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Initial Analysis of Flows between Non-Countryside Uses and Rural Land with Recommendations for Further Work

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CONTENTS

1 INTRODUCTION

This report presents an exploration of the data available within the CS1990 database for land cover parcels for non-agricultural land uses. Although the national movements are quite small (increasing by 4% for urban area and 5% for woodland) the objective of the analysis was to examine the potential of the database for breaking down the pathways between the various categories.

2 SUMMARY OF THE CS1990 RESULTS

The field surveys for CS1990 were targeted at predominantly rural land and squares which were more than 75% built up were rejected. The stratification used was the ITE Land Classification, which divides the approximately 250,000 squares in GB into 32 groups called land classes (Bunce *et al.* 1990). The classification was produced by multivariate analysis of environmental features; the features can broadly be grouped into four types: climate, geology, landscape morphology and human artefacts. For 1990, the urban squares were defined from a 1:250,000 scale dataset which identified just over 5,000 squares in GB. However the squares that were surveyed still contained up to 75% urban land and were fully mapped. Previously ITE had investigated the characteristics of the urban squares and run minor projects classifying and surveying them. When surveyed, the urban land (ie land not covered by bare earth or vegetation) was divided into roads, railways, residential buildings, agricultural buildings, other buildings, hard areas without buildings and quarries and extractive operations.

Countryside Survey 1990, also included the production of the Land Cover Map, which involved the interpretation of multi-temporal satellite imagery covering all GB except the Isle of Man and classifying the land cover into 25 categories (Fuller *et al.* 1993). Two of the categories described were continuous urban and suburban/rural development.

The definitions of urban and rural are essential to the description of the interface between the two types of land cover. In order to ease the comparison of the different estimates produced using different techniques and also to facilitate the comparison with other surveys a dictionary of land cover definitions has been produced which defines all types of land cover (Wyatt *et al.* 1993).

Although the core of each land cover type is readily identified, the point at which a landscape flips from being a rural landscape with a few buildings to being an urban landscape with a few small green areas is arbitrary, lying on a continuum. In terms of the environment, the important question is the relationship between the density of human artefacts and the type and quality of habitats immediately adjacent.

Predictions for GB from the field survey include a prediction for the rural land in the urban squares (ie the > 25% of non-surveyed squares). All squares in GB are classified, so it is possible to make a prediction for that portion of the square. However a number of assumptions are being made when this is done, the most important of which is that the land immediately neighbouring urban land is no different from that which is further afield. On average over 90% of each non surveyed square is urban land, so the additional figures are relatively small for the whole of GB, but the assumption still warrants investigation.

The method of processing the surveyed squares is to digitise the thematic maps and label parcels with their codes. A combined coverage is then produced by adding the themes. The parcels contained in this map are then classified into the 58 summary land cover types. It is a relatively simple process to buffer the urban parcels and identify the land cover in parcels at a series of distances from the source.

Buffering parcels will give an indication of the relationship between urban land and rural land in CS1990 'rural squares' , but assumes that there is no relationship between the proportion of a square that is urban and the rural land cover. In order to investigate that problem, ideally a sample of urban squares would be surveyed using the standard CS1990 techniques. Without that it is still possible to compare the relationship within the surveyed squares between the proportion that is urban and the other land cover types.

Between 1984 and 1990, most of the new built up land replaced agricultural managed grassland, with a considerable area replacing tilled land, woodlands, rough grazing and unmanaged grassland. The predicted increase in built land is between 4% and 5%, this is similar to some estimates (eg Brown 1992 and Eurostat 1992) but lower than that produced by others (Sinclair 1992). The figure for woodland, the other principal non-agricultural change is 50%.

Apart from the land cover types being replaced by built land, it is also possible to identify neighbouring landscape elements associated with urbanisation. A project over a decade ago (Woods 1983) identified that new built land was more likely to appear in squares already containing built land. The relationship seems to be holding true between 1984 and 1990.

3 DISCUSSION OF FLOWS

The UN/ECE project carried out for DoE by Dr R Haines-Young at Nottingham University has demonstrated the importance of examining the flows between land cover categories. In the present study the flows between 18 non-agricultural land uses varying from woodland to roads were examined. The base data for all the analysis were the ARC-INFO parcels labelled for the appropriate categories of the field survey land cover records which were interrogated through the ORACLE database management system.

The areas of change (Figures 1-4) have been produced by summing the areas changing within each square, calculating a mean for each land class and producing a national estimate by weighting each mean by land class area.

The main direction of change within GB is to non-agricultural uses, principally conifer woodland, broadleaved woodland and residential. Generally only small areas are involved in all types of change. In arable landscapes, surprisingly conifer woodland shows the largest gain followed by residential. Further examination showed that this was due to afforestation around the margins of the arable land classes 25 and 26 in south-west Scotland, where it is adjacent to the upland classes. In the pastural landscapes the expansion of the residential category was most important followed by broadleaved woodlands. In marginal and upland classes afforestation was by far the biggest shift.

The number of squares affected (Figures 5-10) has been produced by summing the number of squares with any change in them and dividing this by the number of squares sampled in each land class. These means were then weighted by using the land class area to produce final estimates.

Large numbers of squares were affected by change with most changes in broadleaved woodland, grassland and semi-natural categories. Many changes also involved agricultural buildings, roads and residential categories. In arable and pastural landscapes four squares with conifers confused the overall picture,

otherwise the pattern was comparable to the national situation. This reflects the content between the true lowlands and the other landscape types. In the marginal uplands agricultural buildings had expanded to a considerable extent, with some broadleaved losses. Only conifer transfers were present in the uplands.

The number of parcels (Figures 11-15) was produced by totalling the number of parcels changing in each square and dividing by squares sampled in each land class. Again the land class means were weighted by land class area to produce the final estimates.

The number of parcels changing is also high - to some degree compounded by the expansion of afforestation over fragmented moorland parcels. The patterns are comparable to those of the squares but differ in detail eg in the loss of shrub. Again, there were major differences between the landscape types, reflecting their underlying ecology.

The average parcel size (Figures 16-20) was calculated within each square. These means were then summed and divided by the number of squares sampled in each land class. The final estimates were then produced using the land areas as weights.

The average parcel size shows different patterns but these could be misleading owing the fragmentation of moorland parcels. Further analysis of these data are therefore required.

4 EXAMPLES OF CHANGE BETWEEN 1984 AND 1990

Ten examples (Figures 21-30) were chosen to represent the different types of patterns of change and the potential for further analysis, especially of adjacency of development of existing non-agricultural uses. As has been shown in the previous section the national extent of change is small in total but involve many individual transfers.

Virtually all the expansion of urban development is either adjacent to, or infilling between existing urban areas. In addition, agricultural buildings have often extended and may be on open agricultural land. Similarly forestry has expanded from existing plantations although some other examples where forestry has been planted on land where none existed previously.

The visual patterns in the squares are interesting and there is therefore considerable potential for the application of ARC-INFO GIS to define and compare these subjective observations.

5 RECOMMENDATIONS FOR FUTURE WORK

The analysis of flows showed some interesting features of the data and that the number of parcels concerned justify further breakdowns for examples between the urban categories and the types of rural land cover. This was partly expressed in the matrix of change presented in the CS1990 Main Report but further breakdowns could be included, especially if the relationships between the average species composition and the land cover parcels was incorporated.

The presentation of the sample maps demonstrated that there is considerable potential for the application of GIS to examine the patterns of more rural land use expansion, especially of urban and woodland categories.

The database could also be used to build up transfer coefficients for input into Markov models which could then be used to predict future developments. The different types of urban development as described by Woods (1983) could also be incorporated.

A further excursion of this type of analysis could be to examine the 508 samples 1 km squares in the database through the progressive series of Ordnance Survey maps, going back to the 1840s. Progressive urban development and other non-agricultural uses could be followed over that time. The initiation of planning controls could be examined to see whether they have been successful in limiting development to existing centres.

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7 FIGURES

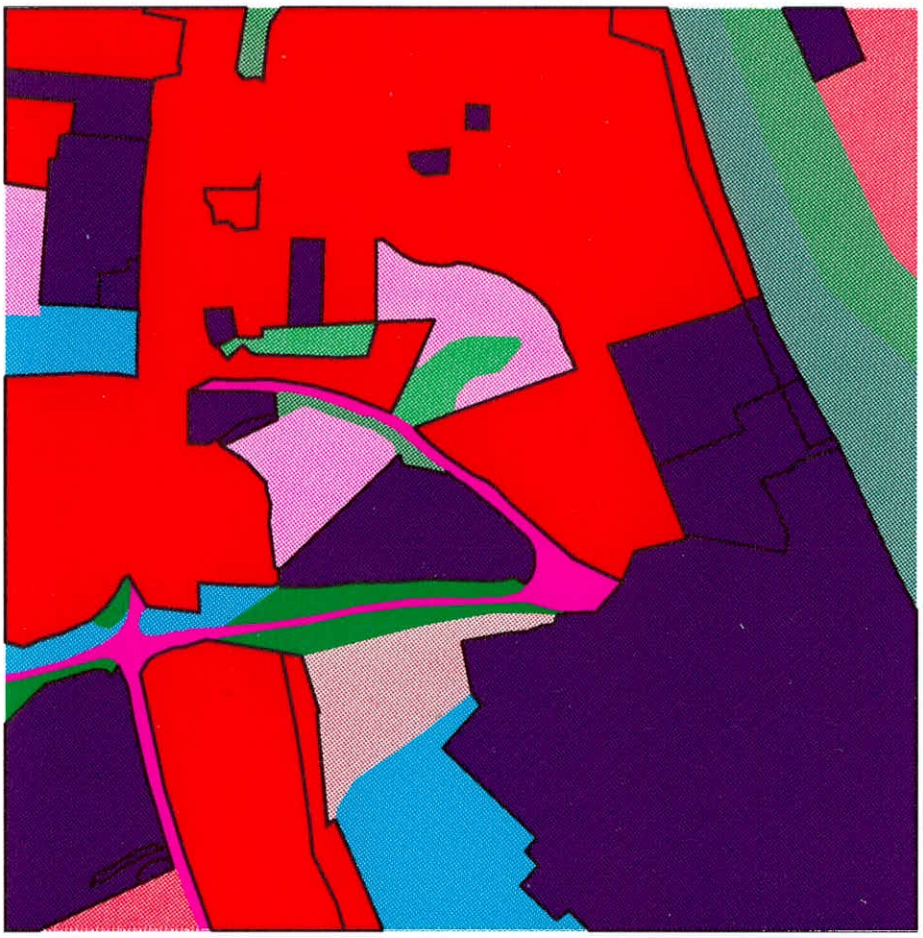
Figures 1-5 Flows in areas within GB: arable, pastural, marginal and upland landscapes.

Figures 6-10 The number of squares affected by changes between non-agricultural uses and rural land in GB and the four landscape types.

Figures 11-15 The numbers of parcels affected by changes between non-agricultural uses and rural land in GB and the four landscape types.

Figures 16-20 The average parcel size within each square of the parcels that changed between non-agricultural uses and rural land in GB and the four landscape types.

