What controlled Dissolved Organic Carbon export in the Thames Basin (UK) over the past 130 years?

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1. Why study DOC?

- Dissolved Organic Carbon (DOC) has significant implications for water quality, as its removal constitutes a cost for water companies [1].
- Its incomplete removal:
  - increases the biological contamination potential of treated water,
  - can result in the formation of potential carcinogens,
  - decreases the aesthetic value of water (i.e. water colour) [2].
- DOC flux from the terrestrial biosphere to the world's oceans is an important flux in the global carbon cycle.
- The increase of DOC fluxes in rivers can be indicative of changes in terrestrial carbon storage. Increased loss of carbon from soils can be due to increased turnover in terrestrial carbon reserves, which means reduced carbon storage in soils [3].

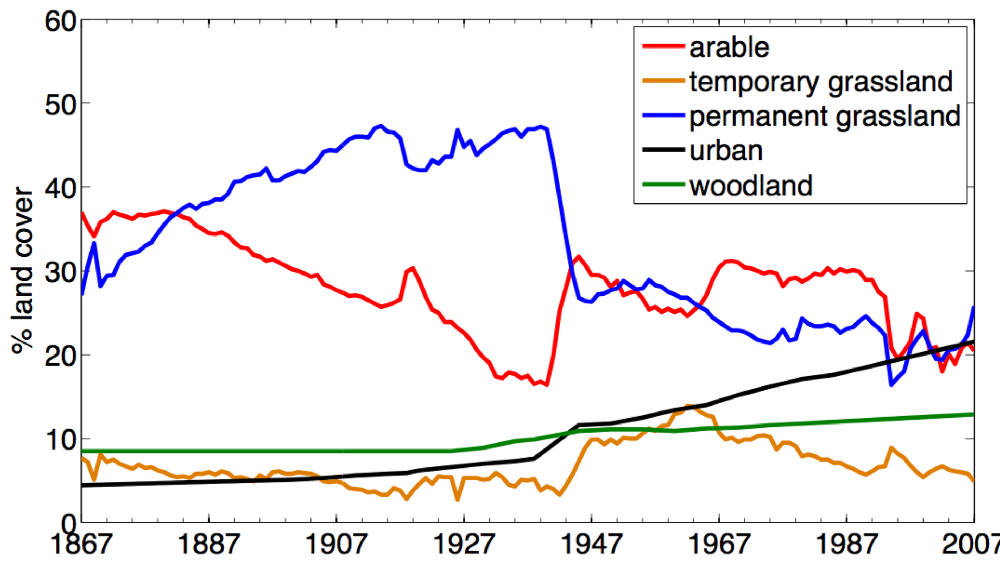
2. Study Site and Databases

The Thames Basin:

- Major UK importance for its size (9948 km^2), population (3.7 million people) and agriculture.
- Provides 2/3 of London's drinking water.
- Longest continuous record of water chemistry in the world (130 years).

Databases:

