, action competence enables students’ opportunities to have authentic experiences while addressing the cause/s, to solve environmental problems (Jensen & Schnack, 1997). Additionally, Jensen (2002) cautions that “the action must be targeted at *effecting real change*; it should be directed at solving a problem, and should be decided upon by those preparing to carry out the action; otherwise, it is not an action” (p.326).

Climate change education pedagogy endorses active learning by encouraging students to take charge of their learning and transforming their knowledge in these uncertain times. Eames et al. (2006) note that any action that is undertaken should be placed in the context of the problem to be solved. Moreover, students must be made aware of the more significant issue their action is helping to solve, or the education may be minimal. For example, turning the heat pumps and lights off in the classroom at the end of the day to decrease greenhouse gas emissions through less energy consumption. Anderson (2010) claims that active learning should be connected with local problem-solving to generate successful learning outcomes and connecting local issues with individual behaviour that makes abstract concepts real.

Without a doubt, well-thought-through actions that use meaningful contexts, empower students to do something with their learning that supports participation in the wider community and develops the competencies that lead to action (Ministry of Education, 2015). Further, mitigating the impacts of climate change in this way enables young people and adults alike, to take action without feeling disempowered or being overwhelmed and left with a feeling of hopelessness. Li and Monroe (2017) indicate that hopefulness is vital for moving people beyond despair and helplessness to mitigate and adapt to

climate change. Cautiously, Leining and White (2014) note that our decisions can provide the triggers, but also the barriers, to achieving effective climate action. Although climate science is a complex topic, which can be challenging for some students to grasp, climate change education empowers learners to make personal choices and decisions to alter their behaviours (Dawson & Carson, 2013)

To sum up, climate change education offers the learner a unique experience and opportunity to develop in-depth critical and creative transformative thinking as well as utilising the knowledge and skills from two distinct disciplines: science and social science. Dawson (2015) argues that climate change meets the criteria for a socioscientific issue as the emerging science is subject to change, and has ethical, political and social dimensions.

2.4.6 Teaching climate change education

Although climate change education has gained popularity in recent years, many teachers feel overwhelmed at the prospect of teaching an interdisciplinary subject that is highly complex and challenging (Anderson, 2010; 2012). While many teachers are unprepared for the integration of action-orientated focus and scientific content knowledge that embodies climate change education, others fully embrace the challenge (Oversby, 2014). Further, Drewes et al. (2018) point out that teachers who are more comfortable with the subject content will allow students to question and discuss the issue/s that are being presented to them, thus becoming part of the in-depth teaching and learning experience. However, if the teachers are not confident in what they are teaching, this can influence the student's interest and outcomes.

A schools ability to provide high-quality professional learning and development for in-service teachers can make a difference in how climate change education is delivered, and whether the teachers understanding of participatory action is enhanced (United Nations International Children's Emergency Fund, 2017). Research indicates, however, that there are limited opportunities for climate change education professional development (Drewes et al., 2018). Therefore, deciding on the best way to address the complex concepts of climate change are decisions that leaders and teachers need to address so that they (and the students) are not overwhelmed by the complexities of the content. In order to do this requires continuous, beneficial professional learning and development

as this has the potential to enhance teacher content knowledge and provide a more in-depth learning experience for the students (Drewes et al., 2018; McKeown & Hopkins, 2010; Vongalis-Macrow, 2010). Moreover, enhancing a teacher's knowledge and capabilities to strengthen the learner's capacity for critical thinking is also essential (Anderson 2010; 2012). Therefore, pre-service teacher education needs to provide learner-centred, participatory and inclusive training. Eames (2017) concurs that teachers must possess a sound understanding of climate change education to be able to educate the citizens of the future.

2.5 Secondary schooling education in Aotearoa New Zealand about climate change and climate change education

For the most part, secondary school education in New Zealand follows a traditional academic pathway. However, climate change education and environmental education are not included. Fahey, Labadie and Meyers (2014) argue that persisting with a traditional content delivery or business-as-usual approach is increasingly seen as inadequate. The Ministry of Education claimed that the national curriculum is focused on 21st-century learning, ensuring learners are equipped to participate in and contribute to a sustainable future (Ministry of Education, 2015). Irina Bovoka, the former Director-General of UNESCO states that education is one of the most powerful tools that we have to tackle climate change, it is not an 'add on' but a fundamental tool in reducing climate change (United Nations Educational, Scientific and Cultural Organisation, 2016). Therefore, in order to adequately prepare our students for an uncertain future with a changing climate, secondary schools need to provide the specialist knowledge and skills that will enable them to think critically and creatively and use problem-solving techniques. Eames (2017) reiterates that in order to prepare our future citizens for the critical decisions that will need to be made around greenhouse gas emissions embracing climate change education must be a priority.

In 2017, Prime Minister Ardern stood on the world stage and stated that tackling climate change is 'my generation's nuclear-free moment' (Ewing, 2017). Therefore, climate change education requires equal consideration, as it is as relevant as the nuclear-free movement was in the 1980s and should be given priority in our learning centres, schools, and post-secondary education.

The trepidation of the effects of climate change and a collective frustration in governments responding too slowly to the climate crisis sparked the global climate strikes.

Consequently, the vast turnout for the School Strikes for Climate in 2019 demonstrated that there is evidence that suggests secondary school students want to see climate change education brought into schools to enable them to understand what is happening in the climate system and the impacts this will have on their future (Gardiner, 2020). Richie concurs “it was very clear from the conversations I have had with some of the young people who attended the strikes, was that they had informed themselves on the topic and the terminology“ and “they were very articulate” (Sharpe, 2019, para. 8; New Zealand Government, 2019).

Therefore, to make sure that everyone is well-informed, it makes sense to educate the youngest members of our societies so they can inform their parents, grandparents and people in their communities. Associate Professor Chris Eames at the University of Waikato argues there is a “moral imperative” to ensure our young people know as much as they can about climate change, as there is no doubt that “climate change will have significant impacts on their lives” (Sharpe, 2019, para. 9). Moreover, Schep (2019) states that schools are at the “frontline of engagement with communities”, are the most influential learning spaces in our society, and every child has the right to learn about the “defining issue of our time” (para. 4 & 6). However, Sophie Handford, School Strike 4 Climate national coordinator explains that standing up for the planet can not be left to young people as climate change poses a threat to all our futures (Franks, 2019).

The literature indicated that a predicted threat In the Waikato could be heavy precipitation leading to floodwaters seriously affecting schools and houses, businesses and infrastructure (Wang et al., 2015). The Ministry of Education (2019) advised that any destruction of school property due to severe storms and flooding will be assessed by an emergency response team that will respond to property-related damage to make the site safe and the school functioning as quickly as possible. Furthermore, the local secondary school is often perceived as being more than just a place for young people to get an education; it is also a hub for the community to gather if they require

assistance. Therefore, the ramifications of having it out of action during an intense climatic event could be a tragedy for the people who may require assistance (Anderson, 2010; 2012) and is a sound reason why secondary schools need to consider educating their students about the impacts of climate change.

2.5.1 Leaders' and teachers' perceptions about climate change and climate change education in a New Zealand secondary school

Climate change education enables leaders and teachers to find a way to assist students in learning about climate change, the impacts on the environment and humanity (Chang, 2014; Westney, 2014; Dawson, 2015). However, the leaders' and teachers' perceptions about climate change and climate change education may be that they are concerned about several conflicting issues. For example, is their knowledge about climate science and/or climate change insufficient? Perhaps they are not sure how to, or if they even want to teach climate change education, or are they unsure about what actions they should take, let alone what actions they should help their students to take. Studies have shown that teachers often feel out of their depth when confronted with the notion of teaching about climate change, let alone how they would inspire and empower young people to take action (Boon, 2009; Chang, 2015; Stevenson et al., 2017). These concerns and questions are valid as the concepts behind the climate science, climate literacy, atmospheric chemistry and the social aspects of the impacts of climate change are complex, and they do require specific knowledge to be able to teach these concepts effectively. Therefore, in order to assist teachers and leaders offering climate change education in their schools, collaboration and cooperation could occur between the teachers in other subject areas.

However, many teachers are apprehensive teaching about climate change education as they believe they are inadequately trained to deliver such complex scientific content, or they do not link the content to the impacts and risks and how this relates to the students' living in New Zealand (Wastney, 2014; Rol-asmi, Rustaman & Tjasyono, 2017). Moreover, educators across the world often find it challenging teaching abstract concepts to students who are not able to engage with the lesson or who find the concepts difficult and disengaging (Chang, 2014). Dawson (2015) argues that if young people are to

participate fully in society and tackle socioscientific issues, they will need to have sufficient knowledge about the underlying scientific concepts.

The literature also suggests that teachers who only have a partial understanding of climate change; do not have the prior knowledge or experience and have had limited opportunities to participate in or observe teachers teaching about climate change may not be very confident in teaching these concepts. As a consequence, they might struggle to get student participation and achievement in this space (Wise, 2010). It is perhaps for this reason that some teachers find it challenging to teach climate change as maybe they do not teach science or might not understand the science very well. Moreover, if they are science teachers, they might not understand the social implications very well as this is truly an interdisciplinary area. Therefore, for climate change education to become a reality in schools, the curriculum leader/s may partner a science and social science teacher together to make this happen.

Although the literature does not explicitly provide many examples of how teachers support their students when taking action or how they feel about students taking action, it is clear that students must be given the latitude to take action to develop problem-solving and critical thinking skills. Cohen, Manion and Morrison (2018) point out that there is a clear link between learning and agency where successes can inspire and motivate learners to take further action. Research from around the world indicates that pre-service and in-service teachers have misconceptions around the issues of climate change, such as global warming, the greenhouse effect and the hole in the ozone layer, which are sometimes passed onto the learners. For example, Chang (2014) claims that alternative conceptions can occur when the teacher is trying to explain a difficult concept such as the carbon cycle, the electromagnetic spectrum, heat energy, the structure of the atmosphere, greenhouse gases or the difference between weather and climate and does not understand the concept/s well enough.

In Rol-asmi et al.'s (2017) research, they found that some teachers also associated climate with the weather so that climate change is considered weather change. Specialist teachers have a central role in making sure the technical terms they use in their subject content are unambiguous, so

alternative conceptions do not occur. In 2012, an Australian study examined science teachers' perceptions of climate change and found that there was a wide variation in their understanding of greenhouse effect and climate change (Dawson, 2012). One in five teachers held alternative conceptions conveying that the greenhouse effect protects us from UV radiation, while more than two-thirds claimed that the greenhouse effect was caused mainly by carbon dioxide gas (Hansen, 2010).

Further, Boon (2010) found that Australian pre-service teachers specialising in science and environmental science had an inadequate understanding of the greenhouse effects and ozone layer which was no better than the pre-service teachers who did not have a specialist science background (Dawson & Carson, 2013). It was of interest to explore whether the teachers and leaders in this study exhibited the same concerns about their knowledge.

2.5.2 Students' perceptions about climate change and climate change education in a New Zealand secondary school

A study in Portugal claims that today's generation of students belong to the "climate change generation" with more information and less scientific uncertainty about climate change and global warming (Azeiteiro, Bacelar-Nicholau, Santos, Bacelar-Nicholau & Morgado, 2018, p. 22). Further, a recent survey asked New Zealand students from Year 5 to Year 13 if they believed climate change was an urgent problem and well over half of them said it was, with only a small proportion believing that climate change was not a problem (Ministry of Education and Statistics New Zealand, 2019). All over the world, young people are insisting that their cities and countries declare climate emergencies to compel their governments to acknowledge the magnitude of the climate crisis and to reduce greenhouse gas emissions from transport, industry and agricultural sources (Sengupta, 2019; Brown, 2019).

Expressing one's views about the most significant event in the history of humanity is empowering for some young people and inspires them to take action. However, the research indicated that not every young person has the opportunity or the interest to attend climate strikes (Thew, 2019). Nevertheless, it was difficult to find current research to corroborate this in the literature. Disturbingly, the research did indicate that it is often the most deprived communities that have little ability to protect themselves against

climate change, particularly the extreme weather events such as extreme storms that lead to flooding or prolonged droughts (Anderson, 2012; Niall & Te, 2019). In a secondary school that has a high percentage of Māori or Pacifika students, the learning around climate change needs to be culturally responsive; incorporate ako (learning and doing); reflect traditional and contemporary environmental knowledge and make clear that Māori and Pacifika peoples have a spiritual interconnectedness to the land, rivers and seas (Morrison & Vaioleti, 2011).

Regardless of the way young people make themselves heard, climate change education empowers them to make informed and intentional actions that will lead to a shift in mindset and individual behavioural changes. Tulloch (2019) argues that if we are to develop future citizens with the capabilities to take action on climate change, we need a radical shift in education that goes beyond what we have now. Therefore, connecting climate change education with local issues and individual actions makes the abstract concepts more tangible and relevant to the students, enhancing student engagement (Anderson, 2012). In a secondary school where student retention can be troublesome, the teaching and learning about the changing climate needs to be personally relevant to the student, meaningful enough to inspire students to want to join the class and engage their interest sufficiently so that they come back for more (Monroe et at., 2017).

Therefore, understanding how much our students know about climate change and the impacts and risks that lie ahead will enable teachers and leaders to prepare the students in a way that will make a difference in their lives and the lives of their community. Chung (2014) argues that if teachers identify what the students know and do not know, climate change education can be implemented more effectively with more acceptance by the students. However, Chang and Pascua (2017) maintain that students who are unable to engage in the conversation on the changing climate, critically debate the issues or take action, will find adjusting to a changing world challenging. As a consequence, the students must have a good understanding of climate and/or earth science to participate in the discussion around the impacts of climate change and global warming (Dawson, 2015).

Interestingly, the research indicated that alternative conceptions are often associated with complex concepts, such as climate change, global warming and the ozone layer (Dawson, 2012; Boon, 2010; Hansen, 2010). Furthermore, Chang (2014) concurs that often students perceive that the hole in the ozone layer causes global warming and the greenhouse effect causes cancer (Jeffries et al., 2001, as cited in Chang, 2014). However, researchers observed that deeply held alternative conceptions of climate change are often more challenging to correct in some students. It is likely that the alternative conception may have developed in earlier schooling on climate change and is further exasperated by the media (Cordoro, Todd & Abelllera, 2008; Chang, 2010; Rol-asmi et al. 2017).

Despite these conceptual challenges occurring, several studies in the literature indicated that overall the majority of the students' recognise that climate change is happening, and realise the acceleration in warming is caused by human activities, such as the burning of fossil fuels. For example, in a Portuguese study, Azeiteiro et al. (2018) found that 76 per cent of the 10 to 12-grade participants believed that climate change was happening (three students did not know, and one disagreed); there were generalised perceptions among the students that the biotic (including human) communities were already affected by climate change. However, most of the students felt that mitigation for climate change should be taken by the government more than individuals.

Unfortunately, there is little available literature on the experience of secondary school students and their perceptions of climate change or climate change education in New Zealand. While there is some evidence around students being taught about climate change in classes offering climate change education, particularly in the US, the UK and Europe, we need to take care when making assumptions that these examples would apply in the New Zealand context.

2.6. Theoretical Framework

The following principles arose from the literature to guide this study:

1. That there is general agreement among scientists that the climate is changing and climate change is occurring.
2. That human activity is significantly contributing to climate change through unrelenting combustion of fossil fuels.

3. That the accumulation of greenhouse gases is having a significant impact on global warming as increased infrared radiation is trapped at the surface of the planet, and there is a consequential rise in the Earth's temperature.
4. That there is a consensus among the climate scientists that global warming and the rise in global temperatures is having an adverse effect on the climate.
5. New Zealand's regional temperatures will produce unprecedented extreme weather events such as intense tropical storms resulting in large scale flooding.
6. That climate change is having a significant impact on the marine and land habitats, loss of biodiversity, the warming and acidification of the oceans.
7. That New Zealand's animal agriculture is producing methane and nitrous oxide emissions far higher than other parts of the world due to its intensification of dairy and pastoral farming.
8. That low socio-economic communities, rural Māori, the very young and the elderly may be more vulnerable to the exposure of risks associated with climate change and their ability to cope and adapt to the changes.
9. That Mātauranga Māori traditional and contemporary environmental knowledge based on kaitiakitanga and mauri concepts, and handed down through the generations would be useful in helping to combat climate change.
10. That many young people in New Zealand are worried about their uncertain future and believe that climate change is the most significant issue humanity has ever faced and is an urgent problem that needs to addressed now by the government.
11. Young people across the world are striking to demand their countries declare climate emergencies to highlight the magnitude of the crisis facing humanity.
12. Climate change education can enhance and inform the learners that mitigation, adaptation and action-taking can bring about change associated with climate.

2.7 Chapter Summary

The literature review covered three main sections. The first section examined the greenhouse gases, the greenhouse effect, global warming and climate change. In the second section, the focus was on climate change education. In the third section, secondary schooling provided a context and looked at students', teachers', and leaders' perceptions about climate change and climate change education.

The *greenhouse gases* in the atmosphere absorb high energy short-wave infrared radiation that helps to retain the Earth's surface and ocean temperature, and the long-wave radiation is returned to space, which is known as the *greenhouse effect*. These gases are released by natural processes such as volcanic eruptions, melting permafrost and anthropogenic activities such as burning fossil fuels that increase the temperature of the planet, which is known as *global warming*. Since the industrial revolution, greenhouse gases, particularly carbon dioxide emissions, have accumulated rapidly due to human-related activities, and the global temperature has increased. However, mitigation strategies that significantly reduce the carbon emissions, and endorse schemes such as planting trees or carbon removal techniques will help to slow down the rising temperatures.

Scientists and councils around the country are in partnership with Māori to find solutions to address the changing climate; traditional, local and contemporary environmental knowledge indicate that knowledge and wisdom built over many generations, may hold the key. However, the irreversible damage that has occurred across the globe requires natural and human systems to adapt to the impacts of the changing climate. Therefore, mitigation is needed to reduce the impacts and risks for the potentially vulnerable such as the very poor, rural Māori, the very young and the elderly New Zealanders. Climate change education can develop resilience in our learners and build an adaptive capacity within our communities to deal with climate change as it occurs.

Climate change education is a critical response to climate change. The key ideas that underpin climate change education are education for mitigation and adaptation, beliefs, knowledge, attitudes, and action-taking. Climate change education enables learners to take informed and intentional action and is essential for students to become agents of change. Climate change education shares key concepts and principles with environmental education such as knowledge, attitudes, participation, and behaviour change which are interconnected and empower students to take action. Inspirational teachers can deliver student-centred activities that increase student awareness, build resilience, and encourage critical and creative thinking. Above all, teaching and learning need to focus on mitigation and adaptive capacity so students

can individually and collectively make choices about the actions they want to be involved in and become agents of change.