Figures 21-30 Examples of 1 km squares demonstrating different types of change



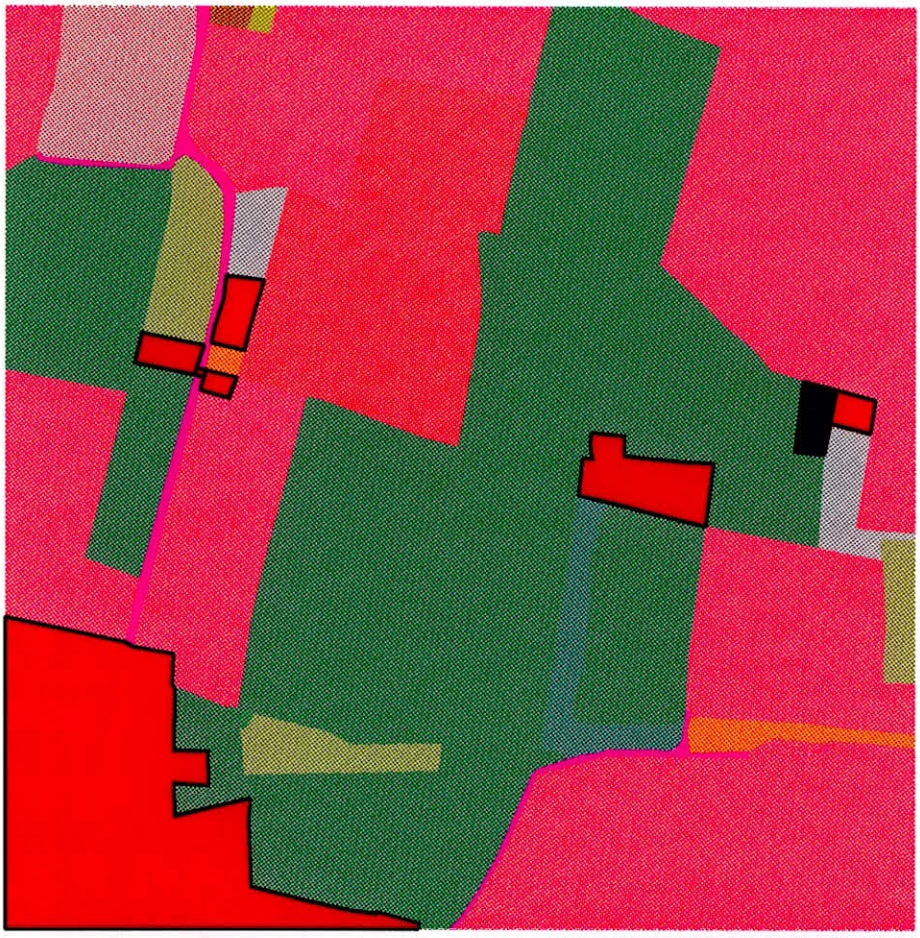
1984

1990

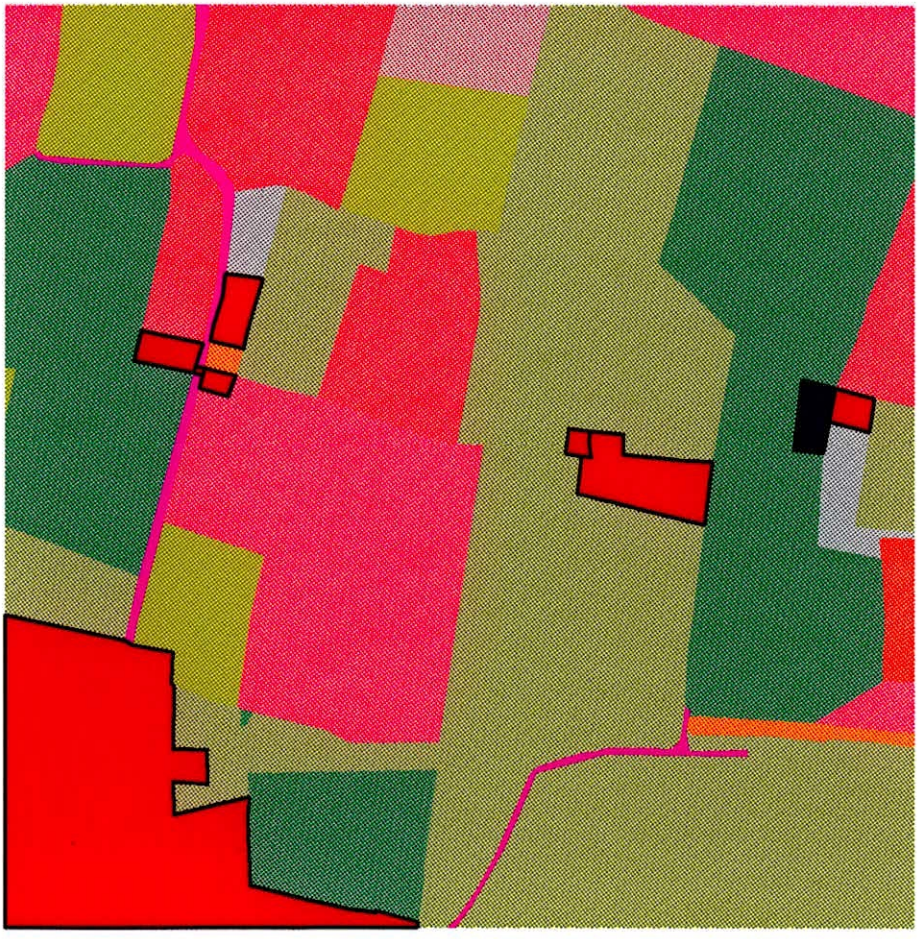
- Residential buildings
- Weedy swards with ›25% rye-grass
- Broadleaved woodland
- Other buildings
- Wheat
- Mixed woodland
- Waste and derelict land
- Well managed grass
- Recreational (mown) grass
- Shrub
- Road
- Pure rye-grass
- Barley
- Non cropped arable

Comment :-

- Change in use of other buildings to residential
- Area of waste and derelict land and residential changed to other buildings
- Area of shrub changed to residential
- Area of recreational grass changed to residential



1984

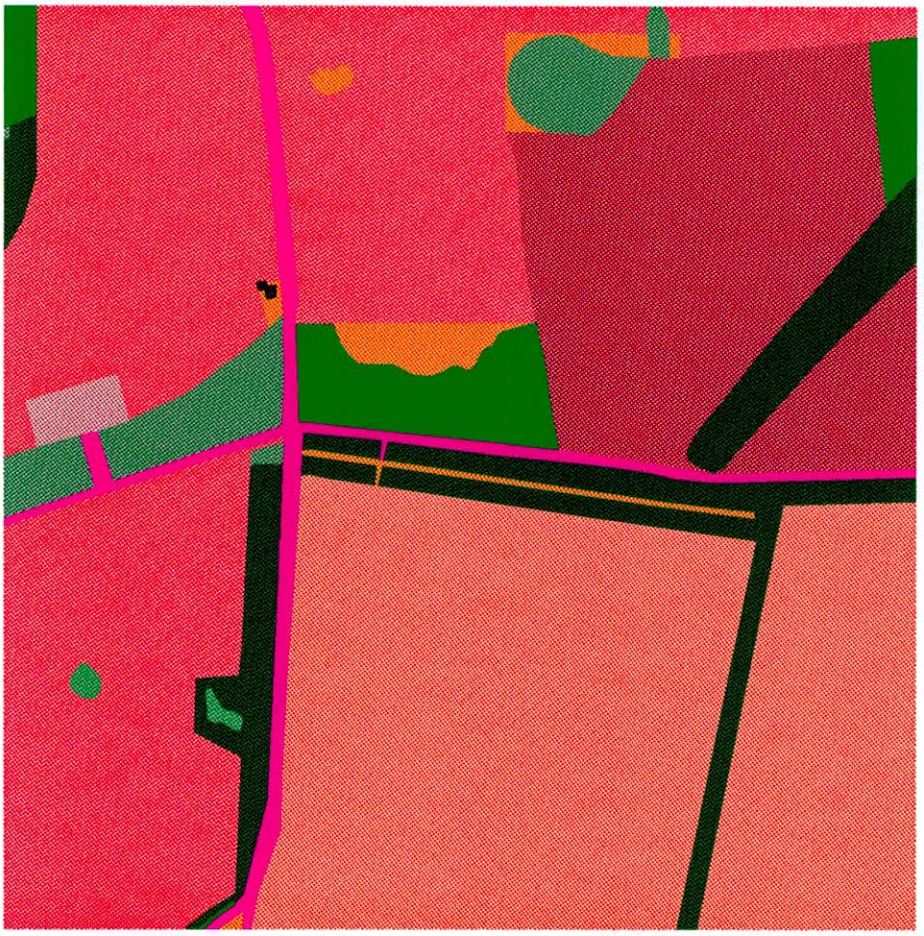


1990

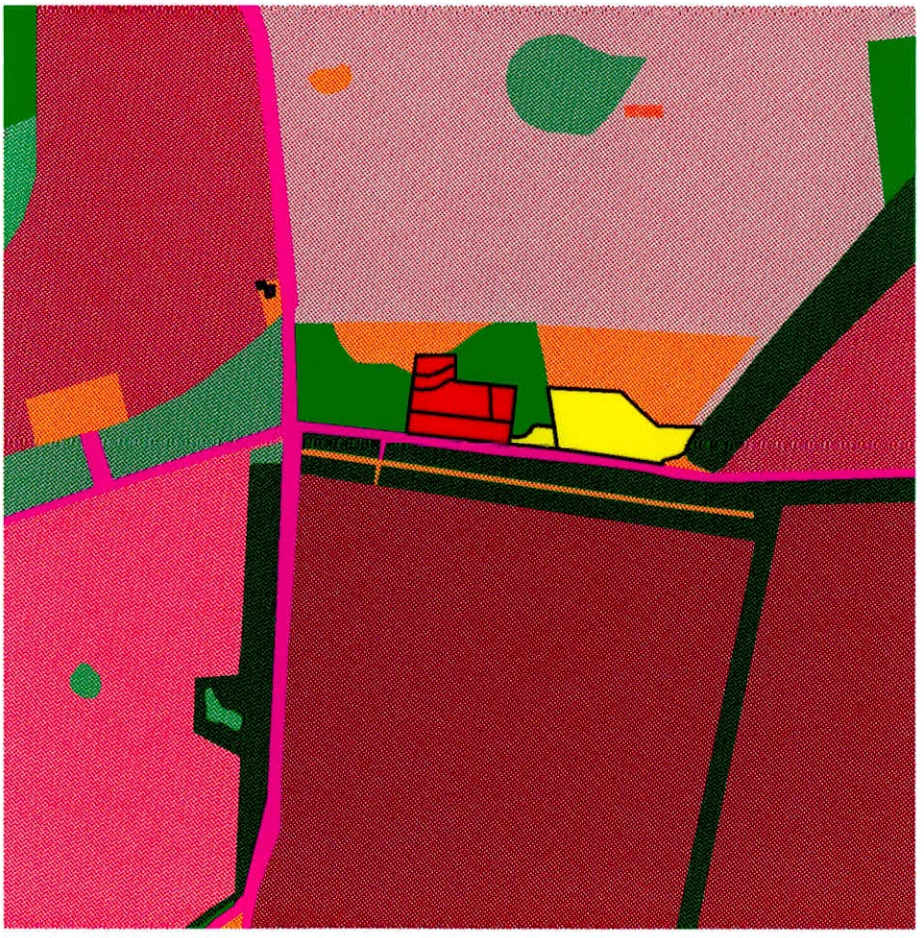
- Pure rye-grass
- Wheat
- Well managed grass
- Barley
- Recently sown grass
- Other buildings
- Residential buildings
- Road
- Broadleaved woodland
- Unmanaged grassland and tall herb
- Non-cropped arable (ploughed and fallow)
- Not-agriculturally-improved grass
- Oats
- Weedy swards with ›25% rye-grass
- Oil-seed rape

Comments :-

- Minor changes in buildings
- Addition of residential buildings at expense of well managed grass
- Unmanaged grass to managed grass



1984



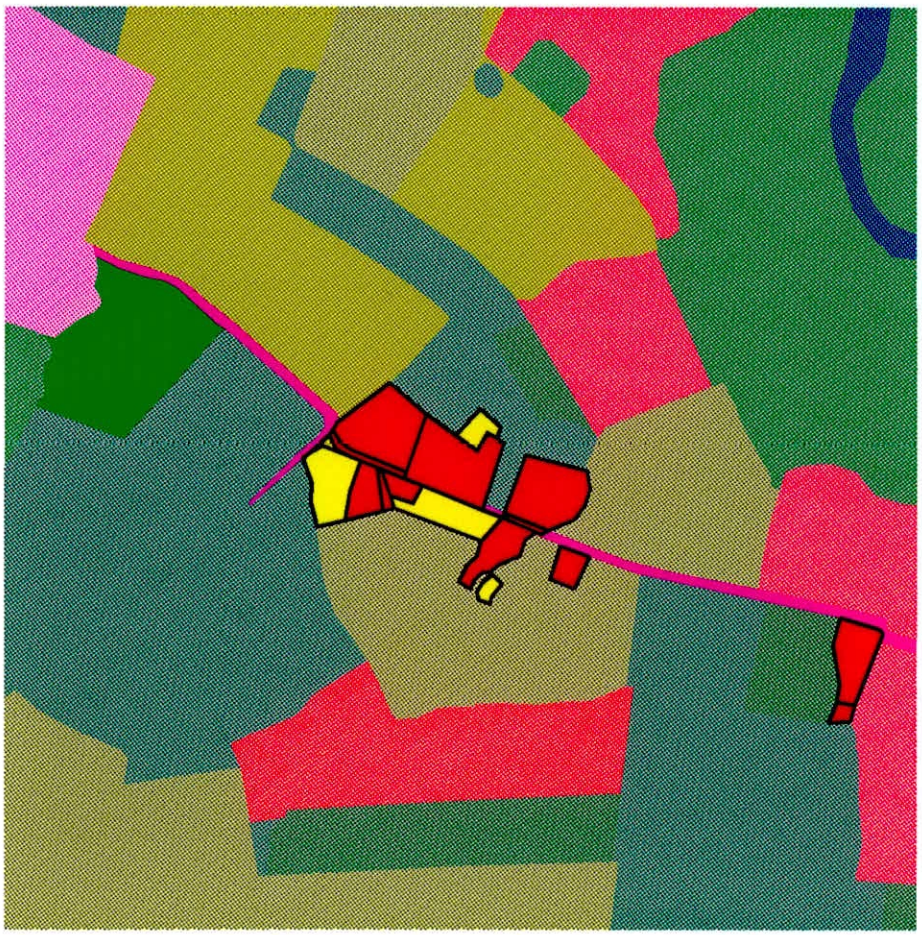
1990

- Broadleaved woodland
- Running water
- Pure rye-grass
- Recently sown grass
- Weedy sward with ›25% rye-grass
- Recreational (mown) grass
- Road
- Wheat
- Mixed woodland
- Well managed grass
- Residential buildings
- Agricultural buildings
- Barley
- Unmanaged grassland and tall herb

Comments :-

- Increase in agricultural and residential buildings around existing residential areas
- Loss of well managed grass to recreational grass

1984

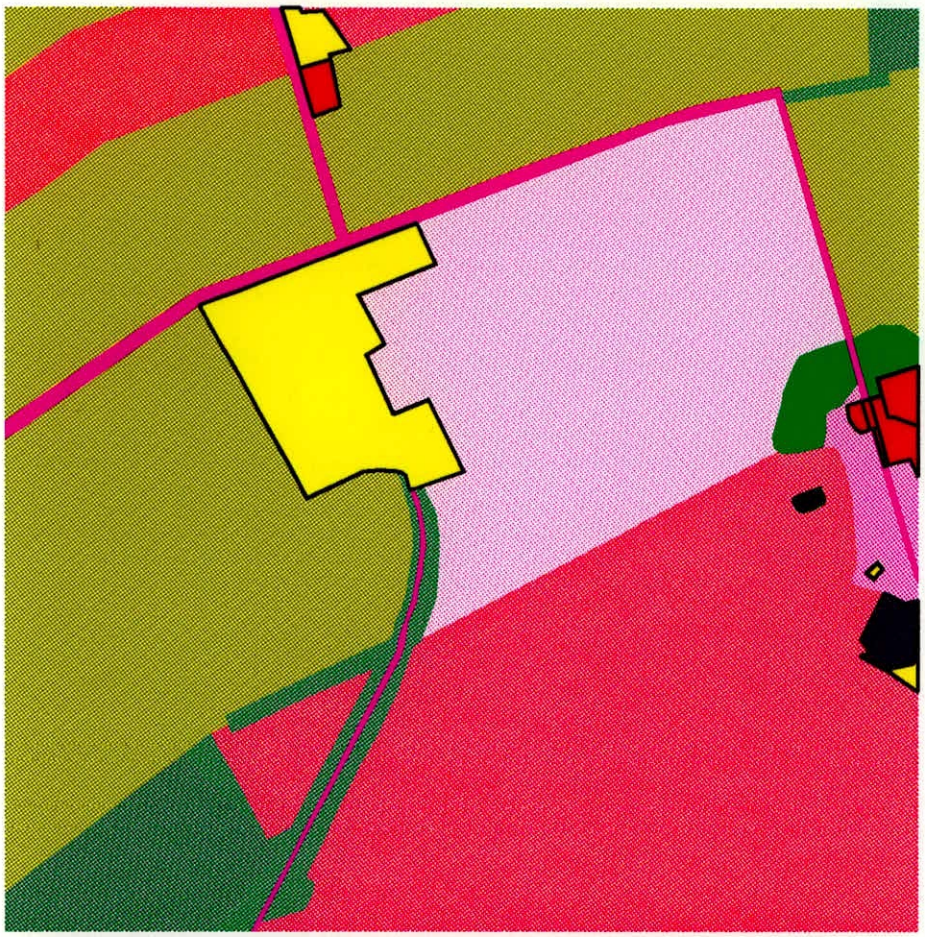


1990

- Mixed woodland
- Sugarbeet
- Road
- Non-cropped arable (ploughed and fallow)
- Unmanaged grassland and tall herb
- Maize
- Shrub
- Broadleaved woodland
- Conifer woodland
- Other buildings
- Residential buildings
- Agricultural buildings
- Wheat
- Other field crops
- Barley
- Mixed and other cereals