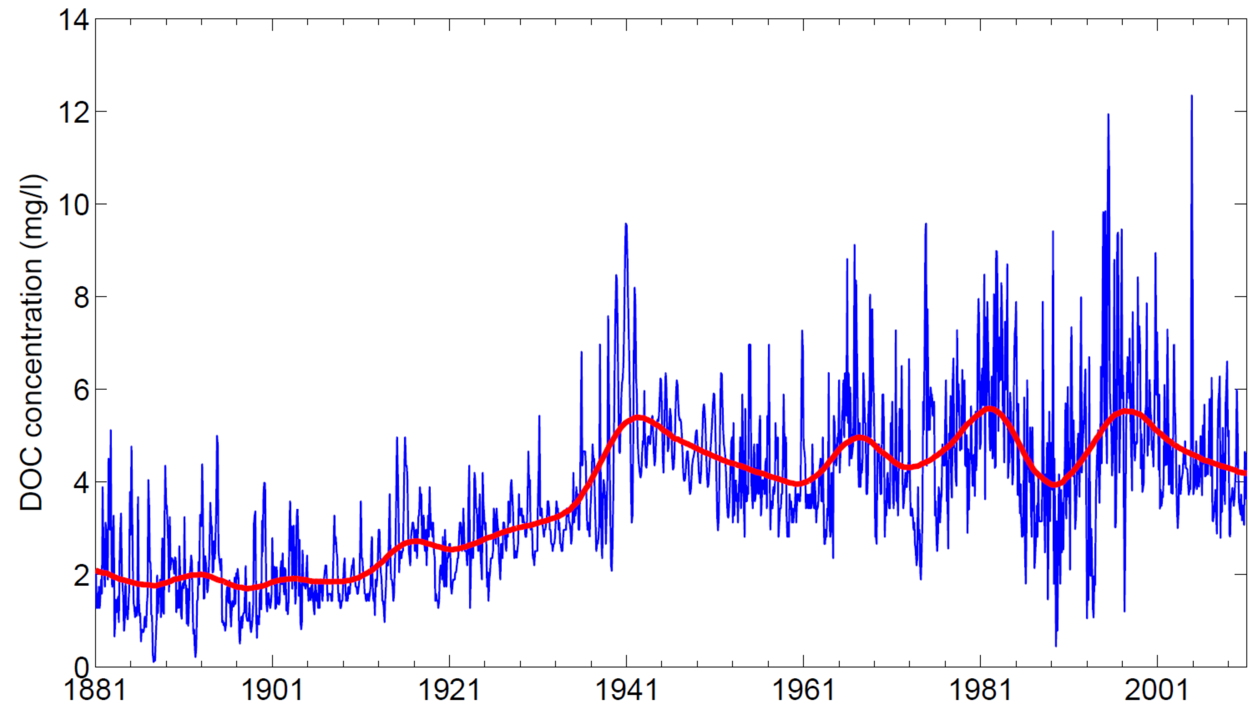
- Monthly mean DOC concentrations measured at Hampton 1881-2011 from Metropolitan Water Board.
- Database of Soil Organic Carbon (SOC) concentrations aggregated from: NSI 1984, NSI 2001, CS 1978, CS 1998, RSS 2001, EW Woodland 1971 and EW Woodland 2001 [4].
- Land use data collated from parish records, [5], National Inventories of Woodland and Trees, and LCM for 1990, 2000 and 2007.



a) Land use change in the Thames basin 1867-2007.

- Main land use changes during WWII (and to a lesser extent during WWI) when extensive ploughing was performed to convert permanent grassland into arable land (a).

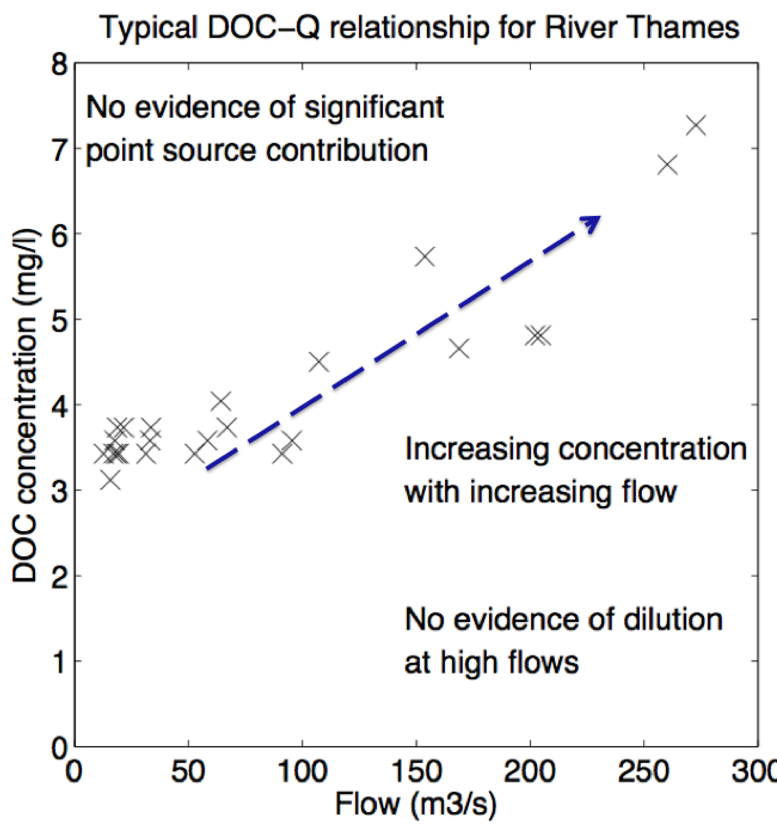
3. DOC Concentration in the Thames River



