Environmental Considerations For Sustained Economic Development

Reports Produced
for
Cambridgeshire Civil Protection Unit
by

MIDDLESEX UNIVERSITY

Centre for Ecology & Hydrology
Natural Environment Research Council

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Contents

Agenda 21 Meeting

21st April 1997
12noon - 1.30pm

Agenda

Welcome	Gordon Lister
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Potential Projects	Chris Brown
Summary	Brian Smith
Open Forum	Chaired by Gordon Lister
A Way Forward	Gordon Lister

Lunch will be available after the meeting

Caveats

ITE data is collected and currently best suited to use at national and regional levels. It may also be used at the Strategic level for areas the size of most counties.

At the level of specific sites (e.g. those that might be the subject of a planning application) ITE information is best used in an indicative sense and could, for example, be used to prioritise field survey efforts. Note however, that this general caveat has not prevented the development of decision support systems that go down to single fields under certain well-researched circumstances.

In common with all forms of environmental data, that used by ITE is subject to a number of other caveats these include:

- limitations on the quality and scale of resolution of the data - both these factors have probably continuously improved over time and can be managed;

- frequency with which data has been updated to account for changes;

- a tendency on the part of users to regard data help in digital form to be free of error and of higher value than data help in other forms.

FUTURE DEVELOPMENTS

Overall more effort is needed to see how ITE data can be fully integrated with data from other organisations. It is likely considerable progress could be made if data held by orgainsations such as ITE and IH were combined with social and economic data held by other bodies, including that held by local authorities.

New caveats would arise in doing this, but and limitations would be outweighed by the advantages to be gained in terms of policy development and the prioritisation of resources.

Foreword

In July 1996 Cambridgeshire acted as enabler and host for a two-day seminar to consider the "hazard dimension" of an extreme environmental disaster on the six counties in the region. All counties and districts in the region took part, as did Health, MAFF, Environment Agency, Department of Transport, the individual county Emergency Services and others.

The Seminar considered a wide spread flood scenario in three phases - preparedness, response and recovery. The enabling agency was the Cambridgeshire Civil Protection Unit (CPU), considerably assisted by Middlesex University Flood Hazard Research Centre, the Institute of Terrestrial Ecology and the Institute of Hydrology.

Most agencies were surprised at the amount and quality of research data which was available from the institutions and, more particularly, the relevance it had to major issues in the day to day working of local authorities. Whilst much of the data was produced to a "national scale" the methodology and application of an unbiased scientific approach held considerable potential benefits.

Following the Seminar the CPU has undertaken work with all these institutions centred on the "hazard dimension" of environmental impacts. The results of this work are contained in two reports herewith produced. They are offered in support of a presentation by the academic institutions that have been involved with us.

It is urged that the data, science and methodology demonstrated in these reports have a much wider application and that the contribution of a partnership between all the participants will enrich all our endeavours.

Institute of Terrestrial Ecology

Centre for Ecology & Hydrology

Natural Environment Research Council

ITE has six Research Stations throughout Britain, which allows the efficient use of resources for regional studies and provides an understanding of local ecological and land use characteristics. The Institute's administrative headquarters is at Monks Wood.

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Report to Cambridgeshire County Council,
Civil Protection Unit

NATURAL RESOURCES OF CAMBRIDGESHIRE

NATURAL AND HUMAN HAZARDS :

REPORT ON INITIAL FINDINGS

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March 1997

SUMMARY

This report outlines progress to date on work being done principally by the Institute of Terrestrial Ecology (ITE), for Cambridgeshire Civil Protection Unit (CPU) in relation to flood hazards, and hazards arising at a number of commercial and industrial installations in Cambridgeshire, some of which are covered by the terms of the Seveso Directives of the EU.

The report illustrates how environmental information can be obtained rapidly from the Countryside Information System in relation to extensive flooding in the County, and by using a more formalised protocol, shows how the national and regional information held by ITE can be used to characterise the environment around specific sites, in this case commercial, industrial and waste disposal installations representing some form of chemical hazard.

The report makes no definitive statements nor draws any definitive conclusions at this stage as it represents a piece of work in progress.

The techniques used to generate information for the CPU may find applications in other parts of the County's local government operations.

CONTENTS

Sections 5 - 7 are numbered by Tables and Figures or independently from the main text

1. INTRODUCTION

Modern decision making, whether about economic development, the use of natural resources, or the delivery of services to the community, increasingly needs to take into account the principle of sustainable development at every level of government. This is reflected in the Cambridgeshire Structure Plan, which puts sustainable development at the heart of the County's future.

It is certainly the case that if development activities resulting from a decision are to be sustainable, the decision itself must be well grounded in a knowledge of the nature of the development, the hazards it poses or is subject to, and the implications there may be for natural and semi-natural resources. However, having this information alone is not enough to ensure that a decision will be sustainable because of the need to conduct either cost-benefit studies or make comparative judgements from amongst a range of development options.

Thus, although studies and research on what constitutes sustainable development is still in its infancy, it is already abundantly clear that to achieve sustainability at both local and national levels, local decisions will necessarily have to be put into a national or regional context. In addition, new partnerships will need to be developed between decision makers and technical experts in a wide variety of fields because making decisions that will lead to sustainable development requires a great deal of interdisciplinarity. The most urgent interdisciplinary developments required are probably in technical fields that use economic and environmental information.

Furthermore, if sustainability is to be achieved then it seems likely that rather more monitoring of the outcomes of decisions will be required in future than is carried out at present. It will only be possible to conduct such monitoring if there is a clear appreciation of baseline environmental conditions and the means by which information about such conditions can be obtained and interpreted at an appropriate geographical scale and time period.

Accordingly, during the past year, component bodies of the Natural Environment Research Council - principally the Institute of Terrestrial Ecology (ITE) together with its sister research institutes the Institute of Hydrology (IH) and British Antarctic Survey - have been working with the Cambridgeshire Civil Protection Unit (CPU) and Middlesex University on a range of problems falling within the remit of the CPU. These problems are concerned with the hazards presented by sea and river flooding and with chemical accidents at large industrial and commercial installations and waste disposal facilities.

These studies are demonstrating the utility of the national flood models and nationally held environmental information to regional and County level activity. These studies are still to be completed but early developments have already established that the basic techniques being used could find wide application in local and regional government, and could be used to help achieve the goal of sustainable development, by making debate and decision-making more informed about the characteristics of the natural environment and by creating a framework in which the effects of decisions can be measured and monitored more usefully.

2. COMMENTS ON DATA AND PROCEDURES

This report does not represent the final results of the work in hand for the CPU. It therefore reaches no conclusions, but simply illustrates techniques that can be used in decision making procedures to obtain and assess information about the environment. It does not illustrate how data from IH or ITE may be combined with data from other organisations beyond the use of height data derived originally from the Ordnance Survey; this would be a useful next step.

ITE is a national organisation conducting research at national scales in the long term and as such many of the datasets it holds are collected at geographical scales that are, currently, best suited to use at national or regional levels (e.g. to determine trends and rates of change in national natural resources over time). ITE information can be used at regional scales but below strategic County planning level increasing amounts of caution are required in the use of the information.

However, under certain circumstances ITE's national and regional information can be used in an indicative sense to help prioritise the use of additional resources (eg by improving the focus of field surveys, by helping decide where land management grants might best be spent on schemes with a conservation objective). Provided sufficient attention is paid to the inherent limitations in the data due to the geographical and temporal scale at which the information has been collected useful site specific interpreted decision-support work can be completed. An example of this type of approach is included within this report for the work on commercial industrial and waste disposal sites. Other "site-specific" decision support systems are being developed for government departments and agencies. The development of these more "local" decision support systems is an challenge that the research community must meet if the goal of sustainable development is to be achieved. It seems likely that this can only be done effectively if the concerns and priorities of local communities and organisations are taken into account, by the development of programmes of work consistent with Agenda 21 of the Rio sustainability conference.

3. EXTENSIVE FLOODING

For an eastern England seminar organised by CPU in July 1996, IH, amongst other organisations, were asked to provide illustrative information on flood extent, whilst ITE were asked to provide information on the nature of natural resources that might be damaged by an extensive flood, as well as providing input to the seminar on the nature of such emergencies and the way they affected natural resources in both the short and longer term.

At the seminar it was suggested ITE and IH information could be used to help determine flood impacts on natural resources such as those related to biodiversity and conservation and to ecosystem integrity, and on environmental resources such as water supply and sewerage, agricultural land, amenities and tourism. ITE data in particular could identify the type of land at risk, and whether it was likely to contain valued habitats (whether legally designated or not).

The effects of a flood were likely to follow the general pattern for all environmental emergencies in that they would have a number of unexpected aspects that were difficult to predict with the current state of knowledge, that the effects would be relatively fast in onset but

slow in offset. It was suggested that the timing of a flood event during the year and its duration would have a very significant influence over the severity of immediate impact and its longer term consequences. Impacts could include loss of production of agricultural land for up to 4 years (in the case of salt water inundation), total loss of certain habitats at certain locations (eg in the case of coastal flooding of SSSIs), and some chemical contamination. The severity of the latter would be difficult to predict for many reasons. It was also pointed out that the economic losses from weather-related natural disasters worldwide appeared to be mounting, with losses in the 1990s running at a level about three times that for the 1980s. It is not known if these increased losses are a result of increased storminess resulting from climatic changes, although there is some evidence for increased wave heights in the open ocean.

During the seminar it became clear that information held by Cambridgeshire County Council, ITE, IH, and Middlesex University could be combined to better effect so as to help focus emergency planning resources, and to estimate the effects of flooding more exactly. One of the most important developments so far recognised arises from the ability of ITE datasets to provide a geographical context to economic and social information held by Middlesex University and the County. Combining information in this way is in progress.

At the seminar, geographical information on the impact of extensive flooding on Cambridgeshire was obtained, in "real time", from the Countryside Information System, a PC-based information package that holds a wide range of information on many different aspects of the environment in the form of data for either 1km or 10km national grid squares. One of the most important and useful datasets held within the system is one which summarises the extent of land-cover types. This is a dataset generated from the ITE Land Cover Map, which is the first map of its type produced from satellite imagery of the land surface. The methodology was originally developed and ground-truthed using land in Cambridgeshire.

As a first approximation, information on the type of land-cover that is likely to be affected by extensive flooding can be obtained by determining the type of land cover that lies at or below various heights. The Table in Annex A shows the information available on all the main cover types for Cambridgeshire at the heights above sea level approximately corresponding, in the case of Cambridgeshire, to three different levels of extensive flooding across the low lying land of the county. The mean heights of the 1 km squares chosen for study were: below 0m, below 1m, and below 5m. Figures 1 to 3 show the extent of this land, which is concentrated in the north and east of the County. Fig 4 shows the potential losses of aggregated land-cover types.

Preliminary inspection of the data in the Table and Figures of the main report and Annex A shows significant losses of urban and suburban land (up to a quarter affected), as well as temporary to medium term losses of tilled land that might be of considerable national significance (being possibly greater than 1% of the national resource in the case of an extensive flood of land at or below 1m above sea level). The loss of tilled land would be of considerable significance at the County level since up to a third of the resource could be affected by extensive flooding of land at or below 1m. Most of this loss would occur in one or two Districts.

Given the nature of the potential losses more work on the impacts of extensive flooding probably needs to be done, focused on combining IH flood plain mapping with ITE data in the most affected Districts.

The Countryside Information System contains many other geographical datasets all of which could be explored to help determine the effects and implications of extensive flooding for Cambridgeshire. This has not yet been attempted.

Further analysis of the data in Table 1 is included in the Annex.

4. INDUSTRIAL OR COMMERCIAL INSTALLATIONS : INFORMATION PROTOCOL AND EXAMPLE INFORMATION CONCERNING SPECIFIC SITES

ITE has just completed research for the Department of the Environment on the development of a Comparative Environment Index (CEI). The CEI is a multi-component index of the quality of the environment around an industrial or commercial site subject to the Seveso Directive of the EU. The research included development of a practical protocol for the work so that operators and regulators of such sites could rapidly obtain the information they needed on the characteristics of the environment around a site and use it to determine the nature of field survey and risk analysis that would need to be done to satisfy the terms of the Seveso Directive. The CEI approach would also provide the baseline data needed in case an accident occurred and damage to the environment had to be assessed and recovery monitored.

The methodology might find application in a number of land-use situations. At present in Cambridgeshire, ITE are conducting trials of the methodology in partnership with the CPU at 9 sites in various parts of the County. Some of these sites will be subjected to more detailed study before the current project is completed later this year.

Because of the potential general applicability of the protocol developed for the CEI a draft form of the protocol is reproduced below. This is followed by example information for 2 of the sites under study. More information on the sites under study is included in the Annex.

4.1 A draft CEI protocol for assessing environmental quality

Introduction

This protocol is intended to guide operators and regulators of CIMAH sites in assessing environmental quality in the vicinity of a CIMAH site. Armed with this information they should be able to identify those components and characteristics of the environment that need special attention. Only the main steps that may be necessary are presented in this protocol. The protocol is not intended to be prescriptive.

The basic protocol could be varied to suit local conditions and its detailed use may be different depending on whether the site in question is an established one or a greenfield/brownfield one.

A fundamental aspect of the protocol is that, as far as practicable, information on environmental quality is gathered in relation to 1 km national grid squares. Alternative levels of resolution could be used if this seemed appropriate.

Three main types of processes are needed to make this protocol work:

(i) information gathering;

(ii) quality assessment by ranking procedures;

completion of these first two stages can, if thought beneficial, lead on to the construction of,

(iii) an environmental quality matrix which represents a multi-component index of environmental quality that can help focus risk analysis and prioritise environmental management options.

In the following three subsections of the report, the information that needs to be gathered and the approach to dealing with it are outlined.

Note that the methodology has been tested in various rural and urban locations in the UK. It has already proved useful when considering potential impacts at a range of chemical works and explosives sites.

The outline methodology has proved very useful in a variety of ways. Importantly some users have derived considerable benefit from just considering Stage 1 and interpreting the information in the form presented in this report or in conjunction with field survey, where Stage 1 data helped focus attention on potential environmental quality.

Stage 1: Gathering information

At least six types of information are needed to determine the extent and quality of the terrestrial and surface water environment that might be affected by an accident at a CIMAH site. These are:

Information type 1:
The area of land, length of river, likely to be affected by an accident - "the area of search"

There are various sources of information available to allow this area to be determined, and opinion varies as to the area of land that should be considered. The appropriate choice of area and/or length is likely to vary with the nature of the chemical hazard involved and the nature of associated risks. .

In the case study included in the report a 3 x 3 km block of 1 km national grid squares centred on a hypothetical site has been used as the area of search. In other trials of this methodology, a 5 x 5 km block around the industrial site in question has been used.

Information type 2:
The nature and extent of land-cover in the area of search

Compile a Table of land-cover statistics (for instance, in percentage terms) at local, regional and national levels for the whole of Great Britain. The most convenient way of doing this is to use land-cover statistics generated from satellite imagery that is now available for the whole of the mainland of Great Britain; alternatives sources of information are also available (eg Ordnance Survey maps) but their information content is probably too low at present. A standard listing of cover types is provided in the next section of this report.

Land-cover statistics can help determine whether any of the nationally scarce habitats identified in the 1991 Guidance are present in the area, as well as providing a list of the land-cover types present.

In certain circumstances, in order to obtain equivalence between the habitats listed in the Green Book and land-cover types certain land-cover types may need to be aggregated. Further information on this is found in section 4 of the report, and in the case study. A look-up Table in the technical Annex explains how this can be done in more detail.

Information type 3:
The presence of land subject to a statutory designation within the area of search

Table 2.1 gives some information on the types of statutory designation that might be noted. There are many regional and local designations of non-statutory status that might be taken into account. Further information on types of designations can be found in Hankard *et al* (1991) and in the Technical Annex to this report

Information type 4:
The presence of Red Data Book species in the area of search

Ways of obtaining indicative information are suggested in the next main section of this report and in the case study (section 5) - note that it is very difficult to produce exhaustive or definitive information on this subject.

Information type 5:
The quality of habitats in the area of search

The quality of habitats in the area of search can be defined in relation to the presence of key indicator species which have high specific affinities for that habitat. Ways of obtaining this information have been developed in the course of this and related studies, and is available in a digital form. More information on this topic can be found in the next main section of this report and in the case study (section 5). The information is needed to ensure good quality habitat that is not designated is included in the risk analysis.

Information type 6:
The quality of surface waters

Information on the quality of surface waters, on both a chemical and biological basis, can be obtained from the Environment Agency in digital format for 8,000 rivers/river sectors in England and Wales. An example is provided in the case study, with supporting data listed in the Technical Annex.

Users only wishing to complete Stage 1 of the process, information gathering, should stop here, and complete an appropriate field survey should it appear from the information gathered that a valuable component of the environment is within the area of search.

Stage 2: Procedures for evaluating environmental quality

Once the six types of information listed above have been gathered the following procedures can be done. These procedures can be varied to suit the particular circumstances of a particular case.

Procedure 1: Area of search

Although no further operations are required on this information, it might be instructive to vary the area of search to determine whether, when observed at a different scale, different factors become more or less important. Such a procedure would serve as a check against the possibility that a highly valued characteristic of the environment lay just outside the area of search. This is probably a good quality assurance measure when working up a real risk analysis.

Procedure 2: Land-cover

Inspect the data in the land-cover table to determine whether any particularly important land-cover types are present in the area of search.

An example is given in the case study, and, although this can be done in a number of ways, three important considerations for CIMAH sites are:

<u>The location and extent of scarce habitats</u>

Certain habitats listed in the DOE "Green Book" Guidance from 1991 (DOE, 1991) are regarded as nationally scarce, and damage to them can readily constitute a major accident to the environment. Thus, if land-cover types equivalent to these habitats are present in the area of search, note the 1 km square in which they are found and their extent (eg in hectares)

From the 1991 Guidance, it is likely that particular attention will need to be paid to squares containing more than 2 ha of this type of land-cover in any risk analysis.

<u>The location and extent of urban land</u>

This information needs to be included to facilitate consideration of risks to human health.

<u>The location and extent of agricultural land</u>

This information is needed to help protect human health from the impacts of a chemical accident.

Procedure 3: Important types of habitat and land-cover

For each of these groups of cover types, rank 1 km squares in the area of search such that squares with greater numbers of hectares of each habitat or cover type are ranked above those with smaller areas. Treat each type of nationally scarce habitat separately, treat aggregate cover types similarly for ranking purposes (ie use the aggregate cover figure for ranking purposes).

In trials of the methodology, some users found that the unranked information on cover type location and extent provided a rapid way of obtaining an impression of the type of environment which is being dealt with. Some users have not used the land-cover data beyond this point, as in certain circumstances knowing the amount and location of a cover type was sufficient to conduct an initial risk assessment.

Procedure 4: Designated land

Total the numbers of statutory designations and other designations of similar national or regional status that apply to land in each of the 1 km squares; rank squares with more designations above those with fewer.

This procedure does not necessarily invoke double-counting of the value of a designated area because designations are made for a various and different reasons, so that each represents a different expression of perceived environmental quality on the part of the designating authority.

Procedure 5: Red Data Book (RDB) species

Add up the total number of RDB species in each 1 km square and rank squares with the highest number of records as the highest ranking square, and so on.

This data is available in digital form for all 10 km national grid squares. The number of RDB species that may be present in a 1 km square must be derived from the figures available for the 10 km square of which the 1 km square belongs (see case study for an example of how to do this).

Note that, the further back in time records are searched, the more RDB records will be found. A cut off, for current purposes, of 1960 is suggested.

Procedure 6: Habitat quality

Squares with larger total areas of high quality habitat should be ranked above those with smaller areas, although it is recognised that good quality habitat can exist in small area of land.

Section 4 contains information on measuring habitat quality using key species. This information is only presently available at a resolution of 10 km but in conjunction with the land-cover information can be applied at a 1 km resolution (an example of how to do this is included in the case study).

Procedure 7: Surface water

Rank 1 km squares containing high quality water courses above those with water courses of lower quality.

Users only wishing to complete Stage 2 of the process, quality assessment of individual environmental characteristics, should stop here, and using the assessment information, conduct the appropriate field survey focused on the individual valuable components of the environment likely to be located within the area of search.

Stage 3: Multi-component environmental index (CEI)

Only users wishing to make comparative judgements about the geographical distribution of high quality components of the environment that might be affected by an accident should proceed to the final stage of preparing an overall quality matrix

Procedure 8: Overall quality matrix

Generate a quality matrix table (or some other similar means of displaying the data) showing all the rankings for all the pieces of contributory information. From this it should be clear where in the area searched for information various components of good quality environment are located.

This information can then be used to aid the risk assessment and analysis process. A table of this kind is included in the case study (Section 5 of this report).

The contents of this matrix constitute a multi-component index of the comparative environmental quality (or comparative environment index, CEI) for each of the 1km squares in the area of search. Risk analysis might be focused on those environmental characteristics shown in the matrix to be the most highly ranked.

Users should only use the matrix in conjunction with the information from a suitably focused and well organised field survey conducted at the appropriate time of the year in all those cases where it appears a valued part of the environment is at risk from an accident.

Under no circumstances should any user combine the ranks from all the different environmental attributes considered in the matrix to derive a single number that, simplistically, might be thought to represent environmental quality. Such a restriction is necessary to prevent misuse and abuse of the underlying information sources.

4.2 Example of specific information for sites within Cambridgeshire

Information for all sites being studied in Cambridgeshire is given in Annex B. The information has been gathered in the manner set out in the protocol, but as part of the research for CPU, some of the data have been displayed differently to see whether this produces information in a form that can be more easily assimilated by the user.

Barrington Cement Works

The proportions of the major land cover types in the area of study vary little from those recorded within the region (Table 3a). Tilled land is the dominant cover type, as is perhaps only to be expected within Cambridgeshire. Unlike many of the other sites (Annex B), the square containing the cement works has a relatively low population density (Table 3b), but a high proportion of agricultural land (Table 3c). It is interesting to note that these criteria tend to be mutually exclusive, such that squares containing large areas of agricultural land are not those with high human populations, and vice versa. Additionally, the presence of high quantities of agricultural land or suburban land generally preclude the presence of large numbers of high quality environmental resources.

The 3 x 3 km study area actually straddles four 10km national grid squares, and thus squares within the area vary considerably in terms of those resources which are mapped on a 10km basis. Despite the absence of nature conservation designation sites, there are a large number of Red Data Book species recorded within the relevant 10 km squares (between 18 and 53 species). Without further investigation it is unclear which habitats these species are associated with. Indeed, these species may be present within designated areas in the 10km squares outside of the area of study. In the absence of nature reserves, less intensive (extensive) farming techniques may be responsible for the persistence of such species in the wider countryside. Further interrogation of databases and field survey would clarify this.

As for RDB species, Habitat Quality is estimated over a 10km square (Figure 6). It may thus be expected that all 1km squares within one particular 10km square would score equally in terms of high quality habitats. However, as can be seen from Table 3f (Annex B), this is not necessarily the case. A square is only assigned a high value for habitat quality if the land cover statistics indicate the presence of a cover type that may be equivalent to the defined habitats, ie. although square 540 250 would potentially contain high quality broad-leaved woodland, the land cover map indicates the absence of deciduous woodland within that square.

Figure 7 clearly displays the variability between squares within the study area. However, the ranking of squares should not be used as an indication of the magnitude of difference between squares. Taking the example of agricultural land, Table 3c (Annex B) shows six squares containing over 80 ha of this cover type, with many squares having numerically similar quantities. Simple examination of the rankings (without the underlying data) may tend to overestimate the differences between squares.

Mepal Tyre Dump

The predominance of tilled land and managed grassland within the area of study (Table 9a) highlight the importance of agriculture within the region. Whilst tilled land may be the dominant cover type, it is of greater significance regionally than locally (66.5% cf 48.4%). Interestingly for Cambridgeshire, the proportion of managed grassland within the region actually exceeds the national average, as does that of rough grassland also.

As at the Barrington cement works site, the square containing the industrial site (Mepal) has a relatively low population density compared to other squares in the area of study (Table 9b), and a relatively low ranking for the proportion of agricultural land (Table 9c). However, this reinforces the importance of examining the underlying data together with the rankings, since 73.6% agricultural cover for the square containing the site is still higher than the figure recorded for Cambridgeshire as a whole.

Again, the presence of high proportions of agricultural land appear to preclude high population densities (Figure 8).

The 3 x 3 km study area block falls within two 10km squares, and as a result information held on a 10km basis is again responsible for differential ranking of squares with respect to RDB species and high quality habitats. Compared to Barrington cement works, there are low numbers of RDB species present (Table 9e) and this is probably directly attributable to the fact that the area seems overwhelmingly dominated by agriculture. Indeed, the majority of squares appear to have potentially only high quality agricultural habitats, ie. improved and mesotrophic grasslands, and arable habitats (Table 9f).

Whilst there are significant areas of water just outside the area of study, the apparent lack of watercourses within the area of study may mean that the effects of an accident may be limited to terrestrial resources only.

Comparison of sites: example

Comparison of figures 7 and 8 suggests that the squares in the area immediately surrounding Barrington cement works are more variable in terms of environmental resources than are the areas at Mepal. Additionally, there are clearly differences between sites as illustrated by the examples in Figures 5 and 6. The study area at Mepal contains very little woodland cover (Figure 5), and indeed examination of Figure 6 (Broad-leaved woodland habitat quality) indicates that any existing areas of woodland are likely to be relatively poor quality. Conversely, the Barrington study area also appears to contain relatively little deciduous woodland (Figure 5), but any woodland present is likely to be of relatively high quality (Figure 6). Whilst these conclusions may be drawn from the raw data, visual display can clearly aid quick interpretation of material.

5. FIGURES

Figures 1 - 9 for the main report are on the following pages.

