Environment Agency

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Addressing environmental inequalities: flood risk, waste management and river water quality in Wales

Science Report: SC020061/SR5

SCHO0507BMRX-E-P

The Environment Agency is the leading public body protecting and improving the environment in England and Wales.

It's our job to make sure that air, land and water are looked after by everyone in today's society, so that tomorrow's generations inherit a cleaner, healthier world.

Our work includes tackling flooding and pollution incidents, reducing industry's impacts on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats.

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Science at the Environment Agency

Science underpins the work of the Environment Agency. It provides an up-to-date understanding of the world about us and helps us to develop monitoring tools and techniques to manage our environment as efficiently and effectively as possible.

The work of the Environment Agency's Science Group is a key ingredient in the partnership between research, policy and operations that enables the Environment Agency to protect and restore our environment.

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- **Setting the agenda**, by identifying where strategic science can inform our evidence-based policies, advisory and regulatory roles;
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- **Delivering information, advice, tools and techniques**, by making appropriate products available to our policy and operations staff.

Steve Killeen
Head of Science

Executive Summary

Addressing environmental inequalities is a major theme of the UK sustainable development strategy and one of the three principles of the Environment Agency's social policy. Issues of environmental inequality are beginning to receive more attention in Wales. This report examines the three policy areas of flood risk, waste management and river water quality, and considers how issues of environmental inequality, related in particular to social deprivation, may arise and be responded to. This work builds on previous analyses undertaken for the Environment Agency on air quality and Integrated Pollution Control sites in Wales.

This is one of five reports produced as part of a research project commissioned by the Environment Agency. The overall project looked mainly at environmental inequalities in relation to flood risk, waste management, water quality and cumulative impacts, with a report produced on each of these topics and data analysis undertaken for England. This fifth report presents data analysis for Wales and sets this within the Welsh policy context. A separate report has been produced on Wales partly because of the policy context in Wales, but also because the data analysis for Wales had to be undertaken on a different spatial basis to that for England.

This report should be read in conjunction with those sections of the other reports that provide background on:

- environmental justice and inequality;
- the nature of social impacts from waste management, water quality and flooding;
- the general UK policy context for each of these topics.

Aims of the project
The main aims of this Environment Agency science project were to:

- examine how flood risk, waste sites and river water quality are distributed in relation to patterns of social deprivation in Wales;

- consider and evaluate the policy context for addressing inequalities in relation to flooding, waste management and river management in Wales;

- make policy recommendations relating to the patterns of environmental inequality identified in Wales and the policy context for addressing these.

Methodology
A review of the documents on relevant policy measures in each of the three areas was undertaken combined with telephone interviews with the main people involved in policy-making. A GIS-based data analysis was also carried out to examine the deprivation characteristics of populations in Wales living:

- within and outside delineated flood risk areas;
- close to waste facilities of different types;
- near river stretches with different biological water quality levels.

However, there are important methodological limitations that need to be taken into account when interpreting results.

Flood risk and environmental inequality
Deprived neighbourhoods are likely to be particularly hard hit by the impacts of flooding. However, such neighbourhoods are not all the same and a number of factors influence the degree of impact.

The GIS analysis of the deprivation profile of people at risk from flooding in Wales does not suggest that the most deprived are more at risk (in absolute or relative numerical terms) than other population groups. The least deprived are least at risk, but the highest proportions of people in flood risk areas are from the middle of the deprivation range.

Flood management policy in Wales does not therefore have to face up to the situation of having large numbers of people already experiencing social and economic deprivation in flood risk zones – as is the case in England for sea flooding. But where deprivation and flood risk do coincide in Wales, there is still a need for appropriate policies to be applied that are sensitive to social differences and vulnerabilities.

Flood risk policy and management in Wales already seeks to take account of the social consequences of flooding through:

- use of different methods of communication;
- giving priority to flood protection spending in deprived Objective 1 areas;
- changes to risk assessment methodologies and flood defence appraisal criteria;
- aspects of flood resilience measures and land use planning.

The following recommendations are made in relation to flood risk in Wales:

- Flood policy and management at all levels should continue to develop in ways that recognise the social impacts of flooding on different social groups.

- Interactions between processes of environmental, social and economic change and how these might increase vulnerabilities for particular parts of society in the future should be identified and policy implications considered.

- The impact and significance of flood risk management policy measures and their effectiveness in taking account of social impacts and vulnerability should be monitored carefully.

- Opportunities should be identified for tackling environmental and social issues together – building local capacity and tackling flood risk problems and social exclusion simultaneously.

- As the Environment Agency Flood Map is refined, further analysis of the impacts of flooding on different social groups in areas protected by flood defences should be undertaken.

- Targeted information and advice to vulnerable groups on flooding should be developed in collaboration with national/local agencies and organisations that work

with particular social groups and have local knowledge.

Waste management and environmental inequality

The Welsh Assembly Government considers waste management to be Wales' biggest environmental problem. Several waste streams pose particular problems for the Welsh context. Many new facilities will be required to implement policies to reduce the proportions of waste sent to landfill and to increase levels of recycling and recovery.

Waste facilities have a range of potential social impacts (both positive and negative), which vary significantly by type, size and capacity of waste facility. The extent to which impacts may affect particular social groups is uncertain, with little specific evidence about the social differentiation of impacts from waste management.

The GIS analysis was exploratory and provided only an initial indication of the association between waste facility location and deprivation in Wales. Methodological problems associated with the analysis include:

- the use of circular buffers around sites to measure population characteristics;
- the use of grid reference points to locate sites that vary enormously in size and shape;
- issues with aspects of waste site data, e.g. what the data do and do not measure, consistency of data collection and the time periods for which data are available.

For these reasons, it would be wrong to use the results to indicate numbers of people who are suffering harm or who are at risk from a nearby waste site, or even to imply any form of social impact due to proximity.

With these caveats in mind, the analysis found that waste sites in Wales have a very different geography. The urban locations of recycling and waste transfer sites mean that not only is the total number of people living near to them high, but also that they tend to have higher proportions of deprived people living near them than the less deprived. Other sites, particularly landfills, are located further away from populations; the total number people living in their vicinity is low and not biased towards the deprived.

The national waste strategy, *Wise about Waste*, is based on the proximity principle, the waste hierarchy and the notion of self-sufficiency. This embodies certain tensions, particularly with regard to facility siting. Because urban areas produce the most waste and have the best transport infrastructure, the proximity principle and the self-sufficiency principle will inevitably lead to a tendency for new waste facilities to be sited in areas that are already home to other waste sites. The legacy of industrial location in large urban areas, plus the fact that this is where the majority of deprived communities can be found, suggests that there will continue to be a spatial co-location between waste sites and deprived communities.

In addition, the operation of the waste hierarchy and the recommendation that waste should be reduced, reused, recycled or recovered in preference to disposal may favour certain types of responses over others. For example, the increased reliance on recycling as a means of managing waste has its own potential consequences with regard to site location and operation, with potentially a greater spatial dispersal of smaller sites.

The following recommendations are made in relation to waste management in Wales:

- Further research is needed to improve our understanding of the social impacts and risks relating to geographical proximity to environmental impacts/hazards.

- Continued research on cumulative impacts and particularly the extent to which they can be (a) identified, (b) assessed and (c) incorporated into meaningful policy is urgently required.

- There is a need to better understand how environmental equity is taken into account in waste planning, siting and licensing decisions (particularly through existing assessment approaches) and to identify how decisions in this context could be enhanced.

- A better understanding is needed of public attitudes and behaviours towards different waste management options such as recycling, rates of which are lowest in deprived and low-income areas.

- The development of future waste management scenarios should take account of the implications of different waste management options, their social impacts and implications for environmental equity under different resource use and waste generation conditions.

- Consideration should be given to the needs of excluded groups and deprived communities who will require access to additional resources (including information) and support if they are to make effective use of opportunities for participation in waste management decisions.

River water quality and environmental inequality
There is little specific literature on the social impacts of poor river water quality. What exists identifies:

- impacts related to the health effects of coming into contact with contaminated river water;
- the economic impacts associated with poor river water quality (and conversely the economic benefits that come in areas where water quality is good);
- aesthetic and nuisance impacts;
- positive benefits associated with recreational use of the river environment.

Despite the generally good quality of river water in Wales relative to the rest of the UK, there are still some pressing water quality issues. Indeed, the initial characterisation of water bodies in Wales as part of the Water Framework Directive suggests that about 90 per cent of Welsh water bodies may be at risk of not meeting the Directive's environmental objectives.

The GIS deprivation and river water quality analysis used an improved methodology compared with previous studies. Even so there are still significant methodological limitations including:

- the use of the biological water quality indicator;
- the choice of 600 m as a buffer distance and its application to all rivers regardless of size;
- the lack of data on access to the river environment;

- the necessary assumption that deprivation does not vary within an electoral division.

The analysis must therefore be taken as preliminary and exploratory. It is also important to not simplistically equate numbers of people living near to rivers with numbers of people experiencing good or bad impacts on their quality of life.

With these caveats in mind and noting that river water quality in Wales is generally good (95 per cent of people live near to a grade A, B, or C river and the lengths of grade E and F are very low), the analysis found that the most deprived populations are more likely than others to live near to a river in Wales. Within this overall pattern there is also evidence that, as river water quality worsens, the concentration towards deprived people living near to those rivers increases.

Although the data analysis found some evidence of a pattern of inequality in the physical association between poor river water quality and deprivation for Wales, this does not necessarily mean that this association is significant either for the management of water quality, or for the life experience of deprived people living near poor quality rivers.

Careful evaluation of the policy implications of evidence of inequality is necessary given that:

- the social impacts of river water quality are multidimensional and complex;
- river management also has to take account of multiple considerations and drivers, some of which are ecological and economic rather than social in nature.

Concerns about environmental inequality have not, as yet, featured significantly in policies for the management of river water quality. The Water Framework Directive is beginning to promote a more integrated river basin approach that seeks to address environmental, economic and social issues within a sustainability framework.

