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Scenarios for Health and Climate

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Abstract:

The climate change research community is working on a toolbox for building new scenarios to investigate and assess the many unknowns that come with future climate change and development paths. The toolkit includes greenhouse gas emission pathways over the next century, as well as the magnitude and pattern of climate change associated with them; descriptions of a variety of possible socioeconomic development pathways, including qualitative narratives and quantitative elements; and climate change policies to achieve specific levels of radiative forcing and adaptive capacity. To build a scenario, these elements are integrated in a matrix architecture. Along axes representing growing socioeconomic and environmental obstacles to adaptation and mitigation, five reference socioeconomic development trajectories have been described. This article expands on these global routes to discuss their potential repercussions for public health and health care, as well as the additional components that might be included to make the new scenarios more relevant to a broader variety of policy-relevant problems than before.

Keywords: *climate change; health, Socioeconomic*

1. Introduction

Because the future is fundamentally unknown, scenarios are used to explain the range and characteristics of possible futures. A scenario is a detailed and realistic depiction of the human-environment system's future, comprising a narrative with qualitative trends and quantitative forecasts important to development patterns [1]. Scenarios make it easier to investigate and assess the extent and nature of uncertainties associated with future climate change and growth paths. Scenario-based analyses are essential for advancing interdisciplinary analysis and assessment of the potential risks of climate change to physical, natural, and human systems, as well as evaluating the effectiveness of mitigation and adaptation options for avoiding, preparing for, and managing those risks. Projecting potential impacts in various futures and identifying trade-offs and synergies among adaptation and mitigation policies necessitates not only scenarios of greenhouse gas emissions and resulting climate change, but also descriptions of how future socioeconomic development pathways could increase or decrease the risks human and natural systems are likely to face under various climate scenarios.

Socioeconomic variables will influence future costs of climate-sensitive health outcomes as well as the state of public health and health-care infrastructure, regardless of climate change. These, in turn, will interact with climate change, resulting in varying levels of danger depending on the growth route chosen. Many climate change health estimates use just a few or no explicit socioeconomic assumptions, such as demographic change and economic development. Typically, these forecasts have only looked at what altering weather patterns could entail for climate-related health consequences. Although such an approach yields useful information, it implicitly implies that the present drivers, distribution of vulnerabilities and capacities, and level of adaptability will remain constant in the future. Because these assumptions are implausible, such forecasts may not give meaningful assessments to aid policy and decision-making. To give more reliable evaluations of the spectrum of probable future health hazards linked with climate change, different socioeconomic scenarios must be addressed.

Climate change projections have mostly been based on scenarios provided in the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (SRES) [2]. The SRES scenarios were created to reflect a wide range of driving variables (such as demography, economic growth, and technological progress) and emissions found in the scenario literature, as well as underlying uncertainties. Along demographic, social, economic, technical, and environmental dimensions, the four primary storylines (A1, A2, B1 and B2) of feasible and internally consistent development trajectories are outlined. The ensuing greenhouse gas and sulfur emissions are projected in each narrative. For each narrative (total = 40), several scenarios were constructed to investigate the spectrum of possible future emission paths linked with identical assumptions about driving factors. The SRES scenarios were created with no specific climate mitigation or adaptation policies or initiatives in mind. Estimated emissions of greenhouse gases and sulfur have been utilized by earth system models to forecast changes in temperature, precipitation, other meteorological variables, and sea level rise throughout the course of this century as a result of the stories' quantification. Impact modelers have utilized anticipated climate changes to investigate the human and natural system effects of various scenarios. Mitigation and adaptation researchers have used the scenarios to explore the possible effectiveness of policy options to avoid and manage projected risks.

In terms of scientific information and assumptions regarding demographic and socioeconomic development over time, the SRES models are becoming outdated. Earth system models now contain the whole basket of greenhouse gases, more comprehensive estimates for land use and land use change over the century are available, and population projections for the mid- to late-century are vastly different from those used in the SRES. To enable the integration of mitigation, adaptation, and impact studies, new scenarios are needed to encompass the larger range of greenhouse gas concentrations studied in the literature (including those that may be attained by mitigation efforts). Policymakers and decision-makers are concerned not just with the size and pattern of climate change and its consequences, but also with how various mitigation and adaptation policies may help manage predicted risks and seize opportunities. Answering these types of questions requires considering how variables not included in the SRES scenarios, such as inequality and governance, could evolve under different development pathways.

Because scenarios developed by the research community have greater scientific credibility, the potential for much wider participation of research groups across disciplines and geographic regions, and the growing ability of the climate research communities involved to self-organize, it was decided at the end of the SRES process that the scientific community would lead further scenario development. The IPCC has sped up the process by sponsoring certain workshops (see below), but it does not organize or promote it.

