Environmental Health Risk Assessment to Correct Climate Change Policymaking Failure

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Summary

This paper is a call for using global environmental health risk assessment of climate change (atmospheric greenhouse gas pollution and associated air pollution) as a way to correct persisting climate change policy failure. A rapidly increasing global surface temperature and unprecedented high levels and rates of increase of Atmospheric GHG concentrations are presented as proof of an extreme state of global environmental health emergency. The 2015 UN Paris Agreement is not an emergency response in any manner. Policy failure correction and IPCC AR5 based emergency intervention are proposed.

Note: For the Intergovernmental Panel on Climate Change (IPCC) references, the Summaries for Policymakers (SPMs) represent a consensus of all scientists on the panel and a consensus of all the world governments (by way of their policymaker representatives on the IPCC panel). Other references are a consensus of all the IPCC scientists.

Policy intention

What is our policy intention with respect to the situation generally described as global climate change? The IPCC does not perform a full environmental health risk assessment with conclusions and recommendations.

Rajendra Pachauri, when explaining that he supports a goal of stabilizing the concentration of atmospheric carbon dioxide at 350 parts per million, said, “As chairman of the Intergovernmental Panel on Climate Change (IPCC) I cannot take a position because we do not make recommendations. But as a human being I am fully supportive of that goal” (as reported by Brainard 2009).

The IPCC does not make conclusions on the climate change situation with respect to dangerous interference with the climate system (DAI). Though DAI is in fact a safety level of atmospheric greenhouse gas (GHG) concentrations in the 1992 UN Framework Convention on Climate Change (UNFCCC), the intergovernmental and UN authorities (IPCC, UNEP, UN Climate Secretariat) do not include a GHG atmospheric safety limit.

Article 2 of the UNFCCC states:

> The ultimate objective of this Convention is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. (UNFCCC 1992)

For a single global environmental health safety limit, the atmospheric GHG concentration has policy relevant advantages over the global average surface temperature increase. Unlike the global temperature increase the atmospheric GHG concentrations provide an indication of the rate of radiative forcing increase, future committed (locked in) increased temperature (and climate change) and increased ocean acidification.

Atmospheric CO2 is an adequate indicator (main source of global warming and only source of ocean acidifcation) , but CO2 equivalent concentration accounts for all the GHGs and is the better indicator.

The greatest of all risks would be a runaway carbon dynamic and oceans ecosystem and marine life (separately or in today's situation together), which would be expected to render the planet uninhabitable.

The IPCC (2007) Fourth Assessment Report (AR4) Working Group 3 recognized risks of several catastrophic climate change impacts:

> The possibility of abrupt climate change and/or abrupt changes in the earth system triggered by climate change, with potentially catastrophic consequences, cannot be ruled out. … Increases in the frequency of droughts or a higher intensity of tropical cyclones could occur. Positive feedback from warming may cause the release of carbon or methane from the terrestrial biosphere and oceans, which would add to the mitigation required. (IPCC 2007b, 2.2.4)

The IPCC AR5 (2014) recognized such impacts.

Within the 21st century, magnitudes and rates of climate change associated with medium to high emission scenarios (RCP4.5, RCP6.0 and RCP8.5) [i.e.all but the bet case RCP 2.6 scenario] pose a high risk of abrupt and irreversible regional-scale change in the composition, structure and function of marine, terrestrial and freshwater ecosystems, including wetlands, as well as warm water coral reefs. Examples that could **substantially amplify climate change** are the boreal-tundra Arctic system and the Amazon forest (AR5 SYR Long report page 74, my emphasis).

Medical and climate change experts at the 2008 American Public Health Climate Change Conference defined catastrophic climate change as:

> Climate change that would result in extinction of up to 50% of terrestrial and marine species, sea-level rise leading to the displacement of tens to hundreds of millions of people, and changes in regional climate that would cause profound disruption to regional food production and the hydrologic cycle (e.g., worse droughts, more severe rain events with flooding and consequent damage). (Schwartz 2008)

The UNFCCC (1992) has clearly defined, specific intentions. The overriding intention is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (DAI)."

From UNFCCC Article 2 Objective, we find the following policy intentions:

- food security for the most vulnerable populations
- health security for the most vulnerable countries and populations
- ecosystem safety
- sustainable development

From UNFCCC Article 3 Principles, the policy intentions are:

- intergenerational equity
- the precautionary principle

The UNFCC intentions and principles fit well with environmental health risk assessment with respect to the impacts and risks to human populations from global climate change.

What is the evidence for climate change policy failure?

The first IPCC assessment was in 1990, and the first UN Conference of the Parties to the climate change convention was in 1995 – the same year as the second IPCC assessment. Yet today, emissions and atmospheric concentrations of all main greenhouse gases are at a record post-industrialization high. "The atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years" (IPCC 2013, 9).

Beyond dangerous anthropogenic interference with the climate system

Atmospheric greenhouse gas concentrations have, for some years, already exceeded the levels for dangerous anthropogenic interference with the climate system.

In retrospect, looking at the adverse impacts projected by the AR4 Working Group 2 (IPCC 2007a) clearly shows that 1°C or less is the danger limit using the parameters of the 1992 UN climate convention; going by the absolute future committed warming of 1.5°C it is even more obvious. 2°C is far beyond dangerous climate interference by the UN climate convention parameters. There is a very large difference in impacts and severity between 1.5°C and 2°C.