Policies that target protection and improvement on the worst quality rivers may already be benefiting deprived communities the most. However, it is also possible that decision-making and appraisal processes do not take sufficient account of social concerns.

The following recommendations are made in relation to river water quality in Wales:

- The multidimensional social impacts of a poor river environment and their relationship to issues of inequality need to be considered and evaluated further.

- The policy significance of the evidence of an association between poor biological river water quality and deprivation needs to be evaluated carefully.

- Further work should be undertaken to explore the factors that may explain the association between poor river water quality and deprivation, including the role of decision-making processes in river management.

- The case for further targeting of policy interventions on poor quality rivers in deprived areas and the form that this could take needs to be examined.

- The management of river water quality needs to be pursued in a manner which provides realistic and co-ordinated solutions to achieve successful partnerships with a range of stakeholders, including members of the public.

- Further research is needed to:
  - improve our understanding of the social impacts of water quality;
  - explore inequalities in relation to drinking and bathing water quality;
  - develop more sophisticated methodologies for analysing patterns of inequality in relation to river water quality;
  - analyse changing patterns of water quality over time.

Contents

1 Introduction

This is one of five reports produced as part of a research project commissioned by the Environment Agency, which examined environmental inequalities in relation to flood risk, waste management, water quality and cumulative impacts, with a report produced on each of these topics. This fifth report is a supplement that presents data analysis and sets this within the policy context related to Wales. A separate report has been produced for Wales partly because of the policy context in Wales, but also because the data analysis for Wales had to be undertaken on a different spatial basis to that for England.

This report should be read in conjunction with the parts of the other four reports (Damery *et al.* 2006a, Damery *et al*. 2006b, Stephens *et al*. 2006, Walker *et al.* 2006), which provide background on:

- environmental justice and inequality;
- the nature of social impacts from waste management, water quality and flooding;
- general UK policy context for each of these topics

Previous research for the Environment Agency examined the relationship between the location of Integrated Pollution Control (IPC) sites, air quality and flood risk and patterns of social deprivation in Wales (Walker *et al*. 2003). This report builds on this work and wider environmental justice literature as reviewed for the Department for Environment, Food and Rural Affairs (Defra) by Lucas *et al*. (2004).

This section introduces the general context and objectives for the project before outlining the specific objectives for this report and the methodology used.

Section 2 outlines the background to the Welsh Assembly Government (WAG) and its powers and responsibilities regarding environmental management and policy. Although the Welsh Assembly Government is unable to create primary legislation and many aspects of environmental management are driven by European directives that apply equally to all parts of the UK, there are some divergences between the UK policy context for flooding, water quality and waste and the Welsh approach.

Section 3 discusses the methodology used for analysing flooding, waste and river water quality data sets against deprivation. Sections 4–6 discuss the Welsh context, the general and specific policy context, and the results of data analysis for flood risk, waste management and river water quality. Section 7 outlines both generic recommendations (repeating some of those contained in the associated reports) and those that relate specifically to the Welsh context.

1.1 Context for the project

The Environment Agency has a wide-ranging role in protecting and improving the environment in the context of achieving sustainable development. It is developing a strong social dimension to its work, recognising that social exclusion can have important environmental dimensions and that all people should have a right of access to a decent environment and to essential environmental resources.

The Environment Agency's social policy is defined through three principles:

- understanding and communicating the social impacts of its work, including opportunities to deliver combined environmental and social benefits;
- addressing environmental inequalities;
- transparency, participation and access to information.

It has also developed a social appraisal framework (Chalmers and Colvin 2005), which subdivides its social policy into six themes:

- promoting health, safety and well-being;
- improving local communities;
- promoting social justice and social inclusion;
- demonstrating the Environment Agency's corporate social responsibility;
- increasing access to information and participation;
- capacity building and learning.

This project focuses on addressing environmental inequalities. This is one of the Environment Agency's three social policy principles and figures centrally in the 'promoting social justice and social inclusion' theme of its appraisal framework. In a recent position statement, the Environment Agency makes it clear that tackling environmental inequalities and ensuring access for all people to a good quality environment is critical to sustainable development (Environment Agency 2004). The position statement sets out the role for the Environment Agency in this respect and calls for a series of policy solutions which include developing 'a better understanding of environmental inequalities and the most effective ways of addressing them'. This position statement builds on a programme of sustained attention given to questions of environmental inequality and social justice within the Environment Agency over the past five years. This has involved working with and responding to the allied agendas of other organisations within and outside government.

Examples of the ways in which the wider political and policy context has evolved over this period include:

- the work of non-governmental organisations (NGOs) such as Friends of the Earth (FoE), which have identified environmental justice as campaigning and research theme, with FoE Scotland in particular making environmental justice a key part of its advocacy work (Dunion 2003);

- a series of pamphlets and publications produced by NGOs, consultancies and political groups highlighting the linkages between the current Labour Government's priorities on social exclusion and the social dimensions of environmental concerns (e.g. Boardman *et al*. 1999, Jacobs 1999, Foley 2004);

- speeches by major political figures such as Jack McConnell, Scotland's first Minister, who in 2002 stated: 'For quality of life, closing the gap demands environmental justice too. That is why I said … that environment and social justice would be the themes driving our policies and priorities...' (McConnell 2002) and Tony Blair who argued in 2003 that 'by raising the standards of our local environments overall, we have the greatest impact on the poorest areas' (Blair 2003);

- programmes of work and reports by government departments and agencies exploring the connections between economic, social and environmental policy areas, e.g.
  - the Social Exclusion Unit work on transport and social exclusion (ODPM/Social Exclusion Unit 2003a);
  - the Sustainable Development Commission (2002) focusing on the connections between regeneration, poverty and environment;
  - the Neighbourhood Renewal Unit (NRU) reports on environmental exclusion (Brook Lyndhurst 2004) and achieving environmental equity through neighbourhood renewal (ODPM/NRU 2003b);

- the Wales Spatial Plan (WAG 2004c), which recognises the need to 'address poor environmental quality which often affects economically and socially disadvantaged communities in particular through degraded urban environments, as well as higher exposure to pollution' (p.13);

- the 1998 Aarhus convention (UNECE 1999), a pan-European treaty that aims to give substantive rights to all EU citizens on public access to environmental information, public participation in environmental decision-making and access to justice in environmental matters;

- the new shared framework for sustainable development *One Future – Different Paths* (Defra 2005a), which aims to 'ensure a decent environmental for all' and which has clear commitments to:
  - address and research environmental inequalities;
  - 'fairness' in the development of sustainable communities;

- the production of an Environment Strategy for Wales by the Welsh Assembly Government (WAG 2006), which sets out the direction for environmental management actions, including those that have social implications.

Within the Environment Agency, important indicators of policy evolution have included the debate on environmental equality at the 2000 Annual General Meeting and the report, *Our Urban Future* (Environment Agency 2002a) and *The Urban Environment* (Environment Agency 2002b), which provided some initial analysis of relationships between environmental quality and social deprivation.

A research project undertaken by Staffordshire and Leeds universities for the Environment Agency (Walker *et al.* 2003) explored evidence of inequalities and acted as a stimulus for debate (Chalmers and Colvin 2005) in three major areas of its work – flooding, industrial pollution and air quality. The research provided a literature review, scoping and gap analysis of potential topics for investigation, drawing on the expertise of a range of stakeholders. It provided an empirical analysis of environmental data sets against the Index of Multiple Deprivation (IMD) at ward level (separately for England and Wales) (NAW 2000, ODPM 2004) identifying varied patterns of inequality. In developing policy and research recommendations for this work, the research team emphasised:

- the need for careful consideration of methodological issues;
- the limits on what the analysis could reasonably conclude;
- the need for further research, including in the area of cumulative impacts.

There is now a growing body of related UK-based research examining questions of social distribution and environmental inequality. This has recently been reviewed in a Sustainable Development Research Network (SDRN) rapid research and evidence review for Defra (Lucas *et al.* 2004). This review found that the research base is interdisciplinary in nature, drawing on a diverse range of quantitative and qualitative research methods and approaches. The available evidence suggests that patterns of environmental injustice are varied and complex and that there is, therefore, a need for some caution in making claims of inequality and to be wary of over-generalisation.

However, there is mounting evidence that:

- environmental injustice is a real and substantive problem within the UK;
- problems of environmental injustice afflict many of our most deprived communities and socially excluded groups;
- both poor local environmental quality and differential access to environmental goods and services have a detrimental effect on the quality of life experienced by members of those communities and groups;
- in some cases, not only are deprived and excluded communities disproportionately exposed to an environmental risk, they are also disproportionately vulnerable to its effects;
- though more needs to be known about both the causes and impacts of environmental injustice, research is also needed to support the development and effective implementation of policy measures to address and ameliorate the impacts of environmental injustice.

This project adds to the research and evidence base that already exists in important areas of responsibility for the Environment Agency. It builds directly on previous research and will contribute to the commitment to further research made in the UK sustainable development strategy.

1.2 Overall objectives of the research project

The project aims to gain a better understanding of environmental inequalities and the most effective ways of addressing them. The project is divided into two parts:

Part 1 will:

- help the Environment Agency to understand the social impacts of waste management, flooding and water quality on deprived communities, and the policy context for addressing these;
- examine the social distribution of waste sites, areas at risk from flooding and river water quality, undertaking where possible analysis for England as a whole, for each of the English regions and for Wales;

- make recommendations for the most effective ways of addressing inequalities in relation to waste management, flooding and water quality, e.g. by identifying the policy interventions designed to address them with a range of stakeholders.

Part 2 will:

- help the Environment Agency to develop an initial understanding of the cumulative impacts of environmental issues in combination on deprived communities;

- identify ways of assessing the cumulative impacts of environmental inequalities, comparing their effectiveness;

- assess and propose an approach to undertaking local case studies that will bring together understanding of cumulative environmental inequalities and ways of addressing them.

1.3 Context and objectives of the Wales report

This report focuses on environmental inequalities in Wales and is one dimension of Part 1 of the overall research project. The work on cumulative impacts in Part 2 does not involve the analysis of data and has a generic rather than spatially specific remit.

