Climate variability and risk management in nursery production©

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INTRODUCTION

One of the key skills of a nurseryperson is the ability to observe small changes in plant growth and the growing environment, and to understand how these factors influence plant production systems. This training in intuitive observation may explain why some growers comment that the seasons are not what they were. They may perceive that winters are warmer; that flowering and seeding is earlier or that rainfall patterns have changed in their area. Is this anecdotal evidence of increased variability in our climate, or just random musings?

The theme of the IPPS Australian Region conference, "The Times Are Changing", provides an opportunity to be future focused, and arguably the most significant change of our times is our changing climate. If the seasons are changing, then our plants and our livelihood as growers of living products will also change. The purpose of this presentation is to highlight the latest scientific research relating to the effects of climate change both globally and locally. It introduces the concept of risk management relating to business planning and discusses how nursery businesses can source local climate projections to plan for climate variability. Finally, I suggest potential opportunities for nursery businesses to engage with climate issues and position themselves firmly as being part of the solution.

DISCUSSION

In the beginning…greenhouse gases and the atmosphere

We know that life on earth is powered by the sun. The average global temperature is a comfortable 15°C and this is due to the naturally occurring presence of a number of 'greenhouse gases' in our lower atmosphere; mainly water vapour, carbon dioxide, methane, and nitrous oxide. These gases absorb heat radiated back from our earth and this warms the earth's surface and lower atmosphere, creating the conditions that sustain life. NASA scientists (2015a) note that our earth's atmosphere has been through various phases of heating and cooling for at least 650,000 years. However, they make the point that atmospheric carbon dioxide (CO_2) has never been above 300 parts per million (ppm) during this period. Figure 1 illustrates the rapid increase in CO_2 levels in recent times and scientists believe that warming of the atmosphere is linked to the increase in CO_2 levels (2015b). Regular updates on current CO_2 levels are available online from http://co2now.org/Current-CO2/CO2-Now/. This data is from the Scripps CO_2 Program (2015) at the Mauna Loa Observatory in Hawaii – the longest-running, high-precision instrument record for atmospheric CO_2. In January this year their sensors recorded atmospheric CO_2 of 399.73 ppm and in April a preliminary monthly average of 403.26 ppm. So what does all of this mean?

The Intergovernmental Panel on Climate Change (IPCC) reports that: "The current warming trend is of particular significance because most of it is very likely human-induced and proceeding at a rate that is unprecedented in the past 1,300 years" (IPPC, 2007:5).

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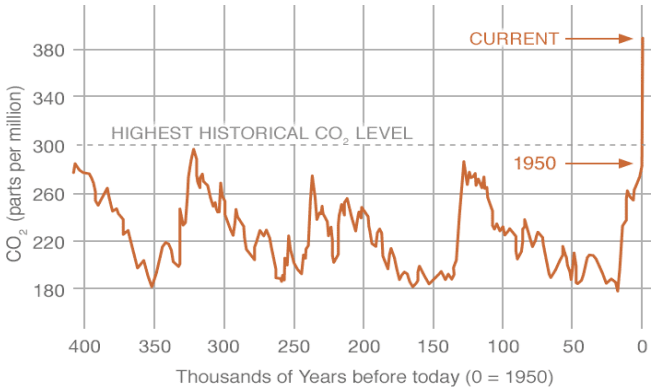

Figure 1. Graph of CO_2 levels during the last three glacial cycles, as reconstructed from ice cores. Data source NOAA. Accessed from NASA (2015b).

Human-induced impacts

Humans have always sought to modify their environment to provide for their needs and to ensure a greater chance of survival. However, since the industrial revolution, human impacts have increased with the extraction and burning of fossil fuels, the large scale burning of vegetation, increase in stock numbers producing methane and the use of nitrogen fertilisers. While the amount of methane and nitrous oxide has increased in the atmosphere, concern is focused around CO_2 levels. This is because CO_2 lasts for a long time in the atmosphere, and it is therefore considered to have a greater long-term warming effect (IPCC, 2014). New Zealand's CO_2 emissions are lower than Australia's because New Zealand has one of the highest levels of renewable electricity generation in the world. However, around half of its greenhouse gas emissions (which include methane and nitrous oxide) come from agriculture, creating debate about how to maintain agricultural development while reducing methane emissions (Ministry for the Environment, 2015). This compares with agriculture in Australia contributing approximately 16% of its greenhouse gas emissions (NGIA, 2014).

