Impact of Glyphosate-containing Herbicide on the Retention and Biodegradation of Pollutants in a Model Porous Paving System (PPS)

SUDSnet Conference 2012

By

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4th September, 2012

Outline of Presentation

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- Research aims
- Experimental method
- Results obtained
- Summary of findings
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Introduction

- Research developed in reaction to the requirement by "Water for Life" (formerly Future Water), which stipulates that individual householders are no longer allowed to seal their front gardens and must use permeable solutions to the perennial problem of where to park car(s).

- Water for Life is the water strategy for England which sets out Government's plans for water in the future to ensure clean water is available for people, businesses and nature. It looks at the water cycle as a whole – from rainfall and drainage through to discharge and treatment.

Introduction contd.

- The drought in South East England in 2004-06, and the floods of 2007 have brought into focus the likely pressures or challenges of climate change hence, the need for the water strategy.

- By encouraging the infiltration of stormwater via permeable solutions, these measures may well assist in mitigating surface water flooding, but they will also infiltrate herbicides applied to the pavement to kill weeds, which may cause contamination of underlying soils and groundwater.

Research Aims

The main aims of this research are therefore two-fold:

- To investigate whether commonly used GCH disrupt the retention and biodegradation processes known to occur in PPS;
- To detect the impact of herbicide on the biological components of the PPS, using protists as possible bioindicators.

Experimental Method

- Experiment was set-up using the 144cm^2 test rigs earlier described (Spicer 2006; Nnadi 2009) based on the four-layered design described by Pratt (1989) as detailed in CIRIA C582 (Pratt, Wilson and Cooper 2002).

Test Model	**Rigs**	**No. of replicates**	**Contaminants**	**Analyses**
1	Oil + Glyphosate	3	Used oil and glyphosate added on weekly basis to applicable rigs followed by rainfall events.	After physical examination of effluent, it was analysed for microbial activity to evaluate biodegradation trend (Coupe *et al.* 2003); indication of microbial respiration using CO_2 evolution (Pratt, Newman and Bond 1999) and O_2 depletion (Held and Rippen 1995); effluent quality using protists (Coupe and Smith 2006); elemental concentration using ICP-OES (Newman *et al.* 2011); Hydrocarbon concentration using infra-red spectroscopy (Coupe 2004); and statistical analysis on Minitab platform involving Tukey's LSD, ANOVA etc.
2	Oil only	3		
3	Glyphosate only	3		
4	No oil or glyphosate	3		

