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Cross Compliance Farm Advisory Service Training Module 3 Nov/Dec 2009

Soil Organic Matter – Scientific Basis

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Outline

- Soil in Perspective
- European Soil Policy Developments
- What is Soil Organic Matter (SOM)?
- Importance of SOM
- SOM & soil properties
- Factors which influence SOM
- SOM threshold value
- Field Assessment of SOM decline
- Options for Remedial Action
- Agronomic & Economic Benefits of SOM

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Soil in Perspective

- Renewed focus on soils
- Soil as a *key resource* underpinning agricultural and environmental sustainability
- Link between soil functionality & food security, human health, water, air, biodiversity etc.

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European Soil Policy Developments

- EC Thematic Strategy on Soil Protection (threats to soil)
- Basis for proposed Soil Framework Directive (preservation, prevention, mitigation, restoration)
- CAP Reform & GAEC relating to soil quality (SOM)

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What is SOM?

SOM – organic component of soil derived from:

- Living soil micro-organisms
- Partially decomposed plant & animal residues
- Humus – well decomposed stable organic matter which stores and holds nutrients in plant available form

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Importance of SOM

SOM – essential in maintaining soil quality & positively influences:

- Soil structure (SOM binding agent)
- Water holding capacity
- Soil fertility & Cation Exchange Capacity (CEC)

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Importance of SOM

Reduces threats to soil quality:

§ Erosion – loss of topsoil, nutrients

§ Loss of soil structure – compaction, soil capping, soil slumping

§ Eutrophication of surface waters

§ Reduced soil fertility

§ Reduced crop yield

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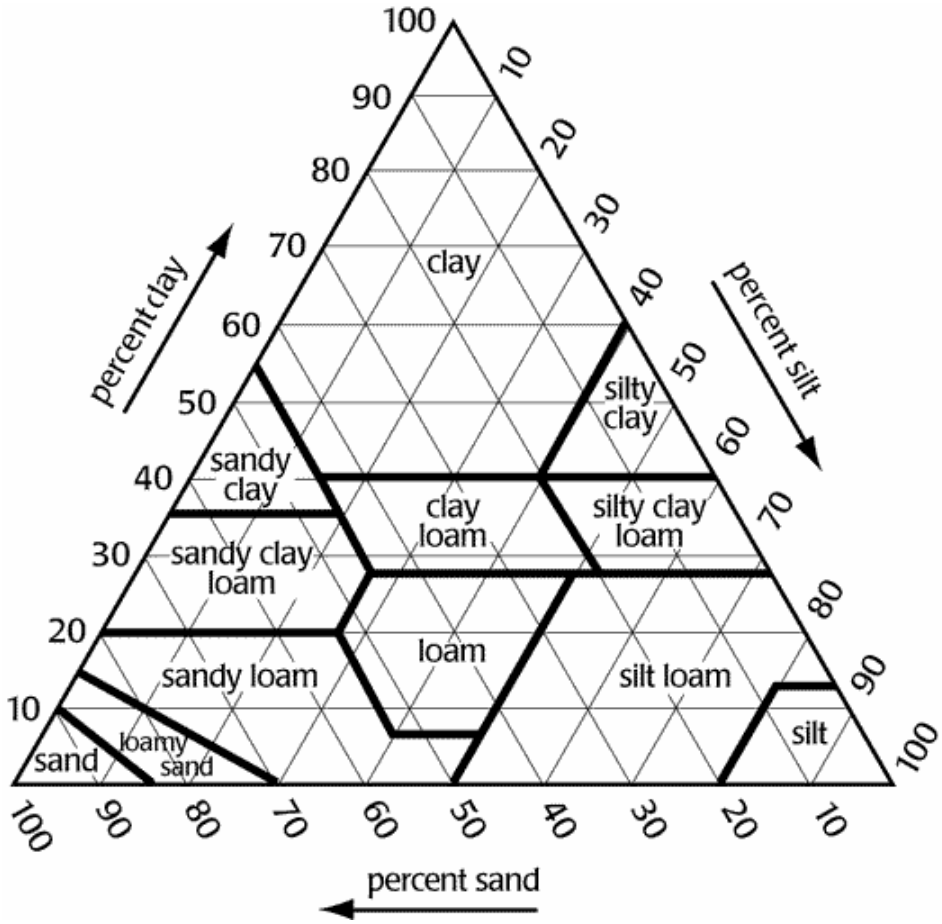
SOM & Soil Texture



