

Composition and Distribution of Organic Waste in Ireland: Implications for Land Application Practices

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Abstract

Questions about the economic and environmental sustainability of current waste management scenarios in Europe for various organic wastes, the policy drive at the EU, and the subsequent adoption of EU policy at national levels, has given momentum for diversion of organic wastes away from landfills and ultimately on to the land. The land has always been the receptor of choice for animal manures, but it is now becoming a popular management route for other organic wastes. Currently in Ireland, land is examined by specific sectors and regarded as a resource available uniquely to each sector. In contrast, it is reasoned in this paper that treating the diverse organic wastes potentially suited for land application as a unit waste stream and developing a detailed accounting of waste quantities and characteristics would serve as a gateway towards a consistent and holistic strategy from which a comprehensive land application strategy at national level or regional level could be developed.

The methodology used is a desk-based inventory that relied on existing secondary data in published reports. A literature based survey and quantification of organic wastes potentially suited for land application, in Ireland, was completed. The survey included a broad range of organic wastes from agricultural and non-agricultural activities - with animal manure, spent mushroom compost, biodegradable municipal waste, biosolids, sludge from onsite treatment plants, organic wastes from industrial sources the major ones. Reports from the Central Statistical Office of Ireland, study reports at the Environmental Protection Agency, Regional Waste Management Plans, Sludge Management Plans, County Waste Registries and European sources were consulted in association with codes and guidelines to determine the quantity and composition of organic wastes potentially suited for land application. Major and minor plant nutrients were used as a basis to describe the composition of the organic

wastes. Finally a GIS-based database of the organic wastes potentially suited for land application was developed and a distributional analysis was performed at different spatial scales.

Results of our analysis confirm that animal waste remains the largest source of organic waste in Ireland - as in most other European countries - and the major concern for management through land application due to the sheer volume of the waste. Between the small percentage of organic wastes of non-animal origin biosolids, sludge from industrial sources, biodegradable municipal wastes and spent mushroom compost constitute the major share. There is a spatial distribution of the organic wastes in terms of both the total quantity of organic waste and type of the organic wastes. While the volume of the non-agricultural wastes appears to be insignificant – compared to organic waste of animal origin – at a National level it constitutes a high local problem at lesser spatial scales, i.e. counties and regions. The research suggests that there is a need to a leap from the present, sector-specific approach used in managing the land application of waste to a comprehensive land application strategy that considers the total quantity and quality of waste relative to the land base suitable for receiving them.

1.0 Introduction

EU hierarchical waste management policy which espouses reuse and recycling over disposal, where prevention and minimization could not be achieved, heralded the evolution of a new perception of waste as a resource from the traditional view of waste as a simple residue of linear processes which needed to be discarded (Powerie and Dacombe, 2006). Waste is now conceived as part of the dynamic material cycle with potential end uses and this view has been echoed in Ireland by S.I. 378 of 2006 (European Communities (Good Agricultural Practice for Protection of Waters) Regulations 2006) which defines a “fertilizer” as any substance (e.g. organic wastes) containing phosphorus or a nitrogen compound utilized on land to enhance growth of vegetation. The term ‘organic waste’ encompasses a wide variety of wastes that have the potential to be recycled back in to the natural system by the action of micro-organisms. Among other things, organic waste includes the biodegradable fraction of municipal solid waste as well as composted green waste, biosolids from wastewater treatment processes, animal waste, and waste from some industrial

sources; in short, organic wastes are amenable to microbial degradation (Westerman and Bicudo, 2005; Sharma et al. 1997).

Organic wastes contain major plant nutrients (Nitrogen (N), Phosphorous (P) and Potassium (K)), minor plant nutrients (e.g., Calcium (Ca), Magnesium (Mg), Sulphur (S) etc.) and organic matter (Moss et al.2000), all of which can improve soil fertility and possibly soil physical properties. However, some organic wastes (e.g. biosolids from municipal waste water treatment systems and some industrial sources) may house heavy metals, potentially toxic elements (PTEs), and persistent organic compounds (POC) (FWR, 2000; Beck et al., 1996; Overcash et al., 2005), which tend to take years to assimilate into the soil system. Most chemical constituents in organic wastes, properly used, constitute a 'free' fertilizer (N, P, and K) and soil conditioning material (organic matter), but mismanagement may also create environmental challenges

Management of organic wastes is favourably linked to the land. Article 51 of the Waste Management Act, (1996) puts agricultural or non-agricultural lands application of organic wastes, for growing vegetation or ecological benefits, as a justifiable medium for organic waste management. Historically the land has always been a receptor of choice for organic waste from animal sources. *"In 19th century Ireland, it was recognized that without the manure of at least one cow, potato yields would not be large enough to feed a family"* (Bell, 1992). According to Gendebein et al. (2001) animal manure is the major type of land-recycled organic waste across Europe. Over 90% of the land applied organic waste had its origin in animal sources. A similar study in Ireland concluded that approximately 99% of organic waste arises from animal sources (Anonymous, 2006). In contrast, the use of the land for management of organic wastes of non-animal origin is a recent phenomenon.

