APSE: Cemeteries and Crematoria Seminar

Do Natural Burials Contribute to Ecosystem Services?

Dr Mark Pawlett

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www.cranfield.ac.uk

Who am I

- Senior Research Fellow of Soil Biology
  - Chartered Environmental Scientist (CEnv) with IES
  - 23 years soil biology research experience

- Interested in cadaver soil decomposition processes in the context of natural burials and for forensic investigations

- **Email**: m.pawlett@cranfield.ac.uk
- **Cranfield**: https://www.cranfield.ac.uk/people/dr-mark-pawlett-788115

- **Reference**: Pawlett M *et al*. (2024) The contribution of natural burials to soil ecosystem services: review and emergent research questions, *Applied Soil Ecology*, 194 (February) Article No. 105200. **Open Access**

Outline:

- What is Natural Burial
- Cadaver decomposition in soil
- What are “ecosystem services”.
- Aboveground: Biodiversity and habitat creation
- Belowground:
  - Soil Nutrient cycling
  - Key factors that affect cadaver decomposition in soil
- Risks
- Knowledge Gaps and Conclusions

What is Natural Burial

- **Various names**: Green Burial, Woodland Burial, Conservation Burial

- Interment of the deceased in the ground with the intention of recycling the body back to nature

- **Identity of sustainability**
  - **Potentially toxic chemicals removed:**
    - No formaldehyde, metals, coffin fittings, varnishes, wood preservatives, grave markers
  - **Materials sustainably sourced:**
    - linen shroud, wool, wicker coffin, cardboard,
    - coffin liners (replace **plastic** with other materials: shellfish waste: (Dutkiewicz, 2002)

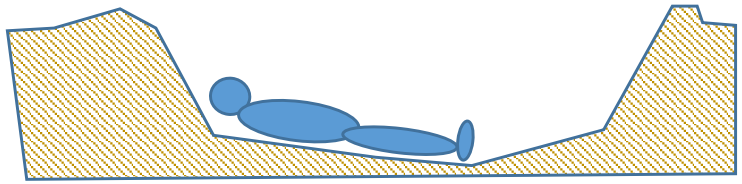
- **Burial space is running out:** Natural burial may reduce pressure

Natural Burial Legislation

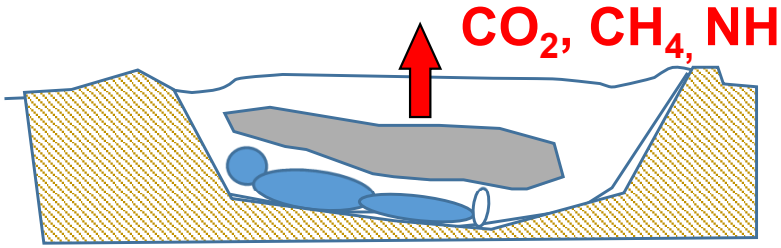
- **Legislation (England and Wales)**:
  - Burial not be within 250m of a spring or well used for drinking water; 50m for other springs and boreholes
  - No standing water in the grave when 1st dug
  - Grave depth should be 0.92 cm (3 ft) unless soil is of "suitable character" where the soil can be 0.61 cm (2ft).