A separate report on Wales was needed because:

- the project evolved from an initial focus on England;
- the data analysis undertaken for each of the environmental topics (waste, water and flooding) had to use a different version of the Index of Multiple Deprivation for different spatial units.

It is also important to consider ways in which the Welsh policy context differs to that for England. Many areas of environmental policy have come under the direct control of the Welsh Assembly Government since the Government of Wales Act 1998 established the National Assembly for Wales (NAW). As such, this report outlines the policy context in Wales for the management of flood risk, river water quality and waste, and highlights areas in which it differs from the English or UK case.

The specific objectives of this report are to:

- examine how flood risk, waste sites and river water quality are distributed in relation to patterns of social deprivation in Wales;

- consider and evaluate the policy context for addressing inequalities in relation to flooding, waste management and river quality management in Wales;

- make policy recommendations that relate to the patterns of environmental inequality identified in Wales and the policy context for addressing these.

The three environmental topics of flooding, waste and water quality were selected by the Environment Agency as concerns for which they had some regulatory responsibility and

which are potentially significant for the quality and safety of the environment in which people live.

1.4 Summary of methods

The overall project involved literature review, data analysis and a stakeholder workshop. Two research methods were applied to achieve the specific objectives of this report:

Review of the academic and policy literature
The literature review looked at the policy context for Wales for flooding, waste management and river water quality (wider ranging literature reviews can be found in the other reports). The review was informed by telephone interviews with people involved in each of these three areas of policy in Wales.

Data analysis
A GIS-based analysis was undertaken to examine patterns of distribution for the three environmental topics against the Index of Multiple Deprivation for Wales at electoral division level. The environmental datasets used in this analysis were:

- the Environment Agency's Flood Map 2005, differentiating between river and sea flooding. This analysis did not include sewer flooding, which is a serious potential problem in some areas and is not covered by the Flood Map;

- national REGIS (Regulation Information System) data on licensed waste facilities distinguishing between site type;

- the biological General Quality Assessment (GQA) indicator for the quality of river water stretches.

2 The Welsh Assembly Government and environmental inequality

2.1 The Welsh Assembly Government

The White Paper, *A Voice for Wales*, published by the UK Government in July 1997 outlined proposals for devolution in Wales and the establishment of a Welsh government (Welsh Office 1997). The essential structures and procedures for the Welsh Assembly Government are laid down in the Government of Wales Act 1998, which established the National Assembly for Wales. The National Assembly for Wales (Transfer of Functions) Order 1999 enabled the transfer of the devolved powers and responsibilities from the Secretary of State for Wales to take place on 1 July 1999.

As a result of this transfer of power, the Assembly Government decides on its own priorities and allocates the funds made available to it by HM Treasury. However, it does not have unlimited powers; Wales remains part of the UK, and the Secretary of State for Wales and Members of Parliament from Welsh constituencies continue to have seats at Westminster. The UK Government continues to set the framework for primary legislation (i.e. statutes and acts of parliament) in the UK and assumes the lead responsibility for policy areas not devolved to the Assembly Government.

The Assembly Government does not have the power to create primary legislation and all laws passed by Parliament in Westminster still apply to Wales. However, it has been successful in promoting 'Welsh-only' Bills and clauses in Bills, and the Government of Wales Act 2006 provides considerably more scope for the Assembly Government to define its legislative base. In addition, it is responsible under statute and European Community (EC) law for ensuring that the requirements of EC Directives (as implemented by primary and secondary legislation) are met in Wales.

Nevertheless, the Assembly Government can choose, within some limits, how it implements policies to ensure compliance with its obligations under UK and European law. It is also free to develop and implement policies that reflect the particular needs of the people of Wales. In many policy areas, the Assembly Government is seen as more progressive than its English counterpart. This is often due to the smaller geographical area of Wales compared with England, which in many respects makes the development and implementation of integrated policy easier to achieve.

2.2 The Welsh Spatial Plan and sustainable development

Planning in Wales is devolved to the Welsh Assembly Government. The most notable differences in the planning system compared with that operating in England are in:

- national guidance – *Planning Policy Wales* (WAG 2002a) and Technical Advice Notes (see below);
- the unitary and local development plan processes.

A further important difference is the two-tier system of governance, as all local authorities in Wales are unitary.

A major achievement by the Assembly Government is the development of a Welsh spatial planning framework. This reflects its commitment to develop and implement an integrated spatial plan for Wales that recognises:

- the importance of spatial planning as a tool for reconciling different policy strands that affect its various geographical areas;
- the role that land use planning can play in supporting different strategies relating to the use and sustainable development of land.

This planning framework encompasses both *Planning Policy Wales* (WAG 2002a) and the Wales Spatial Plan (WAG 2004c). *Planning Policy Wales* sets out the land use planning policies of the Assembly Government and is supplemented by a series of Technical Advice Notes (TANs). These are the Welsh equivalent of Planning Policy Guidance (PPG) in England. Procedural advice on planning matters is given in National Assembly for Wales/Welsh Office Circulars. *Planning Policy Wales*, TANs and policy circulars together make up Welsh national planning policy.

The Assembly Government is introducing legislative and policy instruments that aim to create a fully plan-led land use planning framework for Wales. This will be facilitated by the transition from Unitary Development Plans (UDPs) to Local Development Plans (LDPs) between 2006 and 2010.

The Wales Spatial Plan formalises a number of the Assembly Government's objectives and has been developed in the context of the wider EU spatial planning framework. One of the main objectives of the Spatial Plan addresses inequality and social exclusion by outlining a commitment to 'address poor environmental quality which often affects economically and socially disadvantaged communities in particular' (WAG 2004c, p.13). This objective is partly a response to the levels of deprivation that exist in Wales, the largest concentrations of which can be found in:

- the upper South Wales valleys (particularly in the former mining communities);
- parts of the major cities and towns;
- port and former heavy industrial areas.

Wales also has a long history of ethnic minority settlement, concentrated mainly around the South Wales former coal ports and in the major cities. In particular, Cardiff has two-fifths of the Welsh ethnic minority population and the greatest levels of ethnic diversity. Since 2000, large parts of Wales have benefited from European Union (EU) structural funding under the Objective 1 Programme, which aims to boost those regions whose gross domestic product (GDP) is significantly below the European average.

In addition to a strong and proactive planning framework, the Assembly Government has made the principles of sustainable development a central feature of all of its policy considerations. Its duties regarding equal opportunities and sustainable development are

outlined under the Government of Wales Act 1998; Sections 120 and 121 set out the duty to ensure that, in the execution of its functions, there should be equality of opportunity for all people and that sustainable development is promoted at all times.

The Assembly Government's 12 headline indicators of sustainable development are the same as those in the UK sustainable development strategy. But whereas in England sustainable development principles are a recommendation for policy, in Wales compliance with sustainability considerations is often a statutory requirement for the Assembly Government and associated bodies such as Environment Agency Wales. In particular, local planning authorities in Wales must take appropriate steps to demonstrate that their policies, operational practices and organisational cultures do not lead to any systematic unfairness in the treatment of any group of the population.

Since 1996, every Welsh local planning authority has been required to prepare a UDP for its area. UDPs were intended to provide a firm basis for rational and consistent decisions about land use planning, giving developers and the public a clear indication of the types of development to be permitted at a given location. They were also meant to explicitly consider social considerations relevant to land use issues such as the relationships between planning policies and proposals to social needs and problems (WAG 2001a). This included the likely impact of policies and proposals on whole communities, men and women, children, families, or on specific social groups such as the elderly, members of ethnic minorities, disabled people, single parent families and disadvantaged and deprived people.

However, Section 62 of the Planning and Compulsory Purchase Act 2004 now requires each authority in Wales to prepare an LDP for its area. These will supersede UDPs and all other existing development plans. The introduction of LDPs represents a further step towards integration of the land use planning system in Wales and the achievement of sustainability in planning, since LDPs should be more closely integrated with communities and community strategies. Community Strategies should provide the overarching strategic framework for all plans and strategies within each local authority, facilitating:

- an integrated approach to future sustainable development;
- a co-ordinated approach to community planning, allowing LDPs to be based on a clear understanding of community needs,
- potential to resolve conflicts between community aspirations and national policy objectives by engaging a wide range of stakeholders.

2.3 Environment Agency Wales

Environment Agency Wales carries out much of the environmental quality monitoring and assessment, as well as the issuing of permits and licences in Wales. It is an Assembly Sponsored Public Body (ASPB), which means that it receives most of its funding and direction from the Welsh Assembly Government, and reports directly to it. As part of the Environment Agency for England and Wales, it also benefits from the resources and expertise of the larger organisation. Within the Welsh environmental sector, Environment Agency Wales is able to pursue solutions tailored to meet Welsh needs using the funds allocated to the sector by the Assembly Government.

The Government of Wales Act 1998 requires the Assembly Government to produce a Welsh Sustainable Development Scheme setting out how it proposes to implement its

duty to promote sustainable development during its work. Under Section 5D of the Scheme there is a commitment to 'respecting environmental limits, so that resources are not irrecoverably depleted, or the environment is irreversibly damaged. This includes promoting the sustainable use of natural resources' (WAG 2000, p.2). This means that other bodies with which the Assembly Government works must:

- promote sustainable development actively through their corporate planning and policy development, particularly in key areas such as grant schemes, consultation, guidance and advice to the Assembly Government and others;

- work with each other and Assembly Government partners wherever possible.

Environment Agency Wales has a statutory duty to work to the principles of sustainable development and, under the Sustainable Development Scheme, it must:

- protect and enhance the environment in a way which takes into account economic and social considerations;

- be an independent advisor on environmental matters affecting policy making;

- advise the Assembly Government, other organisations and the public so as to facilitate decisions conducive to sustainable development.

The functions that the Environment Agency must perform in Wales are the same as those of the larger Environment Agency body.