Taking action and developing action competence is at the forefront of climate change education. However, in order to make real change, the action must be placed in context and directed at solving a problem. It also encourages students to be active learners, and take charge of their learning, be hopeful instead of helpless and develop in-depth critical transformative knowledge. Climate change education is unique to other subject areas as it allows a cross-curricular or socioscientific approach to assist in the teaching and learning of climate change, and places the complex science content into a real-world social context.

Moreover, learning about climate change from a Māori perspective can reveal how traditional and contemporary environmental knowledge and Mātauranga Māori (knowledge and wisdom) can develop new ways to mitigate and adapt to the changing climate. Based on ako (learning and doing) a culturally responsive pedagogy determines that the teaching and learning around climate change is responsive to the needs, beliefs and values of the Māori and non-Māori students. Additionally, the learner is able to link Māori environmental knowledge and māaturanga Māori to climate change knowledge.

Therefore, to prepare our learners for an uncertain future, secondary schooling needs to make sure that all students are well equipped to participate in, contribute and adapt to a changing world. Although the national curriculum does not explicitly refer to climate change or include climate change education, teachers may choose to use innovative methods to include climate change education into secondary schooling. For example, an inquiry model can raise awareness, employ critical thinking, which increases student agency, or an issues-based pedagogy such as a socioscientific approach that requires teachers to collaborate across several curriculum areas to enable the students to create new knowledge by making connections to what they already know about climate change.

The teachers' and leaders' perceptions about climate change and climate change education indicated that some teachers feel they are out of their depth teaching climate change. For instance, if they teach science, they may

not understand the social implications, and if they do not teach science, they may not understand the complex scientific concepts or are not sure what actions they or their students should take. Moreover, the research indicated that teachers who have only a partial understanding and little prior knowledge of climate change might not get student participation. If the teacher is to engage the students and keep them interested, focusing on mitigation and adaptation, demonstrates that they can take affirmative action, which is critical for building resilience and adaptive capacity. Setting up cross-curricular classes and collaborating with other teachers is a way that teachers can support each other teaching climate change education.

The students' perceptions about climate change are that for many students, climate change is an urgent problem that needs to be managed now. Climate change education empowers young people to take action that will lead to attitudinal and behaviour change. However, learning about climate change can be challenging for students as it is a complex science and can lead to misconceptions, which can be tricky to reverse. Therefore,f the teaching and learning must be accurate, relevant and engaging so the learners can build resilience and adaptive capacity, which leads to taking action. In order to be effectual, however, climate change education must reflect the importance of understanding and enacting mitigation and adaptation as these are key strategies that can reduce the impacts of climate change on vulnerable communities.

Chapter 3
Methodology

3.1 Introduction

This chapter outlines the methodological basis used for this research, the approach taken for data collection and the data analysis. The research question is presented, and the research design is outlined. The methodological framework is described, as well as the paradigm that guided this research. Next, the research methods are outlined, the data analysis is described, the quality of the research is outlined, and the ethical considerations for this study are explained. Finally, the chapter concludes with a summary.

3.2 Research Question

- What are the perceptions of students, teachers and leaders in a secondary school in Aotearoa New Zealand about climate change and climate change education?

This research was undertaken to examine what students, teachers, and leaders know and felt about climate change and climate change education in a small secondary school, and to explore how perceptions cohered with what the literature suggests for preparing youth about the climate crisis upon us.

3.3 Research Design

The research design is a step-by-step process, which arranges and manages the research and helps to answer the research question. Cohen et al. (2018) note that a research design is a plan that is used to organise the research and make it feasible for the research questions to be answered based on evidence.

The evidence examined here is the knowledge and experience students, teachers and leaders have about climate change and whether they perceived climate change to be a significant factor in their lives. Moreover, the study examined the beliefs of students, teachers and leaders about climate change education. The research design can be seen to be framed by the research paradigm, which indicates the research approach employed to gather that data. These are now discussed.

3.4 Methodological framework

The methodological framework supports the theory and guides the research throughout the research process. Whereas the research methodology identifies, selects, processes and analyses the data and the paradigm, ontology, and epistemology inform the research. Cohen et al. (2018) suggest that the "methodology concerns how we find out about the phenomenon, the approach to be used, the principles which underpin it and the justification for using the kind of approach adopted and how the research is undertaken" (p.186).

3.4.1 Interpretivist Paradigm

An interpretivist perspective focuses on people's socially constructed interpretations and meaning-making and the way they see the world. It is the interpretivist researcher who advances that knowledge by describing and interpreting the multiple realities of a phenomenon (Cohen et al., 2018). The interpretive researcher begins with the individual and sets out to understand their interpretations of the phenomenon (Cohen et al., 2018). Moreover, the meaning is disclosed, discovered, and experienced (Denzin and Lincoln, 2008). Additionally, both the researcher and researched are both actively engaged in the experience (Bhattacharya, 2008).

The basis of the interpretivist paradigm is to understand the subjectivist worldview of human experience, to retain the integrity of the phenomena being investigated and to get to know the person from within (Cohen et al., 2018). Within an interpretive paradigm, the ontology has multiple realities; the subjectivist epistemology is the understanding of knowledge, how knowledge is acquired and how the researcher disseminates knowledge through interpretation of meanings of participants; and the axiology or values and beliefs are central to *verstehen* or understanding a shared meaning between researcher and participants (Flick, 2018; Hudson & Ozanne, 1998; Lincoln & Guba,1985). This research is situated in an interpretivist paradigm and therefore has a relativistic ontology, a subjectivist epistemology, and in order to examine perceptions of climate change and education for it, a phenomenographic research approach.

3.4.2 Phenomenographical Approach

Phenomenography is a qualitative research methodology within the interpretivist paradigm that describes the different ways participants' experience a phenomenon with the research question as a central focus. The data is gathered using semi-structured interviews; however, the interviewer must be careful not to steer the interviewee's thinking. The transcribed data is carefully analysed several times and then organised into categories known as categories of description, using the analytical characteristics: what and how and referential and structural, which enable the concepts to be broken down into manageable parts for analysis (Bowden & Walsh, 2000). Although the phenomenographer does not examine the phenomena itself, the different ways in which people think about, experience, interpret, understand, perceive or conceptualise a phenomenon are identified and are known as different ways of understanding (Marton, 1994; Orgill, 2012).

Phenomenographical research "aims at description, analysis, and understanding of experiences; that is, research which is directed towards experiential description" (Marton, 1981, p. 180). Additionally, Marton and Booth (1997) state that phenomenography is an empirical research perspective that stems from the belief that "in order to make sense of how people handle problems, situations, the world, we have to understand the way in which they experience the problems, situations, the world, that they are handling or in relation to which they are acting" (p. 111).

This study examined the participant's thinking, perceptions and experiences about the phenomenon of climate change. In order to explore the participants' views and experiences, I adopted semi-structured interviews and two focus groups (which I audiotaped), so the students, teachers and leaders could describe their understanding and experiences in a relaxed environment. The phenomenographical research approach is a suitable methodology to use in an educational study if the researcher is exploring the students' perceptions and understanding of a phenomenon in teaching and learning. Further, research indicates that it is in every sense relational; thus, the full range of methodological issues become important (Bowden & Walsh, 2000).

Furthermore, developmental phenomenography can help the students learn about a particular phenomenon from the outcomes of the research. Bowden

and Walsh note that “developmental phenomenographic research methods of data collection and analysis can be used to study a range of issues, including approaches of learning, approaches of teaching, and understanding of scientific phenomena learned in school” (p. 2-3).

This phenomenographical research study suits the use of qualitative data, but quantitative data can also be used to identify the students’ attitudes, perceptions and experiences of climate change. However, as the survey responses were interpreted collectively and not individually, this data can be situated in the interpretivist paradigm. Bell (2005) notes that “some approaches depend heavily on one type of data-collecting method, but not exclusively” (p. 115).

3.4.3 Qualitative Data

Qualitative methods generate data using well-thought-through open-ended questions, and the interpretation of this data presented a rich, descriptive narrative of the participants’ thoughts, views, attitudes and beliefs about climate change and climate change education. Cohen et al. (2018) suggest that “qualitative research can tell us the ‘how’ and ‘why’ - the process involved in understanding and explaining how things occur” (p.304). Additionally, Gonzales, Brown and Slate (2008) claim that qualitative research provides an in-depth, intricate and detailed understanding of meanings, actions, non-observable as well as observable phenomena, attitudes, intentions and behaviours.

This study provided an opportunity to explore the perceptions and experiences of a selected group of students, teachers and leaders about how they thought the climate change was changing, why would certain people be more affected than others, and how important it was to learn more about this phenomenon and take informed intentional action. This was made possible by choosing the appropriate qualitative instruments, using a well-thought-through open-ended question and thematically analysed data.

3.4.4 Quantitative Data

Quantitative research methods measure generated numerical data, which is either divided into categories or ranked into scales (Cohen et al., 2018). Quantitative methods enable the researcher to get the breadth of the data from a larger number of participants and find patterns emerging in the data.

In this study, a questionnaire was chosen to examine the students' perceptions of climate change, and eighteen well-thought-through questions were chosen and ranked using an ordinal scale – "yeah, nah and maybe". Pie charts were selected to highlight the students' perception of the two main sections of data: a changing climate and human-generated climate change and were further divided into their beliefs, knowledge, attitudes and action-taking in each section. The pie charts provide a visual representation of the students' perceptions about climate change and climate change education.

3.5 Research Context

I chose this secondary school to undertake my research as I had worked there for several years and felt that some people in the community might find the impacts of a changing climate challenging. The school is located in a small Waikato town. The student population of the school is just over 200 students, and approximately 79% identify as Māori. In recent years there have been significant changes to the school's curriculum and the way the students are taught with an emphasis on Te Ao Māori and more relevant, localised teaching and learning.

As I had taught in the school and knew many of the students, I decided to adopt a purposive or non-probability sample to select and invite the participants to take part in this research. Purposive sampling is a nonrandom technique that does not need underlying theories or a set number of participants (Etikan, Musa, & Alkassim, 2016). "The selectivity which is built into a non-probability sample derives from the researcher targeting a particular group, in the full knowledge that it does not represent the wider population" (Cohen et al., 2018, p. 217). Just as a purposive researcher handpicks the cases to be included in the sample based on their judgement and characteristic(s) being sought they assemble the sample to meet their specific needs (Cohan et al., 2017). Further, Rice (2003) notes that "in purposive sampling, units are selected subjectively by the researcher on the basis of prior experience" (p. 233).

I selected the teachers and leaders to include those who taught subjects where climate change might typically be taught as well as those not closely aligned to climate change. I invited six teachers to participate in this study. There were four heads of departments and two teachers: Imran was HOD of Mathematics;

Manju was HOD of Science, Biology and Chemistry; Steven was HOD of Social Science and taught English, and Jack was HOD of Technology. Jackie taught Food Technology, and Aaron taught Physics and Mathematics. Further, there were three deputy leaders: Tania taught Accounting, Tash taught Physical Education and Health and Katie taught English.

The student participants were selected on my knowledge of student engagement in environmental issues with an awareness of reducing the effects of climate change. I was able to make this selection as I had taught Environmental Sustainability to the students in my Ag/Hort class a couple of years ago. I looked after the Environmental Group for a year. I got to know some of the students in Puna Ako where I taught them about climate change and global warming and while I was teaching alongside Manju in her Science, Biology and Chemistry classes. The sample consisted of twenty 14 to 18-year-old secondary school students; fifteen girls and five boys; six teachers and three leaders; a total of twenty-nine participants.

One limitation in this research was that I was only able to recruit student participants as a sample size of 20 students in total. This was partially due to the time of the year that I began to collect the data and the number of senior students that were no longer at school in mid-November of that year.

I was granted permission to carry out the students' questionnaire and the focus group interviews during Puna Ako. Puna Ako is the first 100 minute class of the day which begins at 8.50 am with a karakia (prayer) and a waiata (song). During the lesson the teachers and students discuss relevant local, national and global issues through what is known as Global Learning; junior students learn literacy and numeracy, and senior students work independently to complete module work to gain their credits. It concludes at 10.30 with a karakia mō te kai (blessing the food).

Students who were 14 years and under had to get permission from their parent/caregiver to take part in the questionnaire and or focus group and the students who were 16 years and over could provide consent to take part in the questionnaire and or focus group at a convenient time. The teachers and leaders were also provided with a letter introducing the study and asked to sign a consent form. See Appendix A for information letters and consent forms.

3.6 Research collection methods

Selecting the most appropriate instruments for data gathering, e.g. questionnaires that have 'fitness for purpose' enables the researcher to gather useful and usable data, depending on research questions and research design as well as considering the strengths, weaknesses and suitability of each instrument (Cohen et al.,2018).

This study utilised three different methods of data gathering to gain insightful data from the participants. Firstly, an on-line questionnaire was used to gather quantitative data, and open-ended question gathered qualitative data. Secondly, semi-structured interviews and two small focus groups explored more deeply participants' experiences and perceptions of climate change and climate change education. The on-line questionnaire also explored the student's perceptions but did not probe as deeply as the focus group and semi-structured interviews.

3.6.1 Questionnaire

A questionnaire is a widely used instrument for collecting survey information, which provides structure and is often comparatively straightforward to analyse. Moreover, questionnaires are often used as part of a survey, which may focus on opinions or factual information depending on its purpose (Mentor, Elliot, Hulme, Lewin, & Lowden, 2011). Further, Cohen et al. (2018) note that this method of research can include: multiple-choice questions, open-ended and closed questions, rating scales, ratio data and constant sum questions. These authors emphasise that the questions must be fit for purpose. McLafferty (2003) noted that in education and social science research, questionnaires are often used to explore people's perceptions, attitudes and experiences. He stated that "questionnaire research is a research method for gathering information about the characteristics, behaviours and or attitudes of a population by administering a standardised set of questions or questionnaire, to a sample of individuals" (p. 87).

In this study, a questionnaire was used as a primary data gathering tool with students (see Appendix C). It was a self-administering (on-line) survey designed using 'Google Forms' which was straightforward to set up, administer and gather data. Teacher-researchers can design questionnaires in order to collect information about how students perceive a particular topic or

phenomenon through their knowledge, beliefs, attitudes and actions (Xerri, 2017). According to Cohen et al. (2018) “internet surveys are becoming the predominant mode of conducting surveys, superseding paper-based surveys” p. 361). I chose this approach as the students were familiar with filling in questionnaires on Google Forms and felt it would be a more effective way to collect and collate the data.

The questionnaire was completed by the student participants during class time to examine what they knew and/or believed they knew and felt about climate change and climate change education. It contained 18 closed questions and one open-ended question. Closed questions are usually to the point, easy to answer, quick to complete and quicker to code than word-based data. Alternatively, open-ended questions invite an honest, personal comment from respondents and often contain snippets of information that can generate rich data (Cohen et al., 2018). Further, open-ended questions are frequently used when seeking peoples opinions and attitudes in qualitative studies.

This study used a simple choice style of question and response options that would reflect the language the students used in their daily lives. Similarly, the questionnaires were carefully crafted to make sure that the wording was student-friendly and reflected the abilities of the participants. For each of the closed questions, the options available were ‘yeah’ (yes), ‘nah’ (no) and ‘maybe’ (I am not sure). A pilot study was not used in this research.

3.6.2 Focus Group Interviews

The focus group interviews were conducted after the completion of the questionnaires to enable the participants the opportunity to expand on some of the ideas raised in the questionnaires and to express their thoughts using their own words. Cohen et al. (2018) assert that the purpose of a focus group as a data collection method is to gather together people’s beliefs, ideas and views on a particular topic. However, unlike other interviews, it is from the interaction of the group that the data emerge. Further, Bell (2005) notes that “the participants in a focus group should interact with each other and be willing to listen; they may agree or disagree with each others’ views, and perhaps reach a consensus on a topic that is important to them” (p. 162). Cohen et al. (2018) concur “the ‘contrived’ nature of focus groups is both their strength and their weakness: they are unnatural settings, yet they are structured and very

focused on a particular issue and, therefore, will yield insights that might not otherwise have been gained from a straightforward interview" (p. 532).

Semi-structured questions were used during these interviews as this enabled the participants to ask questions, discuss their experiences and feelings while keeping the purpose in my mind. The focus groups are useful for empowering participants to speak in their own words; to gather qualitative data on attitudes, values and opinions and discuss the research issue in more depth than is possible in the questionnaire (Cohen et al., 2018). Additionally, Kitzinger (1994) claims that the "core purpose of the focus group is to collect and analyse data that are primarily concerned with the interaction among members of the group" (cited in Scott & Morrison, 2007, p. 112).

The two focus groups were conducted after the completion of the questionnaire and lasted 20 minutes each. For convenience, these were held during the students' Puna Ako classes in a small meeting room in the Science department. The students were asked to try and not interrupt the person who was speaking and to speak as clearly as they could. An audio recorder was used to capture the participants' knowledge, experiences and perceptions about climate change and the discussion that took place., Cohen et al. (2018) argue that the use of a recorder in the interview might be disconcerting for some participants and constrain them from responding. However, without the use of an audio recording device, the data could be incomplete or misinterpreted. The issue here is that "there is a trade-off between the need to catch as much data and yet avoid having so threatening an environment that it impedes the potential of the interview situation" (p. 520).

3.6.3 Semi-structured interviews

The semi-structured interview was chosen as an appropriate instrument for data gathering from the teachers and leaders. Moreover, I believed it would enrich my study as it employs a conversational, informal exchange of views between two or more people on a topic of mutual interest (Cohen et al., 2018; Longhurst, 2003; Scott & Morrison, 2007). However, I was aware that the interview was more than just a chat with colleagues I liked and respected. A semi-structured interview encourages interviewees to respond open-endedly and to answer a question in his or her own terms but still provide a greater

structure for comparability over that of the focused or unstructured interview (May, 2011).

The semi-structured interviews took place in the study school at a time and place that was most convenient and comfortable for the leaders and teachers and lasted approximately 30 minutes each. Pre-written semi-structured questions were used to guide the interview (see Appendix C), but flexibility allowed the interviewer and the interviewees an opportunity to ask supplementary questions and for further explanation if the question was not clear. Cohen et al. (2018) claim that the common denominator of the different types of interviews is that the "transaction that takes place between seeking information on the part of one and supplying information on the part of the other" (p. 508).