Cadaver Decomposition in Soil

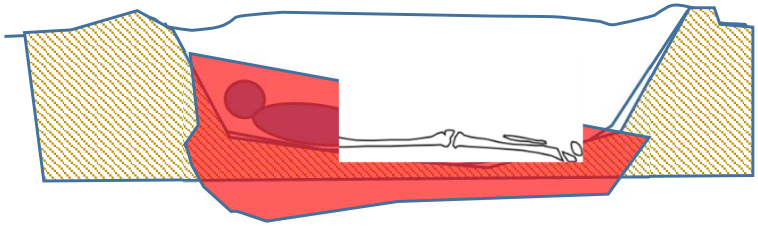
-6 stages described by Payne 1965



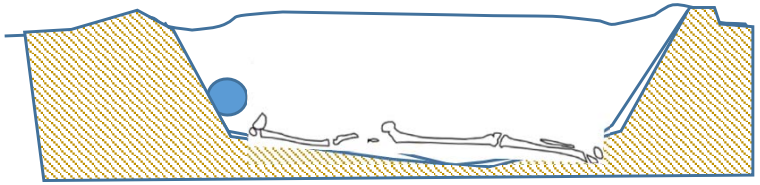
Stage 1: Fresh: autolysis, aerobic 12h



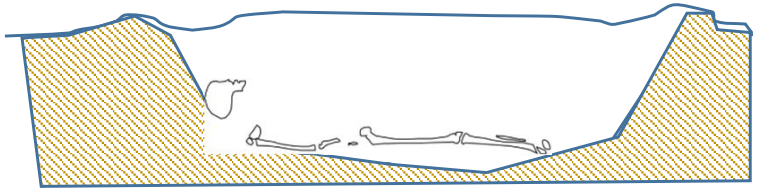
Stage 2: Bloat (gases): putrefaction, anaerobic decomposition 72h



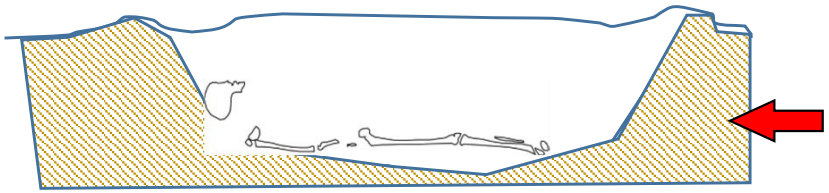
Stage 3: Active decay: Cadaver Decomposition Islands (Carter and Tibbett 2008)



