Accident Analysis and Prevention 43 (2011) 284–289

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

The impact of climate change on winter road maintenance and traffic accidents in West Midlands, UK

Anna K. Andersson[a,*], Lee Chapman[b]

[a] Göteborg University, Department of Earth Sciences Centre, Physical Geography, Box 460, 405 30 Göteborg, Sweden
[b] School of Geography, Earth & Environmental Sciences, College of Life and Environmental Sciences, University of Birmingham, B15 2TT, UK

ARTICLE INFO

Article history:
Received 21 August 2009
Received in revised form
28 December 2009
Accepted 29 August 2010

Keywords:
Road surface temperature
Road traffic accident
Winter road maintenance
Climate change
Temporal analogue
Weather generator

ABSTRACT

Winter weather can be a significant cause of road traffic accidents. This paper uses UKCIP climate change scenarios and a temporal analogue to investigate the relationship between temperature and severe road accidents in the West Midlands, UK. This approach also allows quantification of the changes in the severity of the winter season over the next century in the region. It is demonstrated that the predicted reduction in the number of frost days should in turn reduce the number of road accidents caused due to slipperiness by approximately 50%. However, the paper concludes by warning against complacency in winter maintenance regimes. A warmer climate may result in budget cuts for highway maintenance which in turn may well reverse declining accident trends.

1. Introduction

The British government has a long term aim to reduce the number of casualties on UK roads by 40% in the year 2010 compared with the average for 1994–1998 (Department for Transport, 2009). There have been numerous studies into the influence of weather conditions as a cause of traffic accidents (e.g. Codling, 1974; Palutikof, 1991; Edwards, 1996). However, precipitation, and associated poor visibility, is the main cause of many weather related incidents (Keay & Simmonds, 2006; Songchitruksa & Balke, 2006; Koetse & Rietveld, 2009) and is a problem which becomes particularly acute in winter (Fridström et al., 1995; Edwards, 1999). Indeed, there is often a pronounced peak in accidents in the month of December (Asano & Hirasawa, 2003), where the problems of winter weather are compounded with reduced daylight hours. In colder climates, the risk of an accident increases if the precipitation is falling as snow (Andreescu & Frost, 1998; Suggett, 1999). Andrey & Olley (1990) found that 40% of the total number of winter accidents occurred on roads with ice/snow or rain. In particular, Norrman et al. (2000) identified that the largest amount of accidents occurred when snow was falling on a frozen road surface. However, these relationships are not universal. Some countries are well prepared for winter weather and the onset of snow can actually mean a decrease in the number of accidents (Fridström et al., 1995) or at the very least, the severity of incidents (Koetse & Rietveld, 2009). Drivers respond to the conditions by restricting travel to essential journeys (Parry, 2000; Smith, 1982) and by driving more slowly (Hassan & Barker, 1999). For example, Kilpeläinen & Summala (2007) showed that average traffic flow speed reduced by 6.7% in bad weather. Similarly, in wet and slushy conditions, speed reductions can be as high as 25% (Martin et al., 2000 cited in Koetse & Rietveld, 2009)

The UK does not have a particularly snowy climate, but the appearance of snow is often the cause of traffic chaos (e.g. Thornes, 2005; London Assembly, 2009). To some extent, this represents complacency in the winter maintenance regime. Although a duty of care exists to protect the motorist (as *per* section 42 of the UK Railways and Transport Safety Act, 2003), it is clearly not reasonable for every responsible party to maintain a stockpile of specialist equipment to deal with snowy conditions which may only occur once or twice *per* annum. Instead, the problem which is the focus of attention in the UK is the formation of ice on roads. On many winter nights, the forecast is straightforward and the roads are treated if necessary. However, marginal nights, where temperatures are close to freezing, are more problematic. This paper studies traffic accidents across the West Midlands during the winter months December to February with the aim of applying UKCIP (UK Climate Impacts Programme) climate change scenarios to determine how the number of days requiring winter road maintenance may change in the future and how this subsequently may affect road traffic accident statistics.

* Corresponding author.
E-mail addresses: annaa@gvc.gu.se, anna_geo@yahoo.com (A.K. Andersson).

