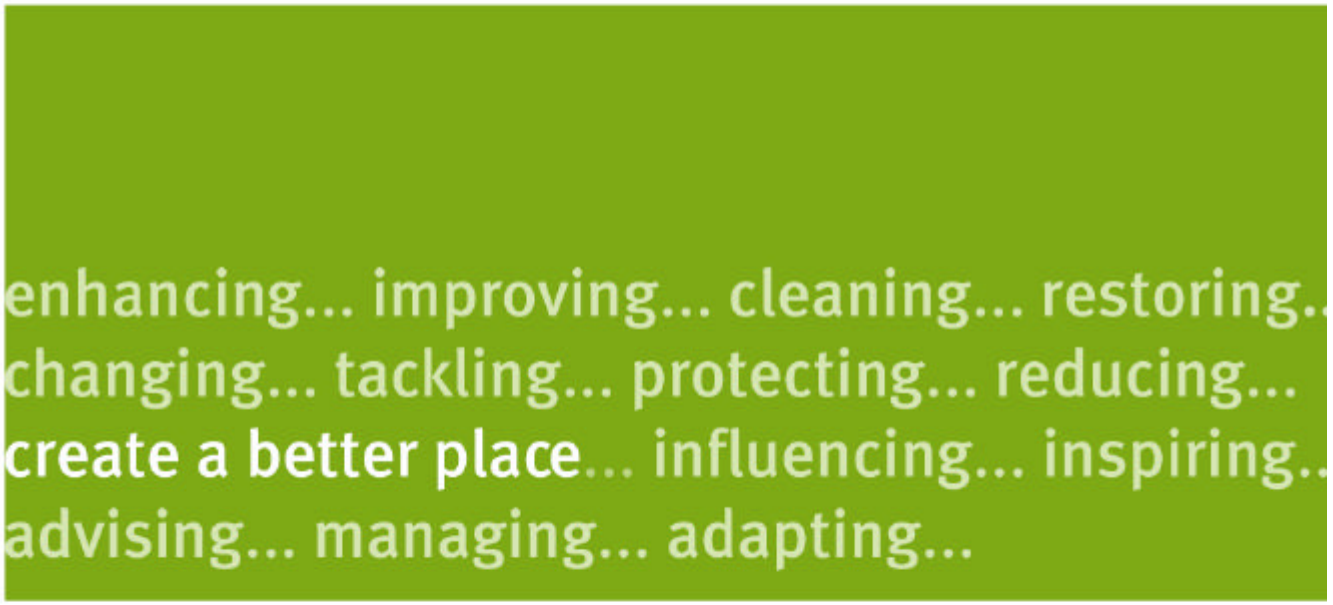

Agricultural Economics Society's Annual Conference 2006: Sustainable Development of Agriculture in England and Wales

A summary of work done in the Environment Agency on the external costs and benefits of agriculture.

ea/br/e/std/v1

Agricultural Economics Society's 80th annual conference - Paris 30-31 March, 2006
The Sustainable Development of Agriculture in England and Wales[1]

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Agricultural Economics Society's 80th annual conference - Paris 30 - 31 March, 2006
The Sustainable Development of Agriculture in England and Wales[2]

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[2] Dr Jonathan Fisher, Economics Policy Manager; and Dominic O'Neill, Economist. Environment Agency (for England and Wales).

1. Introduction

In his presidential address for the AES conference in Nottingham in April 2005, Professor Allan Buckwell[3] reported estimates of environmental costs and benefits and the sustainable development of UK Agriculture. This paper for the next conference of the AES and the Société Francaise d'Economie Rurale (SFER) in March 2006 presents our latest ongoing work to update estimates of the external environmental costs and benefits of agriculture. It also examines other aspects of sustainable development of agriculture and provides forecasts of agricultural activities up to 2015.

2. Natural Capital: Environmental costs and benefits of Agriculture

2.1 Context: Uses and Limitations

This paper uses available assessment methods and information to estimate the external environmental costs and benefits of agriculture in England and Wales and the UK. This indicates the importance of the environmental costs and benefits of agriculture and highlights the need for their further careful and serious consideration.

Any measures to reduce these environmental problems could entail costs, which must be taken into account before deciding on any specific measures. Therefore the estimates in this paper (on their own) cannot determine any measures since this will require careful appraisal of the feasibility and scope for reducing these environmental impacts. Consequently, this paper is an input to the start of the assessment and reinforces the need for careful options appraisal that will subsequently be needed.

2.2 Methodology and Information sources

We used the best estimates from the following main sources:

- *Agriculture and Natural Resources: Benefits, Costs and Potential Solutions* Environment Agency 2002 (from now on referred to as the EA 2002 report).
- We updated this with new estimates for the costs of poor water quality and low flows from our recent economic analysis in 2003/4 to support the environment programme in the Review of the Water Industry 2004 (referred to as the PRO4 report – See Environment Agency (2004).
- *Framework for Environment Accounts for Agriculture*. Eftec and Institute for European Environmental Policy (IEEP) (referred to as the Eftec 2004 Report).
- Defra's RIA[4] for the Third Consultation Paper for the implementation of the WFD

There is no new analysis. Some circumstances will have changed since the above reports were written, for example the knowledge of the contribution of agriculture to problems etc. but this note does not take account of any such changes since the original figures in the above sources were derived. It should be noted that for some of the impacts there is a great deal of uncertainty and more research is needed.

2.3 Environmental Benefits of Agriculture

Table 2.1 gives the environmental benefits provided by agriculture's good management of the land. These benefits estimates are not that much lower than the public expenditures on CAP in 2003 (£2.3bn), which highlights the merits of examining this subject carefully. Only the central figures are provided. There is a large variation in economic value estimates. Further research is needed to provide a clearer indication of agriculture's role in the provision of the non market goods and services provided by the countryside. The figures reflect the benefits derived from all the land managed by agriculture (74% of all land).

[3] *Green Accounting for Agriculture* AES Presidential Address 2005.

[4] Department For Environment, Food And Rural Affairs, Welsh Assembly Government. Third Consultation Paper On The Implementation Of The EC Water Framework Directive: Regulatory Impact Assessment

Table 2.1: Environmental benefits of agriculture in UK (2004-05 prices)

Environmental benefit category	Source	£m per year in 2004 prices
Value of landscape amenity services by the current provision of landscapes	Eftec 2004	498
Value of habitat protection services provided by current land use within the agriculture sector	Eftec 2004	229 (England only)
Value of species protection services provided by current land use within the agriculture sector	Eftec 2004	313
Carbon sink service	Hartridge and Pearce[5]	415
Total		**1455**
Total as % of Gross Value Added of Agriculture £5238m per year		**28%**

Costs were converted to 2004 prices using the GDP Deflator

The countryside provides many non market goods and services through the provision of landscapes, habitats and species. Agriculture contributes to this provision. When assessing the contribution of the sector it is necessary to compare what is provided by the farmed environment with what would occur in its absence or what would occur if the agricultural land was managed in a different way. In many cases if land is left it will turn through natural succession to scrub and then woodland.

Of course agricultural activities can both improve and erode habitats and species. Biodiversity loss can result from inappropriate farm management practices. The figures quoted above are net of the negative impacts on landscape/habitats/species.

Most of the UK is covered in semi natural habitats created from historical agricultural practices. These semi natural habitats often have a higher biodiversity value than the type of habitat that would result if management were removed (scrub followed by woodland- although this is likely to be more valuable than intensively managed farmland). Agriculture is very important in the creation and maintenance of these semi natural habitats. To keep them requires continuation of agricultural activity. Examples of semi natural habitats include grassland, wetlands, moorland, wood pasture, salt marches etc.

The activities of agriculture which can result in external benefits include:

- the maintenance of landscape features such as hedges, dry stone walls, field margins, banks etc;
- the contribution to the aesthetics of the UK landscape through crop cover and permanent grassland;
- maintenance of historic archaeological sites.
- The maintenance of semi natural habitats such as neutral grassland, bog, dwarf shrub heath, acid grassland, fen, Marsh, swamp, farm woodland etc

Some farmers derive significant non-farm income from farm based tourism, which may relate to some of the landscape amenity benefits above. The source of the environmental benefits of agriculture is the Eftec 2004 report except for the estimate for the carbon sink. The Eftec 2004 report cites a IERM and SAC (2001) study which uses a benefits transfer model based on the majority of the existing literature on UK landscapes and habitats. It cites more studies to derive its estimates than other reports.

[5] The source of the above figure for the CO2 sink service provided by agriculture is Hartridge and Pearce 2001. Sink is estimated to be 12.1m tonnes of carbon per year with a unit damage cost of £29.8 per tonne in 1998 prices gives a total of £415m per year (2004 prices). This is not a net figure since the emissions of CO2 are presented earlier (emissions of CO2 from fossil fuel combustion etc of £111m and CO2 emissions from soil cultivation of £82m per year). The total 12.1 m tonnes of C includes: forest biomass and litter (2.1m tonnes); non forest biomass (0.3m tonnes); forest soils (0.1m tonnes); set a-side soils (0.4m tonnes); undrained peatlands (0.7m tonnes); CO2 and N fertilisation (2m tonnes); crops for consumption (6m tonnes); livestock (0.5m tonnes)

2.4 External Environmental costs of agriculture

Overall environmental costs

Table 2.2 Summary of the external costs of agriculture costs - £m per year (2004 prices) in UK

Environmental pollution or impact category	Agriculture's cost £m per year	
	Low	High
Soil	120	219
Water	318	724
Air	583	1959
Total	**1021**	**2902**
Total as % of Gross Value Added at basic prices £5238m in	**19%**	**55%**

Table 2.2 shows the total quantified external environmental costs of agriculture in the UK. The figures for water impacts are underestimates of the UK totals because they are for England and Wales only There is the greatest potential for worthwhile low cost measures for improved soil and water management, which is why attention is usually focused on them. The following sections and Annexes explain the reasons for the ranges presented.

The above damage costs are considered to be conservative because they do not include the following potentially significant environmental impacts:

- Marine eutrophication costs;
- Environmental impacts from pesticides (eg on human health, water bodies, wildlife and biodiversity, apart from inclusion of estimates of water industry's costs of treating water to remove pesticides in providing drinking water);
- Impacts of abstraction on the quantity of groundwater;
- Impacts of water pollution (other than eutrophication) on lakes.
- Impacts of water pollution on shellfisheries.

Environmental costs of air emissions

Table 2.3 gives the environmental costs from agriculture's emissions of air pollutants. Some emitted gases have impacts at the local level such as ammonia's contribution to acidification and enrichment while others have global impacts for example carbon dioxide, methane and nitrous oxide.

Global Impacts

The greenhouse gases emitted by the agriculture sector include: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). CO_2 is emitted by the cultivation of soil and by the combustion of fossil fuels to power tractors and other vehicles. Agriculture is the main source of methane and nitrous oxide in the UK... Methane is formed during the decomposition of organic matter and nitrous oxide is formed from nitrogen fertiliser and from the treatment and disposal of animal wastes.

Local and regional impacts

Along with the 3 greenhouse gases mentioned above ammonia is the main gas (in volume terms) released by agriculture. Most of the ammonia released in the UK is from agriculture. It is released from nitrogen rich products from mainly cattle and pigs. It is also released from the use of inorganic fertiliser. It causes acidification and enrichment.
The combustion of fossil fuels also releases regional impact pollutants such as sulphur dioxide (SO_2) and nitrogen oxides (NO_x) and local impact pollutants. SO_2 and NO_x produce acid rain, which erodes buildings, damages ecosystems, reduces crop yields and impacts on human health. The local pollutants can exacerbate respiratory illness. The estimates used here for the impact of regional and local pollutants focuses only on the mortality risk.

The damage cost figures for local and regional air pollution excludes[6]:

-impacts on ecosystems
-additional health effects
-damage to cultural heritage e.g buildings
-impacts on visibility
-altrustic values associated with health impacts

Table 2.3 External Environmental Costs of Air Emissions

Air Pollutant	Unit damage cost. (£/tonne) 2004 prices	Quantity of emissions (kTonnes per year)	Total damage cost (£m per year 2004 prices)	Source
Carbon*			111	EA2002
Methane	£204 - £816	914	186 – 745	Eftec 2004
Nitrogen Oxide	£194 – 915	18.7	4-17	Eftec 2004
Sulphur Dioxide	£759 - £2341	1.5	1-3	Eftec 2004
Nitrous Oxide	£2849 – 11397	88	250 – 999	Eftec 2004
NMVOC	£1394	4.2	6	Eftec 2004
Ammonia	£89	272	24 – 75	Eftec 2004
Total			583 – 1959	

This figure does not include the carbon dioxide loss from soil cultivation. This is under the soil category.