3.7. Data Analysis

An on-line questionnaire, two focus group interviews and two sets of semi-structured interviews produced qualitative and quantitative data which was thematically analysed and interpreted. Once the students had completed the questionnaire, the closed question data set was downloaded into Excel and then exported into NVivo for coding. A series of pie charts and quoted text indicated what the students knew or believed they knew about climate change and climate change education. Cohen et al. (2018) note that pie charts are useful for showing proportions but must suit the audience for whom they are intended. The responses to the open-ended question in the questionnaire and the data from the two student focus groups were exported into NVivo for thematic coding. At that point, nodes were set up with each node representing a theme. The nodes were divided into two sections: climate change and climate change education, and the data from the transcribed open question and focus group interviews were placed into the appropriate nodes. Once I had completed adding the data into the nodes, I began to assess the themes I had chosen to see where I could combine the nodes and then compare the themes within that data set and look for emerging patterns. Cohen et al. (2018) state that qualitative data analysis involves organising understanding, describing, explaining and making sense of data. The translated themes and the associated data linked my research question to the theoretical framework.

The semi-structured interviews were transcribed from the audio-recodings. The transcript data were exported in NVivo for thematic coding as it was for the student data. The findings are presented in Chapter 4.

3.8. Research Rigour

Trustworthiness

The validity and reliability in research are essential in assisting the data to be a true and accurate representation of what the participants convey to the researcher. The trustworthiness of qualitative content analysis is often presented by using Lincoln and Guba's (1985) criteria for qualitative research: *trustworthiness, credibility, dependability, conformability, transferability*. Further, Flick (2018) claims that the credibility of the research can be increased if the researcher employs methods like triangulation or the combination of methods and data, and member checks in order to correct errors or offer the participants an opportunity to add further information.

Triangulation

Triangulation is a way of strengthening the credibility in the data by looking at several pieces of data to see if they are both saying the same thing or something different and the connections between the data. I used this approach across the questionnaire and the focus group data. I looked at the teachers' and leaders' internal triangulation to see if they had consistency but found what the students were saying was different to what the teachers and leaders were saying and found discrepancies in the data. Researchers often use a combination of research methods in order to strengthen their results and explain more fully the richness and complexity of the phenomena they are studying (Cohen et al., 2018).

Member checking

Once the data is transcribed, member checking helps the transcribed interview data to be credible. I did this by sending the transcribed scripts back to the participants' for a validation check before the interpretation and to get back to me if they had any changes, but no participant required this. Cohen et al. (2018) state that rigour can be achieved with careful audit trails, member checking/response validation and triangulation.

3.9. Ethical considerations

Ethical considerations are essential components of research, relevant in all stages of the research and should be continually addressed throughout the entire research process. Preissle (2008) states that “most qualitative scholars view qualitative research as moral, ethical endeavours because they are human endeavours” (p. 274). Similarly, by focusing on the ethical issues throughout the planning and design; the choice of methodology; data collection and analysis will help to ensure no harm will come to any of the participants involved in the study. Cohen et al. (2018) claim that “ethical decisions are contextually situated – institutionally, socially, politically, culturally, personally, and each piece of research raises ethical issues and dilemmas for the researcher” (p. 111).

Ethics approval was granted for my research by the University of Waikato’s Human Research Ethics Committee in November 2019 (see Appendix B). Further, this study adhered to the guidelines of the New Zealand Association for Research in Education (New Zealand Association for Research in Education, 2010). However, for this research to proceed, a signed copy of consent from the Principal was required. Once I had received consent, I was able to obtain informed consent from the leaders, teachers, students and parents of the younger students that I had invited to take part in the study. The information I provided outlined the purpose and nature of the research, what would be done with the findings, the confidentiality of the data and the right to withdraw at any time from the study, including that the collected data (except the focus group data) would be stored away in a safe place for up to five years.

Before the participants become involved in a project, they should be given a clear description of what the research involves and how it will be reported. It should be made clear that their participation is voluntary, that no harm will come to them and that they have the right to withdraw from the research, (in most cases) at any time (New Zealand Association for Research in Education, 2010). Additionally, all matters pertaining to the research should be kept in the strictest confidence, and the research process should cause no harm. Cohen et al. (2018) argue that ethical concerns need to be addressed very early on in the planning, design and conduct of the research, including informed consent, the right to withdraw, anonymity, and confidentiality.

Informed consent

In research, the participants' consent should be both informed and voluntary. At the beginning of this study, informed consent was obtained from the Principal and all the participants who were invited to take part. The teachers, leaders and students (16-18 years old) were given an informed consent letter (see Appendix A) and asked to read it through. Once they had read it, I answered any questions, and if they felt everything was in order, they were asked to read and sign the consent form. The students who were under 16 (14-16 years old) were given an informed consent letter and consent form to take home for their parents to read through the information and if they felt everything was in order to permit their children to take part in the study. These signed consent forms were then filed away in a safe place.

Confidentiality and anonymity

Confidentiality is making sure the participants' privacy is protected; anonymity guarantees that the participant cannot be identified. The semi-structured interviews were conducted in a meeting room away from other staff and students. Further, the participants were assured that the data would be kept secure and only be seen by myself and the research supervisor. The participants' anonymity was protected further by assigning pseudonyms to teachers and leaders and the letters A-F for the students in the focus groups, instead of using their real names in the analysis and reporting of the data.

Right to withdraw

The participants in this study were advised they had the right to withdraw and could refuse to participate in any aspect of the research. The conditions were laid out in the participants' letters that the students could withdraw up until they submitted the questionnaire, the focus group members could withdraw right up until the end of the interview, and the teachers and leaders could withdraw right up until two weeks after receiving the transcript of their interview.

3.10 Chapter Summary

This chapter began by introducing the research question, the research design and the methodological framework, which guided the study. The interpretivist perspective and paradigm were examined along with the specific ontology and epistemology which grounded the research. The research methods used to

collect the data and analyse it are explained, as well as the research rigour and ethical considerations.

The focus of the study was to explore the perceptions students, teachers and leaders have about climate change and climate change education. Both qualitative and quantitative data were analysed and themes created which produced rich, descriptive data. These findings are presented in chapter four.

Chapter 4
Findings

4.1. Chapter overview

The research findings in this chapter are presented in three groups: students aged between 14 to 18 years old, teachers, and leaders in a secondary school in Aotearoa New Zealand. The group findings are divided into three main sections.

In section 4.2, the data is presented in a series of pie charts and associated quotes drawn from an online questionnaire and two focus groups to illustrate students' perceptions of climate change and climate change education. The students' data appears under four main subheadings: *Beliefs, Knowledge, Attitudes and Actions*

Chapter 4 also presents findings from the views of the teachers and leaders through their semi-structured interviews, under four main *subheadings: Beliefs, Knowledge, Attitudes and Action* are examined throughout these findings. The chapter concludes with a chapter summary.

4.1.1. The participants

Participants of this study included students, teachers and leaders. The study school is a small secondary in a semi-rural location with a high percentage of Māori students.

The students

Twenty 14 to 18-year-old students took part in this research; the sample was made up of fifteen girls and five boys. Each student was invited to take part in a survey questionnaire about their perceptions of climate change and climate change education. Two small focus groups of two and four students respectively teased out the ideas from the survey responses. Letters of the alphabet (A-F) have been used as pseudonyms when referring to students in the focus groups.

The teachers

The study involved six teachers in individual semi-structured interviews. There were two female and three male teachers who were either middle leaders and or classroom teachers in the sciences, social sciences, mathematics, and

technology departments. Pseudonyms have been used when referring to the teachers in the school.

The leaders

There were three leaders (DPs) involved in individual semi-structured interviews. They were also teachers in Accounting and Business Studies, English, Physical Education and Health. Pseudonyms have been used when referring to the leaders in the school.

4.2. The students' perceptions about climate change and climate change education

In this section, data relating to whether climate change is happening or not and whether humans are contributing to it or not are examined using the students' thoughts. See Appendix B for the full list of questions asked in the questionnaire. The following subsections illustrate the students' perceptions of climate change and climate change education. Moreover, it will examine their beliefs about the changing climate; what they think is causing climate change; their attitudes on how climate change will affect their future lives and what action they felt they could take for climate change to address climate change.

4.2.1 Students' beliefs about climate change

The students were asked to consider whether they thought the climate was changing. Figure 4.1 indicates that the vast majority of the students believed that the climate is changing and climate change is happening.

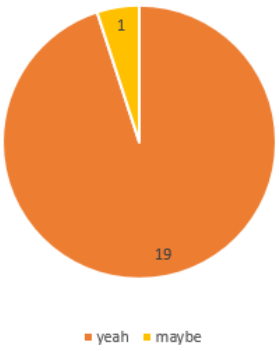

Figure 4.1. "I believe the climate is changing" (n=20)

The students' felt that the climate was much warmer than they had seen before in their lives. In the focus group, Student E said "the temperatures are rising", and added," yeah the camp we went on was so hot, I have never felt it that hot before". These findings indicate that the majority of students believe that the

climate is changing and some believe the temperatures are rising. However, they were less clear about why the climate is changing and the link to global warming.

This viewpoint corresponds with scientific findings as there is general agreement among scientists that the climate is changing and that climate change is occurring. The climate scientists suggest that the change in the climate is due to an increase in global temperatures, warming oceans, changes in the polar regions, changes in land use and continuing anthropogenic greenhouse gas emissions into the atmosphere (Ministry for the Environment and Statistics New Zealand, 2017). Further, the IPCC special report states that human activities are estimated to have caused approximately 1.0ºC of global warming above pre-industrial levels (Intergovernmental Panel on Climate Change, 2018).

A key aspect of global warming is that anthropogenic combustion of fossil fuels is contributing to the rise in global temperatures. Figure 4.2 indicates that the majority of students believe people are making the planet warmer by burning fossil fuels (coal, oil and gas).

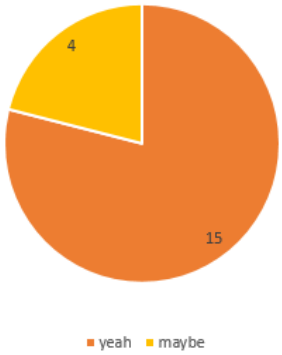

Figure 4.2.” I think people are making the climate warmer by burning coal, oil and gas”. (n=19)

A survey participant noted, "that we should use less coal and oil, stop burning the Amazon forests and look after our other resources". Likewise, another thought driving less was a good idea, and that trying to get people to use their cars less would decrease the gas poisoning the Earth, would be useful. Student B in the focus group stated, "I guess we could walk or bike, but public transport is expensive". Additionally, Students D and E felt changing to electric cars and avoiding petrol and gas could reduce emissions into the atmosphere. Finally, Student A thought "we should try and capture the emissions and try

and change them to something positive". These findings indicate that most of the students were able to link the combustion of fossil fuel with the warming of the atmosphere, but also had ideas for change.

Renwick (2019) states that burning fossil fuels increases the volume of concentrated carbon dioxide in the atmosphere, which in turn makes the planet warmer. Additionally, Withgott and Laposata (2015) note that when we burn fossil fuels, greenhouse gases form; which in turn causes temperatures to increase, modifies climate and weather patterns and increases the frequency of extreme weather events.

A warmer planet could lead to more extreme weather such as heavier precipitation, droughts and intense storms. Figure 4.3 indicates that the majority of the students indicated that a warmer planet could lead to more frequent and heavier rains leading to flooding in the Waikato region. However, quite a few students appeared to be uncertain about the link between the warming up of the region and the impacts of climate change.

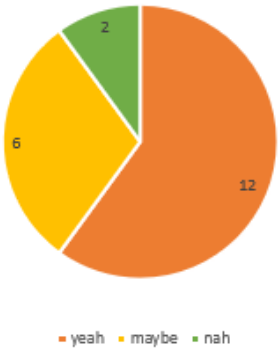

Figure 4.3. “A warmer planet could lead to more frequent and heavier rains leading to flooding in the Waikato region” (n=20)

The students were asked if frequent heavy rains and flooding in the Waikato region was a consequence of a warming planet. The students in the focus groups agreed that the Earth was getting warmer. Student C and D respectively responded with "the weather is changing, and we have to put up with the consequences" while Student E claimed that "all the countries are getting hotter". These findings indicate that the students were able to make some connections between the rising temperatures and extreme weather events but appeared less certain in their beliefs.

The projected forecast for 2020 to 2050 signals heavy precipitation in the Waikato region with far less rain in the later parts of the century leading to more

drought-like conditions (Environmental Waikato, 2008). However, extreme precipitation events are expected to increase with the changing climate, and the most extreme daily precipitation could be located in the north-eastern and northern parts of the Waikato, particularly by 2070 and 2100 (Wang et al., 2015).

A key aspect of global warming is the intensification of localised storms resulting in large scale flooding. Figure 4.4 suggests that there were mixed beliefs by students about whether a warmer planet may lead to more frequent intense storms in their town.

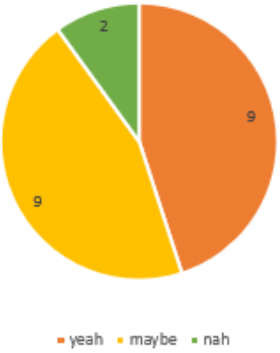

Figure 4.4. “A warmer planet may lead to more frequent intense storms in our town (n=20)

Most student's acknowledged that the temperatures are rising, and understood that a warmer planet could lead to extreme storms, such as an increase in tropical cyclones and extensive flooding. These findings indicated that although the majority of the students recognised that the temperatures were rising, not everyone linked the increase to extreme weather events.

The IPCC Special Report signalled that as the temperature of the planet increases the intensity and frequency of climate and weather extremes will escalate (Intergovernmental Panel on Climate Change, 2018). Additionally, projected long-term average climatic conditions for the Waikato Region is expected to have increases of 0.2-2.0°C by 2040 and 0.7-5.1°C by 2090, with changes in rainfall and extreme events (Environmental Waikato, 2008).

The rising temperatures warm up the land, the lakes, the rivers and the ocean, and this has an impact on all ecosystems across the world. Figure 4.5 illustrates what impacts that the students believed a warmer climate might have for species in a local ecosystem such as the tuna (eels) in the Waikato River, which has great significance to Māori for their mahinga kai (food from

the river) and is an essential part of preserving the practice of cultural traditions (Manaaki Tuna, 2020).

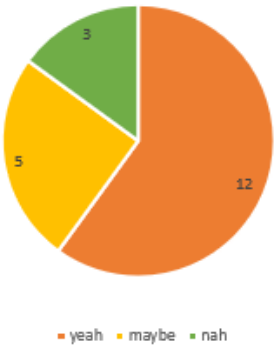

Figure 4.5. “A warmer planet could be good for the tuna (eels) in the Waikato River” (n=20)

The students in the two focus groups identified that a warming planet could have a detrimental effect on koala bears in Australia due to the wildfires burning down the trees (a current event at the time) and the polar bears in the Arctic, with melting ice and their habitat is shrinking. In contrast, the students in the survey felt that a warming climate could be good for the tuna in the Waikato River. These findings indicate that although the students were able to link how the increase in temperature could directly affect certain species, they were unable to make the connection between the warming water and the effect this would have on tuna in the Waikato River.

Climate scientists report that 2019 was the second hottest year on record after 2016 and “this trend is expected to continue because of record levels of heat-trapping greenhouse gases in the atmosphere” (World Meteorological Organisation, 2020). Further, the increased temperatures would warm up the water in our rivers and lakes and adversely affect the eel populations (and many other species) through decreased dissolved oxygen, as well as changing their life cycle. As a result, the change in breeding sites for eels migrating to Tonga for spawning could impact on their population density (Department of Conservation, 2013; Ministry for the Environment and Statistics New Zealand, 2020). Additionally, the loss of biodiversity from the awa (river) erodes mauri (life force) and) less tuna limits the ability of Tangata Whenua to put kai (food) on the table (Ministry for the Environment and Statistics New Zealand, 2019).

Global warming and climate change will affect people in a myriad of different ways, but those who are vulnerable to the impacts of a changing climate will be affected the most. Figure 4.6 indicates that most of the students believe that the people in their community would be more affected by climate change compared to those that live in wealthier communities.

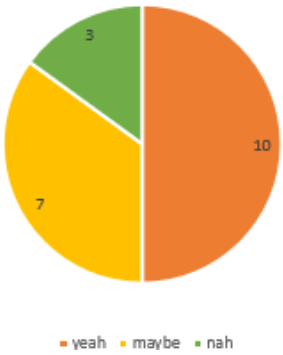

Figure 4.6. “I think people in my community may suffer more from climate change than those in rich communities” (n=20)

Most of the student's felt that people in their community would be more affected by the impacts of climate change. However, the students in the focus groups tended to focus on owning an electric car and not specifically about how their whānau or community would cope with the changing climate. Student B argued that "electric vehicles are so expensive and only people with money can afford them", while Student D felt that "charging the car with power would also be costly and wouldn't be good for the environment". These findings indicate that the students believe that their community might be disadvantaged by their economic status, and the alternatives might not suit their communities or the environment.

4.2.2 Students’ knowledge about climate change

Students were asked about their knowledge of climate change and how they could gain more knowledge about it. Figure 4.7 indicates that the majority of the students did not feel confused about what climate change was.

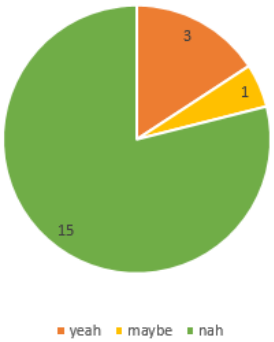

Figure 4.7. “I am confused about what climate change is about” (n=19)

A student participating in the survey wrote "I think climate change is a major crisis affecting the world", while another claimed, "everyone should be aware that climate change is important and should know more about it". Moreover, Student E from the focus group stated that "climate change is affecting everybody and every living thing around us". These findings indicate that the students report that they have knowledge about climate change and can espouse views which are in line with what experts are indicating.

Azeiteiro et al. (2018) argued that today's generation of students belong to the *climate change generation* with more information and less scientific uncertainty about climate change and global warming. However, some years ago, Anderson (2010) argued that education might need individuals and communities to make informed decisions to take action and bring about behaviour change. The data here shows that better information may be having an impact even if not directly through schools.

A key aspect of climate change is the greenhouse gases that cause global warming. Figure 4.8 signifies that more than half of the students indicated they understood what greenhouse gases are.

