In Search of a Sustainable CAP: Assessing the Environmental Impacts of Agricultural Policy

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ABSTRACT

Agricultural policy can have a major influence on the environmental impacts of agriculture. As farming is a major land use in European Union (EU) these impacts can be significant and widespread. A scoring technique has been developed by the University of Hertfordshire to assess the significance of these impacts in relation to sustainability. This technique is presented in the context of a framework to assess the impacts of agricultural policy. Effect-damage functions, indicators and targets are used and the spatial scale is taken into account to produce a policy performance profile. This is accompanied by an indicator of the quality and confidence of the assessment. The method is able to determine where trade-offs exist between different environmental objectives (e.g. nitrate leaching vs. ammonia emissions) and takes into account local and regional environmental sensitivities. The method has potential to be a valuable tool in the development of a greener Common Agricultural Policy (CAP). It may also have potential to support the targeting of agri-environment programmes which can be of both environmental and economic benefit.

Introduction

Agriculture can have a significant impact on the environment (Skinner et al. 1997). This can be widespread as farming is a major land use across Europe. For example in the UK agricultural land constitutes about 76% of the total land area (MAFF et al. 1997) and Europe as whole has 43% of its land in agriculture and 74% if the wooded area is added into the equation (EUROSTAT, 1996). Agriculture is strongly influenced by policy (Weaver et al. 1996), particularly the Common Agricultural Policy (CAP) and also Directives such as the Nitrates Directive (Official Journal of the European Communities, 1991). If land use is to become sustainable across Europe it is important that the implementation of policy takes full account of the likely environmental impact. This should be the case for any policy, including those which aim to solve an environmental problems, such as the Nitrates Directive, as it would undesirable to solve one problem at the expense of creating or increasing another. In the European Union, since the late 1980's there has been debate about introducing a new directive that would address the environmental impacts of policies, known as Strategic Environmental Assessment (SEA). This debate was reinitiated in 1995 and a draft Directive is expected to be published in the Official Journal in 1997 (Baxter & Sadler, 1997). In Canada a method has already been developed to assess the impacts of agricultural policies (Campbell, 1996). Any programme enacted under the Farm Income Protection Act (1991) requires an environmental assessment of the programme to be conducted within two years after coming into force and every five years thereafter. An example where this has been applied is the Environmental Assessment of Crop Insurance (Fox & von Massow, 1994).

This paper describes the development of an SEA method for agricultural policy by the University of Hertfordshire in collaboration with LEAF and Morley Research Centre.

Agricultural and Environmental Policy

The original objectives of the CAP set out in Article 39 of the Treaty of Rome were to increase productivity; to ensure a fair standard of living for the agricultural community; to stabilise markets; to assure food supplies; and to provide consumers with food at reasonable prices. In many respects most of these were met. However, by the late 1980s it was recognised that there were too many negative effects of the CAP, including food surpluses and in some regions negative environmental effects. As a result a reformed CAP was formally adopted in June 1992 and accompanying the reforms were agri-environment measures. These measures are comprised of a number of schemes which aim to pay farmers to introduce techniques and/or maintain systems of production which protect the environment, landscape and natural resources. However, the CAP is still having many regional effects with negative consequences. For example, one analysis of the reformed CAP indicates that it is not appropriate for the needs of rural Greece with significant social, economic and environmental costs associated with its application (Hondraki-Birbili & Lucas, 1997). Similarly, the adoption of CAP in Spain is causing traditional crop cultivations to be abandoned over large areas of central Spain with potential negative consequences for over-wintering seed-eating birds (Díaz & Tellería, 1994).

Consequently, there are calls for more regional targeting of policies which take account of local factors rather than universally applied policy across Europe (Hondraki-Birbili & Lucas, 1997; Baldock, et al. 1996). The regional targeting of EU agri-environmental schemes is already being explored (Morgan, 1997). It is also apparent in the implementation of the EU Nitrate Directive with the establishment of Nitrate Sensitive Areas or Vulnerable Zones (NSA/NVZ) in the UK (Osborn & Cook, 1997).

Cross-compliance is also often forwarded as a solution, whereby environmental conditions are attached to agricultural support measures, such as area payments (Baldock & Mitchell, 1995).

Sustainable development is another theme on the agenda of Europe of which agriculture and rural development are key issues. However, some argue that the CAP is not centrally concerned with promoting sustainable farming in Europe (Baldock et al., 1996). As a result there are calls for further reform of CAP. For example a statement by the European Environmental Advisory Councils calls on the EU and its member states:

- To work towards an integrated rural sustainability policy, incorporating sustainable development principles and delivered in such a way which sustains regional and local character.

- To incorporate environmental objectives explicitly at the heart of a reformed CAP.

- To shift significant resources from unconditional agricultural production support into the expansion of regional and local agri-environmental programmes to meet defined ecological targets.

- To ensure that farmers and land managers throughout Europe meet defined and measurable basic environmental standards of good practice, which reduce pollution, contribute to environmental enhancement and sustain critical natural capital.

- To investigate the re-orientation of EU funds and other instruments to achieve more environmentally sustainable land use.

- To use structural funds to support enhancement of areas where biodiversity and landscape features have been lost.

- To develop environmental indicators to monitor the progress made.