All but one of the damage costs figures are derived from the Eftec 2004 Report, which uses 2001 Netcen figures for the quantity of emissions. The figure for carbon does not include the CO_2 loss from soil cultivation, which is included under the soil category. The EA2002 report figure is used because the report separates out the emissions of carbon and the quantity of carbon sequestration.

The agriculture and forestry sectors also act as a sink for carbon dioxide. The figure for carbon above is not net of this sink function, which is included in the benefits figure.

Environmental costs of soil erosion, poor soil structure and cultivation

Soil erosion, declining organic matter and runoff problems related to poor soil structure are growing problems in UK agriculture. Enhanced runoff and soil erosion have been influenced by factors that affect soil structure and the ability of soils to absorb rainfall, including the conversion of marginal lands; increased intensification; removal of hedgerows/field boundaries; overgrazing practices; untimely vehicle use; and soil cultivation practices that cause slumping and capping of the soil.[7]

Table 2.4 Environmental costs of soil impacts

Soil Impact[8]	£m pa 2004/05 prices	Source
Off site costs	9	EA2002report
CO_2 emissions due to cultivation	82	EA2002report
Contribution to flooding	29 to 128	Evans (1996) and EA2002report
Total	**120 to 219**	

The estimates from the sources for the contribution to flooding have been updated to 2004 prices. They therefore do not take account of changes in circumstances, knowledge, evidence etc since the original figures were derived. It should be noted that there is a great deal of uncertainty in this area and more research is needed.

[6] *Framework for Environment Accounts for Agriculture* Eftec (Economics for the Environment Consultancy) in association with Institute for European Environmental Policy (IEEP) July 2004.

[7] *Agriculture and Natural Resources: Benefits, costs and potential solutions* Environment Agency 2002

[8] This table does not include:

- The cost to the Agency in restocking rivers for fish. Soil particles in rivers will contribute to fish deaths. This cost is included in the water pollution cost.
- The increased water treatment cost from removing soil particles. This is included in the water pollution costs.
- This note does not include on farm costs since these costs are not external to agriculture.

Some of the off site costs of soil erosion might already be incorporated in the values of damages to water, insofar as soil erosion impacts upon water quality. Often it is difficult to disentangle these cost estimates to get a better idea of the damage costs of poor soil structure and soil erosion.

The estimate for soil is likely to be an underestimate of because soil erosion contributes to other damage categories such as groundwater impacts, phosphorus leaching etc[9].

Environmental costs of water pollution and abstraction

Table 2.5 shows that the quantified water environmental damage costs in England and Wales due to agriculture are estimated to range from £349m to £779m per year (2004 prices). To derive the total external cost of agriculture it is necessary to add the cost to water companies of treating water pollution attributable to agriculture. This is estimated to be £127m to £148m pa (2004 prices) giving a total external cost of water pollution and abstraction from agriculture at £476m to £927m pa. The analysis quantified external environmental damage costs caused by current water pollution and abstraction in England and Wales from all sectors. These estimates were reviewed by Government bodies (Defra, Ofwat) and stakeholders (eg water industry, NFU, CLA) prior to their being included in the Government's article 5 report for the WFD in 2005 on the economic analysis of water use. It estimated the environmental damage for the following impact categories:

- Informal recreation from poor water quality;
- Eutrophication of lakes (excess nutrients/phosphates);
- Fishing affected by poor water quality;
- Impacts on amenity and economic development of poor water quality;
- Bathing water quality affected by water pollution;
- Impacts of poor groundwater quality;
- Ecosystems and natural habitat impacts – wetlands affected by poor water quality and low flows;
- Ecosystems and natural habitat impacts – rivers affected by poor water quality and abstraction.

There are certain water impacts that are not included as specific damage cost categories because they are included elsewhere. These include:

i) Faecal Pathogens. Faecal pathogens are included partly in the impacts on bathing water of poor water quality category and in the water treatment costs (in groundwater impacts), which includes the cost of treating cryptosproridium.

ii) Organic waste. To avoid the risk of double counting it is assumed that the affect of organic waste is included in the damage categories covering the impacts of poor water quality.

Annex I details and discusses the methodology for estimating these costs and how they were apportioned to the different sectors. The values of damage costs are expressed in terms of benefits foregone or lost because of poor environmental quality, and the appropriate values are based upon willingness to pay (WTP) to improve water quality. We have estimated the value of improving all river environments to good quality, which is taken for the purposes of this study as being broadly equivalent to RE2 (Environment Agency River Ecosystem classification). This is being superseded by the WFD's Good Ecological Status (GES) classifications. But it has not yet been possible to convert the available valuations into terms of GES classifications.

The WTP values are obtained from a large number of studies carried out over the past decade. This included extensive review by leading experts in Government, academia and stakeholders. In particular we held a workshop of these leading experts to derive these values (see Environment Agency (2003). Inevitably this close scrutiny prompted much criticism of these costs, which are summarised in Section 2.5. But it was generally concluded that these are the best valuations that are currently available, but that further work is needed to improve the valuations of the environmental costs and benefits of options.

[9] We also do not include any estimate for welfare losses and gains from improvements or degradations to soil as a natural asset.

Through discussions with Environment Agency experts, we derived approximate estimates for the percentage share of damage for each damage category caused by water companies, agriculture and other sources.

We then used the ranges of percentage allocations for each impact category to estimate the low and high values for each sector. The low value is calculated by multiplying the low percentage (share of the damage cost attributed to that sector) by the low total damage cost value and the high value is calculated by multiplying the high percentage by the high damage cost value.

Table 2.5 Costs of water environmental damage in England and Wales and allocation among main sectors[10] (£mn per year, £2004/5)

	All sources	Water company share		Agriculture share		Other diffuse and point sources	
Damage category	**£mn pa**	%	£m pa	%	£m pa	%	£m pa
Eutrophication in lakes	**45-73**	50	22-37	45	20-33	5	2-4
Informal recreation from poor water quality	**33-47**	40-60	13-28	30-50	10-23	10	3-5
Fishing affected by poor water quality	**71**	40-70	29-50	20-50	14-36	10	7
Bathing water quality affected by water pollution	**65**	30-60	20-39	35-65	23-42	5	3
Amenity loss (incl. CSOs) (impacts on local property prices of poor water quality)	**49**	50-70	24-34	10	5	20-40	10-20
Impacts of poor quality groundwater	**125**	10-20	13-25	40-70	50-88	10-40	13-50
Ecosystems, natural habitats impacts – rivers affected by poor water quality and low flows	**730-1303**	60-70	438-912	25-35	183-456	5	37-65
Ecosystems, natural habitats impacts – wetlands affected by poor water quality and low flows	**51-112**	60-70	31-79	25-35	13-41	5	3-6
Total cost of environmental damage of current water pollution and abstraction[11].	**1170-1847**	50-65%	589-1204	27-39%	318-724	7-9%	77-159
Environmental Benefits of PRO4	**203-385[12]**						
Remaining costs of environmental damage after PRO4	**967-1461**	40-56%	386-819	33-50%	318-724	8-11%	77-159

[10] These estimates were derived from a meeting with Jackie Vale, Keith Davis and Daniel Forgham and comments from Tony Warn. This builds on estimates in Defra consultation paper on Catchment sensitive farming (p. 19) that agricultural sources of pollution account for about 70% of nitrogen; 50% of phosphorus and the majority of silt pollution in UK waters. The figure for groundwater were derived from discussions with Tim Besien.

[11] For each category the total of all the low percentages does not add up to 100% because all the sectors cannot be at their lowest % at the same time. Conversely the total of all the high percentages do not add to 100%.

[12] This estimate contrasts with the original PR04 estimate of between £218M and £397M (2003/4 prices). Some of this difference is accounted for by uprating the original estimates to 2004/5 prices. The remaining £20M difference is due to revised assumptions regarding the likely benefits derived from the improved quality of groundwater as a result of PR04. These benefits were calculated as a proportion (10%) of the total cost (£303M) faced by water companies in producing potable water from polluted sources, including surface water. However, pollution in surface water is incorporated in other parts of this analysis so to include it here constitutes double-counting. To avoid this, the current estimate only incorporates the costs of treating groundwater and it is assumed that this constitutes one third of the total treatment costs. The benefits from improving groundwater quality as a result of PR04 have, therefore, been revised from £30M to £10M which accounts for the £20M difference in the estimates.

To derive the total external costs of water pollution and low flows, water treatment costs need to be added to the above total. Part of the total cost faced by water companies to treat raw water prior to supplying to water customers is an external cost of agriculture. Just over £300m per annum are spent on removing nitrates, pesticides etc. [13] It was assumed that a third of this cost is for the treatment of groundwater, which is not included here to avoid double counting with the groundwater cost in the above table. Just over £200m pa is therefore spent treating surface water. It is assumed that 60-70% of this is attributable to agriculture. [14] The surface water treatment costs attributable to agriculture therefore range from £120m to £140m pa (2004 prices). The total external cost of water pollution and low flows attributable to agriculture becomes £438m to £864m (2004 prices).

2.5 Methodological issues for estimating environmental costs and benefits

Use and non-use values

Many of the values of the environmental costs and especially the environmental benefits includes both values that people derive from (or lose) from use of the environmental resource in question (e.g. for recreation, angling or enhanced property values) and values attributable to the existence of the resource (e.g. natural habitats, ecosystems, fish etc), regardless of whether people actually use it – a non-use value. Non-use values may include a value attributed to the simple existence of the resource or attribute, or an altruistic wish to benefit the next generation. There has been considerable scrutiny of the non-use valuations relating to water pollution damage costs but less so of the environmental benefits identified in Section 2.4 above, for which the non-use values are likely to be significant.

Taking account of Income Constraints, embedding and substitutes

The report on the Peterborough workshop (Environment Agency (2003)) highlighted the importance of taking account of income constraints on the part of beneficiaries in estimating environmental costs (and foregone benefits). Moreover it is important to allow for substitutes to the environmental asset in question from which people could obtain similar sorts of enjoyment and welfare. This is particularly important concerning the non-use values (eg impacts on natural habitats and ecosystems).

The workshop found that the respective methods of allowing for income constraints, embedding and substitutes each have their respective strengths and weaknesses. Studies (such as Georgiou *et al*, 2000a,b) of individual schemes enable full consideration of the environmental benefits of the scheme but might not fully account for income constraints, embedding and substitutes, especially if there are many overlapping schemes in the programme. Wide-ranging studies (such as Yorkshire Water study[15]) comparing all schemes in a programme would effectively address these matters and trade offs; but do not provide sufficient information on the environmental benefits of the many different schemes to enable respondents to give a valid comparison of the options in question and hence a valuation of them. This latter limitation of such wide–ranging comparative studies will become particularly important for the WFD, which will encompass many more environmental benefit categories and parameters since they have to cover measures affecting, among other things, flood risk management, hydro power (fish passes), agriculture, wetland creation and natural habitat improvements.

We have addressed these issues of income constraints, substitutes and embedding as well as possible in this paper by using the valuations from wide ranging national studies (Willis and Garrod (1996) (in the FWR manual) and EFTEC (2002)) rather than the valuations based on grossing up values from the Georgiou et al (2000) individual study. However, the latter actually gives lower estimates, which we include as lower bound estimates for the non-use benefits. The valuations for the impacts of low flows are based on a national study of the benefits of alleviating low flows at all the major 40 rivers suffering from low flows (Willis and Garrod (1994).

[13] ERM, Stone & Webster *Assessing current levels of cost-recovery and incentive pricing* Defra May 2004

[14] Pretty et al (2000) quoted 70% but Ofwat (background information for what is still a draft report on the "Impact of Agricultural Pollution on Water Companies costs") asked water companies to comment on the Pretty et al (2000) percentages. Some thought the pesticide figure too high. The rationale is that the amount of pesticides in water bodies from non agricultural sources is more than proportional to their share of pesticides consumption because pesticides from these sources can find a more direct way into water bodies. In light of this it is conservatively assumed that agriculture contributes 60-70%.

[15] See Acutt (2003) for a description of the approach and findings in this study.

