1.3 PROCESS

The GBD MAPS project was begun by HEI in 2014. HEI selected the Working Group — including experts from India and China — that designed and conducted the analyses and drafted this report. HEI also recruited an International Steering Committee that advised the Working Group and reviewed its work. The Working Group initially developed a detailed analytic plan in consultation with the International Steering Committee, which in turn reviewed the choice and design of future emission scenarios used in this report. Selected preliminary results for India were presented at the American Association for the Advancement of Science in February 2016 and the HEI Annual Conference in Denver in May 2016.

The draft final report was peer-reviewed with regard to methodologic approach, validity of estimates, and appropriateness of interpretation by independent external reviewers selected by HEI for their expertise in air quality, atmospheric chemistry and modeling, and health effects. The peer reviewers were Dr. Noelle Selin, Massachusetts Institute of Technology; Dr. Pallavi Pant, University of Massachusetts; Anup Bandivadekar, International Council on Clean Transportation; Bhargav Krishna, Public Health Foundation of India; and Kunal Sharma, Shakti Foundation. A draft final version of this report was also reviewed by experts on the GBD MAPS Steering Committee. The Working Group prepared the final report in response to the comments received.

2.0 BACKGROUND

2.1 AIR QUALITY IN INDIA

Ambient air pollution has increased in India over the last 25 years. India has maintained air quality monitoring stations at a number of locations throughout the country for several decades. The GBD project estimates current levels and trends in ambient $PM_{2.5}$, a major component of air pollution, by incorporating ground measurements from these monitors and satellite-based estimates (Brauer et al. 2016). The latest GBD 2015 estimates indicate that the population-weighted mean $PM_{2.5}$ concentration for India as a whole was 74.3 µg/m^3 in 2015, up from about 60 µg/m^3 in 1990. At current levels, 99.9% of the Indian population is estimated to live in areas where the World Health Organization (WHO) Air Quality Guideline of 10 µg/m^3 was exceeded. Nearly 90% of people lived in areas exceeding the WHO Interim Target 1 of 35 µg/m^3. In 2015, at the state level in India, population-weighted mean concentrations ranged from a low of 27.2 µg/m^3 (in Arunachal Pradesh) to a high of 132.4 µg/m^3 (in Delhi). Nationally the population-weighted mean increased by 24% from 1990 to 2015. Between individual states there was variation in the trends since 1990, with increases observed in most of the country.

2.2 BURDEN OF DISEASE FROM AIR POLLUTION

2.2.1 Air Pollution and Health

The air that people breathe is a complex mixture — including hundreds of individual gaseous compounds and particles of complex composition — that varies in composition both spatially and temporally. Therefore, indicator pollutants are typically used to estimate exposures for epidemiological analysis and disease burden assessment. Within the GBD framework, the disease burdens attributable to both $PM_{2.5}$ and ozone are considered, based on evidence of their independent adverse health impacts and on distinctions between the spatial and temporal patterns of concentrations of these two species. However, in this report we focus our assessment on only $PM_{2.5}$, given that in the GBD 2015 report, the burden attributable to $PM_{2.5}$ (4.2 million deaths globally [1.09 million in India]) vastly exceeded that attributable to ozone (254,000 deaths globally [107,770 in India]). In populated regions, a large fraction of $PM_{2.5}$ originates from combustion processes, and it includes both primary particulate matter (PM) (direct emissions) and secondary PM (resulting from atmospheric transformations of precursor compounds such as nitrogen and sulfur oxides). One of those combustion sources is the residential burning of solid fuels (e.g., wood and other biomass) for cooking, lighting, and heating. Although the contribution of such residential pollution to concentrations of ambient $PM_{2.5}$ and to the resulting disease burden is estimated in this report, its contribution to exposures within the household and to the associated disease burden is not. The estimate of disease burden from these indoor exposures is substantial, with an estimated 977,000 attributable deaths in 2015. As such, the estimates of the disease burden attributable to such residential sources substantially underestimate the full attributable burden from this practice.

The health effects of exposure to PM in ambient air are widespread and substantial, and they have been reviewed and summarized in detail (U.S. Environmental Protection Agency [U.S. EPA] 2009; WHO 2005). The epidemiological observations of adverse health impacts associated with elevated ambient $PM_{2.5}$ concentrations are supported by