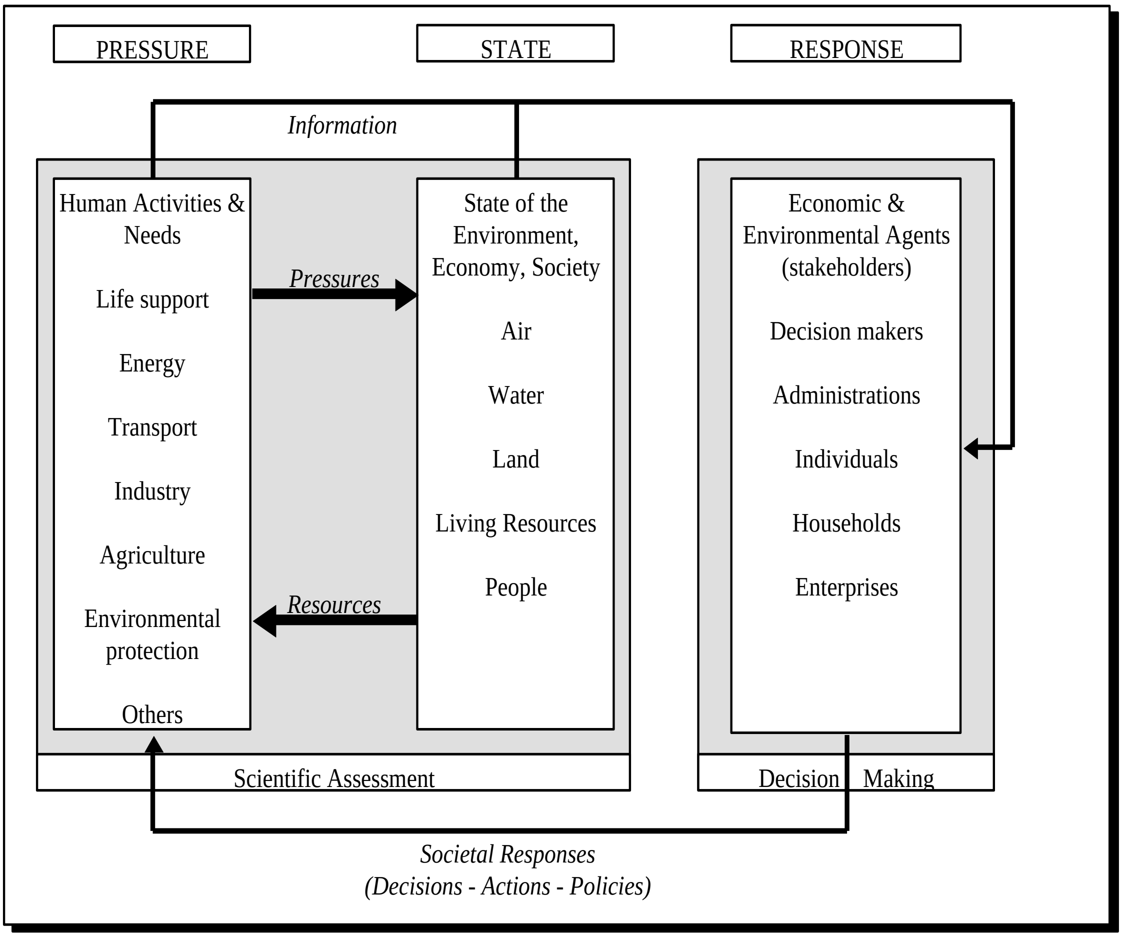
(English Nature, 1996)

In order for the CAP and other European Policies to evolve in a more sustainable direction, it is important that we have the correct tools for analysing the effects of policy. It is also important that this information is presented in a format that aids policy formulation. The method presented below aims to address these issues. Firstly, though, we need to establish what is meant when referring to impacts.

DETERMINING IMPACTS

The world we live in is complex and dynamic, it is a world of change in which any change can be an impact. The question is how do we determine what changes are impacts and whether they are positive or negative. We also need to understand the chain of environmental effects that result from specific human activities in order to identify the cause of identified impacts. To help explain these issues the OECDs (1994) Pressure-State-Response (PSR) Framework has been adapted and is presented in Figure 1.

Figure 1. Adapted Pressure-State-Response Framework



(adapted from the OECD, 1994)

Figure 1 is a simple representation of the complex and dynamic processes that are at work. There are many human activities (on the left) which have effects that exert pressure on the environment, which in turn may change the state of the environment. The scientific community can analyse and assess this process and provide information about these pressures and the state of the environment. This information, however, is then open to interpretation by the different stakeholders in society (on the right of fig. 1). Clearly, if a change affects someone values and interests to a substantial degree then that change may be perceived as a significant impact, and if it is detrimental to those values and interests then it is a significant negative impact. Thus, an important influence on impacts is how they are perceived, which is very subjective. For example, a farmer may view crop damage as more important than damage to hedgerows or woodlands, due the economic interest. Alternatively, a degree of crop damage may be accepted to protect hedgerows and woodlands, e.g. leaving buffers strips untreated with agrochemicals. It depends what value the farmer places on those hedgerows and woodlands.

When a change is viewed as a negative impact this might bring about a response by the individual or society as a whole. In this instance the responses of interest are policies and their associated instruments. The implementation of policies may in turn bring about further changes which could be viewed as either negative or positive impacts.

At a European level the number of potential impacts is vast. In order to ensure that an impact assessment is of a manageable size, it may be necessary employ a degree scoping. Scoping is essentially a process of reducing the potential number of impact areas to a size that can be handled. It can be a very subjective process (Beanlands, 1988), thus it is important to ensure that it is undertaken in the most explicit manner possible to avoid any bias or perception of bias.

What constitutes a significant impact. As mentioned above, an impact is often only perceived if it affects an individuals interests or something that they value, thus it is very subjective. However, if we can divorce this subjectivity from the issue, it is possible to assess significance scientifically. If environmental damage can be recognised scientifically and free from any values then significance in relation to this damage can be assessed. This is enhanced if science can also provide some indication as to critical levels of damage or thresholds of sustainability, i.e. what level of damage is sustainable in the long-term. An important aspect of this approach would be the ability to take account of regional sensitivity to specific problems. For example, different regions and rivers will vary in the sensitivity to nutrients and eutrophication.

There are a number of different areas where uncertainty arises and therefore needs to be handled and expressed. These include:

- uncertainty due to a lack of understanding about environmental processes. Figure 1 shows that there are numerous activities exerting pressure on an environment that can be extremely complex. For example, nutrient emissions can arise from sources other than agriculture, such as sewage treatment facilities, and the flow of those nutrients through the environment can complicated, especially in the case of groundwater.