Over the last decade the use of the land as a waste management alternative for variety of other organic wastes has received increased attention. This is partly explained by the need to safely recycle these wastes in compliance with EU legislative demands, the increase in the quantity of these wastes requiring management on one hand, and the unacceptability of previously available management options (e.g. ocean disposal, land filling) and the unavailability of other waste management infrastructures (e.g. incineration in Irish context). Within decades after the implementation of the EU Urban Waste Water Treatment Directive 991/271/EEC the volume of biosolids produced in Ireland trebled between 1998 and 2005

(EPA, 2007). This has a special significance for land application practices as ocean dumping of sewage sludge ended in 1998. Prior to the ban on ocean dumping Ireland enjoyed the advantage of its extended coastline for management of biosolids and now that this has ended, biosolids management is generally moving towards recycling through land. Sludge Management Plans developed by local authorities, in Ireland, almost unanimously set beneficial recycling through land – especially agricultural land - as the ultimate and most viable management alternative for biosolids and sludge from onsite treatment plants and other non-hazardous sludges (e.g. Fehily, Timoney & Co., 2003). Land application is being viewed as the least expensive way of managing these wastes.

Council Directive 1999/31/EC (the Landfill Directive) on the land filling of waste also requires member states of the European Union to reduce their dependence on the land filling of municipal waste in favor of more environmentally sustainable alternatives. Member countries are to rely less and less on landfill as a management option and adopt a progressive strategy to divert (i.e. 25% of 1995 baseline levels by 2006, 50% by 2009 and 65% by 2016) biodegradable wastes away from landfills. Municipal and industrial organic wastes, which have traditionally been disposed in landfills, have now to find an alternative recycling option. This is a challenge as land filling has traditionally been the predominant disposal option and the development of other waste management infrastructures (e.g. incineration) is at the beginning or facing persistent public resistance – at least in Ireland. Yet, the EU Waste Framework Directive 2008/12/EEC advocates self sufficiency in waste management and generally in regards to organic waste, currently, in Ireland, the land is examined by specific sectors and regarded as a resource available uniquely to each sector (e.g. Department of Environment, Heritage and Local Government, 1999; Fehily, Timoney & Co., 2003).

While recognizing the persuasion behind the examination of the land as an economically and environmentally justifiable organic waste management medium, this research stresses the need to quantify and closely examine the organic wastes which appear destined to be managed through the land in the foreseeable future. Proper understanding of the quantity and characteristics of organic waste will form the basis for determining land needs, logistical needs (i.e. transportation, storage facilities, treatment etc), the type of land application practices (i.e. application to agricultural, forest, reclamation or public contact sites), the spatial dimension of the waste management concerns and the degree of regulatory control and system monitoring required. It is observable that diverse sectors, processes, produce

these organic wastes yet it is perceived that fairly similar biochemical processes in the soil facilitate the assimilation of these wastes back in to the soil system. It is reasoned here that treating the diverse organic wastes potentially suited for land application as a unit waste stream and developing a detailed accounting of waste quantities and understanding their inherent characteristics would serve as a gateway towards a consistent and holistic strategy from which a comprehensive land application strategy at national level or regional level could be developed. The objectives of this research paper are, therefore to identify and quantify organic waste produced in Ireland, assess its distributional contexts and its implication for land application practices.

2.0 Methodology and assumptions

2.1 General:

The overall approach followed in estimating organic wastes arising, in Ireland, utilised desk-based modelling to analyse secondary data available in published reports at National level (and other European sources). By and large, data from the Irish Central Statistical Office (CSO) forms the skeleton for this quantification of organic waste. CSO conducts surveys that provide information on population figures at different spatial scales; agricultural statistics on such measures as livestock numbers; a resume of household and commercial municipal wastes at National levels; and other information that informs the bases for quantification of organic wastes. For non-agricultural waste, however, in addition to CSO data, reports and publications from the Environmental Protection Agency (EPA) form the building block for estimation of quantity and composition. The EPA keeps annual, national, estimates of waste arising in Ireland in different sectors.