Name of soil separate	Diameter limits (mm)
Clay	<0.002
Silt	0.002-0.05
Very fine sand	0.05-0.10
Fine sand	0.10-0.25
Medium sand	0.25-0.50
Coarse sand	0.50-1.00
Very coarse sand	1.00-2.00

USDA Soil Texture Triangle

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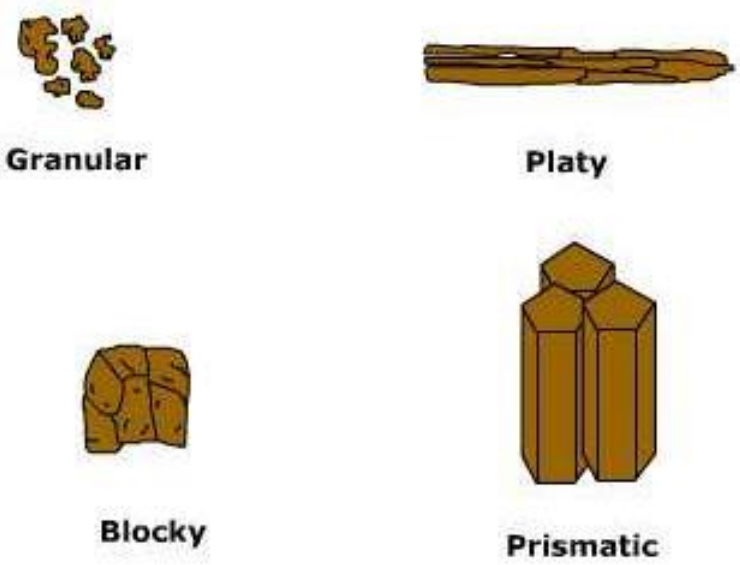
SOM & Soil Structure

Determined by shape, size and organisation of soil aggregates



- Granular – open structure, free draining soil
- Blocky – slower movement of water downwards
- Prismatic – high clay soils, moderate drainage
- Platy – compacted soil, impeded drainage

http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/soil_systems/soil_development_soil_properties.html

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SOM & Water Holding Capacity

- Ability of a soil to retain and release water is related to soil structure and texture
- SOM acts like a sponge
- Sandy soils – free draining
- Clay soils – moderate drainage

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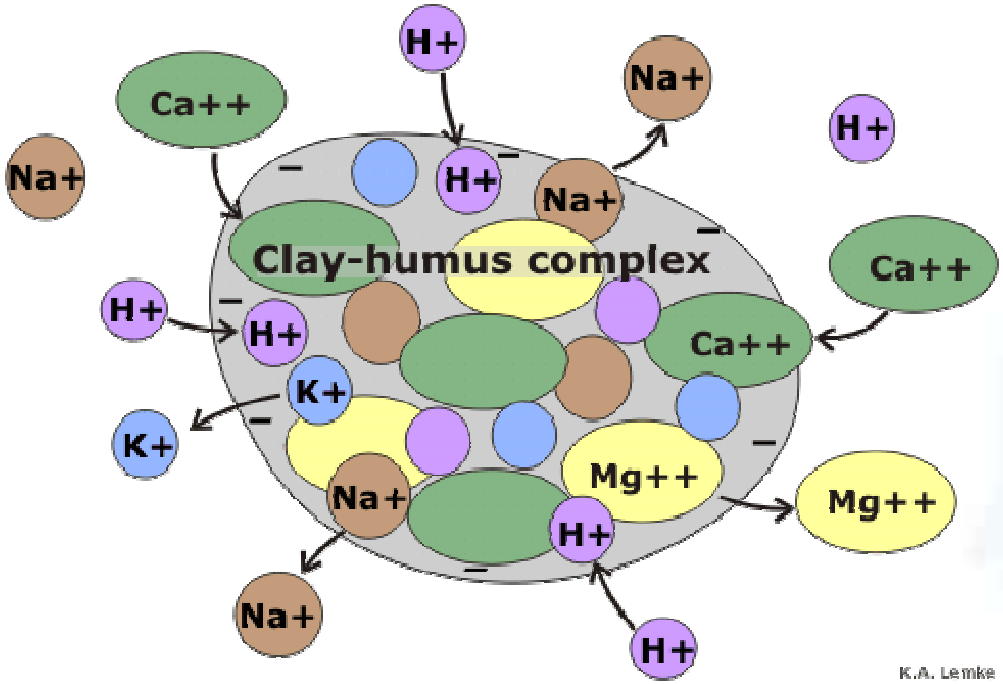
SOM & Soil Fertility – Cation Exchange Capacity