2. Discussion

In 2006, a series of seminars and workshops were held to examine various approaches to and processes for generating new scenarios [3]. Members of the three primary research communities working on elements of climate science participated in the discussions: earth system modeling, vulnerability, impacts, and adaptation (VIA; also known as IAV) researchers, and integrated assessment modeling (IAM). The IPCC's Expert Meeting on Scenarios in Noordwijkerhout, the Netherlands, in 2007 codified a roadmap for developing new scenarios, which followed a three-step, so-called parallel approach [4].

The parallel process describes a new approach to scenario development. Instead of the forward-looking process used for the SRES that starting with driving forces and their resulting emissions (from which atmospheric concentrations would be modeled), the scientific community agreed to first identify a small number of atmospheric concentrations of greenhouse gases (and their associated radiative forcing) in 2100, and then to simultaneously project climate change over the century and beyond, and to develop socioeconomic pathways to describe the evolution of elements over this century that could lead to the chosen concentrations [5].

The current method is a variation of a parallel procedure that is inspired by an insight acquired from the SRES and verified by [6]: socioeconomic development paths and greenhouse gas emissions are only tangentially connected. Rather than assuming that one development pathway would result in a narrow range of greenhouse gas concentrations in the atmosphere, it was discovered that multiple demographic and socioeconomic development pathways can lead to any specific emission pathway, and any single socioeconomic pathway can lead to a variety of emission pathways. For example, depending on policies that encourage energy efficiency, the development of low-emission technology, and other measures, a reasonably rich society with a high population density might have high or low greenhouse gas emissions. Because of this separation, demographic and socioeconomic growth may be characterized independently of greenhouse gas emissions [7]. The new scenario approach is based on this understanding and comprises the following steps:

A phase of preparation aimed at meeting the demands of the earth system modeling community. Four Representative Concentration Pathways (RCPs) were chosen in collaboration with the IAM community. The IAM community then calculated the emissions that would result from each, taking into account greenhouse gas and short-lived species emissions, as well as land use and land cover, on a 0.5° latitude x 0.5° longitude grid. A special edition of Climatic Change [8] chronicles the evolution of the four RCPs. The modelers used the fewest socioeconomic assumptions possible; the goal was not to offer background information on how emission routes evolved. The RCPs are defined in terms of their radiative forcing in W/m2 in 2100 and their change trajectory since they include carbon dioxide and other greenhouse gases. The four RCPs are 2.6, 4.5, 6.0, and 8.5 W/m2, respectively, corresponding to carbon dioxide equivalent concentrations of 490, 650, 850, and 1,370 ppm in 2100. RCP2.6 is a peak-and-fall scenario in which radiative forcing peaks before 2100 and then falls (with negative emissions towards the end of the century) to 2.6 W/m2 in 2100.

- A parallel phase involves earth system modeling and the diverse research communities required to generate socioeconomic scenarios. This is the stage where the new scenario is being developed. The RCPs are being used in Earth system model simulations as part of the Coupled Model Intercomparison Project (CMIP-5), which is providing forecasts of the amount and pattern of climate change over the next century and, in some cases, to 2300 [9]. The IPCC Fifth Assessment Report evaluates the results of these trials. The Shared Socioeconomic Pathways, developed by the IAM and VIA groups, are innovative descriptions of future socioeconomic circumstances (SSPs). The process and architecture being used are described in another special issue of Climatic Change [10].
- An integration phase is now ongoing, during which scenarios for use in climate science research and evaluation will be produced. These scenarios will take into account socioeconomic growth paths as well as climate change forecasts and policy assumptions for mitigation and adaptation [11].

The International Committee on New Integrated Climate Change Assessment Scenarios (ICONICS; http://www.isp.ucar.edu/iconics) and the Integrated Assessment Modeling Consortium are coordinating the new scenario process, particularly the development of shared socioeconomic pathways, shared climate policy assumptions, and scenarios (IAMC).

Undernutrition, malaria, and diarrheal illness are the three health outcomes that are most likely to be impacted by climate change on a global scale [12]. These are also some of the leading causes of avoidable childhood death. According to the Global Burden of Disease Study 2010, infectious diseases killed 64.0 percent (4.9 million) of the 7.6 million children who died in their first five years of life in 2010, with pneumonia, diarrhea, and malaria being the major causes of death [13]. Diarrhea was responsible for 10.5 percent of all childhood fatalities (between 0.5 and 1.2 million), whereas malaria was responsible for 7.4 percent (0.4 to 0.7 million). In recent years, these figures have decreased. For example, the burdens of malaria and diarrheal disease in children 1–59 months declined 4.0% per year between 2004 and 2010 for malaria, and between 2000 and 2010 for diarrheal disease.

Some of this improvement might be attributed to attempts to meet the Millennium Development Goals (MDGs), which contain objectives that have helped spark substantial national and international initiatives to decrease the burdens of undernutrition (MDG 1.C), malaria (MDG 6.C), and diarrheal illness (MDG 6.D) (part of MDG 4). As of June 2013, significant progress had been accomplished on several goals when compared to a 1990 baseline [14, 15].