- The measures that we use to observe the environment all have a an inherent degree of uncertainty. The view of world that we construct through science is of variable resolution and understanding. We cannot observe and measure everything, therefore we base our understanding on the measurements we can make and extrapolate a view. It is essential, therefore, that the measurements upon which decisions are based, represent the closest view to what the real situation is. However, in many instances due to the size and complexity of the environment many of the measurements available can only be classed as indicator measures. Relatively small in number and sometimes technically simple, these measures are representative of large environmental components or processes with their reliability based on scientific understanding. It is essential that the inherent uncertainty involved in using such measures, which are often highly aggregated, is taken into account.

- Further uncertainty is incorporated due to the variable levels of understanding with regard to critical levels of damage and what is sustainable.

The main problems that need to be addressed are:

- how to determine what environmental components or problems are important enough to be monitored for an impact; and

- what to measure

- how to determine what is a scientifically significant impact in terms of the environmental damage being done to an environmental component and/or region.

- handling and expressing uncertainty

The SEA Method (SEAM)

The method is composed of three phases, detailed below, and has an underlying confidence assessment system (CAS).

I. Derivation of Performance Criteria
II. Measurement and Characterisation
III. Impact Assessment

Phase I is essentially a scoping exercise to generate an appropriate set of impact categories, termed performance criteria. These will form the end categories by which the environmental performance of the policy will be presented. Phase II is a process of generating an appropriate set measurements for each of the performance criteria. In some instances data may also need to be processed in some manner, for example in calculating Global Warming Potential (GWP), thus characterising the impact. Phase III uses the data generated from measurement and characterisation in conjunction with effect-damage relationships and target values to generate a score for impact significance. This is completed for each of the performance criteria to generate a performance profile for the policy.

The CAS operates in the background throughout the method to take into account areas of uncertainty. It produces profiles of the overall quality and confidence in the assessment. The CAS is necessary due to problems that are inherent in environmental assessment such as incomplete data sets, qualitative data, poorly documented data, uncertainty as to the causes of effects, the damage that arises and what levels are safe or sustainable. Such information is assessed and conveyed by the CAS in order to improve the decision making process. The CAS is only briefly described as it is not within the scope of this paper to provide full details of its mechanism.

Phase I. Derivation of Performance Criteria

In any environmental assessment a scoping exercise is normally carried out to determine what potential impacts to concentrate on and which can be left out. In EIA expert judgement is used to determine whether a potential impact merits full investigation based on consideration of the likelihood of a significant impact occurring. In some instances it may not be possible to determine whether an impact will occur or not. As we cannot measure everything everywhere (Suter, 1990), a second phase of scoping is often initiated and areas are prioritised according to their perceived societal value and those which have little or no value are scoped out. This is a subjective process (Beanlands, 1988) and ultimately relates to how much individuals and society value something to justify its inclusion in an assessment (and justify the cost). The geographical locality of an impact is also an important factor as different impacts can be identified at different spatial scales. For example, noise is an impact at the local level whereas ozone depletion is an impact at local, national and global scales.

Consequently, values of stakeholders in any environmental assessment are often incorporated when judging impact significance. So for example noise may be more significant than global warming to local stakeholders who are directly affected by it. However, it is important not to confuse value with significance. Significance should be related to the amount of damage caused by an effect regardless of the value of the area under consideration. Values may be used to determine that it would be a positive impact to reduce noise and a negative impact to increase greenhouse gas emissions. But they should not be used to say that reducing noise levels by 50% is more significant than reducing greenhouse gas emissions by 50%. It is dependent on individual values and interests. The significance of the impacts that occur in these two areas should be related to the level of noise and the level of global warming regardless of value or priority.

The aims and objectives of a policy are key aspects for deriving performance criteria. One technique is to correlate aims and objectives of policy with performance criteria. This can be done by creating a matrix of policy objectives against performance criteria. Table 1 demonstrates this approach using objectives of the CAP set out in Article 39 of the Treaty of Rome in 1957.(Table 1)

Table 1. Performance Criteria Matrix for CAP

CAP Objective (1957)	**Performance Criteria**				
	Agricultural productivity	Standard of living	Market Stability	Food supply stability	Affordable food
1	✓			✓	✓
2		✓			
3			✓	✓	
4				✓	
5				✓	✓

1. to increase productivity
2. to ensure a fair standard of living for the agricultural community
3. to stabilise markets
4. to assure food supplies
5. to provide consumers with food at reasonable prices

As can be seen in Table 1 many of the objectives overlap, such as market stability and food supply stability due their inherent link. Judged by these criteria the original CAP probably performed well, especially in terms of agricultural productivity. However, what is lacking are other objectives, such as environmental objectives. How well did the CAP perform if the objectives of reducing greenhouse gases and water pollution are added. Table 2 demonstrates the type of criteria that would be generated with the addition of these environmental objectives.

Table 2. Environmental Performance Criteria Matrix

Policy Objective	**Performance Criteria**				
	Global Warming	Eutrophication	Air Quality	Biodiversity	etc.
1	✓				
2		✓			

1 = to reduce greenhouse gas emissions
2 = to reduce water pollution

Tables 1 and 2 adopt a similar principle to that developed by the Department of the Environment (1994a) in their policy impact matrix.

The next issue to address is what aims and objectives should be used to generate the performance criteria to be used in the assessment of the policy. This is where the subjectivity can become incorporated. Are only a few policies used to generate performance criteria or are a range of policies to be used in order to get a full spectrum of possible impact areas. Another important aspect spatial scale. Different objectives can operate at different scales, as indicated by International Treaties, European Directives, National Policy documents, County Structure plans and Local plans. Essentially, there are two possible approaches:

1. select a group a policies to derive a set of performance criteria; or
2. use a full set of performance criteria for the assessment.

In the first instance policies may not represent all societal values and interests, thus biasing the assessment towards a particular set of values and interests. In the second instance the problem of time and resources required for the assessment arises if a large number of measurements are necessary for the broad range of performance criteria. The second approach is more precautionary as any possible impact will be assessed and decision makers can be confident that all the issues have been examined.