We have been cautious in estimating the impacts on recreation and fishing to allow for constraints on the numbers of (additional) participants and how much they would be willing to pay for more fishing and recreation benefits. Moreover, we applied a plausibly test to the estimates for fishing impacts and then applied a lower estimate.

Data needs and benefit transfer

We had to use existing secondary source data. Therefore we were constrained by the data available and the clarity and manner in which their findings and supporting methodologies are reported. These available data do not always fit neatly our methodology of estimating environmental damage costs, but where appropriate we set out explicitly the broad assumptions we have had to make to convert the available data into a format that is close to and appropriate to our methodology. We also point out whether our resulting estimates are accordingly lower or higher bound estimates.

There are a number of studies containing usable material, which we reference in annex 1 and where appropriate we discuss in the light of our own estimates. The most useful were RPA (1998)[16]) and WRC(1998) [17].

One of the consequences of using limited secondary data is that we have had to treat the damage costs and the benefits foregone in terms of potentially avoided damage costs, as being equivalent. Thus, if there is a valuation based on willingness to pay for the recreation and fishing benefits to achieve or restore current water quality to a good status (RE2), then we have regarded this value as the damage cost ('benefit foregone') with current water quality in the absence of improvement.

Double counting and omission of benefits

We have striven rigorously to avoid double counting or omission of key impact categories. However, relying on secondary source data, we find that there are often overlaps and gaps between the various available studies and sources which cover different categories of damage. Therefore in analysing and discussing each impact category, we spell out explicitly how we have treated the estimates in each study so as to avoid double counting as far as possible in deriving aggregate estimates. Thus for example, we have only used the portion of the estimates in the eutrophication study that relates to lakes so that this can be added to the estimates in the subsequent sections, which relate to rivers. Almost inevitably, given the constraints surrounding the available studies, some omissions and some double counting may remain. But we believe that they are unlikely to have any major net effect on our overall findings and estimates.

Date of the Studies

This assessment is mostly based on studies carried out in the mid 1990s[18], when water quality was worse than now and so it could be argued that the willingness to pay for improvements might have been higher then. On the other hand, environmental improvement is an income elastic good and willingness to pay for environmental improvements could have since increased with rising incomes and increasing concern and interest in the environment. This is suggested by the high valuations given by more recent studies such as Georgiou et al (2000a) and Jacobs Gibb (2002)[19].

3. Changes in Agriculture's Economic, Physical and Social Capital

[16] RPA (1998) The environmental costs and benefits of water resources - A preliminary methodology
[17] WRC and Oxera (1998) *Potential Costs and Benefits of Implementing the Proposed Water Framework Directive* for DETR
[18] The valuations have been converted into 2003 prices.
[19] Georgiou, S., Bateman, I., Cole, M., and Hadley, D., 2000a. 'Contingent Ranking and Valuation of River Water Quality Improvements: Testing Scope Sensitivity, Ordering and Distance Decay Effects'. CSERGE Working Paper GEC 2000-18. Jacobs Gibb, 2002. 'River Mimram Low Flow Public Preferences Study. Final Report – Phase 1'. In association with – Warwick Business School, Corporate Citizenship Unit and Glasgow University. Report to Environment Agency Thames Region.

As well as the environmental costs and benefits of agriculture examined in S. 2.1, sustainable development also concerns changes in agriculture's economic and social state and changes in agriculture's financial, physical and social capital. Therefore we would welcome analysis by agricultural economists and other social scientists of recent trends in agriculture's human, physical and social capital and the reasons for these trends. We here highlight some partial information on this subject highlighting the importance of these aspects.

In keeping with the underlying concept of sustainable development, there are close links between the environmental and economic health of agriculture. Reducing the environmental impacts of agriculture will be facilitated by a healthy economic state of the environment since it will enable environmental improvements to be integrated into decisions on investments and land management. Conversely farmers' difficult economic circumstances will limit their ability to achieve the necessary reductions in agriculture's environmental costs as well as their ability to enhance its environmental benefits as shown in S. 2.

Moreover, understanding changes in agriculture's economic capital and context is essential to understanding how agriculture activities and their environmental impacts are likely to change in the near future, which we examine in Section 4.

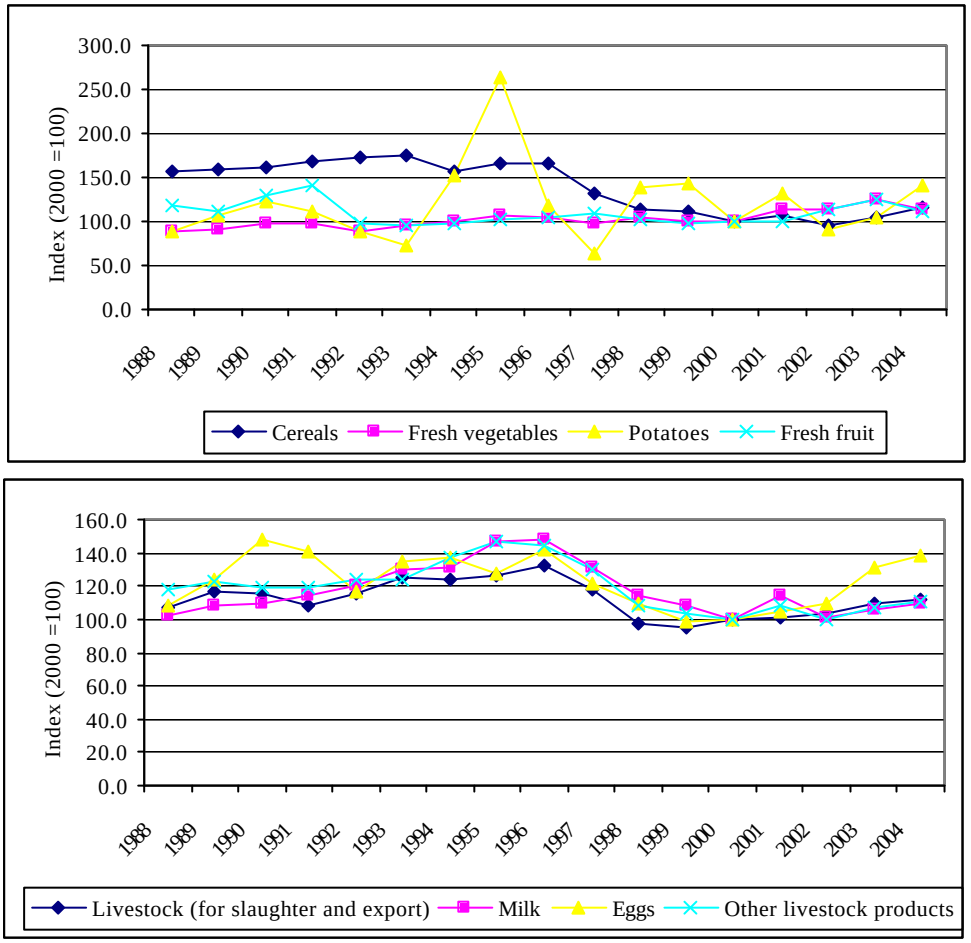
The recent past has been marked with low prices for many of the major agricultural commodities (highlighted by the producer price trends shown in Figure 3.1) compared to the relative highs of the mid-nineties[20]. This has led to a situation of incomes and returns from farming generally declining in recent years, although some recovery was witnessed in 2003/4 due to higher grain and potato prices. This is a major driver behind farmers' decisions (eg on product types and ultimately staying in business) and the significant current and projected structural changes in agriculture, especially the Dairy industry (see Section 4). It highlights the importance of the interesting papers at the AES conference on the role of supermarkets in the declining prices received by farmers[21].

Some farmers derive significant non-farm income from other sources, including farm based tourism. This may not affect specific decisions on crop types and the sustainability of (specific types of) these crops. But it needs to be taken into account in discussions about the social and economic conditions and sustainability of farmers.

[20] The Office of Fair Trading (OFT) has just recommended a fresh enquiry into the market power of supermarkets. It would be useful if this produced substantive analysis of whether supermarkets are using their monopoly purchasing power to force down the prices they pay farmers. In particular, need to examine whether there is any evidence of these prices being forced below the long run costs of producing the food, including the replacement of capital assets.

[21] Market Power In UK Food Retailing: Theory And Evidence From Eight Product Groups
Tim Lloyd, Steve McCorriston, Wyn Morgan, Tony Rayner Habtu Weldegebriel Univ. of Nottingham
Farm To Retail Price Transmission Of Milk: A French-Hungarian Comparison
Lajos Zoltán Bakucs, Imre Ferto Hungarian Academy of Science, Institute of Economics, Budapest, Hungary
C. Bontemps, INRA, Department of Economics, Toulouse, France. Michel Simioni, Hungarian Academy of Science

Figure 3.1 Price Indices for Major Crop and Livestock Outputs



Source: Agriculture in the UK (Defra 2004)

Table 3.1 Distribution of Incomes by Farm Type (2003/04)

	Dairy	Upland	Lowland	Cereals	General	Mixed
Less than zero	16	14	36	11	7	21
0 to less than £5,000	7	11	14	6	..	..
£5,000 to less than £10,000	10	26	14	5	9	..
£10,000 to less than £20,000	24	19	17	20	17	22
£20,000 to less than £30,000	12	13	9	13	12	10
£30,000 to less than £40,000	10	9	..	9	10	8
£40,000 to less than £50,000	6	..	..	9	..	..
£50,000 and over	17	5	3	27	35	20
Average (Pounds per farm)	25,089	14,902	7,215	38,749	59,925	25,091

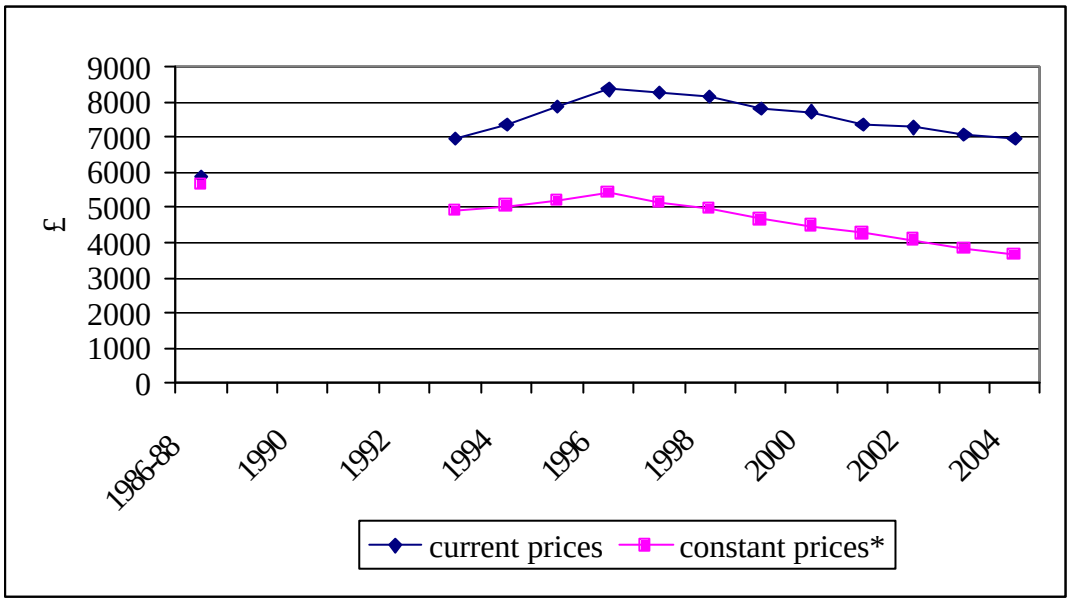
Table 3.1 details the variations in farm incomes within each farming sector. This highlights the large number of farms with low incomes. Table 3.2 highlights recent trends towards larger farms in the dairy sector.

Table 3.3 Number and Distribution of Dairy Production

	Total number of herds (1,000s)	Mean herd size (number of cows)	% of total animals	in herds over this size
1967	132	24	37%0	50
1985	54	58	70%	60
1992	43	63	46%	100
2000	39	67	53%	100
2003	27	82	58%	100

An indicator of the pressures on farm businesses is the steady decline in the aggregate balance sheet for plant machinery and vehicles for UK agriculture since 1996 (see Figure 3.2), which coincided with the peak in farm incomes in 1995. The decline clearly reflects a lack of investment in plant, machinery and vehicles over a period of relatively low incomes. It would also be worthwhile analysing trends in the overall net assets or worth of farms. In 2002/3, the net worth of small and large farms was £290,000 and £1,260,000, respectively.