3 Methodology for data analysis

3.1 Introduction

This section discusses the datasets and methods used to examine the relationship between deprivation and flood risk, waste sites and river water quality in Wales. An outline of the common framework of deprivation and household location data is followed by subsections on flooding, waste and water quality, and a discussion of the use of indicators. General methodological issues for environmental justice research are reviewed by Walker *et al.* (2003a) and are also discussed in the related reports from this project.

3.2 Population and deprivation

3.2.1 Datasets

The spatial unit of analysis used for population and deprivation is the electoral division, of which there are 865 in Wales. Electoral divisions are designed to contain roughly equal populations (approximately 3,500 people); their physical size is therefore dependent on population density, with small electoral divisions in urban centres and large electoral divisions in rural areas.

Deprivation was represented using the Welsh Index of Multiple Deprivation 2000 (NAW 2000), which is the most recent version currently available. The IMD 2000 is based on six separate domains:

- income deprivation;
- employment deprivation;
- health deprivation and disability;
- education, skills and training deprivation;
- housing deprivation;
- geographical access to services.

Each domain score is produced from a total of 33 indicators. The physical environment is not represented in the IMD 2000 and hence there is no danger of auto-correlation in the environmental equity analysis.

For each electoral division, a score is produced for each indicator and then domain. Individual domain scores are then weighted and summed to create the overall IMD score. This IMD score forms the basis for a final ranking of electoral divisions. A map showing the distribution of the IMD2000 across electoral divisions in Wales is given in Appendix 1. This map highlights:

- the concentration of the least deprived areas in the south-east of Wales including around Cardiff, and to a lesser extent in the north-east;
- the concentration of the most deprived areas in the ex-coal mining valleys of South Wales.

Given the nature of the IMD, deprivation data in this project are presented consistently in the form of deprivation deciles that maintain the ranked ordinal form of the data. Details about the construction of these deciles are given in Section 3.2.2.

To improve the spatial resolution of the analysis, the study used Ordnance Survey's Address-Point®, spatial dataset which records every residence (postal delivery address) in Wales (http://www.ordnancesurvey.co.uk/oswebsite/products/addresspoint/). This is a point dataset that gives approximately 98 per cent of locations to 1-metre accuracy (based on the interrogation of the dataset's positional quality indicator). These data were used to locate residential address locations within an electoral division that contained population. Locations were deemed residential if they were 'non PO Box and did not have an organisation name' and, in addition, they were not classified as demolished.

The population figures for electoral divisions reported in IMD 2000 refer to 1998 populations, whereas the address locations taken from Address-Point are from 2003. This discrepancy could be a potential source of error in the resulting analysis and is a clear limitation of the methodology. But after looking at a number of alternative approaches to the analysis that estimated electoral division populations to 2003 levels, it was found that the results of the study were not significantly affected.

3.2.2 Creation of electoral division deprivation deciles

For the purpose of this study the population of Wales was divided into groups so that the differences between them could be determined. Ten groups containing equal populations were used; these are known as deciles.

In order to create electoral division deciles, the overall IMD 2000 rank was used to place each electoral division into a decile of equal population (see Table 3.1). Deciles of equal population are preferred to those of equal electoral division count as the analysis then gives a population-based distribution which is more meaningful for equity-based studies. In all cases, decile 1 is the most deprived and decile 10 the least deprived.

It is important to understand what these deciles represent. Essentially, decile 1 has the largest concentration of deprived people, while decile 10 has the smallest concentration of deprived people. Population-weighted deprivation deciles of this form are often referred to using shorthand terminology, but their precise definition needs to be remembered: decile 1 is not 'the poorest 10% of the population', as some of the poorest people will live in pockets within less deprived electoral divisions, nor is it 'the 10% most deprived electoral divisions' as a population weighting has been applied.

The population within an electoral division and within a decile will vary in their characteristics. The IMD provides a statistical measure for a group of people rather than a precise measure for every individual. This is a well-known limitation within area-based studies and is referred to as the 'ecological fallacy'; it requires a caveat to be placed on any area-based analysis.

Table 3.1 Population-weighted deprivation deciles for electoral divisions in Wales

Decile	Population	No. of electoral divisions	IMD 2000 rank	
			From	To
1	295,756	66	1	66
2	303,561	71	67	137
3	300,369	81	138	218
4	299,361	88	219	306
5	300,428	87	307	393
6	301,111	111	394	504
7	297,988	111	505	615
8	299,734	105	616	720
9	294,134	79	721	799
10	308,241	66	800	865
Wales	3,000,683	865		

3.3 Flood risk methodology

3.3.1 Flood maps

The Indicative Floodplain Maps (IFPM) released by the Environment Agency in October 2004 were used to relate flood hazard risk to electoral division deprivation data. These flood maps are available from the Environment Agency's website (http://www.environment-agency.gov.uk/maps/info/floodmaps/).

Three zones (see Table 3.2) are shown on the Flood Map based on the estimated annual probabilities of flooding. This study considers flood zones 2 and 3.

Table 3.2 Flood zones shown on the Flood Map

Zone	Level of risk	Annual probability of flooding
1	Little or none	<0.1 per cent (1 in 1000 year floods) from rivers and the sea
2	Low to medium	0.1–1.0 per cent (1 in 100 year floods) from rivers 0.1–0.5 per cent (1 in 200 year floods) from the sea
3	High	≥1.0 per cent from rivers ≥0.5 per cent from the sea

The most significant limitation of the IFPM is that it the risk assessment undertaken to produce the map does not include flood defences or man-made structures such as bridges, culverts, and rail and motorway embankments. The lack of inclusion of flood defences means that the reduced flood risk behind these defences is not represented on the maps. An additional dataset that shows flood zones that benefit from flood defences does exist but it currently only accounts for defences built in the last five years, plus a few selected others. It has therefore not been used in this study.

The methods used in this study combine electoral division populations with residential address location to ensure that only the population within electoral divisions that is also

within a flood zone is counted within the analysis. Many electoral divisions will have rivers running through their area but no people resident within the flood zone itself, particularly in rural electoral divisions. Results are reported that show the percentage of population for each deprivation decile that lives within flood zones. This method is described in detail below.

3.3.2 Estimating the population within the floodplain

When calculating the population living within a flood zone, it is not sufficient to simply use the overall electoral division population that the flood zone falls within. For example, the part of the electoral division that falls within the flood zone may in fact contain no population. This isa particular issue in larger rural electoral divisions where floodplains cover only agricultural land. So to use the social characteristics of this electoral division within any analysis would be nonsensical because a flood hazard would be assigned to people that did not exist.

To improve the spatial resolution of the analysis, residential address locations derived from Address-Point were used. Each residential address location was assigned to the electoral division that it fell within. Each electoral division population was then divided evenly across all the addresses within it. This is important because the total population of the addresses must match the population reported in the IMD. By assigning an electoral division to each address, the deprivation decile of each address is also known.

Flood zone maps can be used to determine which residential addresses within an electoral division are located inside a flood zone (see Figure 3.1). Using the populations assigned to the addresses, the population of the electoral division within a flood zone can be estimated and resulting summary data produced.

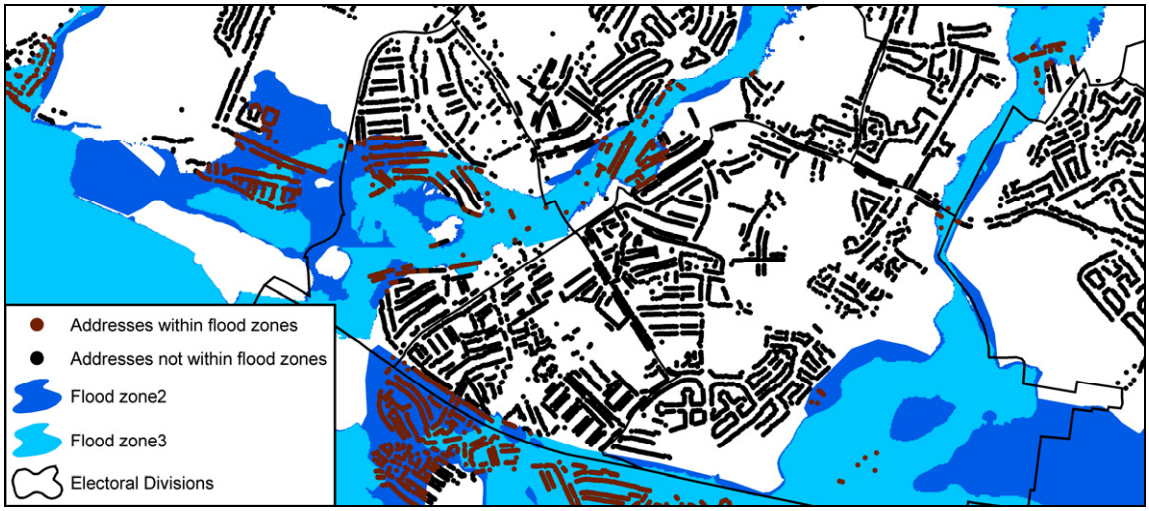


Figure 3.1 Residential address locations within and outside flood zones.

This method is a better than other methods often used in equity studies such as calculating the proportion of the electoral division area occupied by the flood zone and using this to estimate the proportion of the population.

Using Address-Point data does not provide a perfect distribution of the population in each electoral division because, in reality, each address location population will vary slightly

(although average household size does not tend to vary by a large amount within the same locality). In addition, some addresses may be wrongly classified as residential or commercial. For the purposes of this study, however, it provides a very good estimate of the proportion of the population within an electoral division (and therefore each deprivation decile) within and outside of a flood zone.

In addition, large sites such as blocks of flats or apartments will be represented by single points sitting on top of each other. The limitation of these locations is that they will experience edge effects in any analysis because they are representing a large site with a large population as a single point location. Thus, a point could fall outside a flood zone, resulting in the population being missed out while in reality part of the site and associated population is actually within the zone. In contrast, a point could fall within a flood zone resulting in all of the population being included while in reality part of the site is outside the zone. It is important to be aware of these limitations when looking at the results even though the population involved is only a very small percentage of the total population.

Although the use of Address-Point data improves the spatial distribution of population, it cannot provide a more detailed picture of the deprivation characteristics of that population. All addresses within an electoral division are therefore still considered to have the same deprivation characteristics.

