Chapter 2.1

Children suffer most from climate change and burning of fossil fuels

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Introduction

Climate change and its major human source, the burning of fossil fuels, have already inflicted disproportionate suffering on children and are seriously endangering their future health and well-being. The predicted trajectories for climate change and fossil fuel-related emissions of carbon dioxide (CO_2) and its toxic co-pollutants are alarming in terms of their future cumulative impacts on children. Until recently, the effects of climate change and fossil fuel emissions have not been jointly considered, resulting in a piecemeal and fractured accounting of the risks to children, and therefore an underestimate of both the urgency and the benefits of taking action.

This commentary builds on several excellent recent reviews of the direct and indirect effects of climate change[1,2,3] and a prior commentary[4] to present the case for an integrated assessment and a sharper focus on children as the lever for policy change. A fuller accounting is needed of the mounting public health, social, environmental and economic costs of climate change as they relate to children now and in the future so as to spur the "large and concerted global mitigation efforts" required.[5] This accounting must address the major issues of inequity: the disproportionate burden on the young; growing regional and socio-economic disparities in climate-change impacts; and the escalating threat to future generations.

Unfortunately, there have not been comprehensive estimates of the economic costs of climate change and fossil fuel burning and the corresponding benefits of concerted action – either overall or with respect to children. However, the limited estimates

1 Xu, Z., P. E. Sheffield, W. Hu, H. Su, W. Yu, X. Qi and S. Tong (2012). 'Climate change and children's health – A call for research on what works to protect children'. *Int. J. Environ. Res. Public Health, 9*(9): 3298–3316.

2 Sheffield, P. E. and P. J. Landrigan (2011). 'Global climate change and children's health: Threats and strategies for prevention'. *Environ Health Perspect,119*(3): 291–298.

3 Patz, J.A., D. Campbell-Lendrum, T. Holloway and J. A. Foley (2005). 'Impact of regional climate change on human health'. *Nature, 438*(7066): 310–317.

4 Perera, F. P. (2008). 'Children are likely to suffer most from our fossil fuel addiction'. *Environ Health Perspect, 116*(8): 987–990.

5 Peters, G. P., R. M. Andrew, T. Boden, J. G. Canadell, P. Ciais, C. Le Quéré et al. (2012). 'The challenge to keep global warming below 2°C'. *Nature Climate Change, 3*: 4–6.

that do exist indicate that such a concerted policy would have very large and escalating benefits: the estimated health-related costs of just six climate change-related events in the United States between 2002 and 2009 were about $14 billion and annual health-care costs were $740 million.[6] By 2020, an estimated $100 billion per year will be transferred from developed to developing countries for mitigation of greenhouse gas emissions and adaptation to climate change.[7] The avoided health costs (benefits) attributed to amendments to the US Clean Air Act are estimated to reach almost $2 trillion for the year 2020; this amount "dwarfs the direct costs of implementation ($65 billion)".[8]

Focusing on children is essential because the developing foetus and child are more biologically and psychologically vulnerable to the myriad direct and indirect effects of climate change and fossil fuel combustion. The foetus and child are especially susceptible to physical and psychological trauma, nutritional deprivation, infectious agents and environmental contaminants because of their dynamic developmental physiology and immature defence systems. They may therefore be affected by environmental exposures that have no apparent effects in adults.[2,4] In addition, the foetal period represents a window of susceptibility both to genetic damage[9] and epigenetic dysregulation from exposure to xenobiotics and stress.[10]

Considering both their inherent biologic susceptibility and their long future lifetimes over which early insults can be manifested as chronic disease or cognitive impairment, the foetus and child are considered especially vulnerable and at risk for the multiple, cumulative and long-term health impacts of climate change and fossil fuel-related air pollution.[1,2,4] These effects include increased incidence of malnutrition and infectious disease, physical and psychological trauma from extreme weather-related disasters, heat stress, respiratory disease, reproductive and developmental disorders, and cancer associated with various air pollutants (ozone, particulate matter, black carbon, polycyclic aromatic hydrocarbons, mercury, nitrogen and sulphur dioxides). Early impairment and disease can affect the physical and psychological health and well-being of children over their entire future life course. In addition, epigenetic effects of *in utero* and post-natal exposure to both toxic and psychological stressors may be inherited trans-generationally, thereby affecting the health of future generations.[10,11]

Because of their developmental susceptibility, children now bear a disproportionate share of the global disease burden. The World Health Organization (WHO) estimates that a third of the global burden of disease is caused by environmental factors and that children under 5 years of age bear more than 40 per cent of that burden, even though they represent only 10 per cent of the world's population.[12] According to WHO estimates based on the disability-adjusted life years metric, more than 88 per cent of the existing global burden of disease due to climate change occurs in children under 5 years of age.[13] Most of that burden is felt in developing countries and populations of low socio-economic status, which squarely raises the issue of environmental justice. These disparities related to age, region and socio-economic status will continue to grow under the projected trajectory of climate change.[2] In addition, the internationally recognized right of current and future children to a healthy, sustainable life[14,15] is violated by our failure to address climate change and its root cause, our dependence on fossil fuel.