Figure 3.2 Aggregate balance sheet, UK agriculture Plant, machinery and vehicle assets (£ million)



Source: University of Cambridge and Scottish Agricultural College (2006) Business as Usual projections of Agricultural Activities. Phase 2.

4. Baseline Forecasts for Agriculture

We have derived a baseline scenario of the agricultural activities that are likely to arise up to 2015 in the absence of any additional environmental control measures. This takes account of likely changes in the main drivers affecting agriculture. This is to help identify water bodies at risk of not meeting the WFD objectives in 2015 due to agricultural activities in England and Wales. More importantly it is designed to provide an independent, evidence-based and agreed 2015 baseline for agriculture against which we can appraise options for tackling diffuse water pollution for inclusion into Programmes of Measures for the first round of the River Basin Management Plans for the WFD.

Consequently we commissioned the University of Cambridge and Scottish Agricultural College to derive such baseline forecasts. They carried out in 2004 a first study of forecast agricultural activities to input into the River Basin Characterisation assessment.

The second study updated these projections to take greater account of likely structural changes in the sectors including changes in production practices that may influence the environmental impact of agriculture. Both reports can be found at www.environment-agency.gov.uk/economics.

4.1 Methodology for Forecasts

They identified the following Representatative Farm Types (RFT) that represent the bulk of agricultural land uses that have implications for diffuse pollution:

- Upland Livestock.
- Lowland Livestock.
- Dairy
- Mixed
- Cereals
- General Cropping

They reviewed the recent trends in these sectors (including information on trends in their economic capital (see S. 3)).

Table 4.1 sets out the key Drivers of changes in agricultural activities they examined. They reviewed the available information forecasts on the effects on agriculture of likely changes in these drivers. In the first study the discussion centred around the impact of the drivers on land cover while the later study looked at the impact of the drivers on the intensity of land use.

They then held stakeholder meetings to discuss the effects of these key drivers and draft forecasts for each RFT. We then held a workshop of leading experts, officials and stakeholders to discuss the overall forecasts.

Table 4.1 Major Drivers on Agriculture up to 2015

Factor	Details
CAP Commodity Reform	Decoupling – Beef, Sheep, Cereals Oilseeds, Pulses. Decrease in milk price and Quotas in place for dairy. Sugar beet price cut and compensation SFP wholly area based payments by 2012 in England. Historic payment Wales
World Supply and Demand	Changes in supply and demand for commodities influence prices and lead to substitution between enterprises. Institutional Forecasts do not suggest major future changes in prices. EU more susceptible to swings in world markets
EU Enlargement	Minor impacts on agriculture in the UK – increased competition offset by market access; impact on sterling uncertain. Opportunities for dairy exports, but effects on beef and sheep likely to be negligible. Cereals more impact in longer term
Environmental Measures	CAP cross-compliance, Environmental Stewardship Schemes (ELS and HLS), Environmental legislation (e.g., phase out of certain pesticides). Waste Framework Directive; Nitrate Vulnerable Zones; Rural Development Regulations; Air Quality legislation; Silage Slurry and Agricultural Fuel Oils Regulations (see below for detailed analysis)
WTO	Uncertain time frame but likely tariff cuts and removal of export subsidies may mean increased competition from imports with subsequent pressures on domestic prices
Technological Change	New methods, breeds, seeds (GM etc), Integrated Farming, more access to larger machines
Consumer	Change from supply driven to demand driven supply chain, demand for higher quality food, niche markets
Economic Growth	Unlikely to feed through into major increases in demand for food products, but could expand opportunities for off-farm income.
Exchange Rates	Major impact on profitability of agriculture
Biofuels	A certain proportion of energy supplies must come from renewable sources. Renewable Transport Fuels Obligation. EU legislation
Climate Change	Potential to change crop and livestock production patterns in England and Wales. In addition mitigation policies likely to have impact
Animal Health + welfare	Linked to climate change (possible new diseases) and changing consumer demand for products

They consider that there is likely to be a sustained period of relatively low commodity prices. There will be upward pressure on input prices, but no major increase in overall costs. In fact, restructuring of

farm businesses will lower average fixed costs and increase the proportion of production that is viable at current prices

The methodology is essentially based on analysing the fundamental economics of the agricultural sectors, which entails a broad comparative assessment of the prevailing market prices for the agricultural products and the farmers' long run marginal costs of producing the food for these markets. However, we also take account of the fact that farmers' decision making is significantly and subtly different from simple profit maximising. Many land occupiers will continue to accept a lower rate of return on their investments in agriculture than might be obtained by other investments because, for example, farming is their only way of life and because they want their children to have the option of taking over the farm. They will cross-subsidise between activities in order to protect the business as a whole. This will mean that they will continue to produce for some time even if they are not covering the full economic cost.

But we consider that these subtle behavioural factors largely affect the timing of farmers' response to economic fundamentals rather than the ultimate response per se. The actual responses to economic fundamentals may occur at key decision times such as when need to make a major investment (eg replacement of a milking parlour or farm equipment) or replace a worker or when their children decide that they do not want to take over the family farm. There can be major reviews at these times that take greater account of the economic fundamentals relevant to that farm. Much investment in capital equipment in the dairy industry took place in the 1980s. It is now reaching the end of its productive life and the need for replacement might accelerate the rate of changes in the dairy industry in the near future.

4.2 Headline Projections for Cropping and Stocking

Table 4.2 summarises the projections of key agricultural sectors up to 2015. It shows the current updated projections compared with the initial study. This shows some changes. While overall the changes in land use may not be that big. They include significant declines in sectors such as dairy and livestock and increasing intensification in these sectors. This is a continuation of the recent trends due to the trends in the economic pressures on them and their economic state reported in S. 3.

The following changes in cropping and stocking were forecast up to 2015.

- The main changes for cereals are that wheat and oilseed areas are projected to increase by seven and 15.5 per cent, respectively. This occurs because the combined effect of land returning to production, when set-aside is abolished and shifting across from root crops and horticulture, exceeds the area of marginal arable land that leaves production (reverting either to grass or just being left idle).

- Sugar beet reform will lead to 20% fall in production. The potato area is forecast to decline by 10 per cent, which is in line with recent trends.

- The areas down to temporary (under five years) and permanent (over 5 years) grass are forecast to increase by 3 and 5 per cent, respectively mainly due to the more marginal land moving out of crop production.

- Although grass area increases, livestock numbers are projected to decline markedly, particularly in upland areas, due to decoupling and intensification. Intensification in the Dairy sector, which has seen the number of herds decline by six per cent per annum in recent years, will continue. This could result in a significant demise in the traditional medium sized non-family owned tenant dairy farms. Upland livestock farms will be under the greatest economic pressure to restructure or cease production.

4.3 Policy baseline

Our current updated study assesses the effects on agricultural activities of a policy baseline scenario of existing agreed agriculture and environmental policy measures that have been agreed and implemented or will be implemented before 2015. This was achieved with help from Defra, WAG and the Environment Agency. This policy baseline[22] included:

- Recent agreed CAP reforms, under which most existing crop and livestock payments from January 2005 were replaced by a single farm payment scheme with its requirements (known as cross compliance).

- Environmental stewardship schemes. In England it is envisaged that the new schemes will double the level of expenditure on environment stewardship from its current level of approximately £155 million within the next few years (Defra 2005).

[22] Further details are provided in Annex 4.

Table 4.2: Summary of Updated Projections for England and Wales

Crop	Original projections	Updated Projections	Reason	Intensity	Mitigation
	Land area % vs 2002?	Land area % Change vs 2002?			
Set-Aside	-100	-100	Set-aside abolished		
Idle Land as % of Set-aside	25	50	Assumed more land 'idle' through buffer strips etc.	Land kept in Good Agricultural and Environmental Condition	
Wheat (Wales)	11 (7.5)	7.5	More marginal land reverts to grass Less land leaves sugar beet Set-Aside Fewer second wheats	Prices projected to remain at around current level, therefore no marked change in intensity. Greater precision in applications	Cross Compliance reduce Sediment and Phosphorus High uptake of ELS inc management plans and Buffer Strips. (VI) QA
Oilseeds	15.5	15.5	View biofuels as maintaining prices. Continued EU deficit in oilseeds	As Above	As Wheat
Winter Barley	0.0	0.0	Major fall in area occurred up to 2005 but predicted to be relatively stable from now on	As Above	As above
Spring Barley	0.0	0.0	Assumed need for break crops generally and markets for malting barley are maintained	As Above	As above
Oats	2.5	2.5	Stronger demand	As Above	As above
Other Cereals	0.0	0.0	Assumed (no change in?) need for break crops	As Above	As above
Pulses	0.0	0.0	Assumed (no change in?) need for break crops	As Above	As above

Crop	Original projection	Updated projection	Reason	Intensity	Mitigation
	Land area % vs 2002?	Land area% Change vs 2002			
Potatoes	-10	-10	Say here what BAU1 found – report must be read alone separate from BAU1	No major changes in method of production foreseen for conventionally grown crops. Continued improvements in precision and targeting of inputs. Market for organic potatoes not projected to grow significantly.	Cross Compliance reduce Sediment and Phosphorus High uptake of ELS inc management plans and Buffer Strips. Voluntary initiative and quality assurance compliance will be important
Fieldscale Vegetables	-19	-10	Smaller decline than initial projection due to stronger anticipated demand for vegetables, partly due to health benefits	Increased markets for organic but large-scale production and changes in production methods unlikely. Continued improvements in precision and targeting of inputs.	Cross Compliance reduce Sediment and Phosphorus High uptake of ELS inc management plans and Buffer Strips. Voluntary initiative and quality assurance compliance will be important
Sugar Beet	-30	-20	Revised policy – price cut rather than quota cut. Outgoers scheme raises average yield. Possible production of ethanol	Organic beet production unlikely to develop. Yield still key to production and will be maximised by continued improvements in precision and targeting of inputs will be	Cross Compliance reduce Sediment and Phosphorus High uptake of ELS inc management plans and Buffer Strips. Voluntary initiative and quality assurance compliance will be important
Grass < 5 years		+3	Move from marginal arable land will outweigh general movement of land out of agriculture to other uses	Fewer livestock will lead to more extensive grazing and lower fertiliser applications etc	As livestock below
Grass > 5 years		+5	Move from marginal arable land will outweigh general movement of land out of agriculture to other uses	Fewer livestock will lead to more extensive grazing and lower fertiliser applications etc	As livestock below

Livestock	**Original projection s**	**Updated projection**			
	% change in Nos vs 2002	% change in Nos vs 2002			
LFA (Less Favoured Areas) - Dairy	-20	-30	Continued process of increased concentration/intensification in lowland	Fewer larger herds – disappearance of mid-size herd	Cross-compliance and NVZs will have a mitigating effect. Mainly effect manure application (more targeted). Little expected impact from ELS
Lowland – Dairy	-20	-25	Focus of production will be lowland.	Fewer larger herds – disappearance of mid-size herd	As above
LFA Grazing Livestock					
Beef	-15	-20	Continuation of de-stocking that is already occurring - will this rate of destocking increase or decreaase	Extensification likely	Generally little impact from ELS. Possible HFA review important
Sheep	-6	-6	View that de-stocking was already occurring ditto see above	Extensification likely	Little expected impact from ELS. Possible HFA review important
Lowland					
Beef	-15	-15	More viable in lowlands than uplands but still decline	Extensification likely	Little expected impact from ELS
Sheep	-6	-2	More viable in lowlands but still decline	Extensification likely as more grass becomes available	Little expected impact from ELS

- Key features of the Entry Level and Higher Level Stewardship schemes are:
    - Entry Level Stewardship (ELS) is a voluntary scheme open to all farmers and land managers to encourage simple and effective environmental management beyond that of cross-compliance / legislative requirements. ELS started in March 2005 and has a wide variety of options available, some of which are useful in tackling diffuse pollution. Current predictions are that 43,000 ELS agreements will be signed in the first year and that 60% of farmed land will be covered by agreements in 2007.
    - Higher Level Stewardship (HLS) aims to deliver significant benefits in high priority areas. The scheme is voluntary but there will be no automatic acceptance onto the scheme and the funding will be limited (i.e. it is discretionary).