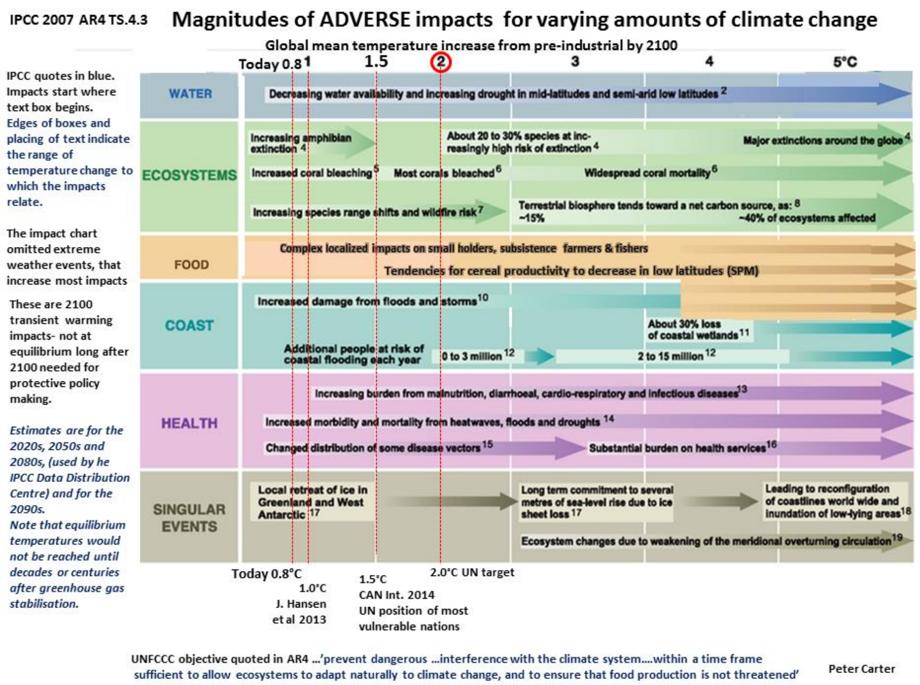

Figure 1: Magnitudes of Adverse Impacts
Source: Adapted from IPCC (2007a) AR4 TS.4.3.

In 2006, John Holdren (Professor of Environmental Policy at Harvard University) started delivering his climate change science lecture, "Meeting the Climate Change Challenge," in which he said:

> The stated goal of the UNFCCC – avoiding dangerous anthropogenic interference in the climate – is in fact unattainable, because today we are already experiencing dangerous anthropogenic interference. The real question now is whether we can still avoid catastrophic anthropogenic interference in climate. (Holdren 2006)

In 2008, James Hansen and others concluded that the atmospheric concentration of carbon dioxide was beyond dangerous. "The present global mean CO2, 385 ppm, is already in the dangerous zone…. [W]e show that it is conceivable to lower CO2 this century to less than the current amount, but only via prompt policy changes" (Hansen *et al.* 2008, 2).

In 2013, Hansen and 17 other international experts of various disciplines relevant to global climate change found the safety limit to be 1°C of warming from 1850 for the calculation of their carbon budget, saying "Our budget is that required to limit warming to about 1°C" (Hansen *et al.* 2013, 21).

To put it simply, we are already experiencing an increase in a wide range of climate change impacts, and we are committed to a much higher degree of global climate change than is already causing these increases. Many disastrous climate change-driven impacts – such as extreme weather events, which are already occurring on all continents – are committed to greatly increase (IPCC 2014).

Current and already committed climate change impacts explained in the IPCC AR5 (2014) are proof that we are already beyond DAI – an extreme risk of catastrophic global climate change to which the world is being committed, if not already committed.

Current and already committed climate change impacts

We are locked in to a committed warming of 1.5°C by 2030-2040. "In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans" (IPCC 2014b, 9).

Ocean acidification has increased 26% (IPCC 2014, 10), and "will continue to increase under all conditions and scenarios" (IPCC 2013, 25). For all scenarios except the best-case (RCP2.6) emissions scenario, "ocean acidification poses substantial risks to marine ecosystems, especially polar ecosystems and coral reefs, associated with impacts on the physiology, behavior, and population dynamics of individual species from phytoplankton to animals.… Ocean acidification acts together with other global changes (e.g., warming, decreasing oxygen levels)" (IPCC 2014b, 17).

For all scenarios but the best-case (RCP2.6) emissions scenario, there are risks of abrupt, irreversible changes and large amplifying climate feedbacks. These are enormous risks to the survival of human populations and most other life because they would greatly boost the rate of warming and climate change over a very long future term. According to the IPCC (2014b), within this century, magnitudes and rates of climate change for all other scenarios "pose high risk of abrupt and irreversible regional-scale change in the composition, structure, and function of terrestrial and freshwater ecosystems, including wetlands" (15).

> Examples that could lead to substantial impact on climate are the boreal-tundra Arctic system and the Amazon forest. Carbon stored in the terrestrial biosphere (e.g., in peatlands, permafrost, and forests) is susceptible to loss to the atmosphere as a result of climate change, deforestation, and ecosystem degradation. Increased tree mortality and associated forest dieback is projected to occur in many regions over the 21st century, due to increased temperatures and drought. Forest dieback poses risks for carbon storage and biodiversity. (IPCC 2014b, 15)

The IPCC (2014) reported that increases in many extreme weather events are increasing and severely impacting ecosystems and human populations.

> Impacts from recent climate-related extremes, such as heat waves, droughts, floods, cyclones, and wildfires, reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability (very high confidence). Impacts of such climate-related extremes include alteration of ecosystems, disruption of food production and water supply, damage to infrastructure and settlements, human morbidity and mortality, and consequences for mental health and human well-being. (IPCC 2014d, 16)

"Some risks of climate change are considerable at 1 or 2°C above preindustrial levels" (IPCC 2014b, 15). The IPCC (2013-2014) Fifth Assessment Report (AR5) changed everything that had been reported before on food security. While it has long been known that the tropical regions would be more vulnerable to the impacts of climate change on their crop yields, previous assessments assumed that the temperate northern hemisphere, at least by 2100, was not vulnerable and might even gain some crop yield increase. Recent research has found that this is not, and is not going to be, the case, showing that climate change is already having negative effects on most if not all major food-producing regions.

> Assessment of many studies covering a wide range of regions and crops shows that negative impacts of climate change on crop yields have been more common than positive impacts (high confidence). The smaller number of studies showing positive impacts relate mainly to high-latitude regions, though it is not yet clear whether the balance of impacts has been negative or positive in these regions. (IPCC 2014d, 144)

It is therefore not surprising that the IPCC Working Group 2 scientists projected that all major crops in all major food-producing regions would be affected negatively above a local and global temperature increase of 1°C (at 1.6°, global and local warming are the same). “Temperature increases in excess of about 1°C above pre-industrial are projected to have negative effects on yields for the major crops (wheat, rice and maize) in both tropical and temperate regions” (IPCC 2014a, 3).

This is shown in the simplified IPCC (2014) graphs from crop projection, below.