2.2 Quantifying and Characterization:

The methodology of O'Reagan (2000), which relies on Central Statistical Office (CSO) data, was used to calculate the amount of animal waste arising. This methodology uses end-of-year inventory figures from CSO and applies standard waste generation rates per animal as contained in existing codes (e.g. DAFF 1999) to determine the quantity of animal waste. S.I. No. 378 of 2006 specifies the storage period for livestock manure throughout Ireland, while pig and poultry operations are assumed to be an in-house operation throughout the year. The CSO December count is used as a proxy for cattle numbers after adjustments to reflect

animal sales and birth by synthesizing CSO and Computerized Cattle Registry from the Department of Agriculture and Food (DAFF).

Where comprehensive quantity estimation reports exist, they have been utilised directly. Yearly figures of biosolids production in Ireland are reported in EPA Urban Waste Water Reports for a Population Equivalent (PE) of 500 and above (EPA, 2007). Population equivalent was also used as the basis for converting the proportion of the town or cities, which are not currently connected to the urban waste water system. CSO reports inform the percentage of population not covered by urban wastewater services. Existing literature was searched for determining wastewater production per head and estimation of the quantity of sludge from onsite treatment facilities was made. The industrial base is fairly predictable in Ireland (EPA, 2005). Quantities of industrial biosolids from EPA reports and regional waste management plans were utilised directly, without modification. The quantity of spent mushroom compost requiring management is obtained from census of mushroom production (Grogan, 2007). Methodology to quantify the biodegradable fraction of municipal waste relied on historical trends of municipal waste generation and composition as reported in the EPA National Waste Data Base Reports through 1998 to 2004. The spatial dimension of municipal waste was studied by taking regional per-capita waste generation figures as reported and analysed in regional waste management plans. The characteristics of organic wastes are mentioned in terms of the major plant nutrients and a literature based reference was made to their biological and chemical properties.

2.3 Distributional Context

The latest comprehensive agricultural CSO census available in Ireland is for year 2000. This severely constrains the geographic implications of the waste quantification exercise for a large component of the organic waste 'pool' (i.e., animal waste, which is the major organic waste stream in Ireland). Even though reasonably up-to-date regional and national CSO estimates exist, there are no current county level data on animal numbers. We assumed regional trends in the animal industry over the past three years are fairly stable and when change occurs we assumed uniformity within regions. Taking year 2000, where a county census is available, as a base year, the animal numbers were adjusted to reflect the scenario in 2006. Regional apportioning was done on the exiting latest information of 2002. But, before translating the adjusted animal figures to animal slurry we checked for the

accuracy of our assumption by comparing it with the Computerized Cattle Registry from Department of Agriculture and Food. We estimated the geographic distribution of biodegradable municipal waste using regional and national per capita waste generation figures.

3.0 Results and Discussion

3.1 Types of Organic Waste

Table 1 shows organic wastes potentially suited for land application, as assembled from literature sources. In many parts of the world, organic wastes from agricultural and non-agricultural sources are recycled through the land. Gendebein et al. (2000) made an in-depth survey of organic waste spread on land in EU member countries. Their survey discloses that the degree to which each member state uses the land for these wastes is different, showing how local dimensions of waste management issues would dictate the practices. In countries where the land is already under pressure from manure surplus the use of the land for other organic wastes is minimal. In Ireland, however, existing literature suggests that, a more measured approach is followed in recycling these wastes through the land (e.g. EPA, 2000; EPA, 2003; EPA, 2005; Fehily, Timoney & Co., 2003). The principal reason behind EU and national directions favouring the use of the land for these diverse organic wastes is the need to claim the nutrients and organic matter which otherwise would have been lost by disposal. Notwithstanding the variation in the amount and form in which beneficial nutrients are available in each of these wastes, there is a perceivable difference in the degree of risk potentially expected in reclaiming these wastes through the land.

Table 1: Example of (Organic) Wastes Potentially Suited for Land application

Organic Wastes of Agricultural Origin
Animal manure/slurry from over wintering of cattle, sheep, deer, horses, pigs, poultry and other domesticated animals (e.g. Eliot and Stevenson, 1977).
Silage effluent, dirty water from milking parlours (e.g. EPA,2002)
Spent mushroom compost (e.g. Carton and Magette,1999)
Municipal compost (organic fraction of domestic waste containing remains of vegetables, fruits , plants and garden waste, food remains from restaurants , hospitals etc) (Petersen et al., 2003; Moss et al., 2002)
Waste from food and drink preparation (e.g. Werner, 2003)
Blood and gut contents from abattoirs (e.g. SEPA,1998)
Organic Wastes of Non-agricultural Origin
Biosolids from waste water treatment plants (e.g. USEPA,1999; EPA,2007; Laturus, 2007)
Sludge from onsite treatment plants (e.g. Peterson et al.1994; SEPA,1998)
<i>Sludge from drinking water production</i> ¹ (e.g. Babatunde and Zhao, 2007))
Dredging (e.g., Anonymous, 2006)
Waste from basic organic chemical and pharmaceutical industries (e.g. EPA, 2005).
Paper waste sludge, waste paper and de-inked paper pulp(e.g. Smith, 1995)
Waste wood, bark and other plant material. (e.g. Werner , 2003)
Waste lime from cement manufacture or gas processing ¹ (e.g. Gendebein et al. 2001)
Waste from leather and tannery industry ¹ (e.g. Soliva, 2004)
Textile waste(e.g. Werner, 2003)
<i>Slag from steel industry</i> ¹ (e.g. Soliva, 2005)