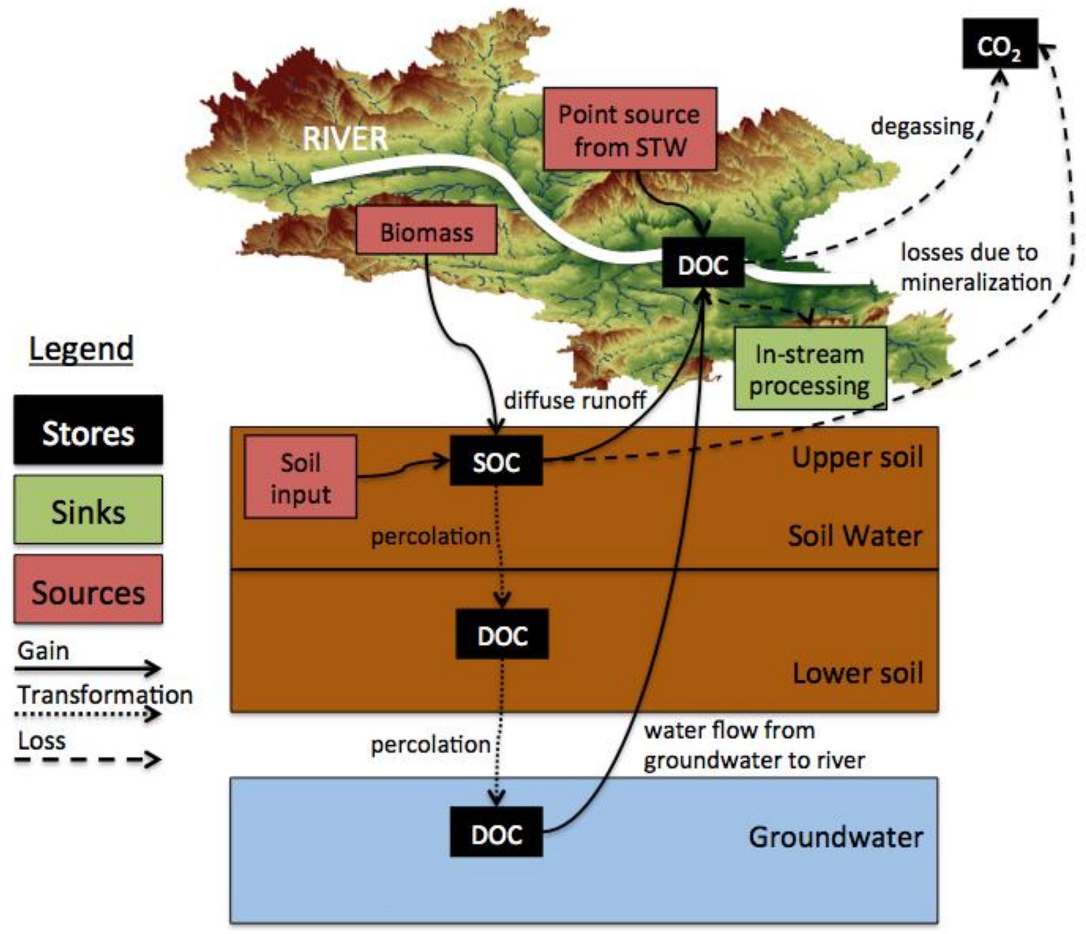
b) Time series plot of monthly DOC concentration with decadal moving average in the Thames River 1881-2011.

- DOC concentration has risen throughout the period.
- Pre-1912 mean concentration was 1.87 mg/l.
- Between 1913 and 1937 it increased at an average of 0.065 mg/l per year.
- Between 1938 and 1941 there was a steep increase of 2.24 mg/l.
- Post-1942 there were big fluctuations, but the mean concentration (4.66 mg/l) was higher than in the former period (b).

4. Major DOC Sources



(c) DOC concentration-flow relationship for River Thames.
x = data between 1961-1962.