Figure 1. Land in Cambridgeshire below 0 metres

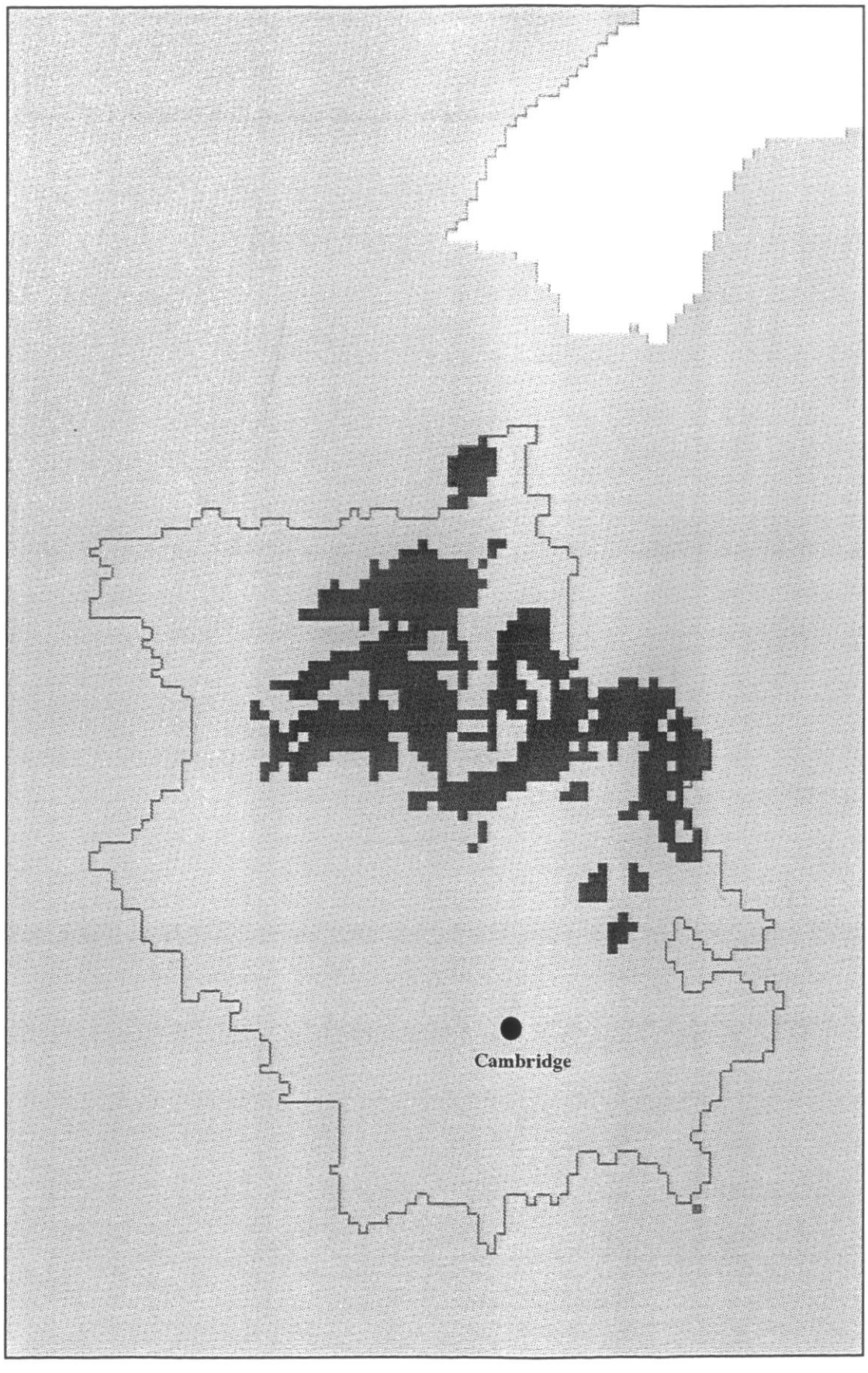


Figure 2. Land in Cambridgeshire below 1 metre

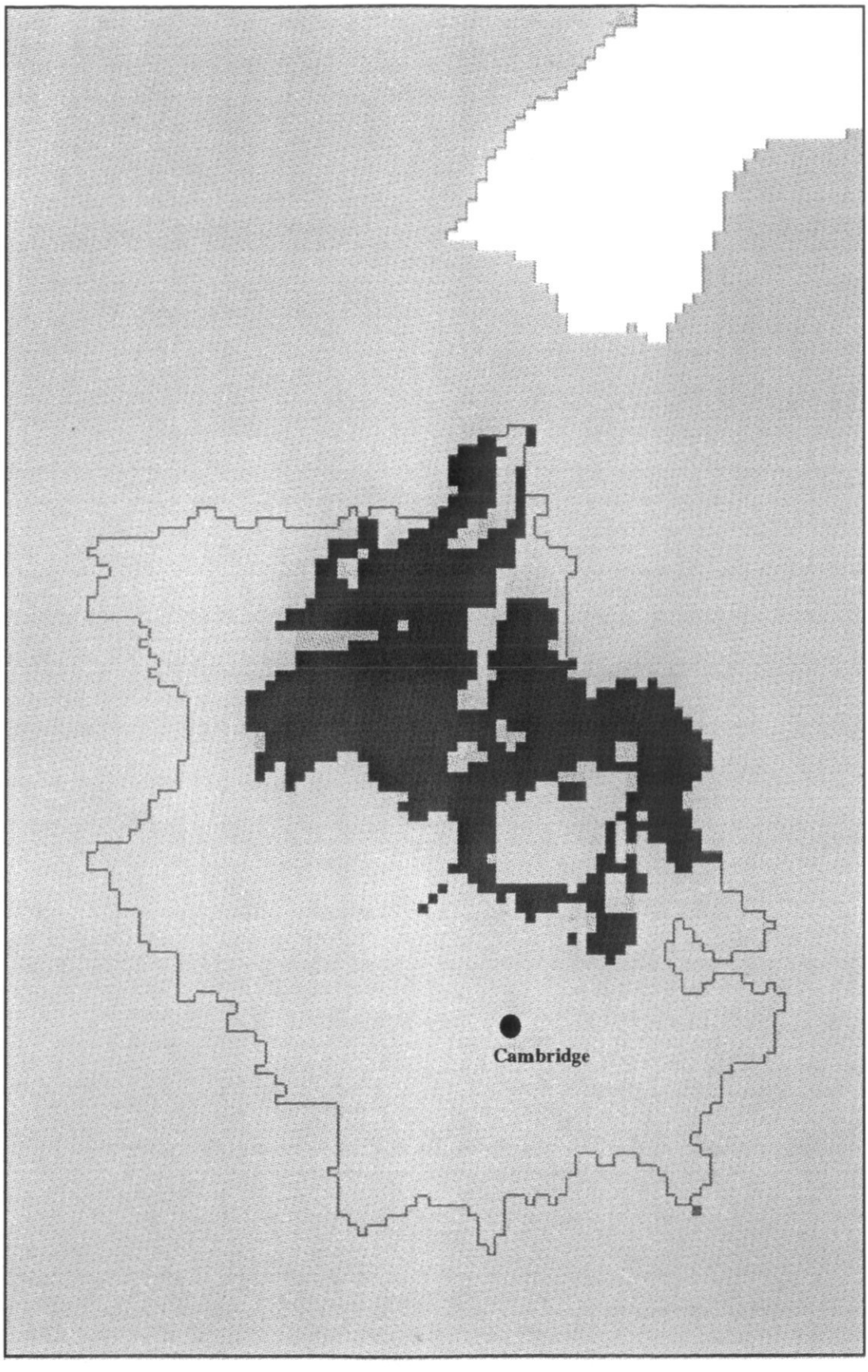


Figure 3. Land in Cambridgeshire below 5 metres

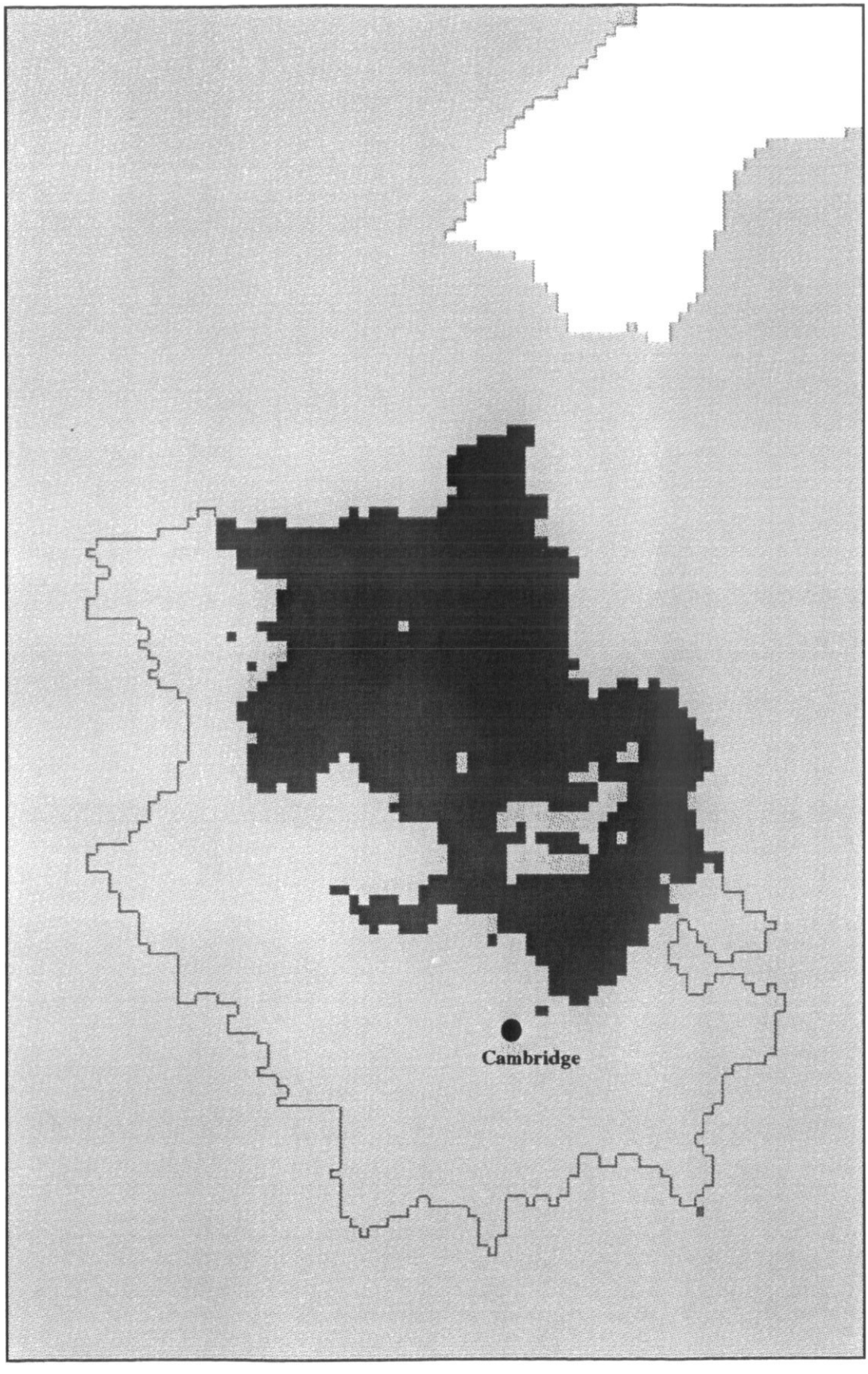


Fig 4 Percentage potential total losses of land-cover types

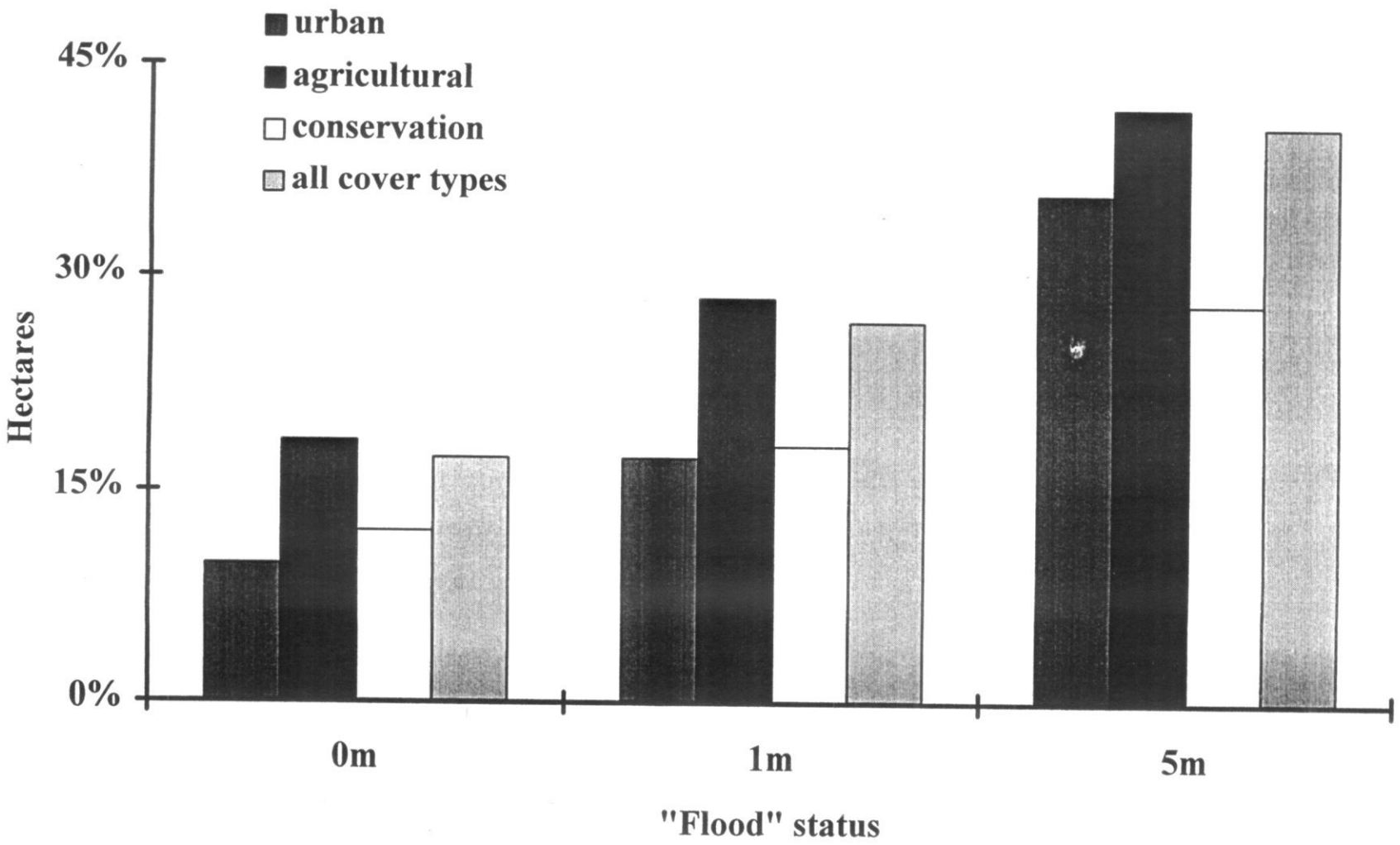


Figure 5. Potential Accident Sites within Cambridgeshire

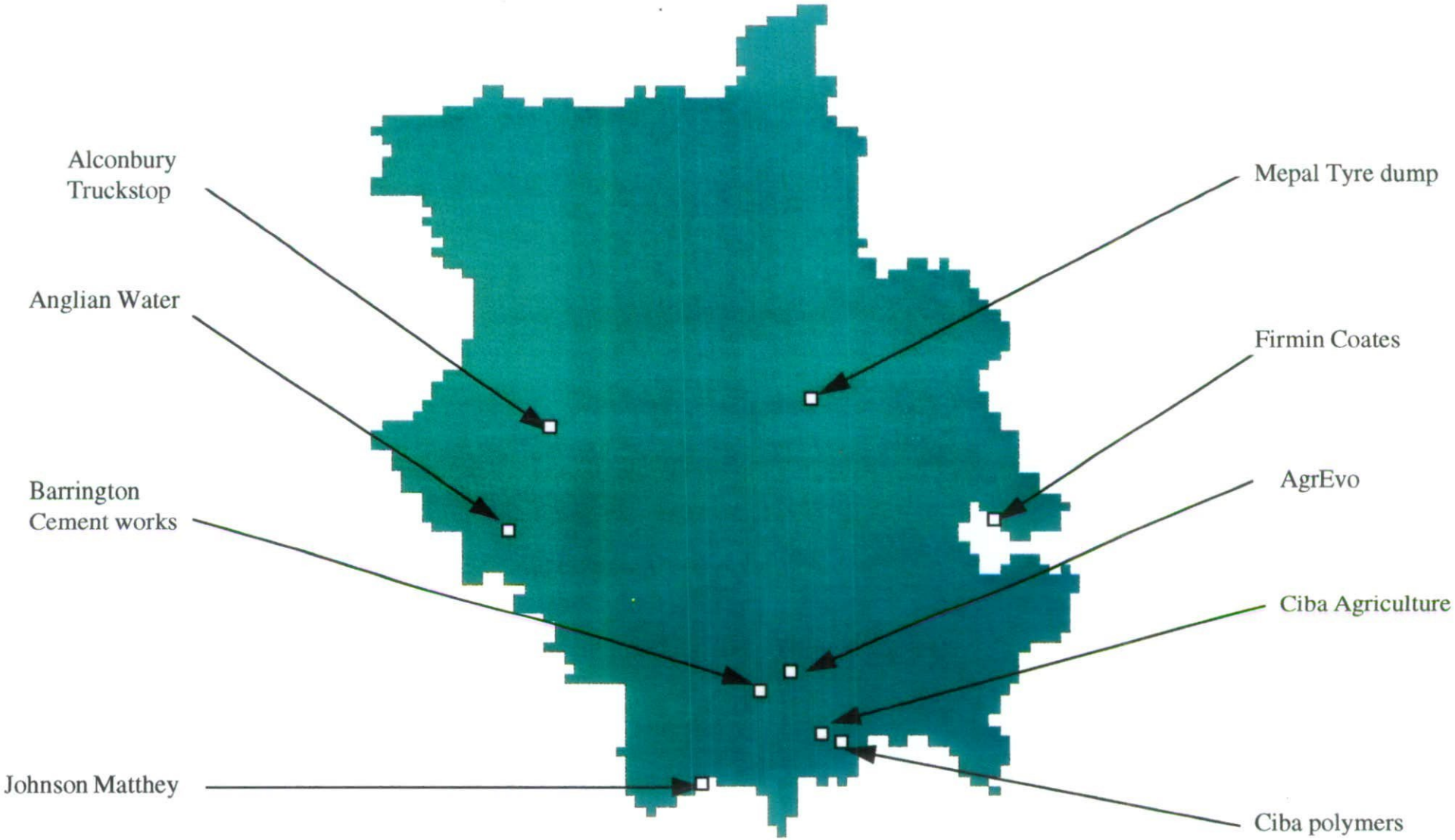
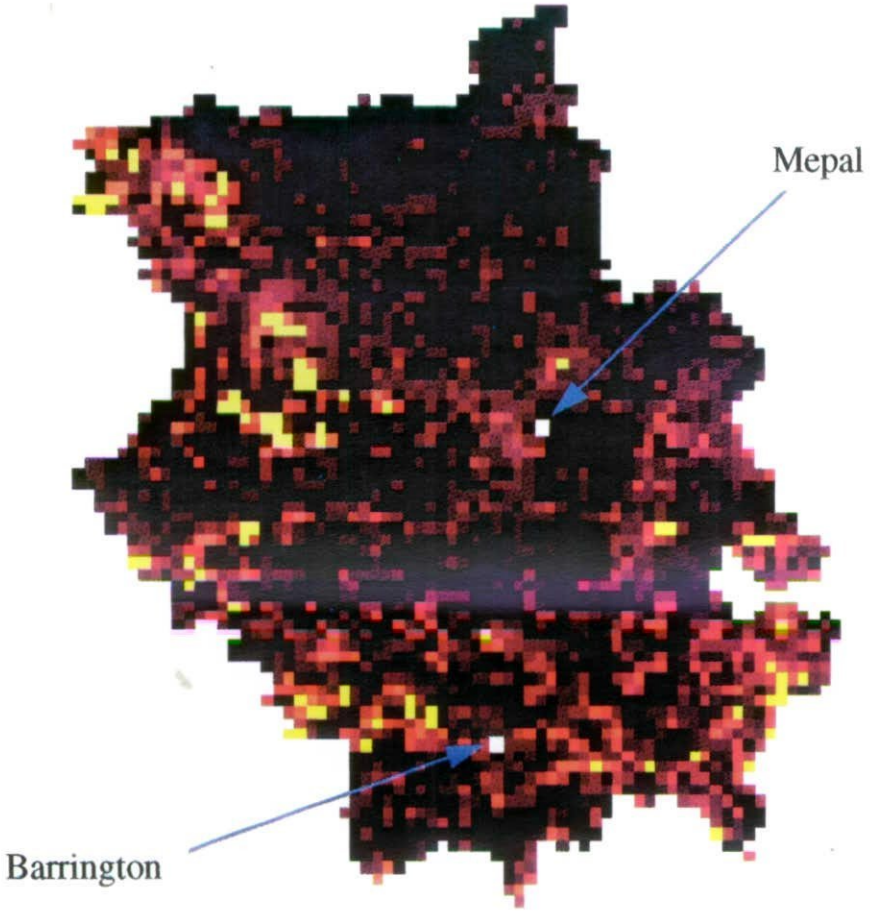


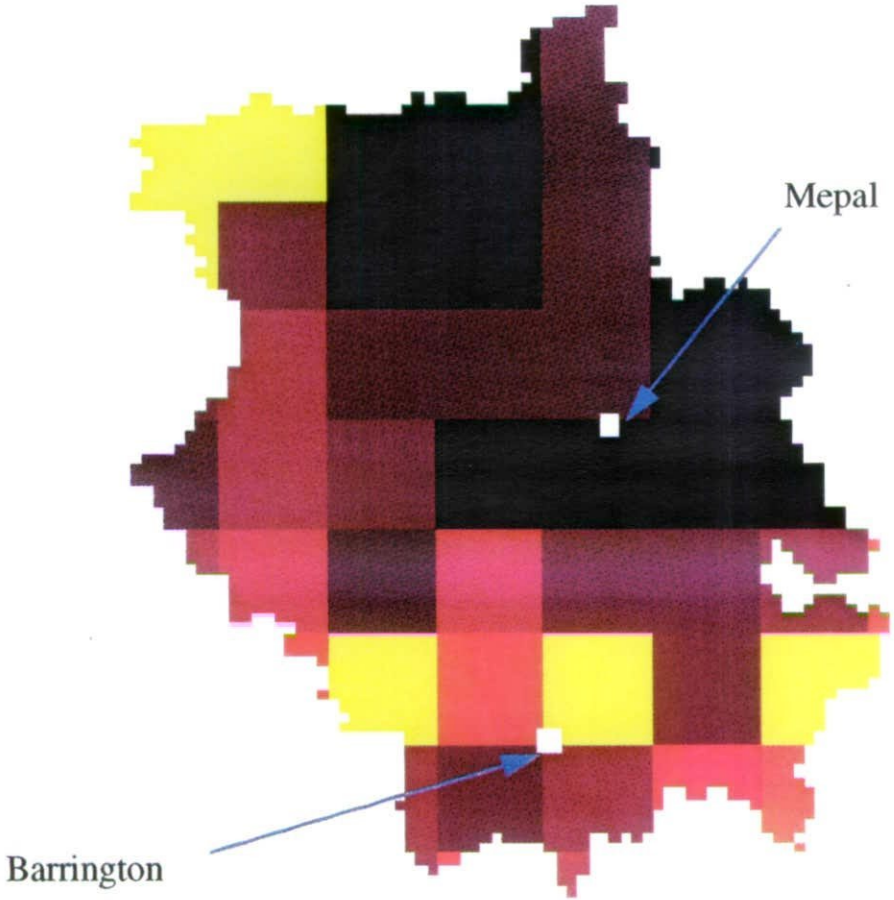
Figure 6. LAND COVER: Distribution and Extent of Deciduous Woodland within Cambridgeshire



KEY

Hectares of Land	No.squares
0 to [0.25]	1845
0.25 to [0.81]	583
0.81 to [1.63]	299
1.63 to [2.94]	245
2.94 to [4.94]	165
4.94 to [8.31]	111
8.31 to [15.13]	85
15.13 to 60.19	83

Figure 7. HABITAT QUALITY: Broad-leaved Woodland within Cambridgeshire



KEY

Number of species	No.squares
0 to [16]	910
16 to [23]	691
23 to [26]	593
26 to [28]	390
28 to [30]	195
30 to [32]	60
32 to [33]	100
33 to [35]	43
35 to [37]	193
37 to 42	241

Figure 8. Ranking of the Nine 1km squares centred upon Barrington cement works (Highest rank = 0; Lowest = -10)

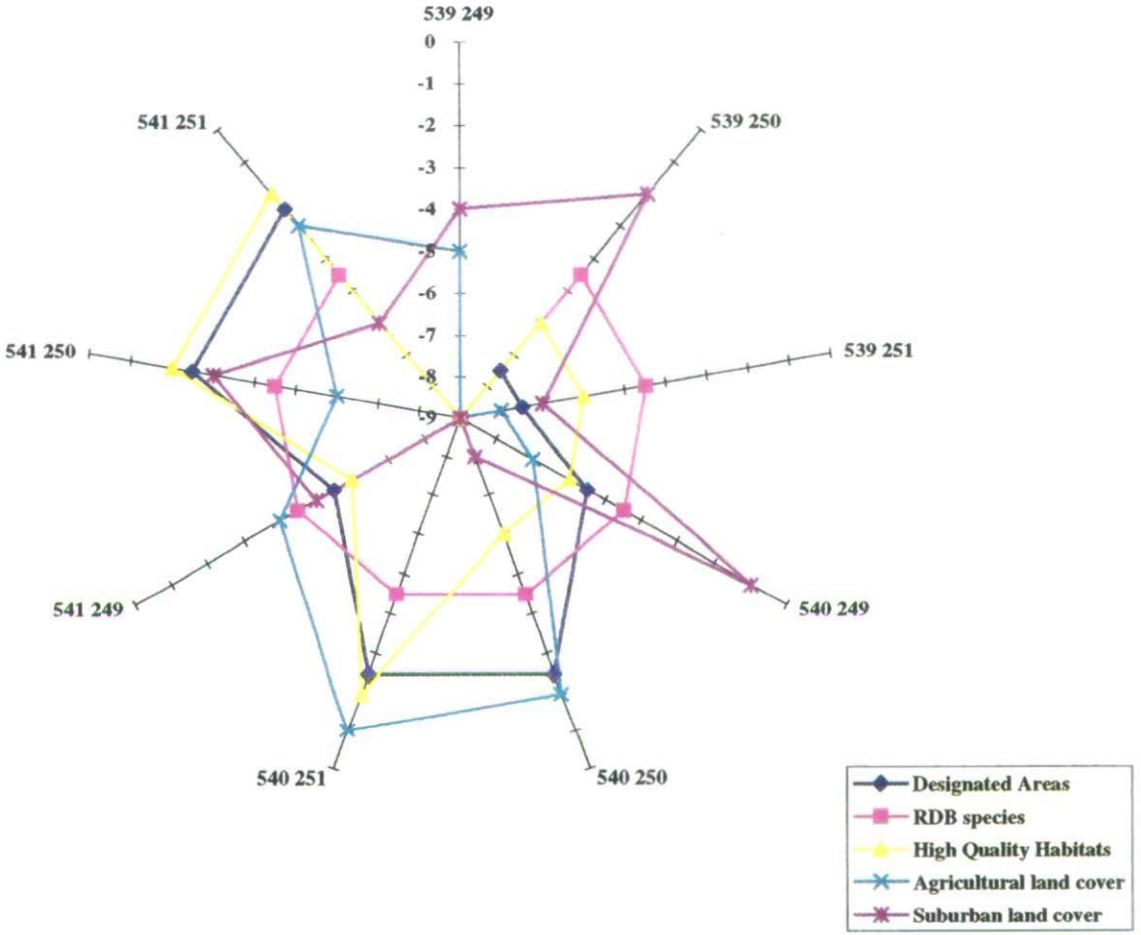
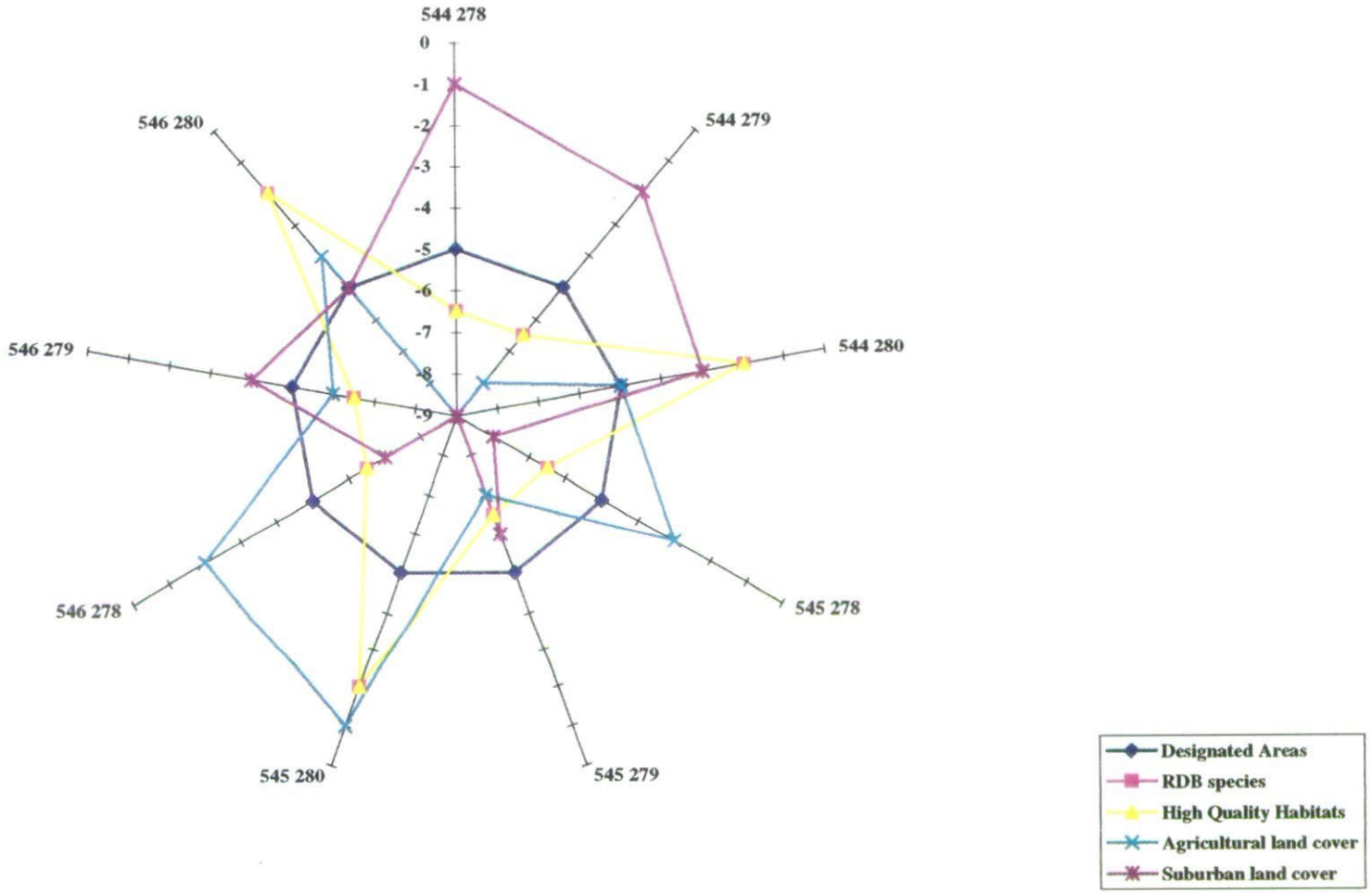


Figure 9. Ranking of the Nine 1km squares centred upon the Mepal tyre dump (Highest rank = 0; lowest = -10)



ANNEX A: TABLE AND FIGURES RELATING TO POTENTIAL LOSSES FROM FLOODING

In this Annex the background data on "flooding" are provided, ie land below certain heights that is more likely to be affected in various ways by flooding than higher land.

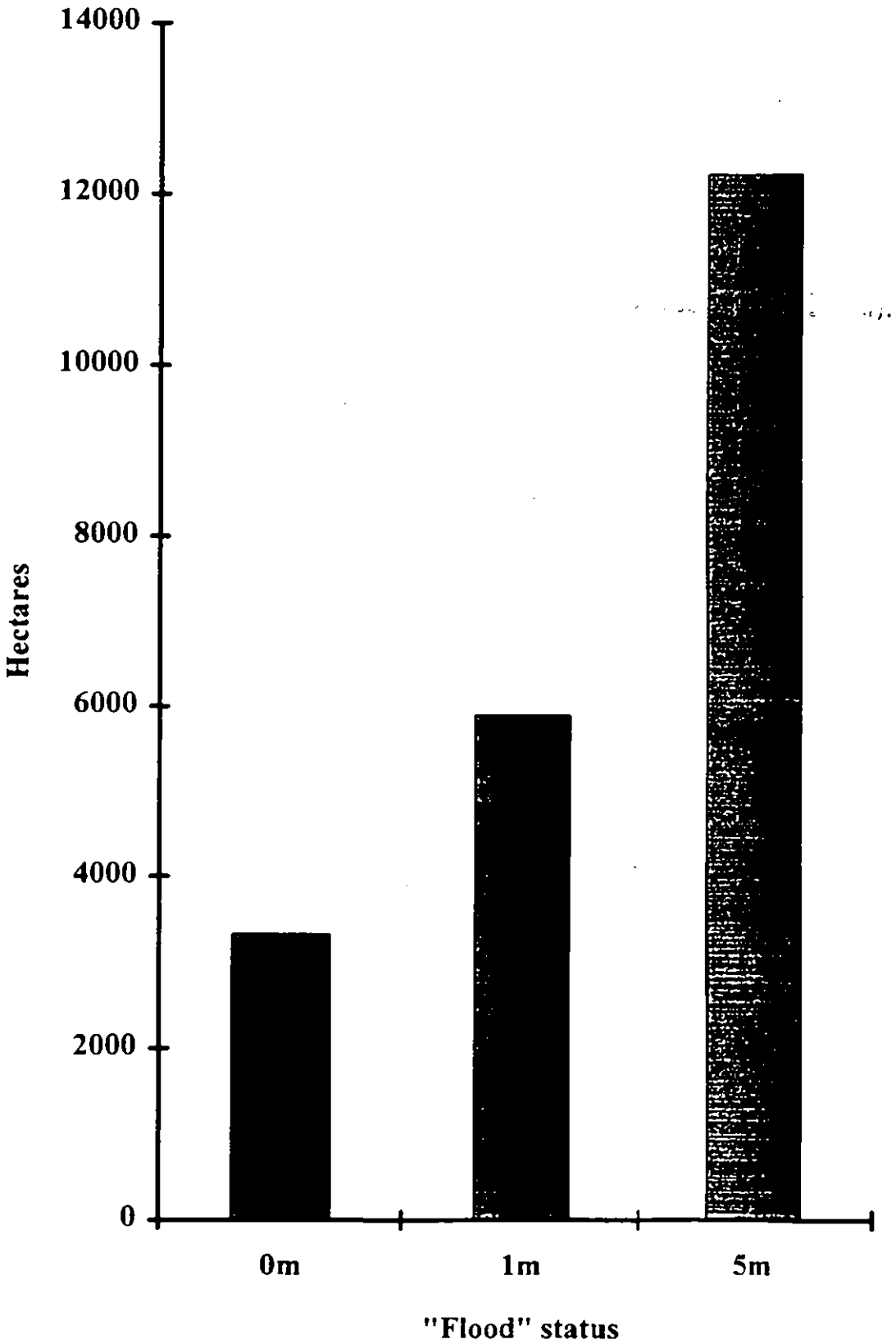
The Table shows land-cover statistics for Cambridgeshire for three mean heights classes of groups of 1 km squares, with some information on national coverage for comparison.

The figures display data generated from this table to provide a view of the progressive impact that various degrees of extensive flooding might have on the County.

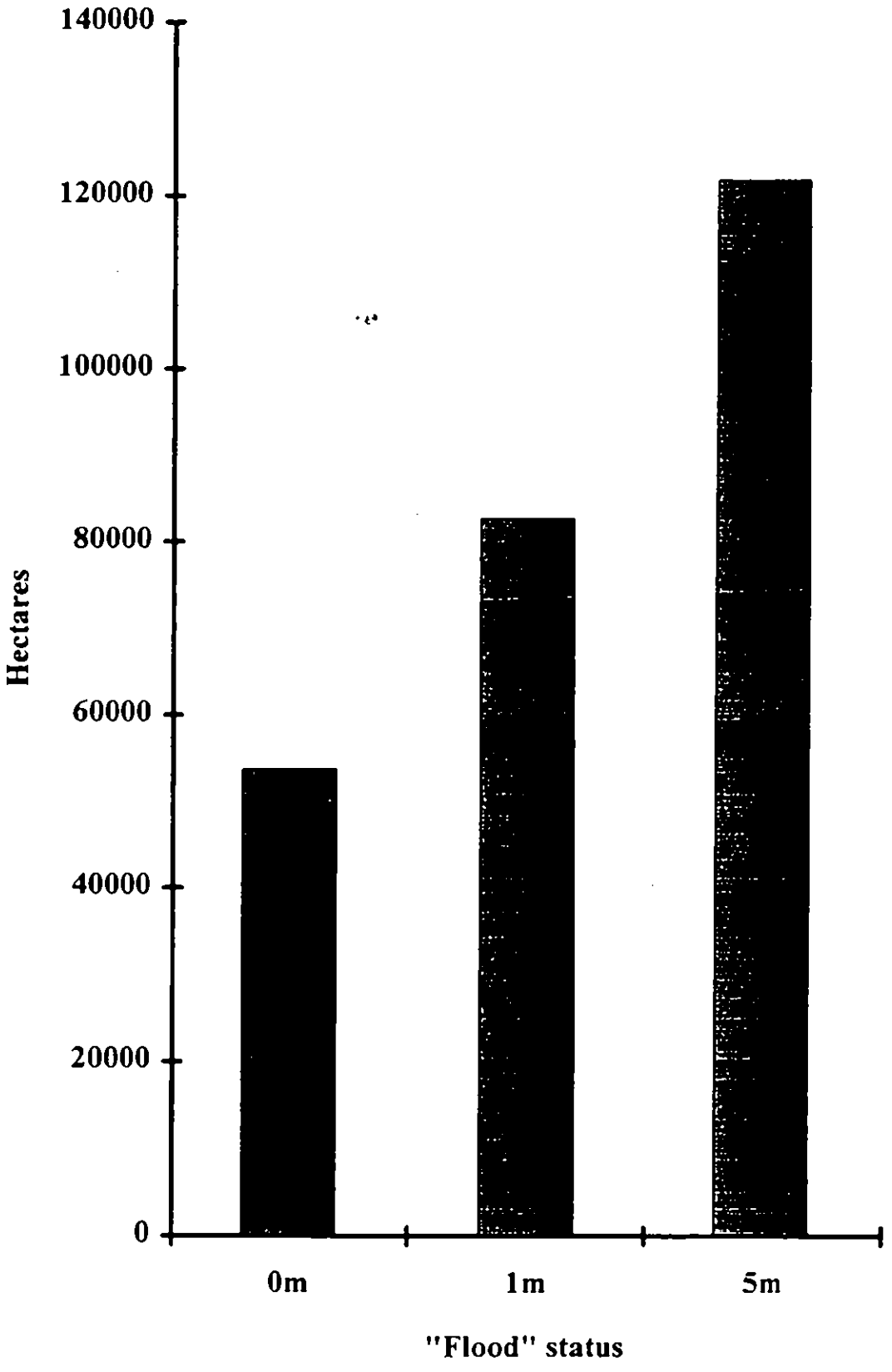
Resource in Cambridgeshire at risk from flooding, presented as a % of Cambridgeshire's resource, as a % of the total Great Britain resource, and as absolute hectares

GB		Cambridgeshire (3416 squares)				below 5m (1394 squares)			below 1m (920 squares)			below 0m (594 squares)		
GB%	Total	Description	Cambs%	%of GB	Total	%ofCambs	%ofGB	Total	%ofCambs	%ofGB	Total	%ofCambs	%ofGB	Total
	ha (GB)			resource	ha		resource	ha		resource	ha		resource	ha
1.11	260300	urban	1.03	1.35	3512	43.94	0.59	1543	25.77	0.35	905	14.92	0.20	524
5.63	1317000	suburban	8.34	2.16	28410	35.37	0.76	10050	16.75	0.36	4758	9.46	0.20	2687
21.92	5131000	tilled land	70.01	4.65	238500	45.37	2.11	108200	31.76	1.48	75750	20.85	0.97	49720
28.05	6567000	managed grassland	14.93	0.77	50850	26.84	0.21	13650	13.46	0.10	6845	7.81	0.06	3971
1.84	430700	rough grass	2.34	1.85	7953	27.66	0.51	2200	17.89	0.33	1423	12.95	0.24	1030
1.54	360300	bracken	0.04	0.04	138	73.91	0.03	102	50.72	0.02	70	37.68	0.01	52
8.63	2020000	heath grass	0.36	0.06	1233	52.31	0.03	645	33.98	0.02	419	20.68	0.01	255
11.91	2787000	open shrub heath	0.00	0.00	0	0	0	0	0	0	0	0	0	0
3.08	722000	dense shrub heath	0.01	0.00	19	47.37	0.001	9	26.32	0.0007	5	21.05	0.0006	4
1.84	430900	bog	0.00	0.00	0	0	0	0	0	0	0	0	0	0
5.27	1233000	deciduous woodland	1.63	0.45	5578	20.80	0.09	1160	16.05	0.07	895	9.65	0.04	538
3.30	772200	coniferous woodland	0.18	0.08	598	8.53	0.01	51	5.35	0.004	32	1.51	0.001	9
1.10	256600	inland bare	0.64	0.85	2188	29.39	0.25	643	10.83	0.09	237	5.48	0.05	120
0.17	38940	saltmarsh	0.00	0.00	0	0	0	0	0	0	0	0	0	0
0.61	142100	coastal bare	0.00	0.00	0	0	0	0	0	0	0	0	0	0
0.73	171400	inland water	0.48	0.96	1649	33.29	0.32	549	11.70	0.11	193	8.25	0.08	136
3.28	768300	sea/estuary	0.00	0.00	0	0	0	0	0	0	0	0	0	0

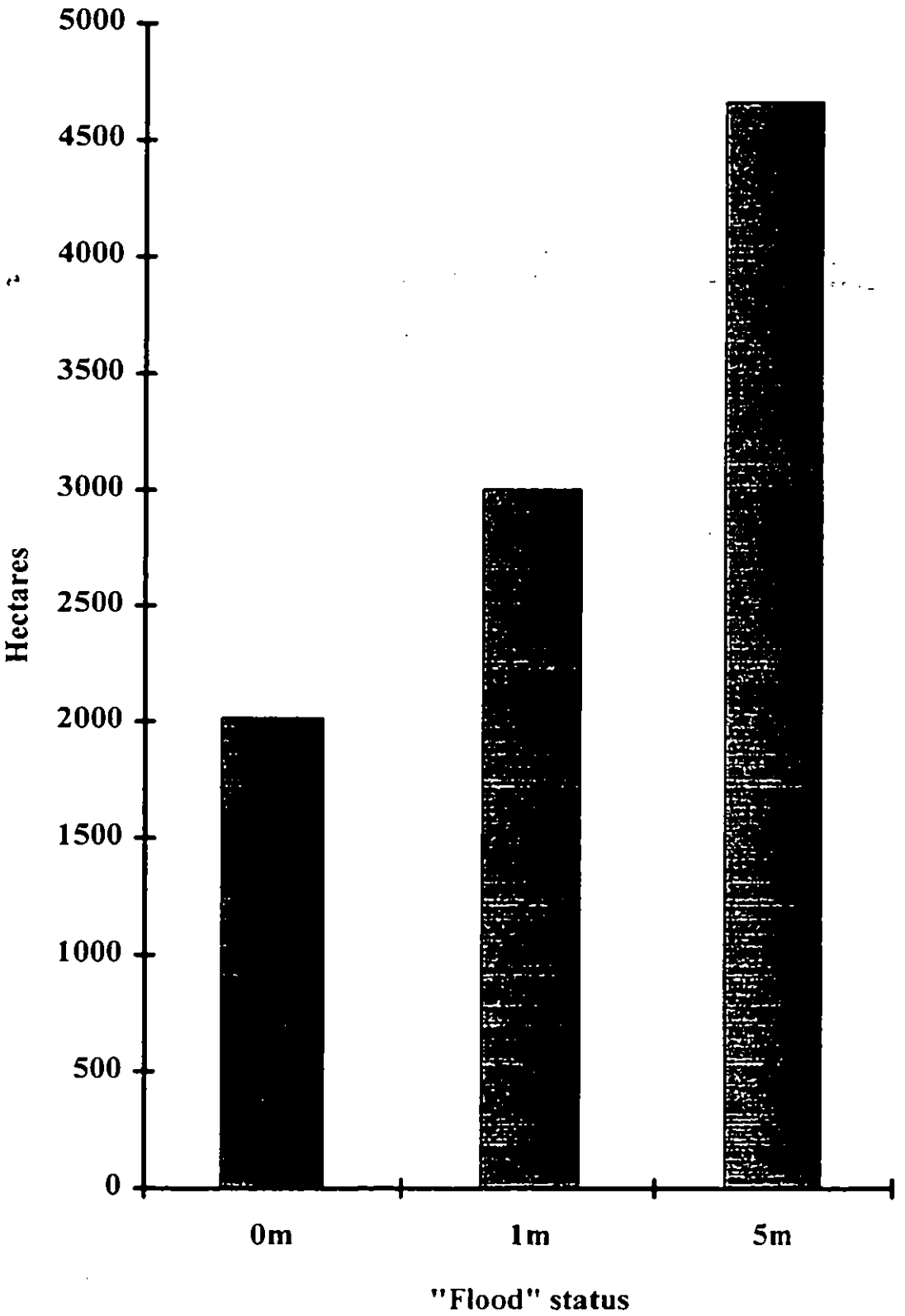
Potential loss of all urban cover types
(Total for Cambridgeshire 34,000)

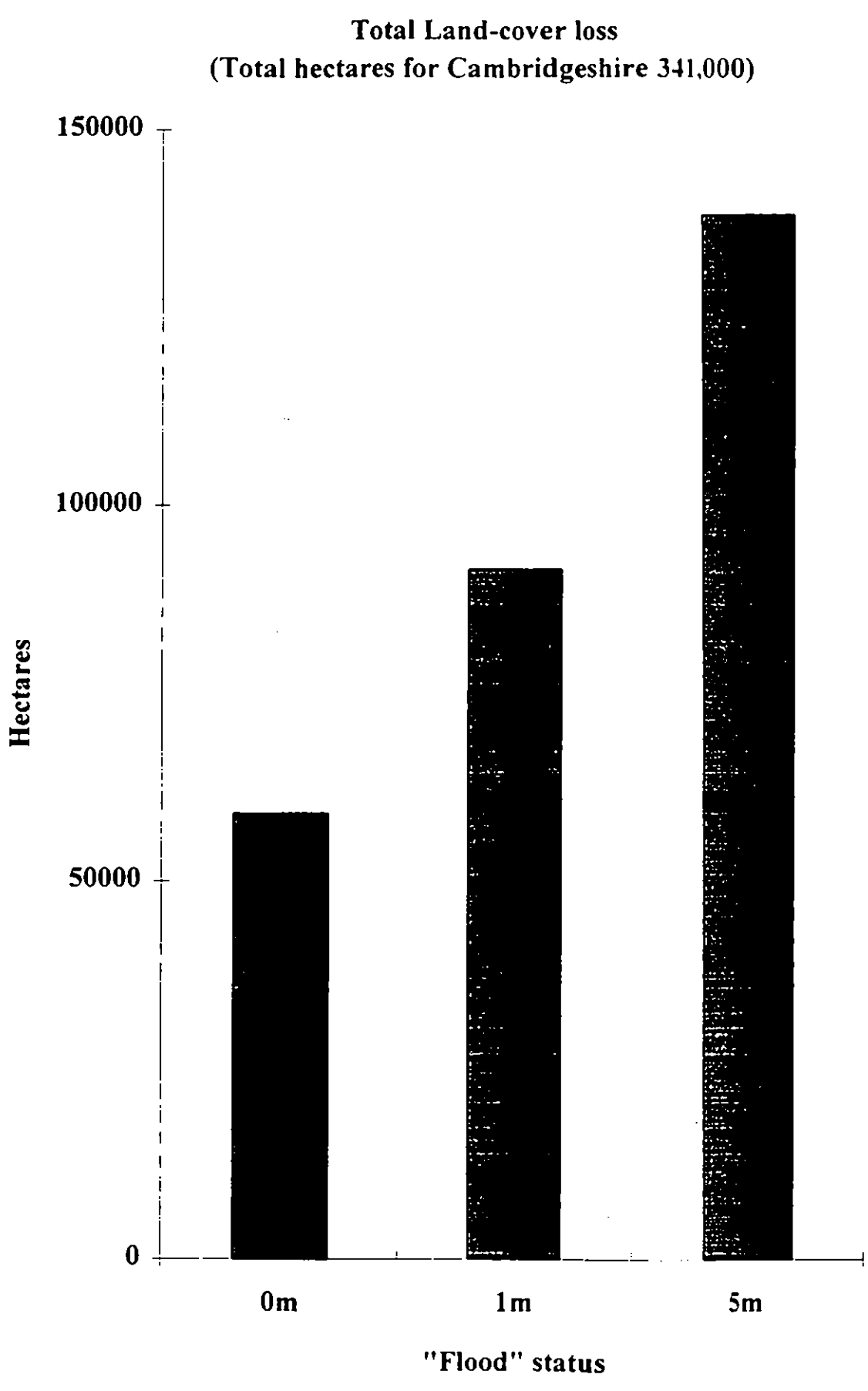


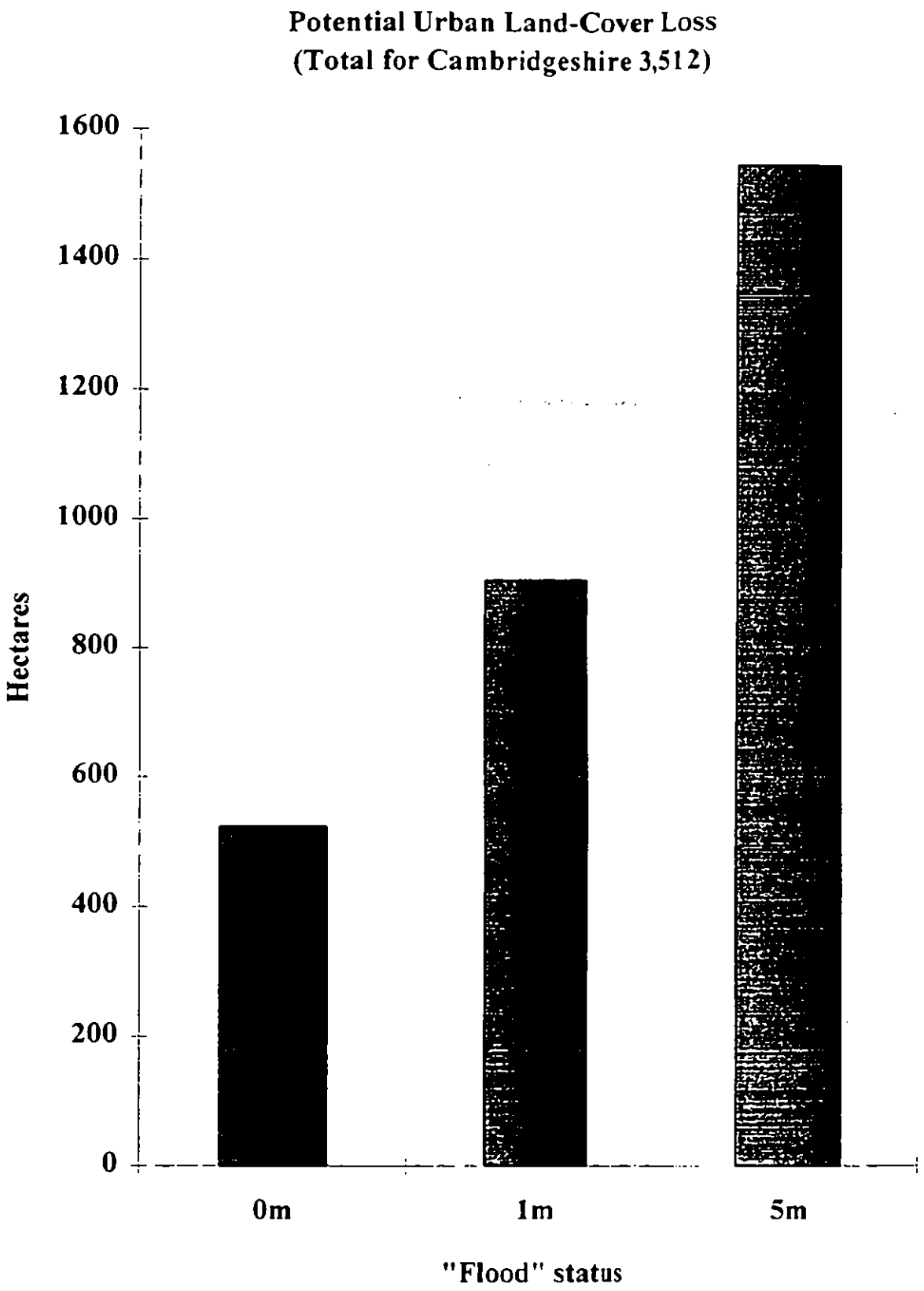
Potential loss of all argicultural cover types
(Total for Cambridgeshire 290,000)