- The capacity of soils to adsorb and release cations such as Mg^{2+}, Ca^{2+},K^{+} and Na^{+}
- Influenced mainly by SOM and clay content
- High SOM = High CEC eg, clay soils
- Low SOM = Low CEC eg, sandy soils

http://www.uwsp.edu/geo/faculty/lemke/geog101/lecture_outlines/11_soil_characteristics.html

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Factors influencing SOM

Natural Factors:

- Climate (rainfall, temperature)
- Parent Material
- Soil Type/Soil Texture
- Topography/Relief (slope, aspect, altitude)
- Vegetation
- Soil Biodiversity
- Time

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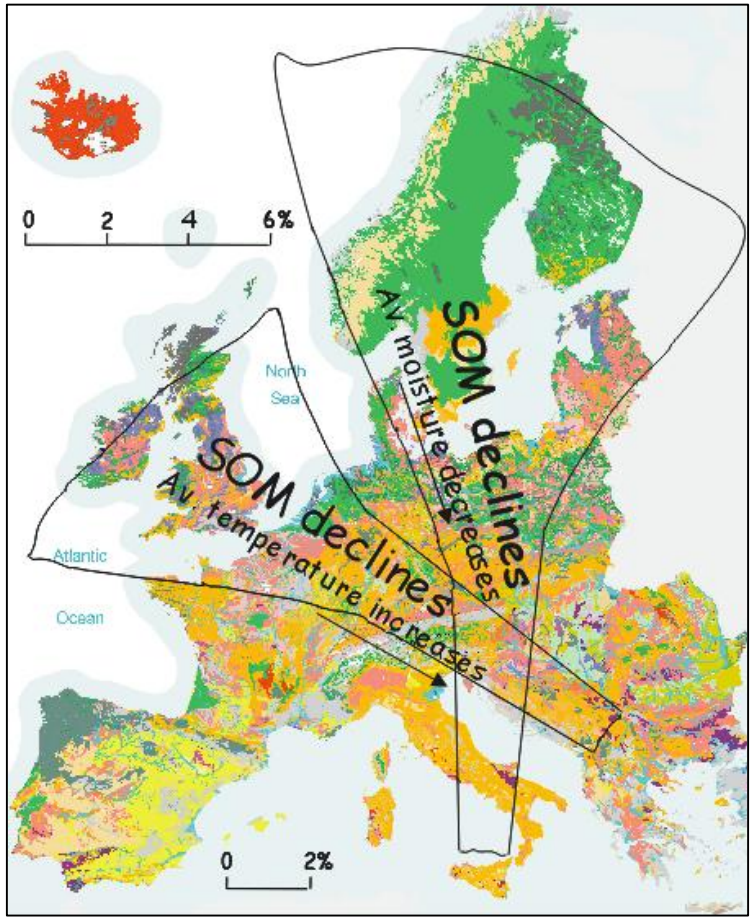
Climate



