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Management of landfill leachate: The legacy of European Union Directives

R.B. Brennan [a,b,*], M.G. Healy [a,b], L. Morrison [b,c], S. Hynes [d], D. Norton [d], E. Clifford [a,b]

[a] Civil Engineering, College of Engineering and Informatics, National University of Ireland, Galway, Ireland
[b] Ryan Institute, National University of Ireland, Galway, Ireland
[c] Earth and Ocean Sciences, School of Natural Sciences, National University of Ireland, Galway, Ireland
[d] Socio-Economic Marine Research Unit, J.E. Cairnes School of Business and Economics, National University of Ireland, Galway, Ireland

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ABSTRACT

Landfill leachate is the product of water that has percolated through waste deposits and contains various pollutants, which necessitate effective treatment before it can be released into the environment. In the last 30 years, there have been significant changes in landfill management practices in response to European Union (EU) Directives, which have led to changes in leachate composition, volumes produced and treatability. In this study, historic landfill data, combined with leachate characterisation data, were used to determine the impacts of EU Directives on landfill leachate management, composition and treatability. Inhibitory compounds including ammonium (NH_4-N), cyanide, chromium, nickel and zinc, were present in young leachate at levels that may inhibit ammonium oxidising bacteria, while arsenic, copper and silver were present in young and intermediate age leachate at concentrations above inhibitory thresholds. In addition, the results of this study show that while young landfills produce less than 50% of total leachate by volume in the Republic of Ireland, they account for 70% of total annual leachate chemical oxygen demand (COD) load and approximately 80% of total 5-day biochemical oxygen demand (BOD_5) and NH_4-N loads. These results show that there has been a decrease in the volume of leachate produced per tonne of waste landfilled since enactment of the Landfill Directive, with a trend towards increased leachate strength (particularly COD and BOD_5) during the initial five years of landfill operation. These changes may be attributed to changes in landfill management practices following the implementation of the Landfill Directive. However, this study did not demonstrate the impact of decreasing inputs of biodegradable municipal waste on leachate composition. Increasingly stringent wastewater treatment plant (WWTP) emission limit values represent a significant threat to the sustainability of co-treatment of leachate with municipal wastewater. In addition, the seasonal variation in leachate production poses a risk to effective co-treatment in municipal WWTPs, as periods of high leachate production coincide with periods of maximum hydraulic loading in WWTPs.

1. Introduction

Landfill leachate is the product of water that has percolated through waste deposits that have undergone aerobic and anaerobic microbial decomposition (Chofqi et al., 2004; Mukherjee et al., 2014). Leachate composition is a function of the type of waste in the landfill (biodegradable or non-biodegradable, soluble or insoluble, organic or inorganic, liquid or solid, and toxic or non-toxic waste material), landfill age, climate conditions and hydrogeology of the landfill site (Chofqi et al., 2004; Slack et al., 2005). A landfill site will produce leachate throughout its working life and also for several hundred years after it is decommissioned (Wang, 2013). As leachate contamination of groundwater, rivers, lakes and soils has the potential to negatively affect the local environment and human population (Ağdağ and Sponza, 2005; Marshall, 2009), the control of a landfill site and appropriate treatment of the leachate it produces is of paramount importance for the current and future protection of surrounding natural resources.

In 2012, 246 million tonnes of total municipal solid waste (MSW) was produced in Europe (equivalent to 487 kg of MSW per person), of which the highest per capita production was Switzerland and the lowest was Romania (Eurostat, 2015). There have been dramatic reductions in the volume of waste being landfilled in many European countries (Ireland, Czech Republic, Slove-

* Corresponding author at: Room 1029, New Engineering Building, NUI Galway, Galway, Ireland.
E-mail address: raymond.brennan@nuigalway.ie (R.B. Brennan).