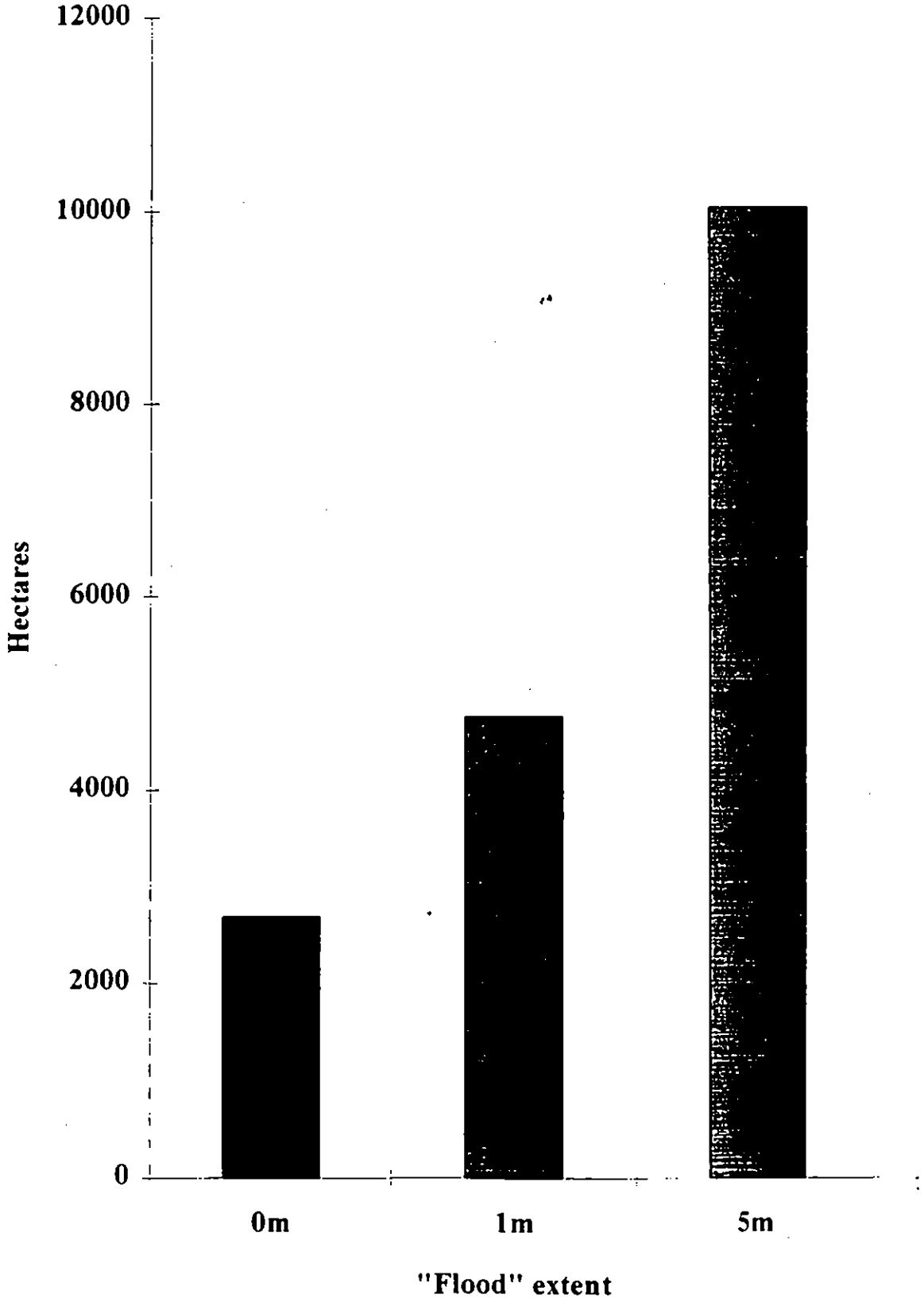
Potential loss of all cover types of likely conservation interest
(Total for Cambridgeshire 16,500)



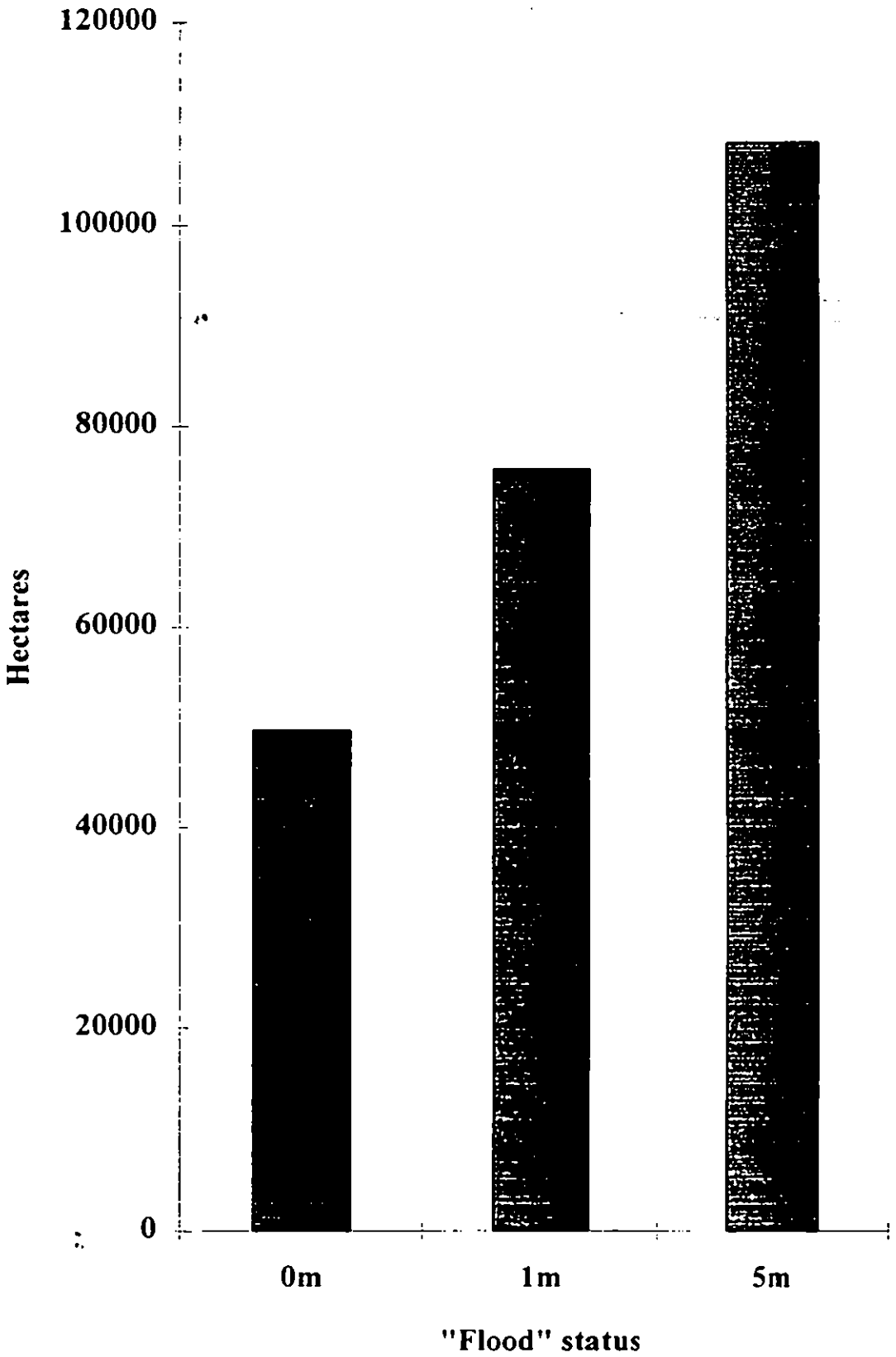

Total Land-cover loss
(Total hectares for Cambridgeshire 341,000)
150000
100000
50000
0
Hectares
0m
1m
5m
"Flood" status


Potential Urban Land-Cover Loss
(Total for Cambridgeshire 3,512)
1600
1400
1200
1000
800
600
400
200
0
Hectares
0m
1m
5m
"Flood" status

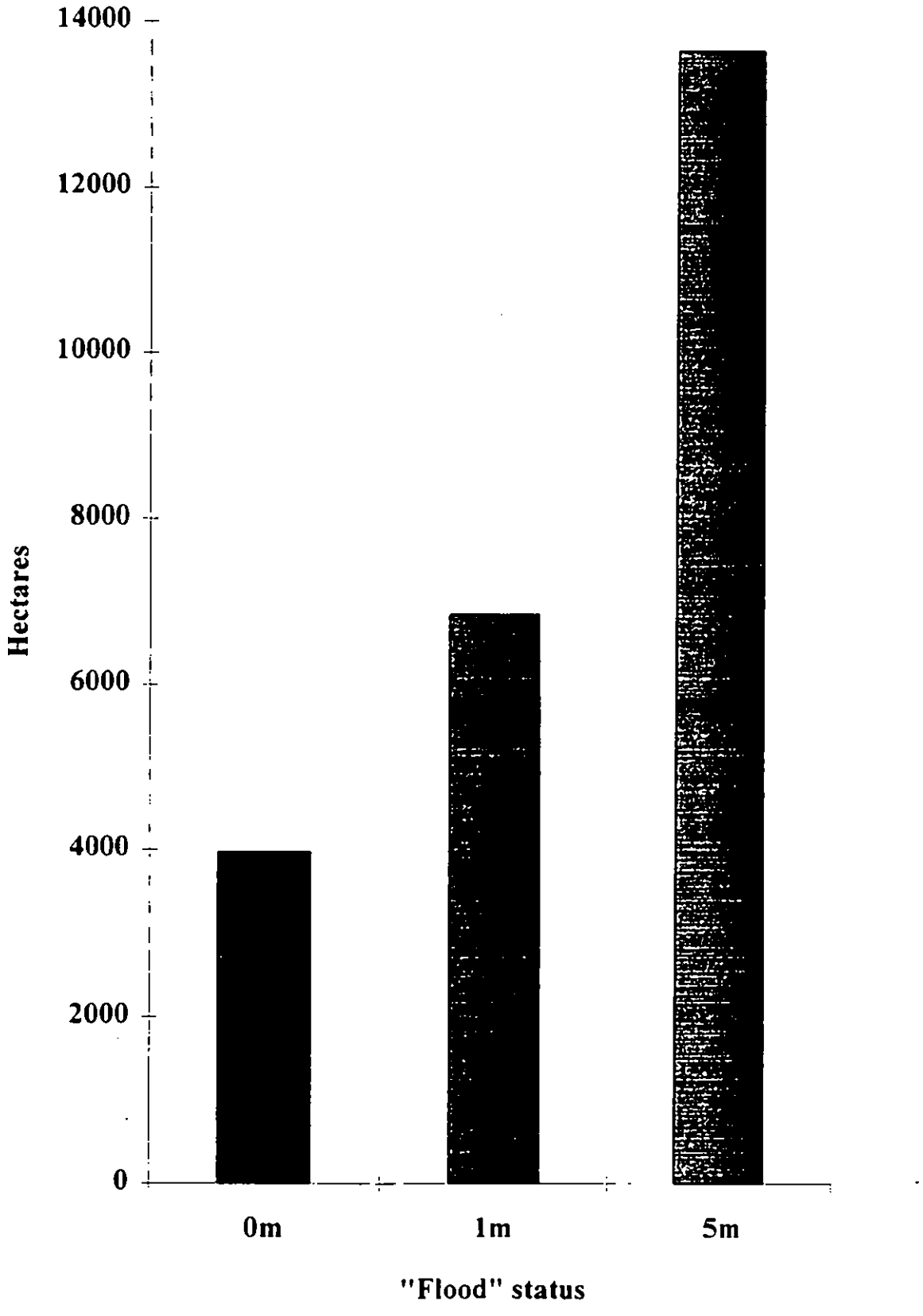
Potential Suburban land-cover loss
(Total for Cambridgeshire 28,500)



Potential loss of tilled land cover type
(Total for Cambridgeshire 238,500)



Potential loss of managed grassland cover type
(Total for Cambridgeshire 51,000)



ANNEX B: BACKGROUND DATA FOR ALL SITES STUDIED

Procedure 1: Area of search

This extended c. 1.5 km from a site located at the centre of a national grid 1km square, making an area of search of 3 x 3 1km grid squares. To provide a regional context, a 9 x 9 km block was chosen, centred on the same 1 km square.

Procedure 2: Land Cover

Land cover data was obtained from automatically generated CIS tables that give hectares of each cover type in the area of search. CIS tables were exported to a standard spreadsheet for further manipulation.

Tables a give the data for land cover in the 3 x 3 km block, the 9 x 9 km block as a percentage of the total area accounted for by the CIS, and also shows national percentages of these cover types derived from the summary data provided in the CIS.

Description of likely land cover in the area of search can be obtained from these statistics.

Procedure 3: Important land cover types

Nationally scarce land cover/ habitat types: no nationally scarce land cover types occur in any of the areas of search.

Cover types of importance to health and the economy: The extent and location of urban developments aids the incorporation of human health considerations into decision-making. Additionally, agricultural land uses are of economic importance and need to be identified. For this purpose tilled land, managed grassland and coniferous woodland have been combined to indicate overall agricultural land use.

Procedure 4: Designated land

From the CIS datasets on designated land types, it is possible to determine which km squares contain designated areas. Squares with more designations have been ranked above those with fewer. However, it must be remembered that the more highly designated land is "double counted".

Procedure 5: Red Data Book Species

This information is held at 10 km national grid square resolution within the CIS. Each 1 km square in the area of search has thus been assigned the record number for the 10 km square to which the 1 km square belongs. This information can be obtained for a series of date classes. For the purposes of this study, RDB records selected were as follows:

Group	Post-date
Butterflies	1960
Carabids	1960
Mosses	1930
Moths	1960
Odonata	1960
Orthoptera	1960
Plants	1930

Procedure 6: High Quality Habitats

The habitat quality information, derived from the species' distribution data, is held on a 10 km basis. Thus, scores are assigned to each 1 km square according to the quality of habitats recorded in the appropriate 10 km square. The 1 km squares likely to contain high quality habitat types are marked provided that the land cover statistics indicate that the habitat type is present within that 1 km square.

Procedure 7: Surface water quality

It is assumed only surface waters within the 3 x 3 km block will be affected.

Procedure 8: Overall assessment of quality for the 3 x 3 km block

The information contained in the various tables can be combined to create a matrix of all individual rankings. This constitutes a multi-component comparative environment index (CEI).

Table 1a: Percentages of land cover types in the area around AgrEvo

Land Cover type	3 x 3 km (study area)	9 x 9 km (region)	Cambs	Great Britain
"dense" urban	1.5	1.2	1	1.1
suburban	14.6	12.1	8.3	5.6
tilled land	61.0	63.8	70.9	21.9
managed grassland	18.1	18.4	14.9	28.1
rough grass	1.9	2.1	2.3	1.8
bracken	0	0	0	1.5
heath grass	0.3	0.2	0.4	8.6
open shrub heath	0	0	0	11.9
dense shrub heath	0	0	0	3.1
bog	0	0	0	1.8
deciduous woodland	1.2	1.4	1.6	5.3
coniferous	0.1	0.1	0.2	3.3
inland bare	1.3	0.7	0.6	1.1
saltmarsh	0	0	0	0.2
coastal bare	0	0	0	0.6
inland water	0	0	0.5	0.7
sea/estuary	0	0	0	3.3

Table 1a clearly indicates the dominance of tilled land, managed grassland and suburban land within the area of search. Tilled land is of slightly greater importance regionally than in the area of search.

Procdure 3: Important land cover types

Table 1b *Suburban plus urban land* cover (ha) present within the area of search

253	5.63 *[9]*	25.87 *[1]*	15.5 *[5]*
252	12.94 *[6]*	23.32 *[2]*	12.88 *[7]*
251	16.44 *[4]*	9.69 *[8]*	22.63 *[3]*
GRID REF	**542**	**543**	**544**

The square containing the site also contains a high proportion of suburban land, indicating that an accident may impact the human population.

Table 1c *Agricultural land* (ha) within the area of search

253	94.01 *[1]*	65.06 *[9]*	83.95 *[2]*
252	82.38 *[3]*	73.45 *[8]*	79.69 *[5]*
251	76.95 *[6]*	80.45 *[4]*	76.07 *[7]*
GRID REF	**542**	**543**	**544**

Procedure 4: Designated land **Table 1d**

253	GRB *[5]*	GRB *[5]*	GRB *[5]*
252	GRB *[5]*	GRB *[5]*	GRB *[5]*
251	GRB *[5]*	GRB *[5]*	GRB *[5]*
GRID REF	**542**	**543**	**544**

All nine 1km squares of the study area fall within a Greenbelt, and thus no one square can be valued more highly than any other.

Procedure 5: Red Data Book Species **Table 1e**

253	53 *[5]*	53 *[5]*	53 *[5]*
252	53 *[5]*	53 *[5]*	53 *[5]*
251	53 *[5]*	53 *[5]*	53 *[5]*
GRID REF	**542**	**543**	**544**

All nine km squares of the study area fall within the same 10km square of the national grid, and thus each square has been given the same value for the number of Red Data Book species present. These 53 species comprise 28 species of moss, and 25 species of vascular plant.

Procedure 6: High Quality Habitats **Table 1f**
Grasslands: I - improved; M - mesotrophic; C - calcareous; R - arable; D - deciduous woodland; F -fens

253	I M C R F *[6.5]*	I M C R F *[6.5]*	I M C R F *[6.5]*
252	I M C R F *[6.5]*	I M C R F *[6.5]*	I M C R D F *[2]*
251	I M C R D F *[2]*	I M C R D F *[2]*	I M C R F *[6.5]*
GRID REF	**542**	**543**	**544**

Whilst all squares fall within the same 10km square (and thus Habitat Quality would be the same for all squares), there are differences attributable to the presence of deciduous woodland in only 3 of the study area squares, and therefore squares not containing woodland land cover are not attributed with High Quality broad-leaved woodland.

Procedure 7: Surface water quality **Table 1g**

253	River Cam	River Cam	-
252	River Cam	River Cam	River Cam
251	-	-	-
GRID REF	**542**	**543**	**544**

Despite the presence of the River Cam or Rhee, and the River Cam or Granta in the above squares, interrogation of water quality databases has been unable to provide information on these stretches of water

Procedure 8: Overall assessment of quality for the 3 x 3 km block **Table 1h**

Grid ref	DA	RDB	HQH	AG	SU	
542 251	5	5	2	6	4	-
543 251	5	5	2	4	8	-
544 251	5	5	6.5	7	3	
542 252	5	5	6.5	3	6	-
543 252	5	5	6.5	8	2	-
544 252	5	5	2	5	7	-
542 253	5	5	6.5	1	9	-
543 253	5	5	6.5	9	1	-
544 253	5	5	6.5	2	5	-
Source table	1d	1e	1f	1c	1b	1i

Table 2a: Percentages of land cover types in the area around Anglian Water

Land Cover type	3 x 3 km (study area)	9 x 9 km (region)	Cambs	Great Britain
"dense" urban	1.2	0.6	1.0	1.1
suburban	5.4	7.2	8.3	5.6
tilled land	36.3	63.6	70.9	21.9
managed grassland	21.8	13.1	14.9	28.1
rough grass	1.5	1.7	2.3	1.8
bracken	0	0	0	1.5
heath grass	1.1	0.3	0.4	8.6
open shrub heath	0	0	0	11.9
dense shrub heath	0	0	0	3.1
bog	0	0	0	1.8
deciduous woodland	2.4	4.6	1.6	5.3
coniferous	0.2	0.7	0.2	3.3
inland bare	0.3	0.2	0.6	1.1
saltmarsh	0	0	0	0.2
coastal bare	0	0	0	0.6
inland water	29.9	8.1	0.5	0.7
sea/estuary	0	0	0	3.3

Table 2a indicates the dominance of inland water, tilled land and managed grassland cover types within the area of search. The presence of inland water is directly attributable to Grafham water, but the dominance of inland water declines with increasing area away from the 3 x 3 km block. Tilled land is of greater importance regionally than in the area of search.

Procedure 3:Important land cover types
Cover types of importance to human health

Table 2b*Suburban and urban land* cover (ha) present within the area of search

267	9.9 *[3]*	9.2 *[4]*	1.9 *[9]*
266	10.2 *[2]*	14.0 *[1]*	3.3 *[6]*
265	2.1 *[8]*	2.4 *[7]*	6.4 *[5]*
GRID REF	**514**	**515**	**516**

The square containing the site also contains the highest proportion of human population within the area of search, and thus accidents may impact upon human health issues.

Table 2c*Agricultural land* (ha) within the area of search

267	17.6 *[7]*	11.5 *[8]*	9.8 *[9]*
266	72.4 *[5]*	76.9 *[4]*	59.8 *[6]*
265	96.6 *[1]*	89.7 *[2]*	89.3 *[3]*
GRID REF	**514**	**515**	**516**

Procedure 4:Designated landTable 2d

267	G *[4]*	G *[4]*	G *[4]*
266	P G *[1]*	G *[4]*	G *[4]*
265	- *[8]*	- *[8]*	- *[8]*
GRID REF	**514**	**515**	**516**

P = Perry Woods SSSI; G = Grafham Water SSSI

Procedure 5:Red Data Book SpeciesTable 2e

267	*5 [5]*	*5 [5]*	*5 [5]*
266	*5 [5]*	*5 [5]*	*5 [5]*
265	*5 [5]*	*5 [5]*	*5 [5]*
GRID REF	**514**	**515**	**516**

All squares within the area of search fall within the same 10 km national grid square, and thus all squares have been allocated the same value for the number of RDB species present (1 species of butterfly, 1 moth and 3 plant species).

Procedure 6:High Quality HabitatsTable 2f
I - improved grassland; M - mesotrophic grassland; C - calcareous grassland; R - arable; D - deciduous woodland

267	I M C R *[8]*	I M C R *[8]*	I M C R *[8]*
266	I M C R D *[3.5]*	I M C R D *[3.5]*	I M C R D *[3.5]*
265	I M C R D *[3.5]*	I M C R D *[3.5]*	I M C R D *[3.5]*
GRID REF	**514**	**515**	**516**

Procedure 7:Surface water qualityTable 2g

267	-	-	-
266	-	-	-
265	-	-	-
GRID REF	**514**	**515**	**516**

Despite the presence of Grafham water in several of the study area squares, there appear to be no watercourses within the study area.

Procedure 8:Overall assessment of quality for the 3 x 3 km blockTable 2h

Grid ref	DA	RDB	HQH	AG	SU	WQ
514 265	8	5	3.5	1	8	-
515 265	8	5	3.5	2	7	-
516 265	8	5	3.5	3	5	-
514 266	1	5	3.5	5	2	-
515 266	4	5	3.5	4	1	-
516 266	4	5	3.5	6	6	-
514 267	4	5	8	7	3	-
515 267	4	5	8	8	4	-
516 267	4	5	8	9	9	-
Source table	1d	1e	1f	1c	1b	1i

Table 3a:Percentage of land cover types in the area around Barrington cement works

Land Cover type	3 x 3 km (study area)	9 x 9 km (region)	Great Britain
"dense" urban	1.1	0.6	1.1
suburban	6.3	8.0	5.6
tilled land	68.3	70.0	21.9
managed grassland	18.2	17.1	28.1
rough grass	2.1	2.4	1.8
bracken	0.04	0.01	1.5
heath grass	0.4	0.2	8.6
open shrub heath	0	0	11.9
dense shrub heath	0	0	3.1
bog	0	0	1.8
deciduous woodland	1.1	0.9	5.3
coniferous woodland	0.03	0.04	3.3
inland bare	2.4	0.8	1.1
saltmarsh	0	0	0.2
coastal bare	0	0	0.6
inland water	0.03	0.1	0.7
sea/estuary	0	0	3.3

The proportions of the major land cover types in the area of search centred on Barrington cement works, varies little from that recorded for the region as a whole. Again, tilled land is the dominant land use both in the area and the region, and therefore likely to be of increased economic signficance.

Procdure 3:Important land cover types
Cover types of importance to human health

Table 3b*Suburban and urban land cover* (ha) present within the area of search

251	2.5 *[7]*	0.9 *[9]*	3.4 *[6]*
250	17.0 *[2]*	2.4 *[8]*	9.2 *[3]*
249	6.9 *[4]*	19.0 *[1]*	4.7 *[5]*
GRID REF	**539**	**540**	**541**

Table 3c*Agricultural land* (ha)

251	78.8 *[8]*	98.1 *[1]*	92.9 *[3]*
250	65.4 *[9]*	96.1 *[2]*	86.3 *[6]*
249	87.3 *[5]*	79.8 *[7]*	88.7 *[4]*
GRID REF	**539**	**540**	**541**

Procedure 4:Designated landTable 3d

251	GRB *[4.5]*	GRB *[4.5]*	GRB *[4.5]*
250	GRB *[4.5]*	GRB *[4.5]*	GRB *[4.5]*
249	- *[9]*	GRB *[4.5]*	GRB *[4.5]*
GRID REF	**539**	**540**	**541**

Eight of the nine squares within the area of study fall within Greenbelt.

Procedure 5:Red Data Book SpeciesTable 3e

251	19 *[7.5]*	53 *[2.5]*	53 *[2.5]*
250	19 *[7.5]*	53 *[2.5]*	53 *[2.5]*
249	18 *[9]*	21 *[5.5]*	21 *[5.5]*
GRID REF	**539**	**540**	**541**

The nine study area squares straddle four 10 km grid squares, accounting for the very different numbers of RDB species recorded across the study area. The majority of species are accounted for by moss and vascular plant species.

Procedure 6:High Quality HabitatsTable 3f
I - improved grassland; M - mesotrophic grassland; C - calcareous grassland; R - arable; D - deciduous woodland; A - aquatic; F - fens; O - coniferous woodland

251	R C I M D *[6]*	R C I M D F *[2]*	R C I M D F *[2]*
250	R C I M D *[6]*	R C I M F *[6]*	R C I M D F *[2]*
249	R C I M *[9]*	R C I M F *[6]*	R C I M F *[6]*
GRID REF	**539**	**540**	**541**

Procedure 7:Surface water qualityTable 3g

251	-	-	Cam (C)
250	-	-	Cam (C)
249	Cam (C)	-	Cam (C)
GRID REF	**539**	**540**	**541**

Four squares within the study area contain stretches of river. However, interrogation of the water quality databases appears to indicate all stretches to be of chemical quality C.

Procedure 8:Overall assessment of quality for the 3 x 3 km blockTable 3h

Grid ref	DA	RDB	HQH	AG	SU	WQ
539 249	9	9	9	5	4	
539 250	7.5	4.5	6	9	2	
539 251	7.5	4.5	6	8	7	
540 249	5.5	4.5	6	7	1	
540 250	2.5	4.5	6	2	8	
540 251	2.5	4.5	2	1	9	
541 249	5.5	4.5	6	4	5	
541 250	2.5	4.5	2	6	3	
541 251	2.5	4.5	2	3	6	
Source table	3d	3e	3f	3c	3b	3i

Table 4a:Percentages of land cover types in the area around Ciba Agriculture

Land Cover type	3x3 km (study area)	9x9 km (region)	Cambs.	Great Britain
"dense" urban	0.7	0.6	1.0	1.1
suburban	9.2	9.3	8.3	5.6
tilled land	67.5	67.9	70.9	21.9
managed grassland	16.9	16.3	14.9	28.1
rough grass	2.9	2.8	2.3	1.8
bracken	0	0.01	0	1.5
heath grass	0.2	0.2	0.4	8.6
open shrub heath	0	0	0	11.9
dense shrub heath	0	0	0	3.1
bog	0	0	0	1.8
deciduous woodland	1.4	1.8	1.6	5.3
coniferous woodland	0	0	0.2	3.3
inland bare	1.1	1.0	0.6	1.1
saltmarsh	0	0	0	0.2
coastal bare	0	0	0	0.6
inland water	0	0	0.5	0.7
sea/estuary	0	0	0	3.3

Table 4a clearly indicates the dominance of tilled land and managed grassland within the area of search, although neither cover type is of greater importance locally than regionally.

Procedure 3:Important land cover types
Cover types of importance to human health

Table 4b*Suburban and urban land cover* (ha) present within the area of search

247	10.5 *[5]*	11.19 *[4]*	12.75 *[3]*
246	9.87 *[7]*	17.44 *[1]*	10.44 *[6]*
245	1.75 *[8]*	1.38 *[9]*	12.81 *[2]*
GRID REF	**545**	**546**	**547**

The square containing the site also contains a much higher proportion of human population than any other square in the area of study.

Table 4c*Agricultural land cover* (ha) within the area of search

247	79.19 *[8]*	80.25 *[7]*	86.26 *[3]*
246	85.94 *[4]*	67.57 *[9]*	85.69 *[5]*
245	92.13 *[2]*	95.63 *[1]*	83.45 *[6]*
GRID REF	**545**	**546**	**547**

The square containing the site contains the lowest area of agricultural land of any in the study area, and thus is perhaps of least importance in the area in terms of agricultural economics.

Procedure 4:Designated landTable 4d

247	SSSI GRB *[1]*	GRB *[3]*	GRB *[3]*
246	- *[7]*	GRB *[3]*	- *[7]*
245	- *[7]*	- *[7]*	- *[7]*
GRID REF	545	546	547

SSSI = Thriplow Peat Holes; GRB = Greenbelt

Procedure 5:Red Data Book SpeciesTable 4e

247	21 *[5]*	21 *[5]*	21 *[5]*
246	21 *[5]*	21 *[5]*	21 *[5]*
245	21 *[5]*	21 *[5]*	21 *[5]*
GRID REF	**545**	**546**	**547**

Again, all squares fall within the same 10 km grid square, and have thus each been attributed with the number of RDB species recorded within that 10 km square (15 species of moss, 6 vascular plant species). However, it may be that all RDB species were actually recorded within the SSSI, and this should become apparent following field survey.

Procedure 6:High Quality HabitatsTable 4f
Grasslands: I - improved; M - mesotrophic; C - calcareous; R - arable habitats; F -fens

247	R C F I M *[5]*	R C F I M *[5]*	R C F I M *[5]*
246	R C F I M *[5]*	R C F I M *[5]*	R C F I M *[5]*
245	R C F I M *[5]*	R C F I M *[5]*	R C F I M *[5]*
GRID REF	**545**	**546**	**547**

Procedure 7:Surface water qualityTable 4g

247	-	-	-
246	-	-	-
245	-	-	-
GRID REF	**545**	**546**	**547**

There do not appear to be any significant watercourses/ waterbodies within the study area.

Procedure 8:Overall assessment of quality for the 3 x 3 km blockTable 4h

Grid ref	DA	RDB	HQH	AG	SU	WQ
545 245	7	5	5	2	8	-
546 245	7	5	5	1	9	-
547 245	7	5	5	6	2	-
545 246	7	5	5	4	7	-
546 246	3	5	5	9	1	-
547 246	7	5	5	5	6	-
545 247	1	5	5	8	5	-
546 247	3	5	5	7	4	-
547 247	3	5	5	3	3	-
Source table	1d	1e	1f	1c	1b	1i

Table 5a:Percentages of land cover types in the area around Ciba Polymers

Land Cover type	3x3 km (study area)	9x9 km (region)	Cambs.	Great Britain
"dense" urban	0.9	0.5	1	1.1
suburban	10.5	9.9	8.3	5.6
tilled land	68.4	68.2	70.9	21.9
managed grassland	15.5	14.7	14.9	28.1
rough grass	2.3	3	2.3	1.8
bracken	0	0	0	1.5
heath grass	0.1	0.2	0.4	8.6
open shrub heath	0	0	0	11.9
dense shrub heath	0	0	0	3.1
bog	0	0	0	1.8
deciduous woodland	1	1.9	1.6	5.3
coniferous woodland	0	0.1	0.2	3.3
inland bare	1.3	1.4	0.6	1.1
saltmarsh	0	0	0	0.2
coastal bare	0	0	0	0.6
inland water	0	0	0.5	0.7
sea/estuary	0	0	0	3.3

Table 5a indicates the dominance of tilled land, managed grassland and suburban land cover types within the area of search.

Procedure 3:Important land cover types
Cover types of importance to human health

Table 5b*Suburban and urban land cover* (ha) present within the area of search

246	10.44 *[5]*	10.19 *[6]*	19.69 *[2]*
245	13.0 *[4]*	22.01 *[1]*	17.81 *[3]*
244	0.19 *[9]*	3.81 *[8]*	5.31 *[7]*
GRID REF	**547**	**548**	**549**

Table 5c*Agricultural land cover* (ha) within the area of search

246	85.69 *[5]*	86.63 *[4]*	74.0 *[8]*
245	83.45 *[6]*	65.89 *[9]*	80.38 *[7]*
244	97.75 *[1]*	91.87 *[2]*	87.82 *[3]*
GRID REF	**547**	**548**	**549**

Procedure 4:Designated landTable 5d

246	- *[5]*	- *[5]*	- *[5]*
245	- *[5]*	- *[5]*	- *[5]*
244	- *[5]*	- *[5]*	- *[5]*
GRID REF	**547**	**548**	**549**

No designated areas are present within the area of study.

Procedure 5:Red Data Book SpeciesTable 5e

246	21 *[5]*	21 *[5]*	21 *[5]*
245	21 *[5]*	21 *[5]*	21 *[5]*
244	21 *[5]*	21 *[5]*	21 *[5]*
GRID REF	**547**	**548**	**549**

Procedure 6:High Quality HabitatsTable 5f

I - improved grassland; M - mesotrophic grassland; C - calcareous grassland; R - arable; ; F - fens

246	I M C R F *[5]*	I M C R F *[5]*	I M C R F *[5]*
245	I M C R F *[5]*	I M C R F *[5]*	I M C R F *[5]*
244	I M C R F *[5]*	I M C R F *[5]*	I M C R F *[5]*
GRID REF	**547**	**548**	**549**

Procedure 7:Surface water qualityTable 5g

246	-	Cam	-
245	-	Cam	Cam
244	-	-	Cam
GRID REF	**547**	**548**	**549**

The River Cam flows through several of the study area squares, and appears to be of chemical quality C within this region.

Procedure 8:Overall assessment of quality for the 3 x 3 km blockTable 5h

Grid ref	DA	RDB	HQH	AG	SU	WQ
547 244	5	5	5	1	9	
548 244	5	5	5	2	8	
549 244	5	5	5	3	7	
547 245	5	5	5	6	4	
548 245	5	5	5	9	1	
549 245	5	5	5	7	3	
547 246	5	5	5	5	5	
548 246	5	5	5	4	6	
549 246	5	5	5	8	2	
Source table	1d	1e	1f	1c	1b	1i

Table 6a:Percentage of land cover types in the area around Firmin Coates

Land Cover type	3 x 3 km (study area)	9 x 9 km (region)	Great Britain
"dense" urban	1.5	1.3	1.1
suburban	7.6	9.8	5.6
tilled land	42.1	43.8	21.9
managed grassland	34.5	31.6	28.1
rough grass	6.0	6.8	1.8
bracken	0	0.01	1.5
heath grass	0.3	0.5	8.6
open shrub heath	0	0	11.9
dense shrub heath	0	0	3.1
bog	0	0	1.8
deciduous woodland	4.5	3.4	5.3
coniferous woodland	1.04	0.2	3.3
inland bare	3.4	2.6	1.1
saltmarsh	0	0	0.2
coastal bare	0	0	0.6
inland water	0.02	0.02	0.7
sea/estuary	0	0	3.3

Tilled land and managed grassland account for the majority of the land within the area and the region, both being found to cover more land than is average for Great Britain, suggesting that both these land cover types may be of economic importance. Contamination of such areas by an accident may thus need to be avoided (e.g. if field survey reveals the grassland to be grazing pastures for stock).

Procedure 3:Important land cover types
Cover types of importance to human health

Table 6b*Suburban and urban land cover* (ha) present within the area of search

268	9.5 *[3.5]*	9.5 *[3.5]*	0 *[9]*
267	8.3 *[5]*	25.4 *[1]*	11.6 *[2]*
266	6.8 *[6]*	5.6 *[7]*	4.9 *[8]*
GRID REF	**562**	**563**	**564**

Table 6c*Agricultural Land cover* (ha)

268	74.6 *[6]*	84.2 *[3]*	94.3 *[1]*
267	80.7 *[5]*	56.2 *[9]*	61.0 *[8]*
266	82.2 *[4]*	87.5 *[2]*	69.1 *[7]*
GRID REF	**562**	**563**	**564**

Procedure 4:Designated landTable 6d

268	- *[7]*	SSSI *[3]*	SSSI NNR *[1]*
267	- *[7]*	SSSI *[3]*	SSSI *[3]*
266	- *[7]*	- *[7]*	- *[7]*
GRID REF	**562**	**563**	**564**

NNR = Chippenham Fen; SSSI = Snailwell Meadows

Procedure 5:Red Data Book SpeciesTable 6e

268	40 *[5]*	40 *[5]*	40 *[5]*
267	40 *[5]*	40 *[5]*	40 *[5]*
266	40 *[5]*	40 *[5]*	40 *[5]*
GRID REF	**562**	**563**	**564**

Procedure 6:High Quality HabitatsTable 6f

268	R C I M F *[5]*	R C I M F *[5]*	R C I M F *[5]*
267	R C I M F *[5]*	R C I M F *[5]*	R C I M F *[5]*
266	R C I M F *[5]*	R C I M F *[5]*	R C I M F *[5]*
GRID REF	**562**	**563**	**564**

Procedure 7:Surface water qualityTable 6g

268			
267			
266			
GRID REF	**562**	**563**	**564**

Water quality information for this study area has yet to be derived.

Procedure 8:Overall assessment of quality for the 3 x 3 km blockTable 6h

Grid ref	DA	RDB	HQH	AG	SU	WQ
562 266	7	5	5	4	6	
562 267	7	5	5	5	5	
562 268	7	5	5	6	3.5	
563 266	7	5	5	2	7	
563 267	3	5	5	9	1	
563 268	3	5	5	3	3.5	
564 266	7	5	5	7	8	
564 267	3	5	5	8	2	
564 268	1	5	5	1	9	
Source table	6d	6e	6f	6c	6b	6i

Table 7a:Percentages of land cover types in the area around Johnson Matthey

Land Cover type	3 x 3 km (study area)	9 x 9 km (region)	Cambs.	Great Britain
"dense" urban	3.3	0.6	1.0	1.1
suburban	16.6	8.6	8.3	5.6
tilled land	48.7	69.8	70.9	21.9
managed grassland	26.0	16.1	14.9	28.1
rough grass	2.2	2.6	2.3	1.8
bracken	0	0	0	1.5
heath grass	1.0	0.3	0.4	8.6
open shrub heath	0	0	0	11.9
dense shrub heath	0	0	0	3.1
bog	0	0	0	1.8
deciduous woodland	0.6	1.2	1.6	5.3
coniferous	0	0	0.2	3.3
inland bare	1.6	0.8	0.6	1.1
saltmarsh	0	0	0	0.2
coastal bare	0	0	0	0.6
inland water	0	0	0.5	0.7
sea/estuary	0	0	0	3.3

Tilled land, managed grassland, suburban and urban land cover types are all dominant within the area of search. Tilled land is of greater importance regionally than in the area of search, but all other locally-dominant cover types are of greater importance locally than regionally.

Procedure 3:Important land cover types
Cover types of importance to human health

Table 7b*Suburban and urban land cover* (ha) present within the area of search

242	1.25 *[8]*	11.13 *[5]*	21.69 *[3]*
241	1.19 *[9]*	17.0 *[4]*	66.06 *[1]*
240	2.19 *[7]*	4.63 *[6]*	47.5 *[2]*
GRID REF	**533**	**534**	**535**

Table 7c*Agricultural land* (ha) within the area of search

242	90.4 *[3]*	77.6 *[5]*	73.5 *[6]*
241	93.9 *[1]*	56.7 *[7]*	26.9 *[9]*
240	92.4 *[2]*	89.1 *[4]*	48.0 *[8]*
GRID REF	**533**	**534**	**535**

Procedure 4: Designated land Table 7d

242	LNR SSSI *[1.5]*	- *[6]*	- *[6]*
241	LNR SSSI *[1.5]*	- *[6]*	- *[6]*
240	- *[6]*	- *[6]*	- *[6]*
GRID REF	**533**	**534**	**535**

Procedure 5: Red Data Book Species Table 7e

242	18 *[5]*	18 *[5]*	18 *[5]*
241	18 *[5]*	18 *[5]*	18 *[5]*
240	18 *[5]*	18 *[5]*	18 *[5]*
GRID REF	**533**	**534**	**535**

Again, all squares fall within the same 10km grid square. The RDB species may all have been recorded within the nature reserve area, and again field survey would be able to verify this.

Procedure 6: High Quality Habitats Table 7f

I - improved grassland; M - mesotrophic grassland; C - calcareous grassland; R - arable; D - deciduous woodland

242	I M C R *[5]*	I M C R *[5]*	I M C R *[5]*
241	I M C R *[5]*	I M C R *[5]*	I M C R *[5]*
240	I M C R *[5]*	I M C R *[5]*	I M C R *[5]*
GRID REF	**533**	**534**	**535**

Procedure 7:Surface water qualityTable 7g

242	-	-	-
241	-	-	-
240	-	-	-
GRID REF	**533**	**534**	**535**

There do not appear to be any significant areas of water/ watercourses within the area of study.

