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Current Commentary

The 2015 Paris Climate Change Conference: COP21

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Introduction and overview

COP21[1] is the latest in the annual "Conference of Parties", which began in Berlin in 1995, with a main aim to review the implementation of the "Rio Convention" – the UN Framework Convention on Climate Change[2] (UNFCCC) – which entered into force on the 21 March 1994. The UNFCCC was adopted at the Rio de Janeiro Earth Summit of 1992, and sets out an overall framework intended to stabilise atmospheric concentrations of greenhouse gases (GHGs) so to "prevent dangerous anthropogenic interference with the climate system." The UNFCCC membership is now practically universal and, as of December 2015, consists of 197 parties. Some of the more significant conferences (and their associated actions) include COP3 (Kyoto Protocol adopted), COP11 (Montreal Action Plan agreed), COP15 in Copenhagen (agreement not achieved to implement the Kyoto Protocol) and COP17 in Durban (Green Climate Fund agreed). COP21 stands out from all previous conferences[1], in that it aimed to limit the rise in global temperatures to "well below" 2 °C above pre-industrial levels (with the background target being 1.5 °C), by establishing a universal agreement on climate, among all the nations of the world, that is legally binding. The negotiations at COP21 led to the "Paris Agreement"[3] being adopted on 12 December 2015, which governs measures for climate change reduction from 2020, and concluded the work of the Durban platform, which was set out as part of the activities of COP17.

However, it is required[3] that 55 countries which produce at least 55% of the world's greenhouse gas emissions (Figure 1) ratify the Agreement, in order for it to enter into force and become fully binding. The Agreement must be signed in New York between 22 April 2016 and 21 April 2017, by these parties, who must also assimilate it, as appropriate, within their own legal systems, *via* ratification, acceptance, approval, or accession. However, it is speculated that some parties, particularly the United States, may not agree to do so. Indeed, although it is a requirement that each country that ratifies the agreement must set a target for its reduction in emissions, there is no compulsory amount for this[4]. Moreover, there is to be no means to compel the setting of a target by a specific date nor

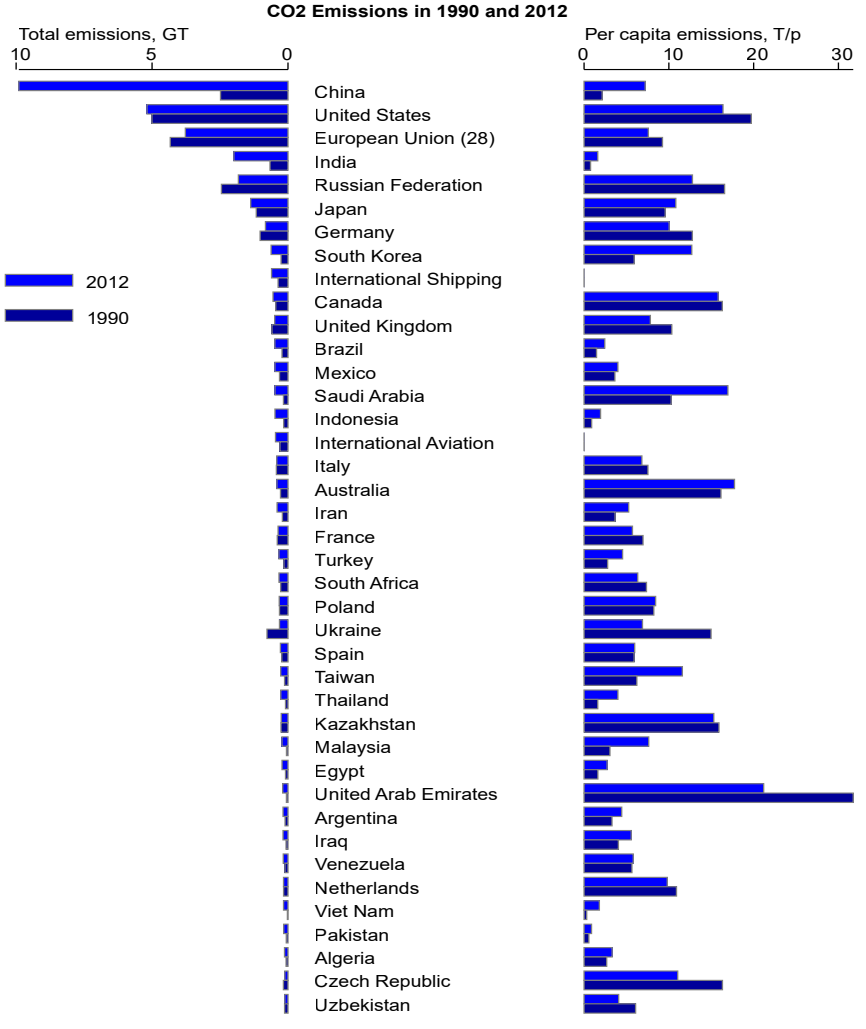

Figure 1 *Shows the top 40 CO_2 emitting countries in the world in 1990 and 2012, including per capita figures. The data are taken from the "EU Edgar database", and includes figures for international shipping and airlines, which are not included in countries' submissions. (This does not include domestic air traffic.) https://upload.wikimedia.org/wikipedia/commons/5/54/Co2-1990-2012.svg Credit: Chris55.*