Results Obtained

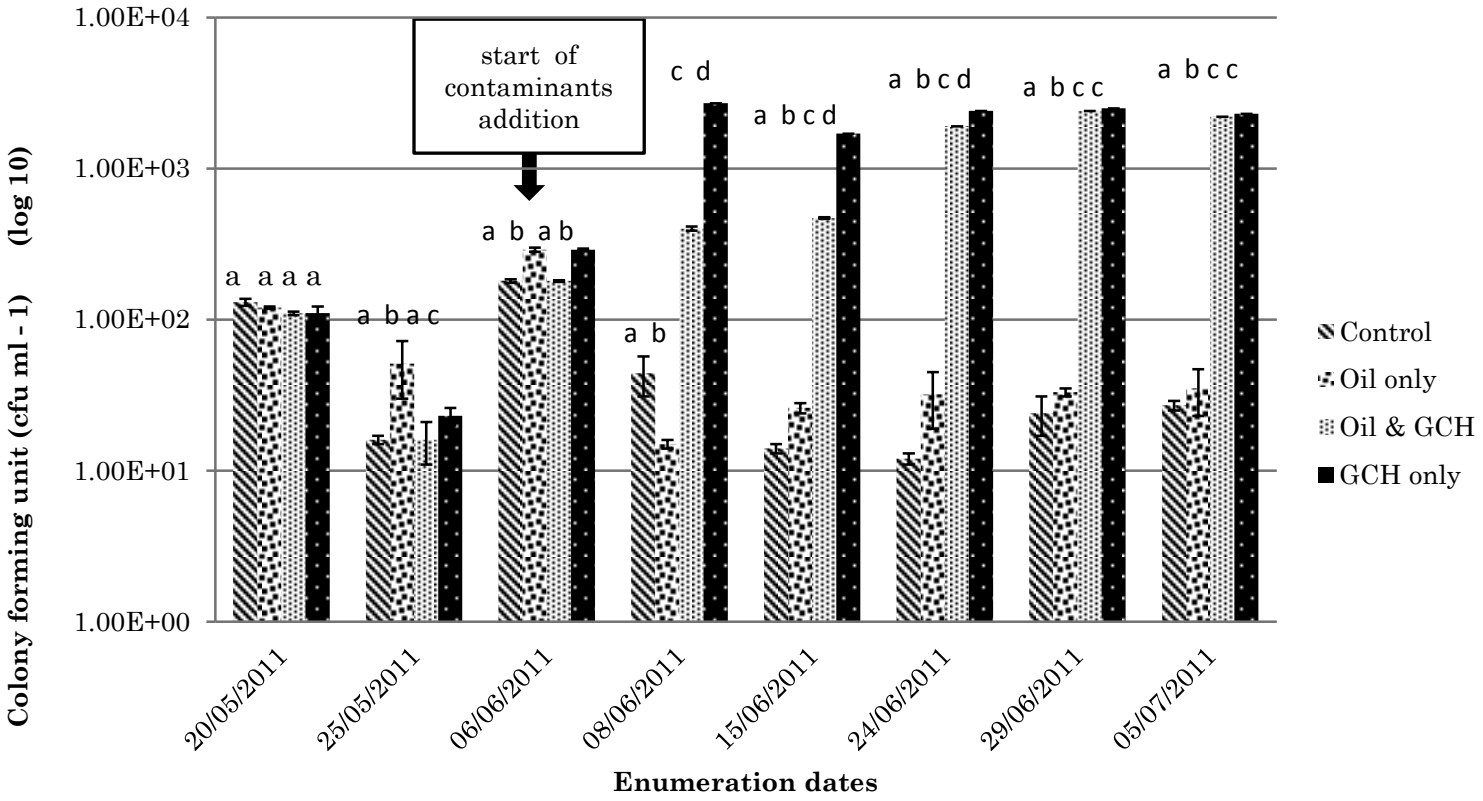

Fig. 1: Effluent bacterial count: 20/05/11 to 25/05/11 were for background studies while contaminants were added on 06/06/11 followed by weekly contaminants addition. The values shown above represent the mean ± S.E. (where n = 3), and for each date, dissimilar letters above bars indicate a significant difference ($p < 0.05$) based on post-hoc test (Tukey's LSD).

- Applied herbicides stimulated the growth of bacterial population.

Results Obtained contd.

