Developing an online tool for identifying at-risk populations to wildfire smoke hazards☆

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HIGHLIGHTS

- Wildfire episodes pose a significant public health threat in the United States;
- Real-time forecasts of wildfire smoke are available but they are not integrated with information on vulnerable populations;
- This tool could strengthen existing situational awareness, and future response and recovery efforts during wildfire episodes.

GRAPHICAL ABSTRACT
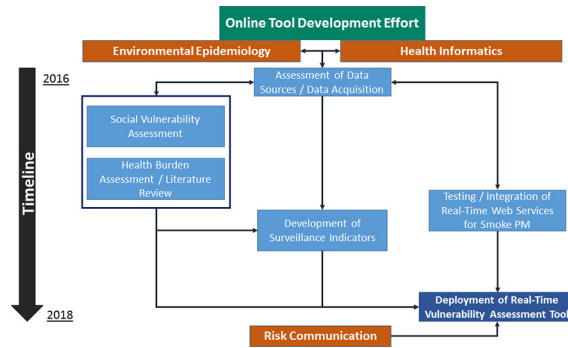
ABSTRACT

Wildfire episodes pose a significant public health threat in the United States. Adverse health impacts associated with wildfires occur near the burn area as well as in places far downwind due to wildfire smoke exposures. Health effects associated with exposure to particulate matter arising from wildfires can range from mild eye and respiratory tract irritation to more serious outcomes such as asthma exacerbation, bronchitis, and decreased lung function. Real-time operational forecasts of wildfire smoke concentrations are available but they are not readily integrated with information on vulnerable populations necessary to identify at-risk communities during wildfire smoke episodes. Efforts are currently underway at the Centers for Disease Control and Prevention (CDC) to develop an online tool that utilizes short-term predictions and forecasts of smoke concentrations and integrates them with measures of population-level vulnerability for identifying at-risk populations to wildfire smoke hazards. The tool will be operationalized on a national scale, seeking input and assistance from several academic, federal, state, local, Tribal, and Territorial partners. The final product will then be incorporated into CDC's National Environmental Public Health Tracking Network (http://ephtracking.cdc.gov), providing users with access to a suite of mapping and display functionalities. A real-time vulnerability assessment tool incorporating standardized health and exposure datasets, and prevention guidelines related to wildfire smoke hazards is currently unavailable for public health practitioners and emergency responders. This tool could strengthen existing situational awareness competencies, and expedite future response and recovery efforts during wildfire episodes.

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1. Introduction

Wildfire episodes pose a significant public health threat in the United States. The potential impact on health, arising from the flame activity near active fires as well as exposures to surface smoke concentrations downwind of the burn area, represent several far-reaching consequences of wildfires (Williamson et al., 2016). Smoke plumes from wildfires represent a complex mixture of pollutants and its composition depends on several factors, including the fuel type and prevailing meteorological conditions (Urbanski et al., 2008). As a result, plume composition can vary over time and space (Lassman et al., 2017) and can consist of several air pollutants, including high concentrations of fine particulate matter ($PM_{2.5}$) and ozone (Jaffe et al., 2008; Pfister et al., 2008). Health effects associated with wildfire smoke can range from eye, nose, and throat irritations to more serious disorders, such as asthma exacerbation, bronchitis, decreased lung function, and premature death (Reid et al., 2016).

A comprehensive strategy to mitigate adverse health impacts associated wildfire disasters necessitates a thorough understanding of population-level exposures to surface smoke $PM_{2.5}$ concentrations. Additionally, identifying vulnerable populations and places, and quantifying the disease burden associated with surface smoke exposures are critical to strengthening public health preparedness capabilities for wildfires. Accordingly, to support preparedness efforts, a need emphasized by state, local, territorial, and tribal (SLTT) health departments (HDs), is access to smoke forecast data, visualization tools, and communication documents, as well as surveillance data on population health and on vulnerable populations, — all of which can be made available on one information system and on a real-time basis. Unfortunately, such a health information system does not currently exist. However, CDC's Environmental Public Health Tracking Network (Tracking Network), which is a surveillance platform with a well-designed repository of environmental health data and user-friendly visualization capabilities, has the necessary information technology infrastructure and expertise to undertake such tool development efforts (CDC 2010).

In this manuscript, we describe CDC's efforts to develop an online tool, which can assist SLTT HDs with conducting a real-time vulnerability assessment and identify at-risk populations to wildfire smoke impacts.