0001-4575/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2010.08.025

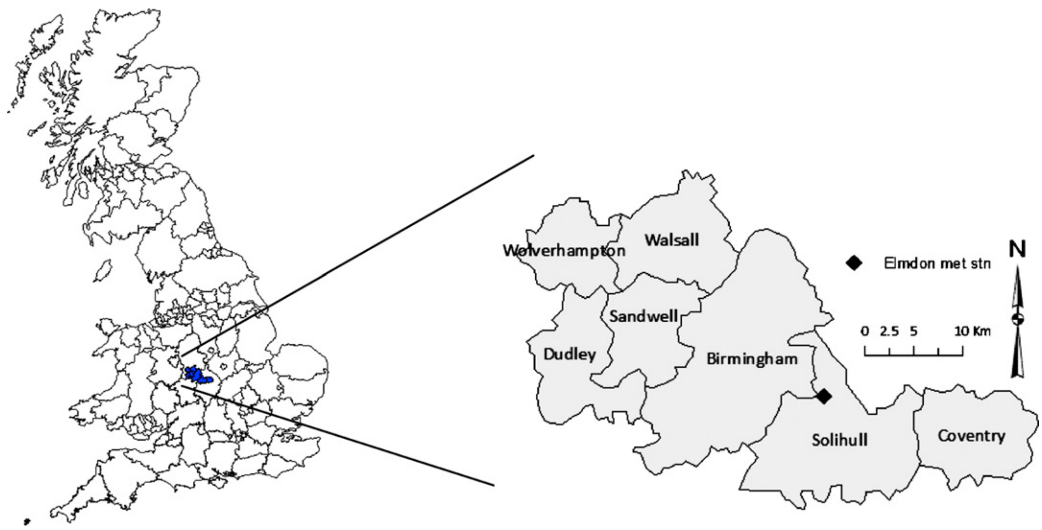

Fig. 1. Area of interest, showing the location of the West Midlands and Elmdon weather station.

2. Methodology

2.1. Area of study & weather data

The focus of this study is the county of the West Midlands (Fig. 1) which is the second largest conurbation in the UK. This study makes use of weather data obtained from the World Meteorological Organisation weather station located centrally in the region at Elmdon (Birmingham Airport).

2.2. STATS-19 data

In the UK, the recording of the weather as a factor in road accidents has been undertaken on police accident report forms (STATS-19) since 1969. All road accidents which involve a fatality or personal injury are recorded on the form, which is filled in at the site of the accident by an attending police officer. However, 'damage-only' or 'minor injury' accidents are not recorded. This means that true accident data are likely to be under-reported. Furthermore, although weather conditions are recorded in the database, it is important to appreciate that road accidents are caused by a combination of factors and that weather may not be the principal cause.

Fig. 2 provides an overview of winter (DJF) traffic accidents numbers that have occurred in the West Midlands over the last 10 years. To put this into context, the accident rates are plotted against the winter mean temperature. Since DJF 1999–2000, there has been a general downward trend in the number of accidents recorded each year. This is in common with other studies and is attributed to be a consequence of improvements in vehicle technology (Edwards, 1996). However, over this time period there is no overall warming trend evident in the mean winter temperatures. Indeed there is a limited relationship between mean temperature and long-term accident rates, although the coldest year (DJF 2000–2001) did produce the second highest number of accidents. In order to improve understanding of the impact of temperature on road accidents, much more detailed analysis of individual years are required.

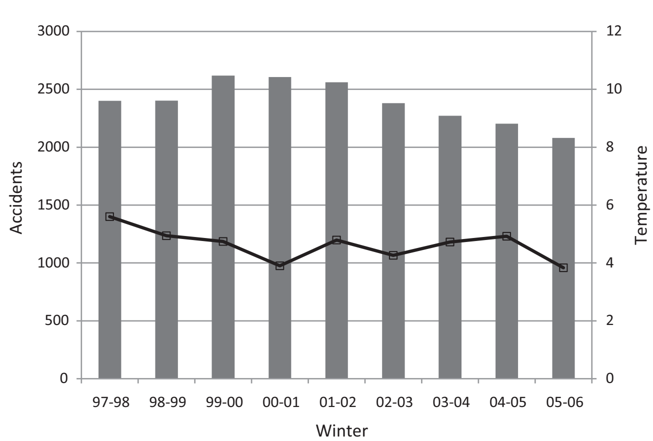

Fig. 2. Accidents in the West Midlands plotted against mean winter temperatures. Accidents (grey bars), (□) mean temperature.

This study contrasts the last 2 years of data shown in Fig. 2 (DJF 2004–2005 and DJF 2005–2006). DJF 2004–2005 was chosen as this was a warm winter (although not exceptional for the last 10 years) with mean temperatures of 1.3 °C above the 1961–1990 baseline (UK Met Office, 2009). As a result, it may represent a temporal analogue of future average weather conditions (e.g. Feenstra et al., 1998). For comparison, DJF 2005–2006 was selected for a more detailed analysis as this was more an 'average' year being marginally warmer than the baseline conditions. Consecutive years were chosen so as to remove the impact of long-term trends on the accident data, for example, increasing traffic numbers or improvements in technology such as anti-lock brakes (Edwards, 1996).

In the West Midlands, there were 2204 traffic accidents in DJF 2004–2005 (although only 2102 had a full record suitable for analysis). In DJF 2005–2006 the amount of accidents was similar totalling 2081 (2070 with a full record). These accidents are plotted in Fig. 3 against the air temperature value measured at Elmdon when the accident occurred. Surprisingly, considering the difference in average temperature recorded in each of the two seasons, the total number of accidents in each of the years is very similar.

Fig. 3b shows a cumulative percentage graph for accident numbers at different air temperatures. Here the difference between the two winters can be more clearly identified with a greater percentage of accidents occurring below the 0 °C threshold in DJF 2005–2006. In terms of winter maintenance, 0 °C is a critical threshold as ice is most slippery at 0 °C when in a semi-frozen state (Moore, 1975). However, this is based on road temperature and not air temperature. Although the two are related, there is no rule of thumb measurement to translate between the two. During the winter months, it is not unusual for road surface temperatures to be several degrees below air temperature (Bogren & Gustavsson, 1991; Thornes, 1991), but this is very much dependent on the