Comments :-

- Residential and agricultural buildings replacing woodland and crop land
- Unmanaged grass around agricultural building at expense of field crops



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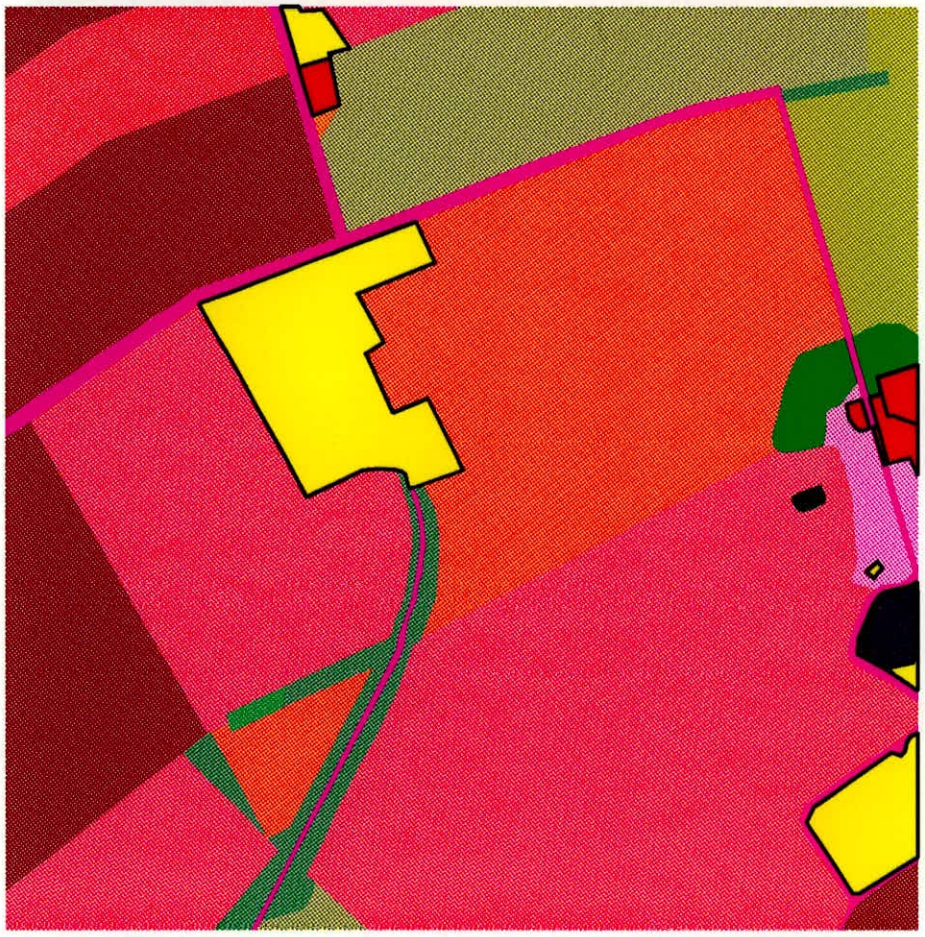


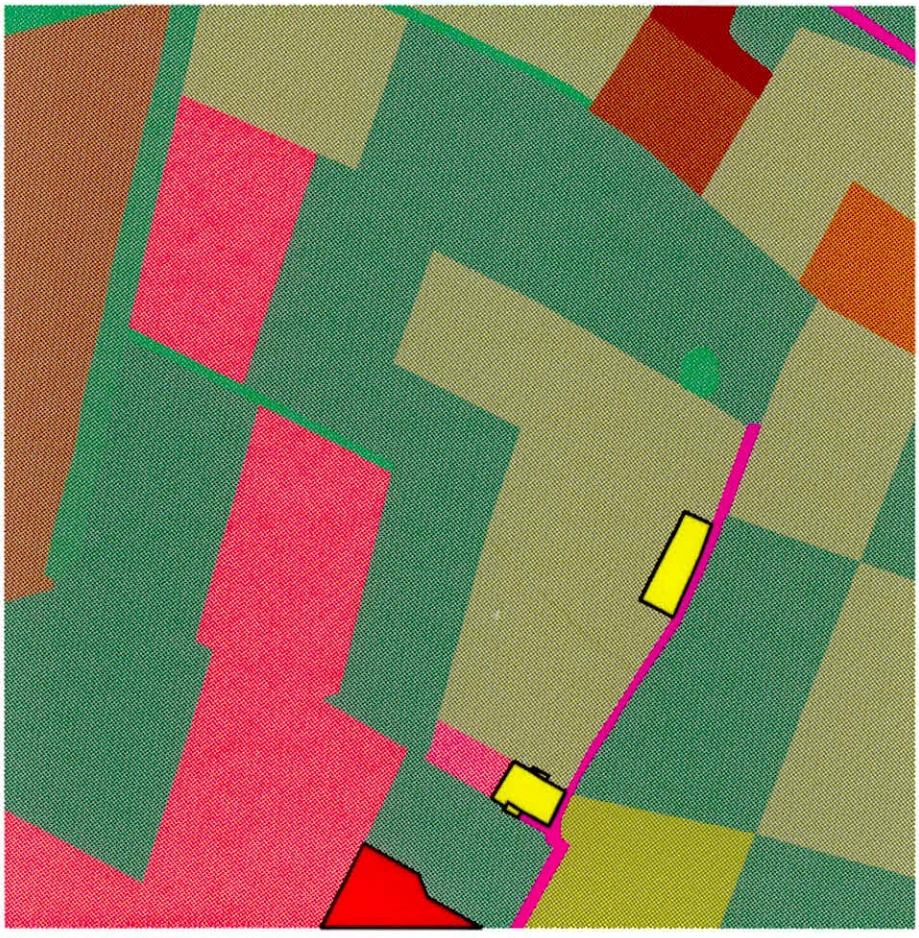
1990

- Other field crops
- Barley
- Road
- Agricultural buildings
- Wheat
- Pure rye-grass
- Recently sown grass
- Residential buildings
- Broadleaved woodland
- Unmanaged grassland and tall herb
- Maize
- Mixed woodland
- Recreational (mown grass)
- Conifer woodland
- Other buildings
- Shrub
- Well managed grass
- Legumes (not peas or field beans)

Comments :-

- Increase in number of agricultural buildings
- New road around new agricultural buildings

1984

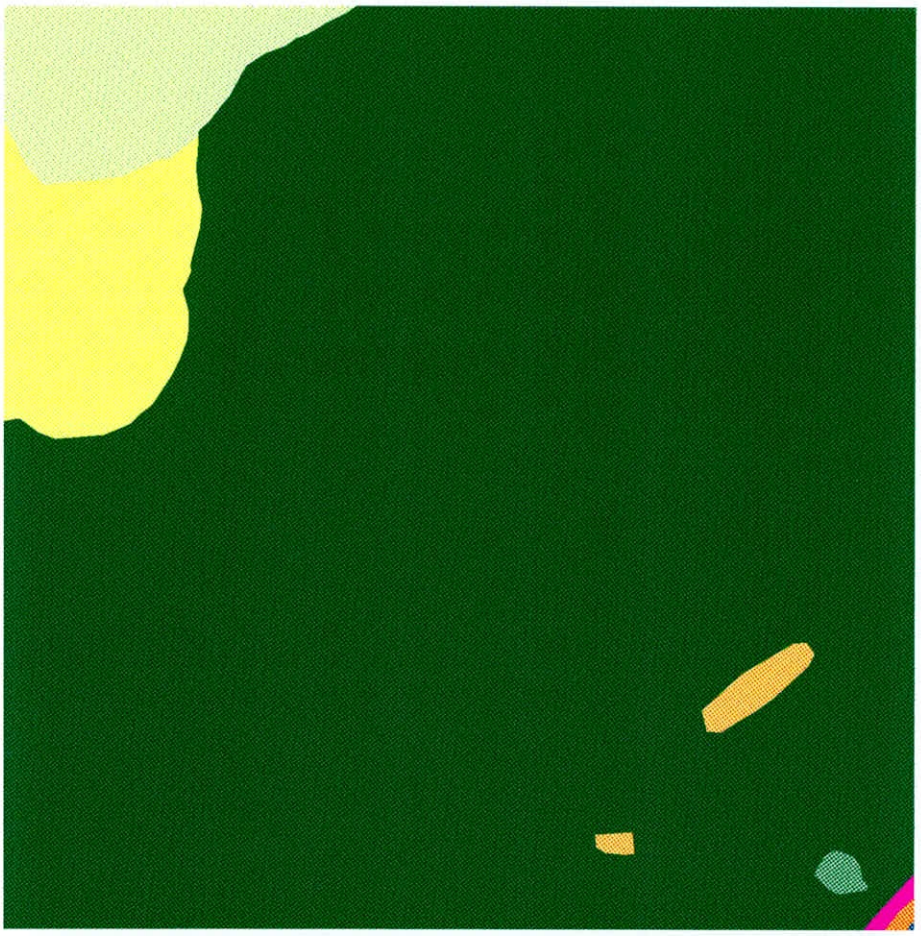


1990

- Well managed grass
- Road
- Pure rye-grass
- Agricultural buildings
- Shrub
- Oil-seed rape
- Broadleaved woodland
- Potatoes
- Barley
- Wheat
- Recently sown grass
- Residential buildings
- Kale
- Turnips swedes

Comments :-

- Decrease in roads
- Two additional agricultural buildings small incremental change



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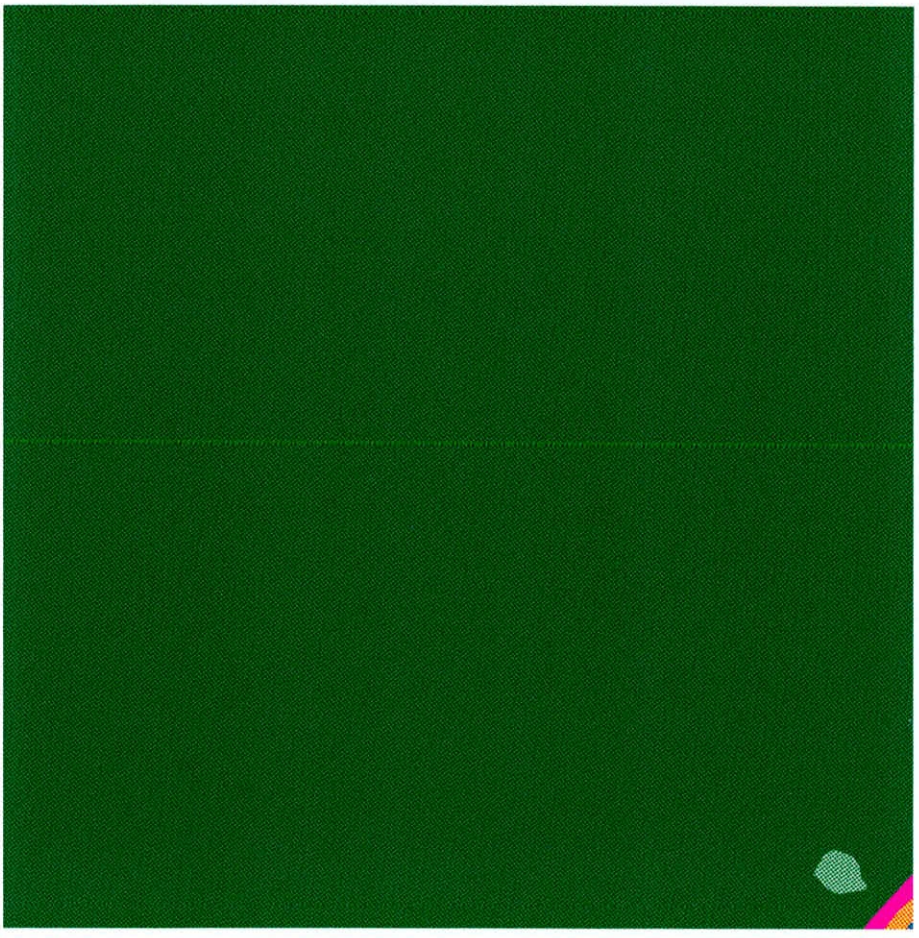
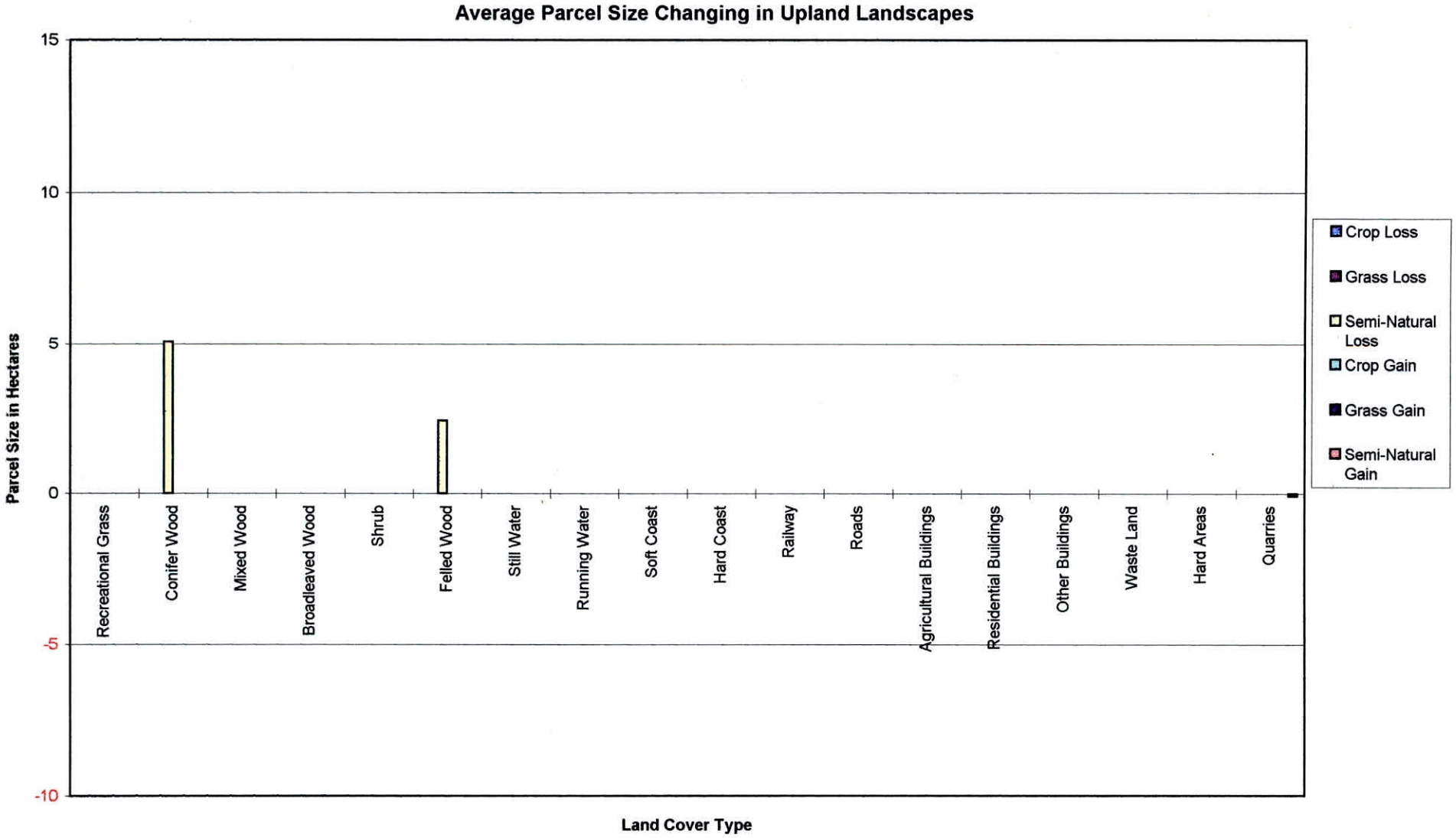