- Actions in Nitrate Vulnerable Zones (NVZs) to reduce or prevent the pollution of water caused by the application and storage of inorganic fertiliser and manure on farmland. It is applicable in 55 per cent of England and 3 per cent of Wales.

- Farm Advice services to reduce environmental impacts, including establishment of Catchment Sensitive Farming Officers to give advice in 40 priority catchments.

- Waste Framework Directive.

- The application of Integrated Pollution Prevention and Control (IPPC) Directive, to the intensive indoor farming of pigs and poultry.

- Water Abstraction controls

These policies were presented to both the stakeholder meetings and the expert panel to gauge their likely impact on the development of agriculture to 2015 and the pressure agriculture places on the environment, respectively.

We are currently examining the environmental effects of these existing policy measures to assess the extent that they will reduce the environmental impact of farming on water bodies and the extent of the remaining gap to be addressed by additional measures in the Programmes of Measures for the WFD.

Our initial assessment has highlighted the following environmental impacts of these existing measures:

- Cross Compliance is expected to have an impact, particularly in reducing levels of phosphates and sediment in water. It will have less impact on inorganic nitrogen but will mean that manure application will have be more targeted therefore reducing the pressure on the environment
- Widespread adoption of Entry Level Schemes (Tir Cynnal in Wales) on cropping farms will help reinforce the gains from cross compliance. Analysis of early adopters shows uptake of potentially beneficial options for water quality, particularly through soil management plans and buffer strips.
- ELS will be adopted in livestock farms, but will have less impact on water quality as the options adopted are less likely to reduce diffuse pollution. There are other 'easier' ways for farms to achieve the necessary points to qualify.
- Nitrate Vulnerable Zones will have biggest impact where manure distribution is a key issue. For inorganic fertiliser applications there will be less of an impact for those following best practice. However, it will be important for the minority of farms that are over-using inputs. NVZs cover a small area in Wales so the impacts will be localised.
- The impact of other policies, such as the new Higher Level Schemes, and advice schemes such as Catchment Sensitive Farming advice officers and the programme on Diffuse Water Pollution from Agriculture are harder to quantify at the present time.
- A key impact is that the likelihood that the continued pushing of the environmental awareness message and the enforcement of regulations will reduce the numbers of farms that over use or misapply inputs. This will help offset the problems identified in work for Defra by IGER (2004) which concluded that losses into water were increasing.

Graham Wynne (Director of RSPB) has stated that CAP reform was the most important environmental achievement of the Government and that its second most important environmental achievement was the

£3.5bn environment programme for the water industry in the recent review of the water industry (PR04).

We suggest that the quantified environmental benefits of the existing environmental policy measures for agriculture in the policy baseline are likely to be smaller than those achieved in PR04. This is because the extent and costs of the measures in the policy baseline above for agriculture are substantially lower than the £3.5bn environment programme for the water industry in PR04. There will remain a significant environmental pressures and risks from agriculture.

But their most important element and we believe the basis behind Graham Wynne's statement is that they, especially the CAP reforms, mark a fundamental change in the framework and structure of economic incentives and price signals for agriculture which could help put support for agriculture on to a more economically and environmentally sustainable footing. It will also facilitate the development of efficient and effective options to improve further the environmental impacts of agriculture as part of the implementation of the WFD.

5 Conclusions

The updated estimates in this paper have shown the high external environmental costs and benefits of agriculture. The external environmental costs of agriculture are about £1bn - £3bn pa or about 23-59% of the industry contribution to GDP (Gross Value Added of Agriculture). The environmental benefits are about £1.5bn pa or 28% of agriculture's Gross Value Added. These are high estimates for each of the environmental costs and the environmental benefits which both merit careful examination of how to enhance the benefits and reduce the costs, especially through the Catchment Sensitive Farming initiative. Our recent in-depth review of the latest available valuations has meant that our updated analyses have increased significantly the estimates for the environmental costs and slightly raised those for the environmental benefits.

Existing agriculture and environmental policies will yield significant environmental benefits. Most notably they are a fundamental change in the framework and structure of economic incentives and price signals for agriculture which could help put support for agriculture on to a more economically and environmentally sustainable footing.

However, even after these policies, there will remain significant environmental pressures and risks from agriculture. Therefore there will need to be careful examination of positive measures to tackle these environmental problems (eg through enhancement and delivery of the Catchment Sensitive Farming initiatives) and means of funding them. But the existing policy initiatives should enable a better basis for the development of efficient and effective options to improve further the environmental impacts of agriculture as part of the implementation of the WFD.

Moreover, the paper has highlighted the importance of the other economic and social aspects of the sustainability of agriculture, which merit careful attention. These include the recent declines in agriculture's profitability and the associated declines in its net capital assets as well as the high social impacts on farmers of working in this difficult economic environment. Therefore it is necessary to take forward and put into concrete practice implementation of the Curry Commission recommendations of how to ensure that farmers' receive better financial prices for food that is produced in a sustainable way.

We have also provided updated forecasts of agricultural activities that take account of these economic pressures on agriculture. This highlights some changes in agriculture, especially significant declines in livestock especially in upland areas and an increase in the current major structural changes in the dairy and livestock sectors. This includes a substantial demise of the traditional medium sized dairy farms due to financial pressures on this sector.

Annex 1: Methodology and empirical analysis for estimating environmental costs of water pollution and abstraction

The water environmental damage costs used are taken from the valuation of environmental benefits for the economic analysis for the Environment Programme in the Periodic Review of the Water Industry (PRO4). This involved estimating the quantified environmental damage costs caused by current water pollution and abstraction in England and Wales across 8 damage categories:

- Eutrophication in lakes;
- Informal recreation from poor water quality;
- Fishing affected by poor water quality ;
- Amenity, economic development and combined sewer overflows;
- Bathing water quality affected by water pollution;
- Impacts on groundwater of poor water quality;
- Ecosystems and natural habitat impacts – wetlands affected by poor water quality and low flows and
- Ecosystems and natural habitat impacts – rivers affected by poor water quality and abstraction.

Discussions with Environment Agency experts allocated the share of damage for each damage category to water companies, agriculture and other sources (see table A1.1). Details of how the figures were derived are given below.

Table A1.1 Costs of water environmental damage in England and Wales and allocation among main sectors[23] (£mn per year, £2004/5)

	All sources	Water company share		Agriculture share		Other diffuse and point sources	
Damage category	**£mn pa**	%	£m pa	%	£m pa	%	£m pa
Nutrients in lakes	**45-73**	50	22-37	45	20-33	5	2-4
Informal recreation from poor water quality	**33-47**	40-60	13-28	30-50	10-23	10	3-5
Fishing affected by poor water quality	**71**	40-70	29-50	20-50	14-36	10	7
Bathing water quality affected by water pollution	**65**	30-60	20-39	35-65	23-42	5	3
Amenity loss (incl. CSOs) (impacts on local property prices of poor water quality	**49**	50-70	24-34	10	5	20-40	10-20
Impacts of poor groundwater quality	**125**	10-20	13-25	40-70	50-88	10-40	13-50
Ecosystems, natural habitats impacts – rivers, affected by poor water quality and low flows	**730-1303**	60-70	438-912	25-35	183-456	5	37-65
Ecosystems, natural habitats impacts – wetlands affected by poor water quality and low flows	**51-112**	60-70	31-79	25-35	13-41	5	3-6
Costs of environmental damage of current water pollution and abstraction	**1170-1847**	50-65	589-1204	27-39	318-724	7-9	77-159

[23] These estimates were derived from a meeting with Jackie Vale, Keith Davis and Daniel Forgham and comments from Tony Warn. This builds on estimates in Defra consultation paper on Catchment sensitive farming (p. 19) that agricultural sources of pollution account for about 70% of nitrogen; 50% of phosphorus and the majority of silt pollution in UK waters.

Environmental Benefits of PRO4	**203-385**[24]						
Remaining costs of environmental damage after PRO4	**967-1461**	40-56	386-819	33-50	318-724	8-11	77-159

Due to rounding, some figures may not add correctly.

It should be noted that the above total costs of environmental damage of current water pollution and abstraction from agriculture do not represent the total external water environmental cost of agriculture. It is necessary to add the cost for water companies of treating raw water polluted by agriculture. The estimate for the water costs attributable to agriculture is conservatively assumed to range between £120m and £140m pa (2004 prices). Therefore the total external water environmental costs of agriculture are estimated to range between £438m and £864m pa (2004 prices).

Table A1.2 Remaining Costs of environmental damage in England and Wales after PRO4 (£mn per year £2004/5)

	All sources	Water company share		Agriculture share		Other diffuse and point sources	
Damage category	**£mn pa**	%	£m pa	%	£m pa	%	£m pa
Nutrients in lakes	**45-73**	50	22-37	45	20-33	5	2-4
Informal recreation from poor water quality	**28-36**	29-47	8-17	36-66	10-23	12-13	3-5
Fishing affected by poor water quality	**54-55**	22-60	12-33	26-66	14-36	13	7
Bathing water quality affected by water pollution	**49**	7-47	3-23	47-87	23-42	7	3
Amenity loss (incl. CSOs) (impacts on local property prices of poor water quality)	**35**	29-58	10-20	14	5	28-56	10-20
Impacts of poor groundwater quality	**115**	2-13	2-15	44-76	50-88	11-44	13-50
Ecosystems, natural habitats impacts – rivers, affected by poor water quality and low flows	**599-1008**	51-61	307-617	30-45	183-456	6	37-65
Ecosystems, natural habitats impacts – wetlands affected by poor water quality and low flows	**42-92**	51-63	21-58	32-44	13-41	6	3-6
Total cost of environmental damage of current water pollution and abstraction	**967-1461**	40-56	386-819	33-50	318-724	8-11	77-159

The values of damage costs are expressed in terms of benefits foregone or lost because of poor environmental quality, and the appropriate values are based upon willingness to pay (WTP) to improve water quality. The WTP values are obtained over the past decade in a large number of studies. In other words, we have estimated the value of improving all river environments to good quality, which is taken for the purposes of this study as being equivalent to RE2 (River Ecosystem. The RE standards range from 1 to 5 with RE1 very good water quality and RE5 the worst quality. It is a system devised by the Agency and is based on chemical parameters that are conducive to healthy fish populations.). Table A1.3 reports the 2002 river quality survey data, which show that there is considerable potential for improvement of river lengths from RE4 and RE5 up to RE1 and RE2. While nearly 30,000km of river are at RE1 or RE2, about 13,000 are at lower quality grades, and this represents a loss of potential value, as poorer grade rivers do not support the beneficial uses such as informal recreation and angling, and offer a poorer ecosystem and natural habitat.

[24] See note 12.

Table A1.3 Quality of rivers in England and Wales by RE grade, kms (2002)

RE grade	TOTAL
Ungraded	113
1	12,856
2	14,188
3	6,886
4	3,087
5	3,125
Worse	139
TOTAL	40,391
Source: Environment Agency 2003, based on 2002 river quality, River Ecosystem (RE) Face Values values (All Determinands) 2002. The Environment Agency's annual survey for 2003 reports little change in river quality nationally from the 2002 data above used in this analysis here. A slight improvement in biological quality (70% of rivers classified as of 'good' biological status) was offset by a small decrease in chemical quality (65% classified as of 'good' chemical quality). See www.environment-agency.gov.uk/ggaresults	

A1.1 Nutrients and Eutrophication in lakes

The costs arising as a result of nutrients and eutrophication are significant and cover a wide range of impacts.

Based on the recent study by Pretty et al (2001)[25], we estimated the total damage costs of eutrophication as being between £58 – 94 million annually. These damage cost estimates do not include health costs to humans, livestock and pets; nor impacts in saline waters. We made the following adjustments to Pretty's estimates. We excluded impacts on drinking water treatment costs to remove nitrogen on the grounds that these are covered in the groundwater category. Also we did not include Pretty's estimates of revenue losses for commercial aquaculture, fisheries, and shellfisheries to avoid the risk of double counting with the impacts on fishing and fisheries of poor water quality (see below). We also excluded monetary impacts on lost tourism revenues, since these regional changes may just be a displacement from another area or type of tourism rather than a welfare loss as such and the impacts on welfare should be captured in the recreation benefits valuations.