- SOM < rainfall decreases
- SOM < temperature increases

http://eusoils.jrc.ec.europa.eu/ESDB_Archive/octop/OCtopMapBkLet76.pdf

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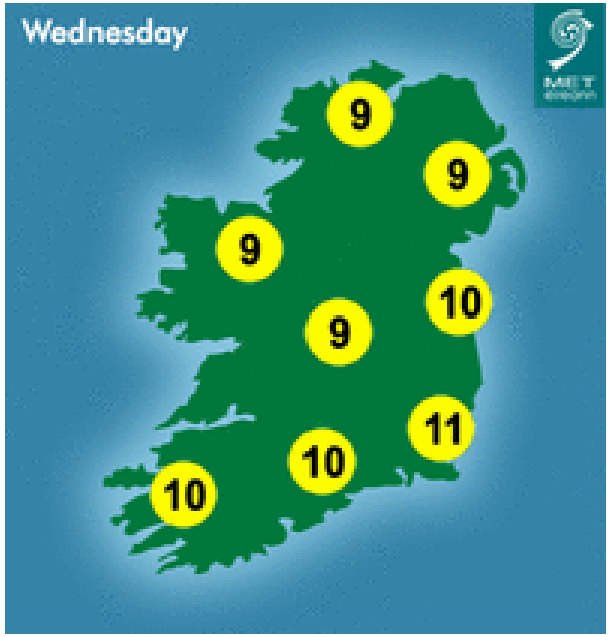
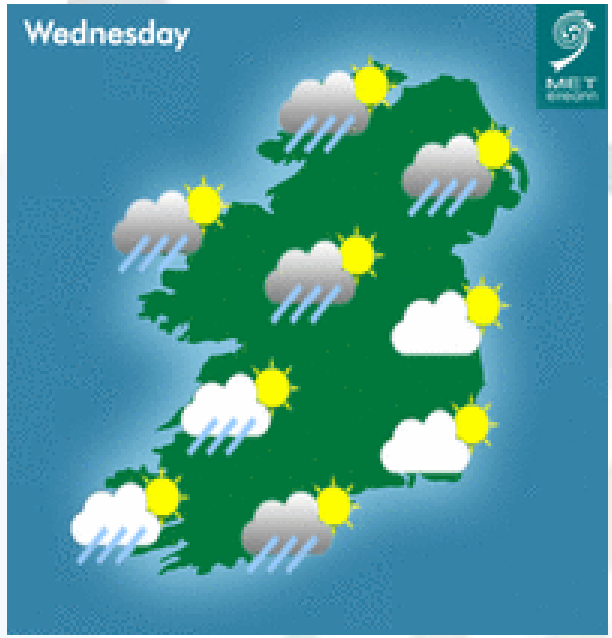
Climate





