Innovative ideas drive sustainability: case studies on land reclamation.

Dr Julie Williamson

j.c.williamson@bangor.ac.uk

School of the Environment & Natural Resources,

University of Wales, Bangor.

Co-workers: Mark Nason, Sue Tandy, Davey Jones, John Healey.

Presentation at ‘Recycling Organic Resources to Land’, Manchester, April 2007.

EU LIFE -Environment funded project

TWIRLS – Treating Waste for Restoring Land Sustainability

www.bangor.ac.uk/ies/TWIRLS/TWIRLS_home.htm

Alfred McAlpine Slate

UPM Kymmene (UK)

Welsh Assembly Government

Soil Science Institute of Athens

Titan Cement S.A., Envar and United Utilities are also gratefully acknowledged.

The TWIRLS partnership

- Recycle organic and mineral wastes;
- Add value to wastes by composting;
- Produce ‘soils’ fit-for-use and safe;
- Restore degraded land to economic, social or conservation end-uses;
- Feed directly into Policy;

- **Engage with stakeholders.**

Why Recycle?

Waste Minimisation

Europe produces around 2000 million tonnes of waste per year, growing by around 10% per year.

Soil Protection

More than 16% of the EU's total land area is considered degraded in one or more of soil vital functions e.g. fertility, erosion control, water infiltration, microbial biodiversity and carbon sequestration. EU Thematic Strategy.

TWIRLS DEMONSTRATION SITES

Schist quarry, Kamariza, Athens

Former steelworks, Wales

Slate quarry, Wales

Former colliery, England

TWIRLS project Demonstration Sites (1)

Using municipal solid waste compost to restore a Greek hard-rock quarry to native pine forest.

Area: Parnitha National Park, nr Athens, Greece.

Site: Black schist quarry, at 1000 m elevation, owned by Titan Cement.

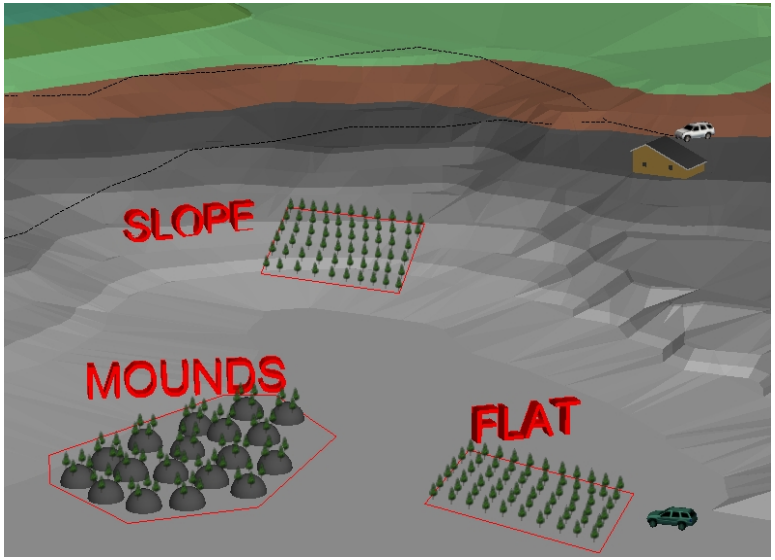
Problems: Low soil organic matter; Low soil water-holding capacity;
Periodic water-logging due to compaction from trafficking.

Solution: Add organic matter using municipal solid waste (MSW) compost produced in Athens;
Restore pine forest by planting nursery-grown Aleppo pine;
Create loose-tipped mounds of quarry waste to minimise waterlogging.

Demonstration Site 1

Waterlogged, quarried-out area
Experimental layout

MSW – Fly tipping vs. reclamation
Mounds reduced pine mortality by 25%



TWIRLS Demonstration Sites (2)

Using composted green waste, biosolids & paper sludge for biodiversity conservation & short-rotation coppicing on a brown-field site.