Procedure 8: Overall assessment of quality for Johnson Mathey Table 7h

Grid ref	DA	RDB	HQH	AG	SU	WQ
533 240	6	5	5	2	7	
534 240	6	5	5	4	6	
535 240	6	5	5	8	2	
533 241	1.5	5	5	1	9	
534 241	6	5	5	7	4	
535 241	6	5	5	9	1	
533 242	1.5	5	5	3	8	
534 242	6	5	5	5	5	
535 242	6	5	5	6	3	
Source table	1d	1e	1f	1c	1b	1i

Table 8a:Percentage of land cover types in the area around Alconbury Truckstop

Land Cover type	3 x 3 km (study area)	9 x 9 km (region)	Great Britain
"dense" urban	1.1	1.0	1.1
suburban	12.7	7.8	5.6
tilled land	44.1	67.1	21.9
managed grassland	32.9	15.0	28.1
rough grass	4.4	3.0	1.8
bracken	0	0	1.5
heath grass	0.2	0.2	8.6
open shrub heath	0	0	11.9
dense shrub heath	0	0	3.1
bog	0	0	1.8
deciduous woodland	2.0	3.5	5.3
coniferous woodland	0.01	0.7	3.3
inland bare	2.5	1.7	1.1
saltmarsh	0	0	0.2
coastal bare	0	0	0.6
inland water	0	0.1	0.7
sea/estuary	0	0	3.3

Both the area of search and the region are dominated by tilled land, managed grassland and suburban land, indicating that an accident here may impact both upon arable agriculture and livestick husbandry, and also upon humans.

Procedure 3: Important land cover types
Cover types of importance to human health

Table 8b*Suburban and urban land cover* (ha) present within the area of search

277	14.1 *[4]*	3.7 *[8]*	8.3 *[6]*
276	22.1 *[2.5]*	35.2 *[1]*	7.9 *[7]*
275	22.1 *[2.5]*	1.4 *[9]*	9.4 *[5]*
GRID REF	**518**	**519**	**520**

Table 8c *Agricultural Land cover* (ha)

277	85.7 *[2]*	81.2 *[4]*	73.4 *[7]*
276	76.2 *[6]*	53.2 *[9]*	71.8 *[8]*
275	76.6 *[5]*	90.2 *[1]*	85.0 *[3]*
GRID REF	**518**	**519**	**520**

Procedure 4: Designated land Table 8d

277	- *[5]*	- *[5]*	- *[5]*
276	- *[5]*	- *[5]*	- *[5]*
275	- *[5]*	- *[5]*	- *[5]*
GRID REF	**518**	**519**	**520**

Procedure 5: Red Data Book Species Table 8e

277	9 *[3.5]*	9 *[3.5]*	8 *[8]*
276	9 *[3.5]*	9 *[3.5]*	8 *[8]*
275	9 *[3.5]*	9 *[3.5]*	8 *[8]*
GRID REF	**518**	**519**	**520**

RDB species present include species of butterfly, Odonata, moths and mosses.

Procedure 6: High Quality Habitats Table 8f

277	R I M *[5]*	R I M *[5]*	R I M *[5]*
276	R I M *[5]*	R I M *[5]*	R I M *[5]*
275	R I M *[5]*	R I M *[5]*	R I M *[5]*
GRID REF	**518**	**519**	**520**

Procedure 7: Surface water quality Table 8g

277			
276	A.B.		
275	A.B.	A.B.	
GRID REF	518	519	520

Alconbury Brook (A.B.) runs through several of the study area squares, and was found to be of chemical quality D.

Procedure 8: Overall assessment of quality for Alconbury Truck stop Table 8h

Grid ref	DA	RDB	HQH	AG	SU	WQ
518 275	5	3.5	5	5	2.5	
518 276	5	3.5	5	6	2.5.	
518 277	5	3.5	5	2	4	
519 275	5	3.5	5	1	9	
519 276	5	3.5	5	9	1	
519 277	5	3.5	5	4	8	
520 275	5	8	5	3	5	
520 276	5	8	5	8	7	
520 277	5	8	5	7	6	
Source table	8d	8e	8f	8c	8b	8i

Table 9a: Percentage of land cover types in the area around Mepal Tyre dump

Land Cover type	3 x 3 km (study area)	9 x 9 km (region)	Great Britain
"dense" urban	0.1	1.2	1.1
suburban	13.9	5.9	5.6
tilled land	48.4	66.5	21.9
managed grassland	32.2	22.0	28.1
rough grass	4.7	3.0	1.8
bracken	0	0.04	1.5
heath grass	0.2	0.3	8.6
open shrub heath	0	0	11.9
dense shrub heath	0	0	3.1
bog	0	0	1.8
deciduous woodland	0.1	0.7	5.3
coniferous woodland	0	0.01	3.3
inland bare	0.4	0.2	1.1
saltmarsh	0	0	0.2
coastal bare	0	0	0.6
inland water	0	0.3	0.7
sea/estuary	0	0	3.3

The predominance of tilled land and managed grassland in the area and the region highlight agriculture to be of importance. Whilst the proportion of tilled land is high compared to the national average, it is below that of the region and also of the county. Conversely, the proportion of managed grassland recorded is higher than the national figure for this cover

type. Additionally, the high proportion of suburban land in the area of search (cf. both the region and nationally) suggests that an accident at this site many impact upon humans.

Procedure 3: Important land cover types
Cover types of importance to human health

Table 9b *Suburban and urban land cover* (ha) present within the area of search

280	18.9 *[3]*	4.8 *[9]*	12.3 *[5]*
279	25.1 *[2]*	11.3 *[6]*	15.6 *[4]*
278	26.0 *[1]*	5.1 *[8]*	7.1 *[7]*
GRID REF	**544**	**545**	**546**

Table 9c *Agricultural Land cover types* (ha)

280	77.3 *[5]*	92.9 *[1]*	83.7 *[4]*
279	69.7 *[8]*	73.6 *[7]*	75.8 *[6]*
278	69.3 *[9]*	91.5 *[3]*	91.9 *[2]*
GRID REF	**544**	**545**	**546**

Procedure 4:Designated landTable 9d

280	- *[5]*	- *[5]*	- *[5]*
279	- *[5]*	- *[5]*	- *[5]*
278	- *[5]*	- *[5]*	- *[5]*
GRID REF	**544**	**545**	**546**

Procedure 5:Red Data Book SpeciesTable 9e

280	*9 [2]*	*9 [2]*	*9 [2]*
279	*5 [6.5]*	*5 [6.5]*	*5 [6.5]*
278	*5 [6.5]*	*5 [6.5]*	*5 [6.5]*
GRID REF	**544**	**545**	**546**

The RDB species present comprise mosses, vascular plants and Odonata.

Procedure 6:High Quality HabitatsTable 9f
R - arable; I - improved grassland; M - mesotrophic grassland; F -fens;

280	R I M F *[2]*	R I M F *[2]*	R I M F *[2]*
279	R I M *[6.5]*	R I M *[6.5]*	R I M *[6.5]*
278	R I M *[6.5]*	R I M *[6.5]*	R I M *[6.5]*
GRID REF	**544**	**545**	**546**

Procedure 7:Surface water qualityTable 9g

280	-	-	-
279	-	-	-
278	-	-	-
GRID REF	**544**	**545**	**546**

There do not appear to be any significant water courses within the area of study. However, the Hundred Foot Drain and the Old Bedford River lie in the squares directly to the north west of the study area, and there may therefore be catchwater drains within the 3 x 3 km block.

Procedure 8:Overall assessment of quality for the 3 x 3 km blockTable 9h

Grid ref	DA	RDB	HQH	AG	SU	WQ
544 278	5	6.5	6.5	9	1	-
544 279	5	6.5	6.5	8	2	-
544 280	5	2	2	5	3	-
545 278	5	6.5	6.5	3	8	-
545 279	5	6.5	6.5	7	6	-
545 280	5	2	2	1	9	-
546 278	5	6.5	6.5	2	7	-
546 279	5	6.5	6.5	6	4	-
546 280	5	2	2	4	5	-
Source table	9d	9e	9f	9c	9b	9g

Natural Environment Research Council

SCHOOL OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT

MIDDLESEX UNIVERSITY

[redacted]

FLOOD HAZARD RESEARCH CENTRE

Cambridgeshire

Flood Hazard Evaluation

Cambridgeshire - Flood Hazard Evaluation.

1.0 Aim.

To develop an understanding of hazard management issues to promote sustained development and prosperity with regard to the economic and natural environment as determined by Cambridgeshire Local Agenda 21.

2.0 Objectives.

a. Develop an understanding of the needs of the planning agencies and their Authorities
b. Make effective use of existing data resources and the means of interpretation
c. Use these resources to the economic advantage of both operating organisations and research institutions
d. Recommend collective programmes to promote and fund core research programmes of mutual advantage.

There are a number of research initiatives both within research institutions and the Environment Agency which are addressing the issues relevant to hazard, and particularly flood hazard, and general environmental management. **See Appendix 1 (p10).**

3.0 Background.

Improvements to flood forecasting and warning are MAFF's highest investment priority, but the sound programme of capital investment and continued maintenance of structural flood alleviation measures by the Environment Agency (EA) and its predecessors should not be underestimated. The Agency currently spends half of its annual budget of £240 millions on flood defence activities.

Recent flood events of considerable severity across Europe, particularly Italy (1994 and 1996), Glasgow and Perth (1993/4) and Spain (1996), with heavy losses to life and colossal economic damages have focused attention on the calamitous effects of flooding on communities and the consequences on economic prosperity and sustained development. Within England and Wales the incidence of major flooding appears to be increasing, with events in the 1990's, although not resulting in death, leading to major economic and social disruption (for example, Chichester, Cardigan, Dover, Polperro and Towyn).

The Institute of Hydrology's (IoH) flood risk maps illustrate the potential gravity of the combined 100 year frequency flood event across Cambridgeshire, with up to half the county, including most of the urban centre of Cambridge, suffering from the consequences of this disaster scenario.

The Environment Agency, through its Flood Warning Dissemination Project, has produced Flood Warning Dissemination Plans for County and/or Police Authority areas in liaison with local authority County Emergency Planning Officers. It has also been proactive in developing local planning forums with county emergency services to plan for major disaster scenarios.

It is 50 years this March since the disastrous and nation-wide fluvial flooding of 1947 and this study is timely to focus on the potential disastrous effects of a repeat worst case scenario. With urban development continuing apace in both the defended and unprotected flood plains of our nation, the consequences of major overtopping or breaching of the flood defence systems will have a major impact on the economic and environmental sustainability. The defences on the Rhine and its tributaries in The Netherlands held back much of the floodwaters during the epic floods of 1995, but nevertheless the subsequent engineering efforts to re-stabilise the embankments cost several percentage points of the Dutch GNP.

This research will apply data and suggest methods developed by Middlesex University to evaluate the potential economic impact on Cambridgeshire of widespread flooding in excess of the 100 year return period event, using flood extent data derived from the Institute of Hydrology's Digital Terrain Model. The evaluation will be initially 'broad brush' with recommendations for future research to evaluate wider impacts. A review of policy issues to plan for and help mitigate against such a catastrophe also forms part of this report with emphasis on:

- Regulation and Planning
- Flood Disaster Emergency Planning
- Flood Forecasting and Warning Response Systems
- Flood Defence Operations and Maintenance

It is hoped that future policies on sustainable development in the wake of potential flood disaster can be managed successfully in partnership arrangements with civil protection, research organisations, local and police authorities and the Environment Agency.

4.0 The Cambridgeshire County 'Worst case' damage scenario

4.1 Primary Sources of Data.

Middlesex University – based on 25 years research experience. **(See Appendix 2, p11)**

Institute of Hydrology – based on a project, completed in 1995 from a MAFF contract, to show areas which, *in the absence of flood defences*, would be inundated by floods recurring with a frequency of 100 years. **(See Appendix 3, p12)**

All the caveats relevant to these data sources have been taken into account to develop a conservative evaluation of the cost of damage.

4.2 Interim Evaluation of 100 year damages

The methodology outlined in **Appendix 4, p14** is time consuming and would require some programming input to determine addresses in flood zone/post code area combinations. An interim evaluation procedure was therefore adopted using existing data. The Cambridgeshire Civil Protection Unit has data on MapInfo GIS on number of households in each Enumeration District (for this study a household is taken as synonymous with property). This layer of data can be superimposed on the IoH mapped database. A quick count of all residential properties in ED's that are more than 50% within the maximum flood outline will give a 'ball park' estimate of properties affected by the 100 year flood.

Clearly, depth of property flooding does not compare with depth of flooding in IoH flood zone for reasons enumerated in Appendix 3. Assuming an envelope for all properties of between 0.3 metres flooding (best case) and 1.2 metres (worst case) flooding will give a range of the magnitude of the flood problem for the county if all worst case events were simultaneous.

4.3 Results of the Interim evaluation

Middlesex FLAIR 1990 data indicates that, at this coarsest level of evaluation, total potential damages to *residential property only*, using the IoH flood risk envelope, ranges from £732 millions (mean property flooding 0.3m) to £1,269 millions (mean property flooding 1.2m) - see Table 1, p34. Population affected is over a quarter million and households affected are over 100,000 (though this includes households living in flats above the flood area). It is emphasised that no account has been taken of losses to industry, agriculture, commercial activities or other non-residential property, nor takes into account socio-economic or environmental factors. The social distress and disruption, including the potential for loss of life, if converted to economic values, would enhance this figure by several orders of magnitude.

The data is too broad to disaggregate on a river catchment basis, but dividing damages into District areas shows Peterborough City and Huntingdonshire to be the worst affected with over half the potential damage in this two Districts:

Peterborough City	27.3 % of total potential damage
Huntingdonshire	25.1 %
South Cambridgeshire	16.8 %
Cambridge City	12.4 %
Fenland	10.6 %
East Cambridgeshire	7.8 %

Converting the damage data to 1997 prices gives the range of worst case aggregate losses from £945 millions to £1,640 millions.

5.0 The Regional Scale Analysis of the Cambridgeshire 100 year flood scenario

Section 4 gives a 'bottom up' evaluation of the 100 year worst case scenario. A global estimate of total flood impact is possible using the Regional Scale Analysis approach (RSA) as developed for the Euroflood project, led by Middlesex University, as part of the European Programme on Climatic Hazards (EPOCH). This method is most appropriate for a global synopsis of large scale flooding and has been applied to flood scenarios on the North German Coast (see 'Floods in Europe' Chapter 4, published by Middlesex University, 1995) and by the Flood Hazard Research Centre for evaluating the benefits of the St Petersburg (Russia) tidal flood barrier with an estimated urban population at risk of circa. 5 millions.

The Socio-economic dimensions of RSA should be split to an appropriate level of disaggregation, i.e. District, urban community, parish etc. to include 5 groups of data to provide a scale of regional impact of the worst case flood scenario:

- The population at risk
- Residential units at risk
- Numbers employed
- Productive capital stock and other property values
- The value added by industrial production

In detail the basic elements of the RSA economic classification are as follows:

A Socio-economic Base

1 Population
- 1.1 status and long term development
- 1.2 age pattern

2 Housing
- 2.1 residential house, flats, residents
- 2.2 housing capital stock

3 Infrastructure
- 3.1 education, recreation
- 3.2 utilities and environmental services
- 3.3 traffic and communications

B Sites and factors of production

1 Production plants and workplaces
- 1.1 employers/employees by economic sectors
- 1.2 size of production establishments

2 Land as a factor of production
- 2.1 land use categories and shares
- 2.2 values of built-up and agricultural land

3 Productive capital stock and other property values of economic sectors
- 3.1 gross capital invested
- 3.2 stocks and other values

C Current results of economic activities

1 Gross value added
2 Tax revenue

D Environmental Assets

1 Environmental structures
2 Conservation and other protected areas

5.1 Flood Defence Policy.

The importance of *Flood Defence Policy*, particularly as it relates to the inter-relationship between *Land and Water planning,* is apparent from the consequences of a failure of flood defences. **Appendix 5, p16** contains a resume of current policies and the statutory support those policies have. Of equal importance is the direction of *Future Policy Guidance*. **Appendix 6, p20** contains a resume of the status and direction of current guidance.

5.2 Summary of Evaluation Factors.

a. The results represent a conservative estimate of damage costs.
b. Only fluvial flooding has been taken into account. NRA published data shows a similar effect on Cambridgeshire of extreme coastal flooding. MAFF are currently considering commissioning IoH to produce a study.
c. No consideration is given to industry, infrastructure, health or environmental etc. costs.
d. No new housing developments have been taken into account in the damage cost assessments.
e. In the context of sustained development it is relevant to note that East Anglia is sinking and the sea levels are rising. It is fair to assume that the cost of flood defences in the Region will inevitably rise in the years to come.

6.0 Flood Emergency Plans including Flood Warning Arrangements

6.1 Improving strategic planning and proactive links with planning authorities is essential to control development and reduce future flood risks. However, many flood plains are already intensely urbanised as either the result of unwise planning or as infill following the construction of flood alleviation measures. Often the public, planners and developers misconstrue "alleviation" for "prevention". No engineering works can prevent flooding but merely alleviate the consequences of flooding. During the December 1994 flood on the Clyde in Scotland, existing defences protecting the Rutherglen area of Glasgow were overtopped (and subsequently breached) by flood water up to two metres above the level of the "defences". However, well conceived and effective preparedness plans as are being developed in the EA/local authority planning forums as a continuation from the Flood Warning Dissemination Plan production, completed at the end of 1996, can mitigate the affects of flooding. Such plans were virtually absent in the Piedmont (Italy) floods.

6.2 The unique position of Cambridgeshire with its exposure to both fluvial and coastal flooding, current and planned development of both housing, industrial and infrastructure make emergency planning a major consideration for all the authorities concerned with

public safety. **Appendix 7, p25** outlines the current status of emergency planning and the current advice given to the Environment Agency.

6.3 Flood forecasting and warning systems, the particular responsibility of the Environment Agency together with flood defence operations, including maintenance, are also vital considerations for the authorities. These issues are outlined at **Appendix 8, p28 and 9, p31** in order to give a rounded picture to this preliminary evaluation.

7.0 Concluding Remarks and future Research Priorities

The flood risk culture in England and Wales would rarely allow for flood protection to a greater standard than once in 100 or 200 years. Thus catastrophic flood events, as in Italy and Central Scotland, will always be a threat in England and Wales despite the astute operational management of our rivers. Amenity and environmental concerns over high protection standards are often valid, with oversized defences impairing the visual, aesthetic and environmental amenity of a river. However, policy decisions to restrict the standard of protection must be backed up by strategies for the development of preparedness plans and guided growth strategies away from flood plains, backed up by flood dissemination programmes supported and resourced via emergency planning agencies with a statutory remit.

Appropriate maintenance to environmentally accepted standards would also mitigate flood losses by reducing the flood stage of the equivalent river discharge in un-maintained river conditions. Diligent tree and bush clearance on riverbanks will not only assist in the conveyance of floodwater but also reduce the probability of bridge blockage with concomitant afflux problems. Capital works to a finite design standard if carefully planned, will also mitigate flood losses beyond the design capability of the scheme. Off-line balancing facilities are an example.

Extreme flood events are increasing across the globe, not least in the UK. Only an increased cultural awareness of this risk and the consequences on socio-economic activities may change attitudes to design principles for flood alleviation and encourage more rigorous standards of protection where economically viable and sensitively managed.

To prevent, mitigate and be properly prepared of the potential conditions, considered by this evaluation, requires partnership working by all of the agencies concerned. The ongoing work of the research organisations as contributors and partners would seem to be a very desirable, if not an essential ingredient to this partnership.

7.1 Future programmes of Work

Following this information evaluation review and high level, rapid appraisal of the worst case flood scenario for Cambridgeshire, the following recommendations for future work are suggested:

- Collaborative work with the EA and IoH to fine-tune the Digital Terrain Models of the 100 year flood risk area for Cambridgeshire. This should include comparisons with the Section 105 flood risk maps for the County as they come on line. Analysis should be done on a catchment by catchment basis to simulate real flood events.

- Further reviews of the available address technologies and demographic databases, to determine a better understanding of the 'at risk' population in the County, to assist in the prioritisation of flood zones at risk. This should be done in conjunction with the Insurance industry databases developed for actuarial purposes The 'RESIDATA' database being developed by EQECAT international in Warrington, and the General Accident data collected as part of a research programme at Dundee University should be investigated.

- Elicit a methodology for separating residential data from commercial/industrial data, as the impact of flooding on non-residential property has a far-reaching effect on the socio-economic base of the County.

- Work with ITE and Silsoe College, University of Cranfield, on the environmental, agricultural and conservation impacts of the disaster scenario flood. Silsoe have complementary data to Middlesex on the impacts of flooding on agriculture.

- Middlesex Contingent Valuation Methodology could be developed to value the economic costs of environmental and recreational degradation as a result of both disaster flood scenarios and, on the reverse side of the coin, the environmental degradation associated with ill conceived flood alleviation projects.

- Using improved IoH flood risk data in conjunction with Section 105 flood plain models and improved 'at risk' demographic data, a more credible worst case flood damage scenario should be developed for the County.

- As an alternative approach, assess the value of the Regional Scale Analysis technique to develop a full impacts study of worst case flooding on the social, economic and environmental development of the county. The Middlesex-led Euroflood project has developed a model to assist with RSA and this should be investigated.

- Develop a programme for co-operation and understanding (a partnership) between the CPU and EA (Anglian Area Emergency Planners) to develop appropriate preparedness plans based on an auditable worst case scenario for the County, identifying priority risk areas.

- Develop 'what if' mock up enquiries to determine that procedures and resources are in place in the event of known potential disasters.

- CPU should use its influence with County strategic planners to encourage guided growth away from the most vulnerable flood plain areas. Production of a joint (CPU/EA) plan led strategy for guiding development away from the most vulnerable areas will facilitate the sustainable social and economic development of the county.

- Educate the local authority decision-makers as to the social and economic consequences of ignoring the impacts of the worst case scenario. Case studies within Europe, both of disaster and Best Practice for land use management, should be part of this educative process and foster pro-action rather than complacency. *Floods don't just happen to other people.*

Dr John B. Chatterton
Middlesex University Flood Hazard Research Centre
6th February 1997

Appendix 1.

Research Initiatives addressing issues relevant to hazard, particularly flood hazard, and general environmental management.

The Institute of Hydrology was commissioned by the Ministry of Agriculture, Fisheries and Food (MAFF) to produce a flood risk map for England and Wales. The Cambridgeshire Civil Protection Unit have a licence from IoH for the use of Eastern Region Data.

The Institute of Terrestrial Ecology has developed a Countryside Information System to combine and present a comprehensive range of environmental information. The Cambridgeshire Civil Protection Unit has five licences for the use of this data UK wide.)

Middlesex University Flood Hazard Research Centre have developed nationally compatible data sets to evaluate the economic losses associated with flooding

The Environment Agency has sponsored research to develop a methodology complementary to that pioneered at Middlesex to look at the opportunity benefits of improvements to flood warning technologies to mitigate against the effects of flood disasters.

Appendix 2.

Middlesex University Flood Hazard Research Centre: Data and Research Capability

The Flood Hazard Research Centre was established in 1972 and is the foremost research and policy institution in the UK on flood hazard management. Its databases and methodology on urban economic flood losses set out in three published manuals, is accepted by MAFF as the 'industry standard'. The 1990 FLAIR (Flood Loss Assessment Information Report) currently in the throws of update provides unique data to provide deliverables, which enhance our ability to protect and sustain communities. The main thrust of research over the past 25 years has been:

- A detailed (multi-layered) urban land use classification system
- Depth damage data banks appertaining to this classification, built up over 25 years
- Vulnerability analysis
- Urban damage assessment modelling
- Road traffic disruption modelling
- Utility outage data and modelling (applicable to any hazard)
- Land Use Surveys and capital flood defence appraisal methodologies
- Valuing environmental resources in economic terms
- Cost Benefit Analysis for emergency planning to optimise resources.

Depth/Damage Data

Painstaking research over 25 years has built up a depth/damage database for the land use types represented in urban communities. At the highest level of aggregation this data is available for residential, retail and related, agricultural buildings, public buildings, professional premises, and manufacturing industry, for up to 15 flood depths and two flood duration's - less than and greater than 12 hours. This data is expressed in economic terms rather than financial values. The philosophy of flood damage assessment is that where the public purse is the main funding agent of damage alleviation, i.e. through structural protection or flood warning strategies, then damage and consequently damage avoided by mitigating actions should be expressed in economic terms. Financial losses i.e. new for old replacement of insured property reflect losses to individuals not resource costs to the national exchequer. Economic losses assume that the customer (property owner) has had some value form consumption and that full replacement costs of damaged contents and infrastructure involves some degree of personal betterment.

Appendix 3.

IoH Flood Risk Maps for England & Wales

The IoH project, completed in 1995 from a MAFF contract, developed maps of England and Wales that show an estimate of the areas which, *in the absence of flood defences,* would be inundated by floods that are expected to recur with a frequency of 100 years. The 100-year frequency is the indicative standard proposed by MAFF in their Project Appraisal Guidance Notes (PAGN), published in 1993 for all fluvial urban flood protection. Exceedance of these standards would produce widespread overtopping of existing flood defences and probably breaching of sub-standard defences. The maps also identify the built-up areas that would be at risk. A digital terrain model (DTM) was developed to translate flooding at the watercourses to flood depth in the flood plain, based on catchment characteristics. Three flood zones were mapped, showing inundation's of 0.5 metres or less, inundation of between 0.5 metres and 2.5 metres and inundation of greater than 2.5m. These zones represent minor flooding, flooding causing significant damage to property and flooding resulting in major flooding with the threat of loss to life..

The resulting maps of flood extent have been compared with existing maps of flood risk (mostly maps developed as a result of the 1973 Water Act Section 25(5) surveys developed by the former Water Authorities. After careful analysis, these were judged to be in good agreement with the derived model in most cases. So much so that it is considered that presenting the results at scales greater than the largest used in the report (1:625,000) would not be inappropriate for providing an indication of the potential extent of flooding.

The results indicate that some 10,683 km^2 of land would be at risk, of which 611 km^2 is built-up. These figures represent 7.1% of the land area of England and Wales and 6.8% of its built up area respectively.

Major caveats in IoH flood risk study

The flood risk maps represent the value to the nation of flood defences and for unprotected flood plains the extent of flooding in a disaster scenario. The flood depth maps show the highest possible flooding from concurrent flooding across the nation for catchment greater than 10 square kilometres. It is emphasised that this is a first cut and not open to site specific scrutiny. Some of the other main caveats possibly exaggerating flood depths are as follows:

- Vertical accuracy is to 1 metre
- Horizontal accuracy is to 50 metres
- No account in modelling is taken of raised roads

- No account in modelling is taken of embankments which will inhibit flood flow
- No account is taken of the effect of fen land pumped drainage
- No account is taken of substantially engineered IDB protection provided on many main rivers
- Flooding on watercourses leading to tidal rivers is not included
- Lock drops, e.g. Jesus lock on the Cam, are not modelled
- Properties built well above fen levels may be isolated above general flood levels
- DTM is based on OS 1:50,000 10 metre contours; 01.m accuracy is spurious; 0.75m accuracy in flood levels is more likely.

Other caveats may underestimate flood level:

- Ice flows and poor maintenance will exacerbate flood levels
- Cross catchment flows are not modelled; floods relate to their normal drainage areas (Cambridgeshire could gain flows from Lincolnshire and Bedfordshire catchments in extreme events).

IoH data gives some indication of the of the scale, if not depth, of flooding to the threatened communities in a 100 year plus event, though ultimately it is the volume of water in the event hydrograph that will determine the depth of eventual flooding. Breaching scenarios are not modelled and these too will influence the extent/depth of flooding..

Appendix 4.

4.0 Ideal methodology for rapid evaluation of 100- year concurrent damages

Aggregate economic losses by post code prefix, for example CB4, for the whole county by commercial and residential property (numbers and damage estimate) by flood depth zone as determined by the Institute of Hydrology's research, less than 0.5, 0.5m to 2.5m and greater than 2.5m.

For major urban areas - Cambridge, Huntingdon, Peterborough the same analysis but by Enumeration District. This will allow us to apply, for residential data, the analysis by socio-economic class, AB, C1, C2 and DE and get a handle on number of motor vehicles at risk, which is a significant part of the urban infrastructure.

The following matrix will summarise the output for each post code district

Property Type and Depth	CB1		CB2	
	No	£m	No	£m
Residential				
Flood Depth <0.5 metre				
Flood Depth 0.5 - 2.5m				
Flood Depth >2.5m				
Commercial				
Flood Depth <0.5 metre				
Flood Depth 0.5 - 2.5m				
Flood Depth >2.5m				
TOTAL				

The ADDRESSPOINT Ordnance Survey database will provide the address lists within each of the post code/IoH flood depth categories. Applying depth/damage data for commercial and residential property, based primarily on Middlesex FLAIR 90 data, will produce a database of cumulative damage by Post Code area..

In all data assembly, conservative assumptions will be made. So, if a post code cuts any boundary, i.e. the 0.5m/no flood boundary, then it is assumed that the whole post code does not flood, and again a split between the <0.5 and 0.5-2.5 will assume <0.5m flooding etc. This is an important assumption considering the coarseness of the IoH grid. Total damage estimates will therefore be conservative.

The more detailed study of major urban areas at ED level will, of course, depend on the availability and cost effectiveness of social class data.

Major caveats will be:

- The size of commercial premises as FLAIR data is in £ per square metre. National averages will be taken.
- The property threshold level of flooding in relation to the IoH ground flood depth.

Appendix 5.

Flood Defence Policies in England and Wales

The Italian floods of 1994 were a classic case of bad management and poor integration of response to the flood hazard. Though rainfall leading to the floods was unusually heavy, the severity of the damage can be attributed to inappropriate development in the flood plain, inadequate emergency planning leading to non-existent flood warning dissemination and ineffective environmental management in conjunction with lack of any effective river maintenance. Whilst we can never reduce the probability of extreme rainfall events, a number of initiatives can be and are being taken to mitigate against the catastrophic effects of flood damage during extreme synoptic events.

Water & Land Planning in the context of sustainable development.

Two significant R&D projects commissioned by the former NRA have reviewed and made recommendations regarding planning policies and flood risk in England and Wales. Both were conducted by Middlesex University's Flood Hazard Research Centre (FHRC):

Planning and Flood Risk: a Strategic Approach for the National Rivers Authority by Tunstall, Parker and Krol, R&D Project 299, 1993.

Strategic Land Use Planning in Europe and USA: Review of Best Practice for the NRA by Chatterton, Green et al, R&D Project 291, 1994.

Project 299 developed a strategic approach to furthering NRA flood defence interests in town and country planning. This included NRA objectives and policies, including the effective communication of these in order to improve, update and facilitate the effective planning and control of the development of flood risk areas.

Project 291, often referred to as the 'sister' project, was initiated to study experience, in selected European countries and the USA, with integrated floodplain land use and flood defence. Examples of Best Management Practice were reviewed to enable the improvement of the planning process with respect to floodplain management prior to the inception of the Environment Agency.

Both reports add up to a full picture of the need for the EA, working with local authorities, to integrate land and water planning and undertake the necessary research, liaison work and information dissemination to that effect.

A key problem for both flood plain management and the wider issue of environmental protection in England and Wales is that the EA is expected to manage and regulate water issues (catchment planning, flood defence, etc.) without any statutory control of land use planning or land use change. Yet many water management problems are in effect land use management problems, be they the prevention of non-point source pollution or the prevention of the growth of flood damage potential (i.e. development) in areas liable to flooding. The 1991 Water Resources Act gave the NRA a duty to exercise a general supervision over all matters relating to flood defence and is charged with advising planning authorities on development and flood risks. This contrasts with the Netherlands whose National Environmental Plan demonstrates the advantages of combining the planning of the water environment with land use planning in achieving sustainable development.

Though EA's consent must be obtained before any structure in, over or under a "main river" watercourse is erected, their power to put in off-site infrastructure to permit new development is not entirely clear and there are different interpretations of the law. Again though legislation on quality of discharge to watercourses is all pervading, the EA's powers over the quantity of discharges to rivers is limited. The EA is dependent upon the local planning authorities to ensure that run-off from new developments and new discharges to watercourses do not give rise to additional flood risks. This contrasts with France where the recent Master Plan for Water Planning and Management (SDAGE) seeks to provide guidelines for a sustainable balance for the water environment within a framework of regional planning policy including innovative source control methods for runoff. Likewise, in the USA storm water management strategies are set in the context of multi-purpose planning and development.

Local planning authorities can restrict the development of land or require it to be used in any specified way. The conditions whereby local planning authorities should consult the EA over planning applications are set out in various Circulars but there is no provision in the General Development Order, 1988, that entitles the EA to be consulted on development in flood risk areas. Circular 30/92 (replacing 17/82) provides central government guidance to planning authorities on development within flood risk areas and stresses the hitherto limited powers of the EA regarding development and flood risk and the responsibilities of the local authorities in this regard.

The new circular emphasises the role of forward planning, local development plans and surveys under section 105(2) of the 1991 Water Act, reflecting a new plan-led approach to planning and development. The new circular recommends a more proactive approach and states that each local authority should seek to agree in advance with the EA, areas and types of development about which consultation should take place. It also lists the circumstances in which local authorities are advised to consult the EA. In general circular 30/92 states that developments leading to unacceptable flood risks should not be permitted until flood defence works have been carried out.

Such proactive plan-led approaches to flood plain management are commendable and might avoid in Cambridgeshire the siting of new development in the wake of flood flows as was common place in Paisley and Kirkintilloch in Central Scotland during the December 1994 floods. Here properties both recently built and still under construction, were flooded to depths of one to two metres. However, defining 'unacceptable flood risk' assumes that some flood risk is acceptable, as absolute protection is impractical. No plan-led policies could have prevented the 4-5 metres of flooding in 30 homes in Hunterhill, Paisley in December 1994. A minor tributary of the Black Cart Water system, itself a tributary of the River Clyde, burst its culverted section during what was close to a probable maximum flood event, ie similar to the worst case scenario analysed in this report. Under these rare but real circumstances, not even assiduous river maintenance, or state-of-the-art real time forecasting could mitigate against these losses.

The above example is thankfully rare and the two cited research projects have recommended a best practice for flood plain management for incorporating EA flood defence interests in town and country planning. These are as follows:

- **The EA must take a more pro-active stance in integrating land and water planning within the context of sustainable development**

  There has been encouragement on a national basis for EA regions to become pro-actively involved in the forward planning process. Chartered planners are becoming a familiar site on EA staff complements. Guidance Notes have been circulated to local planning authorities and EA staff have been involved with a national group evaluating policy for the protection of flood plains and target standards. Other staff has been active within the EA in promoting sustainable development policies.

- **Definitions, data, standards and environmental and economic needs for integrating land and water planning**

  The memorandum of understanding between the former NRA and the Associations of County and District Councils and the Association of Metropolitan Authorities is a step forward in the collection of data and the promotion of EA flood defence and planning interests. A range of surveys albeit slow, are being undertaken under the provisions of the section 105 (2) of the Water Resources Act 1991 associated with the recommendations contained in DoE circular 30/92. In addition, information databases are improving along with the production of Catchment Management Plans. Thames region has developed a 'development plan database' to monitor the take-up of EA policies in local plans. More attention is also being given to local plan programmes.

- **The role of Catchment Management Plans (CMP)**

  There has been considerable discussion within the EA recently about the role of CMP's, and seminars have been held on this subject. The success of land and water management planning is best achieved in the context of the river catchment. The chaos ensuing after the Italian floods can be largely ascribed to poor integration of the diverse land and water management strategies in the tributary catchments of the River Po (denuding of forests in association with the lack of or mis-understanding of river and floodplain environmental maintenance).

Appendix 6.

Future Policy Guidance.

The production of policy documents and their dissemination and associated consultation.

This is in its infancy, though Thames region has produced "Thames 21" which has been discussed by the National Planning Liaison Group. EA's Head Office in Bristol has also produced a new "guide to developers". Thames region has arranged visits to local planning authorities and there is now a national version of a "planning liaison guide" for use as a model by regions. The promotion of EA planning liaison documents and policies to local authorities should be encouraged. The production and promotion of documents for dissemination of information to the public, developers and development organisations are essential.

The National Planning Liaison Group has been operating for several years and provides a better focus for activity in the field of communicating between development and flood defence organisations, with contacts ever increasing. The same applies to links between planning authorities and EA regions; there have been programmes to carry out regular liaisons, but these are not uniform across all EA regions.

It is recognised that the EA needs to improve its communication of its own plans, flood defence schemes, river corridor policies and Catchment Management Plans, in order to ensure that communication between the EA and local planning authorities is a two-way process.

Integration with development plans and monitoring policy effects and performance

Thames region now has an embryonic "planning policy checklist" which identifies opportunities through planning law and European Union directives to promote EA policies. This is a possible initiative for national promotion via the National Planning Liaison Group.

The EA supports the adaptation of policies to fit in with the local planning authorities' requirements and Thames region has been prepared to support the local planning authority at enquiry or examination in public.

Performance indicators are not yet available nationally. The monitoring of local authority planning decision notices and evidence is still being pursued, and evidence is being collected where developments are permitted against EA advice..

Legal and Guidance Framework

The EA continues to review the situation in order to develop better policies within the context of sustainable development. The development of a PPG for river corridor management and planning, to make the integration of land and water management more explicit, is a sound future objective.

The Impacts of Flood Plain Policy (Conservation, Source Control)

The EA continues to be concerned at the secondary effects of flood plain development, including run-off exacerbated downstream, and the environmental effect of any necessary compensation works. The EA is actively promoting the close relationship between flood defence and conservation interests, and seeking to co-operate with all other agencies' proposals and schemes for the natural use of land in river corridors. The Dutch example (as cited in the Geldersee Port case study on the Rhine) chapter 5.1, R&D note 291) is commended in this respect.

Staffing and Resources

A number of significant initiatives have come from Thames region with regard to staff resources. The region promoted the R&D report on Best Management Practice (Chatterton et al, 1994). It also employs several qualified members of the Royal Town Planning Institute and the EA has organised national training courses on planning enquiries with courses planned for the future. Liaison between the EA and the RTPI is continuing, and the National Planning Liaison Group will commend further seminars and joint events with the RTPI and other bodies in the future.

A survey by FHRC in October 1991 revealed that 22 of the 43 counties for which data were obtained had some kind of policy relating to flood risk in their structure plan and liaison at county and district level with the EA is appreciated by planners. However, still more personal contact is necessary to develop on-going dialogue and mutual understanding. This demands more qualified personnel within the EA.

Strengths and Weaknesses

The development of a plan-led strategic approach to development control in close dialogue with local and county planning authorities will greatly assist the reduction in future flood risk as a result of inappropriate development. The introduction of guided growth policies and economic incentives as used in the USA to encourage infrastuctural development well away from flood risk areas should be encouraged. However, R&D project 299 evaluated the present strengths and weaknesses of the planning process that must be addressed at a national level.

Planners look to the EA to provide reliable data on which to act. They are critical of the quality of information that is currently available from the EA on flood plains, flood risks and run-off problems. Planners believe that Catchment Management Plans and Section 105 flood plain surveys will be helpful if they address such issues in sufficient detail.

Lack of strong leadership and national co-ordination at a national level has always hampered the development of a consistent, powerful and innovative strategic approach to planning in the former NRA. Wide differences exist between the regions in the way in which strategic planning is organised and staffed. Planning liaison performance is judged by application response time: thus priority is given to individual planning applications. Development plan consultation is relegated to low priority, yet based on the new plan-led system, external agencies clearly expect this not to be so. The 299 research found that there were apparently no performance indicators within the former NRA, which give recognition to the importance of strategic planning for flood risk. Although the EA are working towards a national policy on flood risk and development, agreed national definitions of flood plains (particularly the differentiation between main and non-main river) and target levels of service for new development are lacking.

As of the date of the R&D Report (1994) there was a lack of clarity within both the former NRA and external bodies about the definition of flood plain and flood defence standards for existing and new development. Only partial accord as to whom should define flood plains and set flood defence standards for new development. It is clear to all external agencies that the EA must provide information on degree of flood risk and infrastructure requirements, yet existing data (section 24/5 surveys etc.) is out of date and requires major enhancement via section 105 surveys. This is a long and costly process and until comprehensively tackled using advanced GIS techniques and appropriate terrain modelling the expectations of the EA by the planning authorities are not being met. The statutory flood defence section 105 surveys provide essential inputs to

catchment drainage plans and flood plain management plans. The work on these surveys must be accelerated.