- Temperature and rainfall have dominant influence on SOM

http://www.met.ie/

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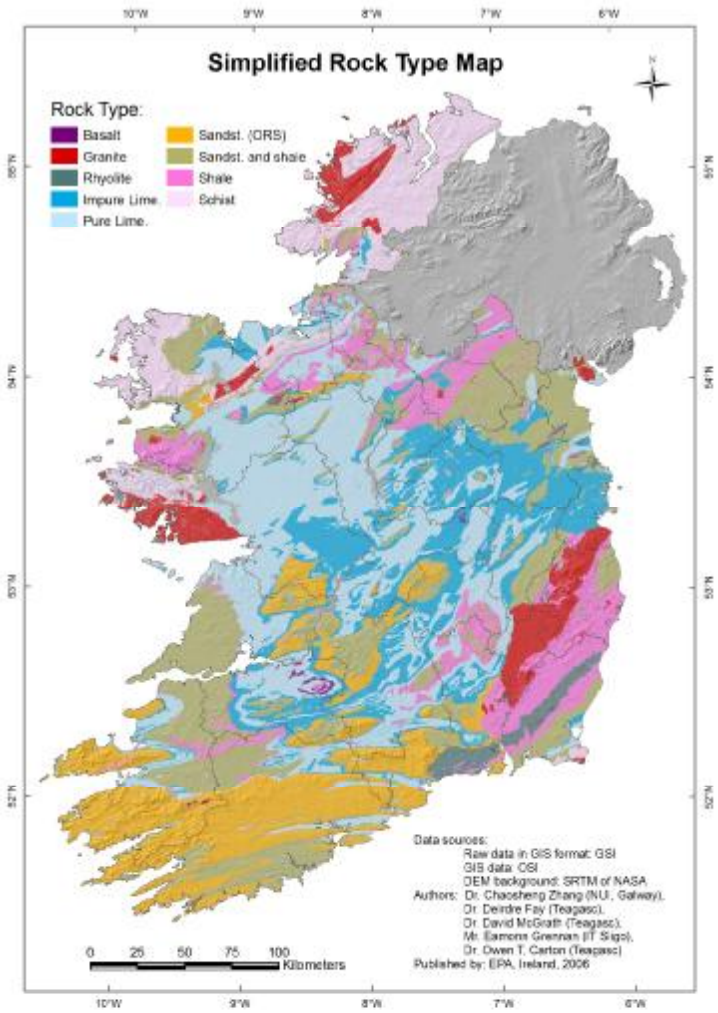
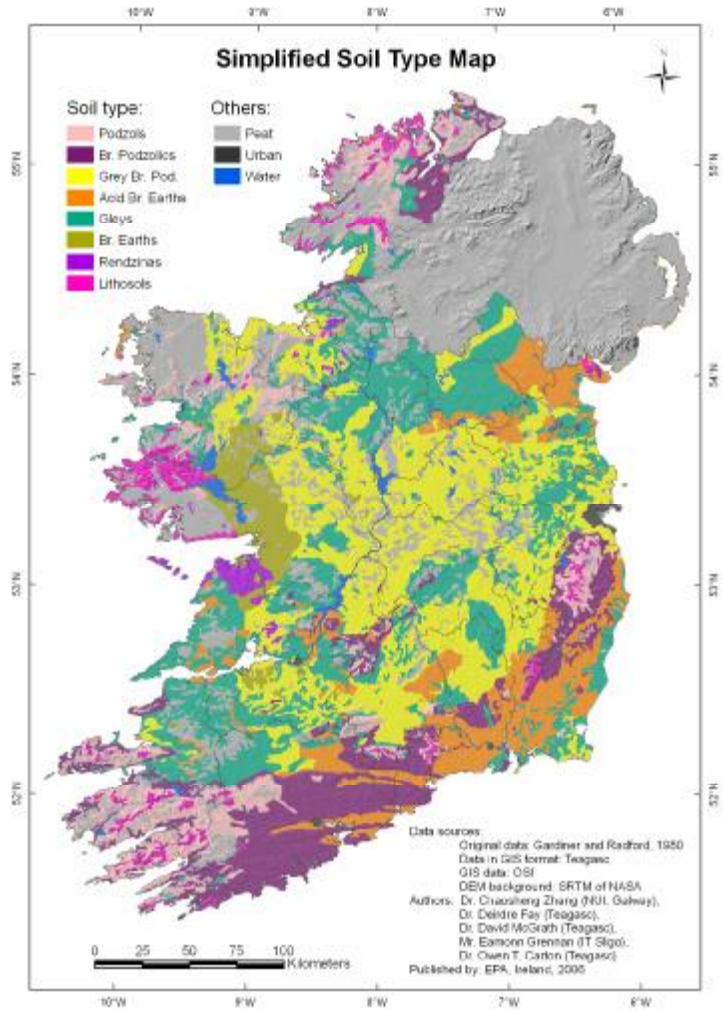
Parent Material & Soil Type





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Topography/Relief

- Altitude – height above sea level
- Aspect – South versus North facing
- Slope – steep versus flat

- Slope on left - North facing
- Slope on right – South facing

ftp://ftp.fao.org/agl/agll/docs/sb80e.pdf

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Soil Biodiversity

1 gram of soil ≡ 1 billion organisms

- 5 million bacterial cells
- 10,000 protozoa
- 200m of fungal hyhae
- 100 nematodes
- Earthworms and Arthropods
- Activity has positive influence on soil structure and SOM

http://www.scotland.gov.uk/Publications/2005/12/01130314/03147

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Time

- Irish soils ~ 15,000 years old
- Effects of climate, parent material, soil type, topography, vegetation, soil biodiversity changing over time
- SOM decline is gradual, however process of rebuilding SOM is also very slow!