Human-induced climate change is a real and escalating threat

There is no longer legitimate scientific debate over whether human-induced climate change is 'real'. Since 2009, it has been recognized as the biggest global health threat of the twenty-first

6 Knowlton, K., M. Rotkin-Ellman, L. Geballe, W. Max and G. M. Solomon (2011). 'Six climate change-related events in the United States accounted for about $14 billion in lost lives and health costs'. *Health Aff (Millwood), 30*(11): 2167–2176.

7 OECD (2011). *Development perspectives for a post-2012 climate financing architecture.* Paris: OECD Publishing.

8 US Environmental Protection Agecy (2011). *The benefits and costs of the Clean Air Act from 1990 to 2020.*

9 Perera, F. P., D. Tang, R. M. Whyatt, S. A. Lederman and W. Jedrychowski (2004). Comparison of PAH-DNA adducts in four populations of mothers and newborns in the US, Poland, and China. In *Proceedings of the 95th AACR Annual Meeting,* 27–31 March 2004. Orlando, Fl: American Association for Cancer Research. 454.

10 Dolinoy, D. C., J. R. Weidman and R. L. Jirtle (2007). 'Epigenetic gene regulation: Linking early developmental environment to adult disease'. *Reprod Toxicol., 23*:297–307.

11 Perera, F. and J. Herbstman (2011). 'Prenatal environmental exposures, epigentics, and disease'. *Reprod Toxicol., 31*(3): 363–373.

12 Prüss-Ustün, A. and C. Corvalán (2006). *Preventing disease through healthy environments: Towards an estimate of the environmental burden of disease.* Geneva, Switzerland: World Health Organization.

13 Zhang, Y., P. Bi and J. E.Hiller (2007). 'Climate change and disability-adjusted life years'. *J Environ Health, 70*(3): 32–36.

14 World Commission on Environment and Development (1987). *Our common future* (Brundtland Report). Oxford, UK: Oxford University Press.

15 General Assembly of the United Nations (1989). 'Convention on the Rights of the Child'. *United Nations, Treaty Series,1577*: 3.

century.[16] We have seen its face in the increased frequency and intensity of weather-related disasters such as Hurricanes Katrina and Sandy in the United States in 2005 and 2012, an epidemic of forest fires in the United States and Australia in 2012, flooding in Pakistan and Australia in 2010 and 2011, drought in East Africa in 2011, and a deadly heatwave in Europe in 2003.

Lending urgency to the issue is the latest report on the trajectory of CO_2 emissions from the Global Climate Project, which shows that emissions of CO_2 from fossil fuel burning reached a historical high of 9.7+0.5PgC (35.6 billion tonnes) in 2012.[5] The observed growth rates are at the top end of all previous emissions scenarios. As a result, CO_2 atmospheric concentrations are approaching (some say have already exceeded) the point where the ultimate increase in the Earth's temperature will exceed the international goal of limiting the increase to 2° Celsius (3.6° Fahrenheit) above pre-industrial levels so as to avoid catastrophic consequences.[5]

A shift to a pathway that would meet that goal is still possible but requires "high levels of technological, social and political innovations and an increasing need to rely on net negative CO_2 emissions in the future … Unless large and concerted mitigation efforts are initiated soon, the goal of remaining below two degrees Celsius will very soon be unachievable".[5] The present climate change models do not account for feedback loops such as the release of vast amounts of methane, a much more potent greenhouse gas than CO_2, which result from the melting of permafrost at higher temperatures.[17]

China, the United States, the European Union (EU) and India are the major CO_2 emitters, largely from burning of coal, liquid fuel (diesel, gasoline and oil) and natural gas. Emissions reductions in the developed countries have been offset by rapid growth in developing countries such as China and India. By 2035, China is expected to emit 55 per cent and the United States 12 per cent of the world's total carbon emissions from coal.[18] Motor vehicle emissions currently contribute 22 per cent of CO_2 globally and are playing an increasing role in developing countries.[19] In addition, black carbon from diesel engines, primitive cook stoves and forest fires is the second most important contributor to long-term climate change.[20]

