



Modeling duration of time lived in a residence, a community and mobility in rural areas of Merced and Ventura, California to assess potential health risks to airborne contaminants



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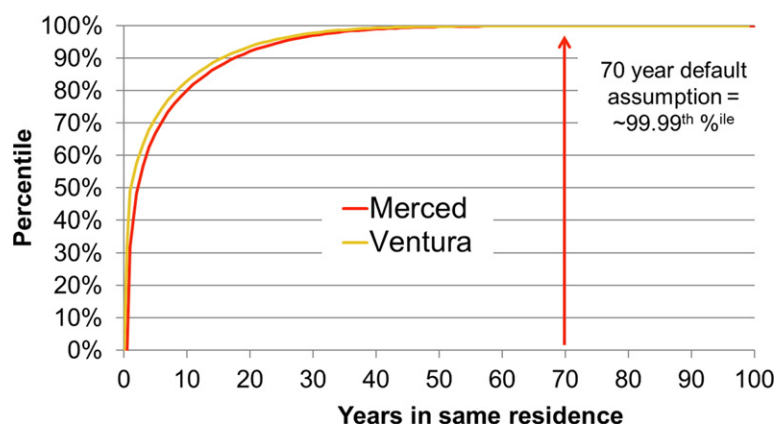
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HIGHLIGHTS

- The soil fumigant 1,3-dichloropropene (1,3-D) is used extensively in California.
- A chronic risk estimate requires knowledge of frequency and duration of exposure.
- A population mobility survey was conducted in high use demand areas of 1,3-D.
- Average time spent in two areas of 1,3-D high use was 22 to 27 years.
- Less than 0.01% lived at the same residence for 70 years (a common default).

GRAPHICAL ABSTRACT



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ABSTRACT

A de novo population mobility survey of 800 households (random digit dialing-based phone interviews) was conducted in high demand areas of the agricultural fumigant, 1,3-dichloropropene (1,3-D) in Merced and Ventura counties of California. The survey included approximately 20 questions relating to the length of time individuals had lived in the high demand areas in each county, and also relating to weekly and annual mobility patterns. Lifetime inhalation exposures to 1,3-D are determined, in part, by the number of years individuals spend in an area where the fumigant is used. The purpose of the survey was to provide location-specific data for probabilistic modeling of long-term inhalation exposures to 1,3-D. The survey found that the majority of residents do not live in a high demand area or in the same house (99.99%) for 70 years (a default assumption used by some regulatory agencies). It was also observed that residents move frequently and are mobile day-to-day and week-to-week, within the use area. Finally, estimates of total residency duration, derived from the survey results indicate that median times spent within a high demand area (which could include more than one residential location) were

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18 and 26 years for Ventura and Merced high demand areas, respectively. The average time spent in the high demand areas was 22 and 27 years for the Ventura and Merced community, respectively. Less than 0.01% of the populations in either of the high demand areas spend 70 years in the same house.

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1. Introduction

The California Department of Pesticide Regulation (CDPR) has a legal mandate for registering and ensuring the safe use of pesticides in California (CA). Dow AgroSciences markets and sells 1,3-Dichloropropene (1,3-D), the active ingredient in Telone® soil fumigant products which is used as a pre-plant nematicide in numerous economically important crops in CA including almonds, grapes, sweet potatoes, strawberries, and a range of vegetable crops.

CDPR regulates 1,3-D based in part on protecting bystanders living near treated fields. The risks posed by 1,3-D are evaluated based on the lifetime average daily doses (LADDs) that are received by populations in local communities. Estimation of a person's LADD requires the consideration of multiple variables including the concentration of the chemical of interest, exposure duration, and frequency of exposure. These variables are dependent on human activity patterns and time spent at different locations near treated fields.