PHASE II. MEASUREMENT AND CHARACTERISATION

It is important that the measurements used are correlated to the performance criteria and that the resolution is appropriate (Baylis, 1997). Table 3 illustrates a matrix that can be constructed correlating performance criteria to specific measurements at different spatial resolutions.

Table 3. Measurement Matrix

	Global Warming	**Eutrophication**
Local	CO_2, CH_4 , N_2O emissions, Global Warming Potential (GWP), Fossil fuel use, etc.	Nutrient levels in surface waters, Biological Oxygen Demand (BOD), etc.
Regional	"	% of watercourses algal blooms recorded.
National	"	"
European	"	"
Global	"	% of ecosystems eutrophic

In the instance of global warming the type of measurements available does not vary from the local to the global levels. However, in the instance of eutrophication measurements at the local level can be more detailed and of a different type to those at more regional or global levels. This is because the measurements such as nutrient levels are only relevant to the local level due to different local sensitivities, thus the measures are there to assess whether there is actually a eutrophication problem. Whereas to measure eutrophication at more regional, national or global levels requires a measure that indicates the extent of the problem.

There are two types of indicators, those which are low resolution but provide an adequate representation, and those which do not directly measure the area of interest but represent it by association or are correlated via an established relationship. These can be split into Pressure and State indicators (OECD, 1994). State indicators measure the condition of the environment. For example determining soil fertility through a small number of soil samples or from vegetation present or previous cropping. Indicators of pressure correlate specific humans activities to environmental damage they are known to cause. For example Nitrogen (N) fertiliser use (pressure) correlated to damaging biodiversity (state).

In some instances it may also be appropriate to aggregate measurements to aid the quantification of an impact, known as characterisation in LCA. SETAC (1993) clearly point out that this step should be based on scientific knowledge about environmental processes. An example is the aggregation of emissions of greenhouse gases via their conversion on to a an index of global warming potential (GWP), based on the cumulative radiative forcing between the present and a defined time horizon (Houghton *et al.* 1995).

PHASE III. IMPACT ASSESSMENT

Allocation (Cause-Effect Relationship)

It is essential when assessing the performance of the policy that its contribution to an effect is identified and evaluated. This is a process of allocating effects to causes. However, many effects have multiple causes, for example eutrophication does not only result from agricultural activity, there may be other contributors such as sewage plants. Identification of the cause of an effect is not necessarily straight forward, it may involve correlating trends in environmental parameters with an identified effect using techniques such a factor analysis. For example, Reisenhofer *et al*. (1995) used factor analysis to determine that nitrate fertilisers were the main cause of eutrophication in a temperate lake in Italy with a secondary factor being the whole biomass and thereby productivity of the lake. Here the contribution of the policy to an effect is expressed as a percentage and is based on current understanding of the processes involved.

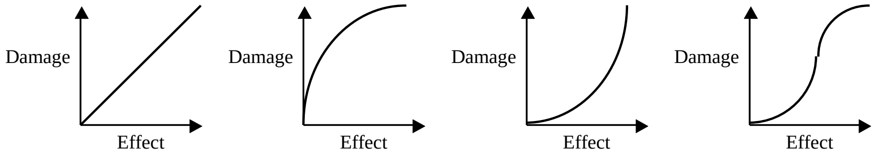
The process of allocation is important when searching for solutions to problems. If an activity is known to be the main cause (e.g. 90%) of a problem then clearly it is a target for improvement. However, if an activity is only a small contributor (e.g. 10%) it should not be ignored. That 10% could be critical in making difference between sustainable and unsustainable. Additionally, it could be an activity that is easily changed with little economic cost. This idea of critical points is explored below when determining impact significance.

Impact Significance

The approach developed attempts to address this issue by developing a numerical scale of significance. It is derived from an technique known as the distance-to-target approach developed by the Dutch National Reuse of Waste Research Programme (NOH, 1995) for use in LCA. In this technique an effect is correlated with the amount of environmental damage it causes, for example levels of heavy metals (effect) and ecosystem impairment (damage). A target level of damage is then used as a means of scoring the current level using an index in which units are set as multiples of the damage at the target level. A similar approach is used in Dutch Environmental Performance Indicators (EPIs) (ENDS, 1994a) and in the construction of Environmental Pressure Equivalents (Hammond *et al.*, 1995). In the method described here there have been a number of adaptations to this approach.

Firstly, NOH (1995) use a standard sigmoidal curve as a model in toxicology for the relationship. However, in reality the actual effect-damage relationship is largely unknown and may take any mathematical correlation. Consequently, the curve may take any shape as shown in Figure 2.

