Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Tracing biomat growth in soil treatment units using a network of automated soil sensors

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Context

Context – On-site sanitation in Ireland (I)

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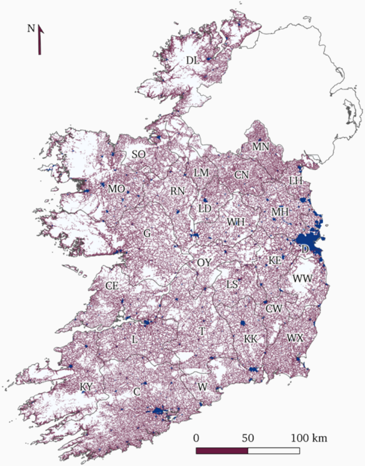
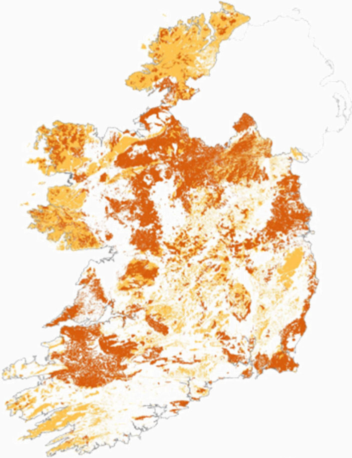
Context – On-site sanitation in Ireland (II)





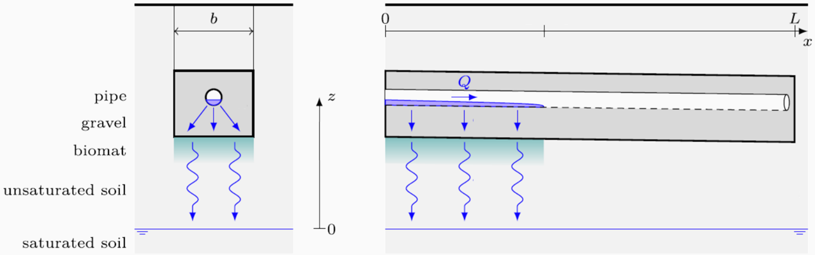
Sewered area

On-site systems

High GW vulnerability

Very high GW vulnerability

Context – Biomat development in percolation trenches



Biomat spread in percolation trench receiving effluent (Winstanley & Fowler, 2013)

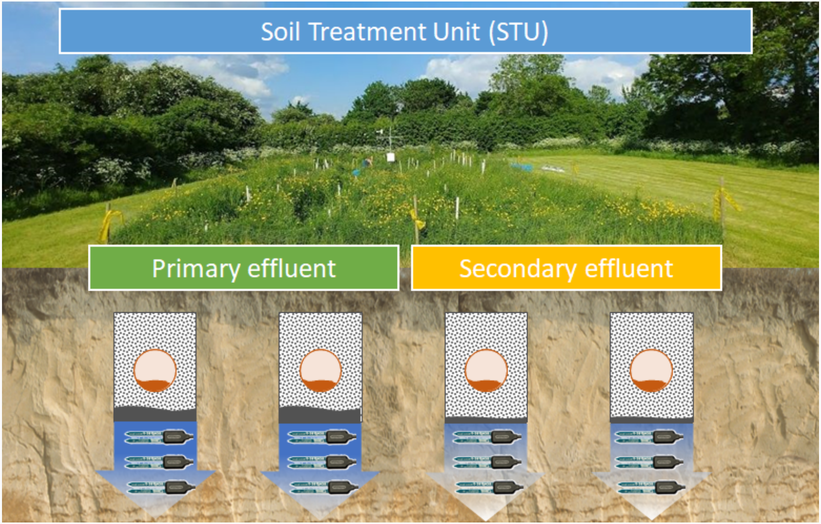
How does pre-treatment influence biomat growth?