While eutrophication affects both standing water (lakes and reservoirs) and rivers, the estimates of damage calculated in Pretty et al apply mostly to standing fresh waters (assumed at 80% of total damage value). Thus we consider that any risk of double counting in the impacts on recreation is effectively minimised by the fact that the eutrophication costs apply mainly to lakes and reservoirs, whereas the other costs apply mainly to rivers and canals. In aggregating for total damage costs we have included only the damage cost estimate for lakes, to reduce risk of double counting. This is estimated at between £45-73 million per year (£2004/5)

Contributions from Main sources

Eutrophication is caused from increased nutrient discharges to water bodies. Phoshorus (P) is the main pollutant associated with the water industry, which causes eutrophication. The widespread use of agri chemicals and the spreading of manure is a major contributor. Current evidence suggests that agricultural sources of pollution account for about 70% of nitrogen; 50% of phosphorus and the majority of silt pollution in UK waters[26]. The Agency estimates that agriculture's contribution is

[25] JN Pretty, CF Mason, DB Newell and RE Hine (2001) *A preliminary Assessment of the Environmental Damage Costs of the Eutrophication of Fresh Waters in England and Wales*, report prepared for Environment Agency. This latest report by Pretty for the Agency has correctly focused on estimating and valuing the environmental damage costs and benefits. It does not include any estimates of control costs as a measure of benefit. It might be worthwhile updating the findings of this study.

[26] Defra (2004), Developing Measures to Promote Catchment-Sensitive Farming: A joint Defra-HM Treasury Consultation

approximately 45% (£20m - £33m pa) with other diffuse and point sources of pollution contributing 5% (£2 - £4m).

A1.2 Informal Recreation from Poor Water Quality

An estimate of the informal recreation costs of current river water quality was made in the WRC/WFD report on the implications of the Water Framework Directive for UK water management.[27] It is based on the benefits of improving water quality in all rivers up to the RE2 standard. The estimates of the numbers of visitors/users of rivers and their WTP for informal recreation were taken from the Foundation for Water Research (FWR) manual[28].

The WRC/WFD's methodology was applied to the data on water quality in rivers in England and Wales (Table C2) to derive the total potential benefit from upgrading all rivers (in England and Wales) to RE2 and to RE3. It does not include potential benefits of upgrading river quality above RE2 (ie to RE1) – and hence may underestimate the damage costs of current river quality.

However, extrapolating benefit valuations for recreation for marginal improvements to achieving good quality in all rivers may overestimate the benefits as there may be limits to the extent to which such increasing recreation opportunities could in fact arise at all rivers and in how much people would be willing to pay for them. On balance, therefore, we consider that Table A1.4 presents reasonable estimates. The values estimated capture leisure visits but exclude angling and boating, which are captured in the eutrophication category.

Table A1.4 Informal recreational benefits from improving river quality in England and Wales

	Improve all rivers to RE2	Improve all rivers to RE3
Length of river below RE3	6351 km	6351 km
Length of river at RE3	6886 km	0
Total length of river	13237 km	6351 km
Trips/Km/year	7500	7500
£/person/trip for rivers changing from RE4 and below	£0.84 (1)	£0.701(1)
£/person/trip for rivers changing from RE3	£0.138(1)	0
Benefits from river improvement from RE4 and below ((£mn 2004/5 prices)	£40m pa	£33.37m pa
Estimated benefits from river improvement from RE3 to RE2 (£mn 2004/5 prices)	£7m pa	-
Total (£mn pa 2004/5 prices)	£47.12m pa	£33.37m pa

Source: Adapted from Table 11.100 WRC & Oxera (1998) (WRC/WFD). See also Annex A Section 3.1.
Notes: (1) Prices converted from 1995/6 prices to 2004/5 using GDP deflator.
River lengths calculated from Table A2 above

The greatest benefits per trip and per kilometre of river are found when improving quality in the worst rivers. The marginal benefit of improvement declines as river quality improves up to RE2, although there may be high marginal benefits of achieving very high quality rivers, which are not captured here. The total annual benefits of improving river quality in all rivers to RE2 and RE3 are estimated to be about £47million and £33million pa respectively, and provide an indication of the damage costs (benefits foregone) of current river quality.

Contributions from Main sources

[27] WRC and Oxera (1998) *Potential Costs and Benefits of Implementing the Proposed Water Framework Directive* for DETR
[28] Foundation for Water Research (1996): Assessing the Benefits of Surface Water Quality Improvements (FWR Manual), December 1996.

The pollutants contributing most to the deterioration of current river quality are ammonia, phoshorus and BOD. The Agency estimates that about 20% of ammonia failure is due to the agricultural sector, with the balance accounted for by water companies. It is estimated that agriculture contributes between 30-50% and so the share of the damage costs of current water quality in terms of informal recreation is estimated to be £10m-£23m. Other diffuse and point sources contribute 10% which is £3-£5m.pa

A1.3 Impacts on Fishing

We used the study by Spurgeon et al 2001, which calculated values for maintaining current angling opportunities at coarse and game fisheries of £2.86-£3.67 per trip. Multiplying the total annual trip numbers affected by the potential improvements in water quality by these values gives approximately £71m pa for the potential angling benefits for improving river quality or the potential angling costs (in terms of foregone benefits) from current water quality. We have used conservatively this estimate in our estimation of the environmental damage costs from current water discharges and abstractions.

Contributions from Main sources

The Agency estimates that the water industry contributes between 40 and 70% of these impacts on fishing, partly due to the impact downstream of sewage treatment works. We estimated that agriculture contributes 20 to 50% (14-£36m pa) and other diffuse and point sources contribute 10% (£7m pa). This will include the impact of diffuse urban run off.

A1.4 Impacts on Amenity and economic wellbeing

The quality of the water environment enhances regeneration and sustainable economic activities such as tourism. There are examples of such benefits in both urban and rural areas – such as the Manchester Ship Canal, or the beaches of the South West. The impact and linkages are however difficult to quantify and value. But these are important benefits from general environmental quality improvements and we argue that these can be captured through looking at the enhanced riparian property values associated with in improved water environment. Poor environmental quality conversely leads to lower property values.

Impacts of changing water condition on amenity value have been calculated on a bottom up approach, from properties alongside each stretch to be improved under PR04

We estimated the total value of benefit expected from PRO4 at about £14.6 million per year[29]. These benefits arise from investments made by the water companies, and at present they are thought to reduce the water companies amenity impacts by about 50% - slightly greater than the reductions in other environmental damages. The water industry is estimated to contribute 50-70% of amenity environmental damages. The total damage costs (benefits foregone) can therefore be estimated on a *pro rata* basis, as around £49 million per year. The damage is mainly visual loss predominantly in urban areas. Other diffuse and point sources are likely to figure quite highly and certainly more than agriculture, with problems such as fly tipping and surface oil. There may be some algal blooms caused by agriculture. The Agency estimates that agriculture contributes 10% (£5m pa) and other sources contribute 20-40% (£10m-20m).

A1. 5 Bathing Water Quality affected by Water Pollution

The damage costs were estimated as a combination of WTP to reduce the risks of stomach illness, plus the direct economic costs of output foregone as a result of gastric illness associated with bathing. The WTP to reduce risk were derived from Eftec (2002).

[29] as at 21st August 2003, final values may be subject to modification as inputs are finalised

The Eftec 2002 damage cost for all beaches is £2.53/household per year (2002 prices); updated to 2004/5 prices this becomes £2.7 per household per year, or £65 million per year. In addition, the indirect costs attributable to illness and loss of earnings as a consequence of intestinal disease have been estimated at £50.7m pa (at 2004/5 prices). For this analysis, a value £65 million per year was used.

Contributions from Main sources

Contamination derives from water company discharges, agriculture, urban run off and birds. While the causes will be location specific, the Agency estimates that overall the contribution of the water companies lies between 30-60% [30], or between £20 – £39 million. The contribution from agriculture is estimated to be 35 to 65% (£23-42m) and from other sources it is 5% (£3m pa).

A1.6 Impacts of poor quality groundwater

Much more empirical research is needed on the value of groundwater resources and the value of the impact of water pollution and abstraction on groundwater, especially since studies in other European countries have demonstrated the high importance of impacts on groundwater.[31].

Box A.1 (prices are in 2002 prices) below reports a study for Defra [32] which found that water companies' expenditures on water treatment from all sources include about £303m pa on removing nitrates and pesticides and reducing risks associated with *cryptosporidium* along with a number of other parameters. Around a third of drinking water is abstracted from groundwater sources, and so it is assumed that the costs are divided pro rata (£100m)[33]. There are also the treatment costs for private abstractions from groundwater. We assume here that the total private treatment costs £25m pa[34].

We use these figures to provide an estimate of the value of the impact of water pollution on groundwater at £125 million per year. This is likely to be an underestimate as:

- it may not adequately take account of the cost of finding and establishing new groundwater sources when existing ones are lost to pollution;
- it does not take account of the added operational costs caused by the reduced flexibility for managing supply abstractions, and
- it doesn't include estimates for the non use values attached to groundwater.

The value of the impact of poor water quality on groundwater is likely to rise significantly in the future as the scarcity of groundwater sources increase. Pollution of groundwater may mean that it can no longer be used as a source of water for drinking or other uses. If it is not possible to treat then the abstractor will need to find an alternative source. The cost of this includes the cost of the new infrastructure etc needed to access the new source etc. This increasing scarcity of groundwater is highlighted by a study for UKWIR by the British Geological Survey [35](BGS 2004).

Contributions from Main sources

Given the two components above we are conservatively estimating that the costs of water pollution on groundwater sources are £125m pa, of which the water industry is responsible for 10-20% [36] (or about

[30] This estimate is consistent with the Agency's estimate for the water companies' contribution to poor water quality (see Section 2.2).

[31] Chegrani, P (2005) Evaluer Les Benefices Envrironnementaux sur les Masses d'Eau. Ministere De l'ecologie et du developpement durable. D4e Unit. Series D'etudes 05 – E08.

[32] Assessing current levels of cost recovery and incentive pricing, ERM, Stone & Webster for DEFRA May 2004

[33] Discussions with Tim Besien (Environment Agency)

[34] Discussion with Tim Besien (Environment Agency) and Nigel Crane (Environment Agency Groundwater Policy Advisor)

[35] British Geological Survey (2004) Implications of Changing Groundwater Quality for Water resources and the UK Water Industry: Phase 3 – Financial Impact. Report for UKWIR, the Environment Agency and the British Geological Survey. It reports that about 2800 ml/d of supplied water is currently affected by groundwater pollution. This represents 54% of the total amount of water supplied from groundwater. They estimate that the quantity of water supplies affected by water pollution could double by 2029, which would raise costly issues in terms of seeking alternative supplies and increasing costs of treating polluted water. They estimate that future capital costs to manage the impact of groundwater pollution are likely to be of the order of £200m for successive AMP periods (ie about £40m pa). There would be increasing operating expenditures possibly reaching £150m pa by AMP8 (ie by 2029).

[36] Discussions with Tim Besien (Environment Agency)

£13-25pa). Other sources are responsible for the remainder (£100-112m) of which the main source is agriculture, which we estimate is responsible for about £50-88m m pa (40-70%) of these costs in 2004 prices. It should be stressed that there is a lot of uncertainty regarding the estimates of the impacts of poor groundwater quality and but we believe the above are conservative estimates. It is important to note that there are no estimates for the non use values attached to groundwater. Much more research is needed in this area.

Box A.1 External water treatment costs in England and Wales in 2002 Prices

Water companies' expenditures on water treatment include about £303m pa on removing nitrates and pesticides and reducing risks associated with *cryptosporidium* along with a number of other parameters. About £211m of these costs are attributable to agriculture. These represent external financial costs incurred by the water companies to treat pollutants from other sectors, most notably agriculture and other diffuse sources of pollutants, who do not pay for these costs.

Estimated annual costs in 2002-03 of external impacts on raw water quality (£m pa 2002-03 prices)

	Annual Costs borne by water Company customers	%contributions due to agriculture	Total annual remediation attributable to external sources
Capital Costs			
Nitrates	14.4	80%	11.5
Pesticides	78.3	89%	69.7
Other parameters	108.6	50%	54.3
Cryptosporidium	23.3	90%	21.0
Sub Total	224.6		156.5
Operating Costs			
Deteriorating raw water quality	70.4	67%	47.4
Cryptosporidium	8.3	90%	7.5
Sub Total	78.7		54.9
Total	303.4	70%	211.4

Source:

ERM, Stone & Webster. Assessing current levels of cost-recovery and incentive pricing, DEFRA, May 2004

Pretty, J.N. et al (2000). An assessment of the total external costs of UK agriculture. Agricultural Systems, 65, pp 113-136.