3.2. Quantity of Organic Waste

The quantification of organic wastes in this research is confined to those wastes that are customarily land applied in Ireland, and those for which the land as a management option is

¹ These are inherently inorganic materials but recycled through the land occasionally

being examined or are partly applied currently, but does not include dirty water and silage effluent and some very small quantity of industrial organic wastes where extracting sensible basis for quantifying is found to be difficult from existing information. The total quantity of waste reported in this research is limited to 'managed waste'. Managed waste here refers to organic waste that has been collected and stored for management. Using the techniques described previously, more than 37 million tonnes of managed organic waste were estimated to have been produced in Ireland in 2006. The organic wastes contained an equivalent amount of 157,861 and 17,500 metric tonnes of nitrogen and phosphorus, respectively. Figure 1 shows the contribution of agricultural and non-agricultural wastes to the total managed organic waste arising in Ireland. Agricultural sources contribute approximately 91% of the total managed organic waste estimated in this study. The agricultural waste is mainly animal waste. In relation to the volume of animal slurry requiring management, the contribution of spent mushroom compost to agricultural organic waste is virtually insignificant. It accounts for less than 1 % of the agricultural waste arising in Ireland.

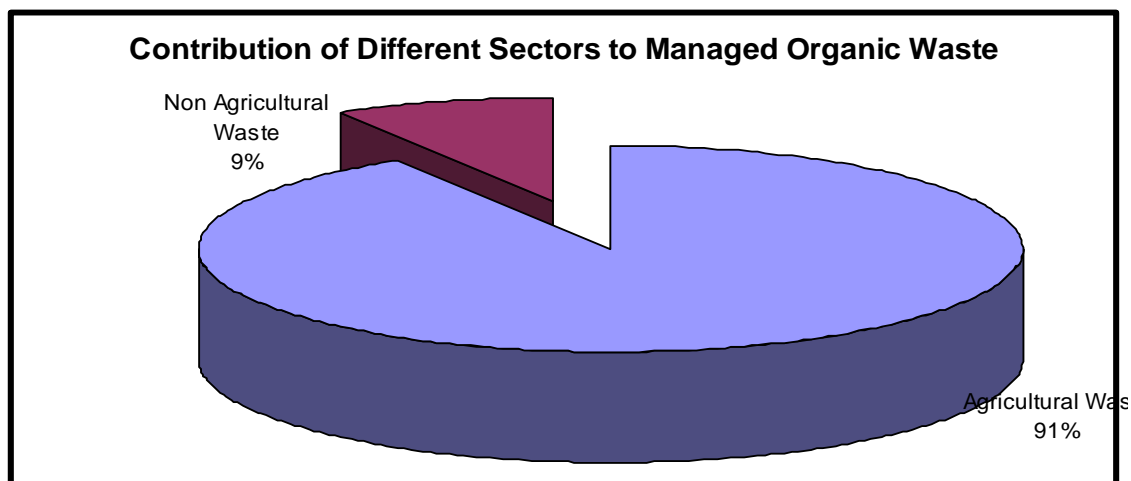


Figure 1: Contribution of Different Sectors to Managed Organic Waste (Potentially though Land Application)

Biosolids, sludge from onsite wastewater treatment facilities, and the biodegradable fraction of municipal solid waste comprise organic wastes of non-agricultural origin. Table 2 below shows the contribution of these wastes to the total organic waste of non-agricultural origin. Municipal sources - biosolids, sludge from onsite treatment plants and municipal bio-waste – generate approximately 80% of the non-agricultural waste, with the remaining 20% coming from industrial origin. However it is to be noted that biosolids production in Ireland is expected to increase due to investments in wastewater treatment processes. Huge

wastewater collection and treatment systems upgrading works are currently underway and there also remain a number of smaller agglomerations that do not have such facilities in place.