penalty measures imposed should a set target not be met[4] (in contrast with the more specific and draconian Kyoto Protocol). Any noncompliant countries will merely be "named and shamed", which has contributed to severe criticism of the whole enterprise, *e.g.* by such eminent figures as James Hansen, who is quoted[5] as saying:

"It's a fraud really, a fake." "It's just bullshit for them to say: 'We'll have a 2 °C warming target and then try to do a little better every five years.'

It's just worthless words. There is no action, just promises. As long as fossil fuels appear to be the cheapest fuels out there, they will be continued to be burned."

At COP21, particular focus has been given to two primary issues: namely, whether the critical temperature limit should be set at 1.5 °C or 2 °C above preindustrial levels; and the appropriate level of funding that should be awarded by developed nations to developing countries that are potentially vulnerable to sea-level rise, and to expectedly more severe weather events[5]. In Hansen's view, all of this carries little weight without taxes for greenhouse gas emissions being imposed equally and globally, being of the belief that this is the only strategy that can drive reductions in greenhouse gas emissions at the relatively rapid rate that is necessary to mitigate the worst possible scenarios of climate change[5]. However, the United States Secretary of State, John Kerry has opposed Hansen's criticisms of COP21, and is adamant that the deal will auger in a global replacement of fossil fuels by renewable energy sources[6]. It should be noted too, that Hansen is on a list of "deniers" (as they have been termed[7]) who believe that it will be necessary to expand the production of nuclear energy, to implement the necessary reduction in carbon emissions, since insufficient renewable energy can be installed to maintain global civilisation without the fossil fuels[8]. This is not the view of Mark Jacobson of Stanford University, however, who has concluded[9,10] that we can run the world entirely using renewable energy sources. (It is worth noting that a "middle route" is offered in the report, "Zero Carbon Britain", published by the Centre for Alternative Technology [CAT], at Machynlleth in west Wales, which concludes that we can essentially maintain our level of civilisation in the United Kingdom [and by implication, elsewhere], by curbing our overall use of energy by 60%, electrifying our transportation network, changing our use of land [and accordingly our diet], with the wholesale installation of a mixture of renewable energy sources[11]).

The Agreement[3] calls for zero net greenhouse gas emissions to be achieved during the second half of the 21st Century. However, if the temperature increase is limited to 1.5 °C, it has been suggested[12] that the goal of zero net emissions must be attained during a significantly earlier period, 2030–2050.

The international community is to provide an annual $100 billion[13] to be made available to developing countries by 2020, to support mitigation and adaptation actions for developing economies. In the Agreement, it is noted that the "peaking of greenhouse gas emissions" across the globe will be different for different nations. Beyond the peak, the emissions would decrease quickly, "so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainability development and efforts to eradicate poverty" (Article 4.1).

Friends of the Earth International has declared[13] the document to be a "sham" and "the outcome of deception and bullying", believing that the

demands on the developed nations were relatively modest, in comparison with the benefits they had accrued. The agreement was further reproved in that compensation mechanisms for damage that cannot be repaired are not included, and that the projected finance is not sufficient for the tasks required[13]. We may note too that, on the basis of the Intended Nationally Determined Contributions (INDCs) (draft national climate contributions, presented publically[14] prior to the conference by 146 national climate panels), a temperature rise of nearer 3 °C might be anticipated. "Climate Action Tracker", which is an independent analysis made by a consortium of four research organisations (Climate Analytics, ECOFYS, the New Climate Institute and the Potsdam Institute for Climate Impact Research), suggests that, on the basis of the COP21 national emissions commitments, the temperature increase is more likely[14] to be 2.7 °C by 2100.

In his timely book based on the conference, Albert Bates has noted[15] that:

"The adoption of The Paris Agreement by 195 countries on December 12, 2015 marks the end of the era of fossil fuels. There is no way to meet the targets laid out in this agreement without keeping 90 percent or more of remaining coal, oil and gas in the ground. The final text still has some serious gaps, and the timetable will have to speed up, but the treaty draws a red line on atmospheric CO_2 we cannot cross. As science, economics and law come into alignment, a solar-powered economy beckons.