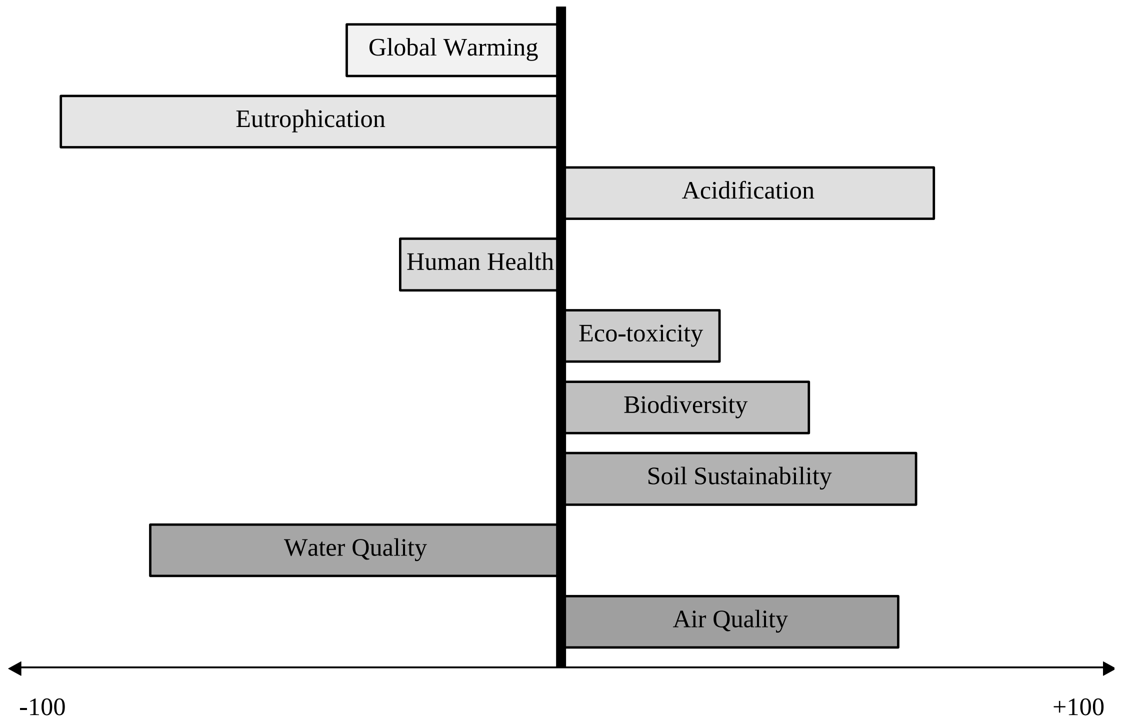
Figure 2. Examples of Hypothetical Effect-Damage Relationships



Secondly, the amount of damage is not scored in multiples of the target level, but on an index of damage in the following manner. A target level and maximum level of damage are identified and the distance between them is divided into 100 equal units of damage. Current (or pre-policy) and post-policy levels of damage are identified and the distance between these two points represents the change that has occurred. This change is scored in units of damage and assigned a negative or positive value according to increased or decreased damage.

This process is carried out for all the performance criteria and a performance profile is constructed. This can be considered the environmental 'fingerprint' of the policy and as the impacts are presented on a common scale of significance, this profile can be represented graphically, as shown in Figure 3.

Figure 3. Performance Profile



Note: representational

Although, Figure 3 is hypothetical, it allows the immediate identification of those impacts (positive and negative) which are most significant. It also shows the true trade-offs by relating them to their significance, such as a trade-off between water quality and acidification (nitrate leaching and ammonia emissions). It is important to note that the although the distance between maximum and target levels of damage is set at 100 units for all types of damage this does not mean that different types of damage can be equated. For example, 50 units of global warming is not the equivalent of 50 units of eutrophication. It simply means that the impacts have been equally significant in the context of the different types of damage caused. Types of damage may be very different and judgements between types is subjective.

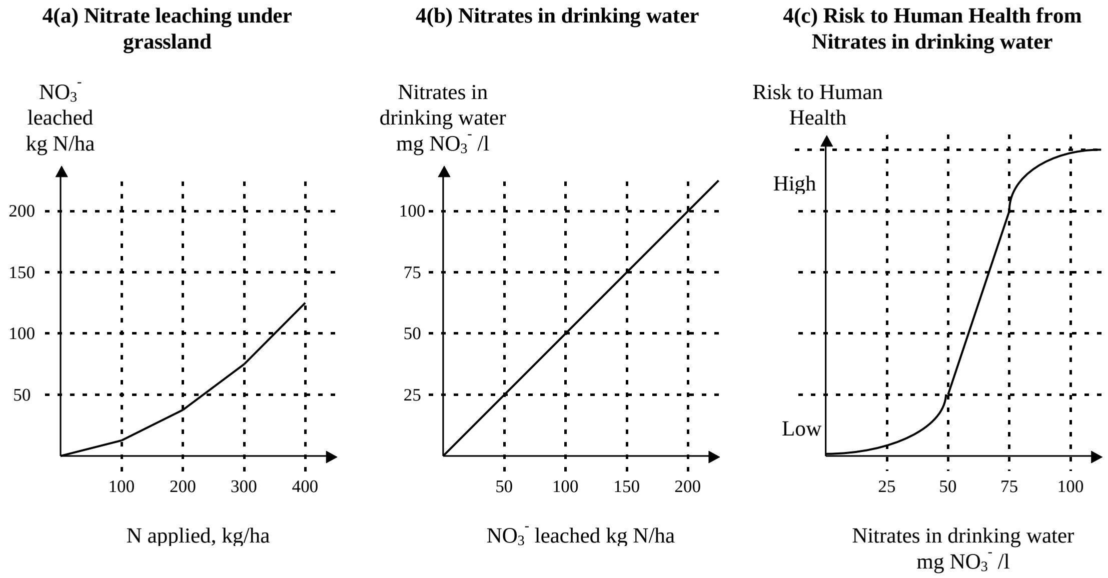
An additional advantage of this approach is the ability to assess progress towards sustainability. If the target levels used in the scoring system are based on what is considered to be sustainable a current status profile can be created. If the target level is given a score of 0 and the maximum damage level is given a score of -100, the current status can be scored and a profile created. If all scores are negative then progress still needs to be made. Any zero or positive scores indicate that the performance criterion has reached a sustainable level. Theoretically, sustainability is reached when all scores are zero or above. It is important that the scores are not added or averaged to give one score. This might imply a false degree of sustainability if the single score is zero or above when there is a negative score in one or more performance criteria. *Sustainability is like a chain, it is only as strong as its weakest link*. Such *weak links* can be hidden if scores are aggregated.

Two aspects of this approach require further discussion. These are the effect-damage relationship and the maximum and target levels of damage, as these can greatly influence the performance profile.

Effect-damage relationships

The establishment of effect-damage relationships is important here and for the wider understanding of the impact of human activities on the environment. However, such relationships are rarely simple. There can often be a chain of effects and processes between a stressor (effect/pressure) and a receptor (state/damage). For example, the use of nitrogen fertiliser (pressure) is correlated to issues of health, agriculture and wildlife (DOE, 1996). The relationship between N use and human health is examined below.