Whilst the consultation guides produced by the EA regions are welcomed many are out of date. The planning liaison guides tend to emphasise planning application consultations rather than development plan consultations, which is vital to flood defence and associated conservation matters.

Likewise, Catchment Management Plans are highly commended, though the process is slow with only a small number of plans yet produced. The CMG must be regarded as the principal comprehensive forward planning instrument that the EA has available for early intervention in the town and country planning process. Development of a national 'coverage' is still too slow to make an immediate impact on development planning.

To exert more influence on land use planning decisions the EA must continue to improve its data on flood plains. Indeed Circular 30/92 sets out requirements including the identification of areas of managed retreat, set back and ways of overcoming flood risk constraints on development. Flood risk mapping (see the FIRM maps adopted in the USA by FEM.) has significant resource implications for the EA, but there are few more important databases for implementing flood defence policy. A high priority must be placed on rapidly improving the flood plain mapping and associated database, including populations at risk from breached defences.

The IoH initiative DTM provides some much-needed data, but its broad brush approach and caveats must be recognised if the data is not to be used out of context. To complement the DTM and more 'accurate' Section 105 surveys, appropriate address technologies should be pursued to establish a nationally consistent customer database of flood plain occupancy

In short, the EA should seek to promote itself as the ultimate source and principal arbiter of information on flood plain delimitation: this is rightly the area of technical expertise that the EA holds. The EA should also agree national policies on flood defence standards for new development in full consultation with local planning authorities.

The Italian experience exemplifies the problems associated with misunderstanding of and misinformation within the planning process (let us hope that out-and-out corruption, so prevalent in Italy, plays no part in the decision making process here). No integrated or systematic approach to flood plain management will succeed without the full dissemination and discussion of factual material between all players affected by or affecting river and catchment

planning. During research for R&D 291, country reviews of Germany, the Netherlands, France, Portugal and the USA indicated that there was no evidence that knowledge polarises opinion. Open management from the inception of a plan through to fruition is fundamental to success. Withholding information, misleading or deliberately misinforming is no part of the planning process. The most productive way of heightening awareness about flood hazards and the dangers and costs of locating in and developing flood plains is to issue systematically further public information about the flood risk. The public awareness campaign instigated as part of the EA's Flood Warning Dissemination Project goes a good way to achieving this and the impetus must be maintained.

Appendix 7

Emergency Planning

There is no organisation in Britain specifically charged by statute with the responsibility to prevent, prepare for, or respond to "peacetime" disasters. In general the responsibility falls on the normal emergency response groups: police, fire brigades, county emergency planners and associated volunteer organisations. This reflects the continued belief in the need for "local" control over the responsibility for responding to major incidents and emergencies. However, implementers of the local emergency planning process, local or regional government or the emergency services, frequently have other priorities and scarce resources to implement plans. Some local authorities have even refused to undertake emergency planning.

During the December 1994 floods in Scotland the Government's Bellwin scheme was invoked which provides a discretionary 85% grant, but only towards emergency expenditure by councils and does not recognise nor support the losses to individuals. It is triggered off during major disasters to assist with immediate works to safeguard life and property to prevent suffering and severe inconvenience. The threshold for invoking the Bellwin formula is determined according to a council's revenue base. Strathclyde's was set at £3.5 million. Thus it is not applicable during flood events with a limited geographical extent, neither does it offset losses incurred to individuals. Thus many residents without insurance are without institutional or financial support to ameliorate their flood losses. Post flood clean-up operations in low-income areas, for example Paisley, were supported by local authorities. This assistance is limited to external clean up and targeted primarily within local authority estates. Owner-occupiers are often left without support or given lower priority in the provision of shelter and institutional support. Emergency centres were set up in the Ferguslie Park area of Paisley within hours of the flood incident, but owner-occupiers in the neighbouring Hunterhill area were 'abandoned' by the authorities for up to several days. Likewise, industrial estates were left to provide there own clean up despite the fact that the Regional Council was negligent in the provision of flood defences. The Old Mill industrial estate in Kirkintilloch was typical of this 'go it alone' aspect of post flood support.

Public and media dissatisfaction with the response of government and emergency planning agencies to recent disasters is high with a high level of public anxiety and disquiet amongst victims. In order to defend itself against charges of complacency, the government has undertaken a consultancy exercise and has involved itself in a number of seminars designed to consult professional and others involved in emergency planning. The government policy appears to be one of damage limitation after the event rather than on maximising the opportunity for learning from disaster events. This reinforces an already secretive approach, one in which civil servants have sought to avoid public scrutiny and critical analysis of politically sensitive subjects, such as dam safety. Regular critical review and assessment of arrangements for preventing and

managing disasters to mitigate loss of life and property appear to be largely absent. Public enquiry mock-ups, simulating flood disaster scenarios, within London are a notable exception. With the increasing emphasis on deregulation, corporatisation and privatisation, the problem is likely to worsen. Though there are very broad Home Office guidelines ('Home Office Guidelines to Local Authorities' published in 1985) regional and local government organisations work in isolation. Disaster planning appears to be no better than in Italy though recent legislation there (1992) has given the remit to regional government to prepare disaster plans. The tragedy in Italy is that these had not been interpreted locally by the Provinces, either because of lack of time or lack of inclination.

A baseline survey of Flood Forecasting and Warning Response Systems for the EA by the consultants conducted in January 1997 made the following conclusions with regard to disaster planning:

- Ensure the development and continuity of strong links to Local Authority disaster plans. There is a strong requirement to ensure compatibility between CEPO and EA plans.

- A national definition of major incident is required with threshold levels triggering off major incidents clearly understood (cf list prepared of major incidents by EA South West region). Co-ordination of a regional major incident list is required.

- The disaster plan should itemise resources available for EA response the Agency's responsibilities, with a clear definition as to when the plan 'kicks in', for each incident level and site. The important issue of resourcing major disasters was highlighted in Lord Crickhowell's letter to Douglas Hogg on 14th July 1995.

- Area flood warning planning groups/forums must ensure links to major incident plans and county arrangements.

- The development of a Decision Support System to manage these floods is suggested to assist in reducing the impact of the disaster scenario.

- Currently the ability and effort concentrates on the management of frequent and minor 'splash' floods, particularly in coastal areas.

- There is a strong R&D requirement to develop procedures to model residual flooding for breach scenarios or for flooding of greater severity than the design criteria. These areas can then form part of the Dissemination Plans.

- Although police co-ordinate disasters and consequent evacuations their role in warning is still sometimes confused (Norfolk and London in particular), despite new FWDP arrangements, and needs clarification.

- Lessons can be learnt from the Glasgow floods of 1994, the Perth floods 1993 and research from 'Hazards in the mega city' by Middlesex University. Simulations of credible disaster scenarios will lead to continued improvement of the civil response system.

Appendix 8.

Flood Forecasting and Warning Response Systems

In the context of the flood hazard, EA are advocating greater use of flood forecasting systems to improve the flood warning lead time to communities and thus attempt to mitigate potential flood damage, and in extreme cases, save lives. An R&D project completed in 1995 for the NRA was aimed at deriving an approach to improve forecasting techniques with research concentrating in three main topic areas:

- A review of radar correction and adjustment techniques;
- A discussion of the optimum accuracy of flow and rainfall forecasting; and
- A cost-benefit analysis of the optimum accuracy of flow and rainfall forecasting.

As the tragedy in Italy showed, with some 63 deaths, any attempt at improving flood forecasting is to be commended. However, the issue of successful forecasting techniques must be complemented by effective flood warning dissemination. Improving the science of forecasting is of no value if not achieved in tandem with effective dissemination strategies.

FHRC, during its research for Euroflood, made a comparison of flood forecasting and warning response systems in five European Union countries with a view to sharing common problems and solutions, and by developing best practices and policies. The need for rapid, simultaneous mass communication between warning agencies and the public is common across the EU. The benefits of the 'Circuit' dissemination of warnings as exemplified in Rotterdam, as against the more conventional 'Cascade' procedure, need to be investigated.

Since 1st September 1996 EA has effective control of flood warnings to the public. To improve timely warning the use of automated flood warning and dissemination systems, like those operating in the state-of-the-art forecasting rooms on the Rhine in Germany, is encouraged. The Automatic Voice Messaging service (AVM) and associated Floodcall service forms an important part of the Flood Warning Dissemination Project introduced to thousands of homes in 1st September 1996. EA has now set Operational Performance Measures (OPM) to gain knowledge about the effectiveness of customer response to flood warnings with a view to develop and enhance the most appropriate response strategies for different types of circumstances.

Existing performance baselines must be identified and performance targets set. Effectiveness indicators should reflect forecasting, warning dissemination and the

response phases, and should include the requirements of the flood plain users as customers of the service. Collection of post event data has been standardised nationally with a view to improving the accuracy, reliability and timeliness of the forecasting service.

As floodplain development in "protected" flood plains continues apace and living standards rise and the prevalence of extreme synoptic flood events appears to be increasing, consistent with the theories of global warming, the increase of flood damage potential also increases. It is estimated that the Glasgow floods resulted in economic losses approaching £100 millions. The following table prepared for a Flood Defence Committee presentation in Reading in 1988 for the Maidenhead, Windsor and Eton Flood Study shows an *order of magnitude* increase (between 1947 and 1990) in the estimated flood damage for the 60 year flood event.

Flood Event (60 year)		Estimated no. of flood prone properties		Estimated flood damage at 1990 £ values	
1947	1990	1,400	3,558	1,330,000	19,055,000

With such an increase in potential for flood damage, flood plain occupiers, perhaps only partially protected by structural flood defence schemes, rely more heavily than in the past on effective flood warning systems designed to save life and property. Such systems were wholly lacking during the Italian floods. However in Glasgow, the flood warning procedures operated by the Clyde River Purification Board for the White Cart drainage system significantly reduced the effect of flooding in the south of the city, specifically in Pollock, Cathcart, Battlefield, Langside and Shawlands. Research on the potential damage savings due to flood warnings indicates that these savings may be substantial.

Public reliance on flood warnings is growing due to:

- Improvements in flood forecasting technology and capability;
- The unpopularity of structural defences on both economic and environmental grounds;
- The recognition and awareness of the flood risk beyond the flood plain protected by structural work;
- EA's exercising of their 'duty of care' to provide flood warnings;

However, the British public is rarely proactive in their response to flood warnings. Unlike in the Rhinelands of Germany where river gauges are interrogable via the public telephone network, or in the Netherlands where residents of the floodplain of the Maas interrogate stage discharge curves via public access TV's environmental channel and make their own decisions to move their possessions. In these areas the 'flood culture' is all pervading; response being related to previous experience. In England and Wales residents are heavily reliant on institutional dissemination of flood warnings, though the principle of self-help is now being promoted by the EA. So much so that in the case of Robinson v Cardiff City Council, following the December 1979 floods, Cardiff City Council and South Glamorgan were found liable for failure to warn the public. This is an exceptional precedent, particularly as authority powers regarding flood warning are permissive. What is important is that the warning system failed because of the absence of clear responsibility for disseminating warnings to the public.

Poor dissemination is the root cause of failure to mitigate flood losses and the national provisions set up as part of the Flood Warning Dissemination Project must maintain impetus. A target standard of 80% effective warning dissemination is aimed at by 2001, from a measured average estimate of 45% currently (FHRC research).

Failure of dissemination negates the investment in improving flood-forecasting techniques be they weather radar techniques, or predictive models derived from an improved density of rain gauges and/or rainfall gauges.

The legal "fog" surrounding the responsibility for flood warnings requires the urgent attention of legislators. Quite apart from the issue of whether or not local authorities should have a statutory emergency planning duty, the emergency response capability of both local authorities and the police is becoming increasingly limited.

No effective emergency procedures were instigated during the Italian flood and the consequences were dramatic. Apart from the tragedy of lost live, which should be avoided, economic losses of some £8 billion were experienced. Without the implementation of an effective Flood Forecasting and Warning Response System (FFWRS) to promote timely and accurate dissemination procedures, synoptic events similar to those in Italy and Glasgow, over any part of urbanised England and Wales, including Cambridgeshire, where flood plains have up until now been the easy option for development, could result in unmitigated flood damages on similar scales.

Appendix 9

Flood Defence Operations including Maintenance

Lack of river maintenance on the tributaries of the Po seriously exacerbated the flood levels in the November 1994 floods. Sound maintenance policies in the context of environmental sustainability will increase the conveyance capacity of natural watercourse and minimise the hydraulic discontinuities as a result of blockages at bridging points. Likewise, during the Glasgow floods serious flooding of the Downie Brae industrial estate, west of Rutherglen, Glasgow was directly attributable to afflux at Dalmarnock Bridge as a result of the build up of vegetal matter upstream of the bridge arches crossing the River Clyde.

Maintenance activities must be well managed. Italian ecological groups often insist on keeping rivers in their natural condition. Fears of concrete canalisation cloud the positive affects of sound river maintenance. The Dutch example on the Rhine and its tributaries is an excellent example of integrated land and water management to the benefit of both hydraulic efficiency and environmental management. The Geldersee Poort experiment, described in detail in NRA project 291, divides the flood plain into winter and summer floodways with buffer zones created in the river corridor where natural 'green' stepping stones link core areas of undisturbed natural habitats allowing migration routes for both flora and fauna. Flood Plain Boards jointly managed by the water agencies (Rijkswaterstaat), agricultural and ecological interests' optimise both hydraulic, agricultural and environmental aspects of river corridor management. Alluvial forests at the edge of the floodplain, away from the winter flood way, serve as buffer zones attenuating lateral flow to the main rivers serving also as a 'sink' for absorption of fertilisers and pesticides, thus also preserving river quality. Such innovation provides a template for optimum maintenance management.

The EA flood defence function has a revenue budget of £72 millions per year of which greater than 85% of this expenditure is incurred on periodic and routine river maintenance. A policy for effective maintenance in the context of sound environmental management can mitigate flood losses during flood events. Such a policy is wholly lacking in Italy. The EA Flood Defence Management Manual (FDMM), however, provides a policy document to enable sound operational management. Standards of Service have been developed as a management tool providing a means for the monitoring of flood defence Standards of Service on a consistent and objective basis. The system provides guidance to engineers when defining the required maintenance strategies for river and coastal management, but does not provide a definitive statement of a particular maintenance strategy that should be adopted.

The Standard of Service system comprises two elements. The first is an assessment of current land use and an appropriate target SoS. The second is monitoring of the actual and estimation of the likely future impacts of flood incidents on the basis of the current maintenance strategy for the watercourse. The output is an assessment of the adequacy of service provision from comparison of the actual service standard with the defined target.

The FDMM provides EA regions with an objective methodology for ranking maintenance priories based on the House Equivalent (HE) as a common numeraire. to compare rural and urban land usage. HE's per kilometre of watercourse for an actual standard of service may be compared with a pre-defined target standard, thus establishing the acceptability of the standard provided.

In addition, the asset surveys, establishing the physical condition of flood defence structures and the techniques employed for justification and subsequently prioritising maintenance where standards are inadequate, provide a solid platform for maintenance management and capital scheme investment to national indicative standards. Prioritising work is a combination of asset condition and economic and environmental rating. Guidelines are presented in FDMM with respect to failure to maintain resulting in increased channel roughness, reduced cross sectional area of the watercourse and a degradation of asset condition. Respecting these aspects of maintenance within an overall prioritising programme can reduce the frequency of out of bank flood levels.

Capital works are prioritised based on an intricate scoring system based on economic, social, urgency and purpose criterion. Economic criteria are based on the MAFF Project Appraisal Guidance Notes, and a social criterion gives additional weight to schemes benefiting residential property. Urgency criteria are essentially based on the length of residual asset life (where renewal or replacement of assets is involved). Purpose criterion reflects, say, preference for existing customers over future customers (e.g. new developments); preference for urban over agricultural schemes and preference for sea/tidal defences over fluvial defences. Additionally, the impact of the work on the natural environment and heritage is evaluated subjectively. Adherence to nationally derived prioritising can ensure a hierarchy of investment to maximise the benefits of flood alleviation.

Midland region's Rivers and Information Maintenance System (RIMS) provides a comparative appraisal methodology for the economic assessment of maintenance activity, whilst computer models such as Middlesex University's FHRC's ESTDAM suite provide objective benefit assessment procedures for input into MAFF project appraisal techniques for evaluating capital scheme works. RIMS and MAFF methodologies support the Treasury philosophy that the benefits of improved standards of service must be measured from the "Do Nothing" baseline as only using this approach can realistic benefits of (damages avoided by) flood alleviation to improved

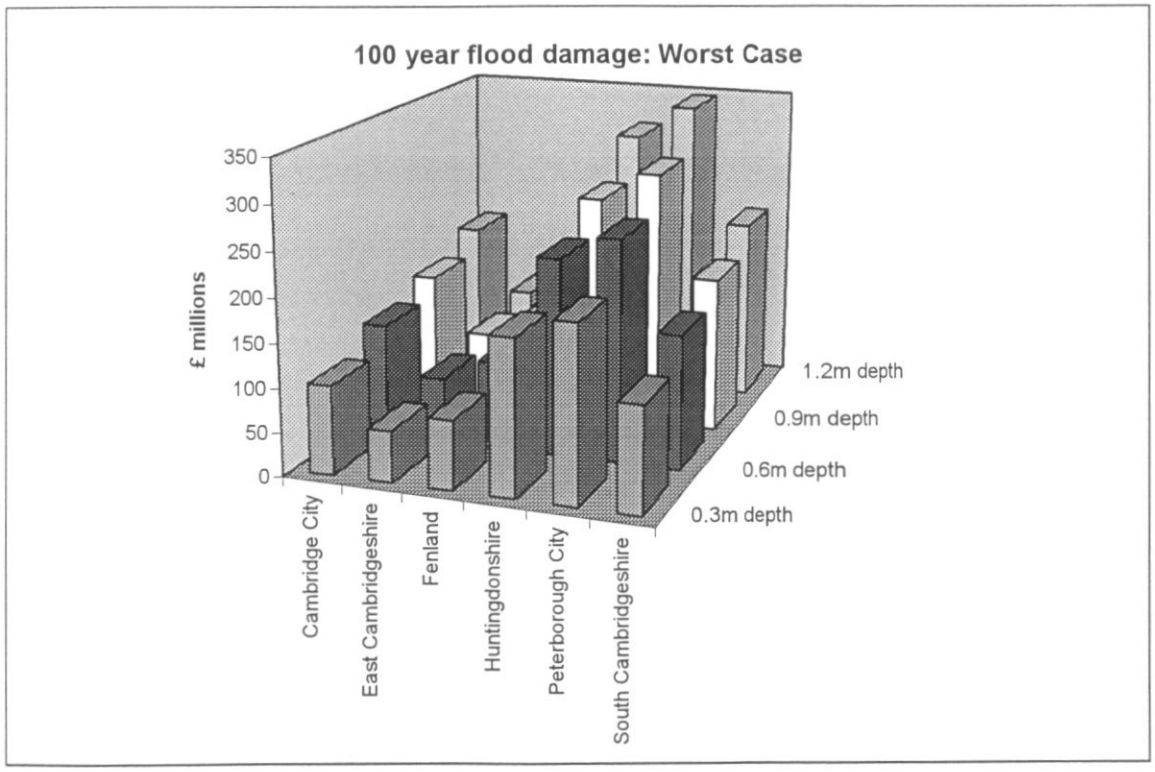
standards be measured. FDMM methodologies have been revised to accommodate the "Do Nothing" philosophy. The benefits of continued channel and flood defence maintenance expenditure can thus be appraised. An EA R&D project is due to start to develop a sound and sustainable methodology for evaluating the urban benefits of maintenance. This project will feed to the national Flood Defence Management System currently being developed by the EA to assist with the sound management of the flood defence function.

However, indicative design standards, as set by MAFF, limit protection to, at most, the 1 in 100 year flood in densely urbanised urban areas subjected to fluvial flooding (extended to 1 in 200 years for urban coastal flood plains). Though MAFF pay great heed to the value of incremental Benefit Cost Ratios between selected scheme design standards, (the incremental benefits of moving from a lower to a higher standard of protection must exceed the incremental costs), the Government may only approve expenditure on capital schemes where design standards are at or below the indicative standard. This may expose flood plains to increased vulnerability if economic criteria alone are adhered to. Certainly, even taking into account other prioritising criteria, such as social and urgency criteria, it would be rare in England and Wales to provide protection to urban areas greater than the once in 200 year standard (London is here an exception and probably the only exception). This is contrary to adopted policies in the Netherlands where the flood culture and perceived risk sets standards for flooding no lower than for other hazards (eg nuclear accident) where large tracts of population are exposed. Standards on inland watercourses in the Netherlands are set at 1 in 1,250 years and for tidal flooding between 1 in 1,250 and 1 in 10,000 years.

Whilst in England and Wales, planned protection for urban floodplains with a 1 in 100 or 1 in 200 exposure risk is soundly managed following prioritising using FDMM techniques, exposure to flood events less frequent is of grave concern. The Mississippi floods of Summer 1993 illustrates the problems associated with adopting a finite flood zoning policy, often the 1 in 100 year standard, as an upper limit for protection. The '500 year flood' in the Mississippi valley caused some £10 billion dollars of damage, much because of urban development within the 'protected' floodplains. Likewise, extreme synoptic events overtopped and breached the Clyde flood defences in Glasgow and several embanked tributaries of the River Po (for example, the Belbo at Canelli in the Province of Asti). Breaching of defences can induce more severe consequences than if defences had not been in place, as evacuation of floodwaters trapped behind partial defences is inhibited. The flooding of Allied Distillers whisky maturing warehouses at West Thorn, Glasgow, illustrates this point well.

Table 1: Residential Flood Damage Costs Cambridgeshire County Worst case 100-year

District	Population (no.)	Households (no.)	Mean flood depth assumed 0.3m	0.6m	0.9m	1.2m
			(£millions)			
Cambridge City	32,592	14,309	101	128	149	175
East Cambridgeshire	20,320	8,163	58	73	85	100
Fenland	27,764	11,023	78	99	115	135
Huntingdonshire	65,866	24,965	176	224	259	306
Peterborough City	71,415	28,169	199	252	293	345
South Cambridgeshire	43,982	17,016	120	152	177	208
Total	**261,939**	**103,645**	**732**	**928**	**1078**	**1269**



Sources: Damage data: Middlesex University Flood Hazard Research Centre
FLAIR data, 1990
(Flood duration greater than 12 hours; 1990 price base)

Household data: Enumeration District data from Cambridgeshire CC


CAR SALES

Predicting Environmental Impacts

MIDDLESEX UNIVERSITY

Centre for Ecology & Hydrology

Agenda

- Flood Hazard Study 20m
  John Chatterton
- NERC Data Evaluation 20m
  Mike Roberts
- Example - Partnership Projects 7m
  Chris Brown
- Open Forum Chaired by 20m
  Gordon Lister
- A Way Forward

Middlesex University

Dr John Chatterton

Flood Hazard Research Centre
Study for Cambridgeshire
Civil Protection Unit

Cambridgeshire Flood Hazard Evaluation

- Contributors
- Preliminary Study
- Hazard assessment - the factors
- Prevention, remedy, protection & response
- Partnership - use of resources

Data Resources

- The Institute of Hydrology
- Middlesex University Flood Research Centre
- The Institute of Terrestrial Ecology
- The Environment Agency

Interim Evaluation

- All research caveats respected
- Conservative estimates
- Damage to residential property only
- Population affected - 262,000
- Households over 100,000
- Flooding 0.3m - £945 Million
- Flooding 1.2m - £1,640 Million

Approximate distribution by District

- Peterborough City 27.3%
- Huntingdonshire 25.1%
- South Cambridgeshire 16.8%
- Cambridge City 12.4%
- Fenland 10.6%
- East Cambridgeshire 7.8%

Regional Scale Analysis

- Socio-economic Base
  - Population, Housing, Infrastructure
- Sites & Factors of Production
  - Employees & Capital Stock
- Results of Economic Activity
  - Value Added & Tax Revenue
- Environmental Assets

Other Topics Covered

- Flood Defence Policy
- Future Policy Guidance
- Emergency Plans & Flood Warning

Summary of Evaluation

- Conservative estimates
- Only fluvial not tidal
- No industrial, infrastructure or retail costs
- No indirect cost - health, absenteeism etc.
- Without any new housing development
- No account of geographical factors

Future Programmes

- Work with EA & IoH - Compare Sect. 105
- Refine "at risk" - Insurance Industry Data
- Partnership with ITE - "rural - urban"
- Agriculture & conservation impacts
- Environmental & recreational cost
- Regional Scale Analysis

Centre for Ecology and Hydrology

Prof. Mike Roberts

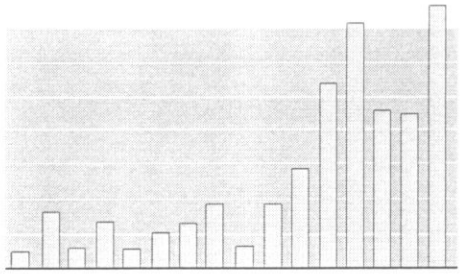
Institute of Terrestrial Ecology
Study for Cambridgeshire
Civil Protection Unit

Centre for Ecology and Hydrology

- Advance the science of ecology, hydrology and environmental microbiology
- Measure and predict change through monitoring and modeling
- Provide interpreted information to the User Community

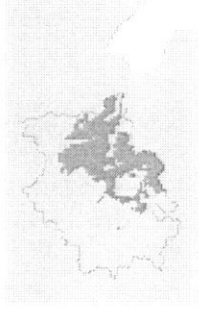
Key Information on Environmental Quality

- The nature and extent of land cover
- The presence of land subject to policy designation
- The presence of Red Data Book species
- The quality of habitats
- The quality of water resources
- Pollutant effects and amounts

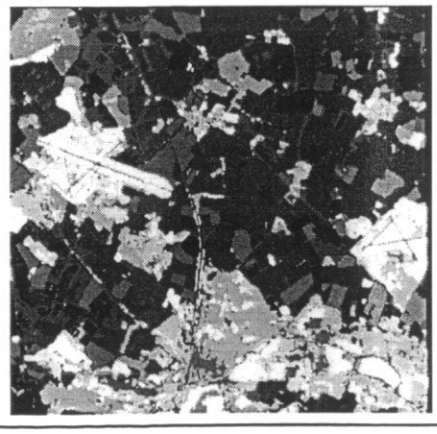


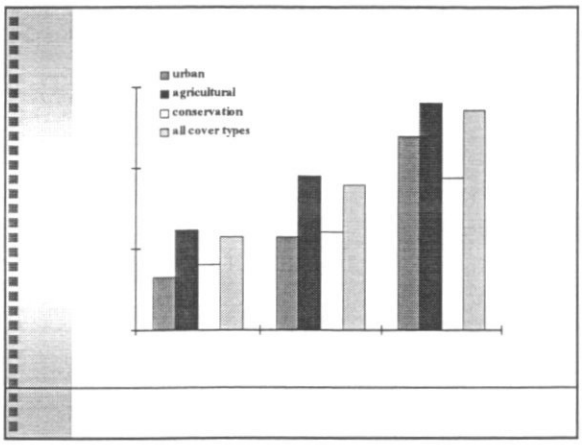
Resources at Risk

- What type of land?
- What valued habitat?
- Unexpected, Worse, Fast on - Slow off
- Exact Timing



Land in Cambridgeshire below 1m
(920 km squares)



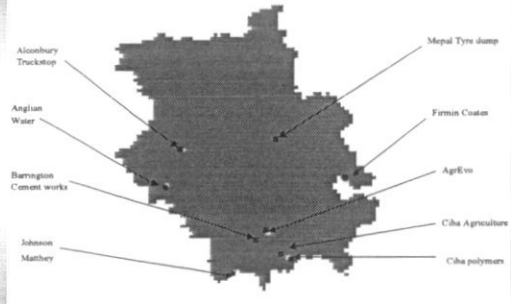


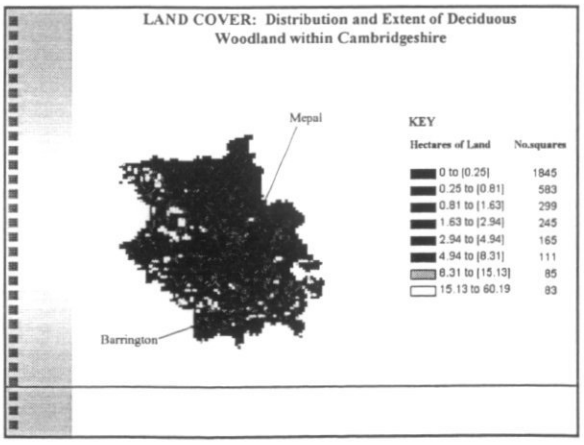
Recovery & Regeneration of Resources

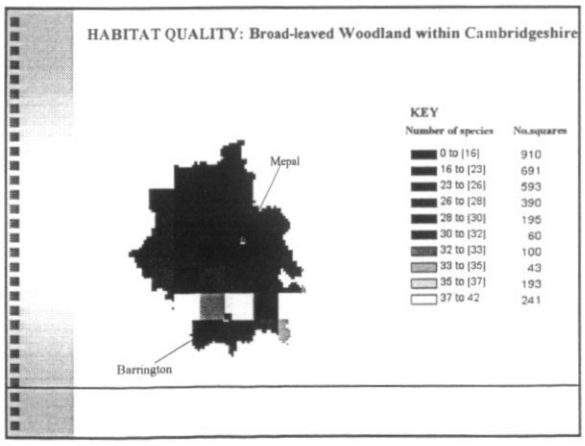
- Persistence and nature of water (agricultural land lost for up to 4 years after sea water flood)
- Habitat loss (conservation areas affected for up to 20 years
- Chemical contamination (no real experience in modern times)
- Managed retreat

Drought Conditions

- December - March 1997 - driest since 1964
- Last 2 years driest since 1767
- Deficit equivalent to 6 months rainfall







Next Steps

- **Recording Biodiversity**
- **National to Regional to Local Information**
- **Better Informed Decisions**
- **Reinforcing Policy**
- **Information Transfer**

Chris Brown

Assistant Director - Environment

Department of Environment & Transport

Cambridgeshire County Council

Chief Executive's Unit

Stimulate partnership working inside and out side the Council, promote policy formulation, review performance and advise the authority's forward direction

Environment and Transport Directorate	Education, Libraries & Heritage	Social Services	Resources Directorate
Land Use Planning	Public Access to Information	Urban Regeneration & Design	Compliance with Legislative Standards and Targets
Transport Impacts	Schools Programme	Public Perception	Environmental Performance Indicators
Waste		Quality of Life	Indicators of Sustainable Development
Emissions			
Air Quality			
Natural & Agriculture Resources			

An opportunity for

- Better understanding of environmental impacts
- Better decision making

Avoiding future environmental problems is "being sustainable"

John Gummer - "*sustainable development means not cheating on our children*"

Biological Records Network

- Up to date, using best IT
- Brings together local recorders and professionals
- Acknowledges contributions of Wildlife Trust, ITE, PECT
- Value to the planning process

"What if" modelling of predicted growth in Cambridgeshire

- To augment and informs joint capacity studies
- Consider amount and distribution of growth
- Impacts particularly on land and water, but also air and energy requirements, and peoples perception of the environment

Land

- Impact on agricultural land
- Impact on biodiversity
- Critical natural capital and constant natural assets

Water

- Flood Risk: avoiding or adding to it?
- What is the price of increasing the demand for water?
- Locally derived supply vs imported supply

Realism and Vision

- Information must be useful, add value to the decision process
- Information must do more than fuel the NIMBY position

but

- Imperfect understanding has caused us problems (from Newts to CFCs)
- Information helps build consensus and 'wise' decisions
- Local authorities as community leaders - taking the long term view and looking to 'good science'

A Technical Partnership

- Inputs of Staff Time
- Sharing of Data
- Shared view of "The Product"
- Mutual Benefit

An Invitation to Form:

Cambridgeshire Partnership

for

Environmental Sustainability

Aims

(Towards Economic Growth and Environmental Sustainability)

- Table Selected Initial Partnership Projects
- Use & interpretation of Established Data
- Promote & use new Research Data
- Whole Community Engagement

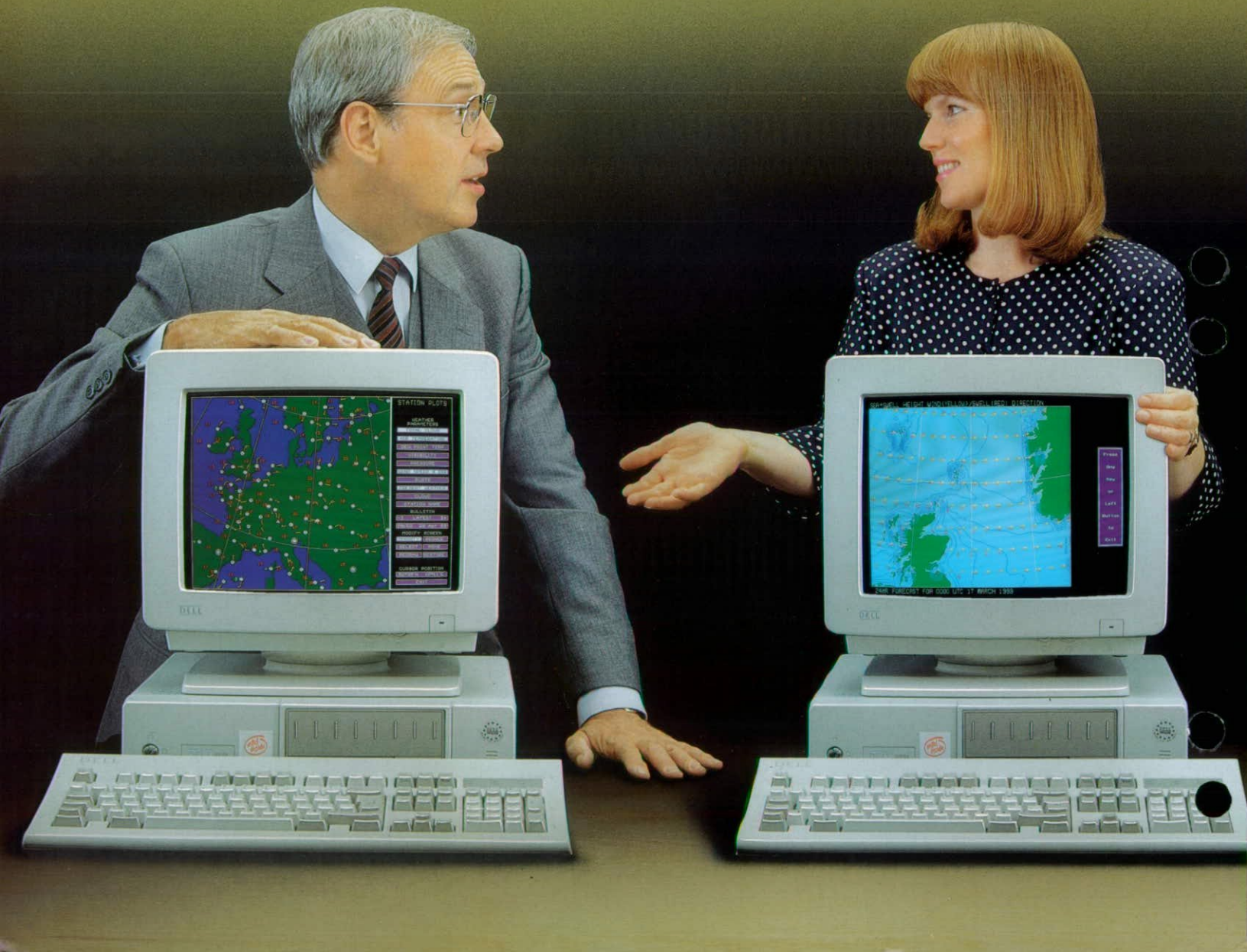
Your own personal Met.Office

COST EFFECTIVE

The information on MIST is continuously updated. So whenever the weather plays a part in your critical decisions – perhaps involving heavy lifts, pipe laying, concrete pouring, buying, road conditions – you can call on MIST, 24 hours a day to help keep costs to a minimum.

OPERATIONAL EFFICIENCY

MIST is designed to help plan the specific requirement of operational activities in different areas of industry and business. For example, it can influence the timing of essential maintenance and capital works, help you align supply and demand, contribute to your efficiency, reduce overheads and maintain your level of customer service.



From routine operational tasks to vital one-off activities, to obtain better performance

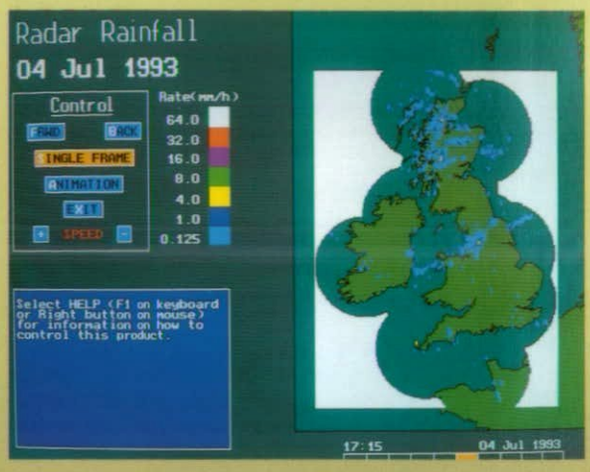
The Met. Office and British Aerospace have jointly developed a unique system to provide business and industry with up-to-the minute weather information in the most convenient form possible...direct to your PC. It's called MIST.

Every business is influenced by the weather – managers everywhere have to take it into account, in purchasing, distribution, scheduling operations, stock control, as well as long-term planning and resource management, but until now few have been able to do so.

The reason is simple. Although the expertise needed to interpret the weather has been available for a long time, the technology to put it directly at the fingertips of the people who need it most has not.

The Met. Office's new MIST system changes all that. MIST brings weather information straight to the PC on your desk, structured in the way which is best for you, helping you to bring a new level of confidence to your decision-making.

MIST can make a valuable contribution across the breadth of industry – manufacturing and distribution, retailing, civil engineering and aviation. It can provide the latest information on possible 'weather windows' at the touch of a button for those critical decisions – from towing oil rigs, to choosing conditions for test flights.



USER ORIENTED

MIST is interactive with user–friendly displays. Users can define their own requirements and criteria enabling the displays to be modified for specific uses.

BUSINESS REQUIREMENTS

MIST's wide range of products provides users with the information required for most business functions such as demand forecasting, logistics, promotion, competitor strategy, resource allocation, production planning and scheduling, buying decisions.

