BEFORE THE SPECIAL TRIBUNAL ACTING UNDER DELEGATED AUTHORITY ON BEHALF OF THE MINISTER FOR THE ENVIRONMENT

Under	the Resource Management Act 1991
In the matter	of an application for a Water Conservation Order pursuant to s201 of the Act
By	**THE NEW ZEALAND & NORTH CANTERBURY FISH & GAME COUNCILS AND THE NEW ZEALAND RECREATIONAL CANOE ASSOCIATION**

STATEMENT OF EVIDENCE OF GARETH RENOWDEN ON BEHALF OF THE HURUNUI WATER PROJECT

26 MARCH 2009

Introduction

1. My full name is Gareth Renowden. I reside at Limestone Hills, 680 Ram Paddock Road, R D 2, Camberley, a small farm of 25 acres, where I grow grapes, truffles and olives. I have lived in North Canterbury for the last 13 years.

2. I am the author of Hot Topic - Global Warming & The Future of New Zealand, published by Auckland University of Technology Media in 2007, and author/publisher of the Hot Topic web site (http://hot-topic.co.nz/), which monitors climate science, politics and policy in New Zealand and internationally. I also write on the issue for other media. I am not a climate scientist, but do work closely with the NZ and international climate science community in researching my coverage of the issue. I have also written books on olive and truffle growing in NZ. I am immediate past president of the NZ Truffle Association and manage the FRST-funded truffle industry R&D programme (with Plant & Food Research). I am a member of the committee of the Meteorological Society of NZ, a founder member of the Waipara River Protection Group, and a trustee of the North Canterbury Radio Trust.

3. A full list of the sources I have used in preparing this evidence is appended, but the principal work upon which I have relied is Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand, 2nd edition, published in May 2008 by the Ministry for the Environment, based on the most recent modelling work by the National Institute for Water and Atmospheric research (NIWA). I have read the code of conduct for expert witnesses, and have prepared my evidence in accordance with its suggestions.

Overview

4. Global warming and the climate change it brings are caused by the build-up of greenhouse gases (principally carbon dioxide, but also methane, nitrous oxides, and various halocarbons) in Earth's atmosphere. This increase is driven by human-caused emissions (burning of fossil fuels, agriculture, deforestation etc). New Zealand produces a very small (under one percent) share of global emissions, and so action to restrict emissions in NZ will have no discernible impact on climate change in either NZ or the globe. The extent of changes in climate experienced here in the long term will be directly determined by the success or failure actions taken by the global community to limit greenhouse gas emissions.The climate of any given region is often described as the "average

weather" - the weather we expect to get at any given time. This can be expressed as averages: the average temperature in Hawarden in July for instance, but climate also describes the probability of extreme weather events. Flood events, for example, can be described as "one in 20 year" or "one in 100 year" events, giving an idea of how often events of that severity are expected to occur in an unchanging climate. Quite small changes in averages can translate into significant differences in human terms. The difference between a summer we think of as ordinary and one that's hot can be as little as 1ºC in the average temperature, and be enough to make a hitherto marginal crop profitable. Changes in the frequency of extreme events can also have marked impacts. Fewer or less severe spring frosts can bring positive benefits, while increases in drought frequency can stress agricultural systems.**Modelling of future climates**

6. The climate science community has developed computer models of the global climate system -- global climate models (GCMs), and these can be used to suggest how the climate system will change as greenhouse gases accumulate in the atmosphere. These models are similar to the numerical models used in weather forecasting, but do not try to predict "weather" decades into the future. They are used to develop projections of climate -- what the averages of temperature and rainfall might be by the 2050s for example, or how often heavy rainfall might be expected in the 2090s. The climate system is immensely complex, however, with oceans and atmosphere interacting in many different ways, and interlocking feedbacks from ice and snow and plant growth. The picture they provide of possible futures also depends critically on how greenhouse gas levels are projected to change -- and those depend on assumptions made about population and economic growth. There are two levels of uncertainty: how the climate system will respond to warming, and how human actions will affect that warming.

