An Assessment of The Costs of Nitrogen Enrichment

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Research Background

- Conducted UK wide analysis of costs of nitrogen enrichment
  - Limited policy value
- Catchment-based analysis to apportion costs to sources of N
  - Eutrophic catchments and coastal zones
    - River Colne and River Stour (Essex, Suffolk)
  - Oligotrophic catchment and coastal zone
    - River Conwy (Wales)
- Preliminary findings only – work still in progress

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Externalities

- Nitrogen used in economy for productive purposes
  - Fertilizer – crops and livestock
  - Fossil fuels – transport, heating
- But these produce side-effects or externalities
  - Costs of overusing natural resources or using the environment as sink are called externalities
  - Side effects are external to markets, and so costs are not part of the prices paid by producers or consumers.
  - Thus markets are distorted by encouraging activities that are costly to society even if private benefits are substantial
- Agricultural externalities
  - Can be negative (costs) or positive (benefits)
  - Often occur with a time lag and damage groups whose interests are not represented;
  - Identity of producer of the externality is rarely known

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Relating nitrogen budgets to costs

- Two levels of analysis
  - UK as a whole system
  - Sub-regional catchments as whole systems
- We have analysed flows of nitrogen
  - Inputs (enrichment)
    - Fertilizer N
    - Feed and food
    - Atmospheric transfers and deposition
    - N fixation
  - Enrichment results in costs and benefits
    - Social damage costs
    - Ecological damage costs
    - Policy response costs
    - Benefits




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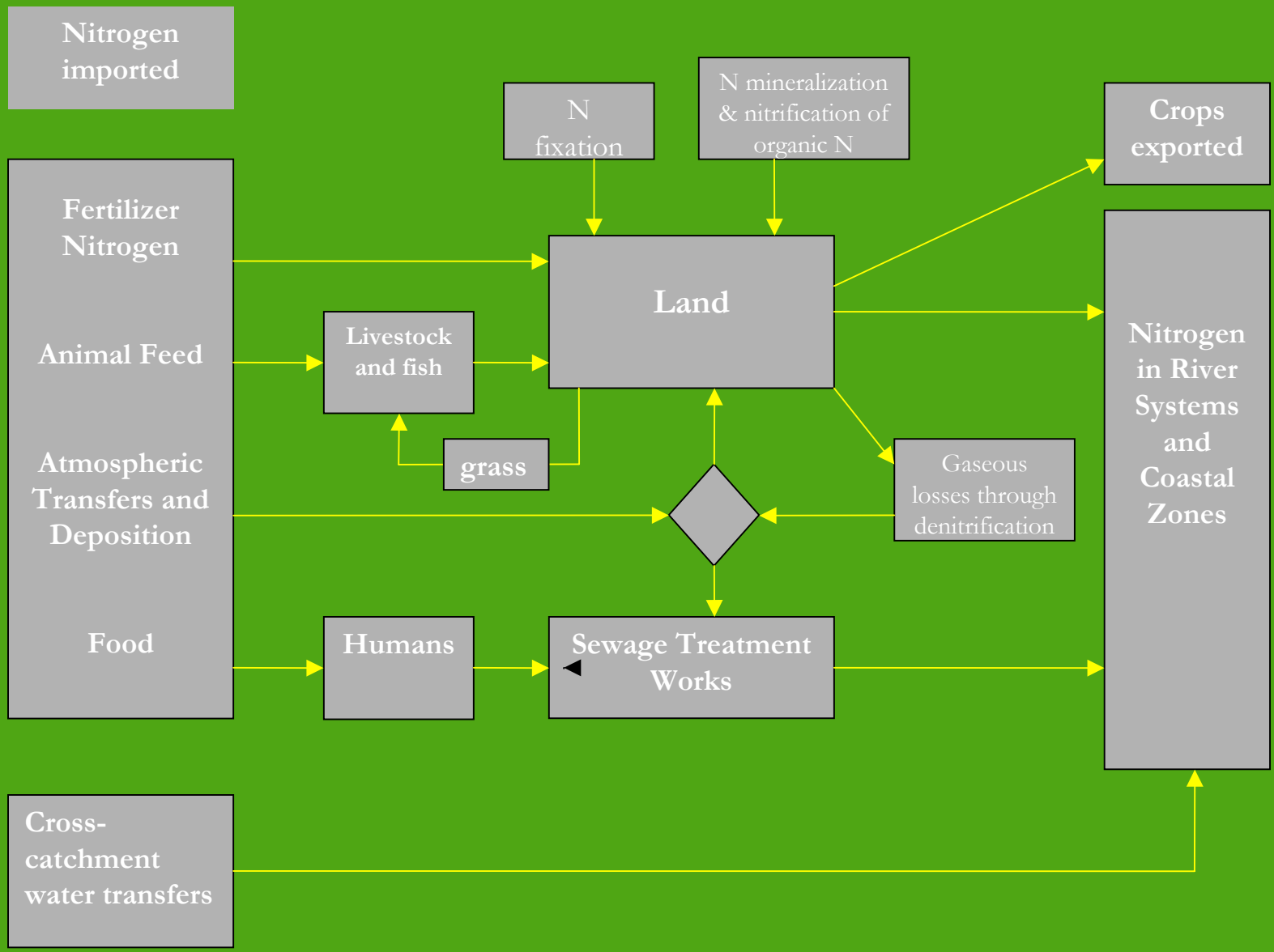

