Land Management:

Role of Land drainage/Water table control in GHG Mitigation

Pat Tuohy  01/05/2020
An Analysis of Abatement Potential of Greenhouse Gas Emissions in Irish Agriculture 2021-2030

Prepared by the Teagasc Greenhouse Gas Working Group
Gary J. Lenihan & Trevor Dornellen (eds.)

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June 2018
Teagasc, Oak Park, Grattan

Teagasc
Association for Food Beam Development

CLIMATE ACTION PLAN 2019
To Tackle Climate Breakdown

Tuarascáil on gComhchoiste um Ghniomhú ar son na hAeráide
An tAthú Aeráide: Comhcheartaigh trasphairí don Ghníomhú
Máirt 2019

Report of the Joint Committee on Climate Action
Climate Change: A Cross-Party Consensus for Action
March 2019
Role of Land Drainage/ Water table control

• Teagasc GHG Working Group-MACC

  • **Measure 10**: Draining Wet *Mineral Soils*
    » **Measure 7**: Extended Grazing

  • **Measure 17**: Water Table Manipulation of *Organic Soils*
    » Also referred to as Rewetting
Mineral or organic soils?

- **Mineral soils** are derived from mineral matter-sand, silt, clay (+ larger particles)
  - Little organic matter (< 10%)
Mineral or organic soils?

Organic

• **Peats** possess an organic layer with at least 20% Organic Carbon (OC) and a minimum thickness of 40 cm.

• **Histic soils** have a peaty (>20% OC) (O) horizon that has a thickness of 7.5 or more
Mineral or organic soils?

**Organo/mineral**

- **Humic soils** contain an A horizon with significantly more organic matter, than mineral matter.
- Minimum thickness is 7.5 cm and OC content is lower (depending on the clay content)
Mineral or Organic soils?

Mapped within Irish Soil Information System
Current work using satellite imagery to refine further
Role of Land Drainage

- **Measure 10: Draining Wet Mineral soils**
- “one-third of Irish land area can be classified as poorly draining…Assuming that one-third of this area (i.e. 10% of total grassland area) was drained by 2030”

  - Nature of Measure: Reducing $N_2O$ Emissions
  - Cost € per t/CO$_2$ Eq: €16.2
  - Mitigation Mt CO$_2$ Eq: 0.197
  - Cost €M: €6.1
Role of Land Drainage

- Measure 7: Extended Grazing
  - “production systems that either require improved drainage or could benefit from on-off grazing…The measure was assessed on 20% of grassland area”
  - Nature of Measure: Production Efficiency
  - Cost € per t/CO₂ Eq: -€96
  - Mitigation Mt CO₂ Eq: 0.066
  - Cost €M: -€6.3
Figure 3.1: Marginal Abatement Cost Curve for agriculture for 2021-2030 (methane and nitrous oxide abatement). Values are based on linear uptake of measures between the years 2021-2030 and represent the mean yearly abatement over this period. Dashed line indicates Carbon
Types of drainage system

• The depth and type of drain to be installed depends entirely on the interpretation soil characteristics.

• Two principle types are distinguished:

  • **Groundwater drainage system:** A network of deeply installed piped drains exploiting permeable layers

  • **Shallow Drainage system:** Where soil is heavy and infiltration of water is impeded at all depths and permeability needs to be improved
Groundwater Drainage System

- A Groundwater drainage system is a network of field drains collecting groundwater which can move through soil layers of high permeability.

- They work by exploiting the natural capacity for movement of water at a certain depth in certain soils.

- By “tapping” into this natural capacity for water movement the system works by lowering the watertable and reducing the amount of water stored in the soil.
Shallow Drainage System

- A shallow drainage system is a network of field drains in tandem with surface disruption techniques which promote water infiltration and drainage

- Used where soil permeability is low at all depths and aims to introduce new pathways for water movement in the soil

- Methods include: Mole drainage, gravel mole drainage, sub-soiling (pan busting) and land forming
“All systems are shown to reduce the overall period of waterlogging and improve surface conditions.”
Dissemination, Extension, Training

Moorepark Dairy Levy
Research Update
Land Drainage - A farmer’s practical guide to draining grassland in Ireland
Moorepark Agricultural and Innovation Centre
November 2016

Getting the most from Land Drainage

Land Drainage: MAINTENANCE

Why do drainage systems stop performing?
How can I ensure future ease of maintenance?
How are new drains designed?
What methods work best?
What time of year should field and open drains be maintained?

LAND DRAINAGE COSTS & BENEFITS

Site investigation is crucial to diagnosing drainage problems. Drainage is an expensive business, so make sure you have the right solution and that it makes business sense to invest in drainage, writes James O’Loughlin and Pat Tahey, Animal & Grassland Research and Development Centre.

