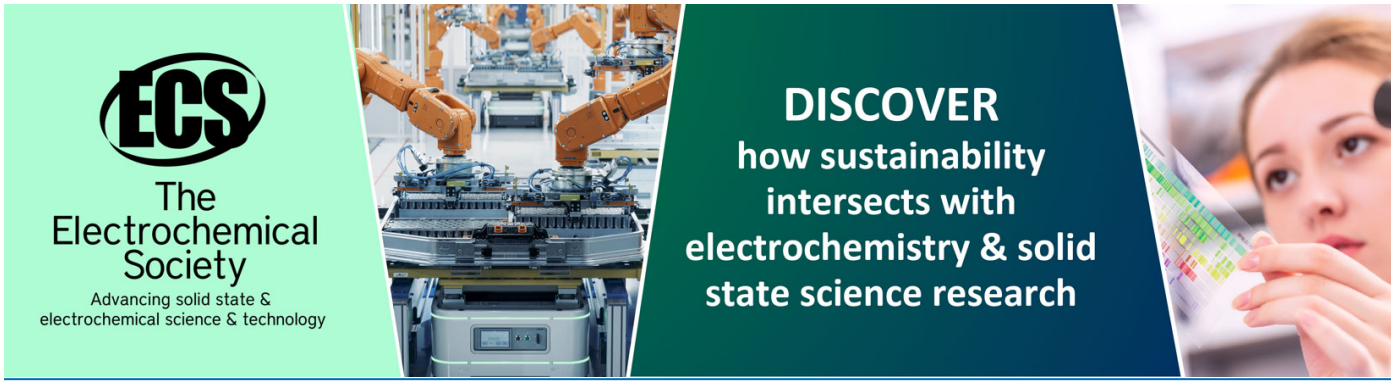
The ethical dilemma of climate change: How unequal is the global distribution of responsibility for and vulnerability to climate change?



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The ethical dilemma of climate change: how unequal is the global distribution of responsibility for and vulnerability to climate change?

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Anthropogenic climate change entails important consequences for international equity because both the causes of climate change and its impacts are unequally distributed across (and within) nations. The equity implications of climate change are attracting increasing attention in the run-up to the UNFCCC COP-15 in December 2009 because a comprehensive international agreement on climate change will only be agreed upon if it is considered fair by all parties to the UNFCCC. Therefore, the distribution of mitigation and adaptation costs across countries needs to consider their responsibility for climate change as well as their capacity to act, and the allocation of funds for adaptation needs to consider, among others, their vulnerability to climate change. Systematic analysis of the international equity implications of climate change has been limited so far (for notable exceptions, see [Patz et al., 2007, Srinivasan et al., 2008]. Such an analysis is complicated for several reasons. There are various potential metrics for climate change responsibility and capacity to act [Höhne et al., 2007]. Climate change affects diverse systems, and impact metrics are not necessarily commensurable [Schneider et al., 2000]. For some sectors and regions, scientific uncertainties do not even allow determining the direction of future impacts. Examples include price changes of staple crops on the world market [Parry et al., 2004] and regional changes in water availability [Milly et al., 2005]. Furthermore, there is considerable confusion as to the appropriate conceptualization of vulnerability to climate change, which may lead to very different vulnerability rankings of countries [Füssel, 2007].

This paper presents initial results of a systematic assessment of the international equity implications of climate change. This analysis relates aggregated national-level indices on the responsibility for climate change (represented here by fossil as well as total CO2 emissions per capita since 1990) with a wide range of indicators on exposure to climate change, biophysical sensitivity, socio-economic coping capacity, and impacts on agriculture, water availability, coastal zones, and human health. These indicators have been derived from international statistical sources as well as from model simulations of future climate impacts. Only indicators with near-global coverage were considered. All indicators were normalized for population (e.g., emissions per capita or percentage of population in coastal zones) to avoid spurious correlations. Absolute emission levels can be relevant for prioritizing countries whose participation in mitigation efforts is crucial but the responsibility to act depends on emissions per capita rather than the size of a country. Relationships between different indicators were investigated using Spearman's rank correlation and Kendall's tau_b. Pearson's correlation coefficient was not included here because the distribution of per capita emissions is strongly skewed and many vulnerability indicators are only available at ordinal scale.

Two generic (i.e., not sector-specific) results are particularly interesting. First, the fossil emissions index shows strong positive correlations with all aggregated indices on socio-economic coping capacity that include economic resources (e.g., Human Development Index, Human Assets Index, physical capital stock). Correlations are somewhat lower, but still highly significant, between fossil emissions and indices for coping capacity that do not explicitly include economic resources (e.g., government effectiveness) and between total emissions and all coping capacity indices. Thus, countries with low (fossil) emissions are not only least responsible for climate change, but they generally have lower socio-economic capacity to cope with adverse impacts of climate change. Second, the two national-level aggregated indices of climate change developed so far [Baettig et al., 2007, Diffenbaugh et al., 2007] are largely independent from each other. The correlation between the two is actually negative, but not statistically significant. Hence, it is not currently possible to state whether high-emission countries will experience stronger or weaker aggregated levels of climate change.

Looking at individual sectors, the equity implications of climate change are most pronounced for food security. Low-emission countries are, in general, more adversely impacted (in terms of projected future yield changes of staple crops), more exposed (in terms of the share of agriculture in gross domestic product and labour force), and less able to cope with adverse impacts (in terms of the current level of undernutrition). These results are robust across all choices of indicators for responsibility, exposure, sensitivity, and coping capacity. The analysis for human health also implies that those least responsible for climate change will be most affected by its adverse impacts. Countries with low emissions levels have, on average, a lower current

health status (measured by infant mortality and life expectancy), higher socio-economic vulnerability to extreme weather events, and already experience stronger adverse climate impacts on human health. The situation for climate impacts on water supply is more complex. Current water availability (measure as surface runoff) is positively correlated with population density but there is no significant correlation between current water availability or future change in water availability and any of the generic indicators for socio-economic coping capacity. Future runoff change is positively correlated with current runoff and with water availability per capita, which implies an increase in current inequalities due to climate change. In addition, there is a strong positive relationship between confidence in projections of future runoff change (measured by the agreement about the direction of change across climate models) and the water poverty index (which is confusingly named because large values signify low poverty) as well as all indices for socio-economic coping capacity. Hence, future water availability is most uncertain and thus anticipatory adaptation most difficult, in those regions where water availability and coping capacity are already low. The results available so far are least conclusive for coastal vulnerability. Indicators on the exposure of land area and population to a 5 m sea-level rise are not significantly correlated with total CO2 emissions but population exposure to a 1 m sea-level rise exhibits a small significant positive correlation with emission levels. These initial findings should be interpreted with care because none of the exposure indicators includes current or future coastal protection measures.

In summary, wide-held beliefs that those countries least responsible for climate change generally have the lowest socio-economic capacity to deal with its adverse impacts are clearly confirmed by the present analysis. This finding in itself constitutes an ethical dilemma of climate change. For food supply and human health, the increase in inequality extends even further to exposure and biophysical sensitivity. The equity implications of climate change for water supply and coastal zones are more complex and require substantial further analysis.

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