Due to rounding, some figures may not add correctly.

The annual water treatment costs excluding the cost of treating pesticides is £155m. This is an underestimate because the operating costs of treating deteriorating raw water quality (£70.4m per year) have been removed. This will involve treating nutrients as well as pesticides. It has not been possible to allocate these operating costs between pesticides and nutrients.

A1.7 Impacts of water pollution and low flows on river ecosystems and natural habitats

Water Quality

We used the Willis and Garrod (1994) value of £0.00217 (2004/5 prices) per household per km per year, for a change from medium (RE3) to good quality (RE2/1) to value the damages (as benefits foregone). For a change from below RE3 (poor) to RE3 (medium) the figure is £0.0065 (2004/5 prices) per household per km per year.

Based on the lengths of river of poor, medium and good quality before the impact of PRO4 the value of benefits foregone can be calculated. See table A1.5.

Table A1.5 Calculating damage costs of current water quality for ecosystems and natural habitats (2004/5 prices)

Length of river below RE3	6351 km
Length of river at RE3	6886 km
Total length of river	13237 km
£/household/km changing from below RE3 to RE3	£0.0065
£/household/km changing from RE3 to RE2/1	£0.00217
Cost of poor ecosystem and natural habitat conservation in poor rivers (below RE3)	£870 million
Cost of poor ecosystem and natural habitat conservation in moderate rivers (below RE2)	£315 million
Total 'non-use' value of poor water quality	£1,185 million
Source: Willis and Garrod Note: 21.07m households	

The estimates in table C4 relate only to current water quality. They do not include the potential benefits of upgrading those rivers that are currently below RE3 to RE2/1. It only estimates the benefit of upgrading these rivers to RE3 – and hence may underestimate the damage costs of current river quality (the benefits foregone of upgrading these rivers from RE3 to RE2/1 is £290m pa (6351 km x £0.00217 x 21.07m). On the other hand, extrapolating benefit valuations for achieving good quality in all rivers may overestimate the benefits since there may be limits to the extent to which such benefits could in fact arise at all rivers and in how much people would be willing to pay for them. Jacobs (2002) have identified and analysed the challenges for the valuation of such non-use benefits and sets out a long term strategy for the Environment Agency to improve gradually their valuation so as to aid decisions on measures. On balance, we consider that table A1.5 are the best estimates that are currently available and represent reasonable lower estimates.

Low flows

There are estimates in the literature for the benefit accruing from reducing the risks of low flows in all rivers in England and Wales. Using ERM & Willis (1993) it is possible to calculate an overall figure. The CVM survey in this study asked respondents for the willingness to pay for low-flow alleviation on all 40 rivers identified as low-flow rivers nationally[37], and the total willingness to pay can be calculated as about £115 million per year (2004/5 prices), almost all of which relates to non-use impacts on natural habitats. A more recent study[38] (in 2002) valued the low flow alleviation benefits at the river Mimram in the context of a programme of measures to tackle all low flow rivers in the Thames region. This gave similar valuations to Willis' earlier study.

Therefore we estimate that the total impacts on natural habitats and ecosystems of current river quality and flows amount to about £1303m pa (1185+115). The above estimates are based on the values given by Willis and Garrod's national studies. The values from a study by Georgiou et al (2000b)[39] are 56% lower. Therefore we have divided the above upper bound estimates by 56% to give a lower bound estimate of £730m pa..

Contributions from Main sources

Water companies have been identified as being the significant source in 24 (or 15%) out of the 164 sites, for which there is evidence of a problem of damage to a key natural habitat site. There are possible links with water company abstraction and discharges in a further 89 cases (or about 54%). Thus water companies have been identified as a source of the damage in nearly 70% of these sites. Water company abstractions are estimated to account for 76% of the abstractions causing

[37] At the time of that study (1993) a total of 40 rivers had been identified by the Agency as having low flow problems. Now, in 2000, some 500 sites have been identified for reduced abstraction related to low flows – it is not clear how these 500 sites relate to the 40 rivers

[38] Jacobs (2002) River Mimram Low Flow Alleviation Public Preferences Study: Final Report. Reprot to the Environment Agency.

[39] Georgiou, S., Bateman, I., Cole, M., and Hadley, D., 2000b. 'Contingent Ranking and Valuation of River Water Quality Improvements: Testing Scope Sensitivity, Ordering and Distance Decay Effects'. CSERGE Working Paper GEC 2000-18.

environmentally unacceptable low flow problems at rivers in England and Wales. We have therefore estimated that water companies contribute about 60-70% (£439m-912m pa) of the ecosystem and natural habitats impacts for wetlands and rivers affected by poor water quality and low flows. The other major contributor is agriculture with an estimated share of 25-35% (£183-456m). Other sources therefore contribute 5% (£37-65m).

A1.8 Impacts of water pollution and low flows on wetlands ecosystems and natural habitats

In addition, we estimated the benefits of PR04 in reducing damage caused by abstraction and water pollution for ecosystems and natural habitats at wetlands as being about £19.5 – 41m pa. If PR04 reduces the water industry's damage by 60% (which is in line with the reductions in the water industry's impacts on natural habitats and ecosystems at rivers), and using the estimate that the water industry is responsible for about 60% of such impacts on ecosystems and natural habitats, then the current total damage to ecosystems and natural habitats at wetlands is estimated to be about £51 – 112m pa.

Contributions from Main sources

In line with the analysis above, we have estimated that water companies contribute about 60-70% (£31-79m pa) of the ecosystem and natural habitats impacts for wetlands and rivers affected by poor water quality and low flows. The other major contributor is agriculture with an estimated share of 25-35% (£13-41m). Other sources therefore contribute 5% (£3-6m).

Annex 2. Comparison of the updated estimates with the figures cited in Professor Allan Buckwell's presidential address to the AES 2005

The totals quoted here for the environmental costs and benefits of agriculture use many of the sources quoted in Professor Buckwell's paper (Whitby and Adger (1996); Pretty et al (2000); Hartridge and Pearce (2001); Environment Agency (2002); Eftec/IEEP (2004)). The estimates here are derived from the majority of these sources. For example virtually all of the air emissions figures in the Environment Agency report are from Hartridge and Pearce.

Table A2.1 presents the figures from the studies cited in Professor Buckwell's paper and adds a column for the estimates in this paper for comparison. The economic analysis for PRO4 provided a more recent in depth study of water pollution and low flows for the revised EA figures and this produced significantly greater valuations than the previous studies. Our revised EA air emission figures use the figures from Eftec/IEEP except for carbon dioxide emissions. The significantly higher damage costs from soil related issues is accounted for by the inclusion of carbon dioxide emissions due to the cultivation of soil and the contribution of poor soil structure/erosion to flooding.

Table A2.1 Updated Estimates of environmental effects of agriculture (£m pa)

	Pretty *et al*	Hartridge & Pearce	Environment Agency	Eftec/IEEP	Revised EA figures
	1990-1996 at 1996 prices	1998 data at 1998 prices	2000 data at 2000 prices	2003 data at 2003 prices	2004 prices
Environmental Costs					
Water	231	428	203	470	476-927
Air	1113	585	760	956	583-1959 mid 1052
Soil	96	21	264	9	120-219
Waste				15	
Environmental Benefits					
Landscape				488	498
Habitats and species				740	544
Carbon sink					415

Annex 3. Recent update of the damage cost figures in the Environment Agency 2002 Report "Agriculture and Natural Resources: Benefits, Costs and Potential Solutions"

All prices below are in 2004 prices unless otherwise stated.

The figures from *Agriculture and Natural Resources: Benefits, Costs and Potential Solutions* Environment Agency 2002 have been updated in the light of new evidence.

The new analysis improves on the EA 2002 report figures by:

- Providing estimates of the values held for certain water pollution and low flow damage categories (see Annex I) previously unquantified including:
  - -valuations held by people for impacts on water ecosystems and natural habitats .
  - -impacts on recreational and amenity caused by inland water pollution.
  - -impacts on groundwater of poor water quality
- Providing damage cost values based on more up to date physical air emission figures and more up to date unit damage cost figures.
- Providing more recent water industry treatment costs.

In the EA 2002 Report the total environmental damage cost from agriculture in the UK was estimated at £1365m per year (2004 prices). The total reported here ranges from £1221m to £3056m per year in 2004 prices.

Table A3.1

£ million per year	Environment Agency 2002 In 2000 prices	Updated 2005 In 2004 prices
Water	203	476-927
Air	760	583-1959 (central figure of 1052)
Soil	264	120-219
Total	**1227**	**1221-3056**

As can be seen from table A2.1 the main difference between the figures is attributable to the significantly larger numbers for water and air. The figures for air are taken from the Eftec Report . . The only new analysis provided by the updated work is the work for the water damage costs.

A3.1 Costs of poor water quality and low flows from agriculture

The analysis of the damage costs of water pollution and low flows was completely replaced by new evidence and analysis of valuations of environmental benefits from the economic analysis of the environment programme in the water industry Periodic Review 2004. See Annex 1 above for details.

A3.2 Costs of Air emissions from agriculture

The EA 2002 Report cites Hartridge and Pearce 2001[40] as the source for all the air pollution damage cost estimates except for ammonia. Hartridge et al use Netcen 1997 figures for the annual quantity of emissions. The main advantage of the figures in the Eftec 2004 *Framework for Environment Accounts for Agriculture* report is that it uses more up to date Netcen figures (2001).

[40] "Is UK Agriculture Sustainable? Environmentally Adjusted Economic Accounts for UK Agriculture" Olivia Hartridge and David Pearce Nov 2001.

A3.3 Costs of Soil erosion, poor soil structure and soil cultivation

Table A3.2 Soil Impacts

Soil Impact	£m pa 2004/05 prices	Source
Off site costs	9	EA2002report
CO2 emissions due to cultivation	82	EA2002report
Contribution to flooding	29 to 128	Evans(1996) and EA2002report
Total	**120 to 219**	

The EA 2002 Report includes the following damage costs for poor soil structure and soil erosion:
- On farm cost (wind and water erosion) £9m (source Evans 1996)
- Off site cost mainly including dredging stream channels £9.17m with £8.68m attributed to agri (95%) . (Source Evans 1996)
- Carbon loss £82m from Pretty et al 2000 (from the cultivation of soil)
- Poor soil structure contributing to flooding £128m

It does not include the following under soil damage costs:
- The cost to the Agency in restocking rivers for fish. Soil particles in rivers will contribute to fish deaths. This cost is included in the water pollution cost.
- The increased water treatment cost from removing soil particles. This is included in the cost of eutrophication (It is in the figure for Phoshorus £21.17m). It was not possible to remove soil particle removal from phosphate removal drinking water costs

The Eftec 2004 Report cites Evans et al 1996 and includes the following soil damage costs:
- off site cost of soil erosion to be approximately £9.37m (mostly the cost of dredging of stream channels). 95% (they cite EA 2002 Report) of this is attributed to agriculture to give £8.98m 2004 prices. It is market cost using local authority data. It includes damages to roads and property (£4.1m), footpaths (£1.21m), traffic accidents (0.101m), and most significantly channel degradation from soil erosion of all causes.

The Eftec 2004 Report does not include:
- On site costs. They are not external and are covered in the existing agriculture accounts and so are not explicitly shown in the environmental accounts.
- The loss of carbon dioxide from soil erosion is under the air emissions section of the Eftec 2004 Report.

Neither of the reports have data, which would allow the welfare losses and gains from improvements or degradations to soil as a natural asset to be assessed.

The updated figures do not include the on site costs since these costs are not external to agriculture. It was decided to continue to use the EA 2002 Report figures for the off site damage costs and the loss of carbon. Both the EA 2002 report and the Eftec 2004 report both quote the same figure for the off site damage costs.
The Eftec 2004 Report has more up to date figures for the annual cost of flooding. They use market data for the UK provided by the Foresight Report (Evans et al 2004) giving the total cost of flooding at £1.14b. They copy the approach of the EA 2002 Report and assume 14% contribution from agriculture giving £156m. The report does however find a general absence or uncertainty of the impacts of land management practices and recommends further research in this area.
The estimate for soil is likely to be an underestimate because soil erosion contributes to other damage categories such as groundwater impacts, phoshorus leaching etc.

