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A 120-year record of the spatial and temporal distribution of gravestone decay and acid deposition

Howard D. Mooers [a, *], Avery R. Cota-Guertin [a, b], Ronald R. Regal [c], Anthony R. Sames [d], Amanda J. Dekan [a, e], Linnea M. Henkels [a, f]

[a] Department of Earth and Environmental Sciences, University of Minnesota Duluth, Duluth, MN, 55812, USA
[b] 14093 201st Ave NW, Elk River, MN, 55330, USA
[c] Department of Mathematics and Statistics, University of Minnesota Duluth, Duluth, MN, 55812, USA
[d] 3 Tamarisk Close, Birmingham, B29 4DB, United Kingdom
[e] 2834 Arthur St. NE, Minneapolis, MN, 55418, USA
[f] 131 17th St Heron Lake, MN, 56137, USA

HIGHLIGHTS

- Gravestone decay is used to quantitatively reconstruct historical acid deposition.
- Spatial variability in gravestone decay reflects changing land use patterns.
- Up to 98% decrease in acid deposition after 1975 because of air quality regulation.

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ABSTRACT

This investigation examines the spatial and temporal variability of marble gravestone decay throughout West Midlands County and adjacent portions of Warwickshire, Staffordshire, and Worcestershire. Gravestone decay has been used effectively as a quantitative measure of acid deposition. Numerous techniques have been used to assess gravestone decay and each is subject to different sources of error. To minimize error we focus only on marble gravestones that use the flush lead lettering technique. Decay of the marble leaves the lead lettering raised above the surface, and the distance can be measured with the use of a digital micrometer. Gravestone decay can be used to quantify the spatial and temporal distribution of acid deposition. Our gravestone decay database consists of 1417 individual measurements on 591 tombstones in 33 cemeteries and covers the period from 1860 to 2010. Sites range from industrial and residential areas to rural settings. These data allow us to establish the natural background rates of decay, the effects of urban/residential expansion, and the efficacy of environmental regulations. Decay rates vary from a minimum of 0.2 mm/century in remote rural areas to nearly 3.0 mm/century in the Birmingham City Center. The data are corrected for environmental variables, converted to acid deposition rates, and plotted at 10-year intervals from 1890 to 2010.

"On every side, and far as the eye could see into the heavy distance, tall chimneys, crowding on each other, and presenting that endless repetition of the same dull, ugly form, which is the horror of oppressive dreams, poured out their plague of smoke, obscured the light, and made foul the melancholy air." (Charles Dickens, The Old Curiosity Shop, 1841).

1. Introduction

This investigation quantifies acid deposition over the last 120+ years in the West Midlands, UK, using lead-lettered marble gravestone decay as a proxy. Gravestone decay has been shown to be a sensitive indicator of air quality (Inkpen, 2013; Gauri and Holdren, 1981) and can be used to determine quantitatively minimum acid deposition rates (Dragovich, 1991; Inkpen, 2013; Inkpen and Jackson, 2000; Cooke et al., 1995; Inkpen et al., 2008). In the

* Corresponding author.
E-mail address: hmooers@d.umn.edu (H.D. Mooers).

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