1990

- Conifer woodland
- Broadleaved woodland
- Road
- Unmanaged grassland and tall herb
- Running water
- Purple moor grass dominated moorland
- Open-canopy heath

Comments :-

- Increase in planted conifer at expense of purple moor grass and open canopy heath
- Infilling of clearing in forest


Average Parcel Size Changing in Upland Landscapes
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-10
Parcel Size in Hectares
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
Still Water
Running Water
Soft Coast
Hard Coast
Railway
Roads
Agricultural Buildings
Residential Buildings
Other Buildings
Waste Land
Hard Areas
Quarries
Land Cover Type
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Crop Gain
Grass Gain
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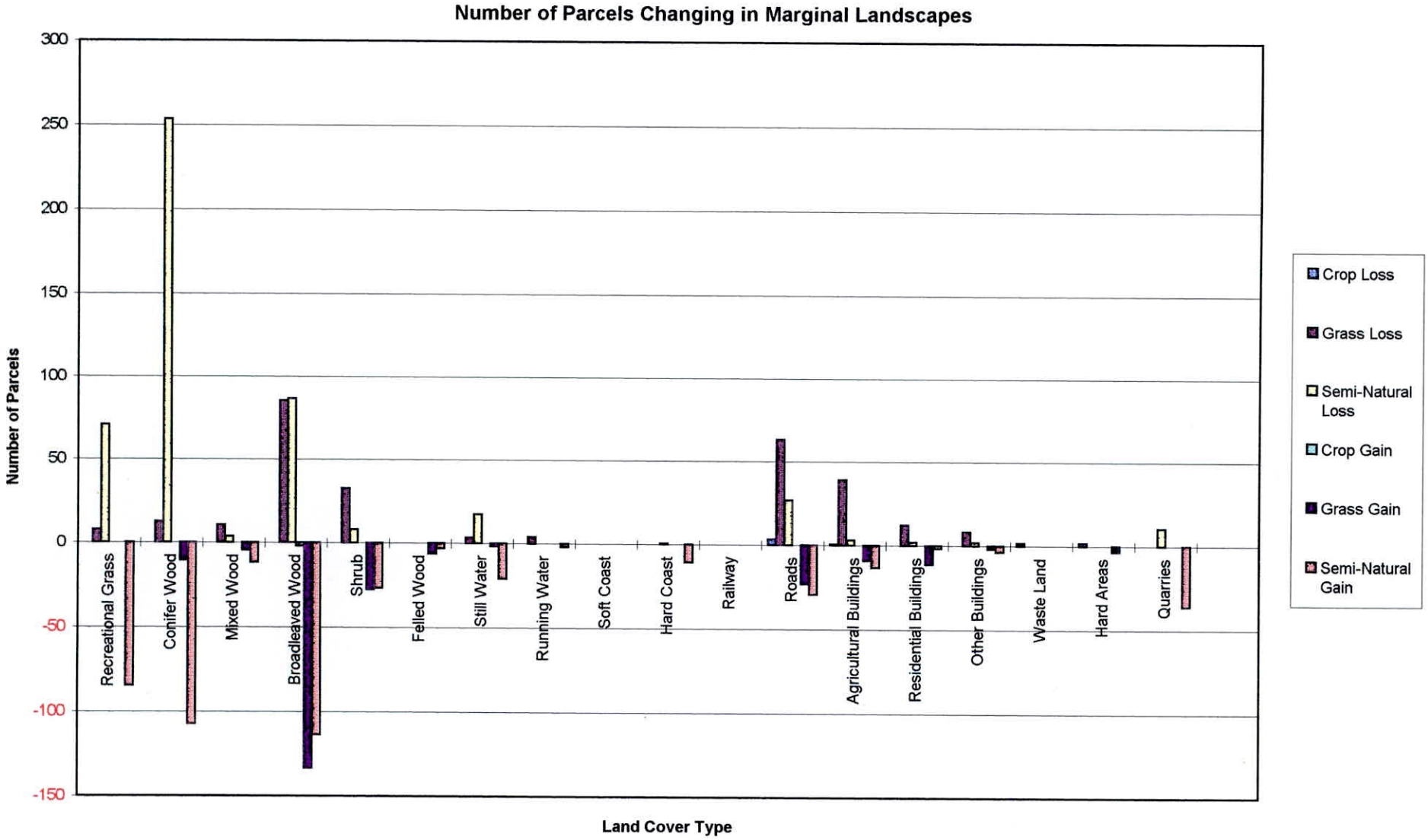
Number of Parcels Changing in Marginal Landscapes
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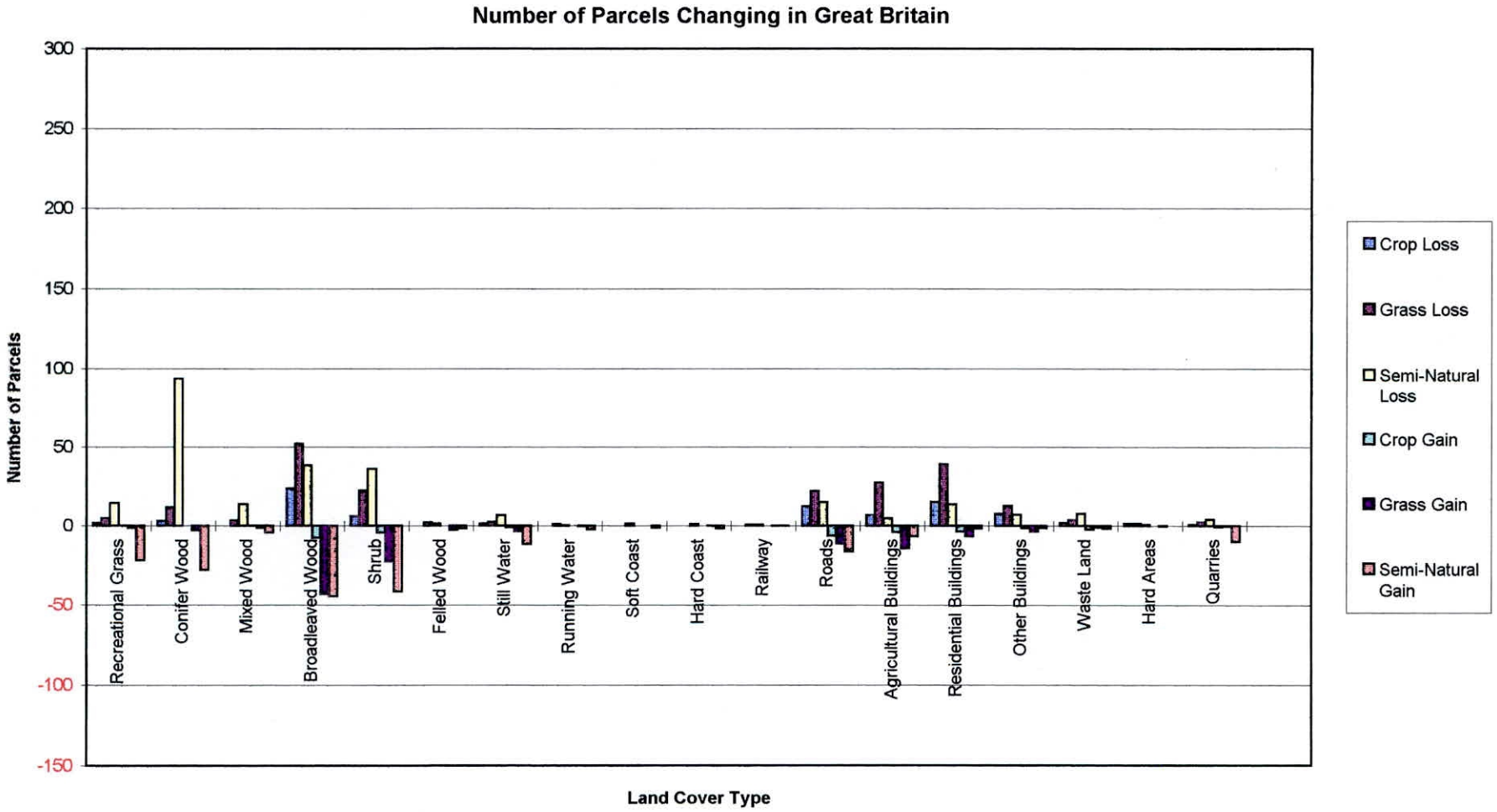
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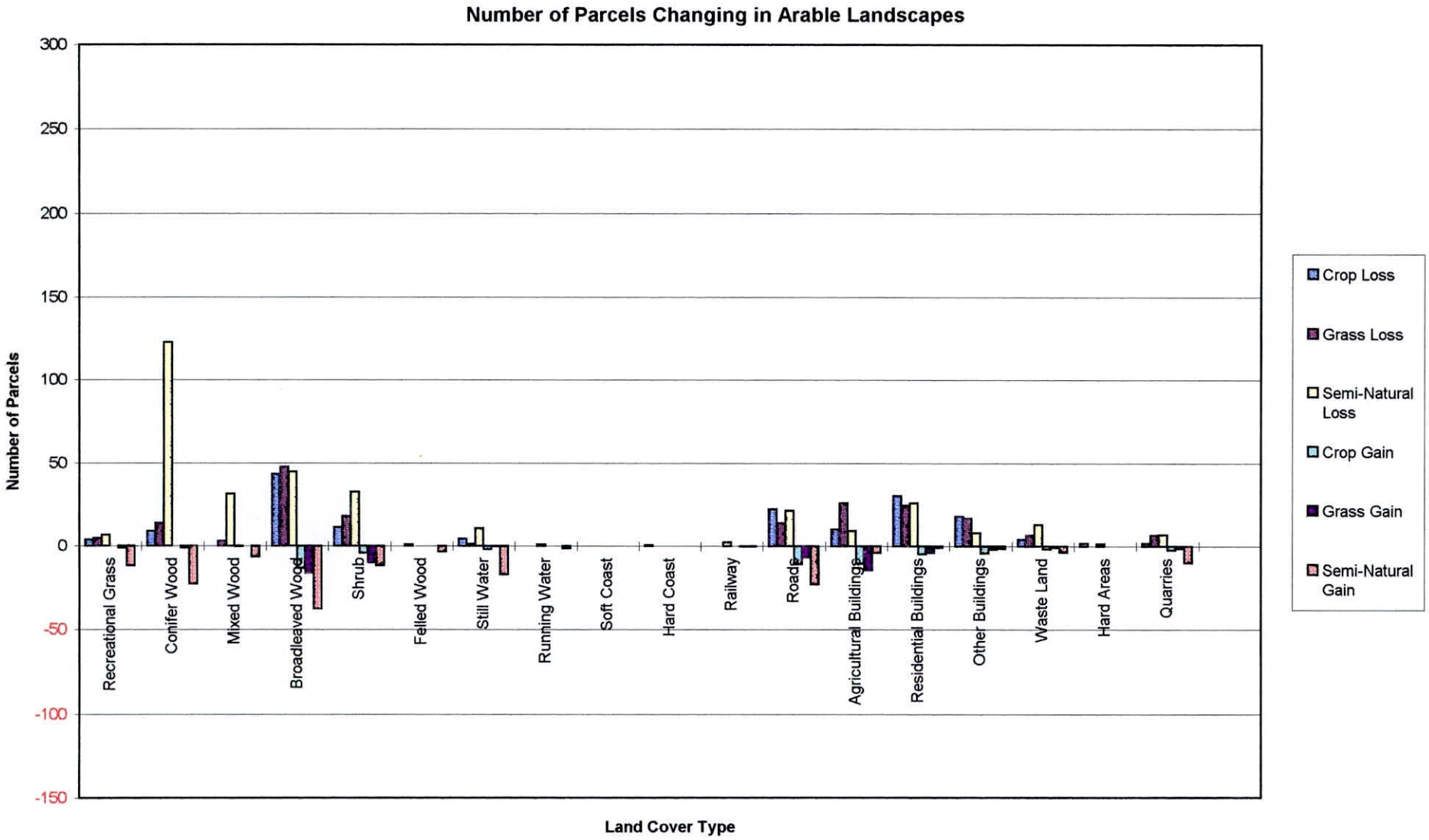
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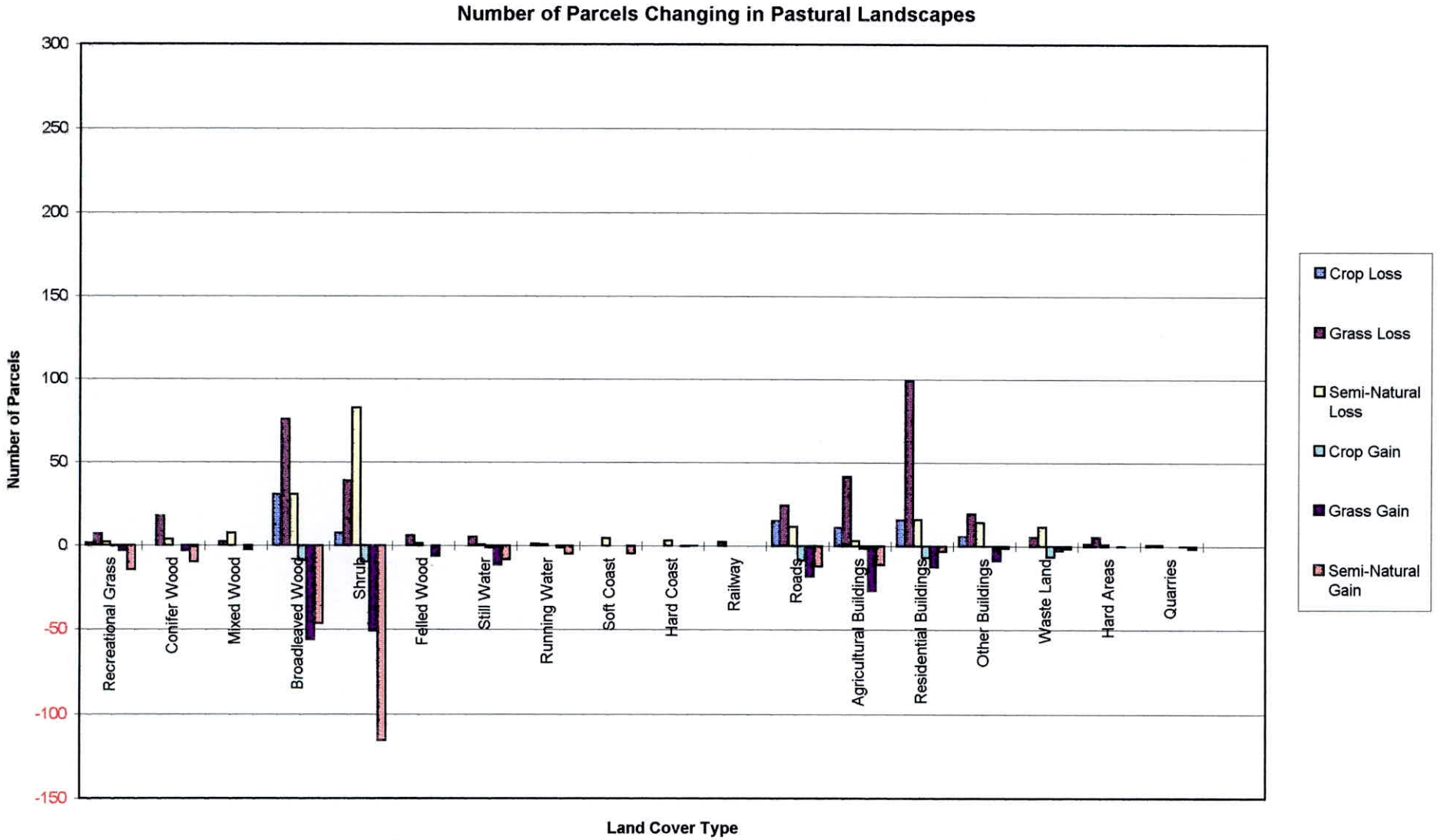
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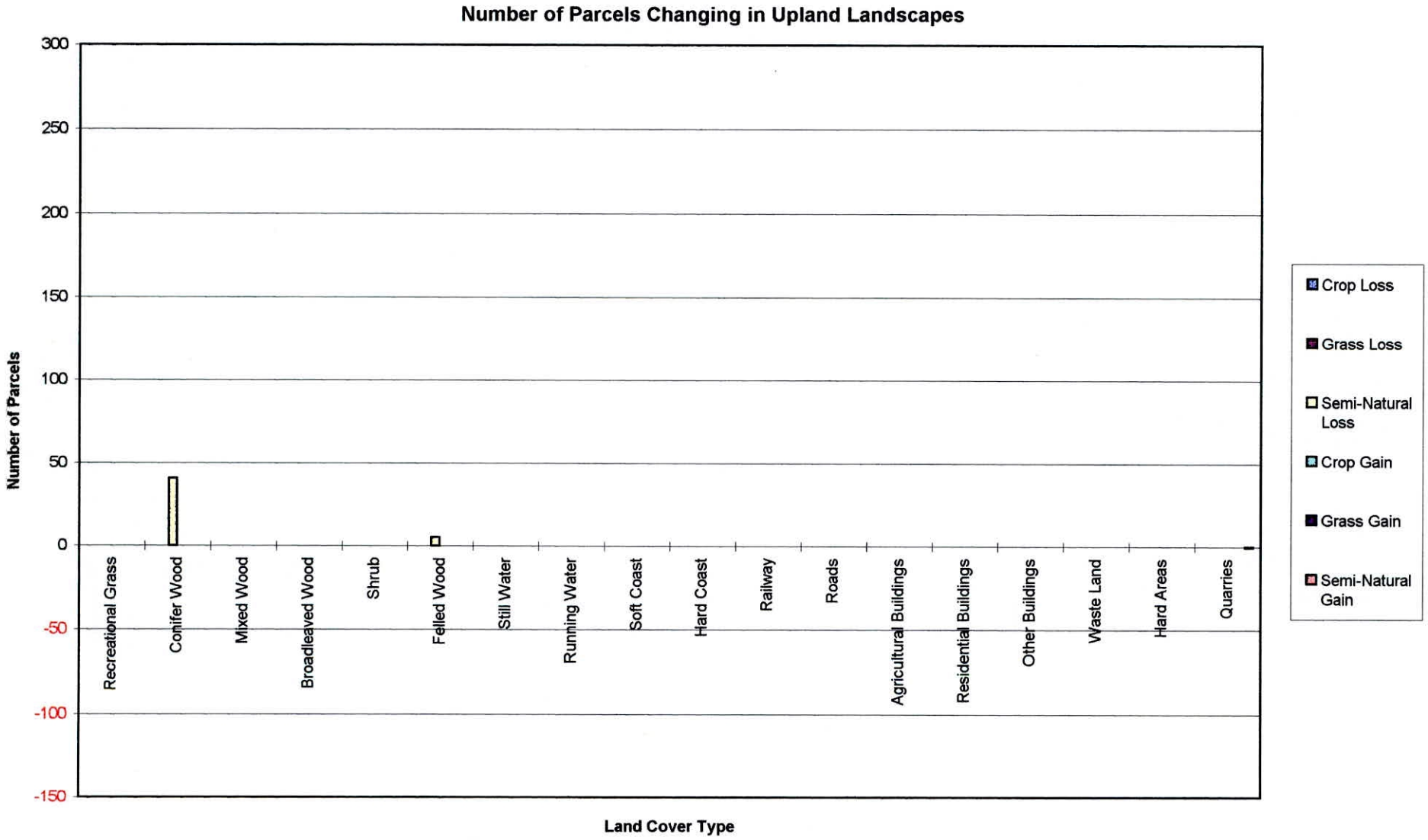
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Number of Parcels
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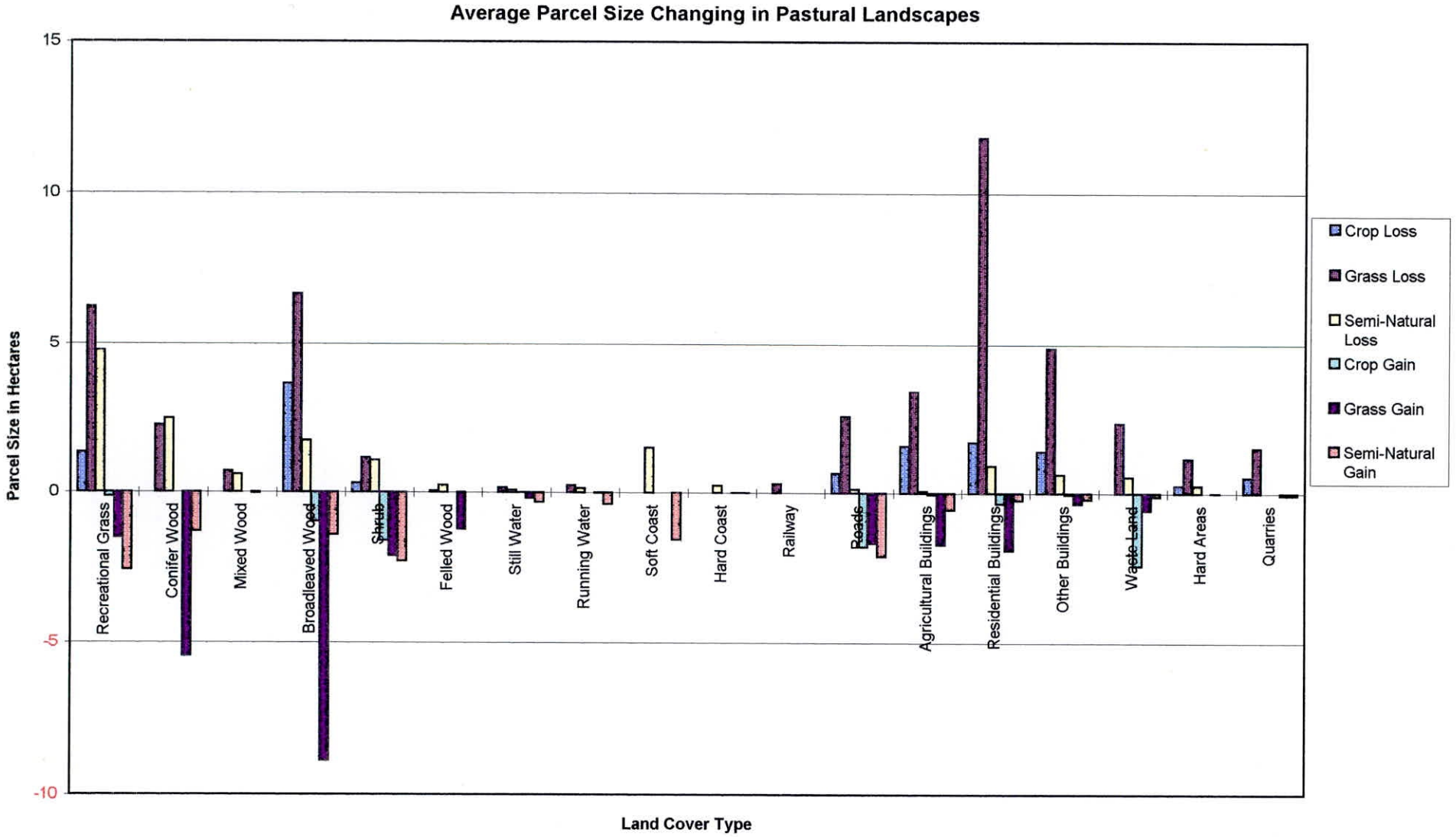