Table 2: Non-Agricultural Managed Organic Waste Produced in Ireland, 2006

Non-Agricultural Organic Waste	Tonnes	Percentage
Municipal origin	2,532,286	78.34
Industrial origin	700,000	21.66
Total Non-Agricultural Waste	3,232,286	

3.3 Distribution of Organic Waste

There is scarcity of data in Ireland at smaller spatial scales necessary to have an in-depth understanding of the distribution and management issues associated with each type of organic waste. The highest resolution at which reasonably persuasive assumptions and interpretations could be made is a county, of which there are 26 in the Republic. Assessment of the geographic pattern of organic waste in this study is therefore confined to county scale. The spatial distribution of organic wastes potentially suitable for management through the land in Ireland is apparent in Figure 2. Among the 26 counties, County Cork produces the highest volume of organic waste followed in decreasing order by counties Galway, Kerry, Tipperary, Mayo, Kilkenny, Wexford and Cavan. These eight counties alone comprise approximately 60% of the total managed organic waste estimated to have been produced in Ireland in 2006. County Cork alone generates 15% of the total organic waste produced in Ireland. Five of the top eight producers of the total organic waste (60% of total) are located in the southern part of the country. These eight counties produced an equivalent amount of 92,906 tonnes of nitrogen and 9164 tonnes of phosphorous – without considering industrial organic wastes whose spatial figures are ambiguous.

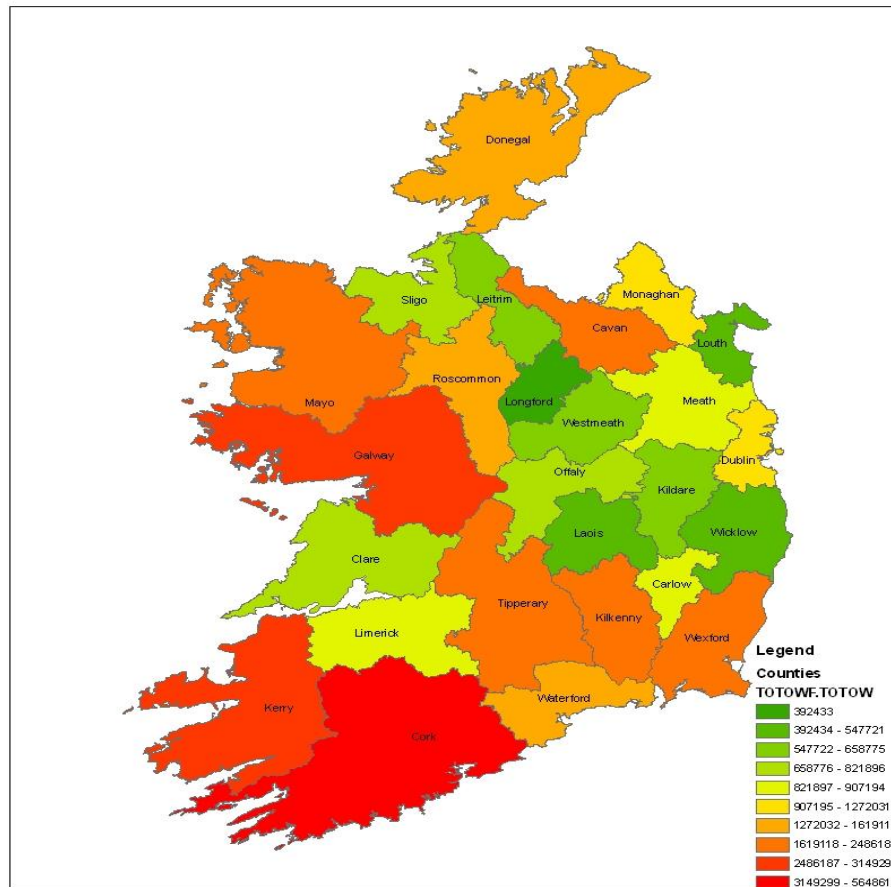


Figure 2: Distribution of (Managed) Organic Waste in Ireland, Estimated for 2006

Different spatial distributions exist among a single unit waste stream such as animal waste (e.g. cattle waste, pig waste, poultry waste etc) or other organic wastes (e.g. biosolids, spent mushroom compost etc). And also, as organic waste in Ireland is predominantly of animal origin, the distributional implication of other organic wastes tends to be concealed if seen together with animal waste. Figure 3 shows the distribution of selected organic waste sources among the Irish counties. The south west corner of the country (i.e. Kerry and Cork) is a 'hot spot' in terms of cattle waste requiring management. Waste from sheep, on the other hand, poses a significant pressure on the land on the western corner of the country (e.g. Galway). Two counties, Cavan (North) and Cork (South), produce 50% of pig waste requiring management. Counties Monaghan (North) and Cork (South) produce approximately 70% of poultry waste requiring management.