7. Even the best climate models, run on hugely expensive supercomputers, provide a fairly "coarse" picture of the global climate. A typical GCM might represent the world on a grid with 300km sides, and New Zealand might only "appear" in a few of those grid cells. To try to get a more detailed picture of what's happening, NIWA modellers have developed a regional climate model (RCM) which operates with a 50km grid. The RCM is "driven" by runs of a GCM, but calculates how that might be expressed as weather at a local level. This process is called dynamical downscaling, and NIWA is still working hard on developing and improving the process. NIWA also uses a process called statistical downscaling, building mathematical relationships between the climate we know and measure now and

GCM outputs. Most of the information we have for future NZ climate was developed using this process.

8. Improving regional climate projections is a key focus of international research, because it is recognised that when planning for climate changes it's important to have detailed local information not just a broad brush global picture.

Projections for New Zealand

9. The basics of climate change are simple enough. More greenhouse gases in the atmosphere means more warming. How much warming, where and when, is much more difficult to work out. NIWA's most recent modelling, detailed in Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand, is based on GCM runs conducted for the Intergovernmental Panel on Climate Change (IPCC) Fourth Report, published in 2007, using what's known as a "middle of the road" scenario for greenhouse gas emissions. This scenario projects an increase in the global average temperature of 3ºC by the 2090s. In New Zealand, the warming is projected to be 1ºC by the 2040s and 2ºC in the 2090s, significantly lower than the global increase. This is because the oceans surrounding NZ will take a long time to warm up, and effectively act as a buffer against warming -- just as they do from season to season. If global temperature increases are greater than projected in this scenario, NZ would still be likely to experience a slower rate of warming than most other parts of the world.

Global impacts with New Zealand relevance

10. The IPCC projects that over the immediate future, modest amounts of climate change could boost agricultural production globally, but that by the 2030s some regions (notably Africa) could be experiencing severe food production problems coupled with water shortages. This suggests that while demand for New Zealand's agricultural exports may fluctuate in the short term, the long term outlook for our agricultural producers may be good.

11. However, societal dislocations caused by climate change impacts in overseas markets - for instance, sea level rise causing flooding and creating refugee problems in the Asian megadeltas - could create considerable economic challenges for NZ and the world, and make it difficult to realise any local competitive advantage.

Drivers of New Zealand's climate

12. New Zealand's climate is determined by its position in the South Pacific/Southern Ocean. The north of the country reaches up into the sub-tropics, while the south dips down into the strong westerly winds that circle the planet -- the "roaring forties". Strong moisture-carrying westerly winds hit the west coast of both islands (but especially the South Island) and deposit large amounts of rainfall. As those winds cross the Alps, they warm up and become the dry Norwester so characteristic of the South Island east coast. The north of the country is also strongly influenced by conditions in the tropics -- tropical cyclones moving south can bring damaging rainfall events.

13. The large cool ocean surrounding the country provides a strong moderating influence on our climate, keeping summers cooler and winters warmer than would be experienced on larger landmasses at similar latitudes. As warming progresses, the westerly winds to the south of the country are expected to intensify (some intensification has already been observed), and a poleward expansion of the tropics is expected to impact the north of the country later in the century.

14. New Zealand's climate is also notably variable -- successive years can differ in average temperature by up to 1ºC. One of the primary drivers of this variability is the El Niño/La Niña cycle, also known as the El Niño/Southern Oscillation (ENSO) a 3 - 5 year cycle of changes in tropical sea surface temperature that affects weather patterns around NZ. During El Niño events, much of the country can be cooler than normal and the east coast of both islands can experience drought, while La Niña brings general warming and less rainfall to the west.

15. As the century progresses, the ENSO cycle will be overlaid onto the gradual warming, so that while cool years will still occur, they will themselves be warmer. By the 2040s, for instance, a "cool" year is likely to be the same temperature as one we currently think of as warm.

NIWA summarises the expected changes thus:

- increasing temperatures over the whole country
- increasing annual average rainfall in the west of the country and decreasing annual average rainfall in Northland and many eastern areas

- reductions in frosts
- increasing risk of dry periods or droughts in some eastern areas
- increasing frequency of heavy rainfall events
- rising sea level

16. In considering the impacts of change on river flows on the east coast of the South Island, we need to look at expected changes in rainfall both at the sources of the rivers, and on the land around those rivers as they flow to the sea. The demand for water from those rivers will be determined by the impacts of climate change on agriculture.