3.4 Waste facilities methodology

3.4.1 Waste facility data

Two Environment Agency datasets were used to locate and classify waste management sites:

- national REGIS data – a full listing of waste management licences from the latest national REGIS Merge 10. The data extracted on 31 December 2004 was used to:
  - determine the date of issue of the licence;
  - classify sites as 1 of 24 types (see Section 5.5);
  - locate each site using National Grid Reference (NGR) co-ordinates.

- Operator and Pollution Risk Appraisal (OPRA) waste database for 2003. These data were used to determine whether a site was currently operational.

These datasets were recommended for use in the study by the Environment Agency.

Although the national REGIS database covers many waste facilities and activities, some are exempt from licensing and only have to be registered with the local authority. Such sites may still cause local nuisance and negative impacts, but are not included in the analysis.

Sites included in the analysis

The waste site datasets (see Section 5.5) were combined using the Environment Agency licence number. The datasets included sites for England and Wales, and covered both closed and operational sites. This study focussed on sites in Wales that are covered by an OPRA assessment and are recorded as operational within this database.

The first step was to select sites in Wales from the OPRA database and to find the site type, the date of issue for the licence and the NGR co-ordinates from the data extracted from REGIS. The grid references were not provided in a consistent format and were of variable quality; they thus needed considerable work to be useable. This provided a set of 483 sites.

For the purpose of analysis relating to deprivation, only operational sites were considered. Any site that is pre- or post-operational is classified as having a 'waste input' score in OPRA of 0. Any site with a waste component score of 0 was removed, leaving a subset of 370 operational sites.

For the purpose of analysis, sites were put into categories based on their site type. The site type descriptions and corresponding categories are shown in Table 5.3. Sites with a type classified as 'other' were not included in analyses relating to deprivation because they were not deemed suitable for this study. This gave a final subset of 350 sites.

3.4.2 Spatial proximity measures

The analyses in this report make use of proximity analysis, i.e. what type of population lives within a set distance of a site. The distance used is a Euclidean or 'as the crow flies' distance. Distances of 500 m and 1 km are the preferred distances in this report used to create buffer zones around the grid references for waste sites. Distances of 300 m and 2 km were also used to test for sensitivity.

The choice of 500 m and 1 km as buffer distances is to an extent arbitrary. The ideal would be to use a more precise and tailored distance or even a 'footprint' of impact for each individual site, but the site-specific information necessary to do this does not exist. Alternatively, it may have been possible to use a different distance for each type of site (e.g. a small distance for a recycling site, a larger distance for an incinerator). However, there were felt to be too many problems associated with the uncertainties in the parameters used to make this distinction – particularly since the sites within each of these categories vary significantly in their size and potential impact. For all but the larger sites producing emissions to air (e.g. large incinerators), however, the distance of any impact is unlikely to extend beyond 1 km and significant problems can arise due to the imprecision of site grid references when analysing impacts at distances of under 500 m (see below). For these reasons, 500 m and 1 km were chosen to provide two simple indicators of the deprivation characteristics of the populations surrounding each waste facility. It is important that they are treated only as indicators of deprivation characteristics and not in any way as a good measure of the population experiencing significant impacts or risks.

The contrast with the flooding data analysis is instructive. For flooding, a risk contour delineates with some sophistication the areas of land that could be affected by a flood of a given likelihood; it is then possible to analyse risk population patterns within this contour. For waste sites, the line drawn around each site has no such status. It is not a risk contour or a delineation of an area of land potentially affected by impacts from the waste site. It can therefore be used only to define an area within which proximate population deprivation profiles can be characterised.

The guidance provided for users of the REGIS database states that they should provide a grid reference for the 'site entrance'. For large waste facilities such as landfills, this may be some distance from where the significant waste management activities are actually taking place (landfill site areas have now been digitised and are present in the database,

but were not available at the time the research was carried out). Small buffer distances drawn around this point may also largely capture the site itself rather than the surrounding area (hence the problem with using smaller buffer distances referred to above). There were also inconsistencies within the database in the spatial accuracy of the grid references specified and the project resources did not allow verification that grid references had been entered properly. For these reasons, the results of the analysis need to be treated with some caution.

The same method was used as for flood risk zones to estimate the population living within the buffers specified around each waste site; Address-Point data were used to locate households accurately within each buffer (see Section 3.3.2).

3.5 River water quality methodology

3.5.1 River water quality data

A number of possible indicators of river water quality were considered for use in this study. The initial intention was to use the data on the predicted risk of water bodies failing the 'ecological status' criteria under the Water Framework Directive (WFD), but this turned out to be inappropriate for the form of inequality analysis to be undertaken. The various measures available under the General Quality Assessment were then considered.

The GQA system provides an assessment of the following aspects of water quality:

- **Biological quality** – an indicator of the overall 'health' of rivers, (monitored on a five-yearly basis);
- **Chemical quality** – an indicator of organic pollution in general through measurements of biochemical oxygen demand (BOD) and concentrations of dissolved oxygen and ammonia (monitored every three years);
- **Nutrient status**;
- **Aesthetic quality** – assesses the amounts of litter; sewage-derived waste; colour and smell of the water; oil, scum, foam, sewage fungus and ochreous deposits, and dog fouling at selected sites.

Biological and chemical quality are measured at 7,000 sites in England and Wales, representing around 40,000 km of the river and canal network. Aesthetic quality was reported on in 2000 for the first time by the Environment Agency from measurements taken at 452 'well visited' sites in England and Wales.

The river environment has a number of relationships with people's quality of life and well-being, though only some (e.g. health impacts) relate directly to the quality of the river water. Although the aesthetic GQA indicator captures more of the quality of the river corridor and how it may be used and perceived by local people as a consequence, the measurement regime was felt to be too sparsely distributed to be used reliably for analysis of the relationship between river stretches and nearby populations.

The biological GQA indicator was felt to provide a broader measure of the overall 'health' of rivers than the chemical indicator and, following guidance from Environment Agency staff, was chosen for use in the analysis.

The GQA system grades rivers into six classes ranging from A to F, where A represents high quality and F represents poor quality rivers. The criteria for assessment of biological quality are presented in Table 3.2.

Table 3.2 – General Quality Assessment scheme for biological water quality

Grade	Description
A. Very good	Biology similar to (or better than) that expected for an average and unpolluted river of this size, type and location; high diversity of taxa, usually with several species in each, rare to find dominance on any one taxon.
B. Good	Biology falls a little short of that expected for an unpolluted river; small reduction in the number of taxa that are sensitive to pollution; moderate increase in the number of individuals in the taxa that can tolerate pollution.
C. Fairly good	Biology worse than that expected for an unpolluted river; many taxa absent or number of individuals reduced; marked rise in numbers of individuals in taxa that tolerate pollution.
D. Fair	Sensitive taxa scarce and contain only small numbers of individuals; a range of pollution-tolerant taxa present, some with high numbers of individuals.
E. Poor	Biology restricted to pollution-tolerant species with some taxa dominant in terms of the numbers of individuals; sensitive taxa are rare or absent.
F. Bad	Biology limited to a small number of very tolerant taxa such as worms, midge larvae, leeches, water louse, present in very high numbers; in the worst case there may be no life present.

Source: Green and Faulkner (2000)

The biological quality element of the GQA uses RIVPACS (River InVertebrate Prediction and Classification System). RIVPACS is a computer-based tool that uses macroinvertebrate sampling (Clarke *et al*. 2003) and is the principal tool used by the Environment Agency for assessing the ecological quality of rivers throughout England and Wales.

RIVPACS depends on the use of a set of reference sites – short river stretches considered to be of high ecological and chemical quality, and representative of the best examples of their particular river type. Statistical models are developed relating to the environmental characteristics of any reference site to its macroinvertebrate fauna. Discriminant analysis is then used to derive equations that represent the best fit between the biological classification and measured values at each reference site. These variables are measured for any new site and the values are used in the equations from the database of reference sites to:

- predict the fauna to be expected at the test site;
- derive an index of ecological quality for that stretch of river.

3.5.2 River stretch data

A reasonably spatially precise indicator of the location of each river stretch is required in order to identify stretches of rivers for the analysis of nearby population characteristics. This study was able to use the GQA stretch network data at the 1:50,000 scale. These data were still in a draft format with the Environment Agency's quality assessment procedure incomplete, but this was not felt to be likely to affect the overall results significantly.

This data was used because 1:50,000 was the minimum level of accuracy required for the analysis undertaken; the previously available 1:250,000 scale stretch network data had

problematic generalisations of parts of the river network and, in many situations, shifted the river course away from its true location. However, a limitation of this dataset is that it provides no indicator of river size. This means that, when the river stretch is buffered for larger rivers, a potentially significant proportion of the buffer area will actually be the water body itself.

The study examined the population within 600 m of river stretches having a GQA biology grade. However, it is possible for people to live within 600 m of more than one river stretch which may have different GQA biology grades. To address this issue and assess its significance, results are reported in two ways:

- population within 600 m of rivers for each individual grade of river;
- population for the best quality river within 600 m (i.e. if an address is within 600 m of a river graded A and a river graded E, then that address will be classed as having a best river within 600 m of grade A).

3.5.3 Spatial proximity measures

The choice of a distance for the proximity analysis is problematic given the many different types of river environments and the multiple ways in which people and rivers can be related and impacts experienced. Rather than attempt to define in any precise way which people living near to a river may experience impacts (good or bad), the scope of analysis allows only a characterisation of the deprivation levels of areas through which the rivers run.

A distance of 600 m either side of the river (creating a 1,200 m wide buffer) was chosen because, as in a previous environmental justice study (Fairburn *et al.* 2005), this was identified as a typical distance that people are prepared to walk to get to green space or woodland (based on a review of a number of studies and policy guides). With many caveats, this distance may also be appropriate for considerations of walking access to rivers and provides a reasonable area over which to assess deprivation characteristics given the typical size of electoral divisions at least in urban areas. However, the 600 m distance is arbitrary and it cannot be presumed that all the people within the buffer around the river are going to experience impacts (good or bad) related to that river. Equally, it cannot be presumed that others outside the 600 m distance will experience no impacts.