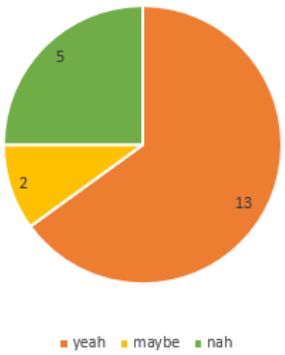

Figure 4.8. “I think I know what greenhouse gases are” (n=20)

Students also indicated that they knew where the greenhouse gases were emitted, linking them to burning fossil fuels. A student taking the survey claimed, "I can limit the amount of greenhouse gases I produce into the environment", and another noted, "we can stop using the fireplace" in response to an open question about what they thought they could do about climate change. Additionally, the focus group discussion indicated that some of the students were unsure about what caused greenhouse gases. For example, Student E and F thought the "steam and smoke" from the factories is causing the warming while Student A linked the greenhouse effect with carbon emissions in the atmosphere saying "the greenhouse effect is trapping all the heat in the Earth's atmosphere, and this is from the factories".

These findings indicate that the students in this study are familiar with greenhouse gases but tend to link pollution and greenhouse gases together and may hold some alternative conceptions about where greenhouse gases come from, which is in line with other similar research. Dawson and Carson (2013) had previously found that students' often merge environmental problems with the greenhouse effect and pollution and greenhouse gases. Further, Choi et al. (2010) reported that students often perceive air pollution as being the major cause of climate change.

Students were asked about their knowledge of greenhouse gases and if they were making the planet warmer. Figure 4.9 indicates that just over half the students felt that they knew that greenhouse gases were making the Earth warmer.

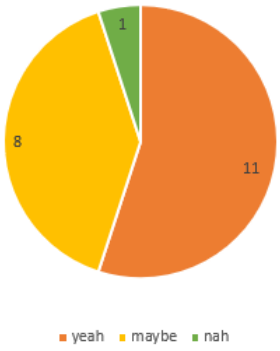

Figure 4.9. “I think greenhouse gases are making the planet warmer” (n=20)

Some further uncertainty about this connection was noted in the open responses to the survey and the focus group discussion. In the focus group, Student A claimed that the "greenhouse house effect is making the Earth

warmer", but she was unable to explain how this happens, and Student E claimed that "CO_2 is going into our air and polluting it, and making everything warmer". However, she had little understanding of this either. These findings indicate that although the students appeared to be knowledgeable about greenhouse gases, they were less clear about their link to global warming and climate change. The students seem to find these ideas confusing and came up with alternative concepts, which is in line with previous research.

Choi et al. (2010) reported that middle and high school students often have misconceptions around greenhouse gases, i.e. confusing air pollutants for greenhouse gases; heat being trapped by a layer of dust caused by pollution or greenhouse gases as air pollutants. It could be argued, however, that the greenhouse gases are polluting the atmosphere in high quantities and a warming climate could make air pollution worse. Research suggests that climate change and air pollution are closely interwoven, so by reducing air pollution, we also protect the climate (United Nations Environmental Programme, 2019).

A key aspect of climate change education is that students are able to understand the complex science behind climate change. Figure 4.10 indicates that just over half the students believe that they want to learn more about climate change at school.

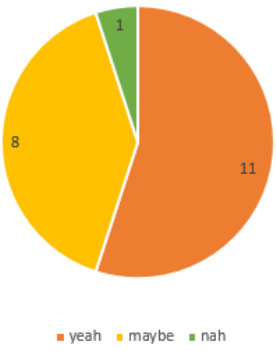

Figure 4.10. “I want to learn more about climate change at school”l (n=20)

Having the ability to mitigate or reduce greenhouse gases and adapt to the impacts of a changing climate is essential if our vulnerability is to be reduced, and humanity is to survive as a species. A student from the survey group commented "it is important that everyone knows more about it" and another felt "it would be good to learn more about climate change at school". When

asked who they thought was responsible for climate change, the students in the focus groups declared in unison "we are all responsible for this". Similarly, Student F added, "humans are" and student E noted that they had been learning about climate change at school. Student B believed that being informed and increasing awareness is an important thing to do.

These findings indicate that the students are on the whole interested in being informed and want to inform others about climate change and they would like this to take place at school, which is in line with other similar research. Research indicates that students with limited knowledge of climate change, refer to less reliable sources of information, thus often conceptualising climate change for themselves often without the scientific knowledge to support their ideas (Dawson & Carson, 2013). Further, Anderson (2010) affirms that investing in quality education to combat climate change is essential, especially for mitigation and adaptation. Finally, Olander and Olander (2017) argue that although education performs a significant role in promoting care for our planet, this process cannot be confined to a school setting.

A key aspect of climate change is that methane and nitrous oxide gases trap more heat than carbon dioxide and are significant contributors to greenhouse gas emissions in New Zealand.

Figure 4.11 indicates mixed ideas amongst the students about whether cows and sheep in New Zealand were contributing to the greenhouse gases in the atmosphere in some way.

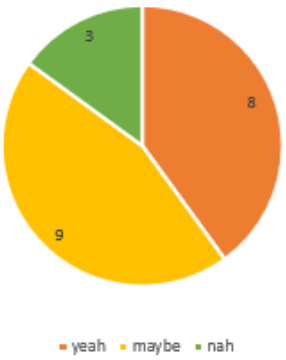

Figure 4.11. “Cows and sheep in New Zealand are producing greenhouse gases that are warming up the planet” (n=20)

These mixed views were further illustrated in the student survey and focus group discussion. A survey participant noted, "I truly think the cause of climate change is coming from farms". This opinion was challenged in the focus group

when Student C indicated that farm animals were to not to blame and Student D agreed that "the cows just live their life, eating grass and not making stuff that affects the universe". However, Student E disagreed and added that "the cows and sheep were helping to warm the planet", but that people were "blaming farming and wanted farmers to get rid of a lot of cows as they burp a lot and that was not right".

These findings indicate that the students' opinions differed around the impact animal agriculture is having on the climate and were unclear about the link between greenhouse gases and global warming. Giampiero, Goglio, Vitali & Williams (2018) state that livestock requires a significant amount of natural resources and produces 15.5 per cent of the total anthropogenic greenhouse gas emissions. Further, in 2018 the Waikato region had 4,000 dairy herds and 1.5 million milking cows (Haggerty & Campbell, 2008; Tikkisetty, 2019).

4.2.3 Students' attitudes to climate change

Most of the students who participated in this study believed that climate change is real, and many of them feel a bit anxious about the impact on their future lives. Figure 4.12 indicates that more students were worried than were not worried about the changing climate, which seems to suggest that students of this age are concerned about climate change.

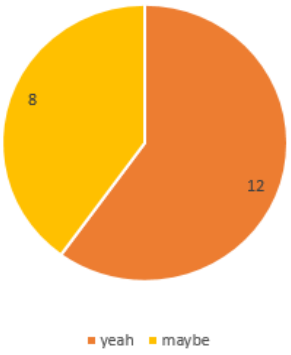

Figure 4.12. "I am really worried about climate change" (n=20)

One of the participants in the survey noted he was unsure how he felt about climate change and he did not know what to do about it; while another participant added, "climate change is a major crisis affecting the world, and we need to take action". While another said. "I genuinely feel like it is too late to fix the problem". These sentiments were echoed by some of the students in the focus group as they felt hopeless and were not sure what they could do to change the situation. Student B said, "even if half of New Zealand tried to make

a difference, I don't think it would make a change". Encouragingly, towards the end of the discussion, the students were starting to believe that there was hope, Student B added, "well I guess we could try, like walking, biking, I mean it is a good idea".

These findings indicate that most of the students felt uncertain about the changing climate and that they often feel overwhelmed by the scale of the impending crisis, which is in line with other research findings. Ojala (2012) concurs that global climate change is one of the most severe threats that humanity is facing today, and feelings of hopelessness, pessimism and helplessness, as well as inactivity among adolescents, is common (Li & Munroe, 2017). It is not surprising then that our young people are feeling perplexed by the uncertainty of the changing climate.

The students were asked to consider whether climate change could affect their future. Figure 4.13 indicates that the majority of the students were worried about how climate change might affect their future.

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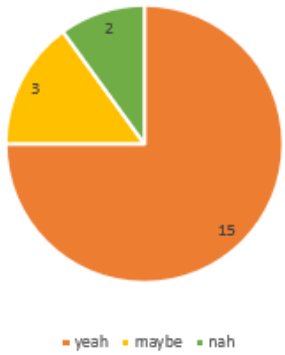

Figure 4.13. “I am worried climate change will affect my future” (n=20)

One of the survey students indicated that they felt that it was too late to do anything about climate change and many people are still in denial. Another added, "I genuinely feel like it is too late to fix the problem; therefore, human extinction is highly possible due to climate change". Further, another student added that the "future of many children had been taken and now we have nothing to live for", and another student felt "it seems like so little is being done to prevent climate change becoming a more major issue". Student B from the focus group argued that influential people, such as politicians, were talking about climate change, but very little was being done to find solutions.

These findings indicate that the students are worried about the uncertainties of how climate change may impact on their future lives and many feel a sense

of helplessness and frustration around a lack of knowledge and inaction by leaders and governments around the world. Armstrong et al. (2018a) claim that the threat of climate change can cause stress, sadness and mental health issues. Further, Li and Monroe (2017) argue that "hopefulness in the face of climate change is vital for moving people beyond despair and helplessness to mitigate and adapt to climate change" (p.455). Additionally, Anderson (2012) states that given the unpredictability of climate change, adapting to an uncertain future is essential. Therefore, education is a critical component of adaptive capacity.

The students were asked whether they thought Māori environmental knowledge would help their whānau to understand the changing climate. Figure 4.14 indicates that the majority of the students recognise that Māori environmental knowledge and wisdom could help people in their community to understand and adapt to a changing climate.

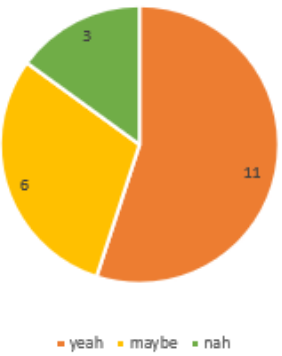

Figure 4.14. "I think Māori environmental knowledge might help people understand the changing climate" (n=20)

In Te Ao Māori, the concept of the mauri (life force), kaitiakitanga (guardianship) and the kaitiaki who protects the precious resources (sky, sea, river and land) are significant to Māori. Most of the students in this school are aware of how important these concepts are to Māori and believe that in this community (including the school) people can help each other build resilience to be able to cope with the impacts of the changing climate. These findings indicate that students think that local environmental knowledge could help Māori to inform and raise awareness so those who are vulnerable could cope with the changing climate, which is in-line with indigenous research.

The Resource Management Act (1991) defines kaitiakitanga as the protector and conserver of the environment by the tangata whenua in accordance with

tīkanga Māori in relation to natural and physical resources (Royal, 2007). Further, King, Goff and Skipper (2007) indicate that a long and close association with the land and its resources and the interaction with local environments over the centuries has enabled Māori to develop a wealth of environmental knowledge. Moreover, King, Skipper and Tawhai (2008) argue that the use of oral histories and environmental indicators to predict changes in the weather and climate has been widely used by generations of Māori across New Zealand, which reflect the world view that all things are connected.

4.2.4 Students' ideas about action-taking

A key principle of climate change education is to empower the students to become agents of change. Figure 4.15 indicates that the majority of the students were interested in finding out more about taking action for climate change.

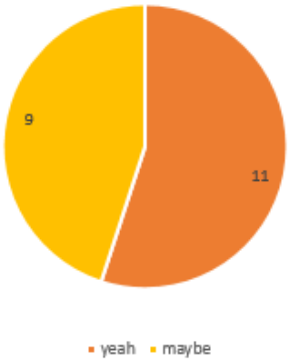

Figure 4.15. "I would like to know more about what I can do to take action for climate change" (n=20)

The students in both the questionnaire and the focus groups felt they wanted to take action for climate change; to alter their behaviour and the behaviour of others. Most felt that they could talk to their families to raise their awareness and inform the community on how they could take action to reduce the impact of a changing climate. For example, one student in the survey group thought that she could make sure that her family reduced the amount of power they used at home, as well as raising awareness at school through the Environmental Committee. Further, Student B in the focus group felt that "if people used their cars less, it would reduce the use of fossil fuels". Another student in the survey noted, "climate change is a major crisis affecting the world, and we need to take action now before it is too late". Moreover, Student E in the focus group added, "as people realise more about it, the bigger the influence will be on all the countries in the world".

The students at this school were concerned with how climate change is going to affect their future, and want to know what they actions they can take to change their behaviour and then raise the awareness of others at home and at school. These findings are in line with scientific research. Sharpe (2019) observed that many students are interested in knowing what action they can take for climate change as the recent climate change strikes across New Zealand by primary, secondary and tertiary students demonstrated. Further, Stevenson et al. (2017) state that it is vital that young people are inspired to take personal actions to mitigate climate change, and this should be encouraged. Additionally, Armstrong et al. (2018a) claim that educators who know their communities well can play a crucial role in distilling scientific information and guiding discussion about the complexities of climate change. They can also lead their students and communities in taking meaningful action to reduce greenhouse gases.

The students were asked to consider whether attending a climate strike would help them to understand the issues about climate change and then talk to their whānau about it. Figure 4.16 indicates that less than half the students felt that going to a climate strike would help them to address the issues around climate change with their whānau.

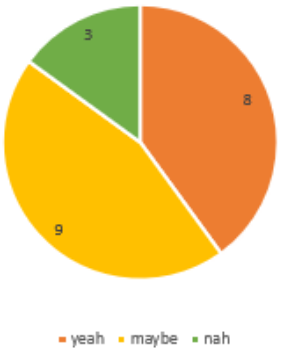

Figure 4.16. “I think going to a climate strike will help young people talk about climate change to the whanau” (n=20)

The survey responses and the focus group discussions indicated that most of the students wanted to raise awareness in their communities, to make sure that their whānau knew how the impact of climate change might affect them. A student in the survey noted that "I could help raise awareness in our school Environmental Committee and take action by researching how solar panels could reduce the energy used in the school and then discuss the idea with the

community". Although most of the students wanted to inform others, they felt that attending a climate change strike was not necessarily the right course of action. As one survey student added, "we see so many people going to strikes for climate change, but it seems like so little is being done to prevent climate change from becoming more of an issue".

These findings indicate that the students want to help their whānau become more mindful of how a changing climate could affect them and understand that the actions they take could reduce the impacts in these uncertain times. The climate strikes are just one way to help people appreciate that climate change will affect everyone in every community across the world. Sharpe (2019) agues there is a sense of urgency with this issue, as the climate strikes have demonstrated. However, for meaningful learning to take place, students need to feel empowered, engaged and informed of the issues. Climate action is one of the United Nations' sustainable development goals (SDG's) for 2030, and our children must know about this (Tulloch, 2019).

The students were asked to consider how and what they were being taught about the impacts of climate change. Figure 4.17 indicates that the students were moderately concerned that their school was not adequately addressing issues around climate change.

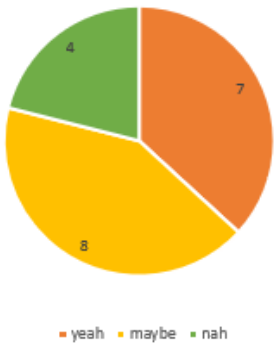

Figure 4.17. "I am worried that my school is not taking climate change seriously" (n=20)

One of the students from the survey group thought that "everyone needs to talk more about the changing climate at school and take action to help reduce climate change". Another noted, "we need to learn more about climate change at school". The students in the focus group debated about how they were learning about reducing rubbish, recycling and pollution in the air as a means of reducing climate change in their Puna Ako (i.e. form room) classes. Students E and F in the focus group added, "just don't drop rubbish and recycle instead

of burning things, as the chemicals in the smoke go into our air and are polluting it" and Student E added, "as people realise more about it the bigger the effect, as countries will just get hotter".

These findings indicate that the students are perplexed about what is causing climate change. However, the majority of students felt that they wanted to know more about how the changing climate will affect them, which is in line with similar studies involving high school students in this age bracket. Tulloch (2019) contends that in order to adequately inform the students about the complexities and impacts of climate change, schools must change the way they think about teaching and learning indicating that “a simple knowledge transfer will be ineffective in driving the kind of learning that is going to make a difference for our planet" (p. 1). Further, Anderson (2012) argues that the evidence shows that educating young people about climate change, is most successful when it focuses on local, tangible actions, especially those that can be addressed by individual behaviour.

Given the complexities of climate change and the crucial knowledge students require to mitigate and adapt to a changing climate, secondary schools must make sure that the students are prepared for future impacts by providing a thorough, yet flexible inquiry/project-based, action-oriented programme that will empower the students to make personal choices and take decisive and informed action (Stevenson et al., 2017).

A key aspect of climate change education is to be well prepared for climate change. Figure 4.18 indicates that the students are keen to know how to be better prepared for the changing climate.

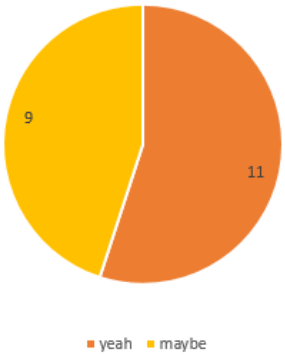

Figure 4.18. “I would like to know how to be more prepared for the changing climate” (n=20)

Most of the students signalled that they wanted to know how to be more prepared for climate change. One of the students from the survey responded, "I am not sure what I should do, but I feel everyone should be aware that climate change is important, and everyone should know more about it". While another stated "spreading awareness at school is a good idea". However, Student D from the focus group responded by saying "we can't stop climate change, but we can be prepared by taking the smallest action", and Student E felt that "even the slightest bit can help a lot, as it gives us more time to realise our mistakes".

These findings indicate that the students want to be more prepared for a changing climate and an uncertain future. However, most of them were unsure of what they could do to achieve this. Eames (2017) states that in order to prepare our citizens for climate change, education must be a priority throughout their lives. Further, research suggests that climate change education empowers and inspires students to build resilience and adaptive capacity and to take informed and intentional actions to become agents of change (Anderson, 2012). Additionally, Stevenson et al. (2017) note that "preparedness for current and potential consequences of climate change is progressively being recognised as essential" (p 69). However, Robottom and Hart (1995) state that while individual actions are a critical part of a holistic response to climate change, educational responses that end with rudimentary or one-off individual actions are not an effective strategy.

4.2.5 Summary of students' perceptions

This research has examined the perceptions of a small group of secondary school students and explored their views into how and why climate change could impact on their future lives. Further, this research considered whether climate change education would be able to prepare these students with the knowledge and skills they needed to build resilience and adaptive capacity for an uncertain future. The majority of students that took part in this study believed that climate was changing and that the temperatures were definitely increasing. They felt that the people in their community would be more affected by climate change, as they were more vulnerable to the effects of a changing climate than people in more affluent communities.