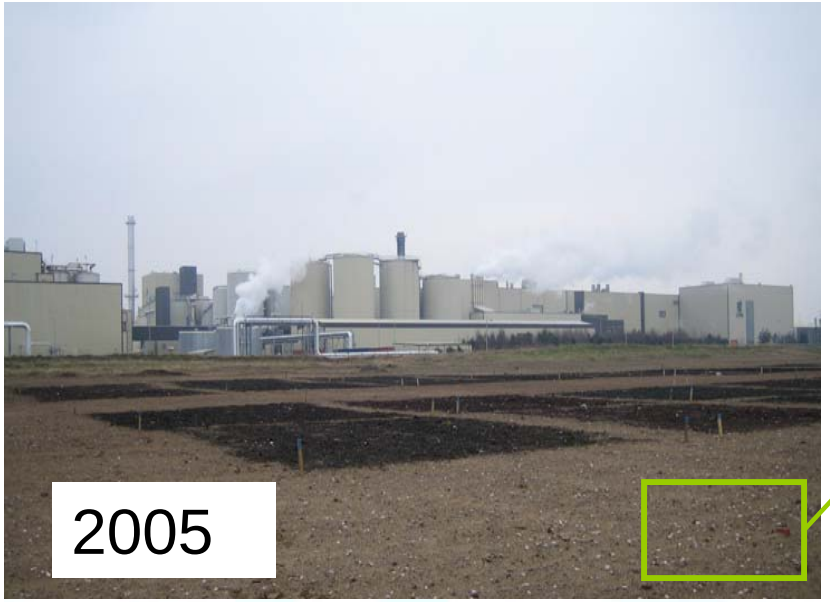
Area: Shotton, Deeside, N. Wales, near SSSI and RAMSAR site.

History: Steelworks established on reclaimed land in 1896. Closed in 1980s. Much of the site has been re-developed as Shotton Paper Mill, owned by UPM Kymmene (UK), but contaminated land remains.

Problems: Low soil organic matter;
Low soil water-holding capacity;
Contaminated (mostly with aromatic hydrocarbons).

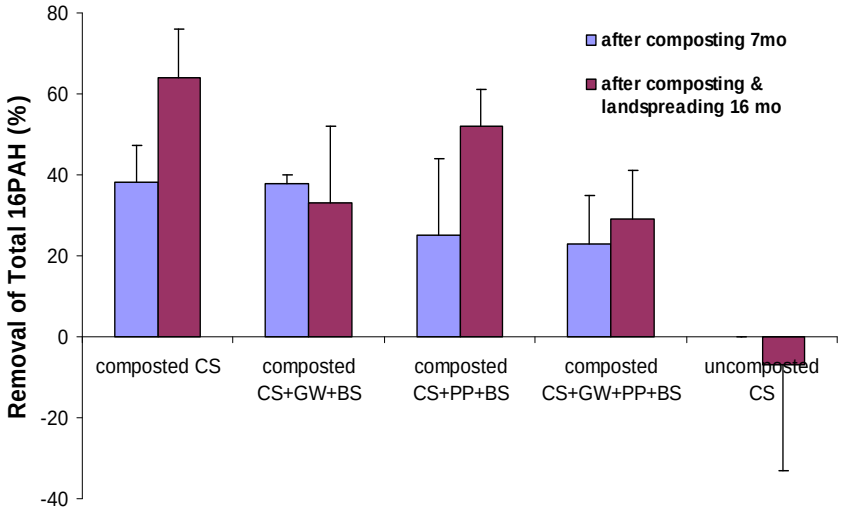
Solution: Co-compost soil with organic wastes to remove or stabilise pollutants;
Add organic matter to made land as composted wastes;
Create biodiverse habitat by seeding with native meadow wildflowers;
Produce biomass crop on marginal land.

Demonstration Site 2



Contaminated soil

Percentage PAH removal after composting and landspreading contaminated soil. Values represent means ± SEM (*n* = 6).



TWIRLS Demonstration Sites (3 and 4)

Using composted green waste, biosolids & paper sludge wastes to create acid heathland at a rural slate quarry.

Area: Blaenau Ffestiniog and Bethesda, Gwynedd, N. Wales;
Surrounded by Snowdonia National Park.

History: Slate extraction for more than 200 years, now owned by Alfred McAlpine Slate;
730 Mt slate quarry waste in Gwynedd.