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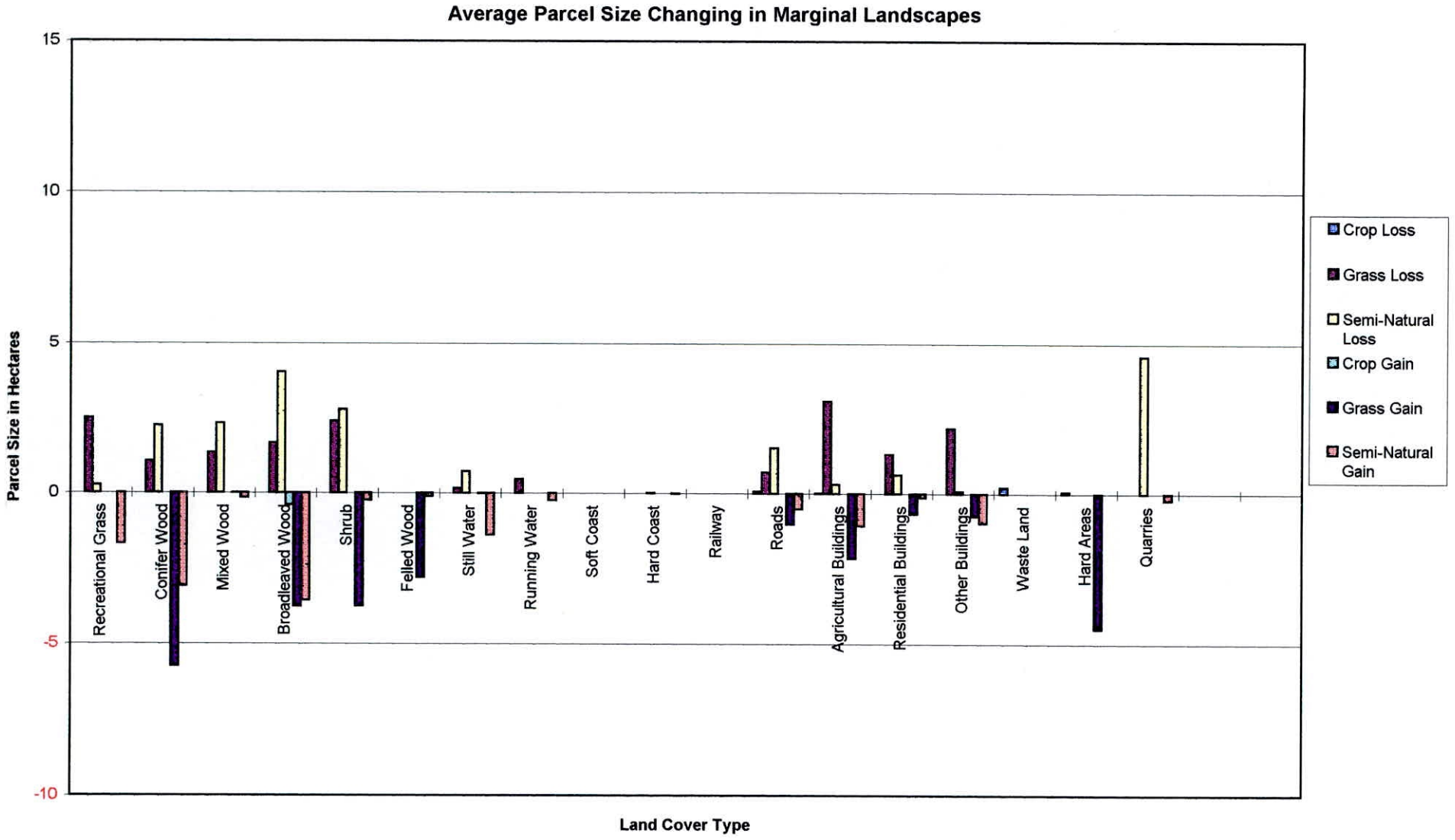
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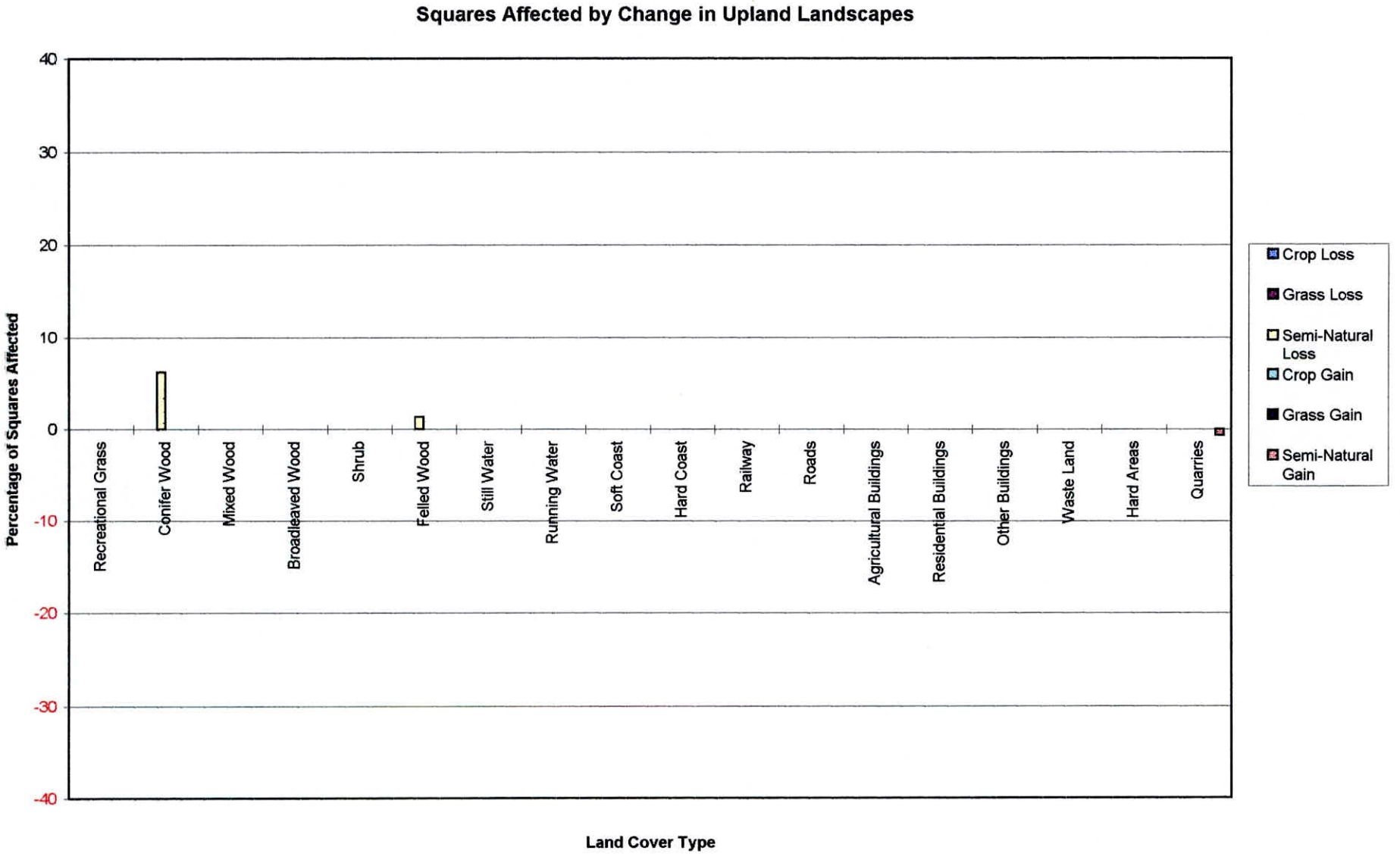
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Percentage of Squares Affected
40
30
20
10
0
-10
-20
-30
-40
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
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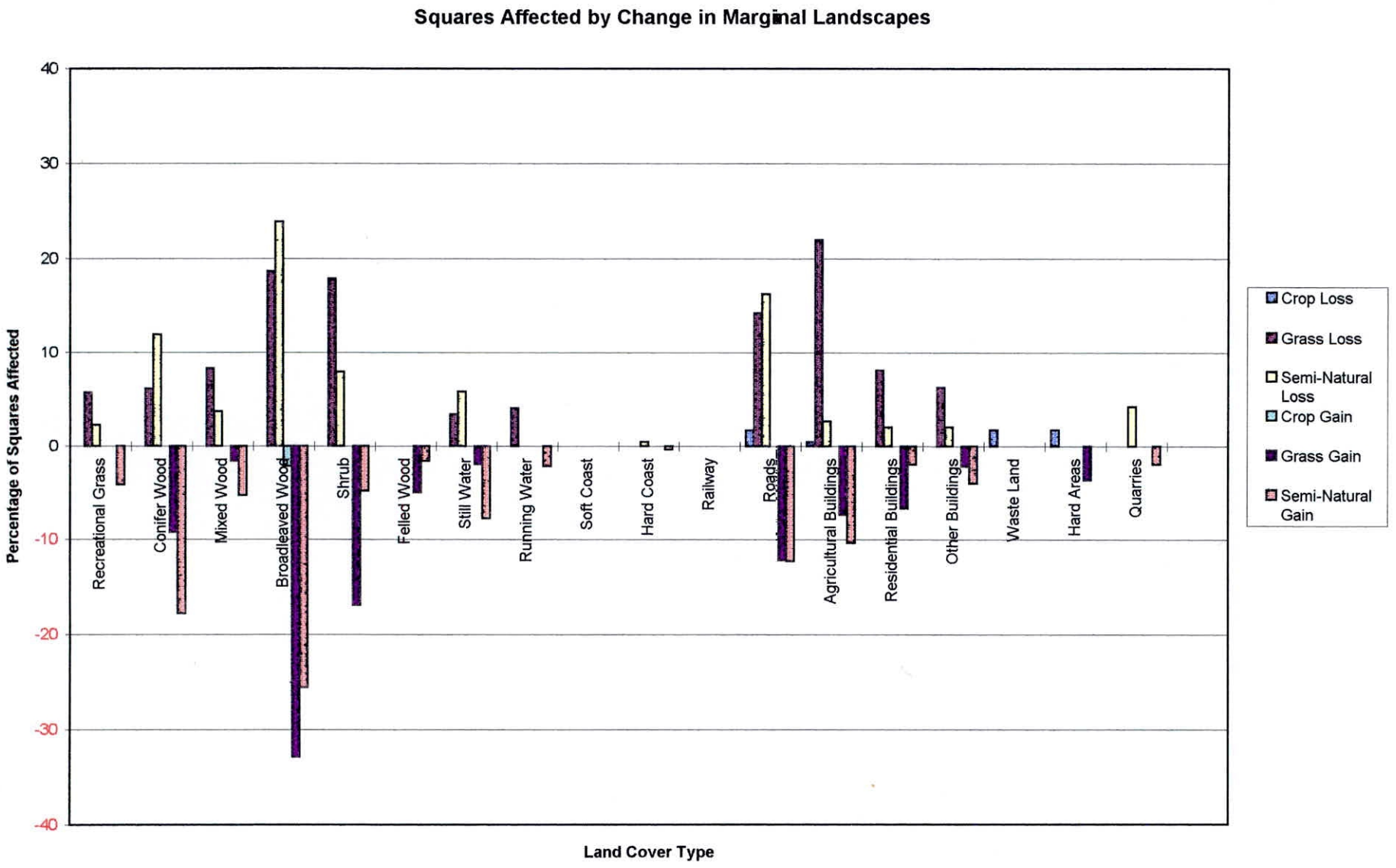
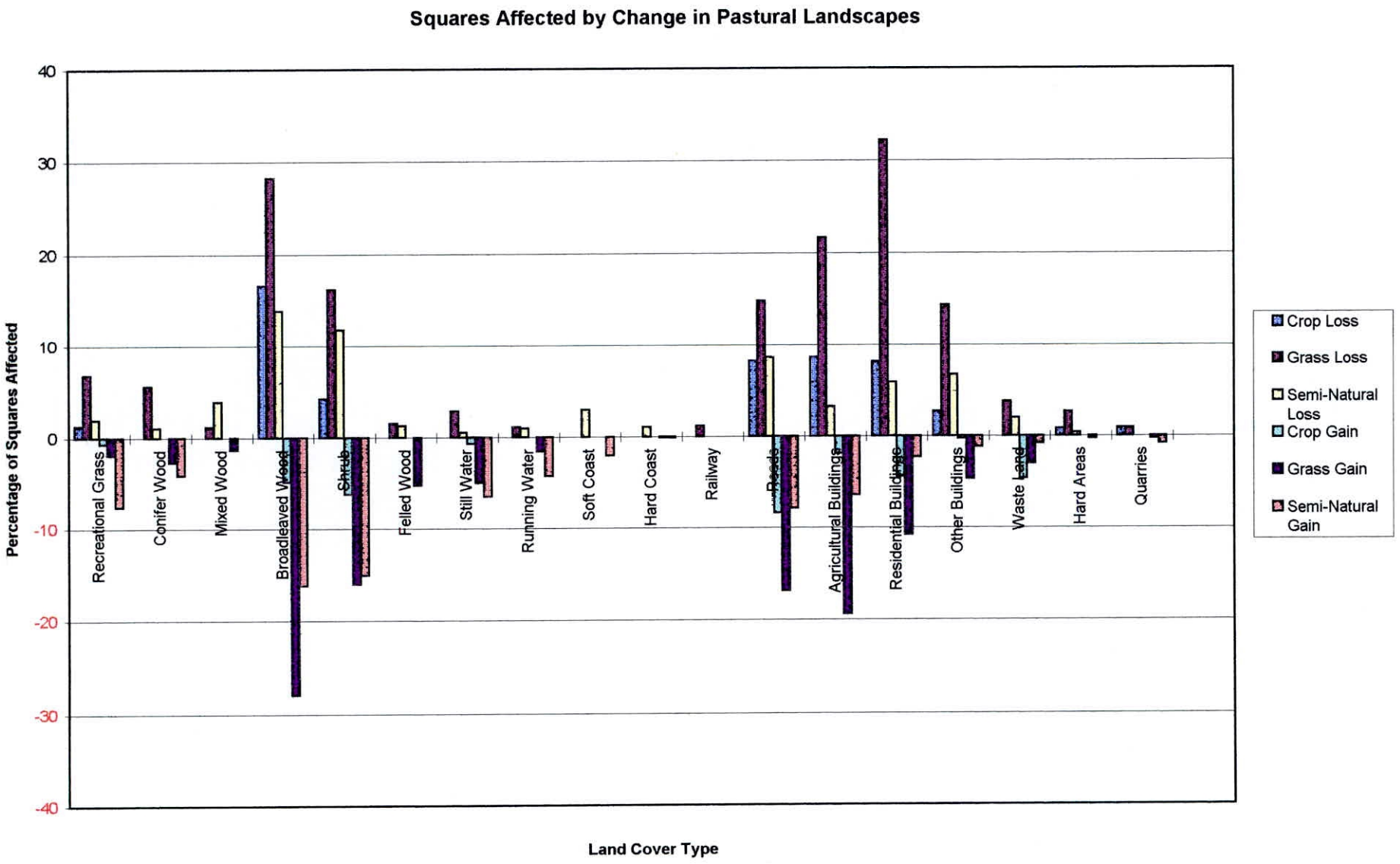
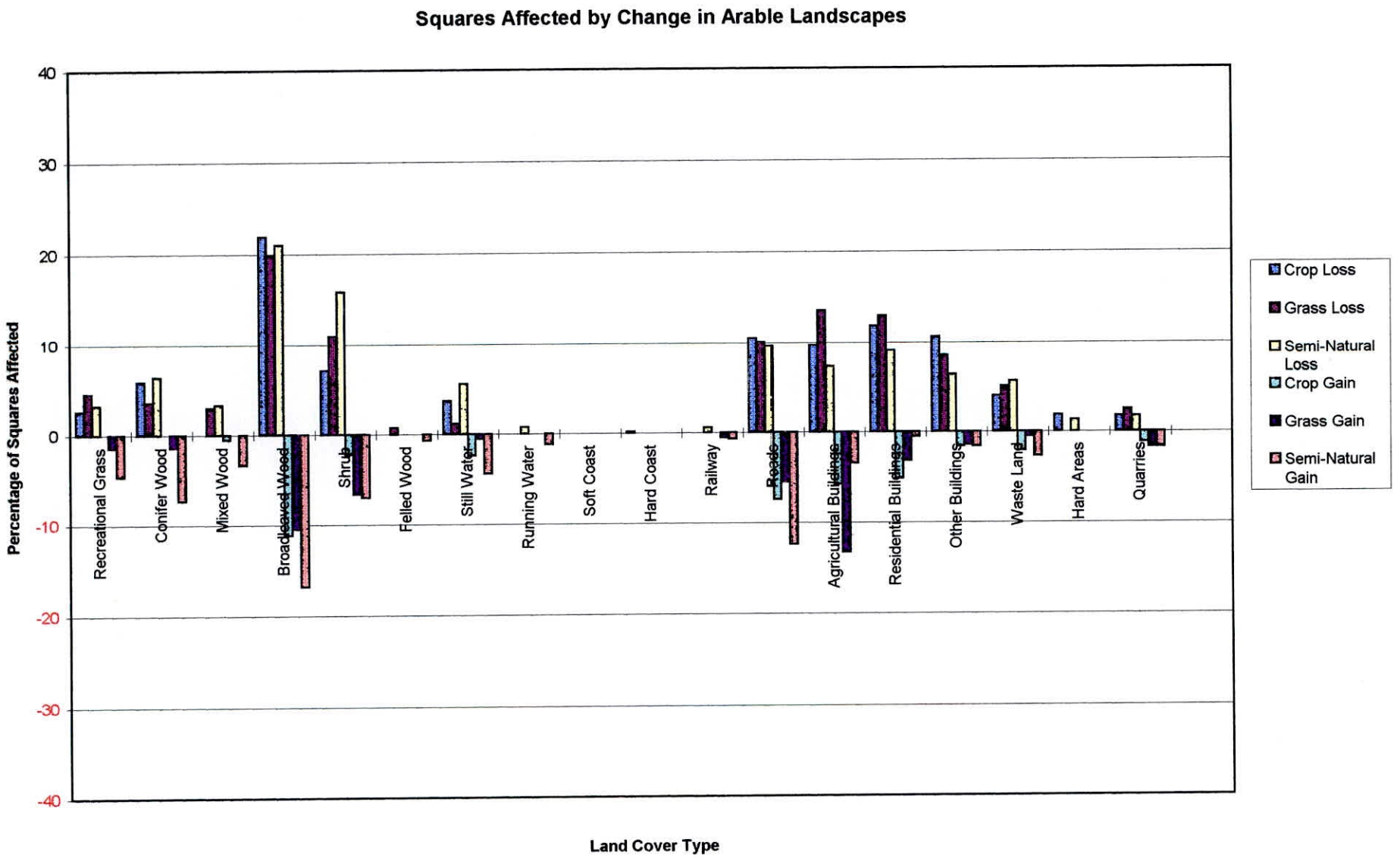
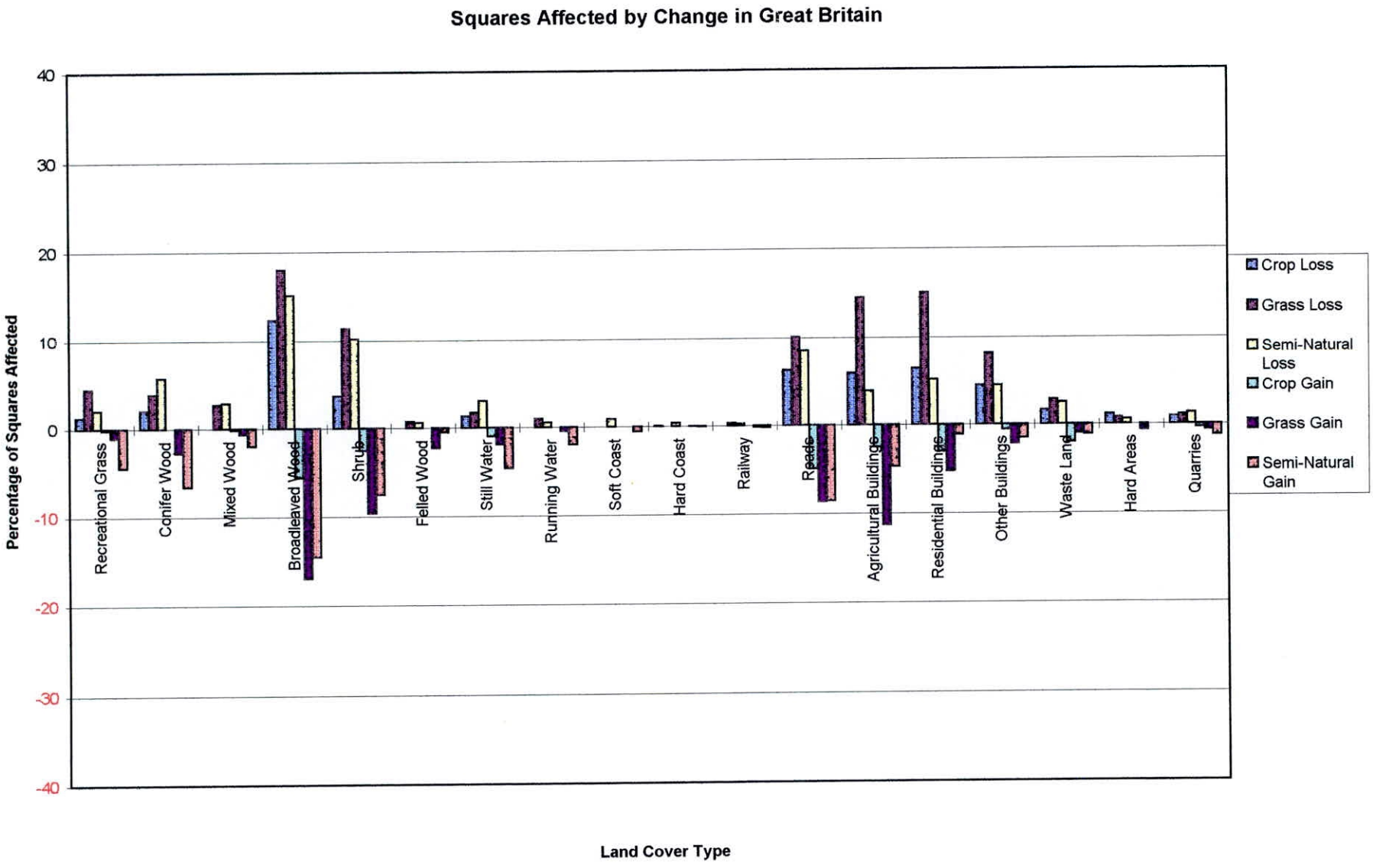
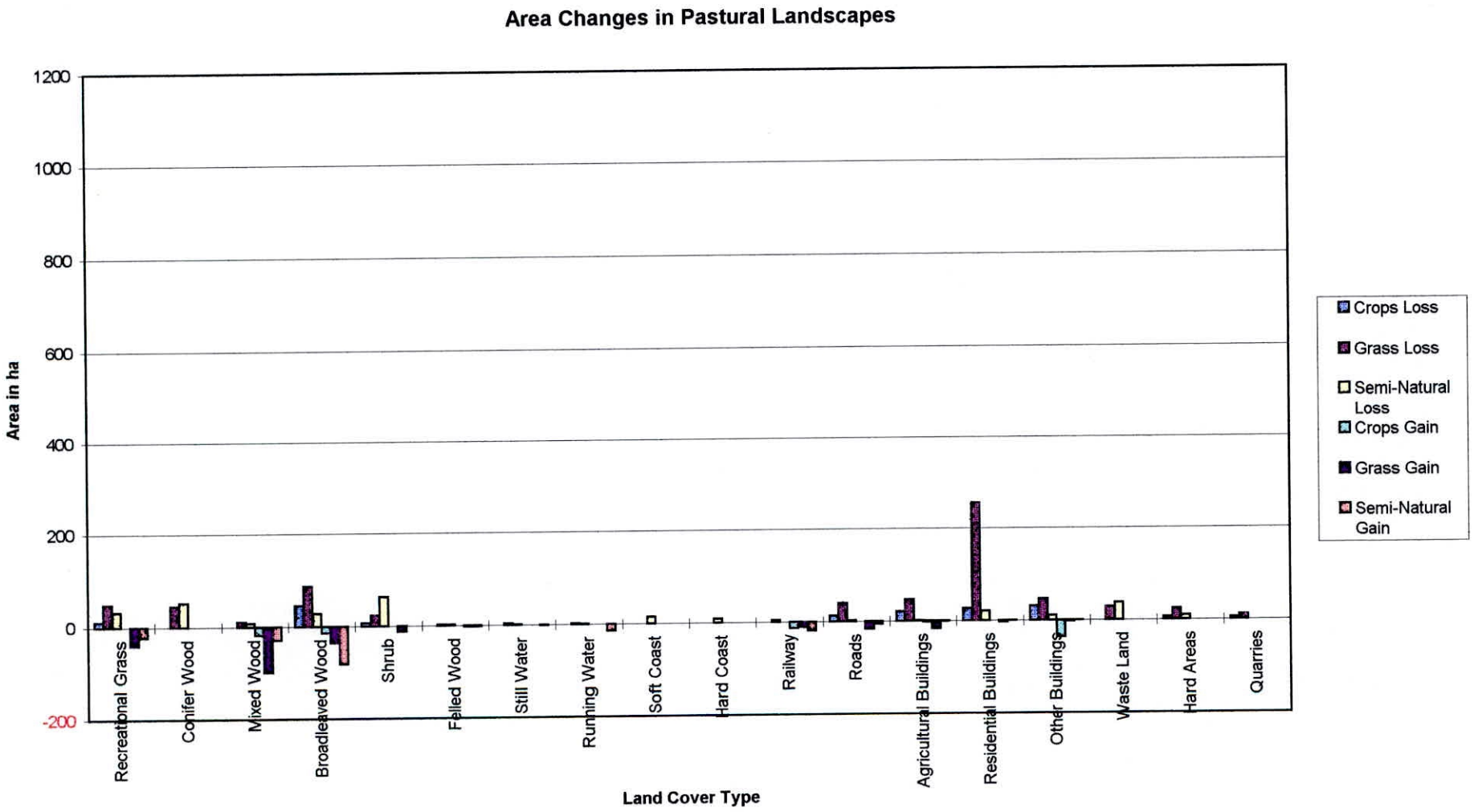
Grass Gain
Semi-Natural Gain