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What comprises costs and benefits?

- Social damage costs
  - Reduced value of waterside dwellings and water bodies
  - Drinking water treatment costs
  - Clean up costs of waterways
  - Reduced value of non-polluted atmosphere
  - Reduced recreational and amenity value
  - Losses to tourist and aquaculture industries
  - Health costs to humans, livestock and pets
- Ecological damage costs
  - Negative effects on biota
- Policy response costs
  - Compliance control costs
  - Direct costs for monitoring
- Benefits
  - Increased value of fisheries
  - Fertilisation effect on farmland
  - Improved sources of food for wild birds and shell fish






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UK – N enrichment and unit costs

- National level studies[1]
  - External costs of agriculture
  - Costs of eutrophication
    - Social damage £47-66M
    - Ecological damage £3.5-5.1M
    - Policy response £4M
- Costs of enrichment due to N
  - £54.4-75.3 million yr^{-1}
- External costs
  - £0.034-0.048 kg^{-1} of N enriched
  - 3.4-4.8 p kg^{-1} of N

  – Real costs 46-65% above current price of N fertilizer (7.4 p kg^{-1})

	Mt yr^{-1}
N fertilizer consumption (1999-2002 mean)	1.165
N from atmospheric deposition	0.380
N from fixation (peas, beans)	0.006
N imported via feed and food	0.026
Total	1.577