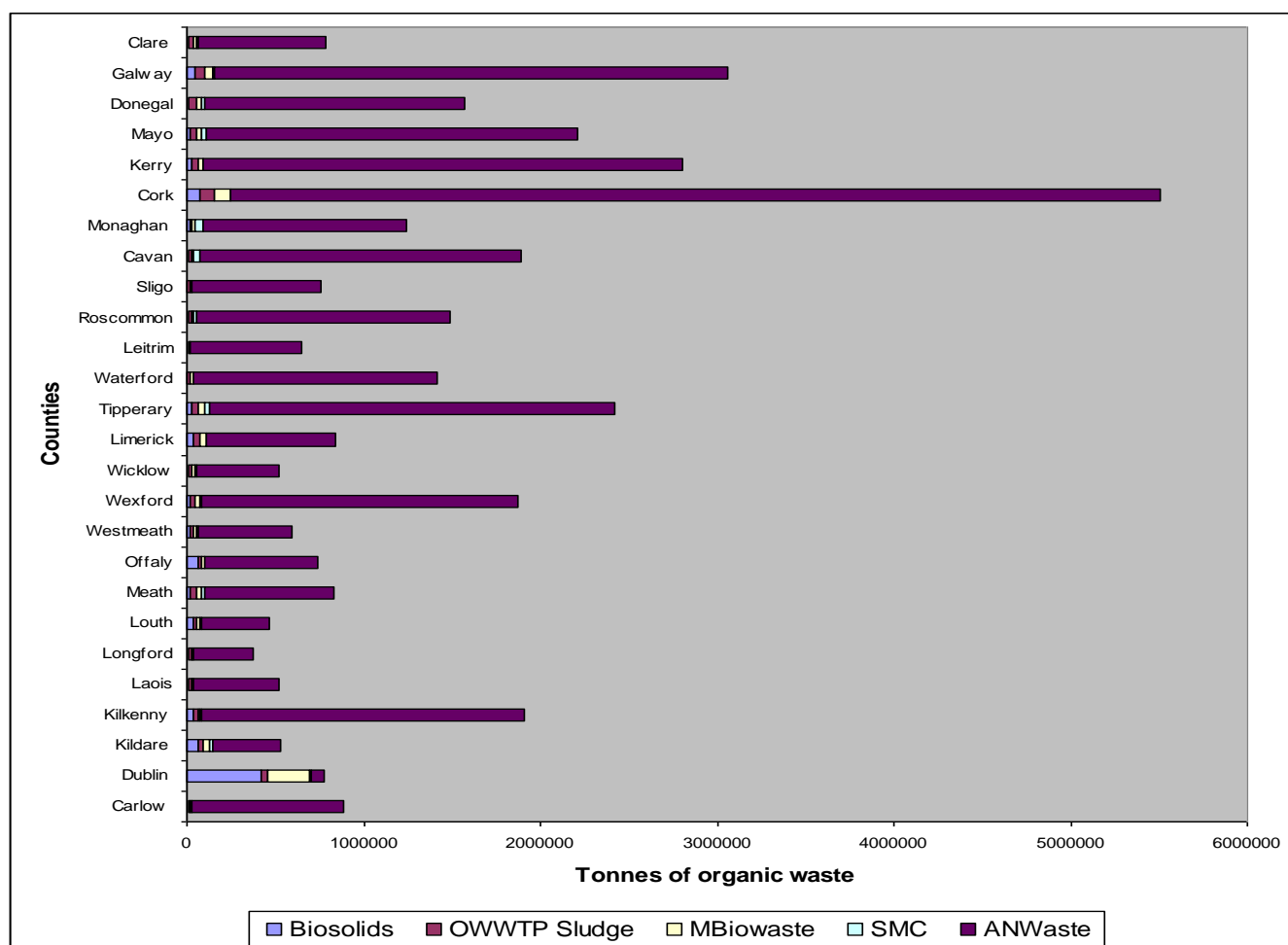


Figure 3: Distribution of Organic Wastes across Irish Counties

3.4 Implication for Management through Land application

A simplified assessment of the land required for organic wastes potentially suited for land application was performed. Using a phosphorous based approach – phosphorus is a limiting design constraint in Ireland and taking grassland (pasture) as a typical land use - grass land covers over 75 % of Irish land use - we established the amount of land needed to manage these wastes in an environmentally sustainable way. An environmentally sustainable management in this research is construed as a management approach that matches the nutrient in theses wastes to the nutrients needs of the grassland. To demonstrate this - and because there is a lack of defined soil phosphorous information in Ireland - the scenario given by Magette and O'Reagan (2002) was taken as the most realistic condition of the Irish soils. This scenario assumes that 50% of the soil is at soil P index 2 and the other 50% is at soil P index 3. In Ireland fertilizer (e.g. organic wastes) application on land is guided by

phosphorous index which is a reflection of the soil phosphorus pool. Where the soil P is high (e.g. P index 4) the application of organic waste on that land is severely constrained.