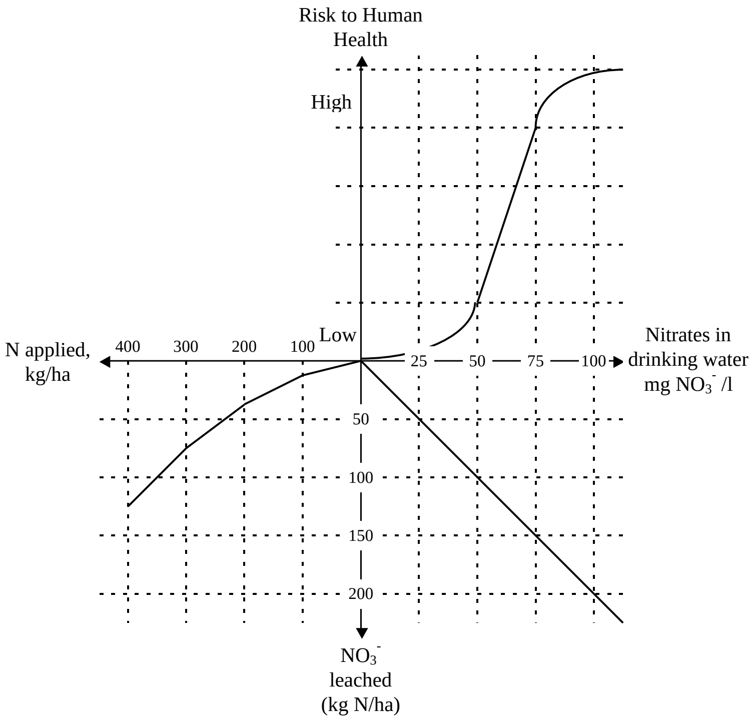
The primary concern of N use in agriculture and human health is the loss of nitrate via leaching, the increase in level of nitrate drinking water and the risk to human health that this poses. Figure 4 presents correlations between (a) N use and N leaching; (b) N leaching and nitrate in drinking water; and (c) nitrate in drinking water and risk to human health, based on information from Lord *et al.* (1993), Scott *et al*. (1992) and the Environmental Working Group (EWG) (1996) respectively.



Note: created for illustrative purposes only.

These three graphs can be combined to correlate N use to risk to human health as illustrated in Figure 5.

Figure 5. Correlating Nitrogen (N) Use to Risk to Human Health



It is then possible to define an effect-damage relationship between N use and risk to health by extrapolating the scale of risk onto the scale of N use. Figure 6 illustrates this process in which defined points on the scale of risk are traced back through the various relationship to identify points on the N use axis, thus extrapolating the N use-risk to human health relationship, which is more conventionally illustrated in Figure 7.

Figure 6. Extrapolating the "N use - Risk to human health" relationship

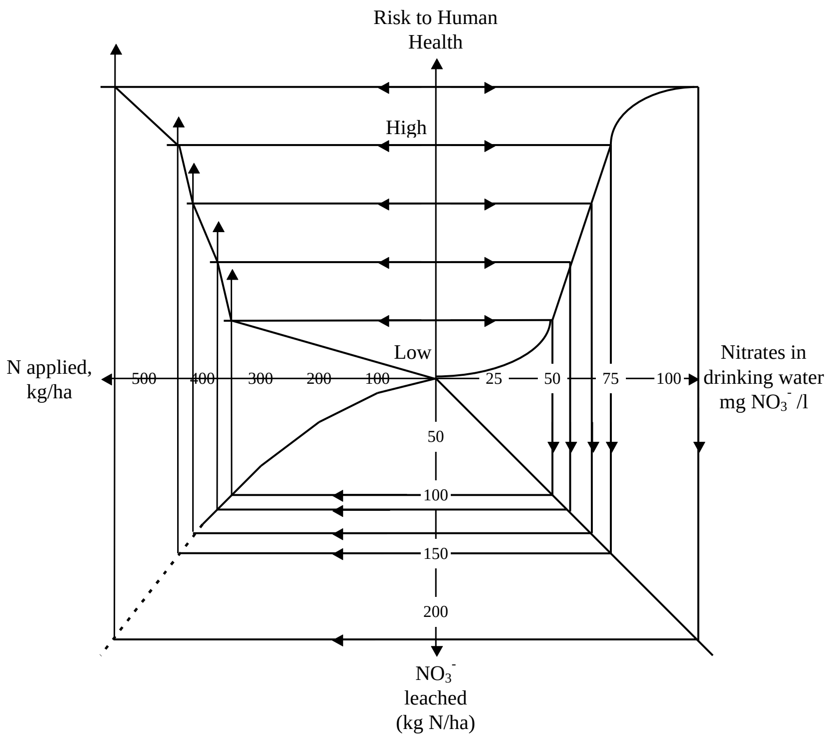
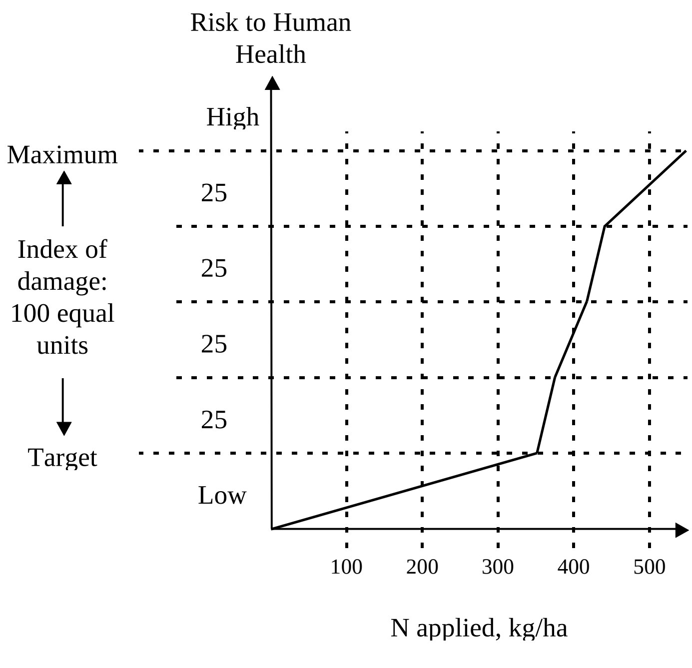


Figure 7. Relationship between N use and risk to Human Health



Policy cannot change what level of nitrate in drinking water represents risk to human health, neither can it change the influence the effect of nitrate leaching has on the level of nitrates in drinking water. However, policy can change the level of nitrate fertiliser use and influence the level of nitrate leaching. It is important, therefore, to be able to identify the critical point at which N fertiliser starts to rapidly raise the risk to human health.