As reviewed here, the scientific basis for action to protect children is in place; what is needed is the political will to take that action. A full reckoning of the predicted effects on current and future children of continued global warming and its proximal cause, fossil fuel burning, would be a powerful driver of such action, since protection of children and future generations is the most widely shared value among all peoples, capable of trumping self-interest.[14,21]

Climate change and children's health

Human-induced climate change has already significantly harmed children's health and well-being and has placed current and future children on a predicted trajectory of increasing ill health and an unsustainable future.

While there are few quantitative estimates of the proportion of childhood morbidity and mortality due to human-induced climate change, there is scientific agreement that both direct and indirect effects of climate change have already taken a significant toll on children and are predicted to increase dramatically unless action is taken. The following summary is based on prior reviews of the known and potential effects of climate change and fossil fuel emissions and the mechanisms of vulnerability with respect to each.[1,2,3,4]

WHO[22] estimated that climate change from the mid-1970s onwards contributed to more than 150,000 deaths and about 5 million lost disability-adjusted life years worldwide in 2000 alone through increases in diseases such as diarrhoea, malnutrition and malaria, mainly in developing countries.[3] This estimate was conservative since it considered only a partial list of health outcomes. WHO estimated that the climate change-induced excess risk of this limited number of outcomes would more than double by 2030.

16 Costello, A., M. Abbas, A. Allen, S. Ball, S. Bell, R. Bellamy et al. (2009). 'Managing the health effects of climate change: Lancet and University College London Institute for Global Health Commission. *Lancet, 373*(9676):1693–1733.

17 Anthony, K. M. W., P. Anthony, G. Grosse and J. Chanton (2012). 'Geologic methane seeps along boundaries of Arctic permafrost thaw and melting glaciers'. *Nature Geoscience, 5*(6): 419–426.

18 Kirkland, J. (ClimateWire) (2011). 'China's booming economy may produce the majority of world coal emissions by 2035 – EIA', *New York Times,* 4 February.

19 International Energy Agency (2012). *CO_2 emissions from fuel combustion 2012 – Highlights.* Paris: IEA.

20 Bond, T. C., S. J. Doherty, D. W. Fahey, P. M .Forster, T. Berntsen, B. J. DeAngelo et al. (2013). 'Bounding the role of black carbon in the climate system: A scientific assessment'. *Journal of Geophysical Research: Atmospheres, 118*(11): 5380–5552.

21 Schene, P. A. (1998). 'Past, present, and future roles of child protective services'. *Future Child, 8*(1): 23–38.

22 WHO (2002). *The world health report 2002: Reducing risks, promoting healthy life.* Geneva: WHO.

The regions bearing the greatest burden of climate-sensitive diseases are those with the lowest capacity to adapt to risks, yet they have contributed the least in global emissions of greenhouse gases.

Malnutrition and infectious disease represent the largest share of the burden of childhood morbidity and mortality attributed to climate change.[2] Children are more vulnerable than adults to famine and nutritional deprivation since they require three to four times the amount of food on a body weight basis than adults. Children represent the majority of the global population afflicted by hunger.[1] Dysfunction from inadequate nutrition during early development can last a lifetime. Children's immature immune systems make them more susceptible to infectious disease pathogens (e.g., cholera and other diarrhoeal diseases) from crop and water contamination due to storms and floods, as well as to vector-borne diseases (e.g., malaria and dengue fever) which have increased in certain regions due to climate change.[3] Cholera and other diarrhoeal diseases claim the lives of almost 2 million children each year in the developing world.[23] Salmonella, a food-borne infectious disease, has also been affected by higher temperatures across much of continental Europe.[3] Malnutrition places children at higher risk of infectious disease.