Study design

Study design – Locations

Site construction – STU trenches

Site construction – Sensor installation (I)

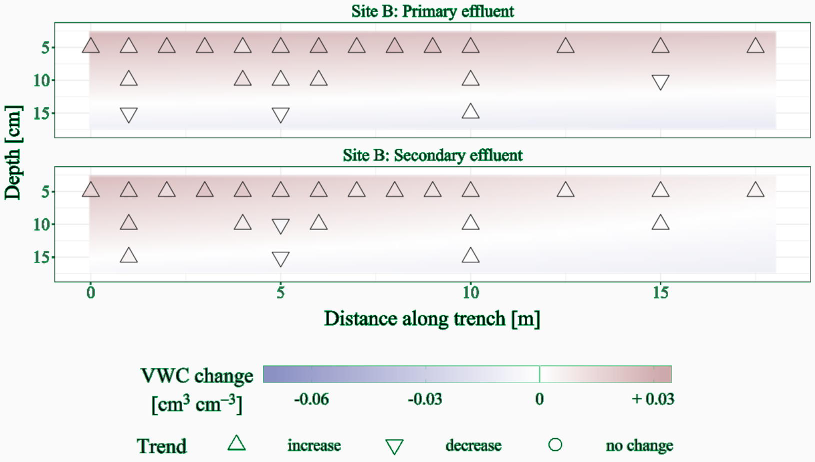


Site construction – Sensor installation (II)

Installation of Decagon EC5 soil sensors below the infiltrative surface to monitor changes in soil water content at various depths

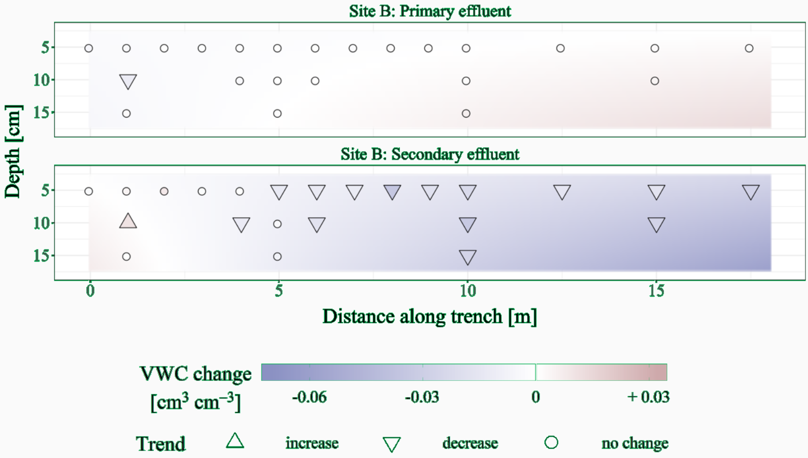
Results

Results – Increasing water retention



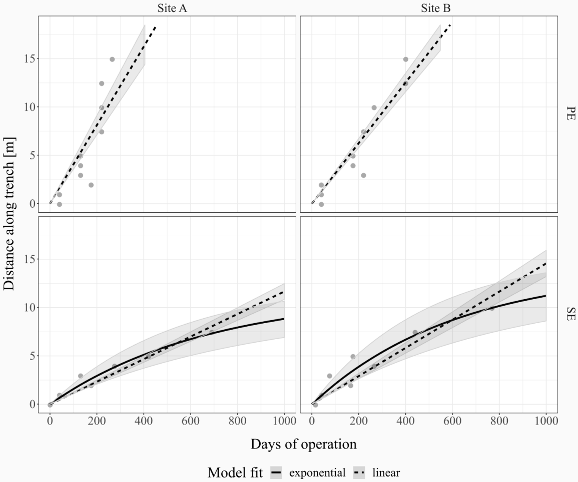
Increasing water retention over 2 years of operation

Results – Hydraulic barrier during drought



Hydraulic barrier effect during drought in summer 2018

Results – Clogging Rate (I)



Time to reach persistent 2.5 % increase in VWC over background level

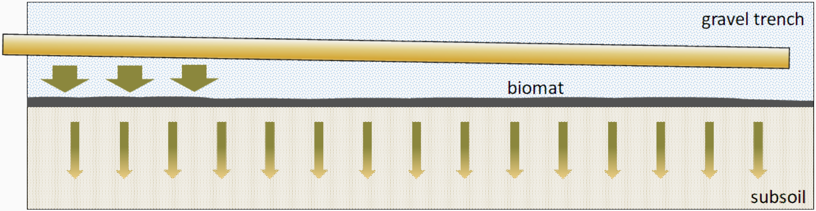
Results – Clogging Rate (II)

Results of linear and growth-limited exponential model fit for clogging rates. Linear: $l_{\text{biomat}} = r_{\text{c}} t$; exponential: $l_{\text{biomat}} = l_{\text{ss}}(1 - \exp(-\mu t))$.