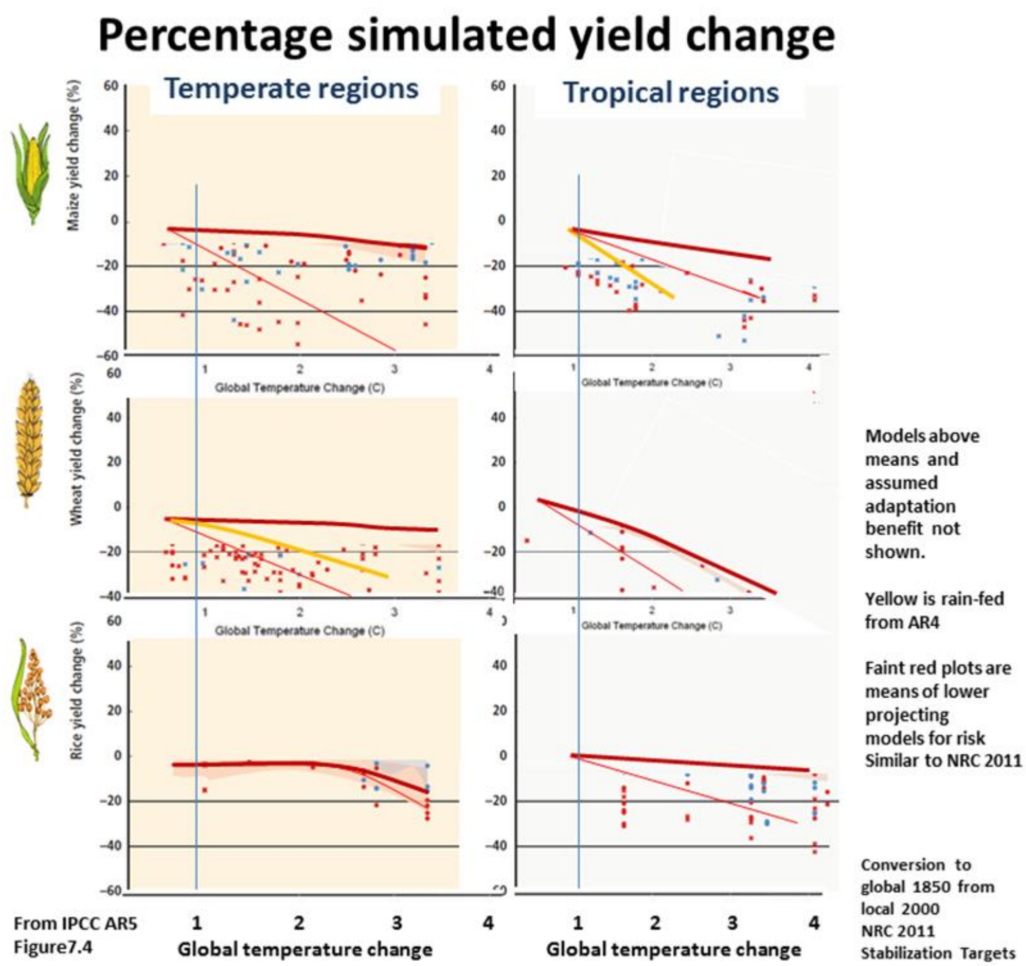

Figure 2: Percentage Simulated Yield Change
Source: Adapted from IPCC (2014a), Chapter 7, Figure 7.4

"Impacts from recent climate-related extremes, such as heat waves, droughts, floods, cyclones, and wildfires, reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability" (IPCC 2014b, 6).

"Some unique and threatened systems, including ecosystems and cultures, are already at risk from climate change and the number of such systems at risk of severe consequences is high at 1.6°C" (IPCC 2014a, Box SPM1).

Climate change commitment

For policymaking, we have to link the projected climate impacts with the committed warming (increasing temperatures), not only the warming in which the impacts are projected to happen. The IPCC (2013-2014) AR5 shows impacts up to 2100 linked to the realized warming by 2100. Prevention of, mitigation of, and adaptation to a particular impact of a particular temperature must be based on the full projected equilibrium warming.

There are, in general, two ways in which we are committed to a larger degree of climate change than we have today: by climate change policy and by climate system science.

i) The climate change policy commitment

This is derived from the combined national pledges or proposals made to the United Nations for emissions reduction. The most up-to-date calculation approved by climate change experts is from Climate Action Tracker.

> Limiting warming to the globally agreed goal of holding warming below a 2°C increase above pre-industrial in the 21st century means that the emissions of greenhouse gases need to be reduced rapidly in the coming years and decades. The unconditional pledges or promises that governments have made, as of early 2015, would limit warming to 2.9 to 3.1°C above pre-industrial levels. (Climate Action Tracker 2014)

This policy commitment, however, is considerably higher than 3°C because this is only a realized warming by 2100. The full committed equilibrium warming long after 2100 will be another 75%, so 5°C or more.

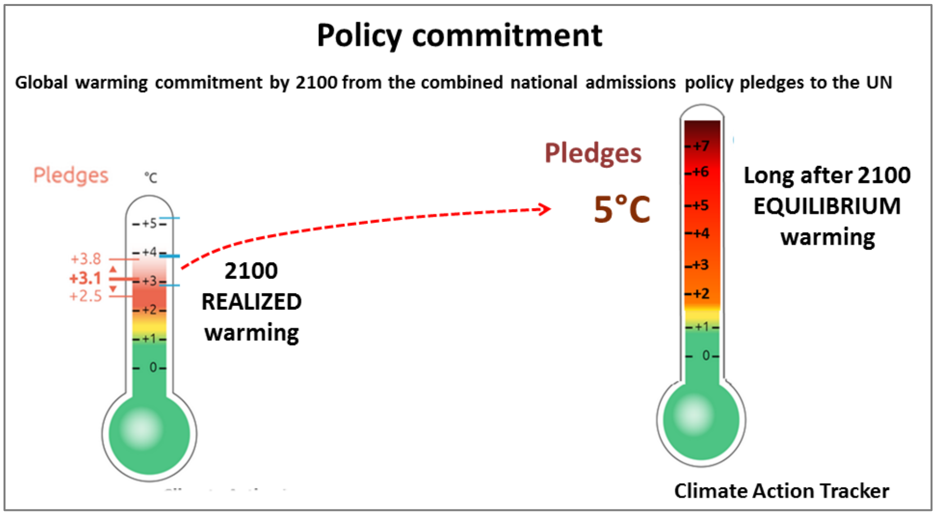

Figure 3: Climate Change Commitment by Climate Change Policy
Source: Adapted from Climate Action Tracker

The IPCC AR5 adds additional warming to equilibrium. "For the RCP4.5 and RCP6.0 extension scenarios with early stabilization, it is about 75% at the time of forcing stabilization" (IPCC 2013, 1103).

There appears to be some confusion in the climate change science with respect to whether the international 2°C target under the UNFCCC is 2°C by 2100, as originally intended, or 2°C equilibrium warming long after 2100. A recent paper published in 2012 investigating 2°C thresholds refers specifically to 2°C as being an equilibrium temperature increase. "A 450 ppm CO2e stabilization level can be associated with a long-term equilibrium temperature change of 2°C, using a best estimate for equilibrium climate sensitivity of 3°C" (Huntingford 2012).

ii) Climate system commitment

Today's global surface temperature increase of 0.8°C is already absolutely committed (or locked in) to increase to 1.5°C by 2100. According to the IPCC AR5, "The era of committed global climate change is 2030 to 2040," locking the world into a warming of 1.5° C by that time (IPCC 2014a, Figure 11.6).

