Chapter (non-refereed)

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them only, that the full rigours of the law should be visited.

What of the future? Agriculture is changing rapidly and will continue to change. Limits on production, first milk, then other commodities, will lead to a reduction of pressure on installations. The end of growing prosperity, and perhaps a fall in output, will mean less nitrogen, less slurry, and an easing of pressure. The landscape may begin to change, more trees, more non-farming enterprises, altogether less pressure from farming. At a time when the farmer is under great pressure which can only get greater, is this not an opportunity for those who share his concern for his environment to extend more firmly and recognizably a hand of friendship and co-operation and to temper the role of the policeman.

7 Reference

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The Cumbria environment – an overview

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Summary
The relationship between Cumbria and other administrative units in Great Britain is discussed in order to place the county in its general environmental context. The pollutants are then divided into 3 groups which operate on different scales as far as overall assessment is concerned. These groups are: general (eg acid rain), agricultural (eg pesticides) and local (eg quarrying). The environmental impacts are also separated into 3 groups which require separate treatment, ie environmental resources, wildlife conservation and amenity. The overall impact of the complex series of pollutants and their interaction with the environment require simplification through the process of modelling, in order to predict impacts through the county as a whole. A model is therefore proposed using the ITE land classification system, by which the relative importance of the pollutants could be assessed.

1 Introduction
The main purpose behind the paper is to emphasize that a framework is required to enable objective statements to be made, rather than a reliance upon intuitive judgements. An introduction to the Cumbrian environment is given first, followed by a discussion of the pollutants and leading finally to a proposed method for assessing relative impacts.

The counties as they appear on the map of Britain today are the result of a combination of geographical, historical, socioeconomic and, finally, administrative factors. Whilst they are not therefore defined by environmental criteria, they are very widely used for comparative purposes in studies where ecological factors are involved. Many counties contain widely different ecological zones which in some cases are closely interlocked, whereas in others they act as separate systems. Thus, wide lowland valleys in the uplands are integrated with the hill land, whereas in other cases a distinct lowland area has little contact with a mountain district nearby. The use of counties therefore presents an ecologist working on planning problems with some difficulties as, invariably, it is necessary to work with county boundaries because advice needs to be given within administrative units. The heterogeneous nature of many counties does make comparison difficult, but it is essential to place a county in its overall context in general environmental terms, as well as for planners to appreciate regions with similar problems to their own. Finally, the impact of pollutants must be considered within counties because adminiistrative decisions are made at this level.

In order to demonstrate the affinities of Cumbria, an analysis was carried out using data for land use in a similar manner to that described by Bunce (1984). Data were drawn from all the administrative units in Britain, ie counties in England and Wales and regions in Scotland. The analysis first separated the units into 2 main groups – those with predominantly lowland or southern land uses, ie arable and grass, as opposed to those with upland or northern characteristics, ie pasture or moorland. Within the upland series, the units were ranked according to the weightings attached in the computer (Table 1). Cumbria occupies a central position amongst this upland series, but is the most upland county in terms of land use in England and Wales. Thus, its planning patterns have in some respects more in common with Scotland than with the south. At first it was surprising that the Western Isles appeared as a close neighbour but, although the region

Table 1. Relationship between Cumbria and other regional administrative units

North Yorkshire	Units with a relatively high proportion of productive land
West Yorkshire	
Gwynedd	
Northumberland	
Dumfries and Galloway	
Grampian	
Durham	
Powys	
Cumbria	
Western Isles	
Strathclyde	
Shetland	
Tayside	
Borders	
Central	
Highland	Units with a very limited proportion of productive land
Orkney	

is not as mountainous as the Lake District, its northerly situation results in a similar matrix of moorland and productive land.

A feature of all these northern units is their heterogeneity. However, as the above analysis indicates, their affinities may be assessed according to the balance of land uses present within them. It is therefore necessary to examine the more detailed composition of the county. To this end, a variety of statistics are available on crops and broad grassland types from the statistical tables produced by the Ministry of Agriculture, Fisheries and Food (1984). A more detailed breakdown of the grassland aand moorland categories, as well as other ecological information on their distribution, is given by Bunce and Smith (1978). For the present purpose, a useful general survey of the major balance of environments within the county is given in Table 2. The surprising feature is the high proportion of intensively managed land, almost 50% – a figure which is confirmed by comparable MAFF statistics. At the outset of the preparation of this paper, it had been assumed that pollutants associated with intensive agricultural use would be minimal in Cumbria because of its upland nature. However, the above figures do not confirm this assumption, and emphasize the importance of objective assessments.