As climate scientists report a greater level of scientific certainty that global warming is mostly due to humans and not natural forces, governments are being called to show greater leadership to cut greenhouse gas emissions. The target is to attempt to keep any temperature increase below 2°C relative to pre-industrial levels. "If greenhouse gas emissions continue to increase at the current rate for a few more decades, we are likely to see average global temperatures warm by more than 4°C by 2100" (Ministry for the Environment, 2015).

Intergovernmental panel on climate change

There are many scientific research institutions around the world working to gather, analyse and report on atmospheric changes and their link to climate change. The lead organisation in this process is the Intergovernmental Panel on Climate Change formed by the United Nations and tasked with gathering together global research and reporting on this every 5 to 7 years. In 2014 the IPCC released its Fifth Assessment Report produced by more than 700 scientists and additional comments on drafts were received from 1,700 expert and government reviewers (Hughes, 2014). Summaries of the IPCC's Fifth Assessment Report have now been released by many countries' scientists and these deserve to be widely read (Hollis, 2014; Hughes, 2014). The latest IPCC report confirms:

"That human influence on the climate system is clear and growing, with impacts observed across all continents and oceans. Many of the observed changes since the 1950s are unprecedented over decades to millennia. The IPCC is now 95% certain that humans are the main cause of current global warming. In addition, the SYR (Synthesis Report) finds that the more human activities disrupt the climate, the greater the risks of severe, pervasive and irreversible impacts for people and ecosystems, and long-lasting changes in all components of the climate system" (IPPC, 2015).

Global effects of climate change

Some of the global effects of climate change reported by the IPCC (2014) are:

- Increased air temperatures and more frequent and intense heat waves:
  The global mean surface temperature change for the period 2016-2035 relative to 1986-2005 is similar for the four Representative Concentration Pathways (RCPs) or greenhouse gas concentration scenarios and will likely be in the range 0.3 to 0.7°C.
- Increase in the frequency and intensity of rainfall events over some regions
- Oceans are continuing to warm and become more acid:
  Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30% (PMEL Carbon Program, 2015).
- Global sea levels are rising:
  Global sea level rose about 17 cm in the last century. The rate in the last decade, however, is nearly double that of the last century (Church and White, 2006).
- Plant and animal ranges, migration patterns and behaviors such as flowering have changed:
  "A large fraction of species faces increased extinction risk due to climate change during and beyond the 21st century…" (IPCC, 2014).
- Glaciers have shrunk, ice on rivers and lakes is breaking up earlier:
  NASA's data (2015a) shows that Greenland ice sheets lost 150 to 250 cubic kilometres of ice per year between 2002 and 2006, while Antarctica ice sheets lost about 152 cubic kilometres of ice between 2002 and 2005.

Key risks for New Zealand and Australia from climate change

For most people the global scale of climate change is almost too overwhelming to relate to. However, closer to home, information on the key risks from climate change in the 21st century is available for Australia and New Zealand. Hollis (2014) and Hughes (2014) both summarise aspects of the risks outlined in the IPCC.

Working Group II assessment report.

Three key risks for both countries combined are:

- Increased frequency and intensity of flood damage to settlements and infrastructure.
- Increased damage from wildfires .
- Increasing risks to coastal infrastructure and low-lying ecosystems from continuing sea level rise, with widespread damage if the more severe projections are realised.

Five other key risks for Australia only are:

- Damage to coral reef systems
- Shrinking mountain habitats and loss of some native species due to increasing temperatures and fire risk
- Constraints on water resources in southern Australia due to higher temperatures and decreased rainfall
- Increased illness, death and infrastructure damage during heat waves
- Reductions in agriculture production in the Murray-Darling Basin and south western and south eastern Australia due to dry conditions

Risks to nursery production

A sector based on the production of plants is particularly sensitive to climate change effects given that plants are living products. Changes in temperature, water, carbon dioxide levels, pollinators, and micro-organisms will have a significant impact on growth and reproduction. Nursery production is also affected by decreases in gardening demand due to bad weather; be it too wet, dry, hot or cold and also from damage to nursery physical structures and wider transport infrastructure from storm events.