Climate change has increased the frequency and intensity of weather-related disasters (floods, droughts, cyclones and hurricanes), which directly affected an estimated 66.5 million children worldwide, 600,000 of whom died, every year from 1990 to 2000.[24] The number affected is predicted to rise to 175 million a year.[25] Children are highly vulnerable both to physical trauma from such disasters and to stress experienced by their mothers during pregnancy or that they experience in childhood directly or through their caretakers.[1,2] Drowning and displacement due to floods and famines associated with drought are major causes of fatality and malnutrition of children in developing countries. According to a recent study, rates of sea level rise between 1993 and 2011 exceeded by 60 per cent the highest projections made by the International Panel on Climate Change (IPCC) in 2007,[26] making coastal storms more dangerous for coastal infrastructure and inhabitants.[27]

Another direct effect of climate change is an increase in the frequency of deadly heatwaves, like the one that resulted in 22,000–40,000 heat-related deaths in Europe in 2003.[3] Heatwaves are predicted to become more frequent and severe in cities such as Chicago and Paris, with large increases predicted for the western and southern United States and the Mediterranean region. The direct effects of heatwaves on children include hyperthermia, heat stress, renal disease and respiratory illness,[28] to which infants and children are especially vulnerable due to their immature regulatory systems.

Air pollution levels have significantly increased as a result of climate change and fossil fuel burning, with direct impacts on children's health.[4,29] Both ambient and indoor air quality are affected by these increases due to the penetration of pollutants into the indoor environment.[30] Children are more vulnerable to air pollutants because they have a higher respiratory rate and take in more air on a body weight basis than adults. Their immature metabolic/detoxification, DNA repair and immune systems place them at greater risk from inhaled toxicants (including ozone, particulate matter, polycyclic aromatic hydrocarbons, mercury, sulphur and nitrogen oxides) and toxins (such as aeroallergens).

Direct toxic effects of fossil fuel combustion pollutants include increased infant mortality, lower birth weight, deficits in lung function, respiratory symptoms, childhood asthma, bronchitis, developmental disorders, and increased risk of cancer.[4] The many observed adverse effects are not surprising, given the diversity of fossil fuel combustion products.[31] What is more, the same pollutant can exert multiple toxic effects. Exposure to air pollution

23 WHO (2013). *Facts and figures: Water, sanitation and hygiene links to health.*

24 Pronczuk, J. and S. Surdu (2008). 'Children's environmental health in the twenty-first century'. *Ann N Y Acad Sci, 1140*:143–154.

25 Save the Children UK (2007). *Legacy of disasters: The impact of climate change on children.*

26 Rahmstorf, S., G. Foster and A. Cazenave (2012). 'Comparing climate projections to observations up to 2011'. *Environmental Research Letters, 7*(4): 044035.

27 Columbia Climate and Health Program (2012). 'Sea level rising faster than expected'. *Emerging Climate Findings Archive*, November.

28 Knowlton, K., M. Rotkin-Ellman, G. King, H. G.Margolis, D. Smith, G. Solomon et al. (2009). 'The 2006 California heat wave: Impacts on hospitalizations and emergency department visits'. *Environ Health Perspect, 117*(1): 61–67.

29 Intergovernmental Panel on Climate Change (IPCC) (2007). 'Human health'. In *Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC.* Geneva, Switzerland.

30 Zhao, Z., Z. Zhang, Z. Wang, M. Ferm, Y. Liang and D. Norback (2008). 'Asthmatic symptoms among pupils in relation to winter indoor and outdoor air pollution in schools in Taiyuan, China'. *Environ Health Perspect, 116*(1): 90–97.

31 Bernard, S. M., J. M. Samet, A. Grambsch, K. L. Ebi and I. Romieu (2001). 'The potential impacts of climate variability and change on air pollution-related health effects in the United States'. *Environ Health Perspect, 109*(Suppl 2): 199–209.

in childhood may result in a reduction in lung function and ultimately in increased risk of chronic respiratory illness[32,33] and greater susceptibility to cardiovascular disease in adulthood.[33]

With respect to climate-related changes in air pollution levels, higher temperatures due to climate change accelerate the formation of ozone from its precursors (volatile organic chemicals, carbon monoxide and nitrogen dioxide). Under the high-emission IPCC scenario, daily average ozone levels could rise by 3.7 ppb across the eastern United States, with projected ozone-related deaths from climate change increasing by 4.5 per cent in the mid-2050s, compared with the levels of the 1990s.[3,34] The seemingly small relative risk translates into a substantial attributable risk because so many millions of adults and children are exposed. In addition to increased mortality, ozone is associated with decreased lung growth and function, and exacerbation of asthma and respiratory tract infection in children. A median increase of 7.3 per cent in summer ozone-related emergency department visits for asthma in children is projected for the New York City metropolitan region by the 2020s.[35]

Higher temperatures and greater CO_2 concentrations also promote the growth of aeroallergens (such as pollens and mould), leading to more allergic disease and asthma in children.[36] Given their developing immune and respiratory systems, children are particularly sensitive to these exposures.