2 The pollutants

The variety and significance of the various pollutants are described elsewhere in the proceedings but, in order to define their overall impact, it is necessary to group them for analytical purposes, as shown in Table 3. General pollutants occur over large areas and therefore need consideration at the broadest possible scale, ie at the scale of a whole kilometre square, as specified below. An essential feature of impact analysis is that even these widespread pollutants need modification by individual site factors. Any system of impact assessment needs a framework whereby both scales can be considered together – the basic reason for the modelling process proposed below. The second group are the agricultural pollutants, which operate at a level involving significant areas, say over 80%, of the kilometre squares. Their separation from the third group of local impacts is arbitrary with, for example, silage being relatively localized whereas sewage, on the contrary, is often more widespread. However, the separation provides a convenient framework for the analysis of systems, and separate impacts need to be specified in any modelling exercise. In addition, there are certain unique point sources of pollution, whose origin is known and which require quite separate studies – as typified by the British Nuclear Fuels plc site at Sellafield.

The Table has been separated into 3 columns because the impact of pollutants is quite separate and the groups are in many cases independent. The environmental category includes renewable resources, such as soil, which may be affected reversibly, or irreversibly, by pollutants. Wildlife needs a separate category, partly on theoretical and partly on aesthetic grounds. Although the 2 aspects are often associated, they may be independent; for example, erosion may lead to loss of agricultural land but may not significantly affect wildlife populations, whether of plants or animals. Amenity invariably concerns visual features

Table 2. Comparison of estimates of principal land uses from the GB and Cumbria survey, the background to which is explained in the text

	GB survey	Cumbria	
	%	km²	%
Cultivated	26.6	2399	33.7
Inbye	18.0	1230	17.3
Upland	31.6	2475	34.8
Other	23.7	1008	14.2

Table 3. Separation of pollutants into 3 broad categories and suggested disaggregation of impact areas, with principal coincidences

	Environment (resource)	Wildlife	Amenity
	General (at 1 km² level)		
Acid rain	+	+	
Industrial	+	+	+
Specific chemicals	+	+	
Erosion	+		
	Agricultural (forestry)		
Eutrophication (including slurry and fertilizers)	+	+	+
Herbicides	+	+	+
Pesticides	+	+	+
Silage	+	+	+
	Local		
Waste disposal		+	+
Sewage	+	+	+
Quarries			+
Waste reclamation	+		+
Verge spraying	+	+	+
Garden sprays		+	
Litter			+

and is therefore harder to define, often being dependent upon perception. For example, fertilizer bags may have no pollution effect, although they are visually intrusive. Separate impact statements are, therefore, required for each of these categories.

3 A method for impact assessment

Although very detailed information is available about the way pollutants act, as can be seen from the proceedings of this conference, there is no study of Cumbria as a system. The work carried out at the ITE Merlewood Research Station on land classification techniques provides a framework whereby such an assessment can be made. An outline for a possible procedure is given below which could form the basis of future work.

The report by Bunce and Smith (1978) classified all the one kilometre squares in Cumbria into 16 strata, termed land classes, on the basis of environmental data. From these classes, a relatively small number of samples, in this case 48, were drawn as representa-