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Factors influencing SOM

Man-made factors:

- Land Use (tillage, grassland, forest)
- Farming system (conventional/min-till)
- Land management (cropping intensity/stocking rate)
- Land degradation (sealing, mining)

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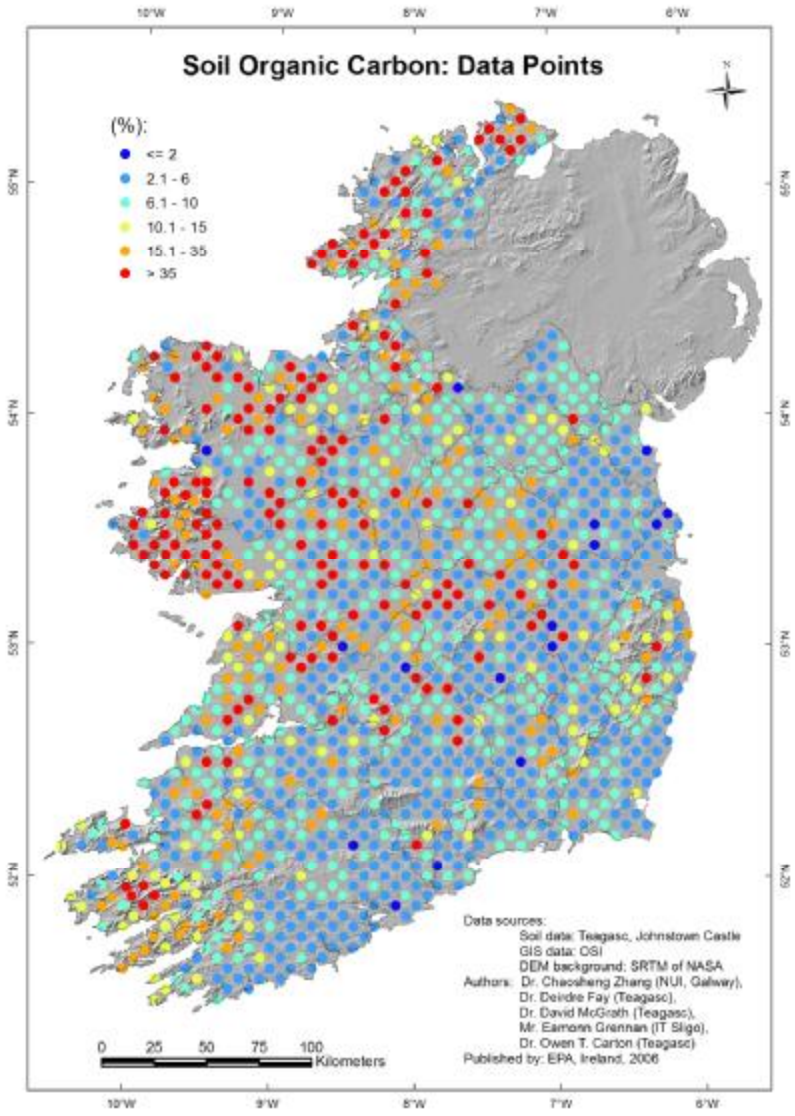
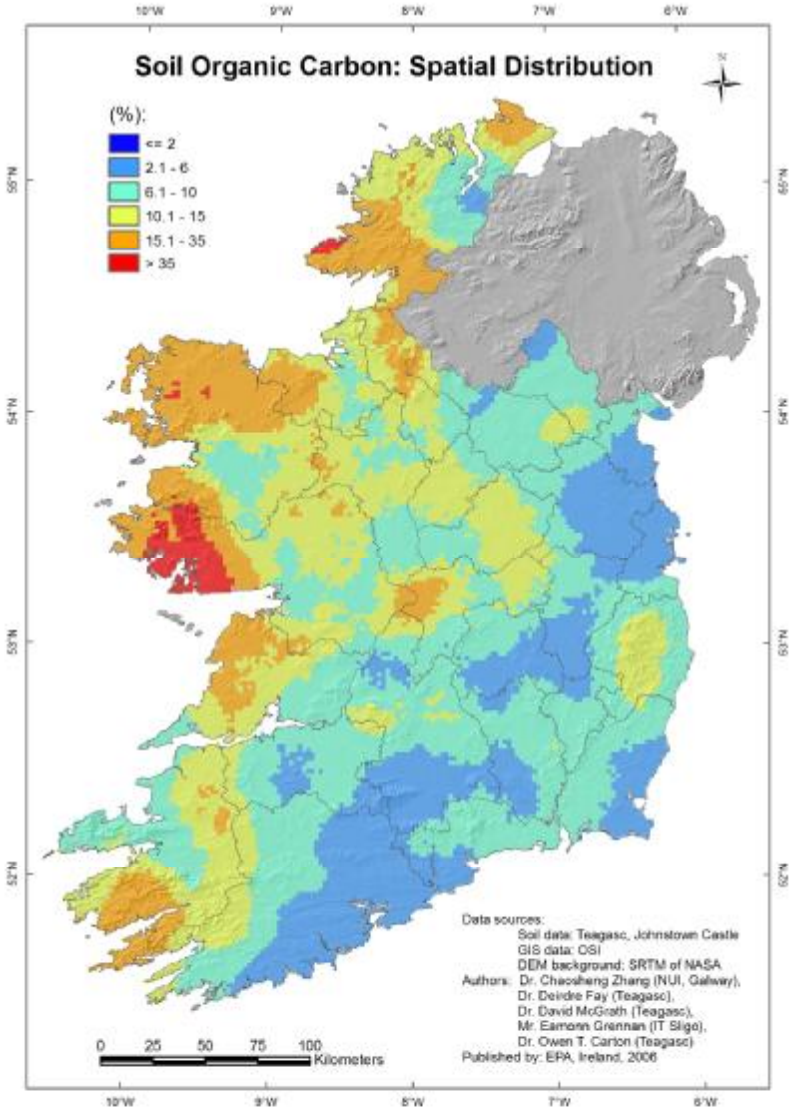
SOM threshold value