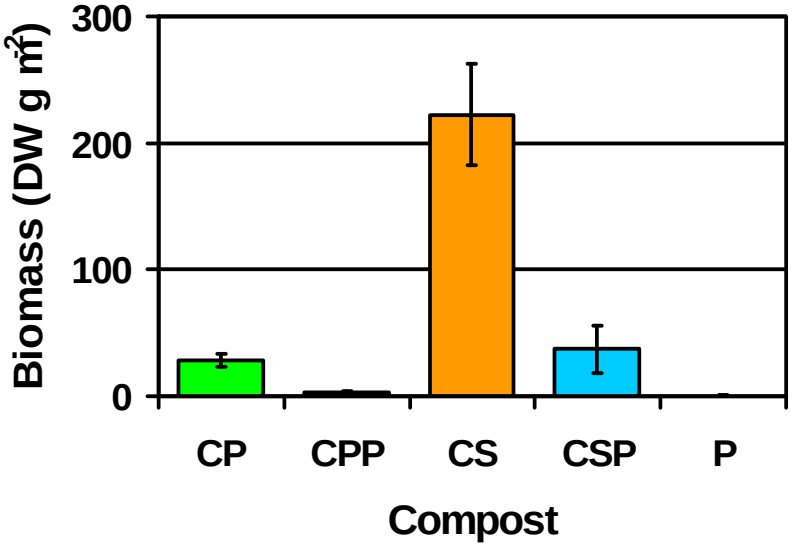
Problems: No soil or vegetation;
No soil organic matter or plant nutrients;
Low soil water-holding capacity.

Solution: Add organic matter and nutrients as composted wastes;
Seed with heather and upland grasses.

Demonstration Site 3

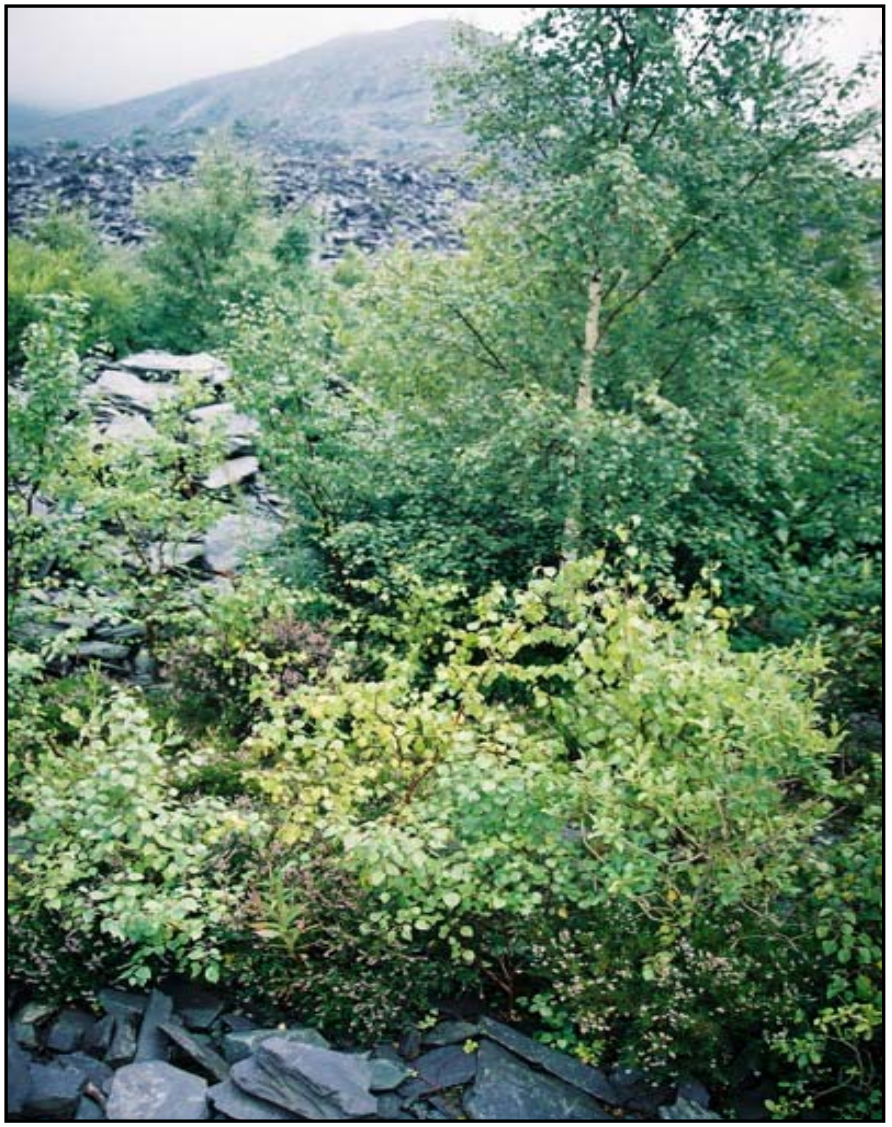
Before landforming.
Experimental layout of plots.

