MANAGING BIOLOGICAL SOURCES AND SINKS IN THE CONTEXT OF NEW ZEALAND'S RESPONSE TO CLIMATE CHANGE

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- You asked me to talk about how agricultural emissions might be integrated into the ETS. A recent *OECD Economic Survey* had this to say:
- "*The effectiveness of the NZ Emissions Trading Scheme, New Zealand's main climate change policy instrument, is being limited by an exemption for biological emissions from agriculture and transitional arrangements that effectively halve the carbon price faced by covered emitters...*"
- The Government has since moved to end those transitional arrangements. That leaves the biological emissions. The fact that the OECD referred to the exclusion of biological emissions as an "exemption" implies that they should be included. And of course, that is the logic of the scheme which in turn reflects the logic of New Zealand' approach to GHG policy for the last 20 years. In a nutshell it might be stated as follows:
- "It's the net contribution to the atmosphere of greenhouse gases that counts whatever the sources or sinks. In the interests of minimising the cost of reducing emissions, any mix of actions will suffice as long as the quantum of gases – adjusted for their radiative warming potential – minus sinks takes us on a downwards path."
- I feel considerable responsibility for this approach. It is the case I advocated during the lead up to the negotiation of the Kyoto Protocol. And because, in the early 1990s, we had large, new, fast-growing forests, we were very happy to count the negative emissions they represented into the equation. In fact NZ's very first domestic target was developed on the basis that we would rely 20% on emissions reductions and 80% on sinks to meet it.
- I recently dug out an address I gave 22 years ago which spelt out the rationale. I noted that we expected to achieve a reduction in net emissions of over 50% below 1990 levels by 2000 given the expansion of forestry. I then chastised Greenpeace for opposing the inclusion of forest sinks in our accounting saying: "Scientifically, it is incontrovertible that an

1 Simon Upton was New Zealand's Minister for the Environment, 1990-1991 and 1993-1999.

atom of carbon locked up (sequestered) is as good as an atom of carbon not emitted into the atmosphere."

- I then qualified that by saying: "No-one is arguing that sinks are the whole answer. Sinks won't last indefinitely – our credit is likely to run out by around 2020." But I don't mind admitting that the sheer scale of forest sinks at the time (and the eternity that a date 16 years away represents when you're only 36) made biological sinks loom particularly large in our thinking.

- People other than Greenpeace were sceptical. I distinctly remember John Gummer, then the UK's Environment Minister (today, as Lord Deben, Chairman of the UK's Climate Committee), saying to me: "But you're just dodging the problem. You'll cover every square inch of the country in pine trees, there'll be no pressure to do anything about emissions and then you'll hit a brick wall!" To which my reply was: "God forbid! Forest sinks are a buffer that will provide a bridge to a low emissions future. It's a transitional strategy that will reduce the cost of the transition while new technologies emerge." And as a country with some very difficult emissions – especially agriculture – that seemed reasonable.

- Of course it has all proved much harder than anyone thought for all sorts of reasons, including population growth. [Slides 1 & 2– actual NZ emission outcomes 1990-2014] I won't attempt a survey of the intervening years. But the Paris Agreement requires every country to think again. Countries adopted the ambitious goal of keeping the rise in average global temperature to well below 2°C and even more heroically to pursue efforts to limit it to 1.5°C. To do that, countries need their emissions to peak and (in the words of the Agreement) need to undertake rapid reductions thereafter so as to achieve a balance between emissions and removals by sinks in the second half of this century.

- That's a tall order. [Slide 3: diagram to illustrate] Between 1995 and 2014, the world emitted an additional 300 billion net tonnes of CO_2.[2] For a 66% chance of keeping the global average temperature rise below 2 degrees, the remaining carbon 'budget' is around 900 billion tonnes – at the present rate it will be fully used by around 2035 so time is not on our side.[3] That's the bad news. The good news is that the international community has belatedly realized that we need to move to net zero emissions by the time we've exhausted the carbon 'budget' compatible with 2 degrees. This is 'good news' in the sense that policy and science are beginning to

2 Le Quéré, C. et al. (2015), *Global Carbon Budget 2015*, http://www.globalcarbonproject.org/carbonbudget/15/hl-full.htm. This figure refers to cumulative CO_2 emissions from fossil fuel combustion, cement production and land-use change, minus removals by land sinks and oceans.

3 *Ibid.*

line up. But the implications are pretty vertiginous. In practice net zero means that:

  - Fossil emission sources that *can* go to zero, need to *go* to zero.
  - Fossil and other sources of long-lived GHGs that *can't* go to zero need to be compensated for through negative emissions technologies that take carbon dioxide out of the atmosphere and lock it away.
  - The inevitable warming associated with feeding ourselves needs to be minimised.
  - Deforestation has to be halted and reversed.