The establishment of the relationship in Figure 6 has enabled the identification of a critical area of N use in relation to human health which can be expressed using the scoring system developed. In the hypothetical example, at up to 350 kg/ha the impact on human health is low and below the target level. Above 350 kg/ha the risk to human health greatly increases, indeed a change from 350 to 450 kg/ha would score -75, i.e. there is a significant negative impact. Whereas a change from 450 to 550 kg/ha only score -25. This is because the level of damage is already high at 450 and the increase in terms of risk to human health is not as significant as the change from 350 to 450 kg/ha. The method can also be easily applied to score the potential yield changes at the different N application levels for different crops, thus offering a trade-off between environment and production/economy.

However, there are number of important factors about the above relationships that need careful consideration. Firstly, in this instance the locality is highly important. The relationship between nitrate leached and nitrates in drinking water is highly dependent on the local geology and hydrological processes. Additionally, there are local factors that determine how much nitrate is leached in relation to amount of nitrogen applied. If the N leached to nitrate in drinking water relationship changes this will influence the level of N use that is critical to human health. This is already apparent in existing policy where Nitrate Sensitive Areas and Zones have been identified (NSAs & NVZs), thus taking account of local variation. The health risk posed by nitrate in drinking water is not affected by locality. However, it is important for determining a target level for scoring.

Target Setting

In terms of the environment, the target level should be based on scientific consensus of what is understood to be sustainable, although such consensus can be difficult to achieve. For instance, is the EU limit of 50 mg of NO_3^-/l in drinking water based on what is considered safe for human health ? In the USA the limit is 44 NO_3^-/l (10 ppm. NO_3^--N) and in Germany and South Africa it is 20 NO_3^-/l (4.4 ppm NO_3^--N) (Environmental Working Group, 1996). There is much debate about safe levels of nitrate, thus illustrating the considerations for target setting.

A great deal of work has been undertaken in the field of developing and setting Environmental Quality Standards and Objectives (EQSs & EQOs). For example, with regard to pesticides there are a number of statutory and proposed EQSs for pesticide levels to protect aquatic life (NRA, 1995). These would make legitimate targets for use in the method. An important point to note is that these standards relate to a specific issue, i.e. that of protection of aquatic life, and not to other issues such as safety of drinking water for which different values may be appropriate targets. This issue is particularly well illustrated in Department of the Environment Report on assessing the impact of contaminated land on groundwater and surface water (DOE, 1994b). A number of water quality standards are presented for use-related classes including: basic amenity and recreation; ecosystems; different fisheries; abstraction for potable supply; industrial and agricultural abstraction; irrigation and livestock watering. Similarly, target setting has to take into account the spatial scale. Sustainable levels of damage will be influenced by the sensitivity of the local environment, local critical loads and carrying capacity of ecosystems.

THE CONFIDENCE ASSESSMENT SYSTEM (CAS)

The issue of data quality and confidence is increasingly important in environmental assessments (Sadler & Fuller, 1997). LCA is a good example where studies have been undertaken to assess the environmental impact of a particular product, but different organisations using different data sets have produced contradictory results (ENDS, 1994b & c). The scientific approach is to undertake a statistical analysis to verify and assess the quality of the data. However, Constanza *et al* (1992) point out that frequently in environmental assessments there are insufficient high-quality measurements for the presentation of the statistical uncertainty. Hence, there is a demand for a mechanism that will represent the uncertainty (confidence) in the absence of a conventional statistical approach.

One approach is to develop a scoring system for scientific quality. Such an approach has been used in medical assessments (Margetts *et al*. 1995) and is also suggested as a solution in LCA (SETAC, 1994). Constanza *et al*. (1992) also use a scoring system to communicate scientific quality of environmental information. The approach taken in this method awards scores to qualitative descriptions of the data and to the level of scientific understanding. The confidence and quality of the following areas are assessed.

- Primary Data Quality
- Aggregation (loss of information)
- Confidence in Cause-Effect Relationships
- Confidence in Impact Significance

It is not within the scope of this paper to provide full details of the CAS, these can be found in other publications (**? Tzilivakis et al., 1997 ?**). The end result of the CAS is a profile of the four areas above scored on a scale of 0-100, where 100 is high quality/confidence. This profile is presented, along with the performance profile, to a decision maker who then judge whether the quality/confidence of the performance profile is acceptable to be used in decision making. It may also identify where areas are inherently uncertain, e.g. cause-effect relationships, across all environmental assessments. Thus rather than discarding the information due to low confidence in one area, the decision maker accept that this area is always uncertain and may choose to use the information anyway employing a degree of precaution as is necessary. Therefore, decisions can be made with more information about how good the understanding behind them is. It is about making the most informed decision in an uncertain world.

DISCUSSION

Economic growth, stability and sustainability in pursuit of improving standards of living have been the principle objectives in society and, as illustrated in the 1957 CAP objectives, there was little environmental concern until recent decades. Environmental concerns are now more prominent societal issues and in 1992 we had both the reform of CAP introducing agri-environmental measures, and the Earth Summit in Rio de Janeiro, which laid the foundations of sustainable development. These two examples illustrate the emergence of a new philosophy, in which economic and environmental sustainability are inherently reliant on each other. This is more of renaissance rather than a new philosophy. It should be no surprise that even in our *advanced* modern world that our long-term well-being relies on the well-being of the environment around us, as has always been the case not only for man but for all life.