Annex 4 Policy Baseline Scenario

Summary of Key Existing Policies Targeted at Environmental Improvement:[41]

Cross Compliance

The single farm payment scheme replaced most existing crop and livestock payments from January 2005. In order to receive full payment farmers need to meet three sets of requirements (otherwise known as cross compliance):

- Maintenance of land in good agricultural and environmental condition (GAEC), including a requirement for soil management and protection. This includes 3 national soil management standards which apply from 2005:
  - Post-harvest management of combinable crops to ensure that the land is not left bare. Restricted activities on water logged soil.
  - Overgrazing and supplementary feeding controls, preventing destruction of natural vegetation and soils.
  - From 2006 farmers will have to draw up a risk-based soil management review dealing with soil problems on their holding, erosion, run off, etc, and these will be put into effect from 2007.
- Member states are required to maintain 2003 levels of permanent pasture.
- Statutory Management Requirements (SMRs). These relate to domestic provisions derived from EC directives. The environmental SMRs that relate to Diffuse Water Pollution from Agriculture (DWPA) include:
  - Groundwater Regulations 1998, Regulation 19.
  - Sewage sludge - The Sludge (Use in Agriculture) Regulations 1989 (as amended in 1990) which implement EC Directive 86/278/EEC
  - Nitrate Vulnerable Zones Council Directive 91/676/EEC (discussed below).

In Wales, although there are similarities with the cross-compliance arrangements in England there are some subtle differences, particularly the requirement for a soil risk assessment proforma to have been completed by 28th February 2005 (rather than soil management plans which are required in England).

In terms of the future, cross compliance will be reviewed in 2008/09 with any changes from the current format applicable from 2012. It is possible that a nutrient management plan could become a requirement under cross compliance in the future.

Environmental Stewardship Schemes

A new suite of Environmental Stewardship schemes is in the process of being implemented in England and Wales. They again have the potential to tackle DWPA. In England it is envisaged that the new schemes will double the level of expenditure on environment stewardship from its current level of approximately £155 million within the next few years (Defra 2005). Key features of the Entry Level and Higher Level Stewardship schemes are:

- Entry Level Stewardship (ELS) is a voluntary scheme open to all farmers and land managers to encourage simple and effective environmental management beyond that of cross-compliance / legislative requirements. ELS started in March 2005 and has a wide variety of options available, some of which are useful in tackling DWPA. There will be indication of scheme take up in October 2005 Current predictions are that 43,000 ELS agreements will be signed in the first year and that 60% of farmed land will be covered by agreements in 2007. (Further details are provided in Annex 1).
- Organic ELS is very similar to ELS, but is only open to those that have some or all of their land registered as organic.

[41] Details of regulations and policies discussed in this section can be found on the Defra website www.defra.gov.uk

- Higher Level Stewardship (HLS) aims to deliver significant benefits in high priority areas. The scheme is voluntary but there will be no automatic acceptance onto the scheme and the funding will be limited (i.e. it is discretionary).

In Wales, similar initiatives have also been progressing, particularly the existence of Tir Gofal (like HLS) and the development of proposed new schemes such as Tir Cynnal (like ELS) and consideration of adding Higher Tier Catchment Sensitive Farming measures within the Rural Development Programme (RDP). Together they cover management of nutrients and waste and help to safeguard natural resources, including habitats, soil and water.

Tir Cynnal for example places considerable emphasis upon resource management, including a requirement for farmers to produce management plans for nutrients (including manures), soils and pesticides/sheep dip. There will be a requirement that at least five per cent of the land will be 'habitat' (which will need to be protected), but this can include watercourses and their banks, as well as suitable hedges.

Environmental Opportunities Reviews and waste audits available via Farming Connect aim to assist farms in identifying business opportunities relating to environmental assets and scope for making cost savings by more efficient use of inputs.

Higher Tier Catchment Sensitive Farming practices are currently being piloted in two demonstration areas, notably Deepford Brook (an intensive dairy area) and part of the Tegid catchment (an upland beef/sheep area). The approaches adopted in these areas include incentives to protect water from the potentially damaging effects of sedimentation, nutrients and pesticides. It is hoped that participation will also encourage the farming community to implement farming methods that deliver better water quality, whilst also tackling diffuse pollution. The whole demonstration will be used to promote good practice more widely across Wales and inform the development of future policy.

Rural Development Regulation (RDR)

The European? Council Regulation on support for Rural Development from the European Agricultural Fund of Rural Development (EAFRD) was agreed by Ministers at Agriculture Council in Luxembourg on 20th June 2005.

It will replace the current Council Regulation 1257/1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF), under the second pillar of CAP from 1st January 2007. The RDR is implemented in England through the England Rural Development Programme (ERDP) and it is estimated that this will have provided £1.6bn in support over the programme period 2000 to 2006. The priorities for the next programme period (2007 to 2013) will be determined by a consultation period.

The RDR is designed to:

- Enhance opportunity and tackle social exclusion in rural areas;
- Protect and improve the rural, urban, marine and global environment, and to lead integration of these with other policies across government and internationally;
- Promote sustainable, diverse, modern and adaptable farming through domestic and international actions.

The new regulation includes:

- the establishment of a special fund (EAFRD), separate from the normal CAP mechanisms, with simpler financial rules;

- a requirement for European and national strategy documents;

- four priority axes for spending (**axis I** agricultural and forestry competitiveness; **axis II** land management; **axis III** wider rural development and **axis IV** LEADER, a horizontal delivery mechanism), with detailed measures under each axis;

- the requirement that a minimum of 25% of community support for each rural development programme to be spent on Axis II, and a minimum of 10% to be committed to Axis I and III;

- Axis IV significantly strengthens the role of LEADER (funding for local action groups in rural communities) within rural development programmes with a minimum spend of 5% needing to be spent through the LEADER approach.

Environmental objectives - the UK consistently argued for 50% minimum expenditure on the land management measures of Axis II, this was not achieved but the 25% was maintained whilst the percentages on all other Axis decreased. Support of the Water Framework Directive was also introduced to the regulation.

Commission proposals for the **EU Rural Development Strategy** are expected in the coming months. The proposed strategy will contain targets and indicators for rural development expenditure and will help steer the development of Member State programmes.

Nitrate Vulnerable Zones (NVZs)

The Nitrates Directive seeks to reduce or prevent the pollution of water caused by the application and storage of inorganic fertiliser and manure on farmland. It is designed both to safeguard drinking water supplies and to prevent wider ecological damage in the form of the eutrophication of freshwater and marine waters generally. The programme is applicable in 55 per cent of England and 3 per cent of Wales.

Current Action Programme:

- Closed Periods: The following Table highlights the periods when fertiliser may not be applied to the land

Fertiliser Type	Arable	Grassland
Manufactured Nitrogen Fertiliser[1]	1 Sept – 1 Feb	15 Sept – 1 Feb
Organic Manures[2]	1 Aug – 1 Nov	1 Sept – 1 Nov

Notes: 1) on all soil types; 2) restriction for slurry and poultry manures on sandy and shallow soils only. August application allowed as a crop requirement

- Nitrogen Limits: The following Table highlights the nitrogen limits for both Arable and Grassland

Fertiliser Type	Limits
Manufactured Nitrogen Fertiliser	Not exceed RB209 recommendations
Organic Manures	Whole farm with 210 kg/ha total N.[1] 250 kg/ha including grazing deposition Field Limit 250 kg/ha total N excluding grazing deposition. [2]

Notes: 1) reduces to 170 kg/ha after the first four years of Action Programme in NVZ; 2) available N from organic manures must not exceed crop requirement

- Spreading Controls:
  - No application of nitrogen fertiliser or organic manures when the soil is: waterlogged; or flooded; or frozen hard; or snow covered.
  - No application of nitrogen fertiliser or organic manures to steeply sloping fields.
  - Spread nitrogen fertiliser and organic manures evenly and accurately.
  - No application of nitrogen fertiliser in a way that contaminates watercourses.
  - No application of organic manures within 10 metres of watercourses.

- Slurry Storage

There must be sufficient storage to meet the autumn closed period for spreading slurry. In addition all new or substantially enlarged/reconstructed storage facilities must complywith the relevant regulations (SSAFO REGS).

- Record Keeping

Adequate farm records must be kept for at least five years covering cropping, livestock numbers, and the use of nitrogen fertilisers and organic manures.

- Future Developments

The Action Programme is currently under review with any changes applicable from mid 2006. Possible changes include:

- Expansion of designations in England (would be from 2007).
- Extending the closed period when manures high in nitrogen cannot be applied to all soils
- Extending manure classification to other types of manure
- Setting a 170kg/ha limit regardless
- Compulsory nutrient management plans for N]
- Increased storage requirement for slurry

CSF Officers and other DWPA advice

The Catchment Sensitive Farming initiative will provide a comprehensive supportive approach to tackling diffuse pollution, particularly with the establishment of a network of Catchment Sensitive Farming Officers (CSFOs). CSFOs will be in place from April 2006 until March 2008 (this period may be extended subject to funding). The exact way of working and what they will do has not been agreed yet, but it is thought that they will target high risk catchments and engage in 1:1 advice provision targeting some 4000 to 5000 farms per annum.
A 3-year pollution minimisation advice contract (called 'Environment Sensitive Farming') providing seminars, workshops and farm demonstrations to improve the understanding of diffuse pollution amongst farmers and to encourage improved management practices. This started in March 2005, and is administered by ADAS.
A key element of Welsh Farming for the Future strategy is the Farming Connect farm advisory service. Working with partners, the service highlights the need for care for the environment to be an integral part of day to day farming activities. At present there are discussions for the development of similar initiatives in other areas of the UK.
Under the new CAP & RDR reform provisions, Member States are required (by 2007) to set up a Farm Advisory Service (FAS) to provide advice to farmers on land and farm management. The details of the FAS are still the subject of discussion but careful consideration will be given as to how the new advisory service will inter-relate with the existing Farming Connect initiative in Wales, and other structures in England.

Other advisory support is available via Rural Development Service, Fertiliser Companies, EA and other bodies on sustainable farming practices. Their impact is difficult to quantify.

Waste Framework Directive

Defra has consulted on and will bring into force early in 2006 Regulations to repeal the current exclusion of agricultural waste from national waste management controls and to apply to it the requirements of the Waste Framework Directive. The classification of manure and slurry as waste, and its consequential control under the Waste Framework Directive, were among the issues raised during engagement with stakeholders and consultation. However, in a recent judgement by the European Court of Justice (C-416/02), it was held that livestock effluent falls outside classification as waste:-

(a) If it is used as a soil fertiliser and:-
(i) that use is part of a lawful practice of spreading; and
(ii) the spreading takes place on clearly identified parcels of land; and

(b) If its storage is limited to the needs of those spreading operations; and

(c) Furthermore, to fall outside classification as waste it is not necessary for livestock effluent used as fertiliser to be spread on land forming part of the same agricultural holding as that which generated the effluent

The IPPC Directive

The Integrated Pollution Prevention and Control Directive applies, amongst other things, to the intensive indoor farming of pigs and poultry. The Directive is implemented through the Pollution Prevention and Control (England and Wales) Regulations 2000. Under these regulations, the EA issues permits to farmers on the basis that they adhere to certain conditions, which include:

- staff training on the environmental effects of farm practices;
- notifying the EA of incidents such as manure over-application;
- minimising manure pollution from livestock housing using best available technologies (BAT);
- devising manure management plans.

The scope of the IPPC Directive does not cover outdoor pig and poultry farming which accounts for about 30% of the pigs and poultry sector.

Water Abstraction

The Water Act 2003 requires all forms of irrigation that abstract $20m^3$ water in any period of 24 hours to be licensed. This means that in addition to spray irrigation used by farmers which is already controlled, all non-spray irrigation – mainly trickle irrigation - will now require a licence. However, the new licensing regime has just de-regulated 20,000 or more currently licensed abstractions (mainly by farmers) that are below the new water abstraction licensing threshold.

The inclusion of trickle irrigation within the regulatory system will improve the Environment Agency's (EA) ability to manage the water resources of a catchment. This is particularly important for the implementation by the EA of the Catchment Abstraction Management Strategies (CAMS) Programme and the need to meet the requirements of the Habitats Directive

A consultation on the changes to the licensing system introduced by the Water Act 2003 was launched in the summer of 2005. There will also be a separate consultation on transitional regulations required to make and determine applications for transitional licenses to abstractors being brought into the system following the removal of exemptions.

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