Winning the war on water

We travel to Macroom to find out how good drainage has transformed Con and Neillie Lehane’s farm.

LAND DRAINAGE GUIDELINES

Approximately 49.5% (3.4 million hectares) of the total land area of Ireland is classified as ‘marginal land’, which is affected by natural limitations related to its soil, topography, relief and climate. The major limitation is its poor drainage status, and much is in need of artificial drainage if its productivity is to be improved. In wet years poorly drained soils may never dry out as persistent rainfall maintains high soil moisture content.

Grass yields are limited due to the adverse effect of excess water and a lack of air at rooting depth, which limits plant respiration and growth. In areas of prolonged waterlogging, plants will eventually die due to a lack of oxygen in the root zone. Furthermore, waterlogged soils are susceptible to mechanical soil failure for long periods due to high soil moisture content and reduced soil strength. This reduces the number of grazing days and erosion also increases, thus lowering higher grass yields.

Land Drainage Systems

- Low permeability is the subsoil (or a layer of the subsoil),
- High water table due to low-hanging position and poor poorly maintained outlet,
- Bounded movement of water from seepage and springs.

OBJECTIVES OF LAND DRAINAGE

To achieve effective drainage, the works will have to:

- Reduce the rate of water movement in the soil column
- Reduce the water table in the soil
- Reduce or eliminate waterlogging
- Increase drainage capacity
- Enhance root growth
- Improve field safety
- Improve water quality
- Improve land health and productivity
- Improve grassland productivity
- Improve agricultural productivity
- Improve farm profitability
- Improve farm sustainability

Pat Tahey, Owen Fenton and James O’Loughlin, Teagasc.

IFM FORAGE AND NUTRITION Guide 2016

PUBLISHED
Role of Land Drainage

- Measure 17: Water table manipulation of organic soils
  - "if drainage was stopped completely and natural water table conditions were restored (on) 40,000 Ha of rewetted grassland"

- Nature of Measure: Rewetting of 40,000 Ha of Organic grassland soils
- Cost € per t/CO₂ Eq: €10.9
- Mitigation Mt CO₂ Eq: 0.44
- Cost €M: €4.84
Figure 3.2: Marginal Abatement Cost Curve for agriculture for 2021-2030 (carbon sequestration associated with land management and land-use change). Values are based on linear uptake of measures between 2021-2030. Dashed line indicates Carbon cost of €50 per tonne CO₂.
**GHG emissions from Carbon rich soils in Ireland drained for agriculture**

Paul et al., 2018 “modelling was based on an extreme drainage situation with a very high water table before drainage and a very low water table afterwards. Less extreme hydrological situations may result in lower emissions.”
Peat-Land Area

- Characterisation of peat areas under agricultural management are required to identify suitable areas for rewetting

<table>
<thead>
<tr>
<th>Peatland category</th>
<th>hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural peatlands</td>
<td>269,270(^a)</td>
</tr>
<tr>
<td>Cutover peatlands (affected by domestic turf-cutting)</td>
<td>612,380(^a)</td>
</tr>
<tr>
<td>Afforested peatland</td>
<td>301,700(^b)</td>
</tr>
<tr>
<td><em>Farmed peatland (grassland and cropland)</em></td>
<td>295,000(^c)</td>
</tr>
<tr>
<td>Industrial cutaway peatlands</td>
<td>70,000(^d)</td>
</tr>
<tr>
<td>Rehabilitated cutaway</td>
<td>18,000</td>
</tr>
</tbody>
</table>

(O’ Sullivan et al. 2018)

- “The (assumed) total area of drained (peat)/histic soils was 370,000 ha (under agriculture)” (GHG-MACC)”
Produced maps of:
- Land Use
- Soil drainage class
BUT ALREADY ARTIFICIALLY DRAINED subgroups predicted:

370,000 ha of histic soils drained (assumed)
426,000 ha of humic soils drained (assumed)

Paul et al., 2018
Summary

• The drainage of mineral soils is positive (in terms of GHG emissions) and also contributes towards extended grazing

• Annual emissions from drained “Carbon-Rich” soils are estimated up to:
  • 8.7 Tg CO$_2$e from histic soils (Organic)
  • 1.8 Tg CO$_2$e from humic soils (Organo-Mineral)

1 Tg (Teragram) = 1 million metric tonnes

• National policy - recognizes the importance of preserving organic (histic) and humic soils’ carbon stock, but requires data that is not readily available.

• We do not know the area of drained organic soils in Ireland

• We do not know how much has already reverted to “undrained” conditions

• Further research will explore the site suitability and cost effectiveness, as well as trade-offs and co-benefits of rewetting.
Summary

- Imperfectly/Poorly drained Mineral
- Humic
- Peat/Histic
- Drained Humic (Assumed)
- Drained Peat/Histic (Assumed)
Questions?

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