Some other potential risks relate to the effects of increasing temperatures driving increased evaporation rates, making water resources increasingly scarce for production. Competition for water resources will increase as rainfall patterns change and some regions become drier. Less water and increased temperatures will also affect how biodiversity copes with climate change (CSIRO, 2014). A warming environment means that weeds, pests and

diseases may expand into new areas creating problems for growers.

A conference, "Species on the Move" to be held in Hobart in 2016, notes that "the global redistribution of our planets' species is widely recognised as a fingerprint of climate change." The IPCC (2014) also reports that "most plant species cannot naturally shift their geographical ranges sufficiently fast to keep up with current and high projected rates of climate change in most landscapes.

For those growers involved in native plant production, an interesting change to seed and cutting sourcing is emerging, known as climate adjusted provenancing. This concept is being discussed by geneticists as an important strategy for some species to improve their chances of adaptation and survival. Rather than using local seed, in some circumstances, it may be better to source genetic material from outside the area and to actively move genes into their potential future ranges. Concepts of provenance and its interactions with climate change, are being explored by organisations such as the Society for Ecological Restoration Australasia, and the Australia Network for Plant Conservation.

So the question is how do we prepare for increased uncertainty and what can we do to lower the risk to our businesses to ensure they are sustainable into the future?

Risk management

"Risk is the combination of the likelihood of occurrence and the magnitude of the consequence of a hazard. It is a useful concept for dealing with an uncertain future" (UK Climate Impacts Programme).

It is normal business practice to plan ahead to manage risk. Although the exact impacts of climate change are uncertain, they can be managed like any other business risk. The point is to start the discussion now with your staff and identify a few key risks and develop an action plan to make your business more resilient to these risks. Use the issue as a catalyst to review and focus on what you can control, rather than worrying about all the things that you cannot. Remember that climate variability will also bring business opportunities as well as threats as will be discussed in later sections of this presentation. Whether you're sceptical about climate change or not isn't the point, it is what your clients' think about the issue, that is the point.

The UK Climate Impacts Programme (UKCIP) has excellent resources for encouraging businesses to take a planned approach to climate change. They list six potential impacts that climate change has on businesses (UKCIP, 2010).

These are:

- Markets: e.g. demand, product mix, diversification
- Logistics: e.g. supply chains, utilities, transport
- Process: e.g. plant growth factors, resource use
- Finance: e.g. insurance, price positioning, costs
- People: e.g. consumer behaviour, demographics
- Premises: e.g. structures, design, energy needs

Businesses can adapt to climate change risks in a number of ways depending on what their key risks are. In regions that may become drier, securing additional water resources and fire mitigation may be a priority. For others in low lying areas, where extreme weather events such as flooding may increase, moving to alternative power sources such as solar power, having emergency backup supplies and other storm mitigation plans may be their focus. Protecting your business financially from climate impacts should include having adequate insurance and business continuity cover in place, as well as security for electronic records to minimise disruption due to adverse events. Training staff for emergencies and investing in their health and safety and professional development also builds resilience in your business.

There are a number of models for managing risk (Ministry for the Environment, 2008; UKCIP, 2010). In general, they involve a process of firstly identifying the potential hazards and risks involved; analysing these risks, and evaluating them against set criteria to prioritise and identify key issues; then identifying adaptive measures including the costs and benefits, and selecting action measures to implement. Whatever process of planning you use,

the key thing is to start now!

Getting started – where to look for information

To get started you will need the best resources, tools and support. The good news is that there is a wide range of helpful resources out there that are easy to access on the internet (Table 1). Some organisations and their websites worth looking at are:

Table 1. List of organisations with useful resources relating to climate change.

