Our changing world

A lot can change in ten years – eight AUT researchers at the forefront of these changes tell us what we can expect

OCEAN SCIENCE
Senior Lecturer Kay Vopel
School of Applied Sciences

"We are about to fundamentally change the chemistry of our ocean. The greatest risk to our marine environment is the accelerating enrichment of seawater with anthropogenic CO_2. This CO_2 pollution results from our ignorance of the fundamental processes that link the marine environment with the atmosphere and the land.

The overall human CO_2 emissions over the industrial era amount to close to 560 billion tons. A little less than half of this CO_2 remains in the atmosphere acting as greenhouse gas leading to climate change. The remainder is, at present, removed in roughly equal parts into the ocean and by land vegetation.

We are emitting roughly 10 billion tons of carbon annually, a rate that exceeds the natural emissions by a factor of nearly 100. About 87% of this release originates from fossil fuel combustion and cement production and another 12% from deforestation.

The ocean is a complex system well-designed for maintaining a balance between inputs and outputs of carbon but the current rapid rise in atmospheric CO_2 exceeds its capacity to maintain this balance.

This has caused a wholesale shift in the chemistry of the upper water column worldwide. This shift will fundamentally change open-ocean and coastal ecosystems in the near future.

The most significant changes to seawater chemistry are decreases in a number of key seawater properties in a process called ocean acidification: pH, carbonate ion concentrations, and the saturation state of calcium carbonate minerals. In some regions, ocean acidification has already decreased mean surface water pH to a level that was not expected to happen for several decades.

The observed shift in seawater chemistry has dramatic impacts on the physiology of many marine organisms, most importantly those that build their shells or skeletons out of calcium carbonate.

For example, ocean acidification decreases the rate at which reef-building corals produce their skeleton, reduces the ability of marine algae and zooplankton to maintain their protective shells, declines marine plankton as a food source in the food web of marine species, and reduces the survival of larval marine species, including commercial fish and shellfish.

The most efficient means of protecting our marine environment is probably education; we must educate our future generations, so they understand the natural feedbacks that will fundamentally change their environment.

Our children must overcome the false feeling of security afforded by living in New Zealand and understand that protecting New Zealand's marine environment does not end with fighting invasive species, collecting trash from our beaches, establishing reserves, and caring for sea mammals; a significant threat comes from what you cannot see and calls for immediate action: a rapid reduction of our CO_2 emissions.

My research group is currently

ECONOMICS
Professor Tim Maloney

"Two key labour market issues will confront New Zealand in the coming decades. The first involves a rapidly ageing population. Currently, the ratio of the population aged 65 and over to the 'working age' population aged 20 to 64 is about one-quarter. By 2050, this so-called 'dependency ratio' is expected to rise to more than one-half. This will mean fewer workers supporting more non-workers.

This scenario is not unique to our country. All developed economies will soon have to deal with rapidly ageing populations. What is unique to New Zealand is our relatively high (and still growing) participation rate for older individuals in the labour market.

Among 38 OECD countries, New Zealand is second only to Iceland in the employment rate of those aged 55 to 64. This can be a mixed blessing.

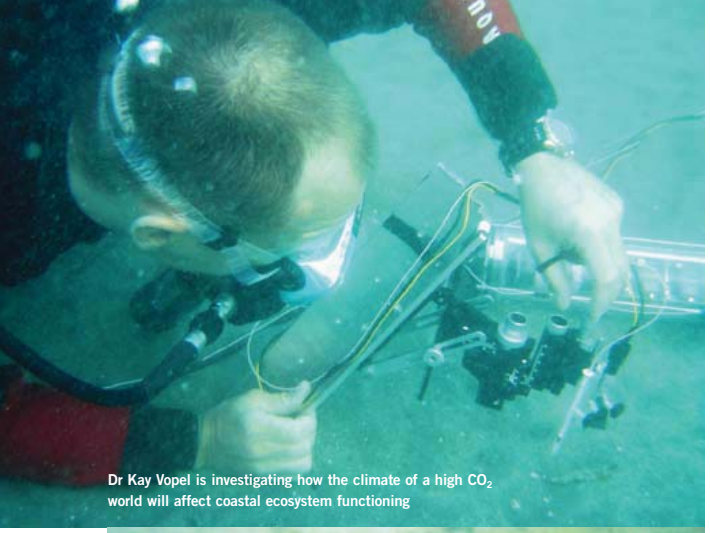
On one hand, a high participation rate among the elderly can mitigate the consequences of a rising dependency ratio. On the other hand, growing proportions of older workers in the labour market will likely alter the very nature of work, and the rules and regulations put in place to protect workers in this country.

The second issue that will face New Zealand is how to lift our recently poor productivity performance.

Over the last few decades we have fallen even further behind Australia, the US and the OECD average in terms of output per hour worked. Why this has happened and more importantly, how we can reverse this trend are issues that are not very well understood.

We do know however that rising labour productivity is essential to any long-term increase in our standard of living. We also know that two key drivers for productivity growth are 'capital accumulation' and 'technological change'. Part of the technology story involves both promoting basic Research and Development (R&D), and maybe more importantly, the dissemination and absorption of recent technological advances.

Much of this relies on our capacity to conduct R&D and to exploit these results in a wide array of industries. This can only happen if we have a long-term commitment to adequately fund our tertiary institutions."



Dr Kay Vopel is investigating how the climate of a high CO_2 world will affect coastal ecosystem functioning

working on two fronts – we are investigating how the climate of a high-CO_2 world will affect coastal ecosystem functioning and we are developing novel tools to assess the sustainability of marine aquaculture.