The same method was used as for flood risk zones to estimate the population living within the buffers specified around each river stretch; Address-Point data were used to locate households accurately within each buffer (see Section 3.3.2).

3.6 Indicators of inequality

Two statistical measures were used in the analysis to provide indicators of degree of inequality:

- Concentration Index (CI)
- Comparative Environmental Risk Indicator (CERI).

These have been selected to aid communication of results as well as to be appropriate to the ranked ordinal form of the IMD data.

Concentration Index
The CI is closely related to the simpler Gini coefficient, which has been widely adopted as a measure of income and health inequalities (Wagstaff *et al*. 1991) and also recently applied to environmental equity research (Lejano *et al*. 2002, Walker *et al.* 2003). Whereas a Gini coefficient is used to calculate the distribution of a variable across a constant unit (e.g. income by population), Gini CI values are used to investigate the distribution of a variable with respect to a second, usually socio-economic, variable (e.g. disease by socio-economic status). A modified form of the Gini calculation method is used in which CI values range from 1 to –1. A value of zero indicates complete equality (e.g. in this study's application, the proportion of the population within the flood zone would be identical for all deprivation deciles), while values of 1 and –1 indicate extreme inequality in positive or negative relationships with deprivation.

The CI does not provide an indicator of the **significance** of inequality, which will always be an ethical and political judgement and is best used in a comparative setting. However, values for income inequality in the UK between 1979 and 2001 ranged from 0.25 to 0.35 (Shephard 2003). Gini values for income inequality in the USA, by comparison, are currently around 0.45.

Comparative Environmental Risk Index
This measure involves the calculation of a ratio of the population 'at-risk' as a proportion of the total population for any particular group over the ratio of the rest of the population 'at-risk' as a proportion of the total rest of the population.

The index produced is a quotient (a ratio of ratios) (Harner *et al*. 2002). In terms of the deciles used in this study, the index can be represented by the following equation, where X is any particular decile:

$$\frac{DecileX^{at-risk} \big/ DecileX}{Not-in-DecileX^{at-risk} \big/ Not-in-DecileX}$$

When looking at the results of this study, the group of people in question (Decile X) can refer to a group of deciles.

Using the example of flooding, if the group reported in the results is 'decile 1 and 2' and the CERI value is '1.653', then this means that 'people living in decile 1 and 2 (as a group) are 65.3 per cent more likely to be at risk in flood zone 2 compared with people living in deciles 3–10 (as a group). A figure of 0.8 would mean that they are 20 per cent less likely and a figure of 1 equally likely. In presenting the results of analysis three CERI values are provided:

- deciles 1 and 2 compared to all others;
- deciles 1–5 compared to all others;
- deciles 6–10 compared to all others.

4 Flood risk in Wales

4.1 Introduction

This section considers the ways in which the severity of impacts of flooding are socially differentiated and related to social deprivation, and introduces the context for flood risk and flood risk management in Wales. The results and implications of a GIS-based analysis of the relationship between flood risk and multiple deprivation in Wales are then discussed.

The policy review pays particular attention to those aspects of policy that take account of distributional social factors, while the data analysis seeks to reveal whether or not some parts of the population living at different levels of deprivation are more or less exposed to flood risk than others.

4.2 The social impacts of flooding and their social differentiation

The associated report on flood risk and environmental inequality (Walker *et al*. 2006) provides an extensive review of the social impacts of flooding and their social differentiation, particularly how impacts may be experienced by deprived communities. The main points from this review are summarised here; Table 4.1 shows how different types of flood impact may affect people in different ways depending on demographic, social, economic and ethnic characteristics.

No research has yet considered the impacts of flooding on deprived communities in the UK. Existing research on the experience of flooding has examined whether particular kinds of individuals and households are especially vulnerable in the face of a flood event and its aftermath. While it is important to emphasise that not all vulnerable individuals and households are deprived, it is nonetheless true that deprived neighbourhoods contain concentrations of vulnerable individuals. Thus, the findings of existing work on vulnerable groups can be used to piece together an understanding of the ways in which deprived neighbourhoods are likely to be affected by flooding.

Recent research for the Environment Agency (Fielding *et al.* 2005a) demonstrated that levels of awareness of flood risk are low among those in the lower socio-economic groups. Levels of awareness of flood risk would therefore be expected to be lower in deprived neighbourhoods than in their more affluent counterparts. Thus, residents may be less well prepared to cope in the event of a flood and its aftermath.

Table 4.1 Differential experience of the social impacts of floods

Social impacts	Evidence of differential effect depending on individual, household or neighbourhood characteristics
Economic impacts	Ethnicity, age, income and property type all have a bearing on the experience of economic impacts.
Non-economic losses	Age and property type inform the perception of, and extent of, this impact.
Physical health	Pre-existing health status, age and gender all have a bearing on the experience of health impacts.
Psychological health	Gender, age, social class and household composition all have a bearing on the experience of psychological health impacts.
Evacuation and temporary accommodation	Age, gender and income are relevant to understanding how this phase affects people. Levels of social capital are likely to be important in understanding community response and resilience.
Household disruption	Gender, ethnicity, age, property type and tenure type all influence how individuals and households are affected.
Community and neighbourhood changes	No research evidence, but suggestion that deprived neighbourhoods and those with low levels of social capital will be particularly hard hit.

Should floods occur in neighbourhoods where household incomes are low and levels of unemployment are high, a high proportion of the flooded population would be expected to be particularly hard hit. To some extent, the impact of flooding is buffered by financial resources, and an insufficiency or lack of insurance has been found to heighten the adverse effects of flooding (Fordham and Ketteridge 1995). Those on low incomes are likely to find it hard to cover the incidental expense associated with evacuation and temporary accommodation, and people employed in unstable, low income jobs are those most likely to lose their jobs if businesses close or move.

Extensive research on inequalities in health has established that deprivation and high levels of morbidity and mortality go hand in hand. Research shows that the impact of flooding on health varies with pre-existing health status; it might therefore be expected that the health impacts associated with flooding will be more extensive in neighbourhoods characterised by poor health.

There are important interactions between the psychological and physical health impacts of floods, with stress being blamed for a range of physical symptoms. It is reasonable to expect that those who suffer the greatest losses and inconvenience (often those on lower incomes and without insurance) may be most susceptible to psychological health effects and, by extension, physical health effects.

Social relations within localities are likely to have an important bearing on neighbourhood resilience to natural hazards. There is UK research which indicates that more deprived communities tend to have lower levels of social capital, and international research that concludes that places with low levels of social capital cope less well in the aftermath of flooding. There has not, however, been any research specifically on the relationship between levels of deprivation, levels of social capital and community resilience to flood event in England and Wales, and this remains an important area for future research. Possible demographic and community changes following flood events are another area where research is needed. It seems likely that neighbourhoods will be differentially affected depending on their economic characteristics, but there is no firm evidence of this.

These considerations suggest that deprived neighbourhoods are likely to be particularly hard hit by the social impacts associated with flooding. However, deprived neighbourhoods are not all the same. Some of the dimensions of difference that may influence how they are impacted by flooding include:

- local social relations;
- relationships with emergency services;
- ethnic and cultural make up;
- type of housing;
- age profile of residents.

Some neighbourhoods that would be classified as deprived have developed local strategies and organisations to cope with the aftermath of flooding and preparation for future flood events. It is also crucial to remember that vulnerable people do not all live in deprived communities. Not all poor people will live in poor neighbourhoods, and research indicates that the experience of rural poverty is particularly isolating. In addition, vulnerable people are not necessarily poor; vulnerabilities associated with age, gender and disability do not simply map onto measures of socio-economic status.

4.3 The nature of flood risk in Wales

Historically, the topography of Wales has generally resulted in transport infrastructure and development being concentrated on valley floors, lowland areas and the coastal fringes. A large proportion of the Welsh population is located in urban centres along the coastal plain in the south of the country (particularly Cardiff, Swansea and Newport) and the coastal settlements of north Wales.

The Welsh Assembly Government estimates that 150,000 residential properties, many commercial and industrial developments and other key infrastructure is at risk from flooding in Wales (WAG 2005). The residential properties at risk represent around 13 per cent of the total housing stock in the country; this means an estimated 500,000 people in Wales live and work on floodplains (the more accurate estimate derived in this study gives a lower number – see Section 4.5).

The extent of river and sea flooding in Wales is such that flooding is often of sub-regional significance, particularly since what happens in one part of a river catchment will often have effects on other parts of the catchment some distance away. This poses particular challenges for Environment Agency Wales in terms of the provision of flood defence and in the dissemination of flood warnings to those at risk.

The most significant flooding in recent years was:

- the Easter 1998 flooding, which also affected much of central England (Environment Agency 1998);
- the autumn floods of October and November 2000 (Environment Agency 2000).

The autumn 2000 floods highlighted several issues relevant to the nature of the flood risk faced in Wales and the flood warning infrastructure. Some 1,500 of the 1,900 Welsh properties flooded in the 2000 floods did not receive a flood warning because the affected areas were situated on river systems where:

- there were no flood warning arrangements in place;
- previous experience of flooding did not identify an urgent need for a warning system to be implemented.

Additionally, only 52 per cent of flooding occurred from main rivers – 12 per cent of those affected were flooded from surface waters and 36 per cent from ordinary watercourses over which Environment Agency Wales (as is the case in England) has no jurisdiction.

4.4 Policy interventions and social factors

This section identifies aspects of current flood policy and management that take account of distributional social factors. The broad view taken seeks to identify any aspect of policy or management which:

- recognises the particular circumstances of different social groups when exposed to or experiencing the consequences of flood risk;
- recognises the differential vulnerabilities of different social groups;
- seeks to ensure that policy or decision making is equitable and/or inclusive.

The aspects of policy and management reviewed below were identified through brainstorming and discussion during a workshop session on flood policy (see Walker *et al*. 2006) and a review of policy documentation. The discussion begins with a general review of the Welsh context for flood management. Both generic policy approaches and particular areas where policy is devolved and different in Wales are then reviewed.