Another source of air pollution exacerbated by climate change is forest fires that are increased by higher temperatures and lower soil moisture, releasing large amounts of particulate matter, including black carbon. These pollutants are associated with respiratory symptoms, decreased lung growth and function, and exacerbation of asthma and chronic bronchitis in children.[1] Increased temperatures in areas of decreased precipitation are also resulting in the volatilization of persistent organic pollutants and pesticides, to which children's developing nervous systems are particularly vulnerable.

The current effects of climate change and fossil fuel emissions may currently be dwarfed by the burden from lack of sanitation and hygiene, urban air pollution, indoor smoke from solid fuels, and lead exposure, but the burden of climate- and pollutant-sensitive disease is expected to grow substantially in future years and decades.[2] This brief review has highlighted the many elements of susceptibility of the developing foetus and child resulting from their rapid development, immature defence mechanisms, and vulnerability to genotoxic and epigenetic damage from environmental and psychosocial stressors. Another element of children's susceptibility is that they have more future years of life during which exposures are ongoing and during which latent effects of early undernutrition, neurodevelopmental, reproductive and respiratory effects can manifest in disease or impairment.

Mitigation and adaptation strategies

To be effective, prevention and adaptation strategies to climate change must be centred around the needs of children.[1,2,4] In 2007, the IPCC concluded that significant progress towards stabilizing or reducing global warming emissions can be achieved at relatively low cost using known technologies and practices currently available.[37] A concurrent McKinsey report concluded that the United States could reduce greenhouse gas emissions in 2030 by 3.0–4.5 gigatons of CO_2 equivalents by using tested approaches and high-potential emerging technologies, and that the net cost of achieving these levels of emissions abatement could be quite low on a societal basis.[38] More recently, Jacobson and Delucchi evaluated the feasibility of providing all energy for all purposes (electric power, transportation and heating/cooling), everywhere in the world, from wind, water and the sun. They concluded that the barriers to a 100 per cent conversion to wind, water and solar power worldwide are primarily social and political, not technological or

32 Gauderman, W. J., R. McConnell, F. Gilliland, S. London, D. Thomas, E. Avol et al. (2000). 'Association between air pollution and lung function growth in southern California children'. *Am J Respir Crit Care Med, 162*(4 Pt 1): 1383–1390.

33 Shea, K. M. (2003). 'Global environmental change and children's health: Understanding the challenges and finding solutions'. *J Pediatr, 143*(2): 149–154.

34 Knowlton, K., J. E. Rosenthal, C. Hogrefe, B. Lynn, S. Gaffin, R. Goldberg et al. (2004). 'Assessing ozone-related health impacts under a changing climate'. *Environ Health Perspect, 112*(15): 1557–1563.

35 Sheffield, P. E., K. Knowlton, J. L. Carr and P. L. Kinney (2011). 'Modeling of regional climate change effects on ground-level ozone and childhood asthma'. *Am J Prev Med, 41*(3): 251–257; quiz A3.

36 Beggs, P. J. and H. J. Bambrick (2005). 'Is the global rise of asthma an early impact of anthropogenic climate change?' *Environ Health Perspect, 113*(8): 915–919.

37 IPCC (2007). *Fourth Assessment Report.* Geneva, Switzerland: IPCC and World Meteorological Organization.

38 McKinsey & Co. (2007). *Reducing US greenhouse gas emissions: How much at what cost?*

even economic.[39,40] These reports indicate that the cost of acting now to make power generation, transport, buildings and appliances more efficient and to invest in alternative fuels and technologies is modest compared with the benefits attached to reducing global warming and pollution from fossil fuels.

Environmental justice and intergenerational equity

Poverty increases the susceptibility of the foetus and child to the toxic exposures and stress that result from climate change and fossil fuel pollution. Poor and minority group children, especially those in urban areas and developing countries, are most at risk, because the effects of toxic exposures are magnified by the inadequate nutrition and psychosocial stress produced by poverty or racism.[41] The striking socio-economic inequalities that now exist in children's health within and between countries[42, 43] are exacerbated by global climate change.[44]

In addition to potentially heritable biological damage from climate change and fossil fuel emissions, other current and future impacts on children include social and political instability from forced migration and population displacement. This perpetuates poverty and civil unrest in low-income developing countries that already bear most of the global burden of poverty and childhood disease and where people aged under 18 years represent 50 per cent of the population.[2]

Finally, unless action is taken now, children and their progeny will inherit an unsustainable world, lacking the necessary ecological resources and services to support them. Climate change is a serious environmental challenge that could undermine the drive for sustainable development.[45] Climate change has already affected natural ecosystems that provide a range of services, often not recognized in national economic accounts but vital to human welfare: regulating water flows, flood control, pollination, decontamination, carbon sequestration, biodiversity conservation, and nutrient and hydrological cycling. These impacts include decreased biodiversity, inundation of large coastal areas and acidification of the oceans.