For services available in your area contact the Commercial Manager at your nearest Weather Centre

Aberdeen
Tel: 0224 210572
Fax: 0224 210575

Belfast
Tel: 08494 22804
Fax: 08494 54091

Birmingham
Tel: 021-717 0571
Fax: 021-717 0579

Bristol
Tel: 0272 276265
Fax: 0272 279060

Cardiff
Tel: 0222 390420
Fax: 0222 390435

Glasgow
Tel: 041-248 7272
Fax: 041-248 3455

Leeds
Tel: 0532 457703
Fax: 0532 457760

London
Tel: 071-696 0573
Fax: 071-404 4314

Manchester
Tel: 061-477 1017
Fax: 061-476 0714

Newcastle
Tel: 091-232 3808
Fax: 091-261 4965

Norwich
Tel: 0603 630164
Fax: 0603 629832

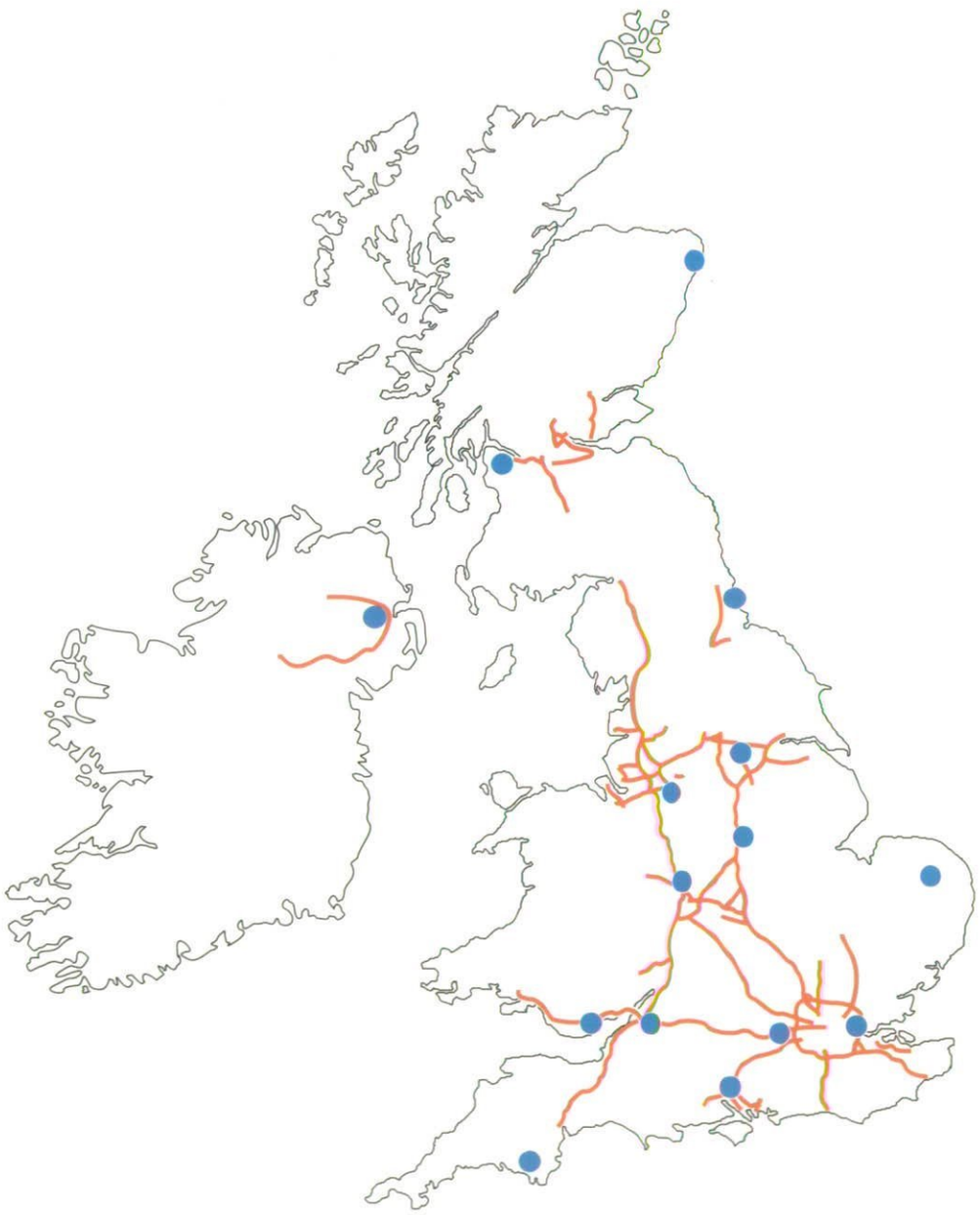
Nottingham
Tel: 0602 384094
Fax: 0602 459243

Plymouth
Tel: 0752 251861
Fax: 0752 251862

Southampton
Tel: 0703 220646
Fax: 0703 228846

Head Office: The Meteorological Office,
London Road, Bracknell, Berkshire RG12 2SZ

International Commercial enquires:
Bracknell Head Office +44 (0)344 856283



The Met.Office

BRITISH AEROSPACE
SPACE SYSTEMS

specialised weather information can help you from your business.

Weather information when and where you need it.

All you need is a PC and a modem, and you have access to the most powerful and extensive database of weather information in the world. The information you require is immediately available, so that you can make your decisions on the spot – where safety and efficiency really matter.

The MIST database.

- structured for individual business sectors' requirements
- easy access with a few simple keystrokes and simple menus
- graphical presentation makes complex weather analyses easy to understand.

Proven, reliable, and available today.

MIST is used with great success for forecasting and contingency planning in businesses as diverse as electric power distribution and aviation. It helped maximise the efficient use of resources at Wimbledon, and gave early warning of bad weather at Silverstone. The high levels of forecasting accuracy now being delivered by the Met. Office's experts, gives every user a competitive edge when combined with MIST.

Delivered, installed and commissioned by experts.

MIST is delivered to the site by specialists and carefully tested to ensure complete satisfaction.

Helpline.

Helpline is available to resolve any operating problems or uncertainties during the working day and if your working conditions demand it, we can provide a 24-hour cover Helpline.

Low cost, secure communications.

Costs are kept to a minimum by use of competitively priced PDN communications between the MIST host and your local exchange. Access to the details of your requirements is protected not only by password, but also granted only to authorised terminals.

Taking the next step.

To find out more about the benefits of MIST, or to discuss your needs, call the Commercial Manager at your local Weather Centre, listed at the back of this brochure.

PUBLIC DISPLAY SYSTEM

If your organisation wishes to catch the eye of passers by, or keep the travelling public up to date with developing weather conditions, MIST's public display system now being developed will give unlimited scope for attracting additional custom and generating public goodwill.

MIST

Your own personal Met.Office

When the success of your enterprise is sensitive to the vagaries of weather you need the reassurance of MIST, tailor-made weather information from the Met. Office.

Mist

Your own personal Met. Office

Technical specifications for your own personal Met. Office

The Met. Office and Matra Marconi Space have jointly developed a unique system to provide business and industry with up-to-the minute weather information in the most convenient form possible...direct to your PC. It's called MIST – the Meteorological Information Self-briefing Terminal.

The most convenient form of up-to-date weather data

- The one-stop weather data and forecasting source.
- Rapid access to time-critical information.
- Real-time data communications.
- You select the specific data you require.
- Visually attractive, easily readable displays.
- Printer output for hard copy.
- Comprehensive system support package.

Easy access

MIST can be delivered in two forms according to your requirements:

- Users who require large quantities of data or information on a regular fixed basis can opt to receive a continual automatic update of the information they require.
- Alternatively, there is a dial-up facility which is more suitable for those users who do not require information on a regular basis but need the ability to choose the data they need when they want it.

Information is transmitted either via the phone and public data networks (PDN) or direct satellite link. MIST can also be accessed using cellular phones.

User friendly

The system is designed for flexibility and maximum ease of use. You select the data you wish to view using the available menus and the information is displayed in a visually attractive and clearly understandable format.

- MIST is easy to use, no training is required.
- Help facilities are on the screen.
- Users' guide will be provided with each system.

The precise weather information you need

MIST provides current observational data, forecast information and climatological data on a local, regional, national or global scale.

Output from the Met. Office's numerical weather prediction and sea state models for any region of the world provide the basis for products tailored to meet business and consumer requirements. MIST also carries specialised local information produced by Weather Centre forecasters with detailed knowledge of the conditions in their area.

System support

Full assistance is provided in the design, installation and testing of your system from the simplest single terminal facility to large-scale systems using local and Wide Area Networks.

A MIST helpline will be available for up to 24 hours a day seven days a week according to the level of licence fee paid.

Software upgrades will be free with the licence agreement and issued automatically either electronically or by diskette with full instructions on how to install the new upgrade of software.

Hardware

MIST is designed to be compatible with existing 486-based PCs with VGA colour monitor. This will display the information, when linked to the PDN. A decoder would be required for satellite transmissions.

Technical specification

Recommended 486 PC with maths co-processor, 8 Mbyte RAM, VGA. Minimum 40 Mbyte hard disk. Colour monitor. 3-button mouse. Printer (if required). Modem (dial-up MIST only). Packet Assembler Disassembler (PAD) (leased line MIST only).

Software

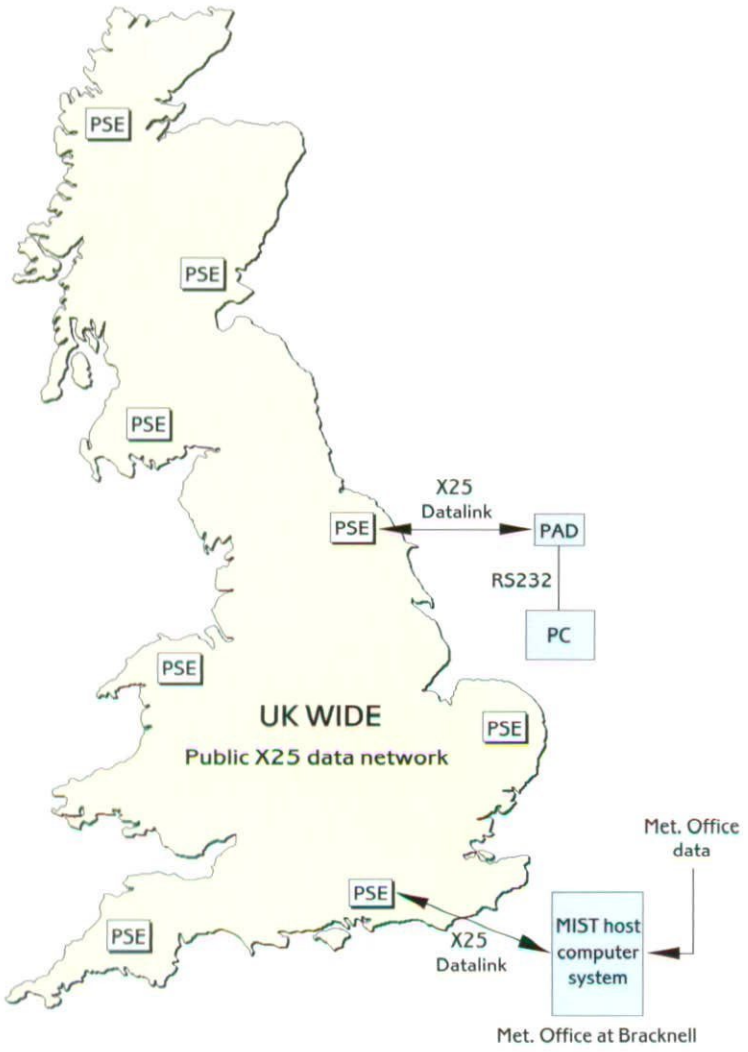
All acquisition and information display functions are accessed via a menu system under mouse or keyboard control.

The future

With PC communications at the heart of all corporate communications, MIST represents the commercial weather service of the future. The Met. Office and Matra Marconi Space jointly aim to continue the refinement of MIST services with a view to develop increasingly sophisticated levels of interactivity for your benefit.

The Met.Office MATRA MARCONI SPACE

Leased Line



How Leased Line MIST works

1. You need an X25 Datalink to connect you to the local PSE.
2. You require a 'PAD' to decode X25 data into serial RS232.
3. The MIST host at Bracknell auto–delivers data to your PC via the data network, your Datalink and your PAD.
4. Your data is automatically sent down the leased line from Bracknell.
5. X25 data charges are independent of your location in the UK.

MIST

Your own personal Met.Office

Dial–up

How Dial–up MIST works

1. You decide which products you want, then proceed.
2. The PC then dials local PSE by telephone line (local call rate).
3. The PC identifies itself as a registered user of the data network.
4. It then gains access to the MIST host at Bracknell (an X25 'call' begins, while local telephone call continues).
5. Host sends request data, then closes the communications 'session'.
6. You now have the data on your PC hard disk.
7. The data network comms charge is independent of your location in the UK.

CIS News

The newsletter for the Countryside Information System

Issue 3 January 1997

A new version of 'The Countryside Information System': Version 5.4!

Version 5.4 includes:

- a number of powerful new features
- a new version of the Environmental Catalogue (also available as a stand alone), and
- many new data sets.

Data can now be analysed for individual regions! Regions can be either user-defined or chosen from the many region definitions available within CIS. The regional data can be saved to files for later use or as regions themselves! This greatly extends the power of CIS and is widely accepted as the most valuable new function of the new version. More on Version 5.4 on page 2.

Welcome to New CIS Users:

Alexander Howden Reinsurance Broker
Bat Conservation Trust
Countryside Council Of Wales
Cumbria County Council
Environment Agency
Joint Nature Conservation Committee
Landmark Information Group
Macaulay Land Use Research Institute
MAFF
Nature Conservancy Council For England
Nene College Of Higher Education
Nuclear Electric
Scottish Agricultural College
Shropshire County Council
University Of Bristol
University Of London (Royal Holloway)
University Of St Andrews

Environmental Assessment using the 'Refine Region' function in CIS

Jo Treweek and Peter Hankard of the Institute of Terrestrial Ecology (ITE) used the 'Refine region' facility with the ITE Land Cover Map Census File to map the distribution of lowland heath in Britain. The map was further refined using heathland indicator species records. The distributions of two protected species, the Dartford warbler and the sand lizard, were superimposed to produce 'potential wildlife hotspots' for remaining heathland. A map of the existing road network was overlain to reveal the proximity of such areas to roads.

Counties that have important heathland areas were found to have a relatively high density of existing roads. When new road proposals were examined these heathlands were found to be under likely further threat.

Kilometre squares in GB where current major roads impinge on 'wildlife hotspots' and the number of squares within each county in which this occurs.

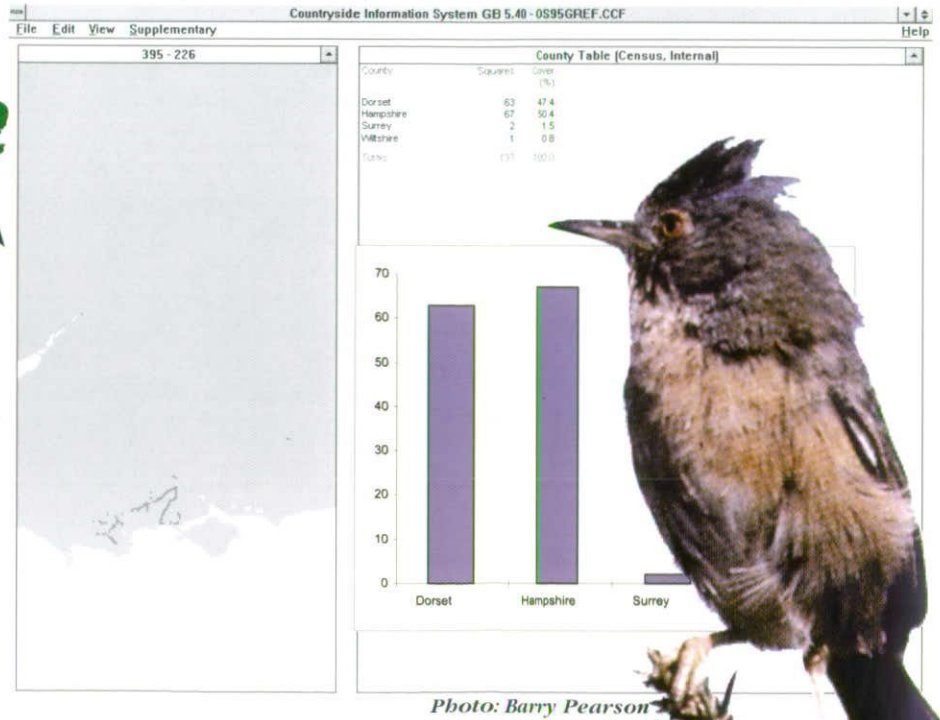


Photo: Barry Pearson

Centre for Ecology & Hydrology

Institute of Freshwater Ecology
Institute of Hydrology
Institute of Terrestrial Ecology
Institute of Virology & Environmental Microbiology

Natural Environment Research Council

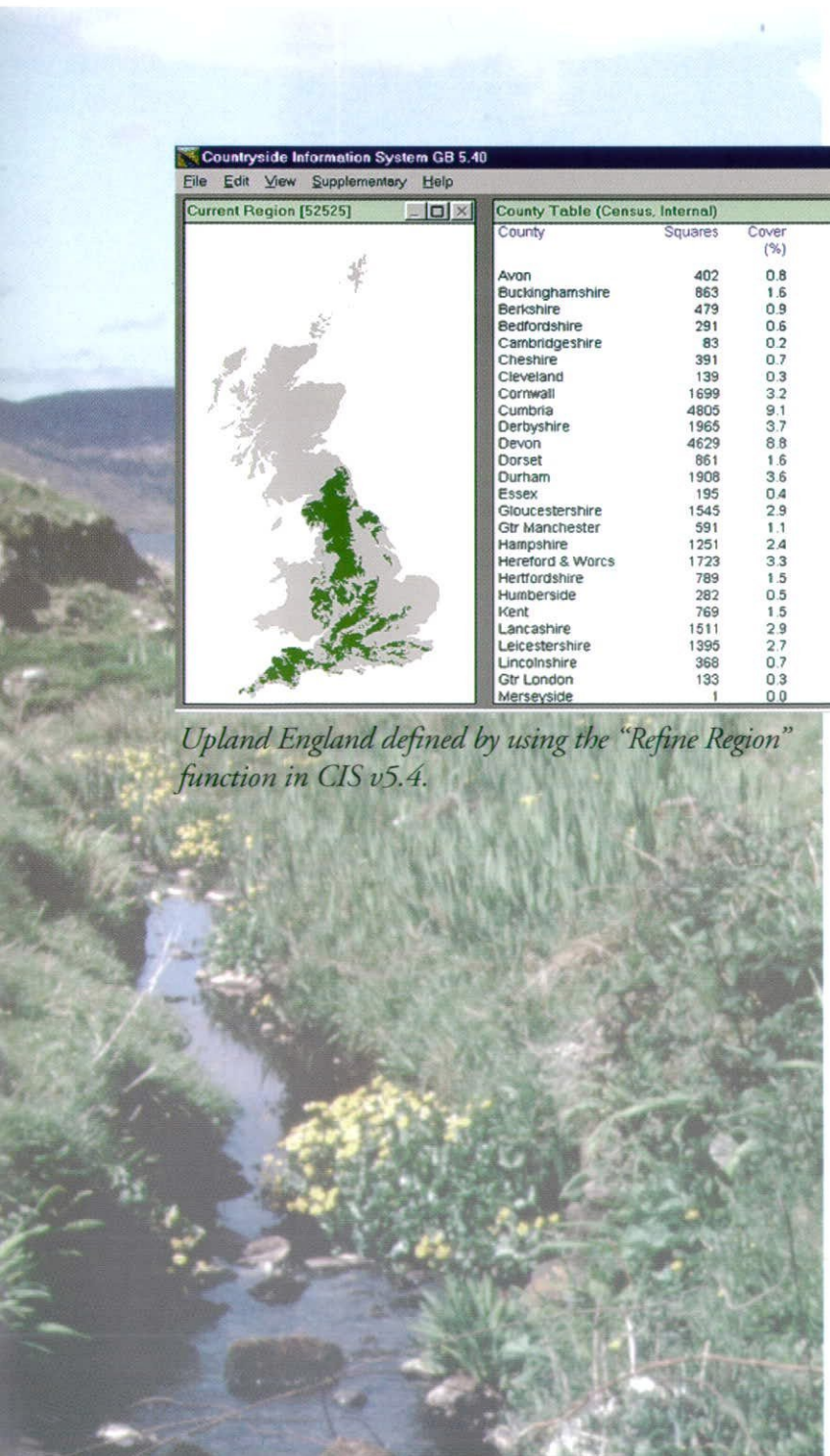
CIS Update

CIS version 5.4 - *New Data Sets and a New Price!*

New data sets are detailed within the new Environmental Catalogue. They include counties and administration regions, land cover information from satellite and national field survey. Enhancements to the data set functions allow the import and use of 10km data sets and the analysis of attribute data.

The pricing structure of CIS has been revised with the release of CIS v5.4, reducing the price of the software with a single copy starting at £500!

For full details of the available data sets, the pricing of multiple copies and copies of the environmental catalogue see the contact addresses on page 4 or visit the 'Countryside Information System' World Wide Web page at: http://wlfiles2.nwl.ac.uk/ih/cis/



Upland England defined by using the "Refine Region" function in CIS v5.4.

CIS Second Stage proposal

1997 sees the start of 'Stage 2' of the CIS which will further develop CIS as an information system. As a result of Stage 2, we will see:

- further critical data available
- enhanced software functionality
- more CIS information available on-line, and
- development of the partnership between CIS and other Information initiatives.

The contract for Stage 2 has been awarded to WS Atkins who have a great deal of experience of CIS and the uses to which it is put. They will be working closely with staff at DOE, ITE and the user community to develop CIS in pace with the requirements of policy staff in government departments as well as general users' needs.

Mail shot launched CIS version 5.4

The release of the new version of CIS (v5.4) was heralded by a large mail shot in September 1996. Information was sent to over 1000 people in the academic, government, commercial, industrial and conservation sectors. The information package contained a disk with the second release of the CIS Environmental Catalogue which gives the latest information on the availability of data in CIS format.

County level CIS

Dr Steve Head, Director of the Northmoor Trust near Oxford, describes how he is involved in developing CIS as a conservation tool at a county level.

The Oxfordshire Conservation Forum is a partnership of local and national organisations with the aim of developing a strategic approach to conservation within Oxfordshire.

The Forum sees CIS as a tool with massive potential to integrate our knowledge of the County, and to produce attractive information for public use.

At present, CIS only recognises eight national Land Classes in Oxfordshire, three account for 85% of the area. We therefore plan to repeat the analyses of physical characteristics used to develop the national scale Land Classification - at the county level.

Analysing Oxfordshire data should yield more local classes with much more predictive power. The new Land Classes will then be built into an internal census file in CIS. We will then conduct a stratified random sampling of kilometre squares in the new local classes. This will give us detailed descriptions of the new Land Classes which we can build into new county-based sample data sets. Other data can be added from county species records as well as from special surveys such as the current Council for the Protection of Rural England hedgerow study.

Such a County level CIS will enable us to:

- determine the distribution and fragmentation of the most important habitat types in the county,
- assess how currently protected sites match the overall picture,
- provide agencies such as the Farming and Wildlife Agricultural Group with local context data for the farmers they will be advising.

Most importantly, the surveys made can be used to start a monitoring system to track changes in the Oxfordshire countryside. We will be able to generate change data sets and use these, alongside national data, to increase awareness of conservation priorities with the public and landowners in the County.

The outcome will probably be the most complete description of the land forms, land use and state of conservation of any county in Britain. **Although this is at an early stage, I would like to hear from people in other counties who may be thinking along similar lines.**

Dr Steve Head, Director of the Northmoor Trust, Little Wittenham OX14 4RA *(Tel 01865 407792, Fax 407131)*

HOW DO I? – solutions

*Import a region from another application by saving a list of 1km squares as Easting {space} Northing into a file with extension *.dat.*
*To view the region in CIS use the 'File/Open Region' option in the 'File Menu' and search for files with the *.dat extension.*

Noticeboard

Who's who?

Dart Computing

Dart Computing is located inside the southern fringe of Dartmoor national park. It was formed in 1984 by Michael Jones in order to carry out environmentally-friendly computer programming work. Michael has carried out all programming for CIS since its inception, using C and C++ for Windows.

The company is also involved in Access programming and the sale of PC hardware, software and consultancy services. Customers include a range of NERC research organisations, a social research unit attached to the University of Bristol, local schools and colleges, small businesses and individual computer users.

CIS Training Course in April

A CIS training course is being held on 2-3 April 1997 at Lancaster University. The course is planned to cover a basic introduction to the CIS, but may be extended to include a further half-day to cover more advanced features if required. Anyone interested in attending this course should fill in the sheet enclosed within this Issue of CIS News and return to Noranne Ellis at the Institute of Terrestrial Ecology, Merlewood.

CIS was developed for the Department of the Environment by the Institute of Terrestrial Ecology with Dart Computing and the University of Nottingham. The Department of the Environment has commissioned WS Atkins to develop the latest version of CIS.

This edition of CIS News was compiled by Noranne Ellis with contributions from George Boobyer, Peter Hankard & Jo Treweek, Steve Head, Tim Moffat, Gavin Stark and Michael Jones. CIS News is brought to you by the Centre of Ecology and Hydrology and supported by the Department of the Environment.

Updated Land Cover Map

The Institute of Terrestrial Ecology has produced an updated version of the Land Cover Map of Great Britain. Corrections have been made to some misclassifications in the join between two classified map sections in the English Midlands which arose from the difficulties in finding suitable satellite images. The correction involves smoothing statistics to correct values in the misclassified region, based on a buffer zone around it. The updated map will be issued to current and new CIS licence holders together with details about the correction.

HOT TIP!

Click 'Find File' to see a title when opening census, sample or region files.

Contact addresses:

CIS Sales
Jeff Parker
Institute of Hydrology
Maclean building
Wallingford
OX10 8BB
Tel: 01491 838800
Fax: 01491 832256
E-mail: J. Parker@IOH.AC.UK

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Data Availability
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Environmental Information Centre
ITE Monks Wood
Abbots Ripton, Huntingdon
Cambridgeshire PE17 2LS
01487 773381
01487 773467
EIC@ITE.AC.UK

SCHOOL OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT

MIDDLESEX UNIVERSITY

[redacted]

FLOOD HAZARD RESEARCH CENTRE

ACTIVITIES PROFILE
No. 9

January 1996

CONTENTS

1. INTRODUCTION

The Flood Hazard Research Centre at Middlesex University is an inter-disciplinary research group, established in 1973. The Centre specialises in the analysis, appraisal and evaluation of environmental policies, plans and schemes with particular reference to water management. Over the years the Centre has developed a national and international reputation for the development of methods and data bases for the appraisal of investment in environmental improvement. The Centre's expertise is based upon research on the estimation of flood damages, leading to the development of the ESTDAM urban benefit assessment computer model.

The main mission of the Centre is to investigate the social and economic impacts of floods and other areas of environmental policy, and to broaden decision-making away form an emphasis simply on engineering solutions. The activities of the Centre are continuing to expand and major research and consultancy studies now include:

- economic, social and environmental impact assessment
- recreational management
- floodplain management
- water resource management
- water quality
- investment appraisal
- environmental economics
- public perception
- hazard and disaster management

The growth path in the Centre can thus be seen as an outward expansion from our roots in the project appraisal of flood alleviation schemes, extending our research and writing:

- to include river basin and water resource management in general;
- to encompass broader assessments of the impacts of projects, including ecological and heritage impacts, thus extending methods of investment appraisal beyond economic efficiency impacts;
- to place more emphasis on higher level investment appraisal than lower level single project appraisal, moving towards the prioritisation of schemes and the determination of the optimum combination of schemes;
- to move towards policy level decision making and the integration of water resource management into overall resource management;
- to increase involvement with both international organisations and individual countries.

The growing international reputation of the Flood Hazard Research Centre has included research and consultancy on behalf of, or in collaboration with: OECD; UNDRO; USAID; ODA; European Commission; Ford Foundation; Ministry of Agriculture, Fisheries and Food; Department of the Environment; Department of Transport; National Rivers Authority; the Governments of Bangladesh, Hong Kong, Canada and Portugal; the Academy of Environmental Sciences in China; Bihar State University in Patna, India. The Centre is also a member of the International Federation of Institutes for Advanced Studies (IFIAS).

Twenty members of staff currently work in the Centre, including two PhD students from the UK and Bangladesh. A third student from Malaysia has recently been awarded his PhD, while a fourth student registered with the Centre is employed by the National Rivers Authority.

Interior view of the Centre

2. RIVER AND COASTAL MANAGEMENT

EUROflood

The second phase of the EUROflood project, between 1993-95, has brought in two new partners from Barcelona, Spain and Catania, Italy. In addition, a number of the projects have expanded their scope, particularly that concerning the German partners and Delft Hydraulics, which are looking at regional scale modelling of flood damages.

The Centre is concerned with 3 projects within this second phase. First, we are undertaking major empirical studies of evacuation during flooding, drawing on historical examples such as Canvey Island (1953), but also the Scottish floods (in 1994). A model is being developed of the impact of evacuation on the people affected, and lessons drawn about best practices for the organisation of evacuations in the future.

Secondly, the Centre is looking, in conjunction with the University of Catania, at the question of flood insurance, as an economic instrument for deterring use of flood plain areas and also spreading the losses resulting from floods. Case studies will be investigated, as will the experience of developers in the UK. Particular emphasis is being put on charging for runoff, in addition to insurance to evaluate the potential for using economic instruments for alleviating flooding problems.

The third area of research within this second phase of EUROflood concerns land use planning. Building on many years of work at the Centre some conceptual work is being undertaken to investigate the reasons for unwise development of flood plain areas. Particular emphasis will be put on the process of flood plain development, rather than case studies (which have been explored extensively by the Centre in the past), drawing on European examples and setting the project within the context of different land use control systems in the European Community countries.

EUROflood - Land Use Module

The land use module is part of EUROflood II; a major project funded by the EC. FHRC is leading the module, but CERGRENE (Paris) also has a major involvement. The Centre is examining the general problem of floodplain land use management by local government. Local government is relied on to perform numerous tasks including most land use management. In many cases it is not clear that the local authorities have the capacity necessary for successful flood policy development or implementation. Capacity in this context involves legal and technical issues, there are also important issues of accountability and political legitimacy. The research will explore these questions, and establish criteria for capacity.

EUROflood - Warnings and Evacuation Module

The second module within the EUROflood project covers flood warnings and evacuation. The first phase of the module examined evacuation from the institutional perspective. A questionnaire was sent out to Emergency Planning Departments across the UK, and information was gathered on flooding, evacuation, flood risk, consultation and plans in each area. The methodology for the second phase included qualitative interviews with people who experienced flooding and evacuation in three case studies: Paisley (1994), Perth (1993) and Canvey Island (1953). The final report will focus on the experience of evacuation from the perspective of the householder, and the issues raised when planning, and carrying out, an evacuation. It will be completed in February 1996.

Thrushcraig Crescent, Paisley

Blackpool South Shore Sea Defences: Appraisal of disbenefits associated with raising the promenade (April 1995). Sir William Halcrow & Partners and Blackpool Borough Council

Blackpool Borough Council in conjunction with Sir William Halcrow and partners conducted a Benefit Cost Appraisal of alternative sea defence schemes to alleviate flooding and prevent erosion of the foreshore on Blackpool's south shore. The preferred scheme involving raising the height of the existing promenade was over £2 million pounds cheaper than the alternative proposal to create an offshore berm.

It was felt that raising the promenade by one metre could produce significant disbenefits as a result of visual impairment to occupants of residential property and visitors to the hotels on the New South Promenade. FHRC evaluated the extent of this visual impairment or diminution of the existing view as a result of construction of the two scheme alternatives. Physical sight line and questionnaire survey techniques were used to quantify any disbenefits which are accepted by MAFF as legitimate social costs within project appraisal. Willingness-to-pay to retain sea views and the effect on market values following potential loss of sea view were evaluated before a conclusive selection of the most cost beneficial scheme could be made.

Flooding in Northern Italy: A report on the November 1994 floods in Piedmont and an assessment of future risk (Alexander Howden Group Ltd.)

The floods of 5-6th November 1994 in the Piedmont region of Northern Italy resulted in at least 63 deaths and physical and economic loss estimated at £8 billion. Most of the property damage occurred in 780 towns and communes situated on or near rivers with little or no flood protection. Landslides on unstable slopes aggravated damages. Depths of flood waters were up to three metres. On the floodplains damage was primarily to contents, exacerbated by a layer of mud up to 0.6 metres thick deposited by the flood water. However, though rainfall was unusually heavy, the severity of the damage can also be attributed to inadequate emergency planning, insufficient environmental management and inappropriate development in the flood plains and hillsides denuded of vegetation.

With the Alexander Howden Group, a leading London-based Lloyd's broker, FHRC have developed a capability to react quickly to flood disasters and provide an immediate assessment of damage and future risks.

Flood debris in Venaria, near Torino, Italy

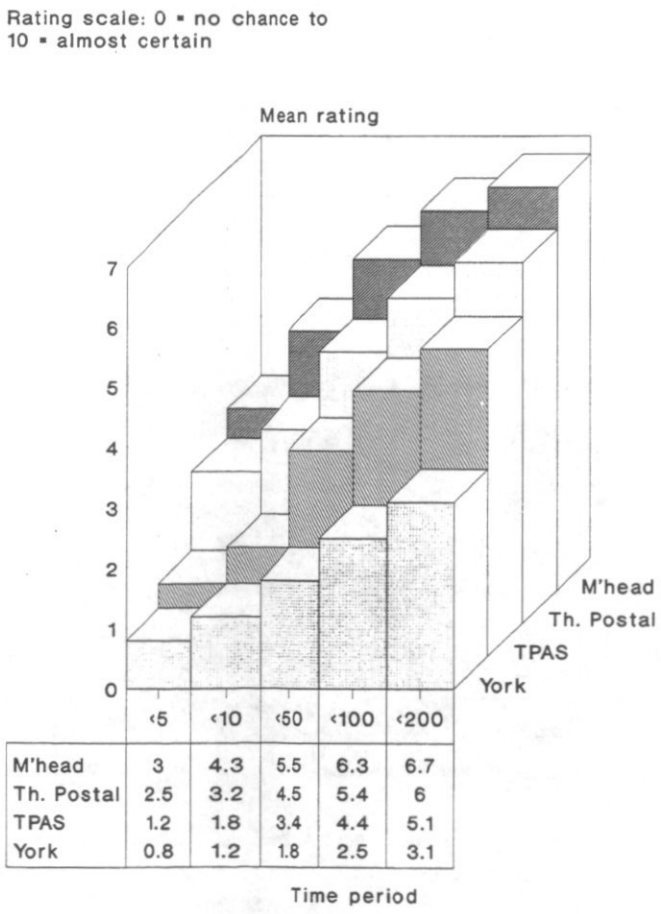
Flooding in Glasgow and Ayrshire: A report of the December 1994 floods in Glasgow and an assessment of residential and commercial property damage (Alexander Howden Group Ltd.)

The Alexander Howden Group commissioned the Centre to undertake a further 'quick look' report following the Glasgow floods in late 1994. The flooding in Glasgow and other parts of the Clyde valley in Scotland following heavy rainfall on the weekend of 10-11th December 1994 resulted in three deaths and economic losses approaching £100 million. Around three quarters of flooding incidents were associated with residential property, with nearly 700 homes affected, primarily in the suburbs of Paisley and Kirkintilloch, where in extreme cases flood water depths exceeded four metres. Many homes were council or housing association properties with low income occupiers, the vast majority of whom did not have contents insurance. With little in the way of state assistance, the urban communities damaged by floodwaters needed many months to recover. Continued urban development within Glasgow is likely to exacerbate the effects of future flood events.

Public perception of rivers and flood defence (National Rivers Authority)

The public perception of rivers, flood hazards, flood alleviation and river management schemes has grown in importance as an issue over recent years. The Centre has been involved in a number of studies between 1987 and 1994 funded by the National Rivers Authority. The research studied the relationship between the public, hazardous events such as floods, and major investment decisions, such as flood alleviation scheme designs and their implication. It aimed to provide an enhanced understanding of this relationship to enable the NRA to act sensitively and in a planned manner with regard to floods and their impacts.

The research has highlighted the value which the public places on rivers and has shown that groups of people vary in their attitudes towards the environment and the flood risks they face. The importance of, and preferences for, public consultation were also highlighted in the findings from the studies. The 1994 final report summarises the findings from the 13 studies carried out as part of the public perception project which involved extended interviews and questionnaire responses from over 3,000 residents living in areas designated as flood plains in three NRA regions: Thames, Northumbria and Yorkshire, and South Western. The report thus draws on a very substantial body of evidence, probably the largest currently available in England and Wales concerning public perception of rivers and flood defence.



	‹5	‹10	‹50	‹100	‹200
M'head	3	4.3	5.5	6.3	6.7
Th. Postal	2.5	3.2	4.5	5.4	6
TPAS	1.2	1.8	3.4	4.4	5.1
York	0.8	1.2	1.8	2.5	3.1

Perceived likelihood of future flooding from four study areas

Public perception of river restoration (National Rivers Authority)

Many of our rivers have been degraded by pollution or have been victims of engineering works such as straightening, culverting and channelisation for land drainage, transportation and flood control. The result of this has had profound consequences on the appearance of rivers, upon their amenity and recreational value and upon the richness of their ecology and wildlife. FHRC has been involved in several studies on river restoration schemes, in particular in looking at the public's perception of, at attitudes to, such schemes. The first involved a public perception survey in 1991 of a possible restoration of a section of the Ravensbourne River in Queen's Mead Recreation Ground, Bromley (Tapsell, S.M.; Tunstall, S.M.; Costa, P.; Fordham, M., 1992). The section of the river was channelised in the early 1970s as a result of severe flooding in the area. This particular study formed part of the major collaborative project between FHRC and the National Rivers Authority Thames Region on the public perception of rivers and flood defence. Results from the study revealed substantial support for a full river restoration scheme in the park.

The River Restoration Project

The Centre is currently involved in a new study by a group of British professionals, the River Restoration Project. The aims of the project are to establish international demonstration projects which show how state-of-the-art restoration techniques can be used to recreate natural ecosystems in damaged river corridors. The project aims to re-establish the whole physical and biological system at the sites chosen and to increase the understanding of the effects of restoration work on nature conservation value, water quality, visual amenity, recreational and public perception. The project hopes to encourage others to restore streams and rivers by disseminating information and guidelines and developing partnerships between institutions and landholders.

River Cole - current channel will be left after new meanders constructed

Two demonstration sites have now been established in Britain on the rivers Skern and Cole. FHRC carried out a public perception survey of 252 local residents for the River Skern project, Darlington, in 1995. Residents welcomed a more 'natural' river environment with the provision of new meanders in the river, additional planting and landscaping, and new wetland areas. Furthermore, it was perceived that restoration would offer increased opportunities for recreation and for wildlife. Despite some concern over the issues of safety and increased visitors, results showed overwhelming support for the proposals for river restoration, which were perceived as a chance to improve the area generally.

Institutional Aspects of River Restoration in the UK

FHRC was invited to undertake a study of the institutional aspects of river restoration for the River Restoration Project as part of the NRA's R&D programme. The objective of this study was to provide baseline information on opportunities for river restoration and on the interest in river restoration, and to clarify institutions' powers, duties and responsibilities. The study also aimed to provide information on schemes and sources of funding for river restoration for the guidance of any organisation or individual interested in such initiatives.

The study found that institutional arrangements for water management and nature conservation are strikingly different in the different parts of the UK and also these are in a process of change. Of the statutory institutions with an interest in river restoration, there was not one institution in common between all four countries of the UK, England, Scotland, Wales and Northern Ireland at the time of the study. There is no single scheme in any part of the UK which is specifically designed to provide a source of funding for river restoration. Any river restoration project in the UK will have to be based on building a partnership between various bodies: the NRA, local authorities, statutory and voluntary conservation agencies, landowners and user groups. Any extensive river restoration scheme is likely to depend on a 'mosaic' of funding covering different aspects of the work and areas of land associated with the river in the scheme. The report stressed the importance of involving local people in order to develop a feeling of 'ownership' of a restoration project (Tunstall 1994).

Upper River Kennet Study (National Rivers Authority)

The Upper Kennet is considered to be a good example of a southern chalk stream. The character of both the river and the catchment has changed during this century. There have been concerns about reduced river levels and the reduction of ecological and amenity value of the river. This NRA funded study focused on the perceptions of the local community and used both qualitative and quantitative techniques.

The river is highly valued by the local community, with a high proportion visiting the river for recreational purposes. However, the study strongly suggests that the river also has a high non-use value. Respondents were greatly concerned by current river levels and stated that these have a significant impact on their enjoyment of the river.

Although the NRA believe the river is behaving within its normal bounds this belief is not shared by the local population. Whilst there

is an acceptance that changes in management and drought are contributory factors to recent low river levels, there is only limited acceptance of the ephemeral nature of the river and an overwhelming perception that abstraction is the main cause of low flows in the River Kennet. In general, the current management is considered unacceptable, with respondents perception of and attitudes to low flows being a significant determinant of their rating of the management. Despite the apparent dissatisfaction with current management and consultation, people still feel that the NRA knows best and can be relied upon to protect rivers.

Group membership is an important factor in public perception f the river and its management. Action for the River Kennet (ARK) is the local group with the highest profile and nearly half of respondents felt it to be representative of the local population. However, it remains necessary for the NRA to be seen to be consulting the general public as well as interest groups.

Low flows in the Upper Kennet

Public Safety of Access to Coastal Structures (National Rivers Authority)

The purpose of this study for the National Rivers Authority was to identify the extent of the hazards to the public arising from access to different types of coastal structure; to estimate the relative risk to the public from each form of structure; and to devise a system to support the achievement of a nationally consistent management strategy. FHRC advised Sir William Halcrow and Partners, the project leaders, on a number of aspects. Any management approach must necessarily be built upon the legal duties and obligations of the Authority with respect to those coming into contact with coastal structures. Professor Brenda Barrett, of the School of Law at Middlesex University, therefore reviewed the statute and case law of England and Wales, and other material, in order to define the legal obligations of the National Rivers Authority.