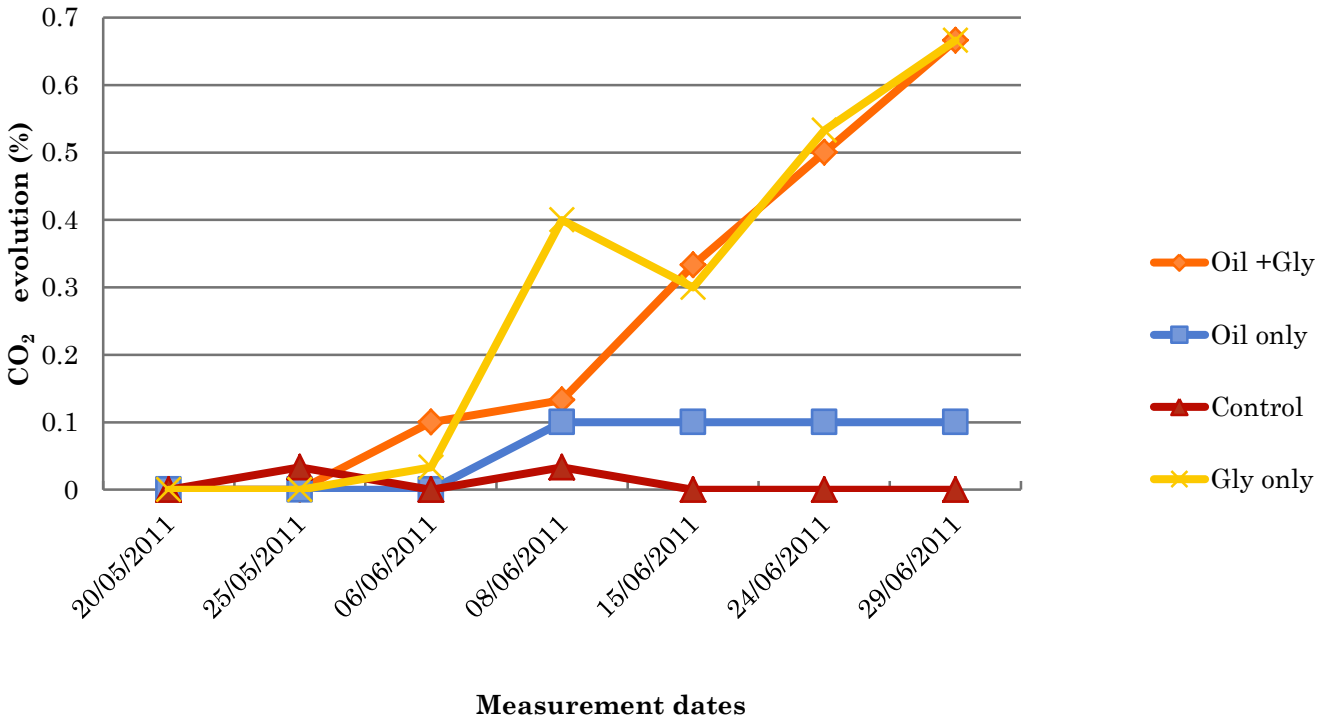

Fig. 2: CO_2 evolution trend from the rigs: 20/05/11 to 25/06/11 represent background studies. Contaminants were added on 06/06/11 followed by weekly contaminant addition. Error bars represent the mean ± S.E. of three replicates (triplicate measurements were virtually the same in many cases thus, the error bars are not observable)

- Indication of higher microbial activities were found in rigs containing herbicide.

Results Obtained contd.