The right of children and future generations to a sustainable future has been internationally recognized. In 1987, the World Commission on Environment and Development, known as the Brundtland Commission of the United Nations, published a report, *Our common future*.[14] The report contained prescriptions for long-term environmental strategies to achieve sustainable development that met the essential needs of the world's poorest people while ensuring intergenerational equity. The rights of current and future children were subsequently reaffirmed by a United Nations convention.[15]

Growing concern over deteriorating environmental conditions has increasingly prompted legal systems around the world to recognize the interests of future generations and the corresponding responsibilities of present generations to protect them.[46,47,48] Intragenerational equity is not new, having been embodied in the constitution of the Confederacy of the Six Nations of the Iroquois, which required leaders to make decisions bearing in mind the 'seventh generation to come'. The failure to address climate change through concerted international action would clearly violate the principle of intergenerational equity that no significant environmental burden should be inherited by future generations.[14] The American Academy of Pediatrics concluded in 2007 that "Any solutions that address climate change must be developed within the context of overall sustainability (the use of resources by the current generation to meet current needs while ensuring that

39 Delucchi, M. A. and M. Z. Jacobson (2011). 'Providing all global energy with wind, water, and solar power, Part II: Reliability, system and transmission costs, and policies'. *Energy Policy, 39*(3): 1170–1190.

40 Jacobson, M. Z. and M. A. Delucchi (2011). 'Providing all global energy with wind, water, and solar power, Part I: Technologies, energy resources, quantities and areas of infrastructure, and materials'. *Energy Policy, 39*(3): 1154–1169.

41 Wood, D. (2003). 'Effect of child and family poverty on child health in the United States'. *Pediatrics. 112*(Suppl 3): 707–711.

42 Marmot, M. (2006). 'Harveian Oration: Health in an unequal world'. *Lancet, 368*(9552): 2081–2094.

43 Waterston, T. and S. Lenton (2000). 'Sustainable development, human induced global climate change, and the health of children'. *Arch Dis Child, 82*(2): 95–97.

44 UNICEF (2008). *Climate change and children: A human security challenge*, Florence: UNICEF Innocenti Research Centre.

45 Yohe, G. W., R. D. Lasco, Q. K. Ahmad, N. W. Arnell, S. J. Cohen, C. Hope et al. (2007). 'Perspectives on climate change and sustainability'. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden and C. E. Hanson, eds. *Climate change 2007: Impacts, adaptation and vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, UK: Cambridge University Press. 811–841.

46 Raffensperger, C., T. Giannini and B. Docherty (2008). *Models for protecting the environment for future generations.* Science and Environmental Health Network and The International Human Rights Clinic at Harvard Law School.

47 Atapattu, S. (2002). 'The right to a healthy life or the right to die polluted: The emergence of a human right to a healthy environment under international law'. *Tul. Envtl. L.J.,16*: 65.

48 Hill, B. E., S. Wolfson and N. Targ (2004). 'Human rights and the environment: A synopsis and some predictions'. *Geo. Int'l Envtl. L. Rev., 16*: 359.

future generations will be able to meet their needs)".[49]

Conclusion

Several factors now provide the impetus for the paradigm shift that is necessary: the large body of scientific knowledge concerning the biological vulnerability of the young to physical and psychosocial stressors resulting from climate change and fossil fuel pollution; the significant harm already inflicted on this vulnerable group; the awareness of striking disparities in those risks; and the politically powerful value shared by all cultures and communities of protecting the health and well-being of present and future children.[14,21]

The benefits of a child-centred policy on climate change and energy include the individual and societal benefits of millions fewer cases of deaths and disease in children, including those from malnutrition, diarrhoeal disease, infectious disease, heat stroke, asthma and allergies, developmental disorders and cancer. They also include the benefits of extending health and security to all the generations of children to come.

49 Shea, K. M. (2007). 'Global climate change and children's health'. *Pediatrics, 120*(5):1359-1367.