After landforming – 0.5M m^3 moved.
Compost plus slate sand was 'best'.



Demonstration Site 4

Broadleaf woodland restoration on slate waste.



Compared the effect on above and below ground biomass of NPK mineral fertiliser with an organic amendment of biosolids + paper waste matched in N.

Organic amendment resulted in greater tree growth *and* a more active soil microbial biomass than mineral NPK fertiliser.

Site 4. Fertiliser effects on selected soil quality predictors 18 months after tree planting into slate waste.

	Fertiliser treatment			P value	Semi-natural woodland
	No fertiliser	Biosolids-paper mix	NPK		
Microbial biomass mg N kg^{-1}	21 a†	135 b	29 a	< .001	137 b
Respiration mg C $kg^{-1}.h^{-1}$	0.40 a	3.29 b	0.44 a	< .001	2.63 b
Microbial diversity (Simpson's Index 1/D)	4.3 a	6.8 b	5.3 a	0.036	7.2 b

† Main effects labelled with same letter were not significantly different (P<0.05)

Site 4. Compost manipulation for target species

Composts are neutral pH and high in available N and P;

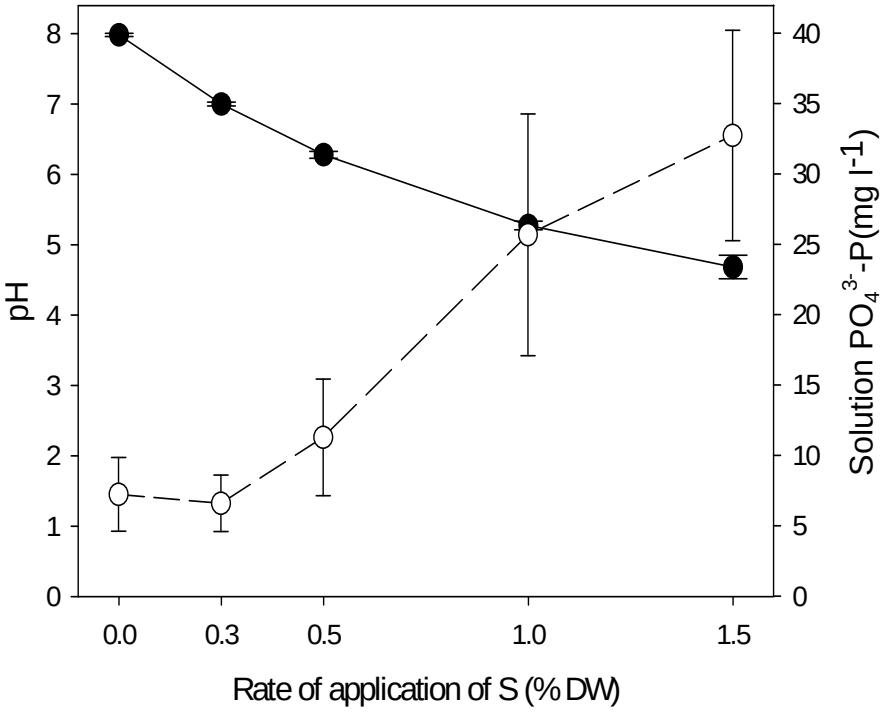
Disadvantageous to slow-growing heathland species;