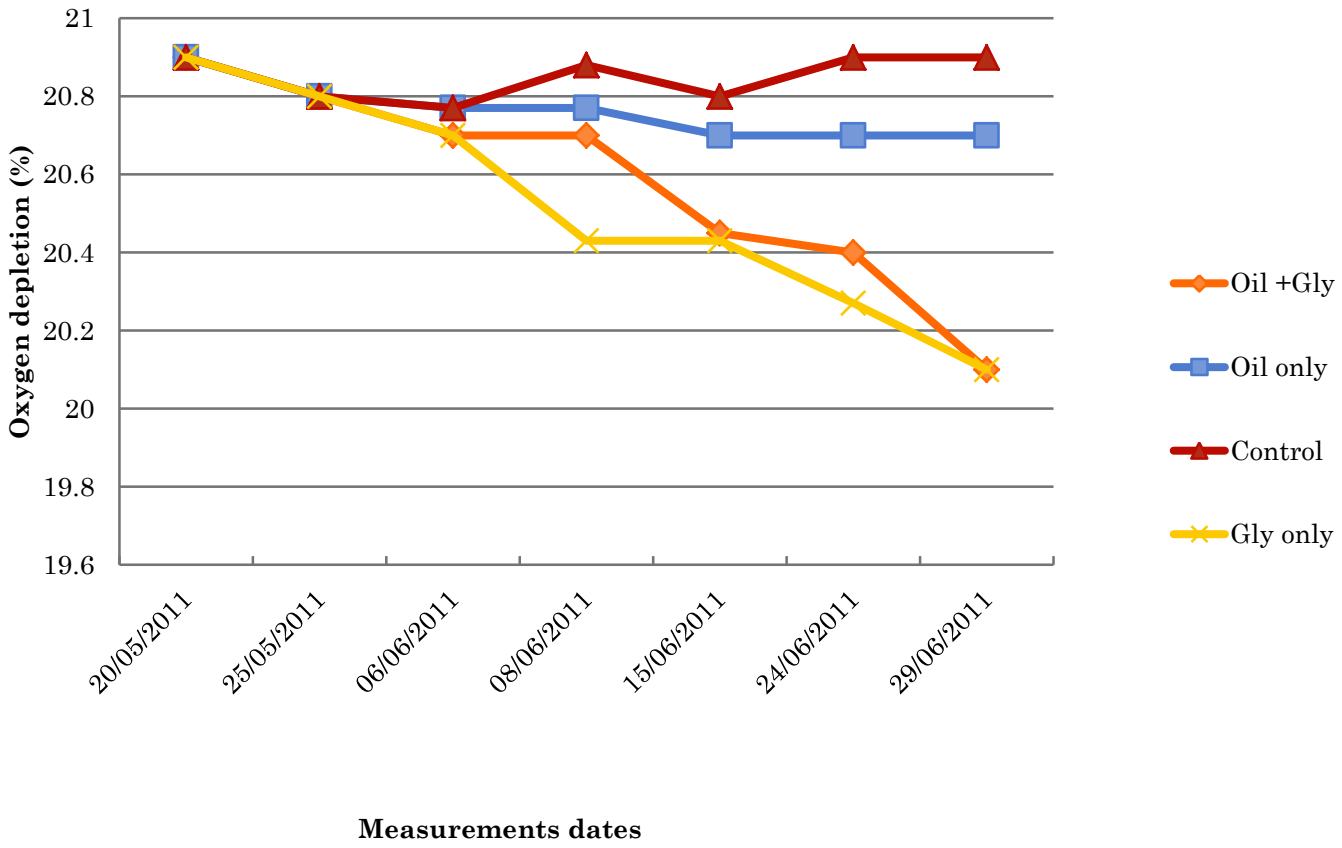

Fig. 3: O_2 depletion trend from the rigs: 20/05/11 to 25/06/11 represent background studies. Contaminants were added on 06/06/11 followed by weekly contaminant addition. Error bars represent the mean ± S.E. of three replicates (triplicate measurements were virtually the same in many cases thus, the error bars are not observable)

- Indication of higher microbial activities apparent in rigs containing herbicide.

Results Obtained contd.