Additionally, the students' believed that humans were making the planet warmer by burning fossil fuels such as coal, oil and gas. Since most of the students had a rudimentary knowledge of global warming, they believed that the rising temperatures could lead to more frequent and intense weather in our region, such as tropical cyclones, heavy rain leading to flooding and widespread droughts. Similarly, they felt that the increase in temperature could adversely affect every ecosystem on Earth. However, the students appeared to be unable to accurately link the increased use and combustion of fossil fuels with the accumulation of atmospheric greenhouse gases that are causing the warming.

The majority of students indicated that they had some knowledge of climate change and the impact it could have on the planet. Most of the students' understood that the increase in temperature could change the intensity and frequency of extreme weather and wildfires. Furthermore, the melting of the polar ice caps and sea ice sheets could affect sea-level rise and that these are all consequences of burning fossil fuels such as oil, coal and gas. However, only a few students understood that it was human activities that were responsible for enhancing the greenhouse effect or that fossil fuels were contributing to the accumulation of greenhouse gases in the atmosphere, which is directly contributing to global warming and the increase in the average surface temperatures.

As many of the students in the school are of Māori descent, the majority indicated that they understand how important the environment is to Māori and recognise the concept of kaitiakitanga. However, only a few of these students knew that Mātauranga Māori is the body of knowledge and wisdom that embodies traditional, contemporary and local environmental knowledge. It was not surprising then that the students in the questionnaire and focus groups indicated they would like to learn more about climate change at school and how Māori scientists are helping to find the solutions to inform and prepare their whānau about the possible impacts of climate change.

Furthermore, the majority of students indicated that they were worried about climate change, and wanted to be prepared for an uncertain future. However, most were unsure about how they would achieve this. A few of the students felt that powerful governments around the world were not doing enough to

tackle climate change, with many of them even denying there is a problem. Additionally, several students felt that there was nothing that could be done to slow down climate change, and felt a sense of hopelessness towards the impending crisis. By and large, the majority of the students agreed that they all needed to be more informed about the impacts of climate change and that every little bit helps to reduce the increasing temperatures.

Encouragingly, most of the students indicated that they wanted to take meaningful action and felt they could do this by firstly changing their behaviour and the behaviour of others. The students in the survey and focus groups felt they could do this by raising awareness and informing their whānau, students and people in their community how they to could take action to reduce the impact of climate change, such as saving power and limiting fossil fuel use. However, there were mixed views on whether or not attending a climate change strike would be a useful experience.

4.3 The teachers' perceptions about climate change and climate change education

In this section, data relating to whether climate change is happening or not and whether humans are contributing to it or not will be explored using the six teachers' views. See Appendix B for the full list of questions asked in the semi-structured interviews. The following subsections illustrate the teachers' perceptions around climate change and climate change education. The teachers' data appears under four main subheadings: Teachers' beliefs of climate change; Teachers' knowledge of climate change; Teachers' attitudes to climate change and Teachers' ideas about action-taking. These categories will examine their beliefs about the changing climate; what they think is causing climate change; their attitudes on how climate change could affect their students' future lives and what actions their students could take to become agents of change.

A changing climate

4.3.1 Teachers' beliefs about climate change

The teachers were asked if they believed the climate was changing, and the majority replied that they thought it was. Steven said, "I absolutely think the climate is changing". Imran noted that "yes there are changes that are happening in the climate that are unusual such as rising temperatures through

the year". In contrast, Manju, Aiden and Jack believed that the "balance on Earth that might have been disrupted, which may be influencing the changing climate". Manju stated that "the signs are apparent all around us that perhaps the climate is changing" and noted that the temperature is hotter now and severe droughts are occurring in New Zealand. Scientific research has indicated that the Earth has been disrupted and is out of balance by the unprecedented use of fossil fuels, the subsequent increase in global carbon emissions and wholesale deforestation (Ogunseemi & Ibimilua, 2016; National Aeronautics and Space Administration, 2017).

These findings indicate that the majority of teachers believe that the climate is changing, and climate change is happening, and they have linked their beliefs with the increase in temperatures, which is consistent with scientific findings. Scientific research has found that since the pre-industrial age, the land surface and air temperature has risen nearly twice as much as the global average temperature (Intergovernmental Panel on Climate Change, 2019). Further, NASA and NOAA indicate that the Earth's average global temperature in 2019 was the second warmest temperature since modern recording began in 1880 (National Aeronautics and Space Administration, 2020b; National Oceanic and Atmospheric Administration, 2020).

4.3.2 Teachers' knowledge about climate change

A key aspect of climate change is that atmospheric greenhouse gases are contributing to global warming. The teachers were asked to consider what they thought might be causing the increase in global temperatures. Steven claimed the human contribution since the industrial age triggered the rise in greenhouse gases in the atmosphere, an increase in global temperatures and a change in the global climate. Imran concurred that "the increase in the combustion of fossil fuels and greenhouse gases are giving rise to an enhanced greenhouse effect". Wratt and Renwick (2007) stated that human activity is contributing to extra atmospheric greenhouse gases that will absorb more of the infrared radiation. As a result, the Earth's surface and the lower atmosphere will warm further until a balance of incoming and outgoing radiation is reached again. This extra warming is known as the enhanced greenhouse effect.

These findings indicated that the majority of teachers understood that the increased warming on Earth is caused by anthropogenic activities and are coherent with current scientific research. The scientific community contends that climate change is real, and the evidence is irrefutable (Meteorological Office UK, 2020), while the speed of warming is accelerating faster now than any other event in the last 2000 years, and this is due to anthropogenic (human-generated) activities (Davies, 2019). Moreover, the 2018 IPCC Special Report states that human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels (Intergovernmental Panel on Climate Change, 2018).

4.3.3 Teachers' attitudes to climate change

The teachers were asked who they thought might be affected most in this region by climate change. Steven claimed that "some people in this region might not be very prepared for the effects of climate change, which could potentially affect them and their whānau. He also felt that "many of our students do not see climate change as a priority because they have more urgent things to deal with". Jackie agreed and noted that everyone would be affected by climate change saying "our kids don't think of a changing climate as being an issue because it is not immediate to them". Environmental health indicators signal that the causes of vulnerability must be balanced against factors that will increase the coping capacity of the people concerned. For example, Māori often have supportive whānau/community networks, and many possess traditional environmental knowledge essential in a changing climate (Massey University and Environmental Health Indicators New Zealand, 2018). Additionally, Jack claimed that "there are always the poor that will suffer and will struggle with a changing climate". Finally, Aiden added that "the people in this region could be affected directly by a changing climate and indirectly in the way they adapt to the issues that arise".

These findings indicate that most of the teachers have a sense of how the changing climate might affect the people, particularly the vulnerable and the youth in this region, which reinforces the need for everybody to be fully aware of the consequences of climate change. Scientific research indicates that in New Zealand, the land environment will sustain the most significant impacts of climate change due to a warming atmosphere, such as extreme flooding and

severe droughts (Ministry for the Environment, 2018). Further, the IPCC argues that many potential risks will be particularly challenging for the vulnerable communities, due to their limited capacity for adapting to change (Intergovernmental Panel on Climate Change, 2014a).

The teachers were asked to consider whether Māori ways of knowing will help people in this region cope with a changing climate. The majority of the teachers indicated that indigenous or ancestral environmental knowledge could provide valuable insight into the changing climate, as this has been passed down through the generations and contains experiences, and value-laden beliefs. Manju added, "ancient people used more sustainable ways of doing things that worked with the environment". Additionally, Aiden noted that "ancestral knowledge could come from any culture as it was how they lived; their home was there, and their knowledge was handed down through the generations". He noted, "we should use the local expertise along with new ideas, new technologies while taking the best ideas to come up with solutions". Indigenous peoples have lived sustainably for millennia in harmony with nature (Etchart, 2017).

Steven claimed that within Te Ao Māori (the Māori world), there is a concept of kaitiakitanga, which is stewardship for the environment and is familiar to most Māori. Consequently, when the debate around climate change is framed in this way, there could be a lot more buy-in from whānau and iwi. But he said. "Yet we have a long way to go in raising awareness and looking for solutions". Further, Jackie felt that the older generations of Māori still valued their traditional ways of knowing, and teenager's find it hard to understand the ancestral concepts of mauri (life force) and kaitiakitanga. Finally, Jack added that "we should not just focus on Māori knowledge alone, but keep an open mind and look at the scientific evidence to teach our students to make informed, logical decisions about the changing climate".

These findings indicated that the majority of teachers considered indigenous environmental knowledge and wisdom an essential part of understanding how and why our climate is changing and that Western science has linked with indigenous ways of knowing so solutions can be found to tackle climate change. King et al. (2007) argued that traditional and contemporary Māori environmental knowledge and wisdom are known as Mātauranga Māori have

long been an integral part of a more extensive holistic understanding of the natural and spiritual world. As a result, it is now helping scientists tackle climate change across New Zealand. In 2019 Lincoln University, Massey University, and Landcare Research all added Mātauranga Māori strands to their work, along with the government's Deep South Challenge, which allocated more Mātauranga funding. As a result, there are currently eight Māori-led projects on the go, and together these represent the largest ever Māori-led research into climate change (Goodall, 2019; Manaaki Whenua Landcare Research, n.d).

4.3.4 Teachers' ideas about action-taking

The two key strategies to address climate change are mitigation and adaptation, which are significant aspects of climate change education. The teachers were asked to consider what action for climate change the students could take, and there were mixed responses. Aiden believed that educating the parents and the community was essential, as well as having an outreach programme that could support teaching and learning about climate change in the community. However, Manju felt that the students must be prepared to take ownership and be ready to learn about what they could do to take action and reduce their carbon footprint, such as saving energy by switching off lights, choosing electricity with renewable resources instead of fossil fuels, planting more trees. She said. "We could also take the students to see the consequences of climate change, for instance, valid examples of sea-level rise". Jackie agreed and added, "the students should take responsibility for their own actions, i.e.dropping rubbish, walk or bike instead of hopping in the car and be the voice of change where they lived by speaking out if somebody was doing something wrong". However, Imran felt that the students could come up with ideas as to how they could reduce the impact of climate change, for example, "burning fewer fossil fuels". Finally, Jack added that for the students to take action, they needed to be shown what action-taking was. He felt that the teachers must take the lead and model taking action in the environment.

These findings indicate that although most of the teachers felt that the students needed to take action, most referred to an *activity* in the environment. Further, they did not mention mitigating or adapting to the impacts of climate change,

which are necessary strategies to enable students to take meaningful action. Mitigation and adaptation are complementary aspects of a coherent climate change strategy that will enable students to think laterally to solve problems, build resilience to take decisive action and adaptive capacity to respond in a crisis (Anderson, 2012; United Nations Educational Scientific Cultural Organisation, 2013). Additionally, Jensen and Schnack (1997) argue that taking well thought through meaningful action can lead to action competence as well as attitude and behaviour change.

Human-generated climate change

4.3.5 Teachers' beliefs about climate change

The majority of teachers believed that human activity is responsible for the rise in temperature across the globe. Steven notes "there is no doubt that human activity has led to a change in the global climate". Imran concurred that "it is the increase in the consumption of fossil fuel that is warming up the planet". Additionally, Manju believed that "human activity in terms of industrialisation, deforestation and the use of fossil fuels is changing the balance" and Aiden claims that " signs of climate change in the Pacific Island countries are evident particularly sea-level rise". An IPCC Special Report suggests that human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels (Intergovernmental Panel on Climate Change, 2018).

These findings indicate that the teachers believe that human-generated activities have caused the increased warming, and most connected the warming to the changing climate and the unprecedented use of fossil fuels, which is concurrent with current scientific research. Conversely, NASA claims that climate-warming trends over the past century are extremely likely due to human activities and most of the leading scientific organisations worldwide have issued public statements endorsing this position (National Aeronautics and Space Administration, 2019).

4.3.6 Teachers' knowledge about climate change

The teachers were asked how possible consequences of climate change might affect the people in this region. Steven argued that vulnerable communities might not know how to mitigate the risk of climate change, which potentially could affect themselves and their whānau. He indicated that "in the past, the

region had been hit by several severe storms, which caused widespread flooding". Climate scientists have predicted that the Waikato region could well be significantly affected by the changing climate well into the 21st century, with their predictions including an increase in temperature, droughts, rainfall, more extreme storms, and sea-level rise. However, this all depends on the future greenhouse gas emissions, which is uncertain (Ministry for the Environment, 2018a). Aiden noted that "we do not know, or most of our kids do not know what climate change is really like, or what the consequences will be until the time comes". Jackie agreed and added, "it's like you see more natural disasters now". "When I was a teenager, it was a big thing, and now it is just a common occurrence".

These findings indicate that the majority of the teachers believe that the vulnerable people in this community might be adversely affected by the changing climate and may need to be more prepared for possible risks associated with a changing climate, and are in line with health research carried out in New Zealand. Fitzharris (2017) argues that vulnerability to climate change is susceptible to an increase in the frequency and magnitude of extreme events, which lead to an increase in natural hazards.

Furthermore, environmental indicators suggest that people are considered vulnerable when they are at risk of exposure or have insufficient resources to cope with environmental hazards such as floods, droughts, wildfires, rises in sea level, pollution and infectious diseases (Gibbons, 2020; Massey University and Environmental Health Indicators New Zealand. 2018; Sharma, 2017). Additionally, the IPCC argues that communities that can adapt to the rise in temperatures can allow individuals to adjust to the impacts of climate change, minimise negative consequences and maintain their livelihoods (Intergovernmental Panel on Climate Change, 2018c).

4.3.7 Teachers' attitudes to climate change

A key aspect of climate change education is to empower young people to develop resilience and adaptive capacity and inspire them to become agents of change. The teachers were asked how they could prepare their students for a future with a changing climate. Aiden and Imran believed that the best option is to educate the students so that they are aware of what climate change is and fully understand the concept of how a changing climate might affect them

in the future. Manju and Jackie agreed that we need to educate the students about the science behind global warming and climate change so that they can make a difference in their future. Manju added that "somehow our students think that they don't need to know about climate change as they are not affected by it, but they do need to know everything about climate change, the consequences and how they can contribute and make a difference".

These findings indicate that overall the teachers believe that educating the students about the complex nature and subsequent impacts of a changing climate is essential for an uncertain future, which is concurrent with other current scientific research. Anderson (2012) states that informing young people about the facts around global warming and climate change will empower them to build resilience and take informed intentional action that will lead to a behaviour change. Further, Monroe et at. (2017) argue that the teaching and learning around the changing climate needs to be personally relevant and meaningful and designed to inspire students to join the class and engage their interest so that they come back for more. Additionally, research suggests that encouraging change as well as developing an awareness that can be taken out into the communities to inform others, requires an understanding of the complex concepts of climate change, such as being able to mitigate and adapt to the impacts of a changing climate (United Nations Educational, Scientific and Cultural Organisation, 2010).

4.3.8 Teachers' ideas about action-taking

The teachers were asked if they knew of ways to inform the students about the impacts of climate change. Jackie felt that "the teachers must inform the students about climate change, as our kids can not fix what they do not know about". Aiden thought that inviting Māori and non-Māori experts to talk to the students would be an excellent way to inform our students about the impacts of a changing climate. Manju, on the other hand, thought that informing whānau would have an impact "as this would help to create an awareness in the home as well as in the community". Finally, Jack noted that the subject teachers could build on what the students already know about taking action as well as weave in Māori environmental knowledge, and strategies like critical thinking and problem-solving. He added, as educators, we must make sure we

empower and inspire our future citizens to take action and become agents of change".

These findings indicate that the majority of teachers recognise there is a need for students to be well informed about the impacts of climate change and reveal innovative ways to enhance teaching and learning, as is conveyed in the research. Anderson (2010) states that children are powerful agents of change, and schools can empower the students by establishing links with climate research and scientific institutions to gain knowledge and expertise.

A critical aspect of climate change education is to enable learners to develop the knowledge, skills, and awareness to reduce their impact as well as helping others to cope with a changing climate. The teachers were asked how the leaders could assist them in preparing their students for climate change. The majority of teachers felt that educating the students was vital in making them aware of the climate crisis. Manju felt that "education is about making students responsible citizens when they leave school". Jackie agreed with this, but also thought that the leaders needed to make sure that the teacher's knowledge about climate change was sufficient to be able to inform and inspire the students. She added, "they can do this by providing informative, inspiring professional development and then take this knowledge into the community to educate the whānau of possible risks and impacts of the changing climate".

Manju agreed with Jackie that "opportunities to upskill the teachers about the science and chemistry of climate change through professional development is essential if we are all on the same page". Imran added the leaders need to make sure that the teachers teach about climate change while emphasising the impact a changing climate can bring. To support these ideas, Aiden highlighted the need for the leaders to bring in experts from the university to help teachers understand the science behind climate change and provide opportunities to see the impacts of global warming first-hand.

These findings indicate that the teachers believe that the leaders have a prominent role in assisting them in preparing the students for climate change and were actively supporting them to support the students, which is concurrent with similar research. Research has shown that children and young people are powerful agents of change and providing them with empowering and relevant education on climate change in a nurturing school environment can reduce

their own and their community's vulnerability (Anderson, 2010). Additionally, Dawson (2012) argued that if students are to develop a sophisticated understanding of the issues around climate change, then the leaders and science teachers need to be well-informed about the science behind climate change.

4.3.9 Summary of the teachers' perceptions

This study explored the perceptions of six teachers in varying disciplines about what they knew about climate change. Moreover, their beliefs, knowledge, attitudes and ideas about action-taking were interpreted as well as their understanding and experiences about how climate change education could enable young people to be thoroughly prepared for a changing climate and an uncertain future. The majority of teachers in this study believed that the climate was changing, climate change is definitely happening, and the global temperatures are rising due to human-generated activities.

Although most of the teachers felt that the rise in temperature was the result of burning fossil fuels (coal, oil and gas), several teachers thought that the Earth's climate equilibrium had been disrupted and was no longer in balance. Nevertheless, most believed that the signs of a changing climate were apparent and that the temperature rise was adversely affecting the seasonal climate and weather patterns around the world. It was also apparent that the majority of the teachers felt that the unprecedented increase in the combustion of fossil fuels was the cause of the increase in temperatures, and this was having an impact on global weather patterns.