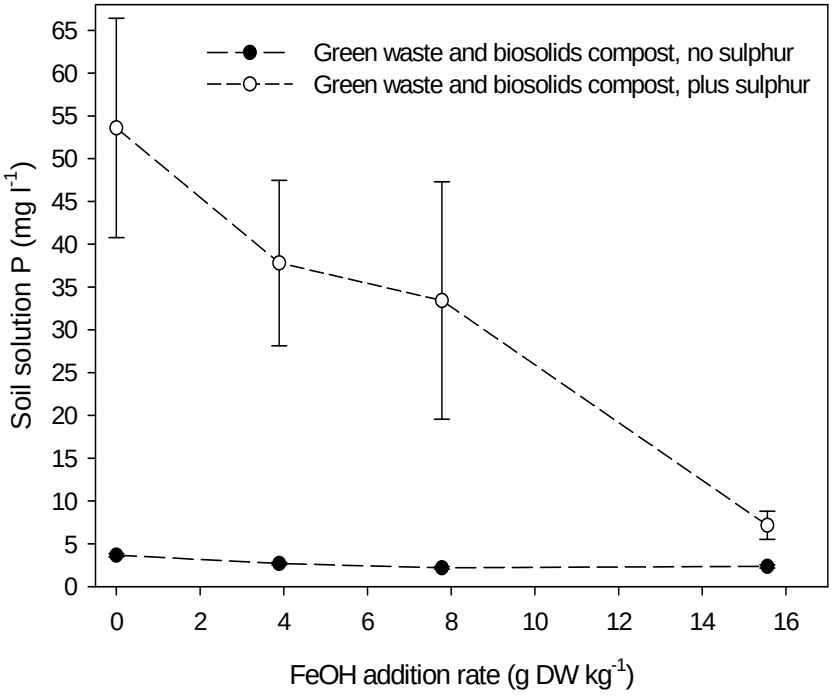
Industrial by-products were mixed with finished composts to modify properties to suit acid heathland establishment on slate waste;

Sulphur wastes and water treatment sludges containing iron hydroxide [$Fe(OH)_3$] are by-products from petrochemical and water treatment industries.

Site 4. Compost manipulation for target species

Addition of waste elemental sulphur (S^0) to composted green-waste is an efficient method of reducing the pH (left) to approaching that of heathland soil whilst $Fe(OH)_3$-sludge wastes bind phosphate solubilised by the pH change (right).





TWIRLS Satellite Sites

• Woolley Colliery – managed by Envar. Monitoring the use of a single application of biosolids and paper sludge wastes to reclaim acid generating colliery shale to agricultural land.

• Farms in Flintshire & Cheshire. Monitoring the repeated use of paper sludge waste to improve arable farmland.

In-Vessel Composting: EcoPOD® system

Composting is the process of stabilising organic matter.