1. Pretty *et al.* in *Ag Syst* (2000); *J Env Policy Manage* (2001); *Env Sci Tech* (2003); *Food Policy* (2005)

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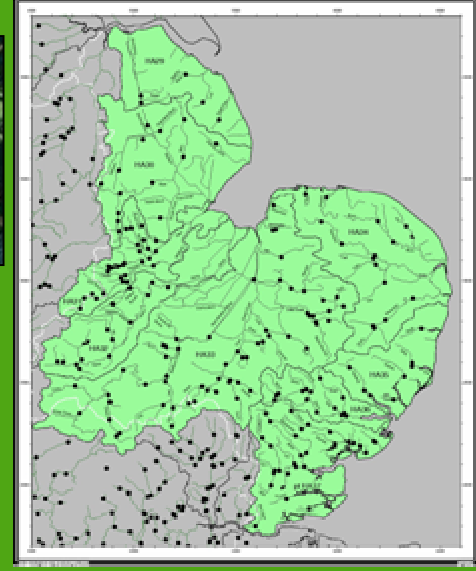
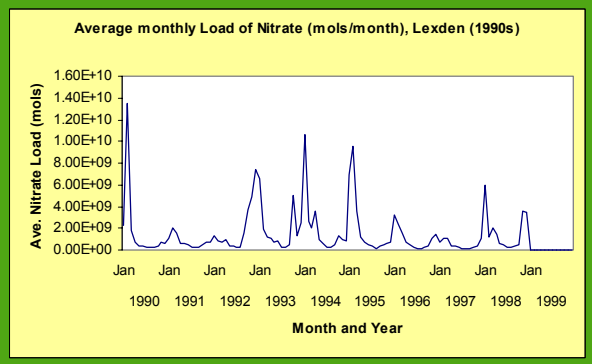
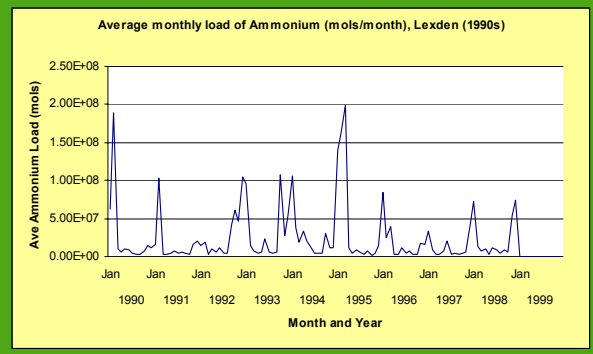
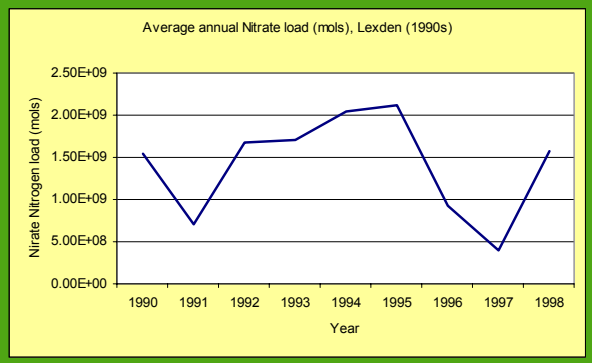
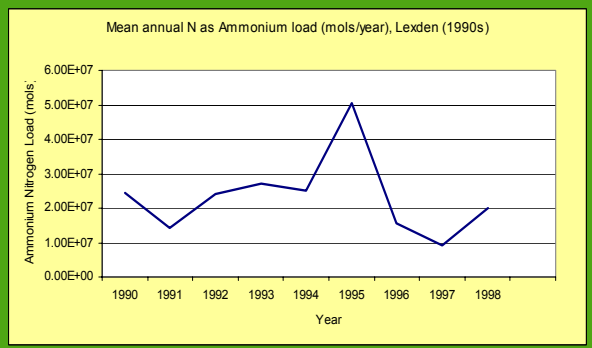
Colne Catchment nutrient loads











Measured outputs of N from sewage treatment works & analysis of population data in sub-catchments show that STWs contribute 2-18% of nitrogen load to the river Colne

- diffuse sources of N most important

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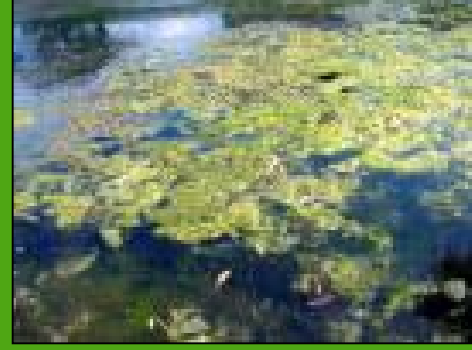
Colne Catchment Draft Nitrogen Budget

- Area of catchment
  - 255 km^2
- Total N enrichment in catchment
  - 2.32-3.34 kt yr^{-1}
- Total cost of enrichment
  - £79-160,000 yr^{-1}
  - £2.90 ha^{-1}

	kt yr^{-1}	%
Nitrogen fertilizer applied (mean 2000-02)	1.376	49%
Livestock feed imported (only 235 large livestock)	0.088	3%
Atmospheric deposition (mean for Eastern region)	0.51-1.53	36%
Losses from humans after food consumption (losses per person x population in catchment)	0.33	12%
N fixed by legumes (ha x fixation ha^{-1})	0.022	<1%
Total	2.32-3.34	