A Guide to the Understanding and Management of Saltmarshes (NRA R&D Note 324) Chapter 6: Economics

The guide has been developed to further the knowledge and understanding of saltmarshes and saltmarsh processes sufficiently to allow and to encourage their use within an overall sea defence strategy.

Saltmarshes have value only in relation to their uses and character, and these are a function of the location of the saltmarsh at the coast - or along an estuary - and the socio-economic character of those areas. The chapter examines the nature of the value of saltmarshes set within the context of i) a focus on the use of saltmarshes in flood defence; and ii) a very brief discussion of economic theory.

The chapter identifies the economically important uses of saltmarshes to economic evaluation, central government guidance on the best techniques and methods for economic appraisal, plus a guide to useful data sources. A case study (Keyhaven Marsh) is used to illustrate the appraisal of the economic value of a saltmarsh.

Recreation Visitor Numbers - Meirionnydd Coastal Management Study

The Flood Hazard Research Centre was contracted to provide information on methods of establishing visitor numbers along the Meirionnydd coast as part of the Meirionnydd Coastal Management Study. Advice was given on site selection and functioning of infra red people and traffic counters, sources of error in visitor estimation with counters, and on the calibration of counter data through surveys and manual counts. A report was produced from the study (Tunstall 1994)

3. WATER QUALITY

Aesthetic Classification of Water Quality (National Rivers Authority)

The National Rivers Authority, the main regulator of water quality in England and Wales, accepts that the management of water quality requires a consideration of the aesthetic quality of water as perceived by the public.

Recent research into the development of an aesthetic classification of water quality first focused on the impact of a range of individual items/attributes found in or along a river. Staff at the FHRC are now working with the Water Research Centre, on behalf of the NRA, to undertake the final stages in the development of an aesthetic classification of water quality.

The classification is based on eleven water quality attributes. Water quality ratings based on perceived water quality scores ascribed by the public to a series of slides depicting a gradual increase in the presence of the individual attributes, and a system of weightings based on the assumption that one or more of the attributes are considered to be less acceptable or more indicative of poor water quality than others, have been developed.

The classification will form part of the new General Quality Assessment (GQA) system used by the NRA in the five yearly river pollution surveys.

Aesthetic Pollution Study (National Rivers Authority)

Previous work by FHRC on the public's perception of water and river corridor quality lead to an investigation into the public's perception of the presence of sewage-derived gross solids, discharged from urban storms drains, on the use of rivers and beaches for recreation. The work was undertaken on behalf of the National Rivers Authority and sub contracted by the Water Research Centre.

The results demonstrated that the presence of sewage-derived contaminants would have a greater impact on the public's enjoyment of a visit to a river or beach than any other aesthetic pollution indicator; but that sewage-derived products are not regularly seen by the public. Single items of sewage-derived waste, when recognised as such, appear to have a greater impact on perceived water quality than an agglomeration of different items. Differences in the impact of different items were recorded, with sanitary towels having a more strongly negative impact on perceived water quality than condoms. The presence of solid waste contaminants in the water seem to have a greater impact on the public's perception of water and environmental quality than their presence on the banks of a river or on a beach. In fact, the appearance of litter on the banks does not greatly affect perceived water quality.

It was apparent from the research that a large section of the public do not associate the presence of sewage-derived waste products on the banks of a river or on the beach as coming from the water.

Aesthetic pollution of River Taff, Cardiff

Drinking Water Directive: pesticides (European Commission)

The Drinking Water Directive requires that the concentrations of pesticides in drinking water do not exceed 10mg/litre. The capital costs of treatment plant to meet this standard is £1 billion for England and Wales alone, with estimated annual costs of more than £100 million. The European Commission funded a consortium lead by Dr Ingo Heinz, University of Dortmund, and including FHRC to identify the benefits and costs of treatment versus control at source. It was shown that the effect of other programmes, particularly those under the Common Agricultural Policy, potentially have as a major side benefit the control of pesticides at source. Environmentally Sensitive Areas, the first tier agreements for which typically include limits on pesticide usage, already cover 15% of agricultural land in England and Wales. In addition, in the case of groundwater, local urban uses can impose a significant pesticide loading which can be abated at a cost low in comparison to the cost of treating the water after it has been contaminated by pesticides.

4. BENEFIT ASSESSMENT STUDIES

Camber Town Quay, Portsmouth: Stabilisation Scheme Cost benefit Appraisal (Portsmouth City Council) 1993

In 1993 the Centre was invited by Portsmouth City Council to carry out a cost benefit analysis for the Camber Quay stabilisation scheme as the appraisal prepared by the City engineer's department was not in accordance with the MAFF Project Appraisal Guidance Notes. The strategy adopted measured alternative schemes against 'Do Nothing', ie allow the quay to collapse and destroy the economic base of the Camber Quay. As well as proposals for new revetment walls a managed retreat option was considered where the minimum amount of engineering and dredging was considered and, wherever possible, maintain the economic activity of the quay and surrounding areas.

The benefits evaluated relate either to delaying the loss of erosion prone assets (land and buildings) or averting the consequential losses associated with 'Do Nothing', such as disruption to business, (importantly the fishing industry and the operation of the Wight Link Ferry service), and residential activities, injury and loss of amenity. A feature of the assessment was the effect on house prices in the new developments overlooking the quay (housing blight) as a result of the dilapidating quay rapidly becoming unsightly and dangerous.

Consequential losses may be conjectural and a robustness test was presented eliminating the more subjective elements from the analysis.

The Perth Flood Prevention Scheme (Halcrow Fox and Halcrow Scotland) July 1995

The Centre provided an in-depth investment appraisal of the proposals by the Babtie Group, and Tayside Regional Council to alleviate a combination of tidal and fluvial flooding to a standard equal to the worst known flood on record on the River Tay in Perth and the suburb of North Muirton. The scheme proposals were as a result of the devastating floods of January 1993, affecting many hundreds of homes in North Muirton and property in Perth City centre. The Tay breached existing defences at North Muirton creating flooding on a scale not experienced in Scotland this Century causing extensive damage and untold socio-psychological problems within the general population.

The cost benefit analysis used the full range of techniques developed at the Centre; ESTDAM for benefit assessment; BUSLOSS for analysis of commercial losses and MROAD for evaluation of road traffic disruption. Full property threshold surveys were undertaken by Halcrow Fox and the effect of future flooding on over a dozen commercial properties and public buildings, including the Perth Art Gallery and Museum, was determined using standard questionnaire survey techniques as detailed in The 'Red Manual'. The investment appraisal was done strictly following the MAFF project appraisal guidance notes (PAGN) in accordance with the audit procedures adopted by the Scottish Office. Expenditure on the proposed scheme of approaching £20 million will be almost as much as spent on flood protection within the whole of Scotland in the last 30 years.

River Irwell Flood Control Scheme: benefit Cost Assessment (National Rivers Authority - North West Region) July 1994

The Centre were commissioned by the National Rivers Authority (North West region) to undertake a Benefit Cost appraisal for the proposed River Irwell Flood Control Scheme in Salford Greater Manchester, where standards of protection fall significantly below the MAFF indicative standards for a high density urban area. With some 4,823 properties potentially affected by flooding from the once in two hundred and fifty year flood event, this represented a substantial assessment on which to apply the new investment procedures (Project Appraisal Guidance Notes - PAGN) published in May 1993.

An earlier project appraisal, commissioned prior to the publication of PAGN, was re-vamped in 1994 to test the cost effectiveness of the proposed scheme options (a combination of flood storage basins and associated embankments) against the 'Do Nothing' baseline as dictated by the Guidance Notes. Innovative techniques were devised to deal with modelling uncertainty. Use of the micro-ESTDAM model facilitated the iterative runs necessary to accommodate the 'what-if' scenarios based on estimates of different channel conditions and the effect of these conditions on out-of-bank flooding.

The flood storage scheme options included environmental improvements to the Amblecotes area of Salford, where alternative sports and recreational facilities are being provided whilst the construction works at the flood storage sites are carried out. An assessment of this enhanced facility is included in the benefit cost appraisal.

Afon Mwdlan Flood Study Cost Benefit Analysis (WS Atkins, Wales) 1994

Severe flooding in June 1993, with property flood depths in excess of 1.5 metres, in Cardigan precipitated the need for cost effective flood control. The town is affected by both tidal flooding from the Afon Teifi and fluvial flooding from the Mwdlan. Atkins, Wales invited the Centre to utilise the micro-ESTDAM model to evaluate the benefits derived from 14 alternative scheme options, including culvert extensions and tunnel diversions, the latter retaining the natural channel characteristics for low flows.

The benefit modelling was greatly assisted by the availability of extensive, good quality real time film footage of the 1993 flood, estimated as a once in one hundred year event. Modelled flood depths could be compared readily with the flood depths achieved in all parts of the town. Innovative methods of estimating utility outages were employed as part of the benefit assessment.

The development of environmentally sound, sustainable options and the development of "green" parkways, although expensive allow the development of recreation and amenity but involve the complications of property relocation.

River Nene Study (National Rivers Authority) 1994/95

For navigation and drainage purposes, the flows on the River Nene are controlled by a large number of locks with associated weirs and other control structures. These structures have little affect upon controlling floods and their main benefit is to maintain navigation head and maintain flow depths. Parts of these structures are nearing the end of their life and the National Rivers Authority commissioned Balfour Mouchel/CES, with the assistance of FHRC, to undertake a benefit-cost analysis of a number of options, including the rehabilitation of these structures, against the baseline case of abandonment.

The classes of benefit assessed included: abstraction for potable water and irrigation; pollution dilution; angling; boating and informal recreation. The study also included the first use of the criteria developed by English Nature to identify critical and constant natural capital since a number of SSSIs, a SAC and Countryside Stewardship schemes would be affected by any change in the water regime.

The Polperro and Newport Pagnell Flood Alleviation Schemes (Scott, Wilson, Kirkpatrick) 1994

The Centre has the ability and reputation to respond quickly to broadbrush benefit assessments required by a wide client base of consulting engineers, who do not have access to micro-ESTDAM and its database of depth/damage information. The Polperro and Newport Pagnell schemes evaluated in 1994 are good examples of the symbiotic relationship between the Centre and consulting engineers. The client will provide the resources for land use data collection and property threshold surveys (where appropriate) and the Centre will use its skills to manipulate the physical and hydraulic/hydrological data provided to simulate a benefit assessment to whatever level required; pre-feasibility, strategic or full flood impacts. The two schemes cited here allow the best results to be obtained from a minimum knowledge base with no site survey by FHRC.

Wentlooge Levels Benefit Cost Analysis (National Rivers Authority, Welsh Region) 1994/95

The Wentlooge Levels are located on the coastal floodplain between Cardiff and Newport. The sea defences are inadequate for protecting the rapidly developing floodplain against even modest flood events. The defences were built up progressively since Romano-British times and factors of safety are low. The Centre were invited by the NRA (Welsh region) to undertake a comprehensive assessment of the benefits associated with further protecting the Wentlooge Levels. The levels were at one time occupied by extensive pasture and isolated villages, but as demand for accessible land in South Wales grew, commercial and residential development expanded onto the coastal plain.

The appraisal considered full flood impacts, including communication links (the main London -Cardiff railway crosses the levels and the M4 relief road is to be built across the flood plain) and the benefits of future development (about 50% of all the approved developable land in South Glamorgan is located within the benefit area).

This investment appraisal represents the first full flood impact benefit assessment to adhere strictly to the MAFF Project Appraisal Guidance Notes. The implications of progressive sea level rise over the time horizon of scheme proposals were a particularly important aspect of the assessment.

Pre-feasibility Study of the St Petersburg Flood Protection Barrier (Sir Alexander Gibb & Partners) 1995

The European Bank for Reconstruction and Development (EBRD) is considering a request from the City of St Petersburg for financial support for the completion of the partially constructed Flood Protection Barrier across the Neva bay. Sir Alexander Gibb, the main contractor, commissioned the Centre to evaluate the potential flood alleviation benefits associated with completion of the barrier. The methodology involves a survey of the potential damage for successive flood return periods to those land uses within the benefit area of the barrier. Databanks on flood damage available from the Centre will be transferred to the St Petersburg situation. A major consideration in assessing the benefits to the City is the evaluation of indirect losses in terms of lost business and other economic activity.

A study of project appraisal methods (Sir William Halcrow & Partners) 1994

The Centre was commissioned by Halcrow Water to produce a state-of-the-art compendium of project appraisal methods in river and coastal engineering for their client the Japanese Institution of Construction Engineers, Tokyo. In post-war Japan, the urgent need for the reconstruction of public works schemes often produced inadequacies in environmental considerations. Public concern now ensures that the implementation of public works projects obtains consensus from the regional communities benefiting from the projects and the Nation as a whole.

A review of appraisal methodologies in the UK, Germany and France, both economic and environmental, is intended to facilitate the consensus building process in Japan. The Centre's work reviewed current methodologies, particularly the introduction of PAGN and the objective methodologies emerging in environmental economics.

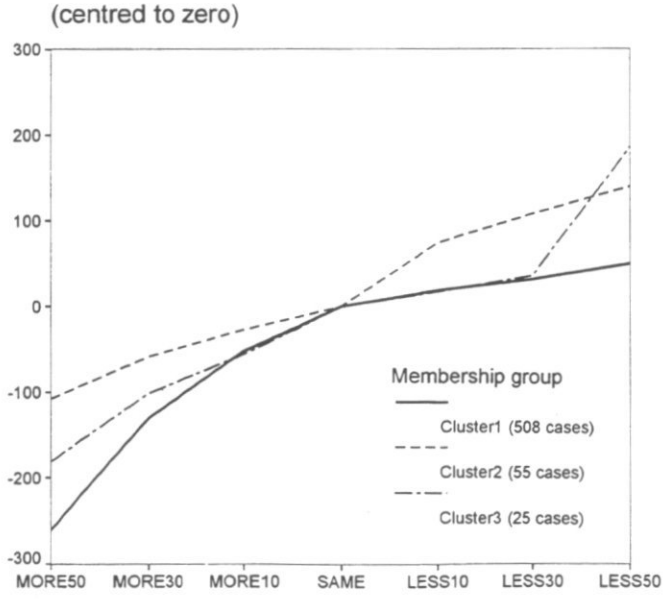
5. ENVIRONMENTAL ECONOMICS

Monetary Valuation of Road Traffic Nuisance (Department of Transport)

In association with JMP Consultants, the Centre was commissioned by the Department of Transport to undertake research and studies which would aim to ascribe monetary values to traffic nuisance from road vehicles. The objective of the study was to derive values which could inform decisions made by the Department of Transport when making investment choices.

In the final stage of this two year project it was decided to use both Revealed Preference (RP) and Expressed Preference (EP) techniques. The Revealed Preference technique took the form of expert valuations, whilst the Expressed Preference technique used Conjoint Analysis (sometimes known as Stated Preference) to obtain monetary valuations, and the Contingent Valuation Method as a means of validation.

The Revealed Preference approach was based on structured interviews with District Valuers, whereby values were sought for hypothetical changes in environmental variables. In the Expressed Preference study surveys were undertaken at fifteen sites chosen to represent a variety of road types, traffic characteristics and housing types. Overall, a total sample of 610 respondents was obtained.



Mean part-worths for housing costs

The conjoint analysis game derived monetary values for ten pre-defined traffic policies. The simple Contingent Valuation (CVM) questions asked respondents their Willingness To Pay for their 'best policy' (as defined from the changes in their nuisance score) along with their Willingness To Accept Compensation for their 'worst policy'. The Conjoint Analysis results indicated that respondents were prepared to pay a mean monthly amount of £18.55 for the traffic flow using the road to be halved. Similar values were obtained for an HGV ban and the introduction of additional pedestrian crossing facilities. The CVM questions produced comparable results to Conjoint Analysis, therefore providing verification of the main approach.

The Expert Valuation Surveys provided percentage changes in compensation award for a number of different policy scenarios. Where these were converted into the value per decibel these were found to correspond well with the results of previous hedonic pricing studies. A 0.3% change in property price per decibel was recommended for practical use.

Assessing the benefits of river water quality improvements

In 1994, the Foundation for Water Research published the Iterim Manual "Assessing the benefits of river water quality improvements" under sponsorship from the industry, OFWAT, the NRA and the DOE. The Manual is designed to enable the desktop assessment of the benefits of all schemes which will result in an improvement in river water quality. FHRC, as part of a team lead by the Water Research Centre, contributed to the Interim Manual which, summarises the results of previous valuation studies. The Manual procedures are being tested at the moment; for instance, in assessing the benefits of schemes for the River Medlock.

Two areas of benefit for which it was recognised by the Foundation that existing data was limited or dated are angling benefits and the fuzzy area usually labelled 'nonuse value'. The Centre was commissioned to undertake a Contingent Valuation study to assess the benefits to coarse and game anglers resulting from improvement to fisheries. A second study is being undertaken to determine whether and why people value rivers in addition to the use value they gain from them. This area, commonly termed 'nonuse value' poses a number of theoretical and methodological problems in that whilst previous research at the Centre has shown that rivers are highly valued as an environmental resource, there are reasons for believing that people value the principle of unpolluted rivers rather than evaluating individual stretches of river in these terms. However, any improvement scheme, and any benefit-cost analysis, of that scheme affects a specific stretch of river. This second study, therefore, involves an innovative procedure based upon Contingent Valuation Method in which respondents are asked how much they are prepared to pay for different programmes of improvements (also see Section 3 on Water Quality above).

PCFC-funded CVM research

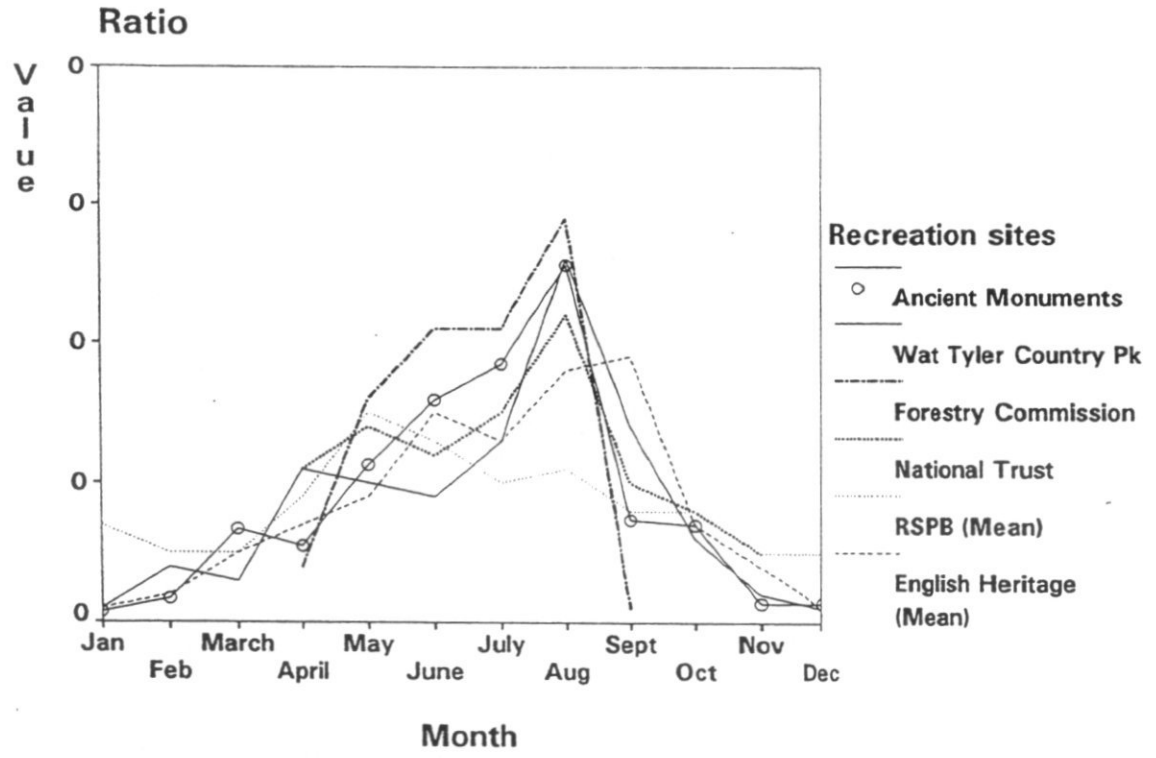
Funding from the former Polytechnic Central Funding Council has been used to explore a range of theoretical and methodological issues in relation to the evaluation of environmental resources by the Contingent Valuation Method. The neoclassical economic model is embedded in a nineteenth century Anglo-Saxon world view and embodies some primitive implicit speculative psychological

assumptions. Time is also not formally part of economic theory.

A series of reviews of concepts of time in the enthnographic and geographic literature were undertaken and some theoretical studies of time as a constraint upon consumption in addition to income. Recent psychological and anthropological analyses of the nature of cognition were also examined to determine the implications for Contingent Valuation studies; 'embedding' or 'part-whole' consequently being argued to result from inappropriate cognitive assumptions being made in the Contingent Valuation studies in which such a bias was reported.

There is a major debate in the economic literature as to the nature of 'non-use value and whether this is a countable economic benefit; in particular, as to whether it is possible to derive a nonuse value for a specific site or a specific species. A series of studies has been undertaken, including a number of focus groups, to explore the nature of the motivations which lie behind such values and the degree to which such values can be isolated to specific instances of a general class.

Finally, a major problem in evaluating the economic value of a recreational resource is typically that data as to the number of visitors to that resource is, at best, inadequate. It may then be necessary to use average data or to estimate the annual number of visitors from short period counts. All available data on visitor numbers, including data from the RSPB, English Heritage, the National Trust and the Science Museum, was therefore analysed to determine whether there are any typical patterns in visitor numbers which can be used to estimate visitor numbers for a site where no data exists.



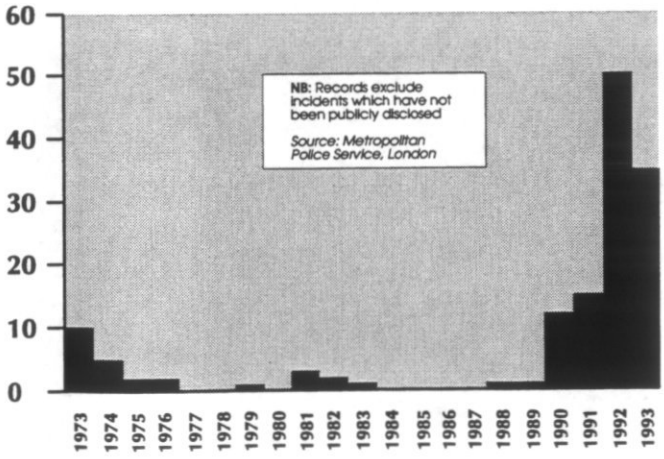
Annual variation in visitor patterns

6. EMERGENCY PLANNING AND MANAGEMENT

Hazard in the London Megacity

The underlying theme from this research was the transformation of human life to a predominantly urban one, and simultaneous transformations in natural and other hazards. The central question of the study was whether or not Britain has learned to be successful at hazard management in Britain's largest city, London.

The London Megacity is defined as a large functional urban region extending well beyond the boundaries of the metropolitan area and into the Home counties: a region containing a population of over thirteen million people. The study focused upon the range of meteorological/geophysical, technological, social and biological hazards facing Londoners. These include rising sea levels, windstorms, drought, seismic hazards, global warming, air pollution, transportation hazards, industrial hazards, crime, water-borne disease and HIV infection. London has enjoyed mixed success in responding to these hazards, and London has not learned as much as it might from its long experience with many of the hazards. Examination of the response to two hazards, flooding and terrorism, suggest that London can respond rapidly and successfully to high-intensity hazards but only just-in-time. Response to low-intensity hazards is less successful.



No of terrorist incidents in the London Metropolitan Area 1973-1993

Strategic land use planning in Europe and the United States of America: A review of best practice for the NRA (National Rivers Authority)

The NRA commissioned the Centre in 1993 to research European and United States experience on the integrated planning of land use and flood defence for river floodplains, taking into account the conservation and enhancement of the riverside environment. Institutional arrangements for land use planning at a strategic level for flood plain management were examined, concentrating on issues that impact on or are impacted by flood defence policies. The state of available tools and procedures was reviewed with respect to flood plain and catchment management and source control. Where relevant, water quality issues were considered to reflect the overall integration of water and river management. Judgmental comments on the effectiveness of Best Management Practice (BMP) were reviewed based on country case studies, particularly in The Netherlands, Germany, France, Portugal and the USA.

The research builds on the Centre's previous work for the NRA - "Planning and flood risk: a strategic approach for the NRA", R&D Project 299. The strategic recommendations emerging from the research build on detailed work in project 299. Together the reports provide a full picture of the need for the NRA to integrate land and water planning and to support this with appropriate research, liaison work and information dissemination to that effect. The research is timely considering the changing institutional procedures to be effected as a result of the legislation for the Environmental Agency as the NRA's successor.

Megacities, Hazards and Sustainability

This project is sponsored by the United Nations University (UNU) and involves a network of people linked through a Study Group of the IGU (International Geographical Union). Research is organised around a number of case studies drawn from the industrialised and developing worlds. John Handmer's site is Sydney, which is by far the smallest city being studied. It offers a very different set of issues to the other major cities being examined: as a low density city in an area which is relatively benign from a natural hazard perspective - with the possible exception of bushfires. Nevertheless, it confronts serious sustainability issues concerning long term environmental degradation, possible social polarisation, and the maintenance of biodiversity. The major report from the study will form a chapter in a UNU book on the subject, as well as a conference paper and journal article.

In the same programme, Dennis Parker is studying London.

Flood Warnings

The Centre organised a small international invitational workshop on "Current issues in total flood warning system design", held in September 1995. The aim was to provide a forum for the exchange of ideas and experiences: to explore new thinking about warning systems to identify paths to improvement. It also acted as a focus for the Centres work in the area. The "total" system includes environmental monitoring and flood detection, prediction, warning message design and dissemination, response and system review and improvement. It can also be conceptualised in other ways; for example the starting point of system design can be the requirements of those at risk of flooding. In turn this needs participation by the flood prone community.

Another aspect of the Centre's work in flood warnings has been the involvement of John Handmer in drawing up national guidelines for flood warning system design and operation in Australia. He was

one of a small committee of academics and users responsible for the guidelines - which were called for at a major conference on the subject. The guidelines are based on the concept of a "total flood warning system", to emphasise the importance of all elements in achieving successful warnings. Maintaining stakeholder interest and commitment was an important consideration in drawing up the guidelines. The final formal aspect of this was endorsement by all state/territory flood warning consultative committees. Following publication, the next step is to ensure that the guidelines are accepted and used by operational staff. It appears that funds will be made available for this.

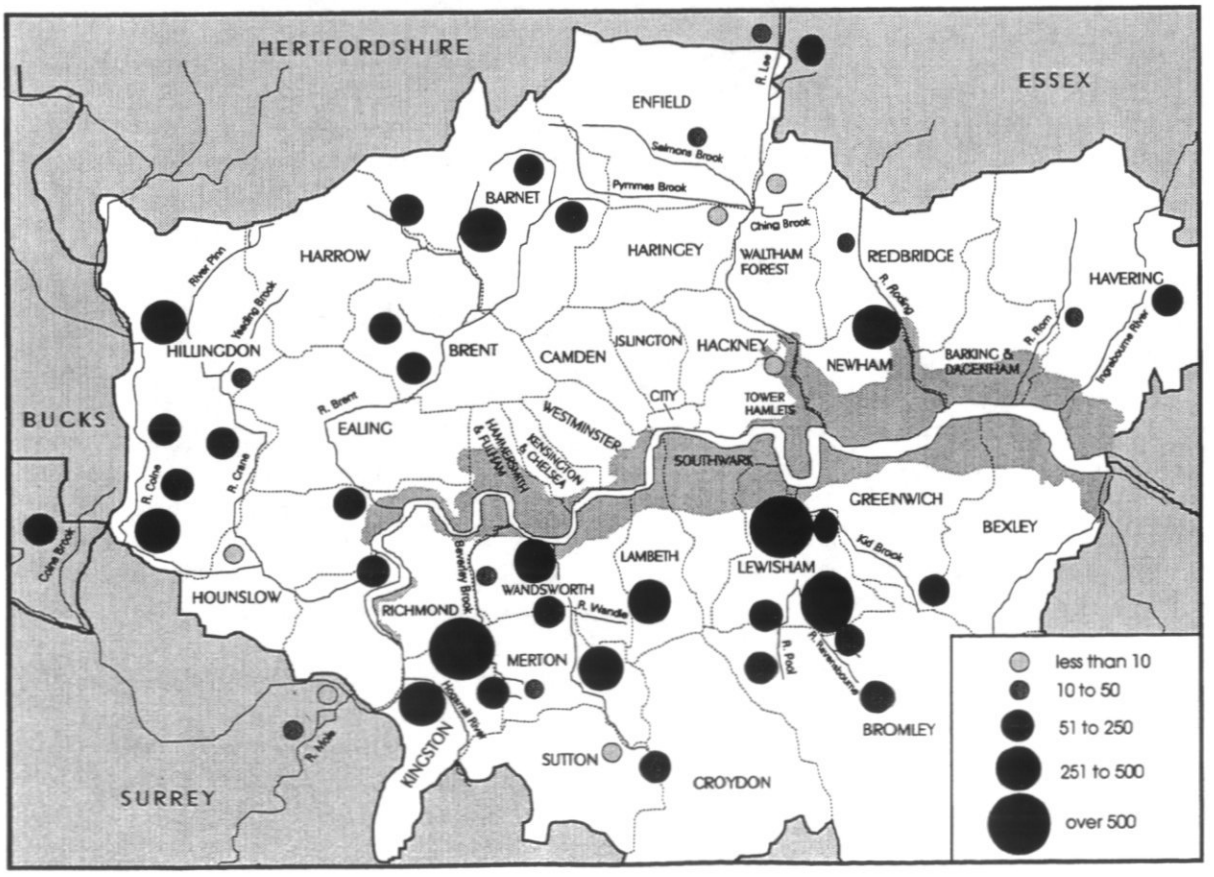
Flood risk to London (Metropolitan Police Service)

The Centre was commissioned by the Metropolitan Police Service to undertake a preliminary scoping study of the flood risk to London. The objective was to produce an outline flood risk assessment for the London metropolitan area and to determine whether or not the scoping study findings warrant more detailed examination and research. The project focused upon the most serious aspects of flood risk and concentrated specifically on threats to life and on the potential for major disruption. It suggested a number of flooding scenarios.

The findings show that London is at risk of flooding from a number of sources and with a range of probabilities of occurrence. Although over a million people might be affected by a major tidal flood in London, the failure or overtopping of the Thames barrier are low probability events; they would, however, have potentially high impacts. Furthermore, serious localised tidal flooding could still occur. The two principal sources of fluvial flood risk are: flooding from the River Thames, and flooding from the tributaries. In the metropolitan London area 10,000 properties are conservatively estimated to be at risk of flooding from a one in fifty year fluvial flood, the related damage potential of which has been conservatively estimated at over £20 million at 1991 prices. In addition, tens of thousands of properties are at risk from flooding from convectional storms and heavy rainfall which can overwhelm local drain and sewer capacities.

The efficiency of flood warning systems is also pertinent as flood warning dissemination is currently problematic due to legal problems, technical difficulties and inefficiencies in the warning dissemination chain. Findings indicate that reliance upon London's existing flood warning dissemination systems is unwise and may lead to disappointment should a significant flood emergency arise.

There appears to have been a (sometimes considerable) degree of relaxation regarding flood risks to London amongst the emergency planning community. In the post-barrier phase this is perhaps understandable, except that London continues to face serious flood risks. The study, therefore, recommended that the scoping study findings warrant further, more detailed examination and research in both assessing the flood risk to London and in examining the ability of the emergency management community to cope with a major flood event.



Properties flooded in London from 1965 onwards from riverine sources

7. OVERSEAS PROJECTS

A characteristic of the Flood Hazard Research Centre in the 1980's and the 1990's has been the development of research projects outside Britain, and even outside its European base, into South and South East Asia, the Far East, the Middle East and Latin America. These research projects have developed as the reputation of the Centre has spread, and reflects a wish by the Centre staff to participate in academic developments on the international scene. The following projects, briefly described, are illustrations of current FHRC overseas work.

Bangladesh and India

The Centre has been involved in research and consultancy in Bangladesh and India since 1989, starting with a post-project appraisal of the Chandpur combined flood alleviation and irrigation project. This culminated in the successful completion of Paul Thompson's PhD, and a subsequent series of influential contracts working on the Flood Action Plan, particularly concerned with the evaluation of completed flood protection projects and improving their operation of maintenance (studies which won the British Council Consultant of the Year award). This work is continuing, particularly with a social focus on the effect of infrastructure development on particular groups within Bangladeshi society, including work on charlands, and the social impact of bridge development in Bangladesh.

Flooded Charland village

Impacts of floods in North Bihar (Collaboration with Centre for Water Resource Studies, Patna University, Bihar, India

The CWRS and the FHRC completed at the end of 1994 their joint research programme which started in 1990 and was facilitated by an academic link under the British Council Scheme and a Ford Foundation grant.

A final workshop was held in Patna in October 1994 attended by government officials and researchers from India and by Edmund Penning-Rowsell and Paul Thompson. The results of the study have been published in a joint report. This highlights the social impacts of flooding such as homestead damages and impacts on quality of life during floods. A number of recommendations were made concerning, among others, the need for integrated floodplain development, improved flood warnings and information, and studies of the impact of relief measures.

Bangladesh Flood Action Plan (FAP) Charland Study

This was a major special study of the FAP Environmental Study, FHRC was contracted to the Irrigation Support Project for Asia and the Near-east (ISPAN) of the United States Agency for International Development to assist in the study. An inventory of resources and people living within the unprotected active floodplain of the three main rivers (Jamuna, Padma-Ganges, and Meghna) of Bangladesh was made, and linked through a GIS with analysis of satellite images.

A total of 4.3 million people were found to live in over 3,300 villages in these hazardous areas. The main rivers were found to be generally widening and migrating, resulting in frequent erosion and accretion of chars (mid-channel islands), and erosion of adjacent mainland where dense concentrations of people are found. On average about 64,000 people were displaced by erosion every year during 1981-92/93, more were displaced by the constant shifting of chars, about half a million people probably permanently migrated away from the study areas. Rapid Rural Appraisal and interview surveys were used to investigate the impacts of hazards on char life and to assess flood losses. These areas cannot be protected by major structural measures, and are relatively neglected by government and non-governmental services.

The results form a planning tool for future interventions in the chars and on the mainland (which may affect the chars). Recommendations made included emphasis on flood preparedness and flood proofing (which was shown to be economically viable). The final reports were completed in mid-1994, and in April 1995 a seminar was held in Dhaka to discuss and disseminate the findings.

River Bank Protection Project in Bangladesh (Halcrow)

This project of Bangladesh Water Development Board aims, with World Bank funding, to halt erosion on the right bank of the Jamuna river at two critical locations: the town of Sirajganj and at Sariakandi, where the Jamuna threatens to capture a smaller river (the Bangali). To achieve this major river training works are needed, and these will displace people living close to the riverbank (many of whom were themselves erosion victims). FHRC was contracted to assist in preparing a resettlement action plan for these affected people. This involved surveys of the inhabitants and landowners of the affected area, and developing a policy framework and set of entitlements. Resettlement plans are relatively new in Bangladesh, where previously the legal compensation mechanisms did not ensure the rehabilitation of affected people and restoration of their livelihoods.

The plan has since been updated and is now in 1995 being implemented.

Jamuna Multipurpose Bridge Project, Bangladesh (Halcrow)

River training works and roads for what is the largest infrastructure project in Bangladesh have displaced or affected over 12,000 households. A resettlement plan had been prepared to ensure that these affected people receive sufficient compensation and assistance to ensure that they are made no worse off than before. As part of the project Management Consultancy led by Halcrow, FHRC was contracted to provide an advisor on implementing the resettlement action plan. This included surveys, advice on resettlement policy and entitlements, mitigation of erosion impacts, resettlement site use, use of residual project lands, evaluating implementation by a contracted NGO, and advice on Management Information Systems, training and rehabilitation.

Malaysia

The Centre has undertaken a project investigating the effect of cultural, socio-economic and physical differences in Malaysia on hazard response. This has contributed to Ngai Weng Chan's PhD research, which has emphasised the way in which a complex series of factors affect the response to flood hazard in Malaysia, set within a contextual model of hazard response (see Section 10 below).

Argentina - Rio Paraña flood study

The Centre has been involved in a major study of the Rio Paraña, Argentina, in association with Sir William Halcrow and Partners (Swindon).

The Rio Paraña has experienced what appears to be an increased severity in flooding over the last 15 years. A major flood occurred in 1983, followed by another in 1992. Both events were massive: the first lasted for 6 months and the latter for 6 weeks. Severe disruption was caused in many Argentinean cities as a result of these floods, not least because these cities are built adjacent to river frontages to allow for the export of industrial products along the navigable waterways. The cities were originally laid out during a period of low flows, between 1905 and 1960 when few major floods were experienced.

The Argentinean Government, assisted by the World Bank, is trying to develop a non-structural approach to flood alleviation in Argentina, given the difficulty of planning structural works at a time when flood frequency and severity appears to be increasing. The aim of the policy is to restrict the types of land uses that would be allowed on the flood plain, although this is difficult in Argentina since there is not a coherent system of land use control or even a system of building regulations to tailor building type to environmental circumstances (including flooding). Pursuing such a non-structural policy is also difficult when powerful land owning interests are likely to resist it and also when the government hierarchy and other vested interests benefit from capital intensive flood alleviation works.

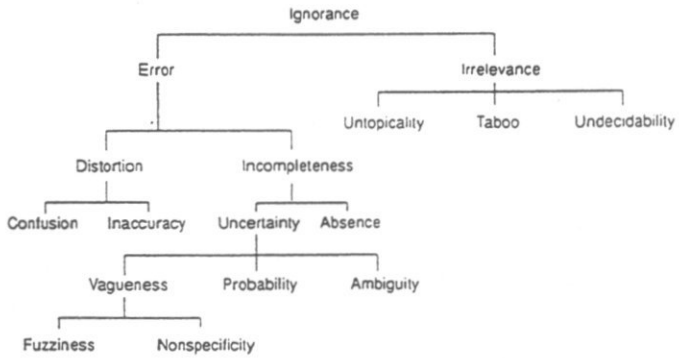
Another complication in Argentina is the legal situation. Whilst there is poor legal provision for controlling land use in areas liable to flooding, and poor regulation of building codes, there is also an inadequate legislative base on which to construct a system to control land use in the future. This is because the napoleonic code legal system does not allow those adversely affected by flooding to sue those who might be responsible, as is possible under common law, since it demarcates more tightly than the common law system the responsibilities and duties of all those involved.

Flood-proofed houses in the Rio Paraña delta

The Centre was instrumental in contributing to a report on the damages likely to be caused in the future by floods in the Rio Paraña basin, and to a review of policies in response to those damages. These recommendations have now been reviewed by the World Bank, which is considering further work in the area of flood damages given the very sparse data base which exists in Argentina in this field.

Sustainability, Uncertainty and Policy

Major sustainability problems such as global warming, biodiversity, etc, take humanity beyond apparently tractable risk problems into areas of pervasive uncertainty and ignorance. Yet policy responses are demanded soon; long before science has any hope of reducing the ignorance - even if that were always possible. Work into these intractable problems arose from a conjunction of research in sustainability, ecology and hazards. The notion of resilience is central, and the implications of the precautionary principle provide linkages with practical policy questions. Currently research is joint with members of the Centre for Resource and Environmental Studies at the Australian National University, and linkages are being developed with researchers at Middlesex and elsewhere in Britain.



The Changing Nature of Ignorance, from Handmer et al (1991)
New perspectives on uncertainty and risk

The Economic Benefits of Disaster Mitigation in Australia

FHRC collaborated with the Centre for Resource and Environmental Studies at Australian National University in this study funded by the Australian International Decade for Natural Disaster Reduction Coordination Committee. Despite a wide range of natural hazards and a history of adopting various mitigation measures, Australia lacks a common framework for evaluating the benefits of alternative measures and investments. Different States follow their own methods, and ad hoc assessments may lack economic rigor. The study developed a set of guidelines on principles in economic assessment of the benefits of disaster mitigation and management, which could be standardised in Australia. This drew on the standard methods for assessing flood losses developed at FHRC, and suggests applications to other hazards including cyclones and bush fires.