An important issue is the translation of common objectives at the European and Global level into actions in specific nations, regions and localities. Agenda 21 recognises that sustainability will be achieved at the local level environmentally and socio-economically. The reason for this is what is sustainable will vary from one location to another. Environmental transformations, carrying capacity, critical loads and sensitivities will determine the damage that arises as a result of human activity, in this context agriculture. Standards of living, values and interests will also vary, and what is acceptable in one location may not be in another. Thus, if we are to assess the significance of impacts we need to take these factors into account.

In many instances the impacts of agriculture are locally significant, for example air quality, water quality, landscape, etc. A local impact will be determined according how sensitive the local environment is. For example, the level of nutrients in a local river that will result in eutrophication. The regional or national significance of these impacts will depend on the distribution and frequency of the local impacts at that spatial scale, e.g. the percentage of a nations rivers observed and eutrophic. This perspective is important not only to ensure that environmental problems are resolved, but also to ensure that regulation is not enforced needlessly and thus more economically. In many respects this type of structure has already emerged to some extent, for example in the use of environmental designations such as NSAs, ESAs, SSSIs, etc., where regulation is in place based on the environmental sensitivity of the location. In the European Union (EU) it is recognised that agri-environment programmes need to be integrated and targeted towards regions. For example, the University of Stuttgart is developing a methodology for landscape analysis to define zones where agri-environment programmes should support land use compatible with environmental targets for these zones (Morgan, 1997).

In other instances it is not the location that is important but the type of activity. Some activities give rise to effects that are of more regional, national or global significance, for example emissions of ammonia or greenhouse gases contributing to acid rain and climate change respectively. In this case policies need to address the causes of such effects and formulate policy and regulation appropriately. In the instances where agriculture is not the sole cause of an effect, e.g. greenhouse gas emissions, policy should be formulated so that the costs of regulation and change are shared proportionally amongst all contributors to the effect. It is likely that some contributors to a problem will find is costly to make the smallest of changes whereas others might make substantial differences at the same cost. However, the regulation must at a level that can be withstood economically by both individuals and an industry as whole, thus being economically sustainable.

The implementation of policy can make substantial changes to agriculture and its environmental impact. Therefore, it is important that all aspects are taken into account including socio-economic and political dimensions, which are critical parts of sustainability. One of the most difficult issues to deal with is risk and the perception of risk. There are risks associated with intervention and non-intervention. The environment and economy are extremely complex and often highly uncertain. For example, in the 'nitrogen fertiliser use-risk to human health' relationship (Figures 3-6), the uncertainties vast. There are uncertainties in the relationship between nitrate applied and nitrate leached, between the amount leached and the amount that ends up in drinking water, and the level of nitrate in drinking water that represents a risk to human health. These uncertainties will affect the level of confidence that can be placed in scientific information which affects the perception of risks and thereby the decisions made about policy (Adams, 1995). The risks posed (environmental and economic) by intervention or non-intervention are interpreted further based on the individual interests and values of those affected. This subjective assessment is an important component for policy formulation (Ochert, 1997). The use of scored performance profiles can aid this assessment by mathematically attaching weightings according to different values and interests (VITO, 1995; Hemming, 1994). In this instance the perceptions of farmers and other stakeholders need to be considered in the design of a policy if it is to be successfully implemented.

In conclusion, the development of this new analytical tool has identified that sustainability needs to be at the heart of the CAP. This must involve incorporating environmental objectives alongside economic objectives. Mechanisms such as cross-compliance may be useful in the short-term, but in the long-term, the loss agricultural support measures may make cross-compliance obsolete (Baldock & Mitchell, 1995), so alternatives will have to sought. Additionally, in order to for more sustainable agriculture to evolve, the policies and instruments that are implemented must take into account the sensitivity of local receptors.

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intro

agriculture & environment in a European context
CAP - old and new
demand for an integration of economic and environmental objectives - sustainability - rural policy and sustainability
socio-economic - environmental objectives
policy
change
regional sensitivities/perceptions
impacts

work at UH
general - env. impacts of agriculture - EMA - scoring and ranking
origin of project - MAFF

Project

thorough review of existing methods
use best nuts and bolts to construct new method
therefore, may recognise some parts
design of policy
impacts at farm level - scale up to national level
what is an impact ?
change in relation to objectives only ?
what is significant ?
determined according to thresholds and criticality's - effect-damage relationships
what is sustainable ?
targets
the scoring system
aid to policy makers
hindsight easier than prediction - increase in uncertainty
uncertainty - conveyance to decision maker

what can be measured
indicators, activity-pressure-state.
activity-effect-damage

There are two factors that are important. These are that different regions have different environmental sensititivies and different people have different values and interests.

We live in a complex and dynamic world. There are many changes occurring many of which are the result of human activities and are thus defined as effects, e.g. agriculture can have an effect on the soil. Whether these effects are positive or negative depends on the objectives or values they are being compared to form a judgement. Effects become impacts when they change something in manner that is judged to be significant. For example, agriculture can have the effect of releasing nutrients into rivers. An impact may be said to have occurred if this effect results in high levels of eutrophication, on the basis that it is judged to be undesirable or unsustainable. However, different regions and rivers will vary in the sensitivity to nutrients and different people will perceive the problem of eutrophication differently in terms of its significance in relation to their own values and interests.

Policy formulation
aims and objectives
integration of objectives
sustainability

Impacts of Policy
what is an impact
chain of effect
activity-effect-damage
regional variations
perceptions/sensitivities

What is Sustainable
damage
criticality's - targets

The SEA Method (SEAM)

I. Derivation of Performance Criteria
II. Measurement and Characterisation
III. Impact Assessment

what to measure or look at
the significance of impacts

brief overview of CAS to avoid questions about coping with uncertainty