Figure 4 below shows total grassland needed for the scenario described above. In total Ireland needed over 1.25 million hectares of grassland to recycle the managed organic wastes produced in 2006. This is less than one third of the total grassland available in Ireland. Around one million hectare (82%) of the land needed is for managing animal waste. However, it has to be noted that the fact that the estimated land need for managing these wastes, in this research, is less than the amount of land area actually available does not necessarily show there is a land capacity to recycle these wastes in Ireland. Although it is understood that determination of the land needed based on the absolute quantity of waste requiring management is important, there are also a number of other factors such as land cover, soil nutrient level (i.e. balance), soil type, depth to water table, location of streams and wells, local regulations, transportation costs, and land owner preferences which are important. The effect of one or a combination of these factors would severely limit the possibility these wastes could be managed through the land. In fact concerns about P surplus, and hence shortage of land, were reported by Brogan et al. 2002; Magette and O'Reagan, 2002; Tanto and Magette, 2008. In Ireland the capricious climatic conditions also plays a significant factor in constraining the availability of land by creating competition between different wastes for land.

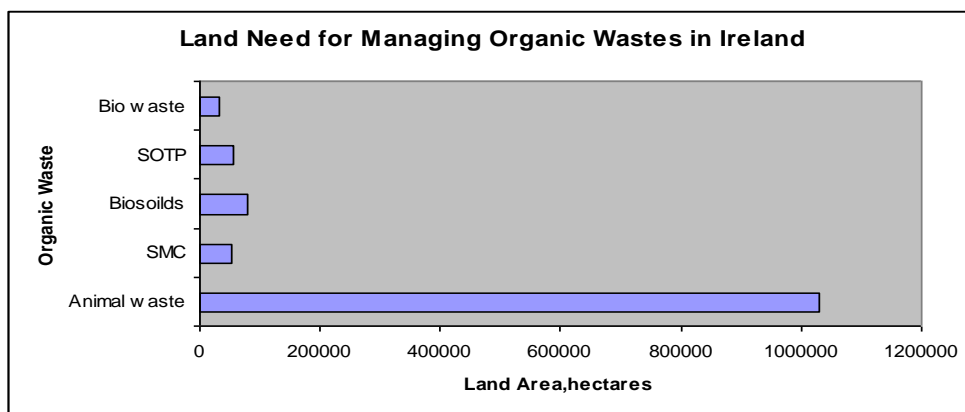


Figure 4: Land needed to Recycle Organic Waste, Estimated for 2006

If we take animal waste out, in land terms, all the other managed organic wastes combined require less than 5% of the grassland in Ireland. The management challenge arising in land application of non-animal organic wastes will potentially arise from the geographic

concentration of these wastes (e.g. Dublin City Corporation transports biosolids outside its administrative boundary to apply on land), the competition arising from the large volume of animal waste requiring management, the relatively recent ingress of some of these wastes to the Irish agricultural land, the public view of them and most importantly their characteristics compared to manure. In addition to the physical land needs there is a temporal dimension in using the land for some of the wastes. For example, safety measures designed to prevent the ill effects from land applying sludge from septic tanks effectively restrict access to the land for six months. This is a challenge to the farmer, land owner, or the waste producer in Ireland where a limited window of opportunity exists for applying organic waste on land.

Even though the cleanness of Irish sewage has been reported by O'Riordan (1983) and McGrath et al. (1993), it is contentious to compare the chemical and biological risk posed by organic wastes from municipal sources with those organic wastes originating from agricultural sources, and especially with those from animal sources (manure). In their studies to develop strategies for land spreading of organic waste, RPS Consulting Engineers (2006) surveyed existing literature on the biological and chemical threats associated with land spreading of various organic wastes and suggested a hierarchical grouping of different organic wastes, with organic wastes from agricultural sources labelled as the safest. This is in concert with the common sense knowledge prevalent within the broad society and especially the farming community. What has been voiced in their report and a number of other studies impress that there is a lack of scientific clarity (e.g. Overcash et al. 2005), and sometimes consensus (e.g. Laturus, 2007; FWR, 2000), on some biochemical issues, which might fuel people's scepticism of receiving these wastes for recycling. While regulatory caps are available, in Ireland and elsewhere, these may be taken just as limits, but not as capable of averting risks (Beecher et al. 2004). To sustain the existing encouraging uptake (EPA, 2007) of these wastes (e.g. biosolids), in Ireland, it is necessary to communicate this dilemma to the land owner, the farmer, and other important stakeholders (i.e. retailers) - who influence the farmers - in a manner which would assure safety. Moreover municipalities need to upgrade wastewater treatment and biosolids polishing processes and consistently maintain the quality of treatment processes, standardize the quality of biosolids produced and tighten controls on discharges in to public wastewater collection system.