Today's long-term equilibrium commitment long after 2100, due to the climate system inertia, is 2°C. "The current RF (radiative forcing) from greenhouse gases maintained indefinitely [i.e., the commitment from constant greenhouse gas concentrations] would correspond to approximately 2°C warming" (IPCC 2013, 1108).

The best possible outcome

In practical terms, even if emissions are declined from 2020, the best we can do is 1.6°C by 2100. The IPCC (2013) AR5 best-case possible emissions scenario, RCP 2.6, has a projected mean warming by 2100 of 1.6°C and a probability range up to 2.2°C. RCP 2.6 is the only scenario not above 2°C by 2100 and the only one that does not keep increasing further after

2100. This scenario for 2100 requires world emissions to be declining from 2020 and is likely to require negative admissions or carbon dioxide removal from the air, which has unknown feasibility. To remain below 2°0C after 2100, negative admissions will be required to continue for a very prolonged period after 2100. (See details and references in the RCP2.6 section, below.)

What is environmental health?

Environmental health relates to environmental factors that have an impact on socioeconomic and environmental conditions with the potential [risk] to increase human disease, injury, and death, especially among vulnerable groups – mainly the poor, women, and children under five (Acharya and Paunio 2008, 5).

What are the advantages of environmental health risk assessment (EHRA)?

i) EHRA offers conclusions and recommendations

Like most such academic papers, the results of environmental health risk assessment lead to conclusions and recommendations. IPCC assessment summaries for policymakers (SPMs) are approved by all world governments, however, IPCC assessments do not make conclusions on dangerous climate change or interference and do not make any recommendations. These are left to government policymakers to make. There is no international agreement or world government consensus on how dangerous the climate change situation is or the measures to take in response.

Agenda 21 (UNCED 1992) and the Johannesburg Plan of Implementation (WSSD 2002) established major goals to protect the environment and human well-being from the impact of substances emitted to the atmosphere. These emphasized the need to identify threshold levels of pollutants and greenhouse gases that cause "dangerous anthropogenic interference with the climatic system and environment" (UNCED 1992, Chapter 9).

ii) EHRA adheres to a very high degree of precaution and very low risk tolerance

Environmental health risks assessments use the precautionary approach or precautionary principle, which is not applied in IPCC assessments. One big example of this is climate sensitivity, which is the fundamental metric that applies to all levels of projection in the IPCC assessments. "The equilibrium climate sensitivity is defined as the change in global mean surface temperature at equilibrium that is caused by a doubling of the atmospheric CO2 concentration. Equilibrium climate sensitivity is likely in the range 1.5°C to 4.5°C […] and very unlikely (0-10% probability) greater than 6°C" (IPCC 2013, 24). No best estimate for equilibrium climate sensitivity can now be given because of a lack of agreement on values across assessed lines of evidence and studies.

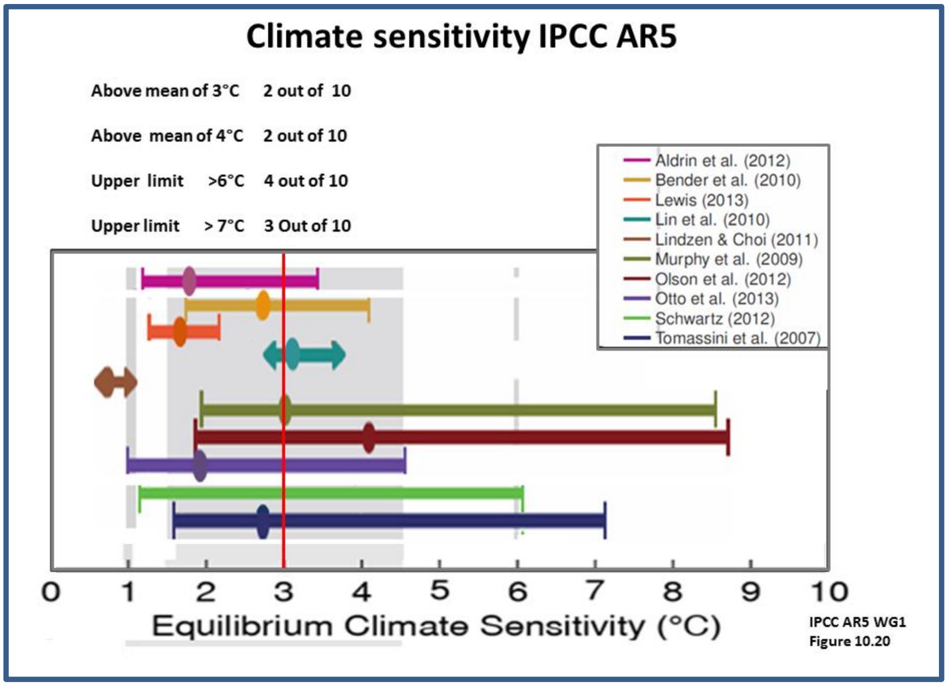

Figure 4: Climate Sensitivity IPCC (2013)
Source: Adapted from IPCC (2013) Figure 10.20

The only climate sensitivity metric used in the IPCC AR5 (2013-2014) assessment and in climate change projections by the science in general is 3°C, the mean of the truncated range above. It is clear from the above diagram that using only one climate sensitivity of 3°C effectively excludes the precautionary principle and risk, thereby affecting other projections in the assessment.

Research indicates that the real-life climate sensitivity is at the upper range of the IPCC range. “Climate models with ECS values in the upper part of the likely range show very good agreement with observed climatology” (IPCC 2013, 85). A climate sensitivity of at least 4.5°C would be used according to the precautionary principle and in consideration of risk for the environmental health risk assessment.

Conclusions, recommendations and all aspects and levels of an environmental health risk assessment are highly precautionary for substances determined to be very hazardous pollution, such as carcinogens and persistent organic pollutants. Some hazardous substances may be determined to have no safe threshold.

“In 1990, Congress established a health-based goal for the Clean Air Act: to reduce lifetime cancer risks from major sources of hazardous air pollutants to one in one million” (Pease 2011).

Environmental scientist and risk advisor, Dana Nuccitelli, pointed out that we are not applying the accepted environmental health air pollution risk assessment and prevention standards, and that “at the moment, climate change looks like humanity's greatest-ever risk management failure” (Nuccitelli 2013).