Organisation	Web address	Resources
Climate Change in Australia	http://www.climatechangeinaustralia.gov.au	Climate Futures Web Tool Users can manipulate data to try out various climate impact scenarios for their area Cluster brochures and reports Maps and climate change projections for all regions of Australia
Climate Council of Australia	http://www.climatecouncil.org.au/category/reports	Reports on climate change issues and projections of impacts on various areas
New Zealand Climate Change Centre	https://www.nzclimatechangecentre.org/	Climate information and a searchable database that links users to active climate change research
UK Climate Impacts Programme	http://www.ukcip.org.uk/decision-making-for-adaptation/	Business Areas Climate Impacts Assessment Tool Scoping impacts of climate change UKCIP Adaptation Wizard Online tool to help you adapt to climate change
National Oceanic and Atmospheric AdministrationNational Centers for Environmental Information (NCEI)	http://www.ncdc.noaa.gov/climate-information/climate-change-and-variability http://www.ncdc.noaa.gov/climate-information/statistical-weather-and-climate-information	Global climate at a glance Various maps e.g. temperature and rainfall changes and access to climate data records
National Aeronautics and Space Administration	http://climate.nasa.gov/evidence/	Climate change information and resources; mitigation and adaptation strategies and technologies

Future focused opportunities

Threats from increasing climate variability have been well covered by the media to the point of fatigue or disbelief depending on your point-of-view (Lloyd, 2015a, b; Asten, 2015). The scale of the problem is very serious, however, there are some positive opportunities specific to the nursery production sector.

1) Plants not only sustain all life and but as part of their photosynthesis processes they also absorb carbon dioxide. As more people equate greening the planet with saving the planet, plant propagators should be seen as the experts in plant based climate change solutions in their communities. The Nursery and Garden Industry Australia (NGIA) puts it plainly when they say "the sector can play a vital role in preventing, stabilising and reversing environmental degradation".
2) Urban greening campaigns such as 202020 Vision which aims to create 20% more green space in Australian urban areas by 2020, increase the public's understanding of the value of plants as well as stimulating demand. Similarly Greening Australia's joint project "One Million Trees" launched in 2014, will see the planting of one

million trees south of Perth, and in western Victoria. The trees planted will not only capture thousands of tonnes of CO_2, but also restore threatened habitats. Both projects have in common significant community involvement. The forestry industry also promotes the value of forests as carbon sinks.

3) As the climate changes in regions, there are opportunities to provide clients with new types of plants adapted for these conditions. Biodiversity conservation will become critical and the demand for native plant restoration skills and seed resources will increase.
4) The world population has now reached 7 billion and is expected to reach 9 billion by 2050. It is estimated that 70% more food will be needed to feed the world population by 2050 (Ministry for the Environment, 2015). Opportunities for food production exports, and therefore the starter plants for the vegetable and fruit production sectors, will increase. Unfortunately, crop and agricultural food production has already decreased in parts of Africa and Europe due to climate change (Hughes, 2014). New Zealand and Australian growers may have a competitive resource and climate advantage in meeting these food demands.
5) New growing technologies achieving energy, irrigation and spatial efficiencies are being developed all the time.
6) Many opportunities exist for growers to educate themselves about how to increase the sustainability of their businesses in the future. Nursery and Garden Industry Australia already offer accreditation schemes to improve nursery practices such NIASA-BMP, EcoHort®, BioSecure. In addition to this, policies on climate change and sustainability already exist in the nursery industry to provide additional guidance for the future (Nursery and Garden Industry Australia, 2011, 2014; Oregon Assoc. of Nurseries, 2011).

CONCLUSION

If the times are changing, what is your vision for the future? The good news is that climate researchers confirm that we have the ability to limit climate change and its risks, with many solutions that still allow for development. The sense of urgency about the level of change required is clear: "…stabilizing temperature increase to below 2°C relative to pre-industrial levels will require an urgent and fundamental departure from business as usual" (IPPC, 2015).

Growers can plan ahead to minimise the risks of climate variability on their businesses. There are some useful tools and resources that have been developed internationally, nationally, and no doubt at a local level, by local government and community leaders already planning for these risks in your area. Opportunities do exist for growers to position themselves positively and raise consumer awareness of the value of plants in their communities.

We need to continue to look innovatively at how we reduce our greenhouse gas emissions and examine our industry practices to reduce their impact on the environment. It may not be business as usual in the future, but there is a greater need than ever for plant production to be acknowledged as having an essential role in sustaining our collective future on this planet.

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