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nia, Norway, United Kingdom, Denmark, Iceland, Austria and Finland (Fig. 1). There has also been a reduction in the number of illegal landfills and an improvement in waste acceptance practices throughout the Member States (EC, 2007). In 2012 across the 28 EU Member States, 34% of all waste treated was sent to landfill, 42% was recycled, 4% was incinerated, and 15% was composted

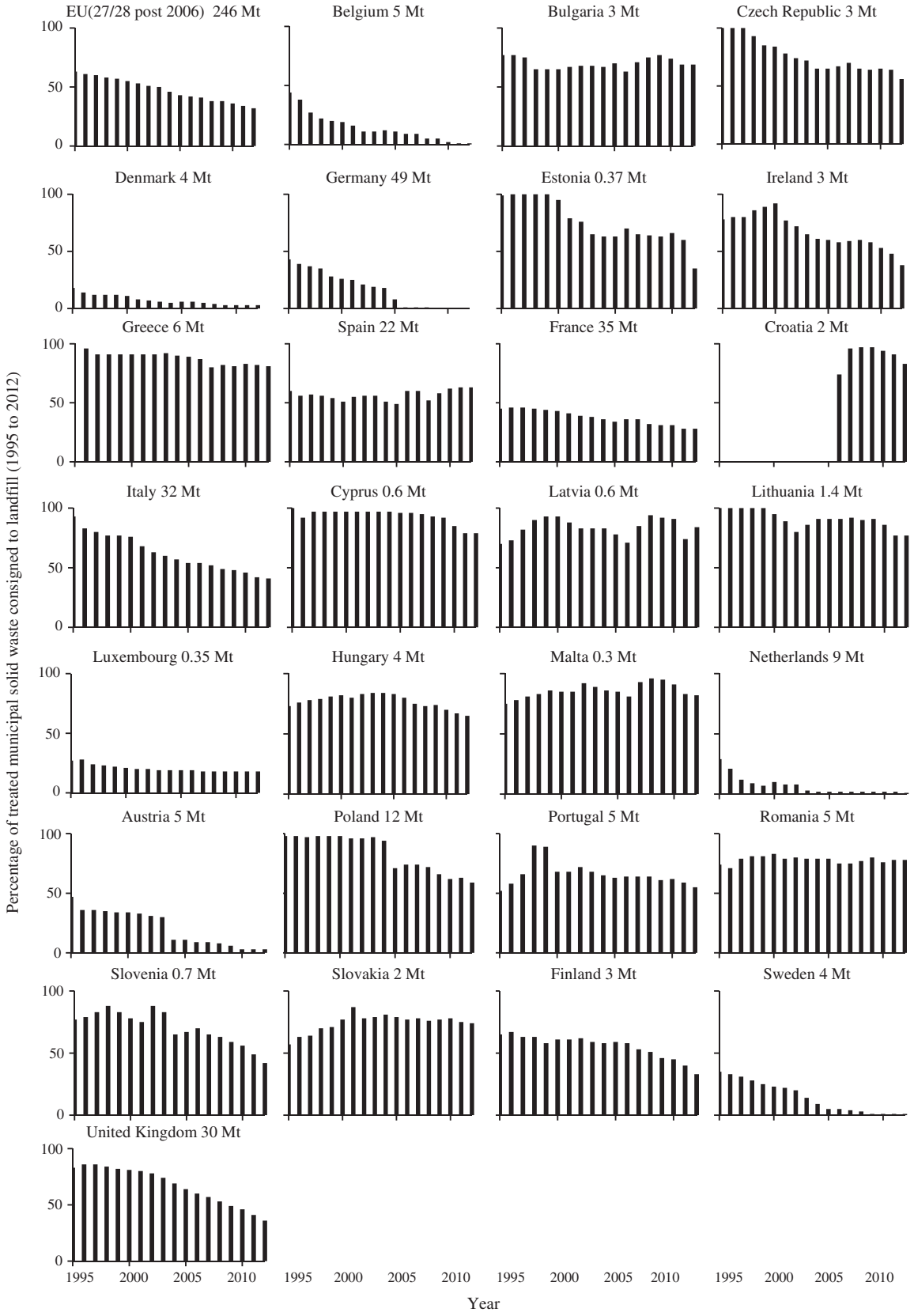

Fig. 1. Percentage treated municipal solid waste landfilled (Mt waste produced) (Eurostat, 2015).