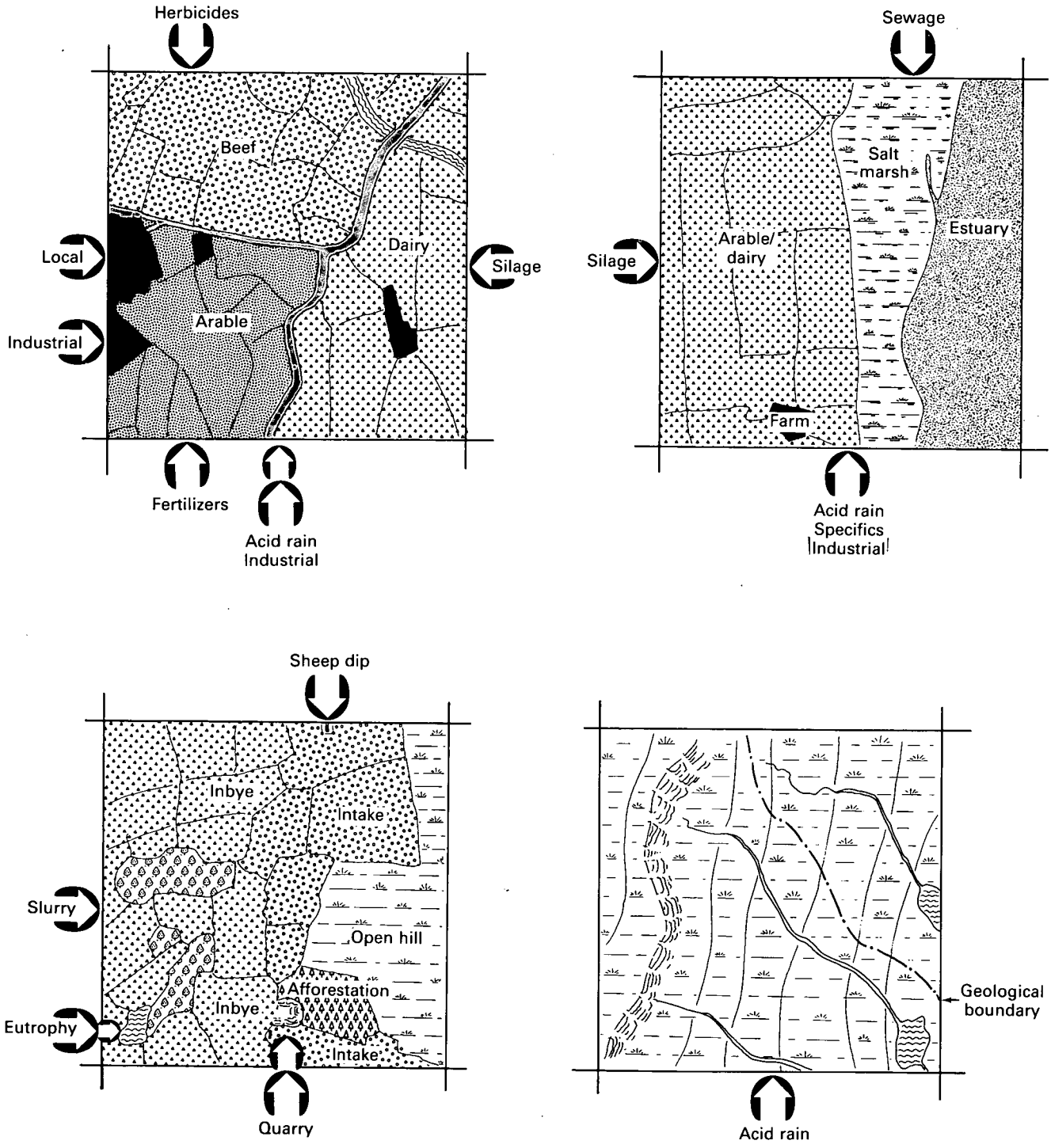

Figure 1. Representative 1 km squares drawn from land classes 1–4, 5–8, 9–12 and 13–16 respectively, demonstrating the contrasts between likely impacts of pollutants in different environments

tive of Cumbria. The survey was primarily concerned with vegetation, and detailed studies were carried out in each of these squares. However, in the subsequent development of the system to Great Britain, interest was extended to land use (Bunce 1984), and the results showed its applicability for data of this type. The further development of the sampling procedure to incorporate estimates of potential land uses in a study of land available for wood energy plantations (Mitchell *et al.* 1983) and subsequent modelling of changes in rural land (Bunce *et al.* 1984) led to a re-examination of the data collected in the Cumbria survey. A rapid exercise was carried out delineating the categories shown in Table 2, and the county predictions were compared with those made from the national data base. The Table shows that the figures are comparable and that the initial series of squares provides a reasonably representative series for the environments of the county – although the accuracy of predictions could be increased by enlarging the number of samples.

The principle of using a sieving technique to progressively identify units of land with defined combinations of criteria could be adopted. Thus, for example, the impact of acid rain on a square might be affected by the distribution of different soil types. An examination of the various pollutants in each of the squares shown in Figure 1 and a consequent estimation of their impact can be made. The estimates for the individual squares can then be combined to obtain mean figures per land class, which can in turn be converted to county figures, as shown by Bunce and Smith (1978). Different parts of the county identified by the land class will have different impacts, as shown in Figure 1.

The use of this approach is important in that high levels of impact may coincide on the same units of land, in which case the effects are dependent. On the other hand, some impacts may occur in different areas, in which case the effects will be compounded to cover a larger area overall. The breakdown of pollutants and areas of impact given above is essential to enable the ecological effects to be partitioned from those concerned with primarily visual changes. The advantages of using the present series of squares is that a considerable amount of information is already available, eg on vegetation, soils and hedgerows, so that repetitive data collection is avoided. Also, a wide range of programmes is already available for manipulating the data and carrying out the modelling process. A further advantage is that co-operating agencies can use the same framework, ensuring that the areas of land concerned are identical. Furthermore, additional data can be added as required. In each case, the impact is identified with an actual area of land, so that field measurements can be incorporated as required. Areas shown as having an intense impact can be studied further, and particularly sensitive areas identified. Many impact assessment studies have shown the importance of varying the initial parameters, so that the sensitivity of the system can be assessed to such changes. Otherwise, there is a risk that the results are dependent on a single variable, which if inadequately measured can alter the whole final assessment.

4 Conclusion

The relative intensity of pollutants varies widely, and their complex spatial interaction with the natural environment means that it is virtually impossible to make intuitive assessments of overall impacts at county level. It is therefore necessary to develop models which, although simplifications of reality, can be used to provide an environmental impact assessment for the county. The accuracy of such models can be increased as finance and the importance of the impact dictate.

5 References

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