An environmental health risk assessment is done by worst-case scenario at all levels, whereas IPCC assessments provide a range of possible scenarios, not specifically the real world best-case or worst-case scenario. The several levels of projections in the IPCC (2013-2014) AR5 assessment give wide ranges of upper and lower limits of probability. The IPCC uses the means of these ranges (as in the climate sensitivity example, above). In the case of the IPCC assessments, this results in what the IPCC recognizes as a cascade of uncertainty. For an environmental health risk assessment, this would be recognized as compounding sources of error and increased risk.

iii) EHRA prioritizes vulnerable populations

An environmental health risk assessment is done specifically with respect to the most vulnerable populations, whereas although the IPCC assessment defines most vulnerable populations, the assessment is not specifically applied to these populations.

iv) EHRA works from the worst-case scenario at every level

The IPCC AR5 assessment assumes the success of or benefit from adaptation, whereas in an environmental health risk assessment, adaptation might be recommended but it cannot be included. The IPCC AR5 assessment says that risk can be reduced by adaptation, and rolls back impacts by assumed, projected benefits of adaptation. This is unacceptable from any perspective. Successful adaptation cannot be assumed in the case of the future and already committed impacts of global climate change, particularly because this future climate is an unprecedented, no-analog climate.

The very worst possible outcome of global warming is a future committed to uncontrollable amplifying feedbacks from multiple large sources. The large amplifying feedbacks are not included in the IPCC AR5 warming projections by 2100. For example: "The loss of carbon from frozen soils constitutes a positive radiative feedback that is missing in current coupled ESM projections" (IPCC 2013, 93).

"Accounting for an unanticipated release of GHGs from permafrost or methane hydrates, not included in studies assessed here, would also reduce the anthropogenic CO2 emissions compatible with a given temperature target" (IPCC 2013, 103)

"The overall spread of projections for the high RCPs [representative concentration pathway scenarios] is narrower than for comparable scenarios used in AR4 because in contrast to the SRES emission scenarios used in AR4, the RCPs used in AR5 are defined as concentration pathways and thus carbon cycle uncertainties affecting atmospheric CO2 concentrations are not considered in the concentration-driven CMIP5 simulations" (IPCC 2013, 18).

v) EHRA includes risks to future generations

The environmental health risk assessment includes risks to future generations as well as present, because some hazardous substances can be highly persistent in the atmosphere, and certain substances, such as some carcinogens, can affect the offspring of an affected individual.

vi) EHRA includes additive, synergistic, and cumulative impacts

The environmental health risk assessment includes potential additive, synergistic, and cumulative impacts, in this case from multiple fossil fuel pollutants and multiple climate change effects, while the IPCC assessment does not.

“Climate change, air quality and stratospheric ozone depletion are closely related, as individual pollutants can have multiple impacts on health, crop yields, ecosystems, cooling or heating of the atmosphere and stratospheric ozone depletion, all with the potential to affect human well-being” (UNEP 2012, 33). Many sources also emit multiple pollutants that can both affect air quality and cause climate change.

vii) EHRA involves community stakeholders

The environmental health risk assessment involves community stakeholders, while the IPCC assessment does not. Conversely, the environmental health risk assessment does not include the involvement of governments or policymakers, whereas the IPCC assessment is unique in that it does.

Fossil fuel greenhouse gas atmospheric pollution plus fossil fuel air pollution

In the environmental health risk assessment approach to global climate change, impacts are broader than in the IPCC assessment, because direct toxic effects from fossil fuel and pollution are included in addition to the health impacts of global warming and climate change. This is shown in the following illustration from the United Nations Environment Program’s (UNEP 2012) 5th Global Environmental Outlook (GEO5).

Impacts of and links between selected substances emitted to the atmosphere

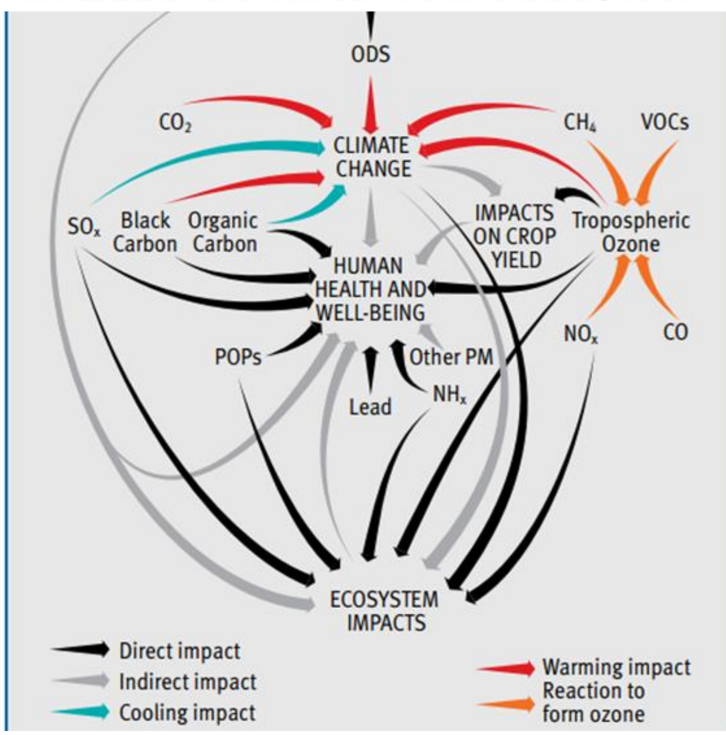

Figure 5: Impacts of and Links Between Selected Substances Emitted to the Atmosphere
Source: UNEP (2012) Figure 2.1

The environmental health risk assessment of climate change therefore shows that fossil fuel pollution and greenhouse gas pollution have an extremely large number of extremely serious health impacts.

This has a large effect on the IPCC climate change cost-benefit analysis. Governments rely mainly on cost-benefit analysis to make decisions regarding the protection of environmental health. Clearly, consideration of the full costs of fossil fuel and greenhouse gas pollution would change the net economic cost of climate change mitigation in the IPCC (2013-2014) AR5 to a considerable economic benefit. The economic costs of fossil fuel pollution are very much higher – and the economic benefits of climate change mitigation are also very much higher – than reported. "Estimates of the aggregate economic costs of mitigation vary widely depending on methodologies and assumptions, but increase with the stringency of mitigation…. [T]o limit warming to below 2°C through the 21st century relative to pre-industrial levels entail losses in global consumption – not including benefits of reduced climate change as well as co-benefits…" (IPCC 2014d, 24).