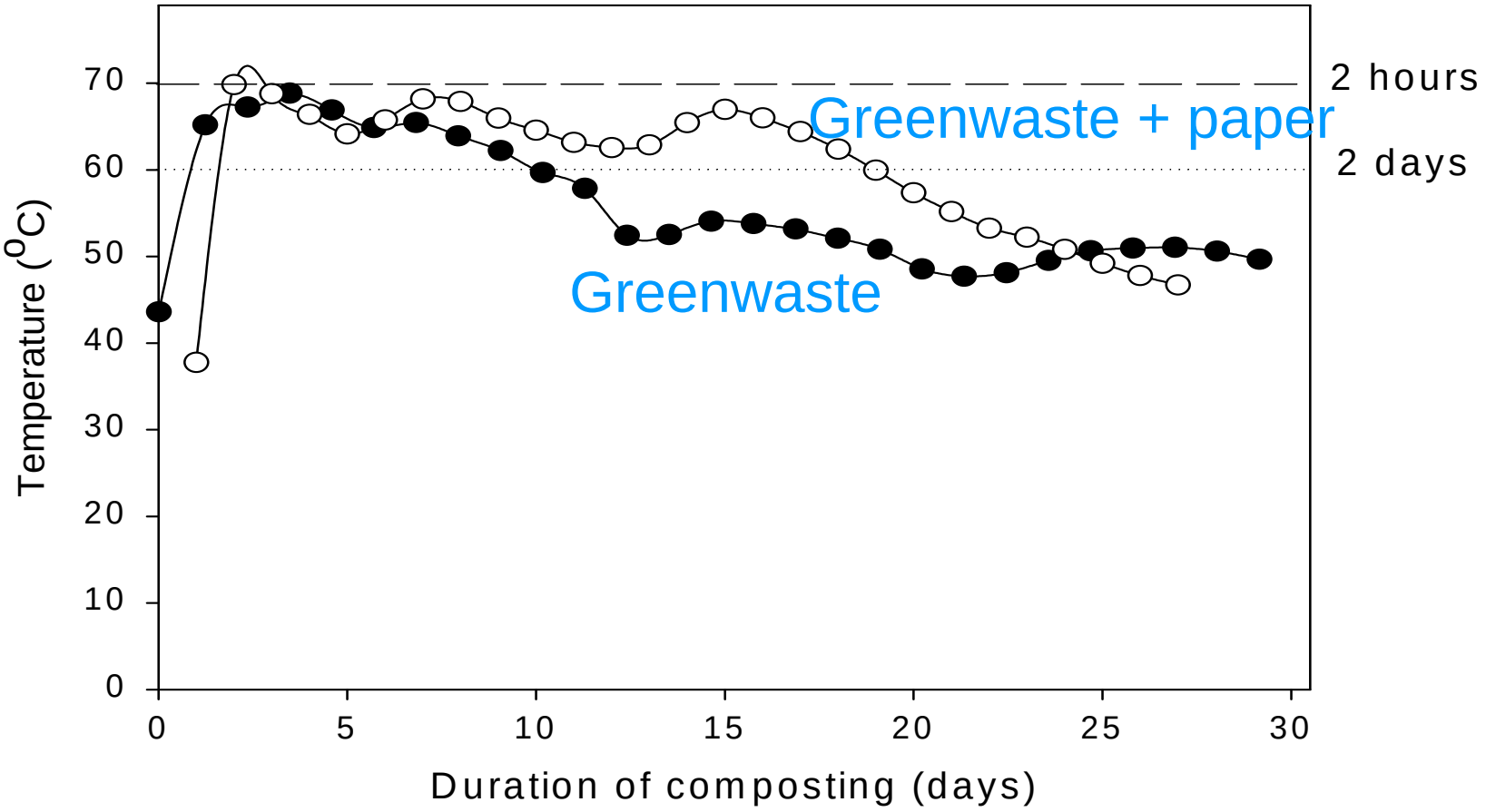
Mixing feedstocks

Filling pods

Aeration ducting

Temperature probes for process control

Deinking paper waste is beneficial in composting.



Adding paper waste to green waste results in better composting because it stimulates microbial activity, creating a longer thermophilic phase and better pathogen kill.

Composting treated biosolids wastes is safe.

Material	E. coli CFU x 10^3 g^{-1} DW By PAS 100 method
28 day composted paper fibre+biosolids	Below detection (Bd)
56 day composted paper fibre+biosolids+greenwaste	39
Paper fibre	150
Biosolids	230
Greenwaste	12,000

	Salmonellae CFU By PAS 100 method
28 day composted paper fibre+biosolids	Bd
56 day composted paper fibre+biosolids+greenwaste	Bd
Paper fibre	Bd
Biosolids	Bd
Greenwaste	Bd

Composts containing biosolids met critical human pathogen limits using PAS 100 – specified methods.

Summary

- Recycling organic resources/wastes to land is important for soil function -> is important for humankind;
- Land application must be done responsibly and underpinned by rigorous science-based knowledge;
- Organic wastes play a critical role in the reclamation of post-industrial and degraded agricultural land;
- Balanced organic wastes outperform mineral fertiliser in both plant and soil microbial biomass;
- Composting is a means of stabilising organic wastes for safe land application;
- Legislation can be a barrier to returning organic wastes to land and to innovation (…..discuss!!);
- **TWIRLS Best Practice Manuals due out later in 2007.**