The impact on groundwater of the land spreading of organic wastes onto biomass crops

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Introduction Land-spreading on bioenergy crops is a possible route for the disposal of some organic wastes. Issues related to water-pollution make research into the environmental impact of these practices a priority. Hazards include the possibility of a decline in surface- and ground-water (GW) quality from pollution by heavy metals (HMs) and nutrients contained within such wastes. The viability of land-spreading of bio-solids and brewer's waste was investigated from an overall water-quality perspective including runoff water, soil moisture, and GW. The interaction of spread waste, crop, rainfall, the soil matrix is very complex; however, and the focus of this presentation will only be on the GW component of the overall water-quality picture.

Material and methods Spreading was conducted on an annual basis on long-established plantations of *Miscanthus X Giganteus* located in Oak Park, Co. Carlow, Ireland. The plots were 0.12 ha in size and organic wastes were applied at 3 treatment levels: heavy (H=100%), light (L=50%) and control (C=0%). Three plots on the Barley Field (BF) were spread with Brewer's Waste (BW) and three on the nearby Near Avenue Meadow (NAM) plantation with biosolid (BS). The procedures for spreading and upper limit of spreading was based on regulatory limits and standards (DoE, 1998; EPA, 2006) and each year was considered as a *replicate* period for statistical purposes. Biosolid waste was spread on the NAM using a towed disc-spreader and BW on the BF using an irrigation system. Prior to spreading, GW wells were inserted into each plot; 3 wells were placed on treated plots and 1 well on each control plot. Monthly samples were taken for 24 months between Oct 2007 and Oct 2009. Samples collected from plots with multiple wells were bulked before analysis each month. All samples were collected in accordance with guidelines published by the US EPA (US EPA, 1996). Samples were filtered using a Sarstedt 0.45um micropore filter, sent to the Teagasc Water Lab in Johnstown Caste, (Co Wexford) and analyzed for NO_3, P and K and heavy metals (HMs): Ni, Cd, Pb, Zn, Cu, and Cr using AA spectroscopy. Conductivity and pH analysis were conducted on all samples and monthly rainfall and GW well-water levels were recorded. Nutrient and HM levels were assessed in relation to waste-spreading quantities applied; mean concentrations recorded over the 24 month monitoring period, and the interim guideline values (IGVs) set by the EPA for each of the species in response to the EU Water Framework Directive (EC Directive, 2004).

Results Table 1 provides mean concentration levels of bulked monthly GW samples for each plot for the 22 month period from Oct 07 to Aug 09. Maximum concentrations are also included in each box (in italics on the right). Results are still pending for Sept-Oct 09 and statistical work on significance, variance, and treatment-correlation is currently being undertaken.

Table 3 Mean/*Max* Nutrient and HM concentrations Oct 07-Sept 09 (H = heavy 100%) (L = light 50%) (C = control 0%).

Plot, Waste Type, and Treatment level	NAM 1, Biosolid (C)	NAM 2, Biosolid (L)	NAM 3, Biosolid (H)	BF 9, BW (C)	BF 8, BW (L)	BF 7, BW (H)	IGVs
Mean/*Max* NO_3 07-09 (mg/l)	6.4/*78.3*	6.2/*22.7*	8.7/*74.2*	8.7/104.2	4.9/*27.2*	7.0/*57.7*	25 mg/l
Mean/*Max* K 07-09 (mg/l)	1.2/*4.9*	The 1.0/*3.0*	3.8/*13.4*	1.9/*4.1*	2.3/*10.4*	40.8/*894.0*	5 mg/l
Mean/*Max* P 07-09 (mg/l)	0.05/*0.91*	0.44/*9.7*	0.2/*2.85*	0.004/*0.04*	0.2/*0.18*	0.5/*0.42*	0.03 mg/l
Mean/*Max* Cu 07-09 (ug/ l)	8.7/*40.7*	8.1/*49.1*	11.2/*57.8*	8.0/*26.2*	13.1/*33.6*	16.3/*85.4*	30 ug/l
Mean/*Max* Zn 07-09 (ug/l)	5.1/*39.7*	5.2/*35.4*	8.4/*62.5*	3.1/*12*	4.8/*22.4*	13.5/*154.9*	100 ug/l
Mean/*Max* Ni 07-09 (mg/l)	13.4./*161.1*	8.5/152.9	11.4/*132.5*	13.9/*238.9*	16.5/*208.2*	9.9/175.1	20 ug/l
Mean/*Max* Pb 07-09 (ug/l)	12.5/*149.1*	25.0/*443.6*	33.6/*445.0*	26.4/*272.3*	18.7/*224.5*	20.5/*300.5*	10 ug/l
Mean/*Max* Cd 07-09 (ug/l)	1.1/*4.7*	0.5/*2.1*	1.5/*17.9*	0.7/*5.4*	1.5/*11.9*	1.4/*13.5*	5 ug/l
Mean/*Max* Cr 07-09 (ug/l)	3.1/*19.0*	0.4/*4.6*	4.0/*16.7*	1.5/*5.6*	2.1/*12.2*	2.2/*12.9*	30 ug/l

Conclusions Maximum concentrations were recorded for several species that were well in excess of IGVs. However, mean values were generally within IGVs (with some exceptions) and treatment did not seem to significantly impact most species' concentrations outside of natural variability. Mean K, P, and Pb concentrations exceeded IGVs; however, this may be due to high background levels or high variability and any correlation with treatment is yet to be fully established.

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