The land is also being examined as a potential destiny for the management of municipal bio-waste. Our examination shows that biowaste does not need more than 34,000 hectares of the grassland area in Ireland, which is less than 1% of the total grassland area. According to the requirements of the Landfill Directive, Ireland has to make provisions for diversion of over 1,000,000 million tonnes of biodegradable waste from landfills. This, however, is a percentage of the 1995 production which is dwarfed compared to what is generated during the periods of economic boom pointing to the insurmountable waste management challenges the country faces. One key national strategy for the management of biodegradable wastes is the development of centralized biological treatment facilities and encouraging, home composting, which considers the land as an end receptor of the 'digestate'/compost.

It is also to be noted that the greater Irish public is suspicious about some bio-waste management strategies such as incineration and landfilling, and to date Ireland is the only country among former 15 EU member states that does not have incineration. Contrary to the positive image compost may have, the proliferation of compost in to agricultural land is not easy in Ireland. Compost quality is at the centre of the discussion. The quality of compost is as good as the input material and municipal authorities need to bolster their investment to improve the collection of biowaste if their strategy to use the land is to be materialized and sustained. In Ireland there is a need to increase the coverage of segregated collection systems and continuously communicate with citizens for the need to safely separate biowaste.

Integrated management of all non-hazardous waste has been promoted at European or national level as the most sustainable, economical and practical method of optimizing sludge/organic waste management. The distributional aspect of the organic wastes highlights the need to contemplate about regional and integrated approaches in managing these wastes. In fact a regional approach towards waste management in general has begun with the formation of eight waste management regions in Ireland, but it has yet to transcend to the idea of seeing these wastes together as a unit waste stream. The spatial distribution apparent indicates the need for sensitivity to local dimension of the anticipated management challenge through the land as well as perceivable benefits in going for integrated approaches. General regulatory measures prescribed to reduce volume of waste may not necessarily transfer to each local context as the nature of industry producing each organic

waste is different among local authorities. A cross sectional view of the whole scenario is necessary. Yet it is also possible to pursue a land application strategy that harnesses the spatial issue by integrating the potential merits of each waste.

The land application practice in Ireland is constrained by P surplus available from animal waste (Brogan et al. 2002; Magette and O'Reagan, 2002; Tanto and Magette, 2008). When P from organic waste exceeds the crop needs, at the any scale, one possible scenario is to transport these waste to areas where the land capacity has not been depleted to avoid nutrient dumping and potential pollution of water resources. Transportation is constrained by economics and it might not be profitable to move waste long distance unless the volume of waste is reduced by treatment. Treatment processes such as anaerobic digestion are important. There isn't any centralized such facility in Ireland but the distributional assessment of this study informs the existence variety of organic wastes that could beneficially be integrated in centralized (e.g. anaerobic digestion) treatment facilities. In addition to the economies of scale that can be realized, there is a possibility to avoid biological health concerns with some organic waste. As it stands now Ireland depends on other countries to recycle paper waste and animal byproducts - which in the long term can not be sustainable- which could have been processed with other organic waste together.

4.0. Summary and Conclusions

This paper made a literature-based survey of organic wastes potentially suited for land application and examined the quantity and distribution of selected organic wastes customarily applied on the land in Ireland. Over 37 million tonnes of organic waste that require management are produced in Ireland, which is equivalent to 157,861 and 17,500 metric tonnes of nitrogen and phosphorous respectively. The number and types of wastes that could potentially be classified as organic waste inform how diverse organic waste producing sectors are lumped under the same heading. All organic wastes are not equally beneficial nor embody equal risk. Therefore, policies and guidance's – concerning land application - need to be structured to reflect the characteristics difference existing between these wastes. There is a need to a leap from the present, sector specific approach to managing the land application of waste to a comprehensive land application strategy that considers the total quantity and quality of waste relative to the land base suitable for receiving them.

Theoretically all the managed organic waste quantified in this study combined may not need more than one third of the grassland base but the picture is be different, confirm to shortage of land area, when nutrient balances are performed including direct deposition manure on land by animals (Brogan et al. 2002; Magette and O'Reagan, 2002; Tanto and Magette, 2008). There is a defined geographic trend in distribution of each type organic waste. Beneficial properties of these wastes could translate in to environmental concern if the geographic density of the quantity these wastes is beyond what the land mass can support. The spatial distribution apparent indicates the need for sensitivity to local dimension of the anticipated management challenge through land application as well as perceivable benefits in going for integrated approaches. The non-animal wastes are dwarfed when compared to the huge volume of animal waste. Presumably in addition to their geographic orientations issues related to their qualities, public attitude and competition from manure will determine their management through land. Alternative land uses such as forest land (12 % of the total land mass), public parking places, land reclamation works present a very good option.

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