2. Materials and methods

CDC's National Environmental Public Health Tracking Program (Tracking Program) has been collaborating with a multi-disciplinary team of experts from several academic, state, and federal agencies to support this effort. In this section, we describe the different phases involved in the tool-building effort. Fig. 1 describes our tool-building framework with specific tasks, which can be classified under the substantive areas of environmental epidemiology, health informatics, and risk communication.

2.1. Assessment of data sources and selection of historical wildfires

Exposure to wildfire smoke is a growing national concern, especially with an ever expanding wildland-urban interface (Theobald and Romme, 2007). There are several databases online that offer invaluable information on historical wildfire occurrence and burn severity; however, considerable effort is required to consolidate such information, which often resides in disparate databases. We conducted an assessment of major databases for obtaining environmental and health data as well as those providing information on vulnerable populations. In addition, we conducted a pilot study assessing the feasibility of bringing together data from several of these datasets into one information system, as well as abstracting health risk information from extant scientific literature.

2.2. Social vulnerability assessment

Social vulnerability or social capital is a construct measured by the prevailing levels of certain socioeconomic and demographic factors. Social vulnerability is a key factor that determines the resilience of communities when under stress from natural and human-made disasters (Flanagan et al., 2011). Social vulnerability metrics (SVMs) assist our understanding of the differential capacity that exists in communities
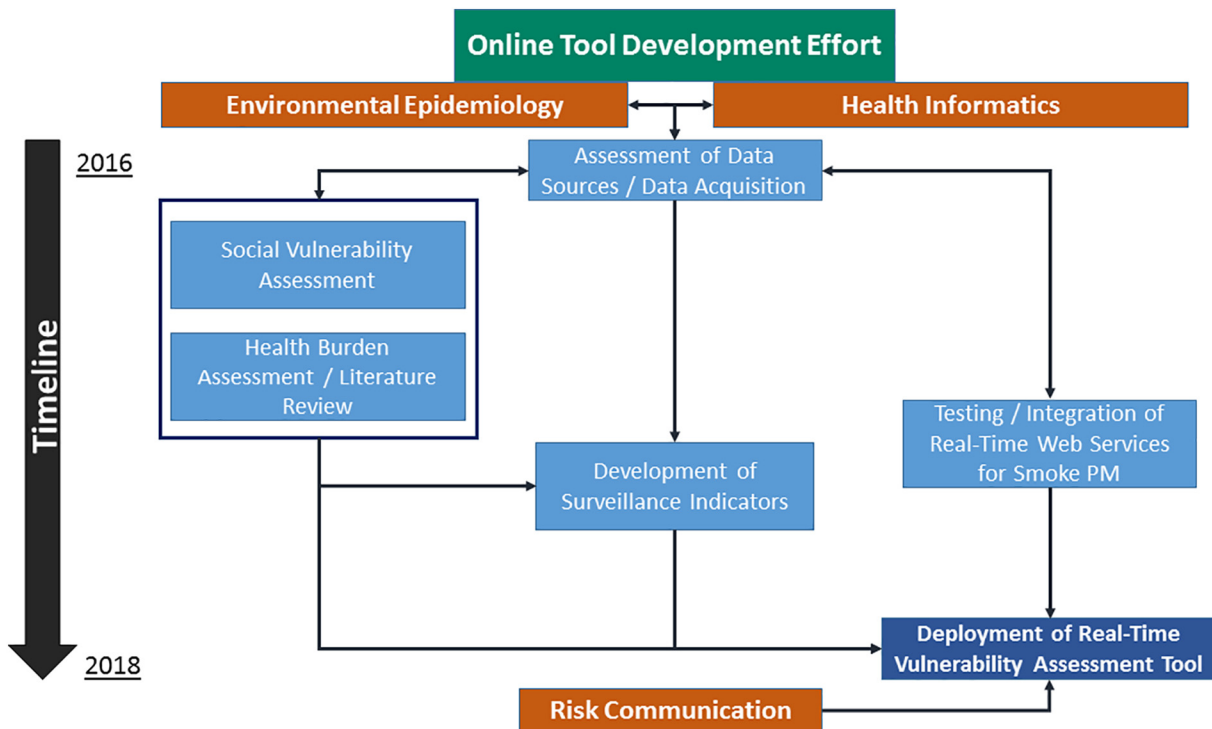

Fig. 1. Tool-building framework with specific tasks.