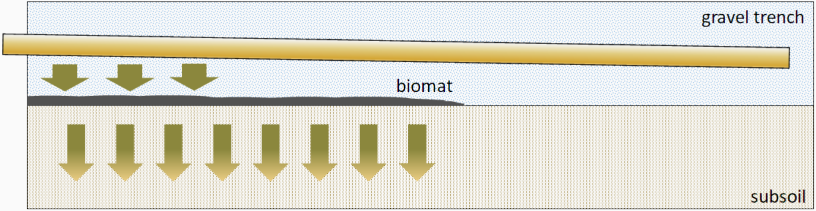
Site	Effluent	Modela	Coefficients
CC	PE	linear	$r_{\text{c}} = (3.13 \pm 0.24) \times 10^{-2}\,\text{cm}\,\text{d}^{-1}$
	SE	linear	$r_{\text{c}} = (1.46 \pm 0.14) \times 10^{-2}\,\text{cm}\,\text{d}^{-1}$
		exponential	$l_{\text{ss}} = 13.95(165)\,\text{m}$
			$\mu = (1.49 \pm 0.34) \times 10^{-3}\,\text{d}^{-1}$
KM	PE	linear	$r_{\text{c}} = (4.06 \pm 0.50) \times 10^{-2}\,\text{cm}\,\text{d}^{-1}$
	SE	linear	$r_{\text{c}} = (1.17 \pm 0.08) \times 10^{-2}\,\text{cm}\,\text{d}^{-1}$
		exponential	$l_{\text{ss}} = 11.41(127)\,\text{m}$
			$\mu = 1.63(42) \times 10^{-3}\,\text{d}^{-1}$

Results - Biomat growth vs. load

Primary effluent



Secondary effluent



Conclusions

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- VWC can be used to track biomat growth
  1. increasing water retention
  2. formation of a protective biomat layer at the infiltrative surface
  3. response to environmental conditions
- Data improves mathematical models of biomat growth
- Further validation needed
  1. in relation to pore water quality data and soil type
  2. microbial composition of biomat
  3. effects on GHG emissions

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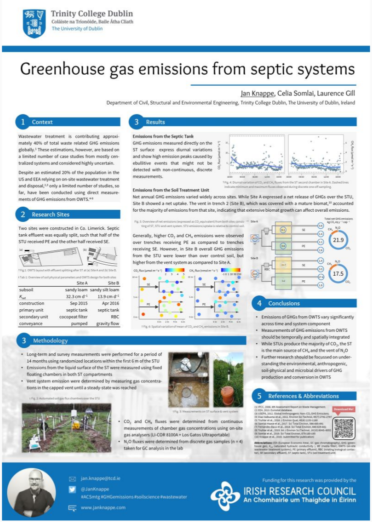
GHG emissions from septic systems



Session 380

Soil-Based Wastewater Treatment: Impacts and Mechanisms

Poster

Poster 1253

4:00 PM - 6:00 PM

Exhibit Hall 1

Tracing biomat growth in soil treatment units using a network of automated soil sensors

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Thanks to all the helping hands:

Patrick Veale, Eoin Dunne, Dave McAuley, Kevin Ryan, Henry Winstanley, John Bell, Laura Brophy, Carolin Kiefer, Lea Duran, Phillip Schuler, Luka Vucinic, Michael Swenson, Fabio Delle Grazie, Ana Alves Cavalcanti, Carolina Ospina Betancourth, Lara Brouillet, and of course the site owners

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Dá bhfuil romhainn
Science Foundation Ireland
For what's next

Appendix

Appendix – Site characteristics

	Kilmallock	**Crecora**
population equivalent	4	4
subsoil	sandy loam	clay loam
K_{fs}	$30.9\,\mathrm{cm\,d^{-1}}$	$13.9\,\mathrm{cm\,d^{-1}}$
construction	September 2015	April 2016
secondary treatment	Ecoflo media filter	Biodisc RBC
conveyance	pumped flow	gravity flow

Appendix – Kilmallock

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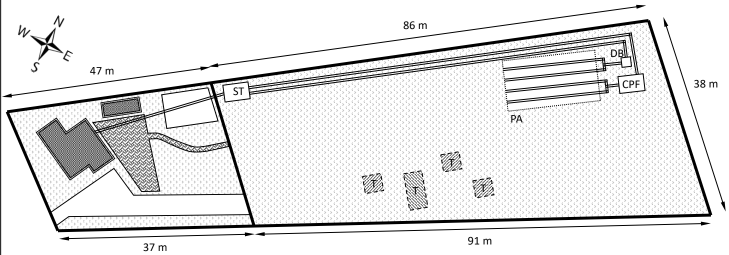