4.4.1 The Welsh context for flood management

The policy framework for flood management in Wales was set out in the National Strategy for Flood and Coastal Defence prepared by the Ministry of Agriculture, Fisheries and Food (MAFF) in 1993 and adopted by the Welsh Office (the predecessor to the Welsh Assembly Government).

Flood defence legislation is set out in the Land Drainage Act 1991 and the Water Resources Act 1991, which apply to both England and Wales. The Environment Agency, covers the whole of England and Wales (geographically and managerially), with competencies set out in the Environment Act 1995. Thus in terms of primary legislation, the context for flood risk management in both England and Wales is the same.

As the underlying legislation for flood risk management is the same in both England and Wales, there is a great deal of commonality between the two countries in their respective approaches to flood risk. Similarly, the Environment Agency in England and in Wales (Environment Agency Wales) has the same powers and responsibilities; they have the same duties to carry out works on main rivers, and the designation of main rivers and ordinary watercourses is the same. However, there are some differences in the application of policy to the Welsh context.

The funding regime differs in Wales to that of England. Funding for flood defence and flood warning systems in England comes from Defra, but funding for flood risk management policy in Wales comes directly from the Welsh Assembly Government. This has implications for the funding of flood defences; for example, flood defence scheme proposals in Wales only need to compete for Welsh funding rather than competing with potential sites across the whole of England and Wales.

The institutional arrangements for dealing with flood risk are also slightly different in Wales. In England, flood risk management was carried out by a complex array of institutions, some with overlapping responsibilities, such as the large number of Regional Flood Defence Committees (RFDCs), Local Flood Defence Committees (LFDCs) and Internal Drainage Boards (IDBs) (though LFDCs have now been abolished and the structure of RFDCs streamlined). In Wales, the institutional arrangements for flood risk management have already been streamlined such that one single Flood Defence Committee covers the whole of the country. This is funded directly by the Welsh Assembly Government through block grants.

In addition, there is a greater possibility of co-ordinated and integrated policy approaches towards tackling flooding in Wales. Environment Agency Wales has a close working relationship with the Assembly Government, and the simplified institutional context for dealing with flooding makes policy development and implementation an easier task in Wales than in England.

Both the Environment Agency in England and in Wales produce performance targets for the effective implementation of flood risk management policies. The basis for these performance targets is the same in both countries, but the same measures have different values. For

example, in England, a key Environment Agency target is to reduce flood risk to 50,000 properties, whereas in Wales, with only 150,000 properties at risk in total, the target for risk reduction is correspondingly reduced. The Assembly Government also produces flood-related performance targets.

4.4.2 Land use planning

Planning was identified during the workshop discussion as a policy area with clear potential relevance to the vulnerability of different social groups – given that it could potentially determine what types of development and, to some degree, what types of people occupy areas at risk of flooding. However, there was some uncertainty at the workshop as to whether the need to take account of vulnerability was recognised in planning guidance and practice.

Technical Advice Note 15 (TAN15) is concerned with development on floodplains (WAG 2004a). This is the equivalent to Planning Guidance Note 25 (PPG25) in England. Although the approach towards floodplain development is very similar in Wales and England, there are certain presumptions in the Welsh context against any floodplain development at all. Any decision to develop in the floodplain must be clearly justified in socio-economic terms.

TAN15 and associated documentation includes the following points of policy guidance which, in some way, address issues of vulnerability in relation to flood risk:

- The sequential test, which guides development away from areas of flood risk if other more suitable sites are available, specifies that all flood risk zones are unsuitable for essential civil infrastructure, e.g. hospitals and fire stations. In addition, higher risk undeveloped and sparsely developed risk areas are, according to the sequential test, not suitable for certain development including general purpose housing or other development comprising residential or institutional accommodation and caravan and camping sites.

- Additional guidance on applying the sequential test developed by Defra and the Environment Agency identifies hospitals, homes for the elderly and schools as unsuitable for development in any identified flood risk area (low, medium or high risk) (Ramsbottom 2003, p.21).

- Sites vulnerable to rapid inundation should defences be overtopped or breached are identified as unlikely to be suitable for those of restricted mobility, whether in conventional, adapted or sheltered housing or in institutional accommodation (Ramsbottom 2003, p.15).

- Caravan and camping sites and other temporary occupancy sites – which may, in some situations, predominantly include people on a low income or specific ethnic groups – are identified as particularly vulnerable. The instability of caravans places their occupants at special risk and it may be difficult to operate an effective flood warning system. Guidance therefore states that sites in high risk of flooding should erect warning notices and prepare effective warning and evacuation plans (Ramsbottom 2003, p.26).

- Owners of hotels, hostels or guesthouses in areas at risk of flooding (which may contain marginal and vulnerable groups) are also advised to establish emergency procedures to be followed in the event of a flood. This also applies to sites designed to attract the public, especially young children and old people (health centres, leisure

centres, theme parks, etc.) or where large numbers of people are expected to be present (e.g. shopping and recreational areas) (Ramsbottom 2003, p.49).

4.4.3 Communication and awareness

Communication and awareness feature in the Government response to *Making Space for Water* (Defra 2005b) as one way in which the 'social justice' implications of decisions on capital schemes may be addressed. Although *Making Space for Water* applies only to England, much of the content has a direct relevance in Wales and is included in the *Environment Strategy for Wales* launched in May 2006 (WAG 2006).

In a section on social justice and community well-being, the Government response to *Making Space for Water* states that even within the risk management framework proposed under the strategy, there will be cases where investment in capital schemes to manage flooding will not be justified. It is then stated that:

> 'In such cases and in line with its policies on social justice, the Government recognises that there is a need to consider extending the risk management tools available, in particular to take account of the needs of smaller rural or dispersed communities. Subject to further work on the legislative and funding implications, consideration will be given to the expansion of available risk management tools to include: the expansion of flood warning and flood awareness …' (Defra 2005b, p.20).

A later chapter refers to promoting awareness and education through:

- community partnerships;
- the use of new techniques for visualising alternative futures;
- information packs;
- DVDs;
- website resources.

It also calls, in general, for support for more active community involvement (Defra 2005b, chapter 9).

The need to differentiate and target communication and awareness raising programmes for different social groups has been recognised by the Environment Agency and implemented in different ways. For example, it produces factsheets in several languages and for people with learning disabilities. Where flood warning is concerned, warning dissemination in England and Wales uses the same system, though in Wales there is a requirement to disseminate flood warnings in Welsh and English.

4.4.4 Environment Agency's older people campaign

Recent flood awareness initiatives have been aimed particularly at older people. The older people campaign, launched in October 2004, is an initiative by the Environment Agency in partnership with Help the Aged.

The campaign consists of the launch of a leaflet, *Flooding: be prepared, a guide for older people*, which contains advice on what preparations older people can make before, what they should do during, and how they can clean up after, a flood situation. It also includes a list of useful numbers and details of what should be put in a flood preparation pack.

The leaflet has been advertised by posters in doctors' surgeries, libraries, buses, magazines and various community outlets located within floodplains. Where possible, the Environment Agency is distributing the leaflet through organisations able to take it into the homes of older people and explain it to them. These organisations include Help the Aged's Handy Van scheme, which helps older people maintain their homes, and Crossroads (a charity that supports carers).

The campaign provides a good example of how the Environment Agency can work with other organisations to deliver appropriate materials to specific vulnerable groups. Help the Aged is expert at communicating with older people and the Environment Agency has followed its advice in developing the materials and organising the distribution channels.

The decision to focus on older people was informed by the Flood Warnings for Vulnerable Groups project (Fielding *et al.* 2005b), which found that older people may be particularly vulnerable (along with single parents, new homeowners and those in lower socio-economic groups) because of low levels of awareness of flood risk.

The Environment Agency plans to target other social groups in future flood awareness activities.

4.4.5 Flood resilience

The Defra consultation document, *Making Space for Water*, (Defra 2004a) notes that the ability of householders to make their homes more resilient to flooding is dependent on income. It states that:

> 'The Government is of the view that, in general, individual building owners should be responsible for improving the flood resilience of their buildings. The benefits for the owner are substantial: lower repair costs following an event, fewer health implications and continued insurance. However, the Government recognises that low income, vulnerable households in high-risk areas may not be able to afford the flood protection products/resilience measures … They may also be the least likely to be able to cope with a major flooding event' (Defra 2004a, paragraph 12.20, p.95).

Flood-proofing/resilience measures can take a range of forms such as replacing timber floors with concrete, changing carpet for tiling or replacing MDF with plastic or steel alternatives. Additionally, flood damage and repair costs can be reduced or avoided by moving expensive items such as boilers, wall sockets and meters above the likely flood level. Homeowners can help control their buildings and contents insurance premiums if they can demonstrate that they have taken steps to minimise the potential damage arising if their home is affected by flooding.

The document goes on to point out the availability of a mechanism for providing financial assistance for vulnerable households. In July 2002, The Regulatory Reform (Housing Assistance) (England and Wales) Order 53 gave local authorities more flexibility to decide how they would provide home improvement grants, loans, help and advice to low income households within their areas. It then states that:

> 'In light of this provision and in view of the chronic health problems caused by flooding and long-term damage done to properties, the Government would encourage local authorities in high-risk areas to consider requests for assistance with flood protection/resilience products as a matter of course alongside other more traditional requests' (Defra 2004a, paragraph 12.21, p.95).

The Government response to *Making Space for Water* (Defra 2005b) refers to a project to assess the feasibility of the Government providing financial support for making particularly vulnerable properties on the floodplain 'more flood resilient/resistant additional'. This is justified through reference to the principles of 'sustainable development and social justice' to be potentially applied where the provision of a flood alleviation scheme is very difficult. This feasibility study will consider:

- the scope of any scheme
- effectiveness
- eligibility
- legal basis
- degree of incentivisation
- cost.