"In heralding the adoption of the Paris agreement, President Barack Obama said this agreement sends a powerful signal that the world is firmly committed to a low-carbon future. And that has the potential to unleash investment and innovation in clean energy at a scale we have never seen before."

Indeed, from a recent study[16] published in the journal Nature by Christophe McGlade and Paul Ekins, researchers at University College London, it was concluded that it will be necessary to leave some two-thirds of the fossil fuels available to us unburned, to achieve just a 50% chance of keeping global warming within the 2 °C limit. From their analysis, they deduce more specifically that it is necessary to leave one-third of the oil, half of the gas and more than 80% of the world's coal in the ground, up to 2050.

This is in line with previous studies, but the real significance of the work is the particular geographical regions that will be most affected, if these findings are turned into global policy. In particular, the Middle East would have to leave half of its oil and gas unburned, while Russia and the United States could only burn about 5% of their coal reserves. 85% of Canadian oil sands (bitumen) reserves and 95% of Venezuelan extra-heavy oil reserves are described as "unburnable". The study is based on a model[16] which limits the total amount of carbon emitted to the atmosphere at 1100 Gt in the form of cumulative carbon emissions between 2011 and 2050.

COP21 and "4 per thousand" – storing carbon in the soil

It would have been a remarkable oversight, had not our use of the land and its soils featured among the discussions about climate change mitigation at COP21. However, at the conference was hosted a side-event and official launch of the "4 per thousand" initiative[17], which aims to increase soil carbon over a 25 year period[18], with the effect of halting the annual increase in CO_2 in the atmosphere. It is important to be clear about what "4/1000" means: it is not an increase in the overall soil carbon by an annual "4 grams per kilogram of soil" as has been claimed[19], but an increase in the existing carbon in the topsoil by 0.4% per year. This has been described from an Australian perspective[20]:

"Let us start with the analogy of a football field (soccer, not rugby!). Imagine it is a fifth larger than normal – making it one hectare in size. The top layer of soil on the field, 30 cm deep, is known as the topsoil.

"Carbon is the main ingredient of organic matter, so organic matter is often referred to as 'soil organic carbon'. In Australian soils, this organic matter makes up on average, between 1 and 3 percent of the topsoil. For the purpose of the exercise, we will assume that the topsoil on the football field contains 1.5 percent carbon. This equates to 58 tonnes of carbon in the topsoil across the whole football field. What the French Government is calling for is to increase that 58 tonnes by 0.4 percent per annum – in our imaginary football field that would equate to an increase of 0.2 tonnes (or 200 kg) of carbon in the topsoil each year."

Thus, the annual carbon increase is 0.4% of 1.5%, or 0.006%, giving a total soil carbon content of 1.506% after year one, and 1.65% after 25 years, with around six tonnes of carbon having been captured per hectare. Done on the global scale, the impact could be enormous. The "4/1000 Initiative: Soils for Food Security and Climate"[21] aims to integrate agriculture as part of the climate change solution, rather than being the major problem it is often deemed to be, which along with forestry and other land use, contributes 24% of global greenhouse gas emissions[22]. The total amount of carbon stored in soils is reckoned at 2400 billion tonnes, making it the largest terrestrial carbon pool[23]. The top 2 m of soil in fact hold four times the amount of carbon that is stored in plant biomass, and soils offer the potential to store carbon over long periods by means of different protective mechanisms. The total carbon emissions by humans amounts to an annual 8.9 billion tonnes, and so the ratio 8.9/2400 = 0.4%, which is the origin of the "4/1000" ratio (Figure 2).

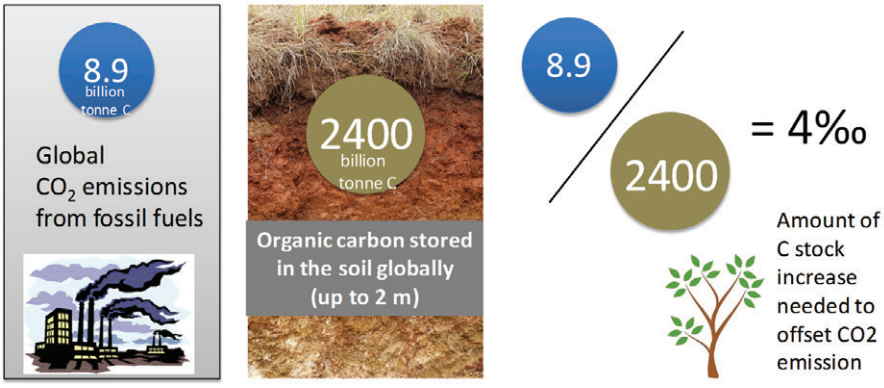

Figure 2 *The 4 per 1000 soil carbon sequestration initiative. Taken from http://sydney.edu.au/news/agriculture/1272.html?newsstoryid=15532*

