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Uncertainty and learning in population and emissions projections

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Future changes in population size, age structure, and urban/rural status are important to climate change both as drivers of future emissions as well as determinants of climate change impacts. Demographers have made probabilistic projections based on a variety of methods for more than a decade. We use an existing probabilistic projection of global population to illustrate two types of applications to climate change. In the first, the full, *unconditional* projection is used as a basis to develop individual *conditional* probabilistic projections, each contingent on an alternative storyline of future socio-economic development paths. Each conditional projection is then used to derive a single representative scenario for use in the development of quantitative scenarios of climate change and ecosystem changes for the Millennium Ecosystem Assessment (MA). Results show that the MA storylines are each consistent with a relatively wide range of demographic outcomes. For some storylines, ranges of plausible outcomes in some regions overlap substantially, indicating that particular population projections could be consistent with more than one storyline. In other cases, uncertainty ranges for different storylines are distinct, indicating that a projection consistent with one storyline is unlikely to be also consistent with another. Comparing variances of the conditional projections also provides insight into how much different storylines constrain future demographic developments.

In the second application, we investigate how fast we might expect to learn about the outlook for long-term population growth. We draw on recent work showing that, because population growth is path dependent, we can learn about the long term outlook by waiting to observe how population changes in the short term. The potential rate of learning is important because it can, in principle, affect decisions on whether to delay, or hasten, emissions reductions in the face of uncertainty. We show that substantial learning about future population growth is possible over the next few decades; that the amount learned depends not just on the length of the time series of observations but also on demographic context; and that learning can increase, rather than decrease, uncertainty in some cases.