- What chance do we have? Some key facts:
  - We can now envisage in practical terms how we might set about mass decarbonisation of the global economy. We now have at least some of the technologies needed to eliminate fossil fuel emissions from some of the biggest sources – renewable electricity from solar and wind, electric cars and so on. There are still massive leaps to be made but the transformation is no longer theoretical – it is becoming commercial. Given that fossil fuel emissions account for the bulk of the problem, this is very good news. But there will still likely be emissions from some difficult sources – like cement, steel or aviation.
  - That leaves the biological side of the equation. The news on deforestation is, if not good, at least hopeful: it's declining and it's possible to imagine a world in which it has been arrested and the carbon stock at least partially restored through re-afforestation. But we are still left with process emissions from agricultural production – methane from animal and paddy fields, nitrous oxide from animals etc.

- All countries face the challenge of developing policy instruments that motivate these massive technical and systems changes. The economy-wide implications mean that we need solutions that are both systemic and flexible. They also have to deal with the fact that we're dealing with not one greenhouse gas, but several, being emitted by sectors with very different characteristics. Finally, they have to deliver results in time – the scarcest commodity of all. Actions taken today have to contribute to making progress in the long run, not just generating an accounting result in the short run.

- To do this requires a properly joined-up understanding of how carbon stocks and flows relate to one another.   To explain, let me make a brief detour into the way in which greenhouse gases are, for the purpose of measuring emissions, compared with one another.   Different greenhouse gases have different potencies when it comes to their capacity to warm the planet. Around 20 years ago, the international community settled on a 'currency' that enabled them to be compared on a common basis. Each gas has an assigned 'global warming potential' (GWP) which is calculated as the amount of warming it contributes over 100 years relative to carbon dioxide

- The trouble with this metric is that choosing a 100 year GWP based on CO_2, is that CO_2 emitted to the atmosphere hasn't been removed from the system in 100 years. Some of it will still be around in thousands of years. It accumulates. An unfortunate consequence of the GWP metric, is that it led lay policy makers like me to believe that these gases were entirely fungible; and that you could tackle the flow of them in any order. It also induced us to focus on flows in the short term rather than stocks in the longer term. A scientific paper published earlier this year (of which Andy Reisinger from the NZ Agricultural Greenhouse Gas centre is a co-author) spells out clearly why we need to address different gases differently.[4]

- It is the *stock* of carbon accumulating in the atmosphere that is the problem, so if we want to contain temperature increases to *any* level (the world has chosen 2 degrees but it would apply just as well to any number) then we have to reach a new equilibrium in which the net injections come to zero. That has implications for which gases are tackled within what timeframe.

- This has led some researchers to suggest that we need to move away from the approach reflected in the Kyoto protocol where GHGs are tradable with one another, and instead have two 'baskets' of gases to manage the trade-off between: long-lived accumulating gases like CO_2 and nitrous oxide which have to go to net zero (or be mitigated by negative emissions technologies);   and shorter-lived gases - like methane – for which we need to establish a sustainable on-going rate of emissions. [5] One basket would not be tradable against the other.

- Taking this approach would mean giving unremitting priority to taking steps that stop stock accumulation while managing the warming that the

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4 Allen, Myles R., *et al.* New use of global warming potentials to compare cumulative and short-lived climate pollutants, *Nature Climate Change* 6 (2016) 773-777. The short-comings of GWPs as a policy guide were well explained as long ago as 2005 in a paper by Shine, Keith P., *et al*. Alternatives to the global warming potential for comparing climate impacts of emissions of greenhouse gases, *Climatic Change*, 68.3 (2005) 281-302.

5 See Smith *et al.* Equivalence of greenhouse-gas emissions for peak temperature limits, *Nature Climate Change,* 2, 535-538, 2012

flow of short live gases provides. What might that mean in New Zealand's context?

- New Zealand's contribution to the accumulating stock problem has come principally from deforestation and drainage, the emission of CO_2 from industrial sources and transport, and the emission of nitrous oxide from pastoral farming. It's important to recall that this is not a process that started yesterday – in fact it stretches back 800 years. With Landcare Research's help we can get an idea of the total stock change contributed by New Zealand [slide 4]. Fully 80% is from the transformation of the landscape. The following maps show this evolution [slides 4,5,6,7]. From a standing stock of carbon of 8.2 GT, we have volatilised 2.6GT. And on the pastoral land that has replaced that forest we now have an annual flux of around 33,000 tonnes of nitrous oxide that, because of its long life, adds to the accumulating stock of GHGs in the atmosphere.