Following a brief overview of each SSP, interpretations of that SSP for public health and health care are provided. These summaries are based on the SSPs' first drawings in [16, 17]. A study including detailed descriptions of the SSP tales is currently being written. The SSPs' working titles are supplied. Sustainability (SSP1) is a world with few adaptation and mitigation difficulties. It is a world that is making reasonably excellent progress toward sustainability, thanks to global collaboration on attaining development objectives and lowering resource intensity and fossil fuel reliance, which is supported by functional international organizations and institutions. Low-income countries are rapidly developing, with fewer people living in poverty, lower levels of inequality within and across countries, higher rates of female education, slower population growth, improved population health, increased planned urbanization, rapid development of clean energy technologies, and a high level of environmental awareness.

3. Conclusions

The new scenario process provides a significant opportunity for the health sector to develop scenarios relevant to questions being asked and decisions that need to be made by policy- and decision-makers about: the extent to which climate change could affect the geographic range, seasonality, and incidence of climate-related health outcomes under different assumptions of future socioeconomic development; the extent to which climate change could affect the geographic range, seasonality, and incidence of climate-related health outcomes under different assumptions of future socioeconomic development; the extent to which adaptation and mitigation strategies could minimize those health hazards while also increasing the health sector's capacity to prepare for, cope with, and recover from climate change, as well as the cost of these policies; and how the balance of adaptation and mitigation policies could alter health burdens over time.

Scenarios created via this method enable for deeper investigation of the interaction between development paths and climate change, allowing for a better understanding of where finite human and financial resources should be allocated to mitigate risks. For example, heatwave mortality is expected to rise as a result of climate change [18, 19, 20]. Scenarios integrating SSPs and RCPs may be used to see how different patterns of urbanization, population settlement, demographics, and climate change affect how easy or difficult it is to plan for and manage heatwave hazards. Understanding these trends can help advise and argue for more robust development options, such as climate change mitigation, later in the century.

To underpin estimates of health consequences under various degrees of climate change and development patterns, the health sector will need to self-organize to generate their own SSP extensions. However, the industry is currently not structured in such a way. The lack of a tradition of international and national organizations supporting health scenario creation is one of the implications of the IPCC guiding prior scenario production.

To make the process of developing health extensions go more smoothly, some international and national public health and health-care organizations should convene an international meeting to discuss and agree on which elements should be added to the SSPs to make it easier to understand and manage potential future health risks. Representatives from relevant groups, including climate change and health consequences, mitigation and adaptation, and development, should attend such a conference. Understanding how climate change might affect the future geographic range of infectious diseases and malnutrition in low-income countries, for example, would ideally include projections of how maternal and childhood mortality might change under various development pathways, independent of climate change. These and other potentially desired factors are significant metrics in and of themselves, as well as indications of a country's ability to offer primary health care and public health services (as well as the ability of non-governmental and other organizations operating in that country).

The current efforts to forecast how socioeconomic and other major determinants of health burdens would change over the next several decades should be expanded to include a larger range of predictions of socioeconomic and health-determining factors across longer time periods and at finer spatial resolution. Partnerships with people and organisations working on problems such as the global burden of illness and health governance initiatives may be beneficial. The suggested conference may also cover the steps for creating and reviewing longer narratives, as well as how to create the required quantifications, how to coordinate these efforts, and potential financing sources.

Another thing to think about is developing scenarios for historical periods other than the current century. The extent and pattern of climate change later this century will have little impact on health adaption options. If the health sector employs iterative risk management, adaptation choices, such as changes to surveillance and monitoring programs to account for shifting weather patterns, can be made in light of predicted climate change over the next few decades. Infrastructure is an exception; judgments on where and what kind of infrastructure to build will be more solid if risks from later in the century, including uncertainties, are taken into account.

For these shorter-term decisions, more detailed narratives and quantifications of the SSPs would be beneficial. One method is to use the vast data collected on progress toward achieving the MDGs, as well as projections of when (and where) certain objectives will be met. The middle-of-the-road SSP (SSP2) might be viewed as a world that accomplishes the MDGs a little more slowly than the current scenario. The globe in the sustainability SSP (SSP1) is moving faster to meet all MDGs and the sustainability goals (SDGs) that will follow them. The fragmented SSP (SSP3) is a scenario where the MDGs are only achieved after a considerable delay, if at all. More story elements and information on how the MDGs and SDGs could grow over the next two to three decades should be included to each SSP. Furthermore, because poverty is a major driver of vulnerability, it may be worthwhile to investigate the potential of developing multidimensional poverty indexes to explain how vulnerability could change as a result of various socioeconomic development paths (e.g., [21, 22]). Variables linked to fundamental material requirements for a decent life, healthy social interactions, security, and freedom of choice and action are all factors to consider [23, 24].

The scope of SSP elaborations is vast, spanning a wide variety of geographical and temporal dimensions. What scenarios would be most beneficial to health decision- and policy-makers in order to assist their efforts to improve resilience to the health hazards of climate variability and change under various development paths, and how would they be developed?

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