The large number of very severe health impacts and their many connections are shown by the flowchart from the National Institute of Environmental Health Sciences report (Portier *et al.* 2010). The dotted red line is added here to divide the direct fossil fuel and pollution toxic effects to the left and the fossil fuel atmospheric greenhouse gas pollution health effects to the right.

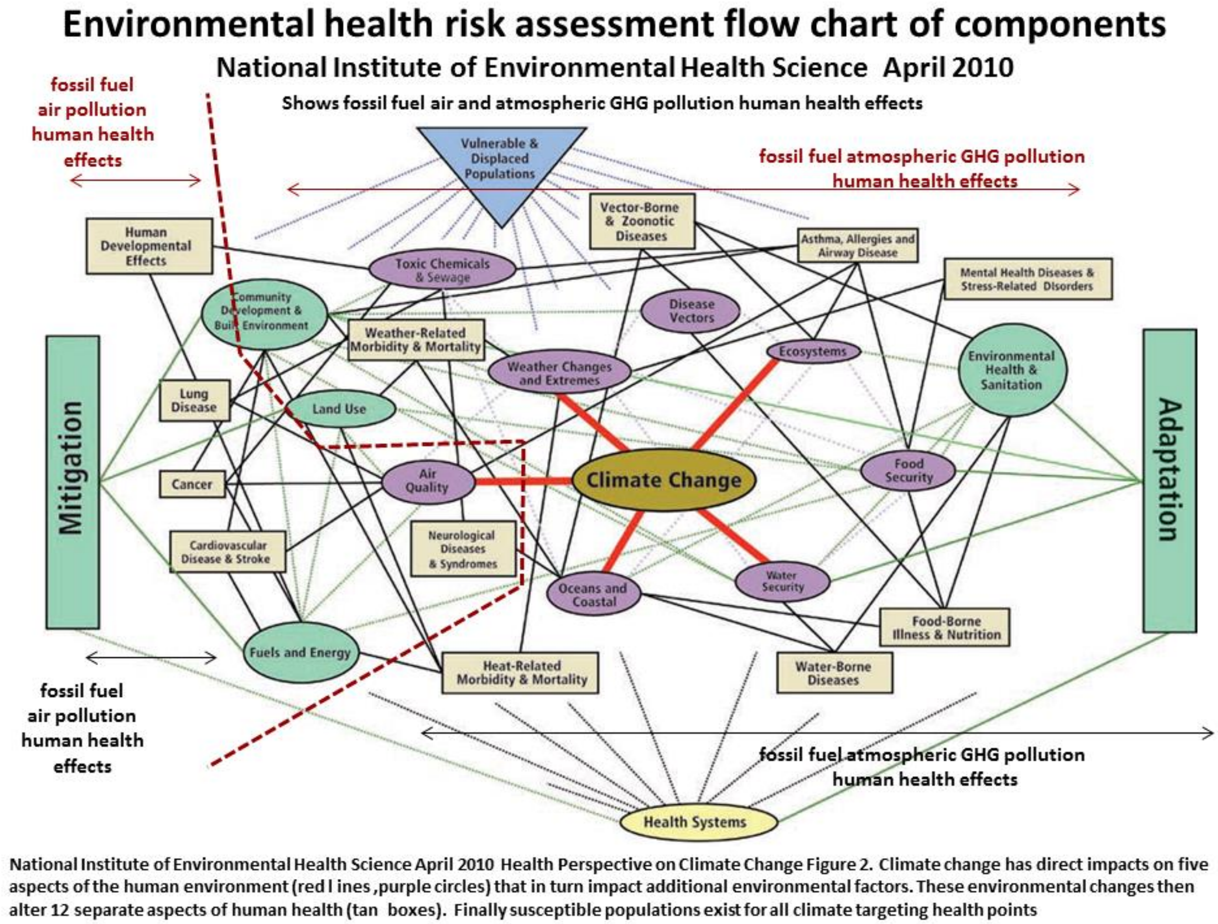

Figure 6: A human health perspective on climate change, adapted from National Institute of Environmental Health Sciences
Source: Portier *et al.* (2010), Figure 2

The health impacts included in the environmental health risk assessment of global climate change are as follows – many more than are included in the IPCC climate change assessment (Institute of Environmental Health Science 2010, 2):

Crosscutting Issues for Climate Change and Health Susceptible, Vulnerable, and Displaced Populations

- Asthma, Respiratory Allergies, and Airway Diseases
- Cancer
- Cardiovascular Disease and Stroke
- Foodborne Diseases and Nutrition
- Heat-Related Morbidity and Mortality
- Human Developmental Effects
- Mental Health and Stress-Related Disorders
- Neurological Diseases and Disorders
- Vector-borne and Zoonotic Diseases
- Waterborne Diseases

- Weather-Related Morbidity and Mortality

“The safety of agricultural crops and fisheries also may be threatened through contamination with metals, chemicals, and other toxicants that may be released into the environment as a result of extreme weather events, particularly flooding, drought, and wildfires, due to climate change” (Portier 2010, 26).

Stringent environmental health control of air pollutants would make a significant contribution to global climate change mitigation. “Emission reductions aimed at decreasing local air pollution could have a near-term impact on climate” (IPCC 2013, 995). In addition, there are other toxic effects of fossil fuel combustion from mercury and lead.

There are also recognized benefits of integrating a pollution policy with climate change policy, in the manner of the environmental health impact assessment.

Simultaneous changes in the emissions of air pollutants and greenhouse gases need to be developed (Liao 2014, 178).

Toxic air pollution

According to the IPCC (2013), “Observational and modelling evidence indicates that, all else being equal, locally higher surface temperatures in polluted regions will trigger regional feedbacks in chemistry and local emissions that will increase peak levels of O3 and PM2.5” (957).

Air pollution has become the world's single biggest environmental health risk. “In new estimates released today, WHO reports that in 2012 around 7 million people died – one in eight of total global deaths – as a result of air pollution exposure. This finding more than doubles previous estimates and confirms that air pollution is now the world’s largest single environmental health risk” (World Health Organization 2014a).

The 2010 Health Perspective on Climate Change identifies an increase in a range of serious disorders from air pollution. “Numerous scientific studies have linked exposure to fine particle pollution to a variety of health problems including increased respiratory symptoms (irritation of the airways, coughing, difficulty breathing), decreased lung function, aggravated asthma, development of chronic bronchitis, irregular heartbeat, nonfatal heart attacks, and premature death in people with heart or lung disease” (Portier *et al.* 2010, 13).