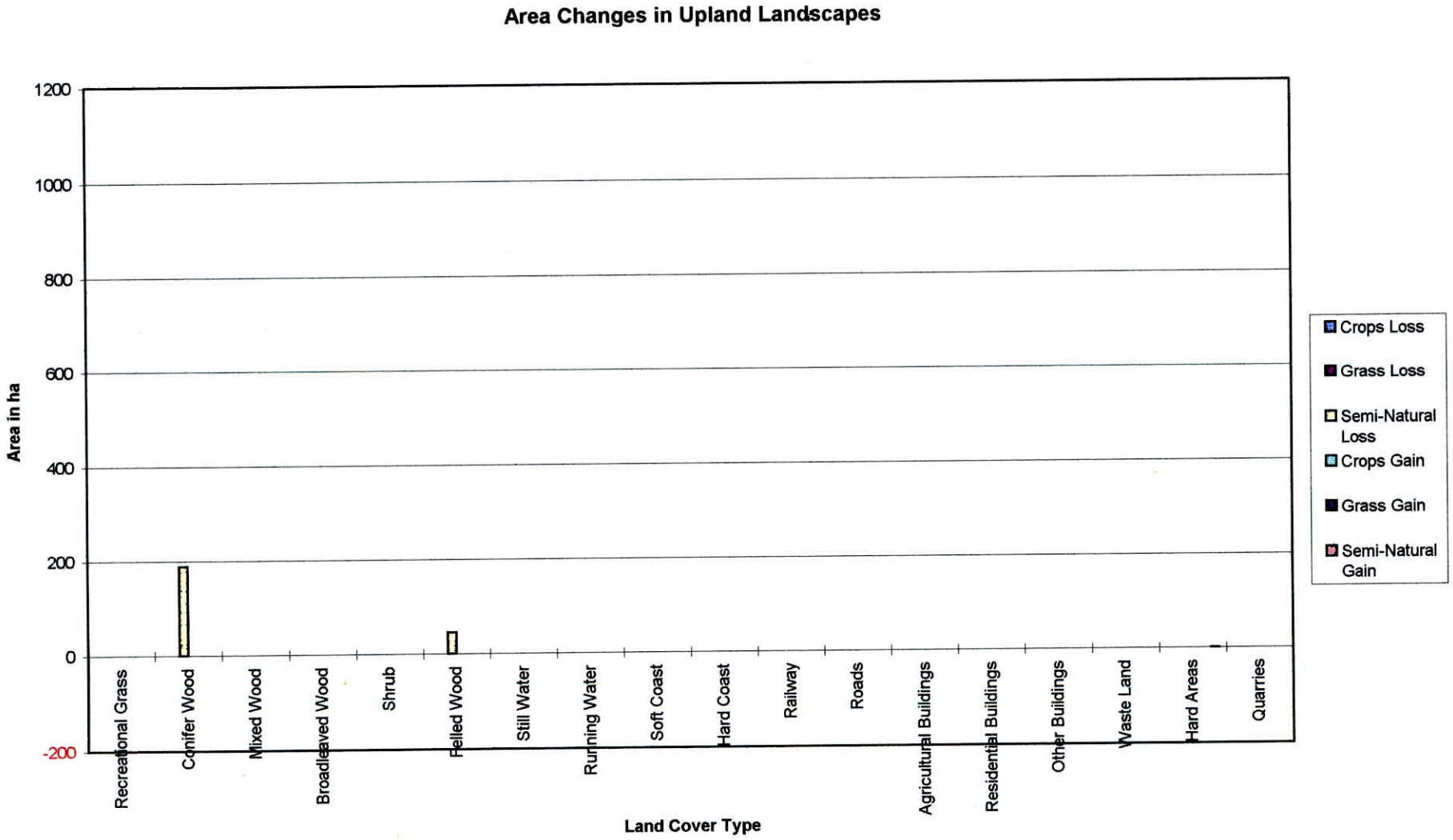

Squares Affected by Change in Marginal Landscapes
Percentage of Squares Affected
40
30
20
10
0
-10
-20
-30
-40
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
Still Water
Running Water
Soft Coast
Hard Coast
Railway
Roads
Agricultural Buildings
Residential Buildings
Other Buildings
Waste Land
Hard Areas
Quarries
Land Cover Type
Crop Loss
Grass Loss
Semi-Natural Loss
Crop Gain
Grass Gain
Semi-Natural Gain