Furthermore, it was suggested that the accumulation of atmospheric greenhouse gases had given rise to an enhanced greenhouse effect and that industrialisation and deforestation had changed the Earth's climate balance. The teachers also thought it was highly probable that the region could be affected by extreme flooding and severe droughts, which had affected the region in the past and considered whether the community could or would adapt. For the most part, the teachers believed that vulnerable people in this region could be affected by the impacts of climate change and might find it challenging to adapt to the changing climate. However, they argued that many of the young people might be more vulnerable as they do not see climate

change as an issue as they have more urgent things going on in their lives that take priority.

On the whole, the teachers agreed that Mātauranga Māori (knowledge and wisdom) offers Māori insight into how their ancestors tackled a changing climate, and coupled with their contemporary knowledge and Western science, presents possible strategies to mitigate and adapt to the impacts of climate change. Additionally, most of the teachers felt that education would empower and inspire our students to make decisive and informed decisions and would enable them to build resilience and adaptive capacity to be able to assist others in this climate crisis.

Furthermore, the majority of the teachers believed that the students needed to take action for climate change and make behavioural changes in their lives so that they could help others. However, in order to become agents of change, the teachers realised the students needed to be well informed about the impacts and risks of the changing climate, particularly around reducing carbon emissions and the build-up of atmospheric greenhouse gases. Furthermore, several teachers felt that the students should take responsibility for the choices they make to reduce their carbon footprint. For instance, save power at home and at school, reduce the level of pollution by recycling, reusing and reducing their consumption and the use of fossil fuels where possible.

Finally, most felt that all teachers and leaders should lead by example and take action to change their behaviour so the students might be inspired to do the same. Additionally, the teachers agreed that inviting Māori and non-Māori experts such as climate scientists and environmental activists into the school, could inspire and empower the students to take action and become change agents in their homes and community.

4.4 The leaders' perceptions about climate change and climate change education

In this section, data relating to whether climate change is happening or not and whether humans are contributing to it or not will be explored using the three leaders' views. See Appendix C for the full list of questions asked in the semi-structured interviews. The following subsections illustrate the school leaders' perceptions around climate change and climate change education. The leaders' data appears under four main subheadings: Leaders' beliefs of

climate change; Leaders' knowledge of climate change; Leaders attitudes to climate change and Leaders' ideas about action-taking. These categories examine their beliefs about the changing climate; what they think is causing climate change; their attitudes on how climate change could affect the learners' future lives and how they could support the teachers, and what actions the students could take for climate change to become agents of change.

Is climate change happening?

4.4.1 Leaders' beliefs about climate change

The leaders were asked if they believed the climate was changing, and they all responded that they thought it was. Tash noted that "the temperatures feel hotter now in December and January than they did a few years ago and it does not appear to start cooling down until the end of March". Tania also felt that "the temperatures were undoubtedly getting hotter", and believed that severe droughts might become more prevalent in the future.

These findings indicate that the leaders believe that the climate is changing, the temperatures are rising, and climate change is happening, which is in line with current scientific findings. Moreover, the literature indicates that as the temperature rises the less precipitation or evaporation, there is likely to be (Hendy et al., 2018). Furthermore, climate research shows that since the beginning of the 20th century, New Zealand's average temperatures have risen by 1ºC (Ministry for the Environment and Statistics New Zealand, 2017). During the Paris Agreement in 2015, countries across the world agreed to pursue efforts to limit the temperature increase to 1.5ºC above pre-industrial levels recognising that this could significantly reduce the risks and impacts of climate change (United Nations Framework Convention on Climate Change, 2015).

4.4.2 Leaders' knowledge about climate change

The effects of climate change can be seen in the oceans, on the land and in the air. The leaders were asked what they perceived the consequences of increased global temperatures to be, and they gave mixed views. Katie noted that "we are seeing the emergence of the first climate change refugees, the Pacific Islanders are losing their land right in front of them, and the recent wildfires in Australia are a result of a changing climate". Further, Lonesco (2019) claims the United Nation's recent ruling acknowledges a legal basis for

migrant protection for those whose lives are imminently threatened by climate change. Tash also felt that "the 40 plus degree temperatures in Australia is a sign the temperatures are rising".

Similarly, Tania noted that "the rise in temperatures in New Zealand's mountains is melting the glaciers in the South Island". Scientists reported that the Fox and Franz Josef, and Tasman Glacier at Aoraki/Mt Cook, are now all retreating fast (Meduna, 2019). Similarly, climate scientists suggest that the wildfires heat the environment dramatically and significantly unsettle the environmental thermodynamics generating lightning, large hailstones and tornadoes (Zhang et al., 2019; Gibbons, 2020). Additionally, she noted that "the rates of melanoma and skin cancer are on the rise, which can be a cause of increased melanoma and is directly linked to global warming". Research has found that confusion exists when teachers and students link the greenhouse effect and global warming to the depletion of the ozone layer (Dawson, 2012).

These findings indicate that the leaders understand global temperatures are rising and the climate is changing as a result. However, they were less clear about why the climate was changing and did not adequately link global warming with climate change, which is in-line with scientific research.

4.4.3 Leaders' attitude to climate change

The leaders were asked who they thought might be affected most in this region. Katie suggested that it may be "primarily our youth and those who are challenged socioeconomically could be affected by the changing climate". Research claims that climate change in the Waikato region may potentially affect vulnerable people, such as poor communities, rural Māori, the young and the elderly (Massey University and Environmental Health Indicators New Zealand, 2018). Tania agreed and added that possible job loses due to the changing land use and changes in non-renewable resources might make it harder for some people to cope financially, as well as the added pressure of a changing climate. Tash considered that the dairy farming industry might be affected by the changing climate that could also result in job losses.

The Waikato region has a large number of dairy farms, so the dairy farmers could well be affected by the impact if localised flooding and droughts affect the region, which has been predicted to occur in the foreseeable future (Wang

et al., 2015). Likewise, Tash felt that the people that use the Waikato River for recreation and as a food source could potentially be affected by the rise in temperatures as the warmer water could encourage unwanted flora and fauna. Pollution degrades the health, mauri, and wairua (spirit) of the waterways and can make our water unsafe for drinking, recreation, food gathering, and cultural activities (Ministry for the Environment, 2020).

These findings indicate that the leaders agreed that there could be people and industry that might be affected by a changing climate. However, the leaders each had a different perspective on whom and what they thought would be most affected in this region by climate change, which research indicates originates from an individual's beliefs, attitudes and experiences. Research suggests that farming, and in recent times, dairy farming, has been the most significant human influence on the land in New Zealand (Haggerty & Campbell, 2008). Further, Hendly et al. (2018) claim that the changing climate and in particular the risk of widespread droughts could have an impact on our primary production (agriculture, horticulture, forestry and freshwater fisheries). Additionally, human activities along the Waikato River and land use through the catchment have degraded the river and reduced the relationships and aspirations of communities with the Waikato River (Waikato River Authority, 2019).

The leaders were asked to consider if Māori ways of knowing could help the people in the region deal with the impacts of the changing climate. Katie's response was "that as long as everyone around the table is genuinely listening, we can learn a lot from an indigenous perspective in Aotearoa New Zealand". She explained that indigenous Māori have an intricate holistic world view, that connects their being with the natural world and its resources, as well as having extensive environmental knowledge. Further, Katie felt that being able to collaborate, critique and create new ways of learning from the past makes it possible to come up with new solutions. She said. "So yes, an indigenous perspective can absolutely help us understand and be more prepared for a changing climate".

Tash believed that Māori could bring their local knowledge and holistic ways of doing things such as sustainable ways of looking after the river that they used back in time that could be adapted and used today. She said. "I think we

should never underestimate the value of local knowledge as Māori can provide alternatives and possible solutions, and if there is a relationship, Māori will share their knowledge". Additionally, Tania signalled that there is a need for a balanced approach to finding solutions that suit different ethnicities and an understanding of Mātauranga Māori' This could help to ensure that there is more buy-in by Māori to the ways of the ancestral knowledge as opposed to Pākehā ways of coping with the changing climate in the region. Tania added. "Working respectfully with Tangata Whenua to educate Māori might help them adapt to the changing climate". Mātauranga Māori is knowledge and wisdom of the climate and the environment, which came via the Polynesian ancestors and has been passed down from generation to generation. It also encompasses the relationship of Tangata Whenua with a kaitiaki that watches over and protects the three essential systems; the atmosphere, the ocean, the land and its taonga (Tunks, 1997; The University of Waikato, 2017a).

These findings indicate that forming partnerships with Māori and incorporating ways of knowing of traditional and contemporary indigenous and Western environmental knowledge along with evidence-based research into the lessons, could enable the teaching and learning to provide relevant contexts that the students can associate with. King et al. (2008) claim that through the interaction with the local environments over the centuries Māori have developed an abundance of environmental knowledge, with the lesson learnt having been integrated into traditional and contemporary practices of agriculture, fishing, medicine, education and conservation.

Further, research has found that Māori could be adversely affected by the risks and impacts associated with a changing climate (Massey University and Environmental Health Indicators New Zealand, 2018). Additionally, Dr Huhana Smith stated that Māori and indigenous-led climate change research is not being communicated in a way that relates to Māori communities who are most at risk and makes them more vulnerable to its impacts (Goodall, 2019). Therefore, sharing traditional and contemporary environmental knowledge based on Mātauranga and Western science can build a body of knowledge that may benefit Māori communities who are most at risk from climate change.

4.4.4 Leaders' ideas about action-taking

A key aspect of climate change education is to take informed and intentional

action to make behavioural change. The leaders were asked to consider what action for climate change the students could take. Katie responded by saying that "sometimes people feel overwhelmed by the scale of the impacts of climate change, and teachers need to be aware that some young people can become quite depressed at the prospect of an uncertain future". Research suggests that the impacts of climate change are global in scope and unprecedented in scale (United Nations, 2019a).

To overcome these feelings, Katie felt that young people could be "encouraged to start with their own self first", i.e. they could reduce their meat or dairy consumption; repurpose or reuse rather than buy new, which could make a bit of a difference and then their family might do the same. She added. "So I think the students need to join together to talk about the things they can do". Further, Katie felt that this was a harder question, but very important to be looking at, as people need to feel empowered to make a tangible difference, sooner rather than later.

Tash also found this question quite hard to answer as she felt that for the students to make changes to their lifestyle, they mostly need the backing of their whānau. However, there are things they can all do such as minimise waste; reduce or buy the plastics we can reuse and then recycle them, purchase a stainless steel water bottle so it can be filled up many times, and even reduce the energy in their homes. Tania felt that increasing their awareness and reducing their carbon footprint were two parts to an action. However, she said. "I don't know if going off to the protests is the best option for us, but there could be more local community appropriate events organised by passionate students who want to share their knowledge".

These findings indicate that the school leaders believed that taking informed action for climate change can empower young people to make behavioural changes in their lives and in the lives of their whānau and community, which is in-line with reported literature. Schep (2016) argues that education is of vital importance for imparting an understanding of climate change and its effects, empowering communities to mobilise positive change and including people in decisions and issues that directly affect them. Furthermore, active learning should be connected with local problem-solving to generate successful learning outcomes and connecting local issues with individual behaviour that

makes abstract concepts real (Anderson, 2010). Additionally, Anderson (2012) claims that taking action can promote a sense of self-efficacy and empowerment as it encourages individual actions towards climate change and promotes behaviour change.

Human-generated climate change

4.4.5 Leaders' beliefs about climate change

The leaders were asked who they thought was responsible for the rise in temperatures, and they all felt that human activity was to blame. Katie felt that "since climate change is a human creation, we need to acknowledge it, and then we can do something about it". Scientific research indicates that human activities have increased greenhouse gas concentrations in the atmosphere above pre-industrial levels (Intergovernmental Panel on Climate Change, 2019). Tash notes that "humans have a significant role to play in the way we live our lives and the way we use our physical world, as this can have an impact on climate change".

These findings indicate that the leaders understand that there are consequences of an increase in temperature and are aware that people's attitude and behaviour needs to change, which is in accord with current scientific research. The IPCC confirms that humans are having a dramatic influence on the climate system and indicates that significant behaviour change is needed to prevent irreversible, long-term damage from climate change (Intergovernmental Panel on Climate Change, 2014).

Furthermore, climate scientists agree that the change in the climate across New Zealand is due to an increase in global temperatures. However, the impacts of this warming can be observed in the oceans and the cryosphere, particularly Antarctica and Greenland; changes in land-use (converting forested land to pasture or urban development), and continuing anthropogenic greenhouse gas emissions in the atmosphere (Ministry for the Environment and Statistics New Zealand, 2017; National Institute of Water and Atmospheric Research, 2016b).

4.4.6 Leaders' knowledge about climate change

The leaders were asked to consider what the consequences of an increased global temperature that could affect this region might be. Katie believed that "this region might be like other regions in New Zealand in terms of those who

are socioeconomically challenged and could be affected by climate change". However, Tash thought that "drought conditions in the region could have an impact on the dairy industry and the farmers' wellbeing". Tash also believed that the warmer temperatures could affect the fish and the eels in the Waikato River. Tania, on the other hand, thought that the change in land use, the drastic reduction in the mining of coal and the associated job losses, could see people move out of the region.

These findings indicate that the leaders believed climate change could have an impact on the region, and the examples they have provided are consistent with research conducted across the world. The OCED reported that meteorological droughts could become more frequent; however, socioeconomic and environmental droughts could affect the populace, the economy and the environment in New Zealand (The Organization for Economic Cooperation and Development, 2016). Additionally, scientific research indicates that as the air temperatures rise, so too will the water temperature and the changing climate will begin to affect the ecology and ecosystems of our freshwater systems. From an ecological view, these changes could affect the habitat, species ranges, food and nutrients and disturbance regimes (Collins, 2013).

4.4.7 Leaders' attitude to climate change

The leaders were asked what they could do to prepare the students for a future with a changing climate. Katie noted that "firstly it is knowledge". The students must be taught the scientific facts about climate change and how a changing climate could affect their lives, as well as the environmental knowledge many indigenous peoples possess. She continued that "the second is empathy" or what the students can do to make the world a better place and be prepared to listen to others who are experiencing the impacts of climate change right now. Katie further noted that "thirdly, teaching the students to use collaboration to come up with better solutions by critically thinking together". Tash believed that "it is essential to educate the students about climate change and provide them with evidence-based research to inform and empower them". She continued "we all need to explain why these changes are happening, so the learners can make informed decisions about changing their behaviour. Armstrong et al. (2018a) claim that teachers can choose precise, well-crafted language that

frames the message they are trying to convey and to evoke salient ideas around the issues of climate change. Furthermore, Tash also felt that there was a definitive need for climate change education to be in the curriculum, this way our learners will possess the knowledge and skills they will need to make a difference in their young lives, as they become adults and parents and for the future. She added. "I think we need to be teaching the students about their carbon footprint, what they can do every day and encourage them to be advocates in their own homes, as well as becoming leaders of knowledge."

These findings indicate that although the leaders were aware of their role in making sure the students were prepared for an uncertain future, the key strategies of mitigating and adapting to the impacts and risks of climate change were not explicitly mentioned. Additionally, the leaders acknowledged that given the uncertainty of the changing climate, education could provide the necessary skills to facilitate critical thinking, open-mindedness and problem-solving across all subjects, which is essential in developing and sustaining adaptive capacity (Anderson, 2010). Research suggests that it is vital that the teaching and learning about climate change should focus on mitigation and adaptive capacity so that the students can individually and collectively make choices about the actions they want to be involved in to make a change (Stevenson et al., 2017).

4.4.8 Leaders' ideas about action-taking

The leaders were asked what they thought the best way to inform the students about climate change might be. Katie felt that teaching the students the facts about climate change in isolation was not enough. The leaders needed to reflect on how the climate crisis comes across to the students and be prepared for the "oh my gosh, now that we know this, what do we do with it situation", as this can lead to feelings of hopelessness. Katie also believed that attending the school strike "would be useful for our students as they have the right to make their voices heard". Thus, the vast turnout of students in the 2019 school strikes is seen as evidence that the students want their voices to be heard (Sharpe, 2019).

Moreover, Tash believed that "the deliberate act of teaching in Puna Ako was a way to inform and empower the students". She felt that strategies such as unpacking the climate crisis, saving power and using less energy; minimising

the harmful effects of pollution, and addressing the lack of recycling in the school, could lead to a change in the students' behaviour. Tash also thought that inviting Māori and non-Māori experts in to talk to the students would be worthwhile, and added, "I do not feel confident teaching about climate science and do not want to misinform the students". Tania, on the other hand, noted that "the teachers could encourage the students to be curious about what is happening around them and then inspire them by weaving interesting, relevant information through the Puna Ako lessons about the changing climate and the impacts of climate change, as this would deepen their knowledge and understanding of the issues".

These findings indicate that the leaders acknowledge that the students need to know about climate change and the possible effects and impacts in their uncertain future lives. However, there were differing views on what was the best approach to prepare the students for a changing climate. Anderson (2010) argues that a critical component of climate change education is to develop critical thinking skills that equip learners with the skills, knowledge and attitude to deal with future uncertainties and challenges. Further, Stevenson et al. (2017) argue that an awareness of current and potential consequences of climate change is gradually being recognised as essential in the formal secondary school setting.

The leaders were asked how they could support the teachers to inform their knowledge about climate change. Katie indicated that as 2019 was the first year of our school's journey of discovery with a new approach to teaching and learning, the senior management team supported the teachers by providing them with all the resources they would need for Global Learning in their Puna Ako classes. The teachers were also given extra support for the topics around global warming, climate change and sustainable development, and they all attended weekly Wednesday learning sessions to share their knowledge, expertise and thoughts. However, Katie added. "This type of learning was new to us too, and we were also trying to find our way".

Tash thought that firstly, bringing in experts/guest speakers to support the staff to inform their knowledge around what is happening with global warming and climate change would encourage buy-in. Secondly, the staff could work on a shared understanding of what is climate change and then they could move

forward as advocates for change. So she said. "I think that this would be the first step; the second step would be learning more, resourcing more and finding ways we can deliver this topic and integrate it into every topic". Finally, Tash felt that the teachers could become experts and help to inform other teachers or lead PLD to support teachers knowledge and understanding around climate change. Tulloch (2019) states that when learners learn in an environment that fosters integrated and holistic ways of thinking they are encouraged to think critically, creatively and holistically, with a focus on unity rather than separateness.

Furthermore, Tania believed that the leaders needed to make sure the non-specialist teachers are aware of the basics, getting them curious and then extending themselves. She said. "Our goal is to allow our teachers to spark an interest and branch off into something they are interested in learning". To achieve their goal, the leaders encouraged the teachers to work together and work with the middle leadership groups so that they could develop critical thinking and problem-solving skills required to teach climate change education, as well as working with experts within the staff or bringing in experts to provide support when required.