- Now let me make three points about land-based sources and sinks that affect the long-run stock of atmospheric gases. The first is rather small but not insignificant. Forest sinks aren't quite as positive from a climate point of view as they appear. Because they're darker, they reduce the reflectivity of the earth's surface so less radiation is bounced back into space. In NZ's case, reduced albedo from forest cover is worth a discount of about 20% of the carbon stored.[6]

- The second point is that trying to re-build those carbon stocks without limiting fossil emissions will achieve little. We currently have 0.55 GtC stored in production forests and 2.9 GtC in native forests and scrub. We could imagine a scenario [slide 9] in which all marginal, eroding farmland was converted into pine forests and maintained as forest in perpetuity. That would increase the stock of carbon stored on the land by 0.15 GtC. [Slide 10 showing the two maps]. Compared with the amount of carbon NZ has released and our business as usual emissions, the potential to store more carbon is rather small. If there was ever a short term case to offset a permanent increase in atmospheric carbon with forest sinks (whose permanence cannot be guaranteed) it has long since vanished. Trading forest sinks against fossil fuels sends the wrong signal in a world that needs to reduce fossil fuel emissions to net zero.

- That doesn't mean that the ETS is irrelevant for forestry. The ETS provides an excellent and sophisticated incentive to replant commercial forests provided the value of that standing carbon stock is high enough. Added to that, New Zealand has done an excellent job at preserving roughly a quarter of the country in native forest. Provided we can control pests and keep all our forests healthy, we should be able to avoid losing any more of

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6 Kirschbaum, M.U.F., *et al*. Implications of albedo changes following afforestation on the benefits of forest as carbon sinks, *Biogesciences*, 8, 3687-3696, 2011

our terrestrial carbon stock to the atmosphere. Indeed, we should be able to claw back some of those stocks we lost to the atmosphere – but not that much. [Click off –blank]

- My third point is that even good land management practices that maximise the stocks of living carbon that provide a 'buffer' against an even warmer world won't be enough. That's because our industrial use of land – pastoral farming – contributes another long-lived stock accumulation gas: nitrous oxide or N_2O. It is powerful stuff. At the global level it is responsible for about 15% of the warming already observed. For some countries, it's industrial process emissions of CO_2 – from things like steel and cement production – that pose the biggest challenge. For New Zealand, the industrial emission that poses our biggest challenge is probably nitrous oxide. We have to work away at technical answers but to the extent that there's a residual, we need negative emissions technologies for CO_2 to net off any on-going N_2O emissions.

- So much for gases which cause stock problems. But not all gases accumulate. Some gases cause much stronger warming than CO_2 but are short-lived. By far the most prevalent one – for the world and for New Zealand – is methane or CH_4. The flow of these gases does not have to go to zero to limit the warming they cause - their emissions can be sustained at some level. But the greater their flow, the more warming they contribute. The level of warming we can live with from these sources is dependent on how much 'head-room' we have left after taking into account the irreversible warming of long-lived gases.

- If the world wants to stay under a 2 degree ceiling *and* live with a certain level of warming from these short lived gases, then it needs to bring the rise in the atmospheric stock of long-lived gases to a halt swiftly. If CO_2 emissions aren't halted then there won't be any room for those food-related methane emissions in a scenario that's compatible with the 2 degree goal.

- I don't think anyone knows what sort of long-run level of agricultural methane would be a sustainable one for NZ in the context of world food production. But it would be safe to assume that with all the extra people that need to be fed in this world, the methane emissions from animals, rice paddies and so on will have to be reduced to fit within whatever flow of emissions we can afford and still stay within two degrees. Unlike nitrous oxide, the goal is not so much net zero as reducing them as much as possible. AgResearch and others are busy working on a variety of strategies to do just this. And of course dietary preferences will become increasingly important.

- So to go right back to the beginning, is the way forward just a matter of including agricultural emissions in the ETS? I'm not sure. There are a number of pieces to the emissions jigsaw in NZ. The fact that they add up to a single ‘picture’ which describes our contribution to global warming doesn’t necessarily imply a single all-embracing policy instrument. Let me recap those elements. New Zealand:

  - has contributed a lot of long-lived gases to the atmosphere – the bulk historically came from land use change but today almost all is from fossil fuel combustion (and some big industrial processes like steel and cement manufacture) and nitrous oxide from farming;
  - has clawed some of that CO_2 back as production forests and is making a bit of progress from reversion of pasture to scrub and forest; and
  - contributes an on-going flow short-lived methane from agriculture.

- Now it’s not too hard to see how in a short time-frame New Zealand, with its abundant renewables, could eliminate coal and gas from energy generation. And with more time – dependent on vehicle developments off-shore and renewable electricity generation expansion at home – it should be able to eliminate a large percentage of transport emissions.

- Dealing with transport and energy emissions using a cap and trade scheme seems pretty sensible. You know you have to go to zero – you set the cap on a downward path and let it play out with the price dictating when new technologies make their appearance including – and these will be necessary – negative emissions technologies that enable us to sequester carbon permanently. For the reasons I have given, forest sinks can offer very little by way of offset and their permanence cannot be guaranteed. They shouldn’t necessarily be tradable with fossil fuel emissions.