Problems with cost estimates



- May be underestimates:
  - Drinking water treatment costs for N are rising
  - Eutrophication costs only calculated for freshwater systems in England and Wales (coastal zone costs missing)
  - Many negative effects on biota difficult to cost
- May be overestimates:
  - Potential double counting as some local deposition comes from local agriculture
  - Transboundary imports of N
  - Some N leached to groundwater and does not impose an immediate cost
    - Also difficult to assess impact of old N to catchments
- Other uncertainties
  - External costs also arise from effects of other nutrients (phosphate) and are difficult to disaggregate
  - Losses of N vary from different types of fertilizers

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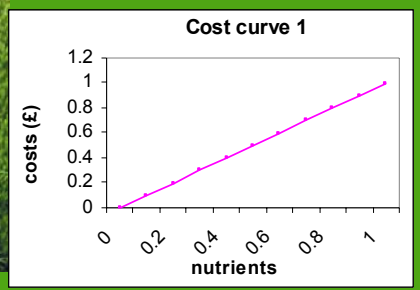
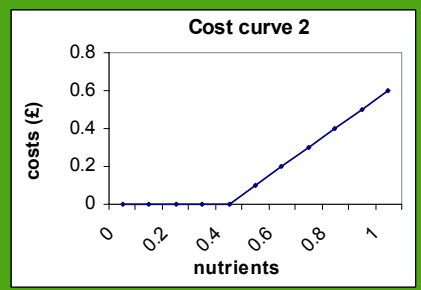
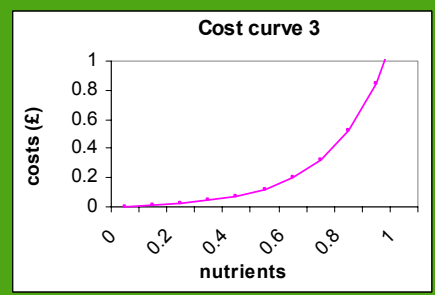
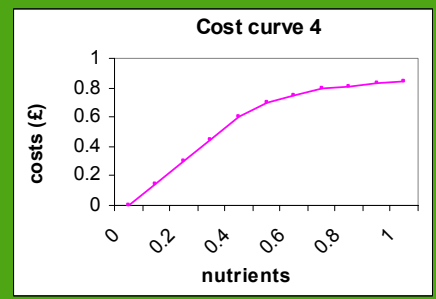
Further uncertainties regarding nutrients and costs

- Aggregate analysis assumes each kg has same marginal cost
  - May be key thresholds
  - Costs unlikely to vary linearly
  - Not clear whether marginal costs are higher at low or high N concentrations
  - Not clear of different costs in eutrophic and oligotrophic catchments









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Policy Implications

- Real price of N much higher than cost paid
  - For both fertilizers and fossil fuels
- Two policy principles
  - Polluter pays
  - Provider gets (of environmental services)
    - CAP reform offers new opportunities

- Policy measures
  - Economic (eg taxes, subsidies)
    - Taxes can be efficient - but little political interest?
    - Subsidies could work to encourage changes in behaviour (provider gets) – especially with CAP reform
  - Regulatory (eg NVZs, WFD)
    - But impose same costs on all land businesses regardless of whether cause externalities
  - Advisory & institutional (GAP)
    - Cheap – but do not guarantee polluters will change behaviour
    - Need social action as prerequisite for catchment or landscape scale change

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Further challenges

- Policy issues
  - How to balance economic efficiency with fairness and justice (trade offs)?
    - An environmental tax could work but would penalise all users equally
  - How to assess the winners and losers?
  - Costs in catchments depend on mixes of crops and livestock and amounts of N deposition
- Catchment studies needed to
  - identify costs with specific sources
  - Allocate costs to different sources
    - Compare different types of catchments according to population density, nutrient status
  - Develop different policy prescriptions
    - Policies will need to be differentiated at local level