Key

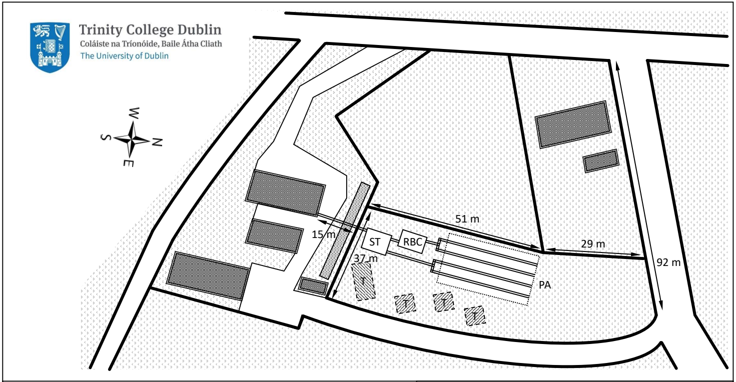
Building	Trial Hole	CPF Cocopeat Filter
Paved Area	T-test Hole	PA Percolation Area
Road	DB Distribution Box	Sewer Line
Unpaved Area	ST Septic Tank	

Site Details

Proposed site layout for domestic on-site wastewater treatment system as research site

Site: Kilmallock, Co. Limerick
System: ST at location of existing leach field with dual pumped effluent pipe; CPF at NE end of property with gravity fed 4-trench PA (18 x 10 m)

Appendix – Crecora



Key

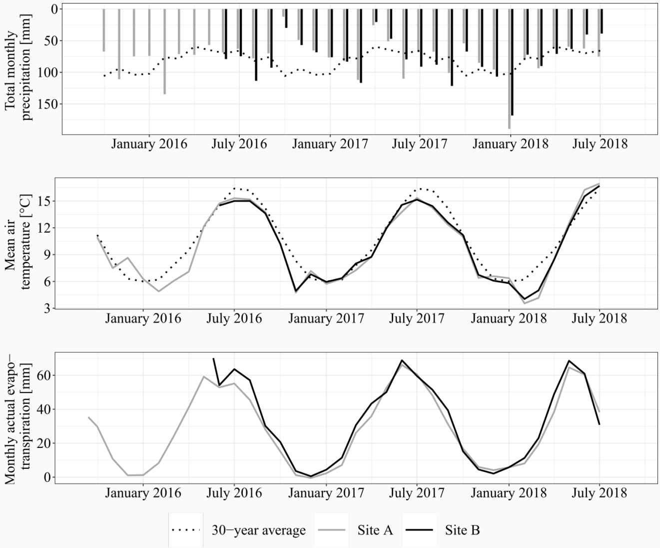
- Building
- Hedge
- Road
- Unpaved Area
- T Trial Hole
- T T-test Hole
- RBC Biodisc
- ST Septic Tank
- PA Percolation Area
- Sewer Line

Site Details

Proposed site layout for domestic on-site wastewater treatment system as research site

Site: Crecora, Co. Limerick
System: bypass and backfill existing ST; ST and RBC at S end of pasture with gravity fed 4-trench PA (18 x 10 m; two trenches receiving ST effluent and RBC effluent each)

Appendix – Weather data



Appendix – Effective hydraulic conductivities

Results of constant-head permeameter tests for determining the field saturated hydraulic conductivity K_{fs} of the undisturbed subsoil and the effective saturated hydraulic conductivity K_{eff} at the base of percolation trenches receiving primary (PE) and secondary effluent (SE) after 1080 d and 860 d of operation for Site A and Site B, respectively.

Site	K_{fs} $\mathrm{cm\,d^{-1}}$	Effluent type	$K_{eff}^{(1\,m)}$ $\mathrm{cm\,d^{-1}}$	$K_{eff}^{(8\,m)}$ $\mathrm{cm\,d^{-1}}$	$K_{eff}^{(12.5\,m)}$ $\mathrm{cm\,d^{-1}}$
Site A	30.9	PE	9.7	12.1	
		SE	3.2	32.1	
Site B	13.9	PE	3.1		4.0
		SE	12.5	11.3	