A particular focus for the research into the impact on the coastal ecosystem is how rapid sedimentation of fine grained land-derived (terrigenous) clay affects the seafloor. This research is timely considering that climate change models predict an increase in the frequency of extreme rainfall events and consequently an increase in the supply of suspended particles via waterways to coastal habitats.

Suspended particles eventually settle at some distance to the shore smothering the seafloor and its organisms. Effects of such deposition on the functioning of coastal ecosystems are well documented and of global concern; the underlying mechanisms, however, are poorly understood.

The assessment tools we are working on aim to simplify and reduce the costs involved in assessing the ecological impact of marine farms – a condition of resource consent.

Using emerging underwater technologies we hope to develop a new robust, integrated and cost effective approach for use here in New Zealand.

Such an approach should encourage frequent monitoring, and importantly, will not compromise the profitability of marine farming operations."

TOURISM

Professor Simon Milne
New Zealand Tourism Research Institute

"New Zealand has certainly gone out there to market itself as clean and green and 100% pure and there's no doubt that people are starting to question that and to raise the issue of 'greenwashing'.

Dual economic pressures are battling with environmental considerations as in the case of the proposed mining on the conservation estate and yet the conservation estate is part and parcel with our clean green image.

There are critical issues there and it is about being true to who we are and, if we are not, we have to realise that in this age of internet and blogs, the global rising of consciousness if you like, we are going to be caught out and that's not a very pretty outcome for us.

> 'Looking to the future, the focus for this country needs to be on how we can ensure that tourism can be a tool to create sustainable livelihoods for New Zealanders'

We also have a major tourism event on our horizon but the question for New Zealand is what the legacy of the 2011 Rugby World Cup (RWC) will be.

When we talk about economic gains, the short term gains are important but clearly it's the long term benefits and spin-offs that we are trying to generate.

Infrastructure is important but we need to be careful not to lumber ourselves with a massive new stadium and hundreds of new hotels which will suffer from poor occupancy rates when it's all over.

In a way, the fact that the RWC preparation is going on during a time when the economy is actually fairly contracted is not a bad thing. It's meant that we haven't gone overboard and been overly lavish in what we have done.

What we have had to do is live within our means, and my sense is that the accommodation and the infrastructure that's in place should be sufficient to cover us for the RWC and should provide us with an ongoing legacy that won't be too much of an albatross around our neck.

Looking to the future, the focus for this country needs to be on how we can ensure that tourism can be a tool to create sustainable livelihoods for New Zealanders.

Over time the notion of eco-tourism or sustainable tourism will probably go the same way as the idea of e-business. A few years ago e-business was all the buzz, but now it's just business.

Likewise I don't think we can afford as a country to be creating a false dichotomy between tourism and sustainable tourism. If we are aiming to create sustainable tourism, we can't just have tourism somewhere on the other side being unsustainable.

It also has to be recognised we are all in this together – tourism is not just the province of tourism operators."

RAPID PROTOTYPING

Professor Olaf Diegel
Creative Industries Research Institute

"3D printing or rapid prototyping allows us to make real products directly from 3D designs. Anything that can be imagined using 3D computer software can be manufactured in a matter of hours.

Ten years ago 3D printing was only used for making prototype parts to test ideas. Today, the technologies have evolved to the point where 3D printers can be used to make production-ready parts out of plastics, and even metals like stainless steel, aluminium, and titanium.

In a few years, we will see the rapid emergence of home 3D printers capable of printing in multiple materials at the same time.

So when you need a new toothbrush, instead of going to the supermarket to buy a new one you will simply recycle the material from the old one and print yourself out a new one with bristles customised to just the way you like and a handle that fits your hand perfectly.

Mass-customisation is one of the new business models that will change the way we live, and within ten years we will probably have widespread access to customised products. Already, 3D printing technologies are being used to create individual hearing-aids and dentists are beginning to use these technologies to print bespoke gold crowns while you wait.

3D printing is already used in the field of regenerative medicine. It is possible to print a new bladder that the patient's body will not reject, because it is printed from their own stem cells. Technology is also being developed to produce heart valves for bypass operations. Within the next 20 years, we are likely to see new 3D printing technologies that will allow for the printing of much more complex organs, like kidneys, and maybe even hearts.

Much like the advent of the robot, which saw car companies around the world retraining workers into different roles, 3D printing will affect society and businesses in a similar way. As printers are developed that allow for the printing of a complete house, for example, traditional builders might need to be retrained in aspects of making, running or servicing the machines, or in the aspects of design needed to maximise the potential of the machines.

A chunk of New Zealand's economic future rests in high-value niche manufacturing and the innovative use of design and technology. Conventional mass-manufacturing has, in large part, moved to countries like China and India where labour costs offer a substantial advantage.

To compete, New Zealand companies need to develop both superior design abilities and competencies in efficiently and rapidly manufacturing well designed high-value niche products. 3D printing offers almost unlimited flexibility, gives the ability to almost instantly respond to customer demands, and drastically changes conventional business models.

Researchers at AUT's Creative Industries Research Institute are working on several new 3D printing technologies including conductive 3D printing, and the bioprinting of diagnostic medical tools.

Conductive 3D printing would allow us to print wiring, circuit boards, and electronic components as an integral part of the plastic shell of a product, meaning products could be of any shape imaginable.

Diagnostic bioprinting will allow us to print sophisticated medical diagnostic tools using standard ink-jet printers. These will test for a number of diseases with the results of the test simply appearing, in writing, on the test strip."

Rapid prototyping by design: artist Bathsheba Grossman's limited-production light