Stage 4: Advanced decay: putrefaction almost complete



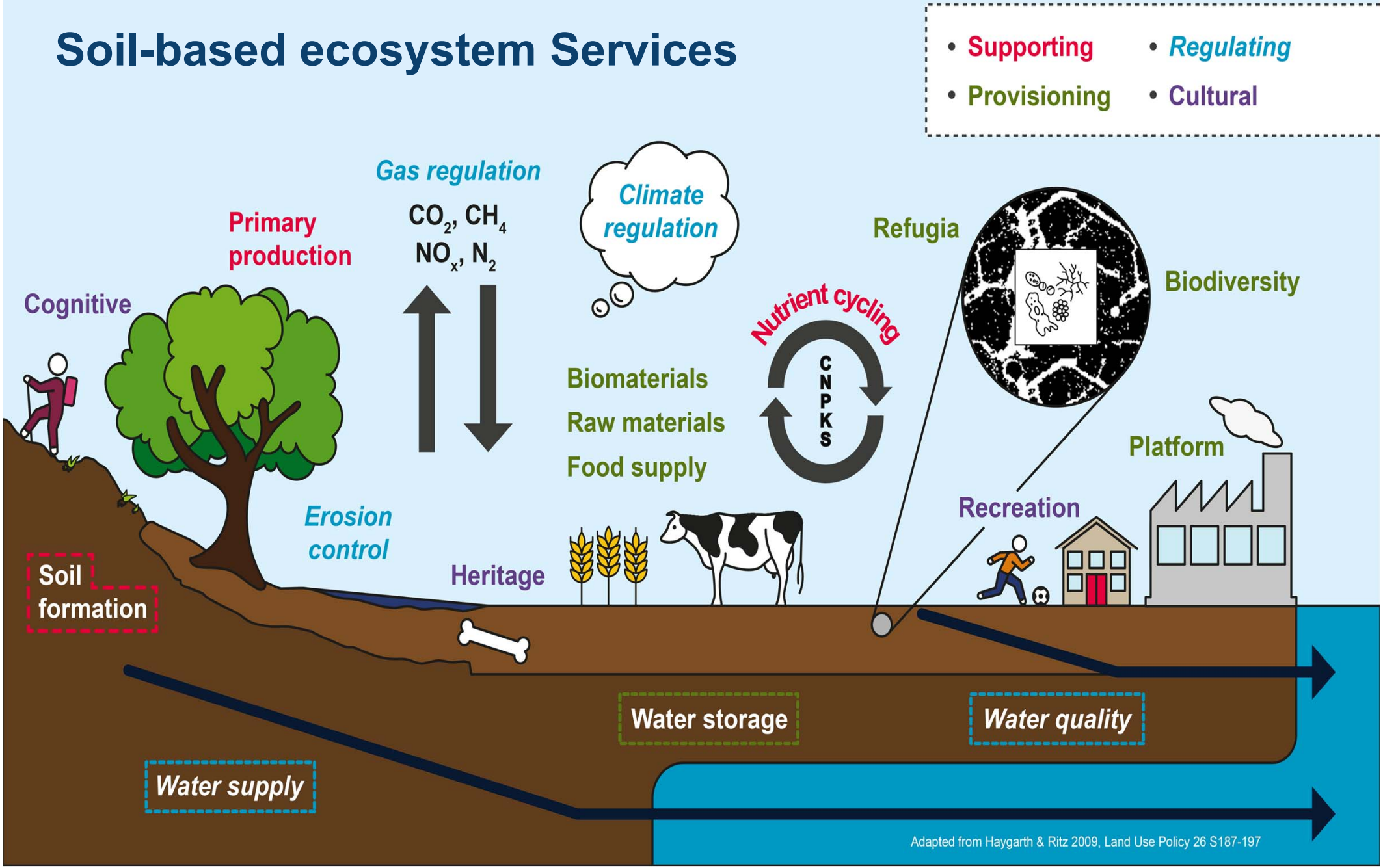
Stage 5: Dry/skeletonised



Stage 6: Remains: 20-200 days depending on local soil conditions (Benninger et al., 2008).

Carbon sequestration?

Soil-based ecosystem Services



Above-ground: Biodiversity and habitat creation

- **Reduced cemetery management:**
    - Cemetery managed for biodiversity
    - reduced pesticides and fertilisers
    - less frequent mowing

- **Habitat Creation**:
    - Use of biodiverse **seed mixes** e.g. for species rich meadow
    - **selective coppicing** in woodland burial sites:
        - provide fuel
        - enhancing carbon sequestration potential

- **RISK?: Invasive species**: bereaved families may request the planting of non-native trees and plants with the risk of potential harm to the native ecology if species become invasive.

Natural Burial: Ecosystem Service Benefits

Supporting

Provisioning

- **Cadaver Decomposition Islands**
- **Nutrient cycling**

C, N, P, Ca and Na, Fe, Pb, Mn, Cr, Cu, Zn, K, Mg

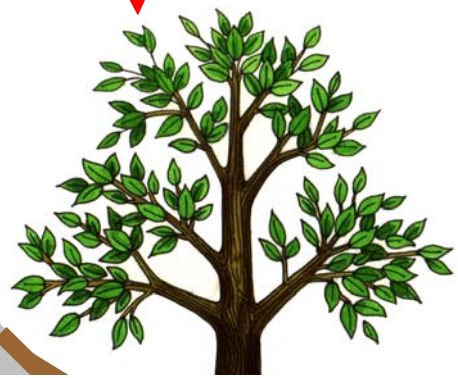
Largely unknown

Contribute to **soil health**: Belowground **Biodiversity**

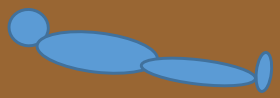
Raw materials?

Food supply?

Early stage: "r" strategists?
Long term: legacy-K strategists



Primary Production: aboveground biodiversity



Carbon Sequestration: global annual death rate is expected to reach 121.7 million/year by 2099 (United Nations, 2022)= 1.95 million tonnes C per year.