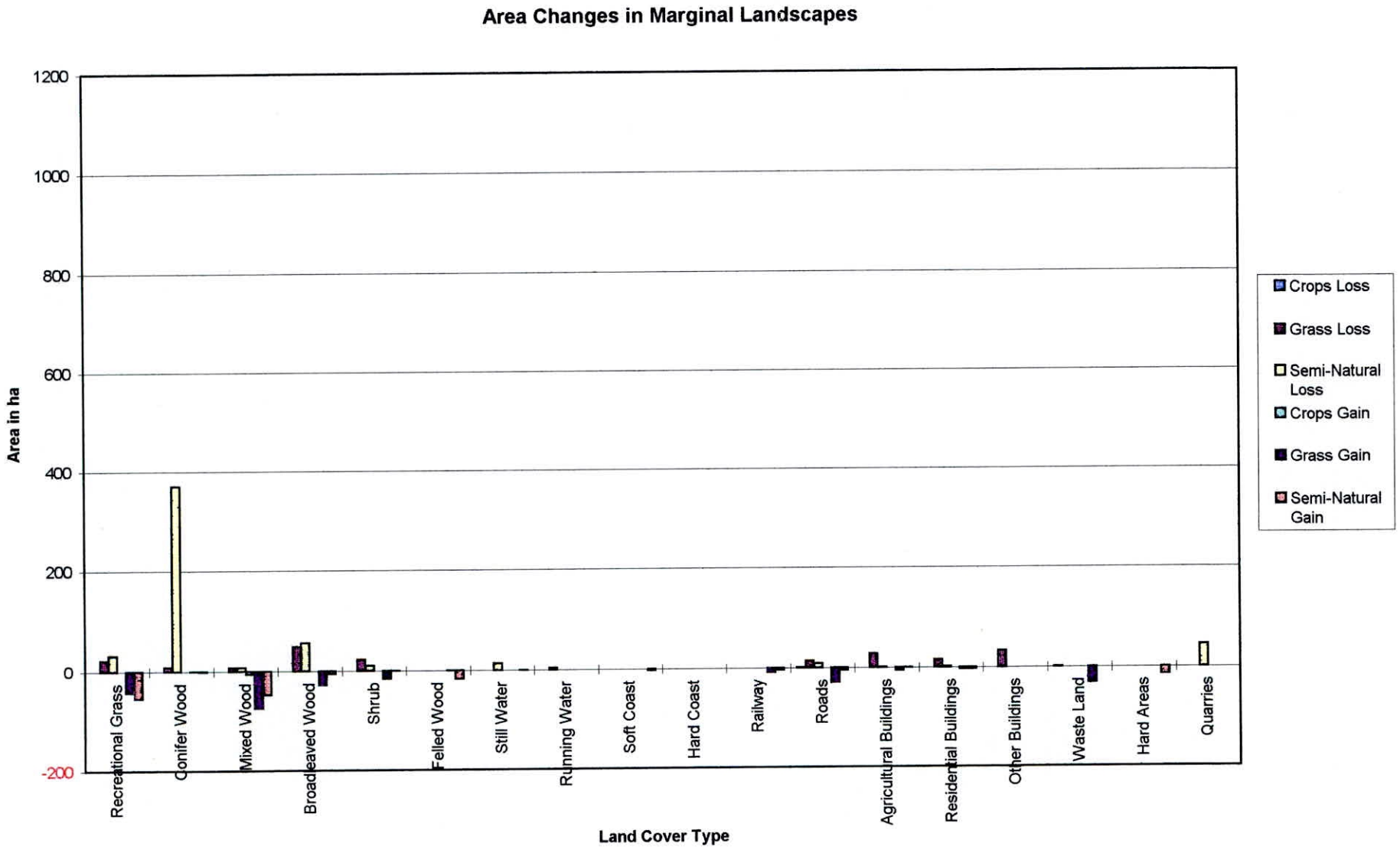

Squares Affected by Change in Pastural Landscapes
Percentage of Squares Affected
40
30
20
10
0
-10
-20
-30
-40
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
Still Water
Running Water
Soft Coast
Hard Coast
Railway
Roads
Agricultural Buildings
Residential Buildings
Other Buildings
Waste Land
Hard Areas
Quarries
Land Cover Type
Crop Loss
Grass Loss
Semi-Natural Loss
Crop Gain
Grass Gain
Semi-Natural Gain

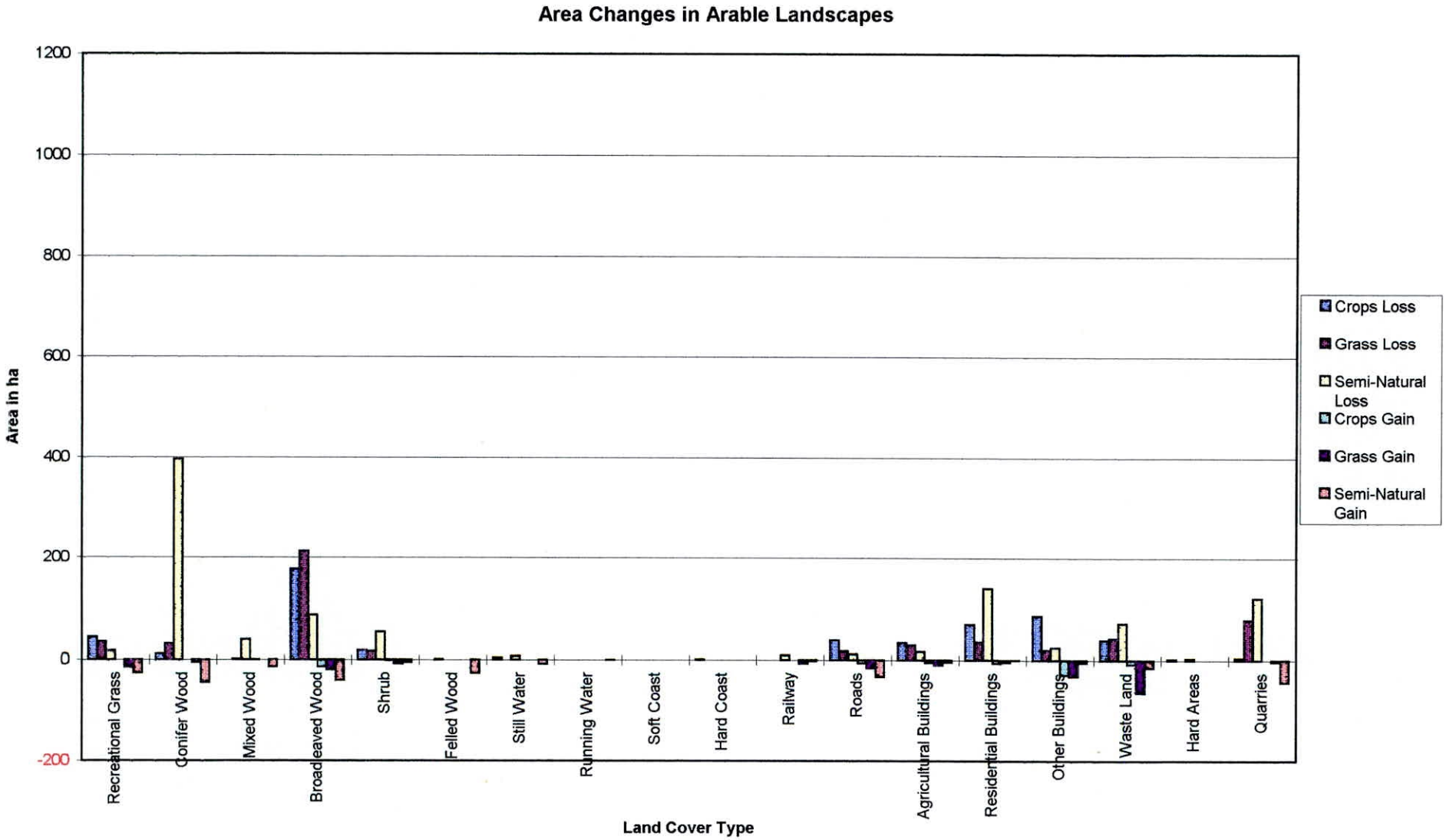

Squares Affected by Change in Arable Landscapes
Percentage of Squares Affected
40
30
20
10
0
-10
-20
-30
-40
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
Still Water
Running Water
Soft Coast
Hard Coast
Railway
Roads
Agricultural Buildings
Residential Buildings
Other Buildings
Waste Land
Hard Areas
Quarries
Land Cover Type
Crop Loss
Grass Loss
Semi-Natural Loss
Crop Gain
Grass Gain
Semi-Natural Gain

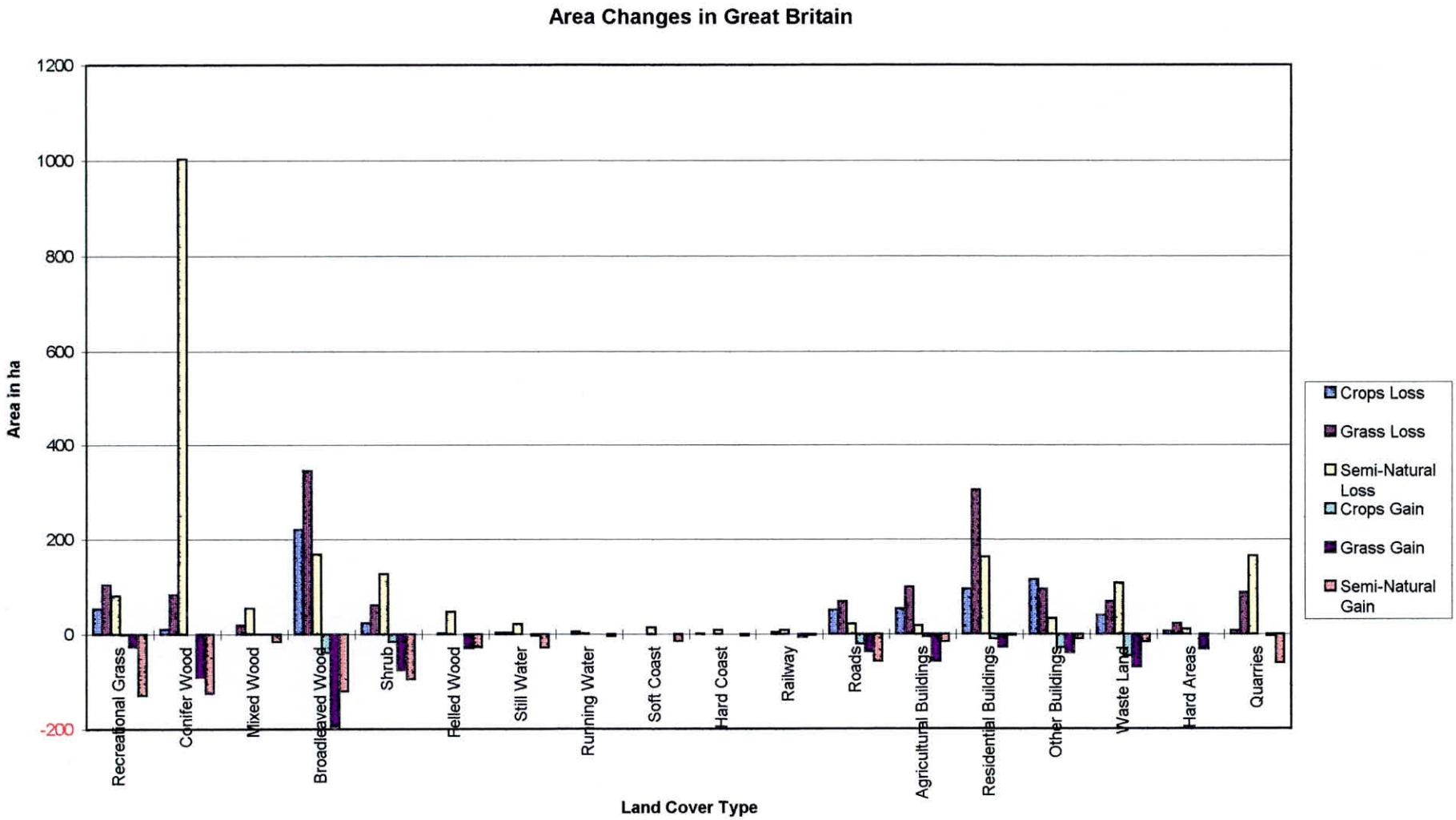

Squares Affected by Change in Great Britain
Percentage of Squares Affected
40
30
20
10
0
-10
-20
-30
-40
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
Still Water
Running Water
Soft Coast
Hard Coast
Railway
Reeds
Agricultural Buildings
Residential Buildings
Other Buildings
Waste Land
Hard Areas
Quarries
Land Cover Type
Crop Loss
Grass Loss
Semi-Natural Loss
Crop Gain
Grass Gain
Semi-Natural Gain


Area Changes in Pastural Landscapes
Area in ha
1200
1000
800
600
400
200
0
-200
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
Still Water
Running Water
Soft Coast
Hard Coast
Railway
Roads
Agricultural Buildings
Residential Buildings
Other Buildings
Waste Land
Hard Areas
Quarries
Land Cover Type
Crops Loss
Grass Loss
Semi-Natural Loss
Crops Gain
Grass Gain
Semi-Natural Gain


Area Changes in Upland Landscapes
1200
1000
800
600
400
200
0
-200
Area in ha
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
Still Water
Running Water
Soft Coast
Hard Coast
Railway
Roads
Agricultural Buildings
Residential Buildings
Other Buildings
Waste Land
Hard Areas
Quarries
Land Cover Type
Crops Loss
Grass Loss
Semi-Natural Loss
Crops Gain
Grass Gain
Semi-Natural Gain


Area Changes in Marginal Landscapes
1200
1000
800
600
400
200
0
-200
Area in ha
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
Still Water
Running Water
Soft Coast
Hard Coast
Railway
Roads
Agricultural Buildings
Residential Buildings
Other Buildings
Waste Land
Hard Areas
Quarries
Land Cover Type
Crops Loss
Grass Loss
Semi-Natural Loss
Crops Gain
Grass Gain
Semi-Natural Gain


Area Changes in Arable Landscapes
1200
1000
800
600
400
200
0
-200
Area in ha
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
Still Water
Running Water
Soft Coast
Hard Coast
Railway
Roads
Agricultural Buildings
Residential Buildings
Other Buildings
Waste Land
Hard Areas
Quarries
Land Cover Type
Crops Loss
Grass Loss
Semi-Natural Loss
Crops Gain
Grass Gain
Semi-Natural Gain


Area Changes in Great Britain
1200
1000
800
600
400
200
0
-200
Area in ha
Recreational Grass
Conifer Wood
Mixed Wood
Broadleaved Wood
Shrub
Felled Wood
Still Water
Running Water
Soft Coast
Hard Coast
Railway
Roads
Agricultural Buildings
Residential Buildings
Other Buildings
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Crops Loss
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