Rainfall and drought

17. One of the key climate change projections is that as the world warms, the hydrological cycle will intensify. Warmer air can hold more water vapour (humid tropics, for instance), and water vapour is an important "fuel" for weather systems. This is currently being seen in many parts of the world in an increase in heavy rainfall events, and in NZ every 1ºC increase in temperature is expected to increase the amount of rain in heavy rainfall events by 8%. Early runs with NIWA's RCM suggests that in some areas this could be exceeded. At the same time, general warming is expected to increase the rate of evaporation of water from soils, and in areas of low rainfall the frequency and intensity of drought is expected to increase. NIWA has estimated that severe droughts -- currently thought of as one in 20 year events -- could be twice as common by the end of the century. More moderate droughts are also likely to increase in frequency.

18. Increased frequency of even moderate drought could make dryland farming in some areas economically marginal. If, say, a one in 10 year drought occurs every five years, farms running only modest surpluses may not be able to recover fully before the next drought strikes.

Climate change in Canterbury

19. NIWA's projections for Canterbury are for an increase in average temperature of 0.9ºC by the 2040s and 2.0ºC by the 2090s. Rainfall is projected to decline only slightly at Christchurch and Hanmer, but increase by up to 8% at Tekapo. This reflects the trend towards increasing rainfall on the West Coast and at the Main Divide -- a consequence of increasing westerly winds. The expectation is that

flows in Canterbury rivers that have catchments up, at, or near the Main Divide will increase, at the same time as the incidence of drought increases nearer the coast. This would in effect be an intensification of the frequently observed pattern of Northwester conditions in Canterbury: plenty of water in the rivers while surrounding farmland is dry. Rivers with catchments in the foothills (eg Waipara River) are likely to see reduced flows. Increases in rainfall intensity during heavy rainfall events (at the Divide, and on the coast) is likely to increase the frequency of damaging flooding in all areas.

20. I'm often asked what the future Canterbury climate might be like. This is something I explored in an article earlier this year:

> For our property in the Waipara Valley, 2007 was a dry year -- only 496 mm of rain. 2008 was much wetter: 809 mm in the year, 10% over the average for the last 11 years, and the second wettest in my record. That's been good news.
>
> However, when I look back at the year, nearly 40% of that rain came in just three events -- a big fall in February to break the dry spell, and then two big storms in late July and August, the latter severe enough to cause dramatic flooding in the region. Roughly 320 mm fell in those three events. I had to wash mud out of the garage three times, dig a drainage trench through the truffiere (truffles don't like drowning), gullies eroded, the road slumped, and the Waipara River lowered its bed by half a metre in places.
>
> Take away those big storms, and we had only 489 mm for the year -- a dry year by my standards. Over the ten years up to 2008, we had a total of three comparable heavy rain events (Aug 2000, Jan 2002 and Sept 2003), and then like London buses, three came along at once.
>
> (http://hot-topic.co.nz/nice-weather-for-ducks/)

21. This is only anecdotal evidence, but if you add in the warm spring and summer we've had in Waipara (due to La Niña), you get some impression of what might be an ordinary year in 30 years time. It's been a great year for orchard crops and grapes, but we were using a lot of irrigation water from November through to mid-February.

Hurunui

22. No specific work has been undertaken on the potential impacts of climate change in the Hurunui district or on flows in the Hurunui River, and so what follows is my "best guess", based on interpreting the latest projections. With increasing rainfall at the Main Divide, I would expect flows in the river to increase (perhaps in line with rainfall increases projected for the West Coast - +5% for Hokitika by the 2040s, +8% by the 2090s - but it should be noted that it is possible that increases at the Divide could be bigger because of the intensification of heavy rain events discussed earlier). It's not clear if there would be any significant change in the seasonality of flows, at least through to mid-century, though winter snowpack will decline as warming progresses. By the end of the century there are suggestions in the modelling that the east coast could be slightly wetter in summer and autumn, but drier in winter and spring, while the reverse is true on the West Coast. The implication is that rivers fed from the Divide could see reducing flows towards the end of the century, but from a downstream farming perspective this might be offset by increased easterly rain in the foothills.By the 2040s the incidence of drought in the lower Hurunui catchment is likely to be increasing, as warming increases evaporation from soils and vegetation. The implications for agricultural systems that rely on large scale irrigation is clear enough: irrigation seasons are likely to be longer, and require more water use. There is therefore likely to be increasing pressure to abstract water from the river for irrigation purposes, and a need to examine water harvest and storage options.