Both particulate matter (PM) and surface ozone can cause chronic lung disease. For PM (called black carbon or soot) in climate change science and for tropospheric ozone, there are no known safe thresholds (UNEP 2012, 46; Frampton 2011).

Not specifically found in the literature but showing in the National Institute of Environmental Health Sciences flowchart (Portier *et al.* 2010, above) are the two human systems particularly impacted by both air pollution and climate change: the cardiovascular system and the respiratory system.

The most vulnerable populations to global climate change will be more vulnerable to increased air pollution. One obvious example is the increase in forest fires caused by global warming, which will severely affect the young and the elderly. Those with all forms of chronic lung or cardiovascular disease will be more vulnerable to such effects of global climate change. The largest of these effects on these same vulnerable subpopulations will be increasing heat waves from global warming.

Particulate matter air pollution

Particulate matter, especially the finer PM2.5, is the most important air pollutant causing damage to human health. Health research worldwide has shown that there is no safe threshold for exposure, as even very low levels cause health damage (UNEP 2012, 46). Impacts on health are predominantly associated with respiratory and cardiovascular illnesses, but the range of effects is broad for both acute and chronic exposure

There is a close, quantitative relationship between exposure to high concentrations of small particulates (PM10 and PM2.5) and increased mortality or morbidity (WHO 2014b.) All of the environmental health impacts recorded by the National Institute of Environmental Health Sciences (Portier *et al.* 2010) are linked to particulate matter air pollution.

Wildfires are increasing already under global warming with regional emissions of hazardous air pollutants. “Wildfires, which occur more commonly following heat waves and drought, release particulate matter and other toxic substances that may affect large numbers of people for days to months (IPCC 2014a, 729).

Tropospheric ozone

Tropospheric ozone is linked to respiratory impacts and causes significant morbidity and mortality. It is an air pollutant with toxic effects to human health, green plants, and hence crops. It is also a greenhouse gas. It is formed from air pollutants, mainly fossil fuels, reacting chemically in the presence of sunlight warmth. It is therefore expected to increase with global warming increase. Its deleterious effect on surface vegetation is expected to decrease the uptake of carbon dioxide by the terrestrial carbon sink, resulting in an amplifying feedback to climate change.

“Ground level ozone is formed through photochemical reactions that involve nitrogen oxides (NOx), carbon monoxide (CO), methane (CH4), and volatile organic compounds (VOCs) in the presence of sunlight and elevated temperatures. Therefore as temperatures rise, many air pollution models project increased ozone production, especially within and surrounding urban areas. There is observed evidence that tropospheric ozone increases in extreme heat, resulting in air pollution mortality” (IPCC 2014a, 728-729).

“Ozone concentrations tend to be higher at some distance – tens to thousands of kilometres – downwind of precursor pollutant sources, causing ozone to pollute at the local, regional and hemispheric scale” (UNEP 2012, 50).

Tropospheric ground-level or surface ozone is particularly hazardous and therefore important in air pollution and global climate change considerations for environmental health risk assessment. Ground-level ozone is particularly hazardous. It causes harm in three main ways:

> Firstly, surface ozone damages human health and its impact is considered second only to particulate matter. Secondly, surface ozone is the most important air pollutant causing damage to vegetation diminishing crop yields and forest productivity. Lastly, ozone is the third most important greenhouse gas after CO2 and methane. Reductions in biomass caused by ozone also influence the amount of carbon sequestered within terrestrial ecosystems. This effect is estimated to increase atmospheric CO2 concentrations such that the additional radiative forcing could exceed warming due to the direct radiative effect of tropospheric ozone in the atmosphere. (UNEP 2012, 48-50)

Climate Policy Responses

i) Climate Action Network International

The best response to climate change from a global environmental health risk perspective is the 2014 position statement by Climate Action Network (CAN) International, which represents civil society as an umbrella group for 900 organizations in over 200 countries. CAN International's position statement calls for a global warming limit by 2100 of 1.5°C, zero carbon emissions by 2050 to be accomplished by ending the fossil fuel era, and 100% replacement of fossil fuel energy by clean renewable energy. Their position on the replacement of all fossil fuel energy by clean renewable energy is most important, because there is no other way to achieve zero carbon emissions, and CAN International is the only source making this recommendation (CAN International 2014).

ii) IPCC AR5 RCP2.6

The best opportunity for responding to the catastrophic risks from atmospheric greenhouse gas pollution would be to use the IPCC (2013-2014) AR5 data in an environmental health risk assessment. However, the crucial United Nations Paris Conference of the Parties, COP21, is in December 2015, and we must have firm conclusions on the extent of today's dangers and the best recommendations to respond to them on a near-term basis. This could all be achieved by recommending the IPCC (2014) best-case emissions scenario, RCP2.6. This would have to be done very soon because this scenario calls for emissions to immediately stop increasing and to decline from 2020, as shown in the composite illustration from the IPCC AR5 temperature and emissions graphs below.

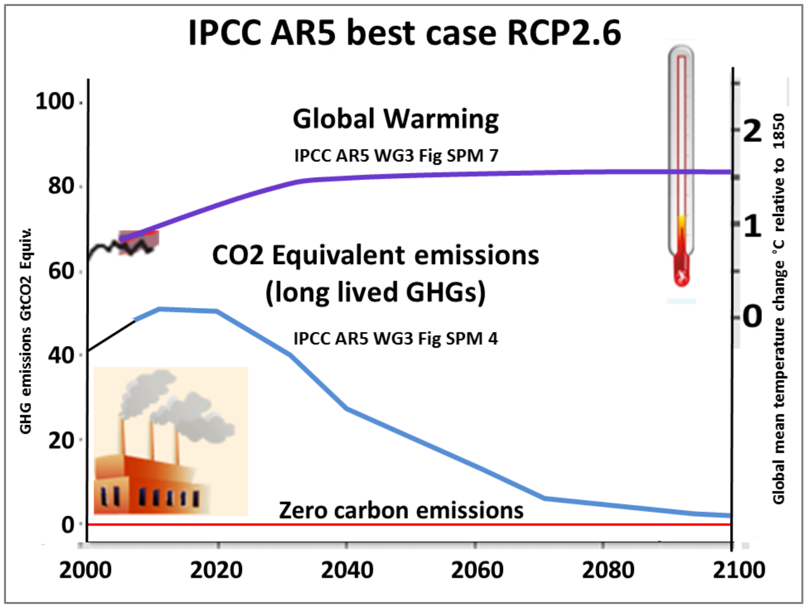

Figure 7: IPCC AR5 Best-Case Scenario RCP2.6
Source: Adapted from IPCC (2014c), Figure SPM7 and SPM4

"RCP2.6 is a scenario that aims to keep global warming below 2°C above pre-industrial temperatures" (IPCC 2014d, SPM2.1). "Warming will continue beyond 2100 under all RCP scenarios except RCP2.6" (IPCC 2013, WGI SPM E.1).