Elevated nutrients in soil: (Cobaugh et al., 2015; (Żychowski, 2021; (Holden and McDonald-Madden, 2018)):

Key Soil Factors Affecting Cadaver Decomposition

- **Temperature:** affects biological activity, burial reduces temperature
- **Texture:**
  - Clays
    - greater nutrient retention in the soil
    - Reduce leaching
    - may reduce decomposition
  - Sandy soils
    - greater gaseous diffusivity and permeability: hence faster decomposition
- **Moisture**
  - Water logging: slows down decomposition e.g. peat bogs
  - Desiccation: mummification
- **Organic matter** in soils can increase decomposition Tumer et al. (2013)
- **Burial depth:** Reduced to increase connectivity with surface ecology

Risk to GHG emissions

- **Anaerobic: reduced oxygen**
  - Sealed graves quickly become anoxic: reduced decomposition.
  - Natural burial: materials (e.g. wicker coffin) promote gas exchange and prevent anoxic conditions thus speeding up decomposition
- **Risk:**
  - Waterlogging (hypoxic conditions)
    - Anaerobic decomposition: methane (CH_4) (Santarsiero et al., 2000).
    - promotes denitrification and thereby potential N_2O pollution (GHG)
- **Solution?**
  - Increase oxygen to reduce CH_4
  - Sandy soils less likely to become anoxic (but groundwater risk?)

Risks to Groundwater

- Increased decomposition rates may be a source of diffuse pollutions: especially N (Kim et al., 2008)

- Fears of groundwater contamination are the most common cause for rejection at the planning stage (Yarwood et al., 2015).

- Microbial pathogens:
  - Do human pathogens survive and enter groundwater (faecal coliforms, E. coli, viruses)
  - case studies showing pathogens from livestock entering groundwater (Kwon et al., 2017).

- Medical interventions and pharmaceuticals may degrade and accumulate in soils, such as Hg and Au from teeth fillings (Fiedler et al., 2012).

Knowledge Gap: largely unknown

Other Risks

- **Scavenging animals** may be problematic for shallow burial?
- **Coffin collapse/subsidence:** in the absence of the supporting coffin?
- **Society acceptance:** largely unknown but is common practice for some groups.

Knowledge Gaps

- **Are current regulations sufficient:**
  - Regulations in UK do not consider the underlying parent materials and soil type.

- ***What are the comparative GHG and carbon sequestration implications of the funeral industry?***
  - There is no comprehensive **LCA** to understand the consequences of different approaches and limited available data to undertake such an assessment.

- **Groundwater contamination**: e.g., pathogens, pharmaceuticals

Knowledge Gaps

- *Is there a **preferred ecosystem type** to mitigate risks and enhance benefits to sustainable management practice in cemeteries?*
  - Woodland Vs grasslands (pasture, species rich meadow)

- **Interactions with the soil microbiome:**
  - little is known regarding the interactions of the decaying cadaver with the soil microbiome
  - Localised nutrient and biological hotspots may affect the wider ecosystem and influence pedogenesis

Innovations

- **Grave design**:
  - Engineered to promote oxygen and thereby reduce methane (GHG)
  - Control of leachable materials
  - Would it be environmentally better to release products of decomposition slowly thus preventing a “flush” of nutrients to the environment.
  - Speeding up decomposition may alleviate pressure for land space suitable for cemeteries

- Can Natural Burial improve soil health and restore degraded soils?

- **Hybrid management** (integration into other land management practice):
  - Integrating natural burial into traditional cemetery
  - rewilding
  - green corridors (Scalenghe and Pantani 2020)

Conclusions

- Natural Burial may provide sustainable solutions to the funeral industry.
- Potential benefits include increased biodiversity and carbon sequestration
- Potential Risks include GHG emissions and groundwater contamination.
- Knowledge gaps identified need to be answered for future sustainable burial practice.

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T: +44 (0)1234 750111

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