- Soils with SOM content <3.4% are considered to be vulnerable based on published literature
- 3.4% SOM ≡ 2% Soil Organic Carbon (SOC)
- SOM = SOC X 1.72
- Soils >13.8% SOM also vulnerable (peaty soils)





- 1.2% soils SOM <3.4%
- Median value mineral soils 10.2% SOM

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Field Assessment of SOM decline

Evidence that decline of SOM (<3.4%) is having an impact on soil quality:

- Poor nutrient supply – yield affects associated with nutrient deficiency (N, Zn, K, Mg, S etc)
- Structural stability/Compaction
- Impeded drainage/enhanced runoff
- Erosion
- Surface capping/crusting

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Compaction – Yield Effects

- Conventional till
- Yellowing of crop coincident with compaction caused by combine tracks

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Compaction – Yield Effects

- Min-till
- Yellowing of crop in areas where compaction caused by combine tracks (harvested under difficult conditions)

Photographs courtesy Ciaran Collins, Teagasc

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Headland Compaction

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Compacted Cereal Stubble

Harvesting under poor conditions, risk of compaction and run off

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Compacted Maize Stubble - Wheelings

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Compacted Maize Stubble - Ruts

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Erosion – loss of sediment

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Erosion – sediment deposition

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Compaction in grazing systems

- Earthworms
- Root systems
- Drying of soil

Photograph courtesy Thomas Herbin, Teagasc

Soil topsoil profile showing impermeable pan caused by poaching

http://www.scotland.gov.uk/Publications/2005/12/01130314/03147

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Surface Capping

Low organic matter tillage soil vs. high organic matter grassland soil

http://soils.usda.gov/sqi/assessment/files/slaking_sq_physical_indicator_sheet.pdf

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Unsustainable Practices

- Access to land when soil is at field capacity can cause compaction, particularly on poorly drained soils
- Bare soil on weakly structured sandy and silty soils can cause compaction and surface capping

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Field Assessment

- Where SOM <3.4%
- Soil type (clay soil versus sandy soil; free draining versus poorly drained?)
- Yield – evidence of reduced yield?
- Soil condition – evidence of degradation eg., compaction/erosion?
- On going or intended management practice?
- Consideration of agricultural and environmental sustainability of the land

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Options for remedial action

- Incorporate Straw
- FYM or mushroom compost (take a/c of nutrients)
- Organic fertiliser (take a/c of nutrients)
- Cover crops (ploughing in green cover)
- Crop rotation (including grass in cycle)
- Reduced cultivation (min-till in conjunction with other measures)

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Agronomic & Economic Benefits of SOM

- Enhanced soil structure
- Ease of cultivation & seedbed preparation
- Fewer passes, less power, less cost
- Enhanced soil fertility
- Less fertiliser inputs due to increased soil fertility
- Enhanced crop yield

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Thank you for your attention

Questions?