However, it is the annual rate of carbon sequestration per hectare which is the critical determinant of how successful the strategy is likely to be. As has been noted[23]:

"The land area of the world has 149 million km^2, and it would be estimated that on average there are 161 tonnes of C per hectare. So 0.4% of this equates to an average sequestration rate to offset emissions at 0.6 tonnes of C per hectare per year. We know that soil varies widely in terms of C storage, for example peat soils in the tropics hold about 4000 tonnes of C per hectare, while sandy soils in arid regions may only hold 80 tonnes of C. The type of above ground vegetation and how quickly the soil biota uses the carbon also can affect this rate. Taking this into account, we would need to add about 4 times the amount of organic matter to meet this sequestration rate."

Previous studies[23] have concluded that a global mean storage rate of 0.5 tonnes of carbon/hectare/year is possible, after the adoption of best management practices such as reduced tillage in combination with legume cover crops. Using digital soil mapping techniques, Stockmann *et al*.[24] have produced a map of global soil carbon stock (up to 1 m) at a resolution of 1 km, on the basis of which the annual sequestration rate (corresponding to 0.4% of the C stock) can be calculated (Figure 3). The C sequestration rate varies from 0.2 tonne per year in agricultural regions of Australia and the United States to 1 tonne per year in boreal areas. Research from the Rodale Institute concluded that if their regenerative practices[25] were carried out across the world's agricultural lands, it would be possible to capture all human carbon emissions. Thus, while achieving a global "4/1000" poses an appreciable challenge[26], even approaching this target would be of considerable benefit, not only in terms of helping to balance the global carbon books, but in improving and restoring the quality of the world's soils[27–29]. The world's cultivated soils are estimated have lost between 50 and 70% of their original carbon content, a trend that can be

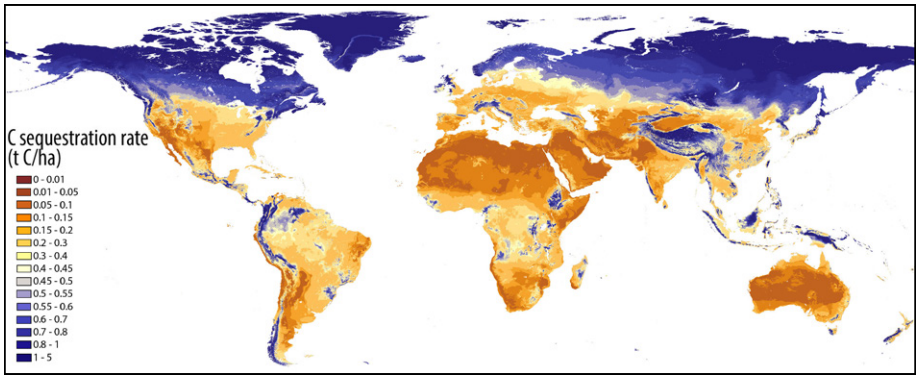

Figure 3 *Global soil C required sequestration rate (tonne C per ha per year) to achieve the 4 per 1000 initiative. Taken from http://sydney.edu.au/news/agriculture/1272.html?newsstoryid=15532*

reversed by using defined agricultural methods. The result is more productive, carbon-rich soils, and so the strategy is able to "reconcile food security and climate change."[30]

The essential methods[31] for 4/1000:

- Avoid leaving the soil bare in order to limit carbon losses;
- Restore degraded crops, grasslands and forests;
- Plant trees and legumes which fix atmospheric nitrogen in the soil;
- Feed the soil with manure and composts;
- Conserve and collect water at the feet of plants to favour plant growth.

If good practices are introduced and sustained, it is expected that the carbon capture will continue for 20 to 30 years.

As applied to the surface horizon of the world's soils[32], which contain 860 billion tonnes of carbon, the 4/1000 target would result in 3.4 billion tonnes of carbon being stored annually, which amounts to around 40% of anthropogenic CO_2 emissions. The majority of soils, not only agricultural soils, could be so addressed, including forests. The above practices could be undertaken by almost half the world's population, who live in rural areas, and work 570 million mainly small farms. It has been estimated[32] that for crops, the costs would be $20 to $40 (US) per tonne of CO_2, and for grasslands and forests, it would be $50 or $80 (US) per tonne of CO_2.

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