Responses to climate change

24. There are two possible responses to this scenario: existing water users may wish to increase their irrigation take in order to maintain their current agricultural system, or they could choose to switch to alternative crops that have good income potential but lower water usage. It's interesting to note in this context that a gradual reduction in the frequency and severity of spring frosts could lead to an expansion of the vineyard area in the region. Vineyards use only a small fraction of the water required to maintain grass growth on equivalent areas, and there has been a significant expansion in vineyard area in the region in the last ten years.

25. Of course, other factors may drive land use change, and given current expectations of the rate of change in New Zealand, it is unlikely that climate

change will force dramatic changes in the first half of this century. Responding to policy actions to reduce emissions in New Zealand, and actions taken in our key export markets are likely to be much more important drivers of changing agricultural practices in the near to medium term. Carbon pricing here and overseas could make high emissions agricultural systems such as large scale dairying less economically attractive, for instance.

26. Whatever the future brings in these respects, it is very likely that pressure to harvest water from the Hurunui are likely to grow as the years pass. Land use change could, however, reduce the amount of water required per hectare, and encourage small-scale schemes that harvest high flows for on-farm storage and later use in dry spells.

Renewable energy

27. Reducing carbon emissions is already an important policy objective for the New Zealand government, in order to meet our obligations under the Kyoto Protocol. This is likely to become even more important beyond 2012 when a successor to Kyoto, currently being negotiated, is due to be implemented. Any post-Kyoto deal is likely to involve steeper targets for emissions reductions. A key part of the policy response in NZ is the encouragement of renewable energy generation. The previous administration had implemented a moratorium on new thermal sources for electricity generation, and though this has been lifted by the new Government, the impetus to develop low and zero carbon energy sources is likely to continue.

28. Hydroelectricity already plays a dominant role in NZ's energy generation profile, and it would be reasonable to expect that in a carbon-constrained economy, opportunities for new hydro schemes would be keenly explored. I am not able to make any judgement about the suitability of the Hurunui in this respect, but would note that advances in small-scale hydro generation could reduce the need for new large Waitaki-style schemes. These could take the form of small run-of river plants, or "head race" schemes utilising water flows in irrigation schemes.

Uncertainty and risk

29. As noted earlier, there are two sources of uncertainty associated with climate projections: the fact that we are dealing with a complex and imperfectly understood system, and the way that our society responds to the issue by

reducing emissions (or failing to). These uncertainties mean that it's very difficult to define the risks associated with climate change, but there are a couple of key points that it's important to understand. The first is that the changes are effectively one-way -- irreversible on a human timescale. Once an ice sheet has melted, or a shoreline disappeared under rising seas, it will not be possible to put it back the way it was. This applies equally to ecosystem responses -- species lost to climate changes can't simply be replaced. The second, and perhaps more important point is that there is a great deal of "inertia" in the climate system. Even if we could cap greenhouse gases at today's levels (and we can't), there would still be 20 - 30 years more warming "in the pipeline" as the system achieves thermal equilibrium. In other words, whatever actions we take to reduce carbon emissions today, we are committed to further warming out to mid-century. These are changes to which we can only adapt.

30. Finally, there is a risk that climate change will not be a gradual (in human terms) process -- that it could proceed faster than we expect or in fits and starts, or that the system could "flip" into a new warm state. These are risks that can't be quantified, but they are things that are known to have occurred in the past, and so can't be ruled out in the future. It should be noted that in some respects, change is already being seen to occur faster than expected, notably in the reductions of Arctic summer sea ice and loss of ice mass in Antarctica.

Summary

31. To the best of our current knowledge, New Zealand is likely to warm up more slowly than the rest of the world. This should make it easier for the New Zealand agriculture and horticulture to adapt to changes. However, warming will bring climate changes to all parts of the country, which can be summarised as a gradual warming (as if NZ were drifting slowly towards the equator), and an intensification of the westerly wind flows that dominate our current climate. In North Canterbury, this is likely to mean increased water flows in the major rivers fed from the Main Divide and reduced flows in rivers with foothills catchments, but warming will also bring increased drought risk to the farmland around those rivers, and increase demand for irrigation water. I therefore consider that it may be prudent to "keep options open" for the future.

References

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36. The Heat Is On: What will a warmer New Zealand Be Like, G Renowden, NZ Geographic 93, Sept/Oct 2008, p38-45 - gives a general interest overview of the latest projections

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Dated 26 March 2009

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G Renowden