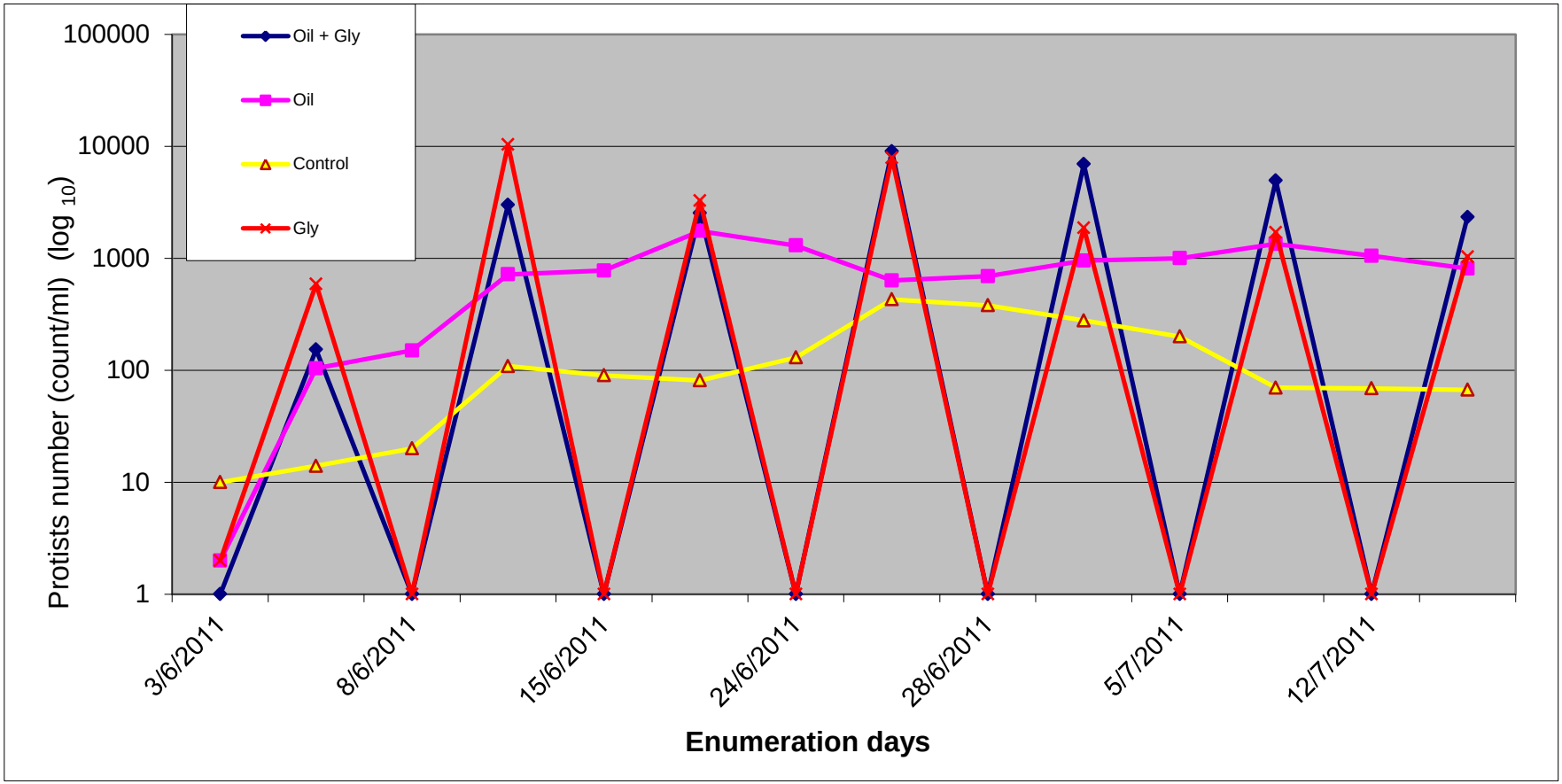

Fig. 4: Number of protists found in effluent from test rigs. Peak heights indicate protists growth level prior to contaminants addition. Each data point represents the mean of three replicates.

- The applied herbicide had instant catastrophic effect on protists although they quickly bounced back within a week.

Results Obtained contd.