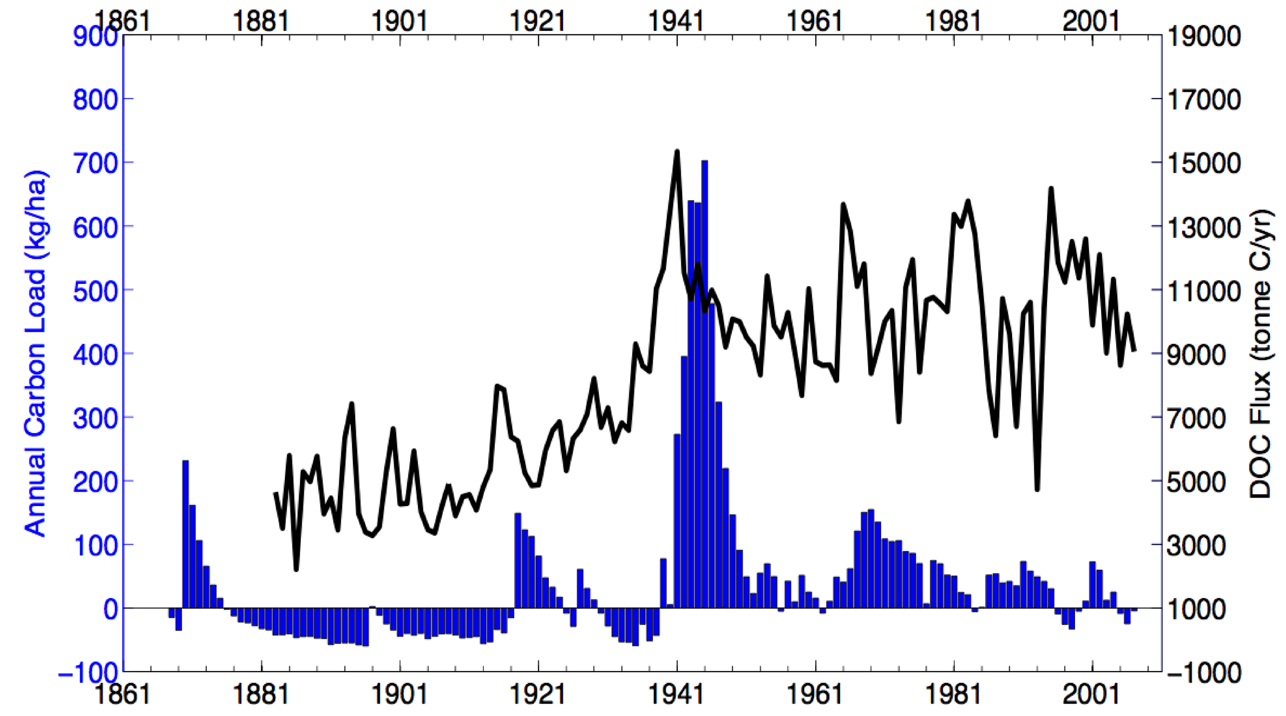


(d) Schematic Diagram of C Stores and Transformations

DOC concentration-flow relationships were used to estimate the relative inputs of DOC from sewage point sources and diffuse sources. For the majority of years the main contribution to annual DOC load came from diffuse sources (c), showing no clear point source signature (as there are no high DOC concentrations at low flow and decreasing DOC concentration with increasing river flow which would suggest dilution).

Preliminary results reveal that the major contribution to river DOC concentration comes from diffuse runoff, rather than groundwater. This is in agreement with [7] and the understanding that DOC leached from soils may partly be retained in the unsaturated zone before reaching the aquifer.

5. Preliminary Results



(e) DOC flux (1883-2007) and Carbon load due to land use change (1868-2007).

Carbon load was calculated with a SOC model [4], which considers soil C losses due to land use change as C emissions to the atmosphere.
In the future we will try to partition these SOC losses into DOC lost to surface waters, DOC leached into deeper soil layers and losses to the atmosphere as CO_2 (d).
Some of the major peaks in DOC fluxes in the river Thames occurred at approximately the same time as peaks in Carbon load due to land use change (e).

6. Preliminary Conclusions

- There are clear links between fluvial DOC rises and large-scale land use changes that released large quantities of SOC.
- A process-based model of carbon stores and transformations is required to approximate the DOC export from the catchment.
- The majority of DOC in the Thames river comes from diffuse runoff and diffuse sources, rather than from groundwater and point discharges such as sewage effluents.

References

[1] Eatherall, A. *et al.* (2000) *Science of the Total Environment*, 251, 173-190.
[2] Worrall, F. *et al.* (2004) *Science of the Total Environment*, 326(1-3), 95-112.
[3] Worrall, F. & Burt, T. P. (2007) *Global Biogeochemical Cycles*, 21(1).
[4] Bell, M. J. *et al.* (2011) *Global Biogeochemical Cycles*, 25.
[5] Crooks, S. & Davies, H. (2001) *Physics and Chemistry of the Earth Part B-Hydrology Oceans and Atmosphere*, 26(7-8), 583-591.
[6] Worrall, F., *et al.* (2012) *Journal of Hydrology*, 448, 149-160.
[7] Jutras, M.-F. *et al.* (2011) *Ecological Modelling*, 222(14), 2291-2313.

Acknowledgements

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