The study is producing a small manual setting out standard guidelines for the assessment of the economic benefits of disaster mitigation activities. The manual is based on research on flooding, as the expertise of the authors (John Handmer and Paul Thompson) is greatest in this area. However, the principles would apply to all hazards. An extension of the original project will produce a set of decision rules specifically for application in the South-west Pacific.

8. MISCELLANEOUS

Social Trends and Attitudes: their significance for nature conservation (English Nature)

This small study provided a synoptic account of the main trends in socio-economic characteristics and social attitudes. English Nature wanted to know what it needed to know about these trends and changes in socio-economic factors and attitudes as well as why it needed to know, together with a guide to where to find out in detail as to the nature of these trends. Changes in income and demographic changes create demand pressures which place pressure on the environment. These pressures may be a first or second order impact; for example, a shift to teleworking may result in more car journeys rather than less since the greatest proportional increase in car journeys has been for leisure and shopping. If teleworking is accompanied by working and living in rural areas, then the net effect is likely to be an increase in car journeys.

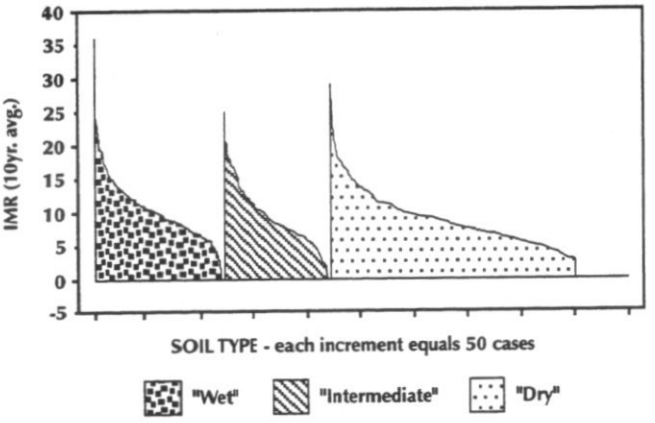
Changes in preferences may either compound these pressures by increasing demand or shifting demand towards activities and consumption which reduce the pressures on the environment. At the same time, social attitudes about the importance of the environment, their preferences as to what they want the environment to be like, and particularly the trade-offs they are prepared to make between private consumption and the environment, either strengthen or weaken the hand of English Nature. Therefore, three different elements were identified as being of importance: socio-economic and demographic variables; attitude variables and behavioral variables. Of these, behavioral changes are arguably the most critical. In addition, English Nature must be concerned with European wide shifts and with leading indicators of change, perhaps attitudes amongst school children, rather than following indicators.

	1985	1986	1987
	%	%	%
The countryside:			
is much the same	20	22	20
has changed a bit	23	25	21
has changed a lot	49	48	55
don't know/not answered	7	5	3
The countryside has changed:			
for the better	11	13	12
for the worse	49	51	56
better in some ways/worse in others	11	8	8
Respondent is:			
very concerned	31	40	44
a bit concerned	37	35	33
not particularly concerned	32	25	22

Perceptions and evaluations of countryside change, 1985-1987
Source: British Social Attitudes Report: 1986, 1987, 1988

Infant Mortality and Soil Character in South/ Central England

The Centre has been cooperating with Mr Munro of Swindon to investigate the relationship between infant mortality rates and soil moisture characteristics in an area of Southern England between Swindon and Luton. Mr Munro has been collecting this data for over 10 years, and has established a correlation between the incidence of winter waterlogged soils and high rates of infant mortality. The Centre has produced a report on this, which has been the subject of some publicity, and also has contributed to a Seminar at the Geological Society of London. That Seminar saw the paper produced by the Centre and Mr Munro discussed by a wide range of disciplines, including a geologist, a soil scientist, a statistician from the University of Oxford, staff from the Office of Population of Censuses and Surveys, a specialist in Spatial Analysis and a specialist in child health from the Charring Cross Hospital. All discussants agreed that the paper was most interesting and innovative and that the results were important. A number of limitations were noted in the study, as agreed by the Centre, and now the task is to obtain resources to fund a more widespread and systematic study of this important phenomenon.



Infant Mortality Rate by Soil Classification (10 year average)

A summary of the results is shown in the figure above giving the distribution of infant mortality rates over the 540 wards studied for the 10 year period 1980 - 1991. This shows that the average infant mortality rate for wet soils is calculated at 10.21 deaths per 1,000 live births, whereas the infant mortality rate for the dry areas is only 7.74 deaths per 1,000 live births. In addition, and contributing to these averages, it is significant that a large number of wards in the "dry" wards have zero infant mortality over the whole 10 year period, whereas this is practically absent in the "wet" areas.

9. SOFTWARE DEVELOPMENT

Micro-ESTDAM Version 2.1 (NRA Severn-Trent)

A software development contract between 1992 and 1994, was founded by the NRA (Severn-Trent region), to upgrade and extend the user interface to ESTDAM and enable direct use by river engineers without more detailed computing knowledge - in other words taking the ESTDAM calculation engine with a usable PC menu driven package. The latest version (2.1) of Micro-ESTDAM was released to the NRA in September 1994 with the User Manual. This completed the contract and Severn Trent Region are acting as support site for the NRA, distributing the software to all regions on a one copy per region basis. The package includes standard depth/damage data files for residential, retail/retail-related, and professional offices which may be used on request by the user. Other depth/damage data sets may be directly entered by the user. Currently land use and ESTDAM control files may be created via a menu-driven system, which, as far as possible, will only allow 'correct' data-sets to be entered. The existing summary results and individual land use items impact may be examined using the new system. In addition, editing and searching (on address field) is possible for land use and results files.

Latest work includes editing of the ESTDAM control file and creation and editing of depth/damage data files. All facilities have been implemented in a self-contained system which will handle all activity from data entry, ESTDAM runs, results inspection, and the management of the many data files that are generated through the several scenarios (variants) that a study entails. Meaningful error messages and context sensitive help has been built- in. Subsequent development, depending upon funding, would include: graphical output; validation of data files routine (for the users who insist on using an Alien Editor); better format for intermediate level results tables; use of a mouse; "pocket guide" to Micro-ESTDAM including scheme analysis tips. A course for consultants etc is being planned for delivery as soon as possible.

Micro-Estdam Version 2.1 is the essential software tool for Flood Damage Assessment using FHRC methodology, and brings the capability away from just a few mainframe "hackers" to the river engineer in his/her office.

```
GLOSSY FLOOD PREVENTION(GLOSSY.EC1 11/05/1995 16:30)          Micro-ESTDAM V2.1
                                  Edit Window
PROPERTY ADDRESS  47 COSMO AVE      1            LAND USE CODE  110000
GRID REFERENCE  50506040    FLOOR HEIGHT IN METRES  2.31  INDIRECT        0
MATCH 2  SUB-AREA NUMBER  1  COUNT  1  PROFILE POINT   8  DISTANCE    47296
       RETURN     FLOOD      FLOOD            DAMAGES (£)        PRESENT
       PERIOD     LEVEL      DEPTH        DIRECT     INDIRECT     VALUE(£)
          2.0      0.13      -2.18             0                         0
          5.0      1.00      -1.31             0                         0
         10.0      2.47       0.16          4928                      3877
         25.0      3.70       1.39         18938                     15147
         50.0      3.90       1.59         21069                     21451
         75.0      4.10       1.79         23365                     23784
        100.0      4.30       1.99         26137                     25077
        250.0      4.50       2.19         28664                     27662
                                                      RECTANGLE        29458
                                                      TRIANGLE         29506
F1 HELP     F5  NEXT RECORD       F7  SEARCH FOR RECORD       F10  QUIT
                                 Information Window
```

Example of Micro-ESTDAM file

10. RESEARCH DEGREE PROJECTS AT FHRC

A contextual analysis of flood hazard management in Peninsular Malaysia - Ngai Weng Chan, University of Malaysia

This research seeks to explain the creation and perpetuation of flood hazards in Peninsular Malaysia in terms of a 'hazard response-in-context' model. Socio-political (socio-cultural and political economy) and institutional contexts are found to be central to understanding hazards as essentially socially-created phenomena superimposed onto a physical process system through which hazards are transmitted.

Malaysia is an ex-colonial, newly-industrialising country. The pace of social, economic and political change is fast, as is the pace of technological change. Other things being equal, these are the contexts in which flood hazards are magnified. Contexts are changing, and changing physical systems have given rise to increased flood risk, exposure and vulnerability. Other contexts, largely structural, such as persistent poverty, low residential and occupational mobility, landlessness, and ethnic culture have also contributed to increased vulnerability to flood hazards.

Flood prone areas in Malaysia

The situation, behaviour and response of individual floodplain occupants in Peninsular Malaysia are found to be heavily influenced by macro socio-political contexts. These are also termed contextual forces and they are fundamentally 'structural'. Macro contexts also 'condition' institutions (meso context) and influence their approach to hazard management including their effectiveness. Institutions (including organisations) were found to be largely inadequate in their management and reduction of flood hazards, and can be improved to create positive influences on flood hazard reduction as well as help individuals (micro context) cope more effectively. Both socio-political and institutional contexts were found to be important as they amplify hazards or fail to adequately address and reduce them. The pioneering of what is termed 'segment analysis' to analyse links between contexts at various levels is an important contribution in this research.

The research concludes that the hazard response-in-context model is appropriately applied to Peninsular Malaysia as it handles both structural and institutional contexts and individual management of flood hazards effectively.

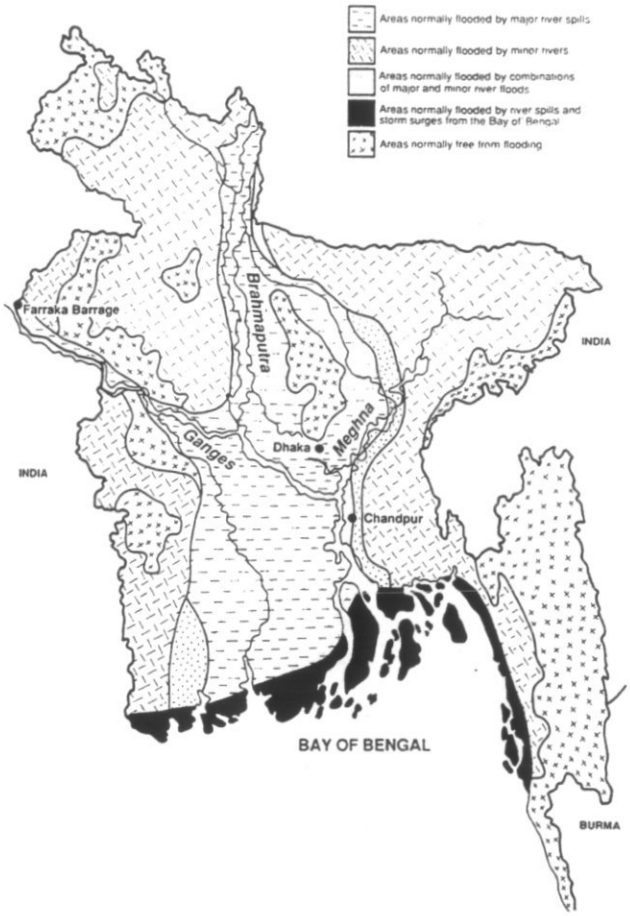
The Impacts of Flooding and Their Methods of Assessment in Urban Areas of Bangladesh - K M Nabiul Islam, Research Fellow, Bangladesh Institute of Development Studies

Most research on flood impacts in Bangladesh is concentrated on agriculture. As the country is urbanising rapidly, it was therefore decided to undertake a study on urban flood impacts. The study, funded by the Overseas Development Administration (ODA) UK, is currently in progress. The field level data collection and preliminary analysis having been completed, the research is in the write-up stage. The perspectives on which the flood research is based are those of highly advanced and industrialised societies, and following that, the study is expected to develop a methodology of assessing urban direct and indirect impacts suitable to flood and socio-economic conditions in Bangladesh. One other component of the research aims at working towards conceptualisation of urban impacts and their modelling in that perspective. Through applying the methods to a few case study areas, the study will also determine the extent of impacts and vulnerability of the various sectors of the urban economy of flood ravaged Bangladesh.

The preliminary analysis indicates that with some modifications, the existing assessment methods can largely be applied in modelling urban flood losses in a developing country such as Bangladesh. The unit loss method is generally applicable in appraising urban protection schemes. The findings manifest that constructing 'synthesised standard' data in Bangladesh is not feasible. Construction of 'average' potential data sets for disaggregated levels of depths and durations on the basis of actual damages is feasible, as floods in Bangladesh are not sparse. However, this is expensive as it demands a large sample size. The construction of 'average' data on the basis of 'potential' via subjective assessments of the respondent entrepreneurs and householders appears to be more realistic and suitable.

As regards impacts, the research reveals that non-agricultural losses are important in Bangladesh. The various non-agricultural sectors

of the economy are largely vulnerable to flood losses. The investigations also reveal that the poor are the most vulnerable to flood hazard. Considerable and significant differences are evidenced in flood impacts caused due to different types of floods. Linkage effects of flooding appear to be important at the micro-level, but not at the national or regional level in Bangladesh. There appears to be no evidence of considerable fluctuations of particularly industrial output due to flooding at the macro level.



Flood affected areas in Bangladesh

Environmental Values Within Aspects of European Costal Zone Management - Jo Sawyer, Research Student, Flood Hazard Research Centre

The environmental values of both individuals and organisations affect, either directly or indirectly, decisions which are made. The current positivistic economic paradigm, which shapes decisions, approaches and definitions (including those for the environment) is, at least in part, responsible for inappropriate environmental management in coastal areas. It allows decision-makers to limit or even avoid the ethical component of environmental decision-making. There is a need for non-use environmental values to be better articulated and incorporated into policy-making and decision-making.

The basic assumptions underlying this research reflect a more ecocentric approach to environmental values to which hermeneutic approaches are best suited. The research plan comprises two major components. The first involves the consideration of the arguments and perspectives on: environmental values (use, non-use, articulation); coastal zone management; conflict resolution (mediation, consultation); decision-making, environmental ethics; and policy analysis.

The second involves two independent but interrelated investigations which will consider the impact on the environment of various aspects of coastal management in Europe. Study 1 is an investigation into coastal management within Europe with particular reference to the application of EU environmental legislation by various nations. Study 2 involves in-depth analysis of two aspects of current coastal zone management in the UK (Estuary Management Plans and Flood Defence) in order to determine environmental values and their impact within decision-making processes.

It is hoped that the consideration of the non-use environmental values within decision-making will lead to the development of a theory of "ethical" environmental decision-making.

An evaluation of integrated flood warning systems for small river catchments in the Thames basin - Chris Haggett, NRA Thames Region Flood Warning Centre

Following a review of the literature and current operational practices it is intended, through case studies, to investigate the feasibility of introducing a more integrated structure to the current forecasting and warning arrangements in small river catchments (less than 100 sq km) in the Thames Basin.

It is envisaged that two river catchments will be included in the study: one with relatively advanced procedures for detecting and forecasting floods; the other with only rudimentary arrangements. Catchments will also be chosen on the basis of contrasting social make-up so that differences in response characteristics can be gauged. The current performance of the various subsystems in a total warning system will be evaluated and any weaknesses in present arrangements will be identified. A programme of improvements will be drawn up and where practical, these will be implemented operationally. The warning system from detection and forecasting through to response will be re-evaluated and improvements to performance assessed.

11. RECENT FHRC STAFF PUBLICATIONS AND REPORTS

(A full list of FHRC publications is available on request.)

1995

EUROflood UK Evacuation Study: Interim Results. Paper presented at TIEMEC '95. 9-12 May 1995. Nice, France. ISBN 1 85924 052 6. (A.M. Ketteridge and M. Fordham)

Flood Forecasting Warning and Response Systems: The Problem of Warning Dissemination. Paper presented to the Workshop on Integrating Radar Estimates of Rainfall in Real time flood Forecasting. 25-26 July 1994. Monselice, Italy. ISBN 1 85924 051 8. (M. Fordham and C. Haggett)

The Flood Risk to London: A Preliminary Scoping Study. A report prepared for the Metropolitan Police Service. New Scotland Yard. ISBN 1 859 046 1. (D.J. Parker, M. Fordham, J. Portou and S.M. Tapsell)

Community preparedness for natural disaster reduction: World Disaster Reduction Day 1994. Canberra: CRES, Australian National University. (Sponsored by the Australian IDNDR Committee - International Decade for Natural Disaster Reduction.) (Ed) (J.W. Handmer)

Risks and opportunities: managing environmental conflict and change. London: Earthscan. (V. Brown, D.I. Smith, R. Wiseman and J.W. Handmer)

Flood warning: an Australian guide. **The Australian Journal of Emergency Management.** 31-33. (C. Keys, J. Elliott, J.W. Handmer and J. Salter)

The World Conference on Natural Disaster Reduction. **The Australian Journal of Emergency Management:** 6-8. (J.W. Handmer)

Non-structural measures for flood mitigation: current adoption in urban areas. Volumes 1 and 2. Prepared for the National Landcare Program, Department of Primary Industries and Energy. Canberra: CRES, ANU. (D.I. Smith, J.W. Handmer, J. McKay, M. Switzer, and B.J. Williams)

Cost-effectiveness of flood warnings. Prepared for the Australian Bureau of Meteorology. Canberra: CRES, ANU. (J.W. Handmer, J.W. and D.I. Smith)

A safer world for the 21st century? The 1994 Yokohama World Conference on Natural Disaster Reduction. **Journal of Contingencies and Crisis Management.** 3(1): 35-37. (J.W. Handmer)

Ignorance, sustainability and the precautionary principle. **Ambio.** 24(2): 92-97. (S. Dovers and J.W. Handmer)

Assessing Vulnerability to Flooding: Nodes and Networks. Paper presented at the IDNDR Workshop, Royal Society, London. 31 March 1995. ISBN 1 85924 062 3. (C.H. Green)

Economics: casting light or darkness upon sustainable development. River Basin Management for Sustainable Developments. South Africa. 15-17 May. ISBN 1 85924 029 1. (C.H. Green)

Aesthetic Pollution. Report to Water Research Centre. ISBN 1 85924 055 0. (M.A. House and M. Herring)

Aesthetic Pollution and the Management of Sewage-Derived Waste. River Basin Management for Sustainable Development. Kruger National Park, South Africa. May 1995. ISBN 1 85924 054 2. (M.A. House)

Assessment of Public Perception of Aesthetic Quality. Interim Report prepared for the Water Research Centre, Swindon, Wilts. (M.A. House and J. Portou)

River Skerne Public Perception Survey: Stage Two. Report to the River Restoration Project. April 1995. (S.M. Tapsell, M. Fordham, S.M. Tunstall, M.J. Rivilla, J.L. Garner and J. Portou)

Public Perception of Rivers and River Water Quality: Results from a Focus Group Study. Report to the Foundation for Water Research. (S.M. Tunstall)

Impacts of Floods in North Bihar. Middlesex University and Patna University Report. May 1995. ISBN 1 85924 053 4. (T. Prasad, E.C. Penning-Rowsell, A. Verdhen and P.M. Thompson)

A Contextual Analysis of Flood Hazard Management in Peninsular Malaysia. Centre Internal Publication. ISBN 1 85924 060 7. (N.W. Chan)

1994

Floods Across Europe, Flood Hazard Assessment, Modelling and Management. ISBN 1 898253 01 3. E. Penning-Rowsell and M. Fordham (Eds.). (Available from Middlesex University Press, Bounds Green Road, London N11 2NQ.

EUROflood I: Technical Annex for Flood Forecasting and Warning: Supplementary Case Study. ISBN 1 85924 043 7 (J-P. Torterotot)

EUROflood I: Technical Annex for the Full Flood Impacts Module. ISBN 1 85924 045 3 (M. Fordham; C.H. Green; A. Herring; A-M. Ketteridge; D.J. Parker; E.C. Penning-Rowsell; A. Van der Veen; E. Wiestra, E. Overkamp)

EUROflood I: Technical Annex for the Flood Forecasting and Warning Module. ISBN 1 85924 044 5 (M. Fordham; C.H. Green; A. Herring; A-M. Ketteridge; D.J. Parker; E.C. Penning-Rowsell; J.B. Chatterton; J. Handmer and J-P. Torterotot)

Disaster Vulnerability in London. Paper presented at the International Geographical Union, Regional Conference. Prague, Czech Republic, 22-26 August. ISBN 1 85924 041 0 (D.J. Parker)

Hazard in the London Megacity. Inaugural Lecture October 12 1994. ISBN 1 85924 061 5. (D.J. Parker)

Australia and Antarctic environmental management. **Australian Journal of Environmental Management.** (J.W. Handmer J.W. and M. Wilder)

Recreation visitor number surveys and benefit assessment - Meirionnydd Coast. Report to Shoreline Management. (S.M. Tunstall)

Cliftonville: An assessment of coast protection benefits. Report to Thanet District Council. ISBN 1 85924 014 3. (J.L. Garner, S.M. Tunstall and C.H. Green)

Assessing the benefits of streamflow gauging. Paper presented at the Economic Benefit of Meteorological and Hydrological Science. Geneva. September 1994. ISBN 1 85924 027 5. (C.H. Green)

Benefit Transfer: Rivers and Coasts. Group on Environmental Costs and Benefits. H M Treasury. London. July. ISBN 1 85924 028 3. (C.H. Green, S.M. Tunstall, J. Garner and A.M. Ketteridge)

Socio-economic impacts of floods and flood protection: a Bangladesh case study (P.M. Thompson and E.C. Penning-Rowsell). **Disasters, Development and Environment**, A. Varley (Ed.). Chapter 6, pp 81-97. John Wiley and Sons Ltd.

Putting environmental economics to work for rivers and coasts. Paper presented at the Countryside Recreation Network Conference on Environmental Economics, London, April 1994. ISBN 1 85924 025 9. (C.H. Green)

Recent developments in multi-criteria and multi-attribute utility analysis. Paper presented at the Civil Service College, July 1994. ISBN 1 85924 015 1. (C.H. Green)

Cairo wastewater project Egypt Interim Evaluation. Evaluation Report EV539 Volume I & II. (Available from the Overseas Development Administration, Room V204, London). (M. Surr, A. Starmer, D. Watson, D. Young, C. Green and E. Potts)

Report on the transferability of flood loss estimation data between countries. Report to the Societe d'ingenierie pour l'eau et l'environnement. (C.H. Green and D.J. Parker)

Integrated Design Approaches for Urban River Corridor Management. In: **Integrated River Basin Development.** (M.A. House and J.B. Ellis) pp. 311-324. (Celia Kirby and W.R. White)

Economic benefits of the alleviation of low flows. Report prepared for the National Rivers Authority, Bristol. (M.A. House, S.M. Tunstall, C.H. Green, J. Portou and L. Clarke)

A 'Tragedy of the Commons'? Perceptions of Managing Recreation on the River Wye, U.K. **Natural Resources Journal**. 34, pp 635-661. (E.C. Penning-Rowsell)

Institutional Aspects of River Restoration in the UK. Report to the National Rivers Authority Bristol. R&D Note 265. (S.M. Tunstall)

Public Perception of Rivers and Flood Defence: Final Report. Summary of Regional and National R&D. Report to the National Rivers Authority Bristol. (S.M. Tunstall, S.M. Tapsell and M. Fordham)

Social Trends and Attitudes: Their Significance for Nature Conservation. Report to English Nature. (C.H. Green, L. Clarke, S.M. Tunstall, M. Fordham and S.M. Tapsell)

12. NEWS ITEMS

VISITORS TO THE CENTRE 1994/95

January to May 1994
Edith Floret-Miguet - PhD research student, University of Paris XII

March 1994
Lord Flowers - Governor of Middlesex University

April 1994
Els Overkamp - Placement student from University of Twente, Netherlands

May to October 1994
Parvin Sultana - Visiting Academic - Bangladesh

May 1994
Baroness Platt - Chancellor of Middlesex University

July 1994
David Neal - University of North Texas - USA

July 1994
Erik Wiestra - University of Twente, Netherlands

October 1994
Visitors from the University of Lapland

November 1994
Visitors from Kazahkstan

December 1994
Henriette Otter - University of Twente, Netherlands

March 1995
Visitors from China: Ming-Ai Institute and Sichuan Education Association

May 1995
Guido Borelli - Politecnico di Milano, Italy

May 1995
Henrietta Otter - University of Twente, Netherlands

May 1995
Bartolomo Reitano - Universita di Catania, Italy

May 1995
Anne Van Der Veen - University of Twente, Netherlands

August 1995
Natalie Pottier - CERGRENE, Paris

September 1995
Jiang Tong and Professor Yu Xiaogan - Nanjing Institute of Geography and Limnology

13 OVERSEAS VISITS BY CENTRE STAFF IN 1994/95

Edmund Penning-Rowsell

Barcelona - several visits as council member of International Centre for Coastal Resources Research

Paris - April 1994. To attend EUROflood workshop

Argentina - May and July 1994. Rio Parana Flood Study

India - October 1994. Centre for Water Resources Studies, University of Patna, Bihar

Barcelona - February 1995. To attend EUROflood workshop

Dennis Parker

Paris - April 1994. To attend EUROflood workshop

Prague - August 1994. To present paper at International Geographical Union, Regional Conference

Bellagio, Italy - May 1995. Member of Team Residency at Rockefeller Centre for project on Intergovernmental Dimensions of Environmental Management

Maureen Fordham

Paris - April 1994. To attend EUROflood Workshop

Monselice, Italy - July 1994. To attend workshop on Integrating Radar Estimates of Rainfall in Real Time Flood Forecasting

Colin Green

Paris - April 1994. To attend EUROflood workshop

Malta - May 1994. To teach on training course on Coastal Zone Management with a focus on Small Islands, International Ocean Institute, University of Malta

Frankfurt - July 1994. Invitational workshop on Contingent Valuation

Barcelona - February 1995. To attend EUROflood workshop

Kruger National Park, South Africa - May 1995. To attend Conference on River Basin Management and Sustainable Development

Paris - June 1995. To attend EUROflood workshop

Sylvia Tunstall

Maastricht, The Netherlands - April 1994. Delft Hydraulics to advise on survey and questionnaire design

Rotterdam, The Netherlands - September 1994. To attend workshop on computer assisted interviewing and conjoint analysis

Lisbon, Portugal - July 1995. To attend EUROflood workshop

Margaret House

Portland, Oregon, USA - March 1994. To attend Rivers Symposium

Kazakhstan - June 1994. Research presentations to State University

Budapest, Hungary - July 1994. To attend International Conference on Water Quality

Kruger National Park, South Africa - May 1995. To attend Conference on River Basin Management and Sustainable Development

John Handmer

Delft, Netherlands - February 1995. To attend Urban Habitat Conference.

Bellagio, Italy - May 1995. Member of Team Residency at Rockefeller Centre for project on Intergovernmental Dimensions of Environmental Management

Centre for Resource and Environmental Studies, Australian National University, Canberra -April 1995. Finalising research projects and papers.

Cracow, Poland - Sept 1995. Attend conference on the Flood Protection of Towns: Ideas and Experience.

Paul Thompson

Based in Bangladesh

Argentina - August 1994. Rio Parana Flood Study

Anne-Michelle Ketteridge

Paris - April 1994. To attend EUROflood workshop

Barcelona - February 1995. To attend EUROflood workshop

Nice - May 1995. To attend International Emergency Management and Engineering Conference

Cracow, Poland - Sept 1995. Attend conference on the Flood Protection of Towns: Ideas and Experience.

Ngai Weng Chan

Malaysia - July 1994. To complete fieldwork study for PhD

Jo Sawyer

Barcelona - February 1995. To attend EUROflood workshop

Josie Difrancesco

Paris - April 1994. To attend EUROflood workshop

Sue Tapsell

Tunisia - November 1994 and December 1995. To teach on student field course

14 CENTRE STAFF

The Centre includes specialists in geography, social surveys, economics, ecology, hazard management, engineering, computer science and water pollution. Current staff at time of publication:

Professor Edmund C. Penning-Rowsell, MA PhD - Head of Centre

Ngai Weng Chan MA - PhD research student

Lisa Clarke BSc - Research Officer

Annabel Coker MSc - Principle Lecturer in Geography and Environmental Management

Josie Difrancesco - Centre Administrator

Sally Eden PhD - Lecturer in Geography and Environmental Management

Maureen Fordham PhD - Research Centre Manager

John Gardiner PhD - Professor in Environmental Management

Jane Garner BA - Research Officer

Colin H Green MArch - Research Manager, Reader

John Handmer PhD - Reader in Natural Hazards and Environmental Management

Margaret House PhD - Principle Lecturer in Geography and Environmental Management

Kathy Ingrey - Centre Administrator

K M Nabiul Islam MA - PhD research student

Anne-Michelle Ketteridge MSc - Research Officer

Robert Nicholls PhD - Lecturer in Geography and Environmental Management

Professor Dennis J Parker PhD - Head of School of Geography and Environmental Management

Jackie Portou BSc - Research Officer

Maria Jose Rivilla Lopez - Placement Student

Jo Sawyer BSc - PhD research student

Sue Tapsell MA - Research Officer/Associate Lecturer, Third World Studies

Paul M Thompson PhD - Senior Research Officer

Sylvia Tunstall MSc - Associate Research Manager, Surveys

Roger Witts MSc - Senior Lecturer in Computing Science

ASSOCIATES:

John B. Chatterton PhD - J.B. Chatterton & Associates, Water and Environmental Management

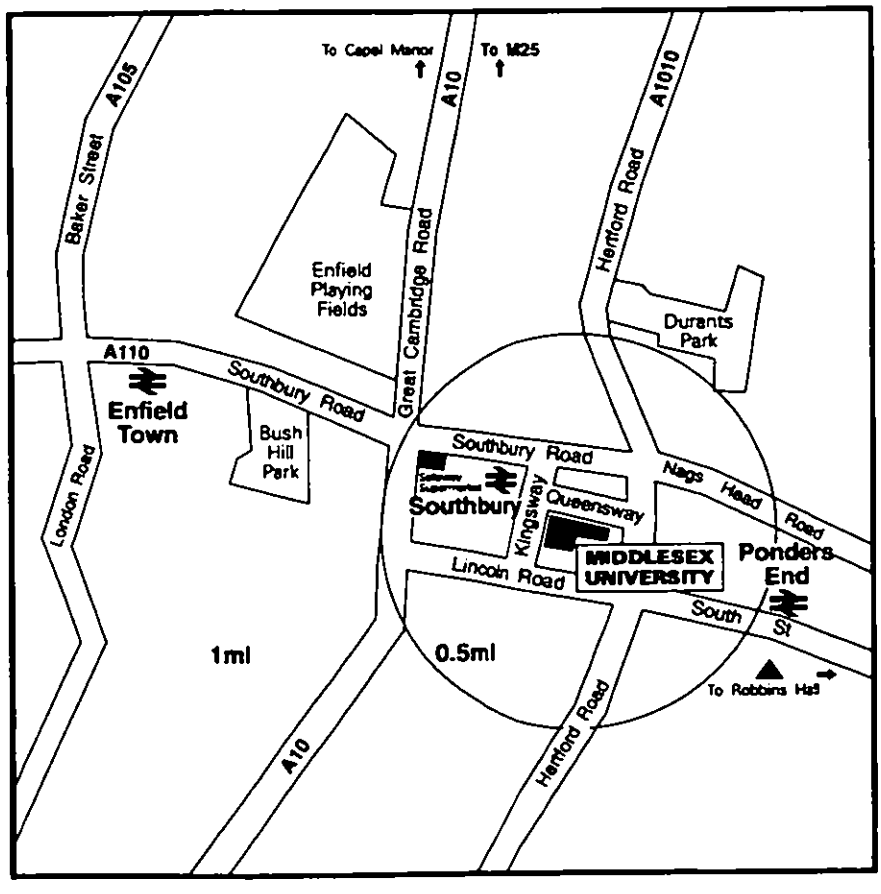
Rutherford Platt - Land and Water Policy Centre, University of Amhurst, Massachusetts, USA

15 CENTRE INFORMATION

THE CENTRE AND MIDDLESEX UNIVERSITY

The Centre is based at the Enfield campus of Middlesex University in north London, as part of the School of Geography and Environmental Management and the Faculty of Social Science.

Middlesex University is one of Britain's largest public sector higher education institutions with more than 18,000 students (both full-time and part-time) engaged in degree, higher degree, continuing education and other programmes with a strongly vocational orientation. The University is promoting its research work through a number of individual staff initiatives, but also through the creation of Research Centres in Urban Pollution, Microelectronics, Road Traffic, Criminology, Planning and the Flood Hazard Research Centre.



VISITING THE CENTRE

The Centre welcomes visitors, who are asked to contact the Centre prior to their visit. Overseas visitors should note that the Centre is 8 miles due north of central London and is most easily visited by travelling to Seven Sisters Underground (subway) station and then the British Rail to Southbury.

The Centre is about 2 miles from the M25 motorway and also within about one hour's travel time of Heathrow International and London (City) Airports.

CONTACT:
Flood Hazard Research Centre,
Middlesex University,
Queensway,
Enfield,
Middlesex EN3 4SF

Tel: 0181-362-5359
Fax: 0181-362-5403

Flood Hazard Research Centre

INTRODUCTION: Middlesex University's Flood Hazard Research Centre is a multi-disciplinary research unit specialising in the analysis and appraisal of environmental policies, plans and schemes with particular reference to water management. Founded in 1970, the Centre has gained a national and international reputation for the development of methods and data bases for the appraisal of investment in environmental improvement.

The Centre embraces a number of disciplines including:

- Geography
- Environmental Assessment
- Economics
- Planning
- Risk Analysis
- Psychology
- Statistics
- Geomorphology
- Sociology
- Ecology
- Engineering
- Environmental Chemistry

The Centre has undertaken both fundamental and applied research for British Research Councils, governmental departments, Local Authorities, water authorities, international aid donors and international policy organisations. Specialist advice has been given to public enquiries, House of Lords Select Committees and international agencies such as U.N.D.R.O. and O.E.C.D. The Centre is a member of the distinguished International Federation of Institutes for Advanced Study.

EXPERIENCE: Over the past twenty five years FHRC has undertaken major research and consultancy studies in:

- Investment appraisal
- Economic, social and environmental impact assessment
- Recreational management
- Flood plain management
- Catchment management

FHRC has been commissioned to develop benefit-cost methodologies for:

- Flood alleviation
- Sea defence
- Water pollution abatement
- Coast protection
- Land drainage
- Sewer rehabilitation

These methodologies have included assessment of:

- Direct and indirect flood damage
- Recreational impacts
- Land loss through erosion
- Environmental impacts
- Distress and health damage

Other research and consultancy has included studies of:

- Management of recreational usage of river corridors
- Flood plain management including development control and non-structural flood alleviation methods
- Risk perception
- Dam safety
- Disaster planning
- The application of water quality indices to river basin management
- Public participation in catchment management
- Post-project evaluation

Research and consultancy has included work on behalf of:

OECD, UNDRO, World Bank, US AID, ODA, EU, British Council, Ford Foundation, MAFF, DoT, NRA, DoE, etc

SERVICES: FHRC offers services in the following areas:

- Research
- Consultancy
- Data bases and use of dedicated software
- Project appraisal and evaluation
- Land use surveys
- Social surveys and in-depth interviewing
- Environmental economics
- Specialist training courses, workshops and seminars
- Library searches

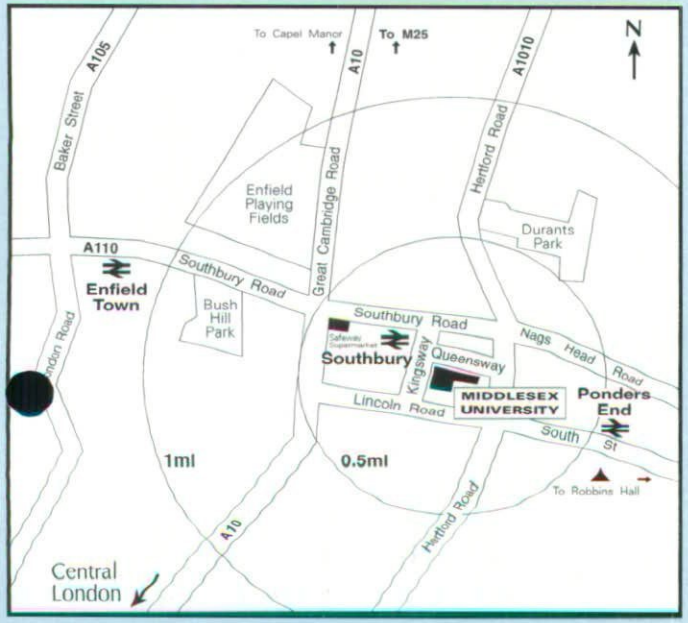
STAFF: FHRC includes geographers, economists, environmental scientists, social survey specialists, ecologists and risk analysts. Members of the Centre have appeared as expert witnesses at the following Public Inquiries:

- Amberley Wild Brooks
- Whitstable Sea Defence Scheme
- Lincoln Flood Alleviation Scheme
- Sizewell 'B' PWR
- Soar Valley, House of Lords Select Committee Hearing

FACILITIES: These include a 9,000 item library, extensive computing capability and a range of dedicated software including:

- *ESTDAM* - suite of programs for the assessment of flood alleviation benefits
- *BOCDAM* - for prioritising reaches within a catchment for flood alleviation feasibility studies
- *SROAD* - evaluates the costs of traffic disruption
- *ANALYSIS* - sensitivity analysis for benefit assessment framework
- *COPRES* - coastal protection benefit assessment framework
- *WQI* - programs for the assessment of surface water quality

LOCATION AT THE NORTHERN EDGE OF LONDON



RECENT PUBLICATION TITLES:

The economics of coastal management: a manual of benefit assessment techniques

Floods across Europe: flood hazard assessment, modelling and management

Ignorance, the Precautionary Principle and Sustainability

Infant mortality and waterlogged soils: Significant cause for concern

Public Perception of rivers and flood defence

Hazard Management and Emergency Planning

The Centre has produced a large number of books, papers, reports and conference papers *(the full list is available upon request)*. We would welcome collaboration with other research bodies and individuals.

The Centre has experience of research and consultancy projects in:

Argentina
Australia
Bangladesh
China
Egypt
England
France
Germany
Hong Kong
India
Italy
Malaysia
Netherlands
Northern Ireland
Norway
Portugal
Scotland
Spain
Thailand
USA
Wales
Yemen

Head of Centre
Professor Edmund Penning-Rowsell

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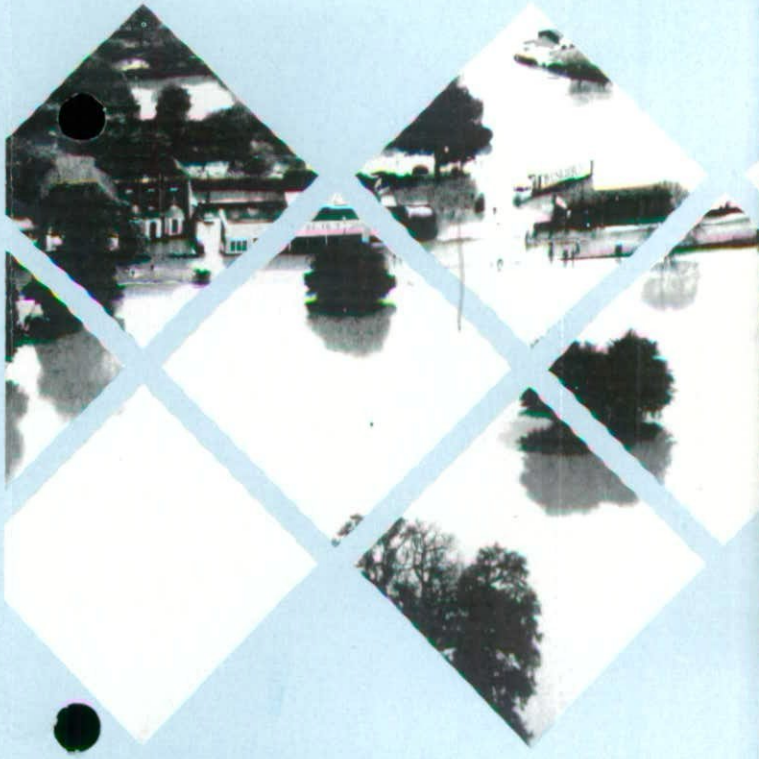
Designed by the School of GEM Technical Unit

SCHOOL OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT

MIDDLESEX UNIVERSITY



Flood Hazard Research Centre

FHRC