Chapter

7

Satellites, Settlements and Human Health

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7.1 INTRODUCTION

In mapping the road to a sustainable future as human populations expand and develop across the globe, the application of advanced science and technologies toward preserving the planet's life-support system becomes a national and international imperative (Kates et al. 2001; Turner et al. 2003). These technologies must serve as sharpened tools for better understanding the relationships between these human populations and the environment—and their vulnerabilities to change. As humans settle across the world in places of varying habitability, the ability to assess and predict the vulnerability and resilience of these settlements is increasingly important. Better decision making and management are needed, particularly in light of the massive migration from rural areas and the rapid expansion of cities (Kates and Parris 2003). Remotely sensed data and observations are providing powerful new tools for addressing environment-related human health problems relevant to human settlements. This is being accomplished through increased capabilities for monitoring, risk mapping, and surveillance of epidemiological parameters useful to such problems as vectorborne and infectious diseases, air and water quality, ultraviolet (UV) radiation, contaminant transport, and thermal stress. Remote sensing, geographic information systems (GIS), computational capabilities, and interdisciplinary research between the Earth science and health science communities are being combined in rich collaborative efforts resulting in more-rapid problem-solving, early warning, and prevention in global health issues. Although the exploitation of space-based technologies for health applications is, in most cases, not well developed, the potential for use of these technologies is great indeed. This chapter provides a brief overview of remote sensing technologies presently being used to address health issues relevant to human settlements, as well as a partial listing of sensors that have good potential for studying global health issues.

The need is pressing to better understand the links between environment, weather, and climate, and health problems such as infectious and vectorborne diseases; urban, regional, and global air and water pollution; heat stress; UV radiation; waterborne diseases; and contaminant transport and deposition into ocean, atmosphere, and ice (Patz et al. 2000; McMichael et al. 2000; NRC 2001). This need has been well documented—particularly by the recent Intergovernmental Panel on Climate Change (IPCC) and the US National Assessment. Accordingly, over the past several years, interest in the relationship between changes in temperature, rainfall, wind, soil moisture, solar radiation, vegetation, and the pattern of extreme weather events and the occurrence and patterns of diseases (especially infectious and vectorborne diseases) and other health problems has significantly grown among scientists. Environmental impacts on human health have become increasingly more visible with every major flood, hurricane, or drought, while El Niño effects, ozone depletion, and severe

weather events have been linked to a variety of risks to human health. Tropical storms can affect more people through diseases resulting from destruction of water and sewage systems than by rain and wind damage. Infectious diseases are considered to be one of the major threats to security in the coming 20 years, partly due to alterations in the biological ranges of disease vectors caused by climate change or land use changes (National Intelligence Council 2000). Most recently, since the 9-11 attacks, people in many areas of the world and in every human settlement location—urban or rural—are facing daily uncertainties about deliberate or accidental releases of chemical, biological, and/or nuclear warfare agents.

Vulnerability of populations to health impacts from environmental, weather, and climate factors varies among populations and regions according to the location and type of settlement (McCarthy et al. 2001). These vulnerabilities are especially significant in low-income settlements characterized by persistent poverty and conventional development cluster issues such as unsanitary conditions, smoky fuels, food insecurity, hazardous industrial pollution, and climate change (McGranahan et al. 1999). For climate change, IPCC identified settlement areas in coastal deltas, some floodplains, and low-lying small islands as especially vulnerable to increased flooding as a result of climate change, while also indicating a high degree of potential impact in certain other coastal and floodplain regions, permafrost areas, semi-arid areas, and steep hillsides (McCarthy et al. 2001). Different types of human settlements—urban, informal, or rural—will exhibit different degrees of vulnerability according to their level of exposure, adaptive capabilities, and sensitivities. For example, sea-level rise could displace millions of people in delta regions—especially in rapidly growing cities in and near coastal areas—and increase their exposure to flooding. These impacts are especially severe in settlements of low socioeconomic status due to high population densities, inadequate shelter, lack of access to safe water and health services, and the likelihood of more direct exposure to extreme weather/climate events. IPCC (McCarthy et al. 2001) identified 12 major impacts of climate change on human settlements, all of which have a greater impact on settlements in resource-dependent areas or riverine or coastal regions. These impacts include flooding, landslides, tropical cyclones, water contamination, sea-level rise, heat/cold waves, water shortage, fires, hail, windstorms, agriculture/forestry/fisheries productivity, air pollution, permafrost melting, and heat islands. Many remote sensing tools are available that can assist populations in the entire range of settlement types by providing improved information for local decision making, to significantly reduce their vulnerability to these climate, weather, and environment-related health impacts.

In response to the need for improved observations of environmental factors to better understand these links to human health problems, several remote sensing and health programs are being developed. For example, NASA has developed the NASA Earth Science Public Health Applications Program (PHAP) to improve the utilization of NASA's Earth science data, information, and technologies for health applications. The NASA Healthy Planet Program at Goddard Space Flight Center is leading an effort to develop research programs for the application of the entire suite of NASA's Earth science sensors to better understand the environment-health relationships as well as to develop health early-warning systems (http://healthyplanet.gsfc.nasa.gov). The Center for Health Applications of Aerospace Related Technologies (CHAART) at NASA Ames Research Center has worked with the health community for a number of years on the applications of remote sensing and GIS to expand use through training, education, and applications projects (http://geo.arc.nasa.gov/sge/health/chaart.html). The National Oceanic and Atmospheric Administration's (NOAA) Office of Global Programs (OGP) has developed the Climate Variability and Human Health Program (CVHH), which promotes the use of climate information to mitigate the impacts of adverse climate on health in the US and internationally (http://www.ogp.noaa.gov/). All of these programs have technologies, data, and scientific expertise that can provide information and be directly and/or indirectly useful to improved management of health effects on populations in human settlements.