These findings indicate that the leaders realised that some of the teachers might find teaching about climate change a challenge as they may not have the required knowledge or skills. Therefore, by providing opportunities for the staff to enhance their content knowledge, as well as teaching about global warming and the issues associated with climate change could increase their confidence and improve their teaching. Oversby (2014) argued that many teachers are unprepared for the integration of action-orientated focus and scientific content knowledge that embodies climate change education, while others fully embrace the challenge. Additionally, Anderson (2010) claims that enhancing teachers' knowledge and capabilities to strengthen learners' capacity for critical thinking is essential.

The leaders were asked to consider how they could support the teachers to inform the students about climate change. Katie explained that the essence of Puna Ako is that senior leaders and middle leaders support teachers in the planning and gathering of resources to inform the students through Global Learning. However, in practice, the leaders were providing the resources and

were making most of the decisions about what content they should cover. At the end of the trial period, the Global Learning lessons were appraised, and the leaders reflected on the dissemination of the resources and the school's achievement. Katie said. “This year is about building on what happened last year”. She added. “The teachers have more agency into how and what they teach around climate change and sustainable development and feel they can have more buy-in into what and how these lessons are taught”. Katie noted that two inspirational Māori speakers had been asked to speak to the students and teachers about local issues during the Puna Ako; one was an expert in Mātauranga Māori and indigenous ways of working in forestry, and the other a Doctor of Science and Climate Change. Educators can support their learners (teachers and students) by incorporating Mātauranga Māori worldviews through their lessons as well as demonstrating how Western science can benefit from indigenous knowledge of the natural world (Goodall, 2019).

Similarly, Tash felt that the leaders could support the teachers by giving them time to plan meaningful lessons, help them to organise resources as well as bringing in experts to support the teacher's knowledge of the complexities around climate change education. Miler et al. (2012) claim that "teachers find the topic [climate change] important, complicated and the lesson preparation time-consuming and that teaching climate change topics requires "climate literate teachers" (p. 1439). Tania agreed and added that most of the teachers needed to expand their capabilities, which could come from sharing their knowledge with the staff as well as delivering valuable professional learning and development on a Wednesday morning. She said. “This could give everyone the confidence to be able to teach about climate change through Global Learning.

These findings indicated that the leaders believe they are providing teachers with the support and encouragement to teach about climate change by providing resources, expert knowledge and professional development to help them with the scientific concepts, which is supported in the literature. Research emphasises that there is a need for climate and scientific literacy to be achieved through long-term interactive learning rather than short defragmented sessions such as one-off workshops or in-school professional development (Reis & Ballinger, 2018). Similarly, Miler et al. (2012) argue that

educators who are teaching climate change need to be climate literate or this process could be counterproductive for the learner.

4.4.9 Summary of the leaders' perceptions

This study explored the perceptions of three experienced school leaders in varying disciplines about what they knew about climate change and climate change education, and how they could support heads of departments and teachers to inform and empower young people about climate change, to be thoroughly prepared for a changing climate and an uncertain future.

The leaders all agreed that the climate is changing, and climate change is happening. They believed the temperatures are increasing and the summers are getting hotter and longer, which could lead to more droughts in the future. Moreover, they concurred that human activity is responsible for the increase in global temperatures, and the human influence on the climate system requires a significant shift in behaviour to prevent irreversible, long term damage from climate change. Furthermore, the leaders indicated that the increase in global temperatures is causing unprecedented events across the world. For example, climate refugees are beginning to emerge; the Small Island States in the Pacific are being affected by sea-level rise; severe lightning storms, large hailstones and tornadoes develop from the intense heat of the wildfires in Australia and California and glaciers are melting in New Zealand.

The leaders recognised that increasing temperatures are a sign of global warming and the consequence of climate change. They considered how the effects of climate change might impact the region and believed the vulnerable people, including the socioeconomically challenged, the elderly and the rural Māori could be affected the most by the impacts of a changing climate. Additionally, the leaders asserted that everyone could learn from an indigenous perspective and the lessons of the past. However, they cautioned that it must be a balanced approach that suits all ethnicities within the community.

The leaders emphasised the importance of informing our learners about what climate change is and how it has impacted on Earth, as well as making sure they are prepared for and can cope with an uncertain future. Similarly, they agreed that the students must be empowered to become agents of change and to make their voices heard so that everyone in the community will

understand how they could be affected by a changing climate. Further, they recognised that taking intentional action is vital in changing people's attitudes and behaviour; however, they felt that students sometimes felt overwhelmed at the prospect of doing something to help mitigate the effects of climate change. One of the leaders thought that the students could start with their "own-self first", by making changes in their behaviour and helping their whānau to do the same. Hence, the leaders agreed that the students needed to be informed about taking intentional action for climate change, so they felt empowered enough to want to become agents of change in their homes and community and make informed decisions in their future lives.

Similarly, the leaders acknowledged that the teachers required expert support and specific professional development in order to teach the students about climate change. Research indicates that teachers often feel overwhelmed at the prospect of teaching an interdisciplinary subject that is highly complex and action orientated. Furthermore, the leaders felt that making sure all the teachers are adequately informed about climate change is essential if they are to inform and inspire the students and empower them to take action. Therefore, inviting experts into the school to inspire the teachers during the Wednesday morning learning sessions as well as providing beneficial professional development would enrich their understanding and delivery of the topic.

4.5. Summary of the chapter

The findings presented in this chapter are based on the data obtained from the study, research question and focus groups. For the most part, the questionnaires survey and the open-ended question indicate that the majority of the students have a reasonable understanding of the changing climate and the impacts associated with climate change. Most realised that the climate was changing, that climate change was happening and it was human activities that were making the planet warmer, particularly the unprecedented combustion of fossil fuels. However, the science behind the increase in global temperatures, such as the acceleration of atmospheric greenhouse gases and the increase of carbon dioxide was not as well known. Interestingly, the data indicated that the majority of the students felt that they would like to learn more about climate change at school and would like to take action to slow down the effects of climate change, which is highlighted in the literature.

The semi-structured interviews indicated that the teachers' and leaders' perception of climate change was sufficient, in terms of their knowledge of the changing climate and the climatic impacts, such as sea-level rise, ocean warming, the melting of glaciers, and snow and ice at the poles, the extreme storms and wildfires, floods and droughts and deforestation across the globe. However, most only have a rudimentary knowledge of the science behind these unprecedented, often irreversible events, the increase in the global temperatures, the complex atmospheric and climatic systems and strategies of mitigation and adaptation for global change. Research indicated that teachers often feel unprepared for teaching about climate change, due to the nature of the complex content, and some are uncertain about their feelings towards the phenomena.

The data also indicated interesting responses as to how the teachers could support the students, and the leaders could support the teachers to inform and inspire the teaching and learning around climate change. Essentially, both groups felt that regular PLD was needed, the leaders believed that the experts on the staff could help those who needed extra support and everyone agreed that they would all benefit from experts coming into the school to talk to them about their field of expertise and to inspire the students to take action.

Chapter 5

Discussion, Conclusion and Recommendations

5.1. Chapter overview

In this chapter, the findings of the research are discussed. The discussion focusses on the research question, the themes that emerged from the data analysis and the link to the reviewed literature. The discussion is presented into two sections: the perceptions of secondary school students aged between 14 to 18 years old; the perceptions of middle leaders and classroom teachers coupled with the perceptions of leaders about climate change and climate change education. Finally, the conclusion, implications and limitations of the study are outlined, as well as recommendations for consideration.

This explorative study sought to examine the students', teachers' and leaders' beliefs, knowledge, attitudes and actions towards climate change and climate change education, to see how this was supported in the literature and to inform my teaching practice in this field.

- What are the perceptions of students, teachers, and leaders in a secondary school in Aotearoa New Zealand about climate change and climate change education?

Discussion of this research question includes comparisons to previous research, conclusions and implications of this research, and recommendations for further research.

5.2. Discussion of the findings

Within the findings chapter, the students', teachers' and leaders' perceptions were divided into two sections: *whether climate change is happening or not;* and *whether humans are contributing to it or not* and these sections were each divided into four sub-categories: *beliefs, knowledge, attitudes and action-taking.* I chose these categories as the key ideas that underpin climate change education are beliefs, knowledge, attitudes and action-taking associated with climate change, as discussed in Chapter 2. Further, the motivation to undertake this study was to examine what the students knew and/or believed they knew as an individual response (questionnaire) and collective responses (focus groups) about the phenomena of climate change

and whether the students wanted to learn more about how the changing climate could impact on their future lives.

The perceptions from the teachers and leaders perspectives were derived from individual semi-structured interviews which examined their understanding and experience of climate change, their views on climate change education and how they could prepare the students for an uncertain future. The theoretical framework that guided this research is presented in Section 2.6. The main points of the framework looked at the consequences of climate change and the impacts of the changing climate. The framework is divided into the beliefs, knowledge, attitudes and action-taking about climate change and climate change education.

Additionally, prior to the study, the students had had discussions around climate change, the greenhouse effect and global warming in their Puna Ako Global Learning lessons, so they had been exposed to the phenomena.

5.3. Students' perceptions

Students' beliefs about climate change

The findings in Chapter 4 indicate that the majority of students do believe that the climate is changing, with most being able to link this change to a warming planet. The findings clearly show that students at this school have a current understanding of the state of the climate and is in line with what climate scientists believe (Intergovernmental Panel on Climate Change, 2018; Ministry for the Environment and Statistics New Zealand, 2017; National Oceanic and Atmospheric Administration, 2020b).

Similarly, the students were also able to identify key impacts such as the rising temperatures, warming oceans and polar ice melting; however, they were less clear about the science behind why this is happening. This has also been found in a study by Boon (2009), who indicated that the knowledge and understanding of the greenhouse effect and climate change have historically been inadequate to inform people of the facts around this complicated phenomenon.

The findings indicated that the majority of the students felt that humans were responsible for contributing to the rise in global temperatures by burning fossil fuels in our cars, cutting down the trees in the Amazon forests and not using

public transport enough. Moreover, they were able to link these activities to the warming of the atmosphere, which is what scientists believe (Renwick, 2019; Withgott & Laposata, 2015).

Likewise, the students believed that the rising temperatures could lead to more frequent and heavier rain leading to flooding and the potential to create more intense storms, such as tropical cyclones. However, they were less sure about the science behind global warming, the accumulation of greenhouse gases and the greenhouse effect. This is in line with Dawson and Carson's (2013) study, that indicates students of a similar age find the concepts of global warming, the greenhouse effect and the accumulation of atmospheric greenhouse gases confusing and often misunderstand or form alternative conceptions to explain how each will affect the environment.

Interestingly, the students felt that the rising temperatures that were warming up the land, lakes and oceans could not harm the eels (tuna) in the Waikato River. This reasoning by the students appeared to be an alternative conception as the warming water has been suggested to have an impact on the eels in the river (Environmental Aotearoa, 2019; Manaaki Tuna, 2020; Ministry for the Environment and Statistics New Zealand, 2020; World Meteorological Organisation, 2020).

The interpretive approach in this study focused on the students' understanding and experiences of the changing climate. Their responses indicated that they believed Māori communities could very well be affected by the changing climate, particularly those who were rural, or lived close to the coast and might depend on collecting kai moana (seafood). This is in line with research carried out by Māori scientists and health researchers looking at people's vulnerability to climate change effects (Goodall, 2019; Massey University and Environmental Health Indicators, New Zealand, 2018).

Students' knowledge about climate change

The majority of the students in this study indicated that they understood climate change was a major crisis and felt that everybody and every living thing would be affected by the impacts of a changing climate in different ways. In Lee, Gjersoe, O'Neil and Barnett's (2020) narrative synthesis, it was found that young people of a similar age had a comparable understanding of the impacts of climate change, which varied depending on where they lived in the world.

Similarly, the majority of the students indicated that they knew what greenhouse gases were and were able to link them to the combustion of fossil fuels. However, some of the students had alternative conceptions about where greenhouse gases come from and linked them to the pollution from industry. The findings showed that although the students appeared to be knowledgeable about greenhouse gases, they were less clear about their connection to global warming and climate change. Dawson and Carson's (2013) Australian study reported that a student's lack of understanding could lead to alternative conceptions being formed when trying to make sense of the complex concepts of climate change.

In this study, the majority of students were not very sure if cows and sheep were producing greenhouse gases, and most were confused about how they could be partly responsible for warming up the planet. The scientific views on the production of agricultural greenhouse gases differed from the students' perception (Giampiero et al., 2018; Tikkisetty, 2019). However, a key finding was that the majority of students indicated that they wanted to gain more knowledge about climate change, and how the impacts of a changing climate could affect their future. The students felt it was important to know more about climate change and that being informed and raising awareness was necessary to help others understand this crisis. These findings are in line with the literature. Dawson & Carson (2013) note that it is essential for all students to understand the systems and effects of climate change. Similarly, Anderson (2012) indicates that the more awareness the student has of environmental issues, the deeper their understanding and responsibility of the issues will be, which could lead them to take informed and intentional action.

Students' attitudes about climate change

Most of the students who participated in this study were worried about the changing climate, and some felt it was too late to do anything about climate change, while other students just felt hopeless. Similarly, the vast majority of students indicated they were worried about how climate change might affect their future. These findings indicated that some of the students felt uncertain about their future lives; while others felt overwhelmed and hopeless. Further, most felt frustrated at the lack of interest the government was showing. Li and Monroe's (2017) research indicate that students who feel hopeless about their

future often feel overwhelmed by the scale of the crisis. Similarly, Ojala's (2015) study shows that many young people are worried about their futures, while others are cynical and often deny there is a problem.

Likewise, the majority of the students recognised that Māori environmental knowledge and wisdom could help vulnerable people to understand how to cope with the changing climate in their community. This is in line with Māori scientific and indigenous research that indicates Māori have always had a strong connection with the land, sea and air and its resources, and have developed a wealth of environmental knowledge. Furthermore, Māori scientists are working alongside Western scientists to come up with tangible solutions to combat climate change and look after the vulnerable communities across New Zealand (King, Goff & Skipper, 2007; King, Skipper & Tawhai, 2008).

Students' ideas about action-taking

A key finding in this research was that the students indicated that they wanted to learn more about taking action; this meant changing their attitude and behaviour and raising awareness in the community to reduce the effects of climate change. Most students felt that they could reduce energy use at home and school, walk or bike to school or take public transport, in order to burn fewer fossil fuels. Jensen and Schack (1997) have claimed that taking relevant, meaningful action enables the learner the opportunity to change their behaviour and become an agent of change.

Further, being prepared for a world with a changing climate and an uncertain future was of more interest to these students than whether they would attend a climate strike. Their focus was on raising awareness in the school and community, inspiring others to change their behaviour and to take action. The literature highlights the educators' role in making sure learners feel empowered to want to take meaningful local actions to reduce the effects of climate change. Further, given the complexity of climate change, secondary schools need to make sure students have the knowledge and skills needed to be thoroughly prepared for the effects of climate change. In agreement with this, a study by Stevenson et al. (2017) indicated that increasing students' awareness and understanding of climate change means they are more likely to take action and make behavioural changes.

5.4. Teachers' and leaders' perceptions

Teachers' and leaders' beliefs about climate change

The findings in this section indicated that the teachers' and leaders' perceptions are that the climate is changing, and climate change is happening. They all agreed that the summers are getting hotter, and this is having an effect on the global weather patterns, such as more severe droughts, heavy precipitation and extreme storms. The teachers' and leaders' understanding and experiences of the dramatic rise in temperatures and the effect this is having on Earth, is confirmed by climate scientists observing the change in weather patterns across the globe and how these are changing over time (National Oceanic and Atmospheric Administration, 2020).

Teachers' and leaders' knowledge about climate change

The findings indicated that most of the teachers and leaders understood that the rise in global temperatures, the enhanced greenhouse effect and the changes in the climate were due to human activity since the industrial age. Further, they mostly agreed that the acceleration of concentrations of greenhouse gases, mainly, carbon dioxide in the atmosphere and the rise in global temperatures was directly related to the unprecedented use and combustion of fossil fuels. Scientific research indicates that warmer land and ocean temperatures are increasing the intensity and magnitude of storms, melting glaciers and polar land ice more rapidly and the result is a rise in sea levels (Intergovernmental Panel on Climate Change, 2020; National Institute of Water and Atmospheric Research, 2016f).

Teachers and leaders' attitudes to climate change

The teachers and leaders felt that people in poor, rural and isolated communities, youth and those who were financially challenged might not cope with a changing climate. The teachers' believed that vulnerable people in this community might not know how to mitigate the risks or adapt to the changing climate. Further, the leaders' considered that there could be job losses in the region, which could add extra pressure to whānau that were already struggling, or changes in land use as a result of severe droughts and/or floods, which could affect the livelihoods of farming families. Similarly, the warmer temperatures in the lakes and rivers might mean they become degraded and could affect those who depend on the waterways for food (kai). Massey

University and Environmental Health Indicators New Zealand (2018) defined a vulnerable population and identified those who would be more at risk from the impacts of climate change.

Moreover, the findings in this study indicated that the teachers' and leaders' believed that as the community had a high population of Māori, an indigenous perspective and ancestorial knowledge could help people in this region cope with a changing climate. King et al.'s (2008) research reiterated and explained that Mātauranga Māori (knowledge and wisdom) has been passed down through the generations and offers Māori and non-Māori a more extensive holistic understanding of the natural and spiritual world and some of the ways their ancestors tackled a changing climate.

A key aspect of this research was to examine how teachers could prepare young people for a changing climate and an uncertain future. The teachers in this study felt that the students needed to be taught about the science behind global warming and climate change as this was the best way to prepare them and their whānau for the impacts of a changing climate. But at the same time, they realised their own knowledge and understanding of climate change needed to be developed to facilitate this. Similarly, the leaders recognised that the students and teachers needed to be fully informed about the impacts of climate change; be prepared to listen to other people's experiences and to collaborate with other students and teachers to come up with tangible, innovative solutions. Furthermore, they felt the students needed to feel empowered so that they could make informed decisions about behaviour changes. These findings are in line with a study Stevenson et al. (2017) conducted in Australia that highlighted the need for teachers and leaders to prepare students for an uncertain future by encouraging them to think critically and creatively and to take meaningful actions.