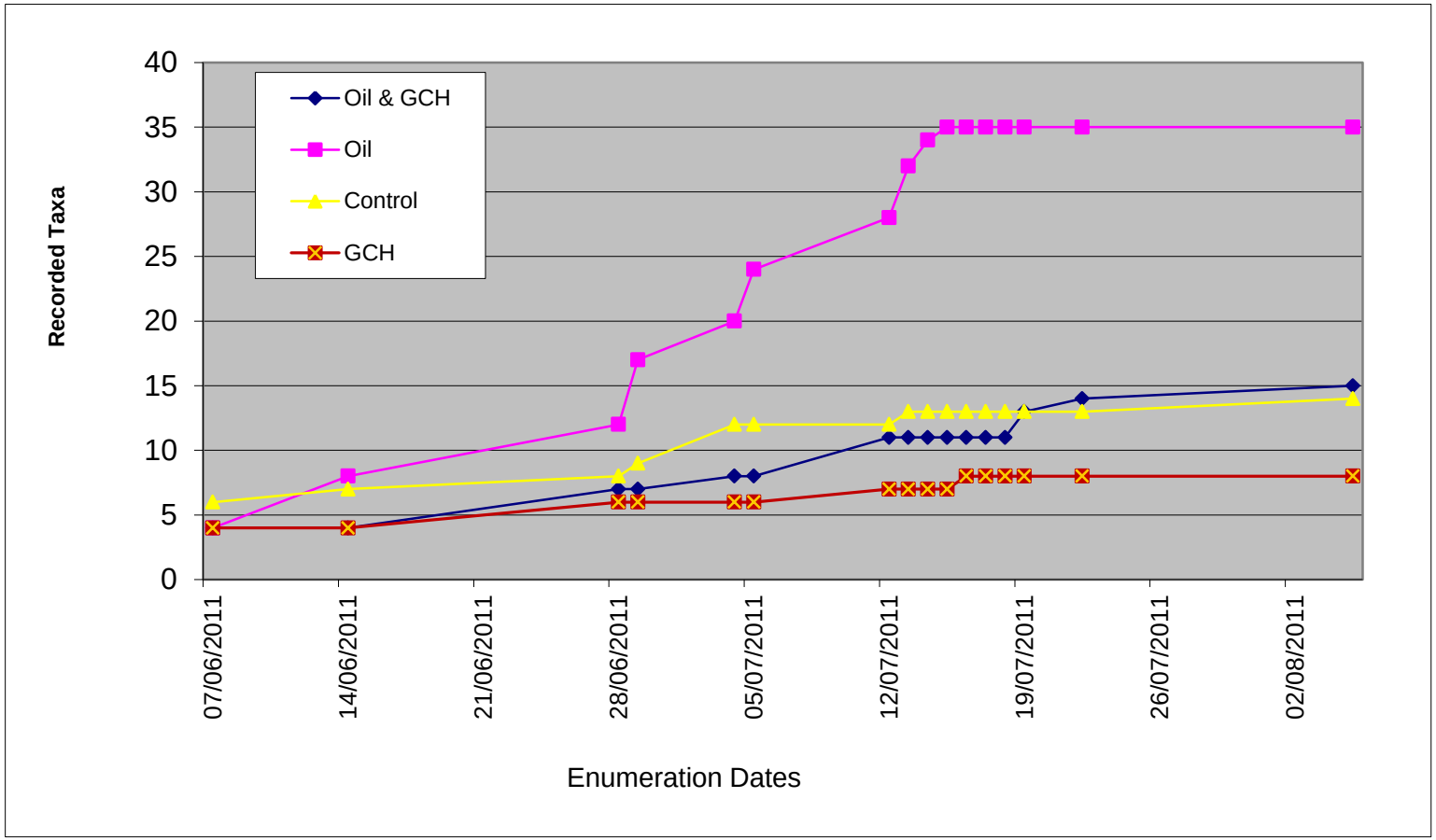

Fig. 5: Cumulative taxonomic richness of protist taxa at each sampling interval found in effluent from test rigs. Each data point is the mean of three replications.

- GCH-only rigs had the least taxonomic richness despite having the highest number of protists.

Summary of Findings

- The addition of GCH results in the stimulation of bacterial as well as fungal populations thus increasing the number of degraders of organic pollutants available in the PPS environment.
- Although the protists are instantaneously completely removed from PPS effluent where glyphosate is added, they recover within a week, although their taxonomic richness is much reduced relative to oil only models.
- In the presence of a hydrocarbon source (used engine oil), the protists taxonomic richness is enhanced.

Further studies on larger scale PPS environment are underway for investigation of the time period over which the bioindicator organisms are affected by GCH following application of the herbicide. This should reveal the point at which the GCH has been degraded by the system.

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The End!

Thanks.