Residential mobility is the measure of how often individuals change residences in a given period of time (e.g., probability of moving during one year). Mobility can also refer to time-activity patterns. In the context of this “residency and mobility” survey, mobility also refers to short- and longer-term movement of individuals, i.e., daily, weekly and annual patterns of movement outside of the study area. Residential mobility determines the distribution of the number of years an individual will reside in a single residence and the number of years an individual will spend in a 1,3-D high use area. Residential mobility is highly variable, differing across individuals and across different portions of an individual's life. An individual may spend less than a year or spend their entire lifetime in a single residence. However, the vast majority of individuals move multiple times during their lives (U.S. EPA, 2011; Wheeler and Wang, 2015). An assessment of population mobility can assist in determining the length of time household members are exposed in a particular location. For example, the duration of exposure to site-specific contamination will be directly related to the period of time residents live near the source of a chemical of interest. Existing data typically do not associate specific product use information with actual consumer user's or bystander's demographic, geographic and time-activity characteristics. This latter association is critical to the development of credible and realistic, assessments of exposure to soil fumigants in specific townships in California.

CDPR's past risk assessment for 1,3-D assumed that individuals residing in a 1,3-D fumigant use area live there for 70 years, and furthermore that their mobility is limited to a single township (6 × 6 mile area) where 1,3-D is used, for their entire lifetime (CDPR, 1997). These extremely conservative assumptions were made in part due to the lack of data demonstrating the actual residency and mobility of residents in townships with 1,3-D fumigant use. The existing mobility data, however, are typically national in scope, and mobility varies across communities and regions with large numbers of rental properties or younger individuals, which tend to have shorter residential durations. Communities of older homeowners tend to have longer residential durations (U.S. Census Bureau. American Fact Finder-Community Facts, 2010; <https://www.census.gov/en.html>). As a result, the most certain estimates of residential duration should be based on data from the communities of interest.

Assessing exposures to 1,3-D raises an additional challenge for mobility surveys because if a person changes residence but still resides in a high demand community their exposures will continue. Therefore,

the assessor needs data on the frequency of both changing a residence and changing a residential community.

Residence duration in the same house has been characterized at the upper bound (90th to 95th percentile) in a number of surveys of various populations at approximately 30 years (Israeli and Nelson, 1992; Johnson and Capel, 1992; Price et al., 1992; Sedman et al., 1998; Census Bureau, 2008) as summarized in Supplemental information¹ (Table 1S and Section 1.0). Although such an upper bound default may be useful as a first approximation for screening level assessments, it cannot be used in stochastic assessments of inter-individual variation in lifetime exposures.

The purpose of this mobility/residency study was to provide scientifically defensible data, specific to residents of rural agricultural areas of CA with significant 1,3-D demand. These data should be sufficient to determine:

- How long people lived in the same house;
- The fraction of time that they spent away from their community;
- How long they lived in a community.

2. Materials and methods

2.1. Overview

A telephone survey was selected as the method of obtaining the residency and mobility information for this study, since virtually every resident has either a landline or a cell phone and many have both (CDC, 2012). The survey focused on two clusters of townships where demand for 1,3-D consistently exceeds the allocation of 90,250 lb per year of 1,3-D that can be applied in a township under the current CA 1,3-D Management Plan (CDPR, 2002). The study area consisted of four contiguous townships in Merced County and three contiguous townships in Ventura County. Changing residence will not automatically end an individual's exposure to a local source of 1,3-D since it is possible that the new residence is also in the high demand community. As a result, it is necessary to model community duration as well as residential duration and therefore the survey collected data on time spent in a specific residence and the time spent in the cluster of high demand townships (hereafter referred to as a high demand community). These data were used to estimate a distribution of both residential and community durations for individuals who live in two clusters of high demand townships of Merced and Ventura counties.

California Survey Research Services Inc. (CSRS), an independent survey research firm that has extensive experience with consumer and business-to-business telephone research, designed and implemented the survey used in this study (Kaplan, 2014). Although the survey was strictly observational in nature, the protocol was reviewed and approved by the Schulman Associates Institutional Review Board (IRB). Based on the “Common Rule,” it was concluded that the mobility survey qualified as “minimal risk” (see 40CFR26.116) which allowed for an appropriately modified informed consent form and process that provided the benefit of reducing the adverse impact on survey response rates. The English version of the IRB-approved questionnaire for this study is presented as part of Supplemental information (Appendix 1).

¹ Supplemental information provided for this manuscript (on-line version) includes a glossary for key terms.

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