Teachers and leaders ideas of action-taking

A key aspect of climate change education is taking informed, intentional action. The teachers in this study felt that action-taking could be things the students could do to reduce the impacts of climate change such as saving energy, planting trees, burning fewer fossil fuels and dropping less rubbish. Moreover, they felt that the teachers and leaders should all lead by example and take actions to change their behaviour, so the students could be inspired to do the

same. The leaders believed that the students needed to feel inspired and empowered to make personal changes in their behaviour. One idea was that the students could be encouraged to start with their own self first, i.e. consider changing to a plant-based diet, repurposing or reusing rather than buying new.

In contrast, another leader thought that increasing the student's awareness and reducing their carbon footprint was something that they could do and perhaps share their knowledge with friends and whānau. A study by Monroe et al. (2017) emphasised that students should be actively engaging with relevant local examples of climate change impacts, so they become acutely aware for the need to take meaningful action which will make a difference in their community.

Finally, the leaders felt that the teachers (and leaders) required expert support and specific professional development to enable them to confidently teach the students about climate change. The leaders agreed that they could support the teachers by giving them time to plan meaningful lessons and organise resources. Further, the leaders thought that they could invite experts into the school to inform and inspire the teachers (and leaders) about climate science and literacy, global warming and climate change. Moreover, the expert teachers could share their knowledge during the designated professional learning and development (PLD) morning or on a teacher-only day several times a term. Additionally, specific PLD could be offered with a more practical theme to enrich everybody's knowledge and understanding of the topic. Drewes et al.'s. (2018) study pointed out that professional development is essential for teachers to improve their knowledge, alter classroom practice and encourage higher student achievement across the school.

5.5 Conclusion, Implications and Recommendations

In this section, the conclusion and implications are drawn from the findings and recommendations are made. The perceptions of the students, teachers and leaders in this study believed that climate change was indeed happening, that human activities were primarily responsible for the temperature rise, and this was due to the increased combustion of fossil fuels. This study also showed that the students wanted to learn more about climate change at school, and the teachers thought that educating them about the science of the changing climate was necessary. Moreover, the leaders wanted to make sure that the

teachers had a thorough understanding of climate change and that they could provide professional development and invite experts into the school to enhance their knowledge. Additionally, this research indicated that the students, teachers and leaders wanted to increase their awareness of the risks and effects that could occur in their community, region and country. Encouragingly, the students wanted to be able to change their attitude and behaviour in reducing carbon emissions and take meaningful actions for climate change. Therefore, professional development should be a priority in schools so that the teachers can develop the students critical and creative thinking, problem-solving skills, resilience and adaptive capacity in becoming agents of change.

The review of the literature highlighted the importance of educating our learners about climate change, which is critical if we are to make sure they have the knowledge and skills needed to adapt to the changing climate. In this study, the students' signalled they wanted to know more about climate change and how the changing climate could affect their future lives. Therefore, climate change education needs to be placed into the school curriculum as an interdisciplinary subject, adopt a relevant, real-world context as this will enable the students' to be able to understand the scientific aspects of climate change and appreciate the way populations and people could be affected by the impacts of a changing climate. Additionally, the teachers wanted to make sure the students were suitably informed, and given accurate information for how and why climate change is happening, as well as what the scientific community are basing their predictions on for the future increase in temperature. In order to achieve this, the teachers must have a sound climate science and atmospheric knowledge and be confident in how this context is presented, as this can make all the difference to the students' outcomes. Hence, the programme must concentrate on local, relevant content; meaningful action-taking; a formal and informal structure based on *ako* (learning and doing), which can involve all our learners.

Finally, the leaders' wanted to make sure that they were able to support the teachers, by providing quality planning and resource collection time, to have high-quality professional development and access to experts in the field to enrich their knowledge of a world with a changing climate. Unfortunately,

climate change education is not formally included in the New Zealand Curriculum.

This research was a small exploratory study in a small secondary school examining the perceptions of a purposive sample of students, teachers and leaders about climate change and climate change education. Although the results of the study provided me with an indication of whether climate change education was something the students wanted to learn about and the teachers wanted to teach a more extensive study across several secondary schools or even in a large city may reveal quite different findings. This study is not a representation of all secondary students, teachers or leaders in New Zealand.

5.6. Recommendations

The Ministry of Education must mandate climate change education into our secondary schools across New Zealand, through an interdisciplinary programme. I believe this should formally begin at Year 7 and 8 with an introduction to the greenhouse effect, the difference between the weather and the climate, the water cycle and how people might be affected by a changing climate. At Year 9, climate and atmospheric science and the enhanced greenhouse effect could be integrated and would link nicely into the *Level 4 Climate Change Learning Programme*, which could start in Year 9 or 10. In the senior school (NCEA Levels 1-3), a socioscientific inquiry approach could explore the interrelationship between the climate and atmospheric science, the carbon cycle and the accumulation of greenhouse gases. Additionally, the human impact and the effect on environmental systems as well as the economic, social and cultural structures could be examined. The fundamental strategies for climate change education are mitigation and adaptation, which enable the learner to think laterally and creatively to solve problems, and which can lead to informed and intentional action-taking. However, in order to develop the necessary knowledge and skills our learners require; enhancing the teachers' knowledge and capabilities as well as strengthening their capacity for critical thinking is essential to build the students' resilience to take decisive action and adaptive capacity to respond to the changing climate.

Nonetheless, teacher education must provide the teachers with a sound understanding of the complex science of climate change and how this action-orientated topic can be integrated across the disciplines at both the junior and

senior levels. I recommend that Faculties of Education across New Zealand include climate change education in the prescribed subjects primary trained pre-service teachers receive as part of their degree structure. Furthermore, pre-service secondary school science and social science student teachers should have a sound level of knowledge about climate change and climate change education. Additionally, in-service education and professional development should be available to all new and existing teachers, heads of departments, and school leaders for the inclusion of climate change education integrated across the school.

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Appendix A

Letters and informed consent forms

Date

The Principal

Dear

I would like to invite your school in a research study. This study will explore students, teachers and leaders' perceptions of climate change and climate change education in a New Zealand secondary school. This research is essential to understand the role that climate change education can play in addressing this issue. This research is an explorative study to examine what school staff know and/or believe they know about climate change and climate change education and their position in schooling. I am also keen to let students have a voice and to express their views about climate change and climate change education.

I am writing to ask for your permission to involve your school in this study. In order for me to collect a range of rich data, I would like to invite 6-7 staff members from your school. This will include yourself, and three Deputy Principals, the Head of Science, the Head of Social Science and the Head of Technology and three teachers. The interviews will take 30 minutes each to complete at a time that is convenient for yourself and the staff and approximately 30 minutes to review the transcript once they are returned.

I would also like to invite approximately 20 students to participate in the study. I would like to include two age groups: 14-15 years and 16-18 years. Once I have gained consent from the parent/guardians of the students under 16 years and the senior students,' I will ask them all to complete an anonymous online questionnaire and possibly take part in a focus group (of up to 30 minutes). With your permission, the invited students could complete the surveys and focus group discussions during several Puna Ako classes.

The data collected during the study may be used in writing this thesis, publications or in presentations. I will not use your name, any other staff member's or student's name (unless you/they expressly permit me to do so), the name of the school or the names of other participants in any publications or presentations. I will make sure that I store all the information I gather from the teacher securely.

The staff can decline to be involved in the research and can withdraw any or all data they have provided me up to two weeks after they receive their transcript from me. If the teacher decides to withdraw from the study, I will destroy any data I have gathered from them.

The students can decline to be involved in the research. However, the data collected from the survey and the focus groups can not be withdrawn once they have submitted their survey, and the discussions have taken place.

I would appreciate your consent for you and the school to be involved as described. If you need any more details about the project, or issues arise for you during the project, please contact me via email: pab7@students.waikato.ac.nz. If I am unable to resolve your concerns, you may contact the project supervisor Associate Professor Chris Eames via email: c.eames@waikato.ac.nz.

Yours sincerely

Patricia Bevins

Research Consent Form – Principal

I have read the attached letter of information.

I understand that:

1. My school and my own participation in this project is voluntary.
2. I have the right to withdraw my school up until the end of the data collection. I have the right to withdraw my own interview data up to two weeks after receiving the transcript of my interview.
3. Informed consent will be gained from all participants before collecting any data from them for this project.
4. Data may be collected from my school and myself in the ways specified in the accompanying letter. This data will be kept confidential and securely stored.
5. Data obtained during the research project will be used for the purpose of writing this thesis, published papers and making presentations. This data will be reported without the use of names of participants (unless you explicitly allow this), or the name of your school.

I can direct any questions to Patricia Bevins via email pab7@students.waikato.ac.nz.

For any unresolved issues, I can contact the Project Supervisor, Associate Professor Chris Eames via email: c.eames@waikato.ac.nz.

I give consent for my school and my participation to be involved in the project under the conditions set out above.

I give my consent for an audio recording of the interview.

Name:_____

Signed:_____

Date:_____

Informed Consent Letter – Staff participant

Date:

Dear

I am writing to invite you to participate in a research study. This study will explore teachers, leaders and students' perceptions of climate change and climate change education in a New Zealand secondary school. This research is essential to understand the role that climate change education can play in addressing this issue. This research is an explorative study to examine what teachers know and/or believe they know about climate change and climate change education and their position in schooling. I am also keen to let students have a voice and to express their views about climate change and climate change education.

I would like to involve you in this study. As a participant, I would ask you for 30 minutes of your time for a face-to-face interview exploring your perceptions of climate change and climate education, at a time that is convenient for you. With your permission, I would like to audio-record the conversation so that I may capture it accurately and then I will send you the transcript of our talk so that you can check if I have represented your views correctly. The transcript will take you approximately 30 minutes to review.

Your interview data collected during the study may be used in writing this thesis, publications or in presentations. I will not use your name (unless you expressly permit me to do so), the name of your school or the names of other participants in any publications or presentations. I will make sure that I store all the information I gather from you securely. You can decline to be involved in the research and can withdraw any or all data you have provided me up until two weeks after you receive your transcript from me. If you decide to withdraw from the study, I will destroy any data I have gathered from you.

I would appreciate your consent to be involved as described. If you need any more details about the project, or issues arise for you during the project, please contact me via email: pab7@students.waikato.ac.nz. If I am unable to resolve your concerns, you may contact the project supervisor Associate Professor Chris Eames via email: c.eames@waikato.ac.nz.

Yours sincerely

Patricia Bevins

Research Consent Form – Staff participant

I have read the attached letter of information.

I understand that:

1. My participation in the project is voluntary.
2. I have the right to withdraw from the focus group at any time up until its completion. However, once the discussions have taken place, your data cannot be withdrawn.
3. This data will be kept confidential and securely stored.
4. Data obtained from me during the research project may be used in the writing of this thesis or published papers and making presentations about the project. This data will be reported without the use of my name unless I expressly permit this.

I give my consent for an audio recording of the interview. I give my consent to the following for the study to proceed. I can direct any questions to Patricia Bevins via email: pab7@students.waikato.ac.nz. For any unresolved issues, I can contact the Project Supervisor Associate Professor Chris Eames via email c.eames@waikato.ac.nz.

I give my consent to be involved in this project under the conditions set out above.

Name:_____ Date _____

Signed: _____

Student participant Letter - Informed Consent

Date:

Dear

I am writing to invite you to participate in a research study. This research is an explorative study to examine what students know and/or believe they know about climate change and climate change education. This research is essential to understand the role that climate change education can play in addressing this issue.

I would like to involve you in this study. As a participant, I would ask you to complete an online questionnaire taking about 15 minutes and participate in a focus group for approximately 20-30 minutes to explore your views of climate change and climate change education. These activities will take place during Puna Ako so it will not disrupt the rest of your day. With your permission, I would like to audio-record the conversation in the focus group so that I may capture it accurately. The data collected during the study may be used in writing this thesis, publications or in presentations. I will not use your name (unless you expressly permit this), the name of your school or the names of other participants in any publications or presentations. I will make sure that I store all the information I gather from you securely. You can decline to be involved in the survey and focus group, but your data cannot be withdrawn once the survey has been submitted, and the focus group discussions have taken place.

I would appreciate your consent to be involved as described. If you need any more details about the project, or issues arise for you during the project, please contact me via email: pab7@students.waikato.ac.nz. If I am unable to resolve your concerns, you may contact the project supervisor Associate Professor Chris Eames via email: c.eames@waikato.ac.nz.

Yours sincerely

Patricia Bevins

Research Consent Form – Student participant

I have read the attached letter of information.

I understand that:

1. My participation in the project is voluntary.
2. I have the right to withdraw from the focus group at any time up until its completion. However, once the discussions have taken place, your data cannot be withdrawn.
3. This data will be kept confidential and securely stored.
4. Data obtained from me during the research project may be used in the writing of this thesis or published papers and making presentations about the project. This data will be reported without the use of my name unless I expressly permit this.

I give my consent for an audio recording of the interview. I give my consent to the following for the study to proceed. I can direct any questions to Patricia Bevins via email: pab7@students.waikato.ac.nz. For any unresolved issues, I can contact the Project Supervisor Associate Professor Chris Eames via email c.eames@waikato.ac.nz.

I give my consent to be involved in this project under the conditions set out above.

Name:_____ Date _____

Signed: _____

Informed Consent Letter – Parent/Guardian – Student participant

Date:

Dear

I am writing to invite your child to participate in a research study. This research is an exploratory study to examine what student's know and/or believe they know about climate change and climate change education. This research is essential to understand the role that climate change education can play in addressing this issue. I would like to involve your child in this study.

As a participant, I would ask them to complete an online survey taking about 15 minutes and participate in a focus group for approximately 30 minutes to explore their views of climate change and climate education. These activities will take place during Puna Ako so will not disrupt the rest of their day. With your permission, I would like to audio-record their conversation in the focus group so that I may capture it accurately. The data collected during the study may be used in writing this thesis, publications or in presentations. I will not use their name (unless they expressly permit this), the name of your school or the names of other participants in any publications or presentations. I will make sure that I store all the information I gather from them securely. Your child can decline to be involved in the survey and focus group at any time, but their data cannot be withdrawn, once the survey has been submitted and the focus group discussions have taken place.

I would appreciate your consent for your child to be involved as described. If you need any more details about the project, or issues arise for you during the project, please contact me via email: pab7@students.waikato.ac.nz. If I am unable to resolve your concerns, you may contact the project supervisor Associate Professor Chris Eames via email: c.eames@waikato.ac.nz.

Yours sincerely

Patricia Bevins

Research Consent Form – Parent/Guardian – Student participant

I have read the attached letter of information.

I understand that:

1. My child's participation in the project is voluntary.
2. My child has the right to withdraw from the focus group until it finishes. However, once the discussions have taken place, their data cannot be withdrawn.
3. This data will be kept confidential and securely stored.
4. Data obtained from me during the research project may be used in the writing of this thesis or published papers and making presentations about the project. This data will be reported without the use of their name unless they expressly permit this.

I give my consent for an audio recording of the interview. I give my consent to the following for the study to proceed. I can direct any questions to Patricia Bevins via email: pab7@students.waikato.ac.nz.

For any unresolved issues, I can contact the Project Supervisor Associate Professor Chris Eames via email: c.eames@waikato.ac.nz

I give my consent for my child to be involved in this project under the conditions set out above.

Name:_____

Signed: _____

Date: _____

I give my consent to be involved in this project under the conditions set out above.

Name:_____

Signed: _____

Appendix B

FEDU Acceptance Letter 2019

Te Kura Toi Tangata
Division of Education
The University of Waikato
Private Bag 3105
Hamilton, New Zealand, 3240

DivED Ethics Committee

fedu.ethics@waikato.ac.nz
07 8384500 ext. 7870
www.waikato.ac.nz/education

6/11/2019

Dear Patricia Anne Bevins

Division of Education Ethics Application Approval FEDU082/19

I am pleased to advise you that your ethics application for the project entitled "The perceptions of secondary school leaders, teachers and students in a low decile secondary school in Aotearoa New Zealand around climate change and climate change education." was approved by Te Kura Toi Tangata Division of Education Ethics Committee on November 6th, 2019.

Please be aware that the Te Kura Toi Tangata Division of Education Ethics Committee must be advised (by memo) of any changes to the details recorded in your ethics application. Please send any such advice to fedu.ethics@waikato.ac.nz. You will receive a memo of approval once the change(s) has been considered.

Kind regards

Co-chair
Te Kura Toi Tangata Division of Education Ethics Committee

Appendix C

Student questionnaire – Goggle Forms

1. I believe the climate is changing.
2. I am really worried about climate change.
3. I think people are making the climate warmer by burning coal, oil and gas.
4. I am confused about what climate change is about.
5. I want to learn more about climate change at school.
6. I am worried that climate change will affect my future.
7. I think people in my community might suffer more from climate change than those in rich communities.
8. I think Māori environmental knowledge might help people understand the changing climate.
9. I think I know what greenhouse gases are.
10. I think greenhouse gases are making the planet warmer.
11. Cows and sheep in New Zealand are producing greenhouse gases that are warming up the planet.
12. A warmer planet could lead to more frequent and heavier rains leading to flooding in the Waikato region.
13. A warmer planet may lead to more frequent intense storms in Huntly.
14. A warmer planet could be good for the tuna (eels) in the Waikato River.
15. I think going to a climate change strike will help young people talk about climate change to the whānau.
16. I am worried that my school is not taking climate change seriously.
17. I would like to know more about what I can do to take action for climate change.
18. I would like to know how to be more prepared for the changing climate.

What do you think you could do about climate change?

_____

Thank you for helping me with my study :)

Semi-structured Interview Questions – Teachers

1. Do you think the climate is changing?
2. Who do you think is responsible for creating this change?
3. What do you think the consequences of increased global temperatures might be?
4. How might the consequences of climate change affect this region, do you think?
5. Who might be affected most in this region, do you think?
6. Could Māori ways of knowing help people in this region deal with climate change, do you think? How?
7. What do you think might prepare the students for a future with a changing climate?
8. What action for climate change do you think our students could take?
9. What do you think might be the best way to inform the students of the impacts of climate change?
10. How do you think the leaders could assist you to prepare your students for climate change?

Semi-structured Interview Questions – Leaders

1. Do you think the climate is changing? Why/why not?
2. Who do you think is responsible for creating this change?
3. What do you think the consequences of increased global temperatures might be?
4. How might the consequences affect this region, do you think?
5. Who might be affected most in this region, do you think?
6. Could Māori ways of knowing help people in this region deal with climate change, do you think? How?
7. What do you think might prepare the students for a future with a changing climate?
8. What action for climate change do you think our students could take?
9. What do you think might be the best way to inform the students of the impacts of climate change?
10. How do you think you could support the teachers to inform their knowledge about climate change?
11. How do you think you could support the teachers to inform the students about climate change?