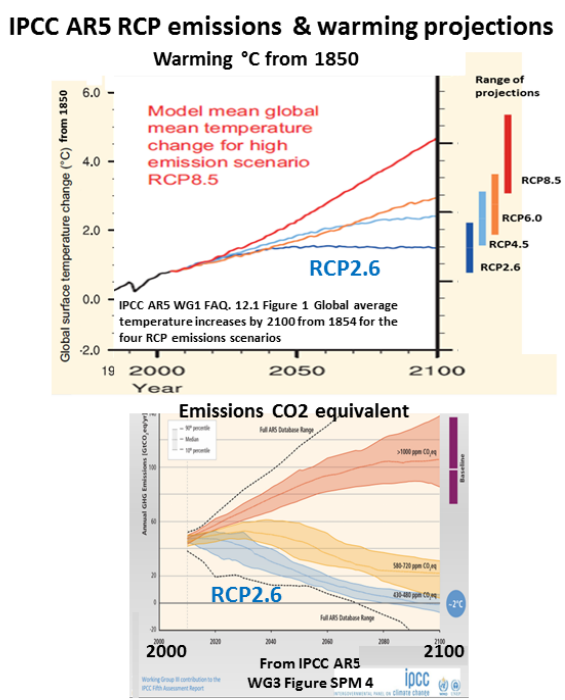

Figure 8: Global Warming and Emissions for the RCP Scenarios
Source: Adapted from IPCC (2013; 2014c)

Conclusion

Fossil fuel air pollution is highly toxic to most human body systems, with no known safe thresholds. Global climate change will increase that pollution, hence those risks.

Environmental health climate change safety limits (for dangerous anthropogenic interference) are already surpassed. The atmospheric CO2 danger limit for climate change and ocean acidification is 350 ppm CO2, according to Hansen and colleagues (2008) as well as IPCC (2007) AR4 and IPCC (2014) AR5 data. We are now at a warming of 0.85°C (IPCC 2014) and 400 ppm. The environmental health danger limit for global equilibrium temperature increase is 1.0°C, according to J. Hansen *et al.* (2013) and from IPCC data and impact projections. This is a committed climate change global environmental health and planetary emergency situation.

The safety limit for emissions is zero for the long-lived greenhouse gases. “These [mitigation] pathways would require substantial emissions reductions over the next few decades and near zero emissions of CO2 and other long-lived GHGs by the end of the century” (IPCC 2014d, 14). The faster we reach zero, the fewer the catastrophic risks to the life-supporting systems of the planet.

Recommendations

Unfortunately the UNFCCC negotiations are strict regarding sources of science and recommendations on climate change. The only government-recognized sources are the IPCC and the National Academies and Royal Societies. The latter are mandated to make reports or recommendations to their governments with respect to scientific issues of public importance. So while the IPCC does not make recommendations on climate change or ocean acidification, science academies could – and should – make policy recommendations to governments on climate change policy.

The last inter-academy statement on climate change was in 2009, addressed to the G8 prior to a G8 meeting in Italy. This recommended a 50% reduction in global emissions from 1990 levels by 2050, but did not recommend the year for emissions to peak and decline, and did not recommend the all essential zero carbon emissions target. “The national science academies of the G8 nations and Brazil, China, India, Mexico and South Africa have signed a statement on climate change and the transformation of energy technologies for a low carbon future” (Royal Society 2009). The statement called on world leaders, especially those meeting at the G8 Summit in L'Aquila, Italy.

Only the IPCC assessment could persuade the big economies to decline the emissions rapidly from 2020, as all governments have acknowledged and agreed to this emissions scenario through the IPCC scientists and policymakers consensus process.

Assuming there is no emergency-based emissions agreement at the Paris December 2015 UN climate conference, we have only a couple of years to get on track for the best-case RCP emissions scenario, RCP2.6. This scenario stops increasing right away and declines from 2020 at an increasing rate up to 2040. This would allow the option of continuing on the same rate of emissions decline after 2040, for a possibility of virtual zero emissions by 2050.

The best-case RCP emissions scenario must be acted on immediately as a matter of survival.

Though the Climate Action Network International and the most vulnerable nations are calling for a decline starting this year (2015), the UNFCCC agenda is for a possible post-2020 emissions decline. The current UNFCCC (2014) draft text, called the December 2014 Lima Call to Action, includes both the below 1.5°C limit and the 2°C target. On emissions, it has five different options representing the different positions of the nation Parties to the convention.

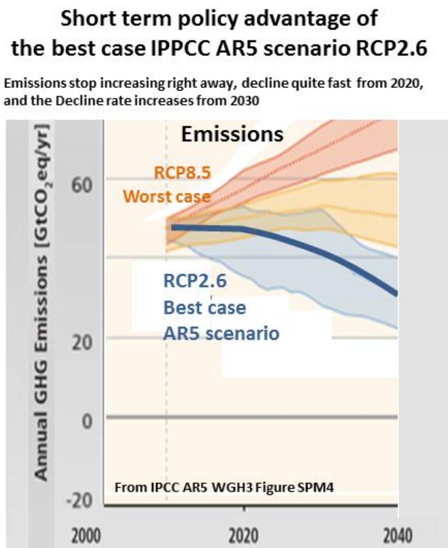

Figure 9: Short Term Policy Advantage of the Best-Case IPCC AR5 Scenario RCP2.6
Source: Adapted from IPCC (2014) Figure SPM4

If the world's science academies were to recommend RCP2.6 now, based on the IPCC (2014) AR5, there is still hope for our future. This is because the RCP2.6 scenario calls for omissions to stop increasing right away and to decline from 2020 after which they decline at an increasing rate until 2040. At 2040, the option will be open to keep the rate of decrease of emissions the same with a chance of achieving virtual zero, and emissions by 2050.

National governments, or their science academies, should commission a high precautionary / low risk tolerance environmental health risk assessment of fossil fuel air, water and atmospheric pollution. This would complement the IPCC AR5 assessment by including assessment conclusions and recommendations for the great benefit of the public to understand what the situation is and to drive the political will of certain governments. It would also provide the information to conduct a full cost / full benefit economic analysis of the risks and impacts of already committed climate change and conversion to a zero-carbon world economy for mitigation.

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