- As another long-lived gas, one could argue that nitrous oxide from agriculture should also be part of the ETS. It is certainly true that it is in the same ‘basket’ of long-lived gases. But that doesn’t necessarily mean that it has to be in the ETS. A tax could arguably be a simpler and better way to incentivize change. Or maybe the government could work directly with the pastoral sector to implement mandatory changes in management practices to set these emissions on a steadily downwards path. As with emissions from cement, steel and aviation, it is likely that negative emissions technologies will be needed to off-set the emissions we can’t eliminate. And as I hope I’ve made clear, that is not pine forests.

- When it comes to methane from agriculture we’re not dealing with a long-lived gas. The aim here should be to minimise it. And there’s a good production efficiency reason to do that anyway. I’ve suggested that forestry sinks don’t belong in the same basket as CO_2 emissions. But they might be an appropriate offset for methane since here we are talking about buffering the heating associated with a short-lived gas. You would need some careful science to come up with a respectable basis for such an offset but it might be worth thinking about a second 'basket' linking methane and other short-lived gases with improved forest cover.[7]

- There could be some appealing practical land management dividends. Although individual landowners manage their own land as best they can, the long-run productivity and sustainability of land-use plays out over wider areas – sub-catchments, catchments, ultimately the entire landscape. Impacts on one property can affect water quality and biodiversity loss far away. Anything that can encourage landowners to work collaboratively for better sustainability outcomes at the level of landscapes should be welcomed.

- However these gases are tackled, I'm not convinced that it makes sense to lump everything into the same scheme – for two reasons: firstly, aided and abetted by the common currency of the GWP metric, it can unwittingly encourage a mismatching of timeframes and risks: very long-lived carbon emissions being offset against forest sinks whose permanence can't be guaranteed; an over-preoccupation with agricultural methane because of its short term potency compared with, say, nitrous oxide that stays around much longer.

- Secondly, a common policy instrument also mixes up very different industries with very different physical and monitoring characteristics which face very different challenges – and very different lobbying weights. The political economy reality of the climate challenge is that the sectors with the most intractable emissions and no immediately obvious alternative technologies have the most to gain from delaying action. By combining all gases in a single 'basket', every lobbyist is invited to the same party with the result that more rapid progress in some sectors is delayed because of arguments with 'hard' sectors.

- Maybe a two baskets approach – one based on agricultural emissions, one based on fossil emissions – might be a better way forward provided it respects the different imperatives that attach to long and short-lived gases. Whether the agricultural one relied on a cap-and-trade instrument or a mix of other instruments would be a matter for debate. But one thing is clear: industrial agriculture, as we practice it in countries like New Zealand, cannot exempt itself from its share of responsibility for climate change. Taking the long view, being the most efficient and productive food producer in the world will, in part, be linked to being the most sophisticated in responding to the challenge of climate. A climatically disordered world will not be an easier place to farm. Lower inputs and

7 Australian researchers have suggested that 1 tonne of carbon sequestered would offset an ongoing methane emission rate of roughly 1 kg CH_4 per year. See Lauder et al. (2013), "Offsetting methane emissions — An alternative to emission equivalence metrics", *International Journal of Greenhouse Gas Control*, Volume 12, Pages 419–429, http://dx.doi.org/10.1016/j.ijggc.2012.11.028.

more resilient production systems will be essential. So getting on with the job is more important than designing the perfect policy instrument.

- The choice of regulatory versus market-based instruments obviously has consequences for the resource management profession. A trading scheme like the NZ ETS has to operate separately from the RMA. Indeed, the development of the NZ ETS has shielded RMA practitioners from many climate considerations. But if a different, more sectorally nuanced approach was taken, that might not continue to be the case. As Taupo has demonstrated, land, water, biodiversity and climate do not exist in separate silos. So understanding the synergies between them is really important in choosing tools to address the array of environmental pressures we face.

- In terms of meeting their international commitments under the Paris Agreement, countries live in a bottom-up world. Countries will take an interest in each other's efforts – or lack of them. But it is firmly in the hands of individual countries to design their responses. The fact that the UNFCCC system may, for reporting purposes, have decided to lump long and short-lived gases into a single basket does not dictate how countries tackle their emissions. The goal of trying to meet a temperature target means we cannot ignore the different characteristics of the gases we are trying to manage. While they can be managed as part of a common trading system covering all gases, they could also be managed differently. But they need to be managed. Either a clear date is set to include agricultural emissions in the NZ ETS, or alternative pricing and regulatory measures need to be developed. In the wake of Paris further deferral of action is not an option.

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