There is a commitment to then develop a pilot grant scheme. Such a grant scheme has been in operation in Wales on a pilot basis since 2004. This scheme aims to provide grant aid (paid by local authorities) to those who wish to modify their homes to reduce potential flood damage should a flood event occur.

4.4.6 Flood risk assessment and Catchment Flood Management Plans

The assessment of flood risk is an important part of flood risk management – identifying where flood risks are high and low, and potentially directing where intervention of various forms is to be implemented.

Traditionally, flood risk assessment has not taken account of social factors in the methodologies followed, being largely taken up with the assessment of flood probability and economic damage. This was identified in the workshop session as a negative feature of past and current policy, although recent developments were recognised.

Making Space for Water (Defra 2004a) asks whether the assessment of risk at all levels should take account not just of economic damage but of environmental and social factors as well. It notes that, at the national level, the Environment Agency is working to assess and map flood probabilities on a consistent national basis and that the maps will be 'used for the derivation of estimates of risk through a project on risk assessment for strategic planning' (Defra 2004, p.38). The estimation of risk that is currently used is one of damages to economic assets measured in monetary terms, whereas the strategy notes that 'this will need to be broadened over the lifetime of the Defra strategy to take better account of environmental and social aspects' (Defra 2004a, p.39).

The consultation document also suggests that more comprehensive, consistent and reliable assessments of risk will provide the driver for improved prioritisation of risk management factors. Areas of potential action could be prioritised by reference to the contribution that could be made to risk reduction from a consistent national methodology for measuring risk. This would, over time, replace Defra's scheme-based prioritisation system. This is currently used to determine the relative priority to be given to a range of potential schemes to make best use of available funding (see below).

Defra is sponsoring research into the development of multi-criteria approaches. The consultation document notes that more formal adoption of these approaches 'will allow greater and more consistent account to be taken of non-quantifiable aspects of an

environmental or social nature' (Defra 2004a, p.42). In the Government response to the consultation document, these proposals are supported as part of developing 'a more holistic assessment of risk' (Defra 2005b, p.19).

One way in which this broadening of approach to risk assessment is already taking shape is in the framework being developed for the production of Catchment Flood Management Plans (CFMPs). CFMPs are a:

> 'strategic planning tool through which the Environment Agency will work with other key decision-makers within a river catchment to identify and agree policies for sustainable flood management' (Environment Agency, Defra and WAG 2004).

The overall objective is to achieve the sustainable management of flood risk. Sustainable is defined in guidelines for the production of CFMP as indicating that 'social economic and environmental issues have been taken into full account and balanced to optimise the benefits to them in the long term' (Environment Agency, Defra and WAG 2004, p.9). This guidance also states that:

> 'through effective stakeholder dialogue and consideration of the wider social agenda, the CFMP can make a significant contribution to achieving the broader objectives of sustainable development: equity, social inclusion and engagement in decision making (e.g. regeneration, sustainable communities, partnerships)' (Environment Agency, Defra and Welsh Assembly Government 2004, p.18).

Section 5.4.2 of the guidance deals with developing a strategic assessment of flood risk and stresses the need to take account of the full range of the impacts of flooding. Under 'impacts on people', a broad perspective is taken with reference to loss of life, injury and distress and to groups particularly vulnerable to flood risk.

4.4.7 Modelling and Decision Support Framework

A Modelling and Decision Support Framework (MSDF) (http://www.mdsf.co.uk/about.shtml) has been developed to be used by the Environment Agency and consultants in the development of CFMPs, Shoreline Management Plans (SMPs) and other flood studies.

The MDSF consists of a set of procedures and GIS-based software which provide tools and guidance for a range of tasks, including one focused on social impacts. These tasks include:

- facilities for managing and viewing catchment data;
- advice on catchment hydrological and hydraulic modelling using external modelling software;
- advice on future land use and climate change scenarios;
- import of river flood level data from external models;
- calculation of flood extent and depth;
- calculation of economic damages for commercial, industrial, residential and agricultural assets;
- **calculation of social impacts** including population affected and social vulnerability;
- presentation of results for a range of cases for assistance with preferred policy selection;
- a framework for policy evaluation;

- procedures for estimating uncertainty in the results for each policy.

To calculate social impacts, the MSDF uses the Social Flood Vulnerability Index (SFVI) developed by the Flood Hazard Research Centre, Middlesex University, for the Environment Agency. Social impacts can be assessed in terms of estimates of:

- the number of people flooded;
- the percentage of specified areas flooded;
- the relative vulnerability of people living in those areas.

4.4.8 Flood defences

It is estimated that without the existing flood defence infrastructure, the average annual costs of damage from flooding in Wales would be around £220 million. Existing flood and coastal defences reduce the figure for annual flood damages to £70 million (WAG 2005). In 2004, the Welsh Assembly Government invested £8.6 million on new or improved flood defences, providing improved protection from flooding to over 2,000 properties in Wales. In 2005–2006, the budget for flood defence was a further £11.5 million.

The methodology historically used for appraising where to invest public money in flood defences can lead to socially inequitable outcomes. Under a conventional cost-benefit analysis approach, the benefits to be achieved are assessed by estimating the economic cost of flood damage that is avoided if the flood defences are in place. These savings are then set against the cost of the flood defences to indicate whether the investment is economically efficient. However, the focus on economic impacts means that a high-income area with high cost property and other assets may be assessed as a higher priority for flood defence investment than a low-income area.

Defra guidance to operating authorities (Defra 2004b) on the economic appraisal of flood and coastal defences addresses this problem to some degree:

- **How to reflect socio-economic equity in appraisal.** This is guidance on how to assess 'distributional impacts' within the overall framework provided by the Treasury Green Book (http://greenbook.treasury.gov.uk/) where this is considered 'necessary and practicable'. In addition to using information on property type and age, information on social class is also to be obtained and used to apply weighted factors in the derivation of 'damages avoided'. This will have the effect of increasing the estimated damages for lower social class populations.

- **How to appraise the human-related intangible impacts of flooding.** Drawing on a research project on the economic valuation of impacts such as stress, health effects and loss of memorabilia, this guidance indicates how an additional monetary cost can be added to the appraisal methodology in order to take intangible impacts into account. A value of £200 per household per year is recommended to be applied through a matrix which adjusts for the standards of protection before and after an option is implemented, with some account taken of distributional differences within this matrix.

More directly, the Welsh Assembly Government has a policy to prioritise the funding of flood defence schemes in deprived Objective 1 areas. A £12.5 million, three-year project funded jointly by the Assembly Government and the EU is developing flood defence schemes for some of those towns in Objective 1 areas that would otherwise would be unlikely to receive one. For example, Llandovery received flood defence funding in 2003–2004 from this source.

It has seen considerable urban regeneration as a result of newly protected homes and businesses once again becoming eligible for insurance cover under a revised flood risk assessment.

4.4.9 Summary

The approach to flood risk management in Wales is much the same as that in England due to similarities in legislation and the flood-related powers and responsibilities of the Environment Agency in both countries. In the cases where there are differences in approach between England and Wales, Wales is often ahead of England. For example, the streamlined institutional context made possible by the smaller size of Wales means that the bodies responsible for flood management policy can often discharge their responsibilities in a more integrated and co-ordinated manner than is possible in England.

The Welsh Assembly Government's commitment to uphold the principles of sustainable development and equal opportunities for all has meant that:

- the social and economic consequences of living in an area at risk from flooding have been carefully defined in Wales;
- policies relating to flood risk management have, to some degree, been implemented with a greater sensitivity to social and economic inequality than has been the case in England.

The Assembly Government is keen to promote a clear understanding of flood risk and its consequences for communities prone to flooding. Environment Agency Wales is therefore mapping Welsh floodplains in greater detail than in England and, by the end of 2005, will have conducted a LiDAR (Light Detection And Ranging) survey of all Welsh main rivers. This will enable Environment Agency Wales to:

- develop detailed mathematical models of the floodplain;
- gain a greater understanding of the way that flooding in Wales affects those who are at risk.

This will make it easier to target flood awareness and information initiatives.

4.5 Flood risk and deprivation in Wales

As discussed in the separate flood risk report, two previous studies examined the relationship between exposure to flood risk and deprivation. Both made use of the Indicative Floodplain Map produced by the Environment Agency to identify areas in England and Wales at risk from river and sea flooding. In 2005, the Environment Agency produced a new Flood Map, which improves upon the IFPM by providing more accurate and consistent information on flood risk and defining flood zones at different levels of risk. The analysis discussed below makes use of the new Flood Map, along with an analytical methodology that identifies patterns of deprivation and household location with a better spatial resolution than available in previous research.

4.5.1 Total numbers of people at risk

How many people live within flood risk zones in Wales?
Nearly 333,000 people in Wales (11.1 per cent of the population) live within a flood risk zone or in an area with a greater than 0.1 per cent annual probability of flooding (the zone 2 area)

(Table 4.2). Nearly 240,000 live within zone 3 which has the higher risk of flooding – 1 per cent of greater annual probability from rivers or 0.5 per cent or greater from the sea.

The estimated zone 3 population of 239,938 is higher than that derived from previous research using the IFPM which defined the same probability boundary; Walker *et al.* (2003) estimated a total population of 225,337. This may be because the more precise definition of areas at risk by the new Flood Map has increased the population covered by the flood risk area. However, differences in the way that population figures have been derived could also be contributing to this difference. The total population figure is lower than the Environment Agency estimate of 150,000 households at risk from flooding would imply.

For zone 2 and 3, the total number of people at risk from river flooding in Wales is higher than that for sea flooding, with the proportional difference greater for zone 2 than zone 3.

Table 4.2 Total populations living in flood risk zones in Wales

Zone	Total population	% of Wales population	River flooding	% of Wales population	Sea flooding	% of Wales population
Zone 2	332,986	11.10	233,896	7.79	154,499	5.15
Zone 3	239,938	8.0	151,834	5.06	119,723	3.99

The total population living in flood risk zones does not equal river plus sea populations, as some people live in both river and sea flood risk zones

4.5.2 Flood risk and deprivation

Are deprived populations more likely to be living within flood risk zones than others?
There is a general but weak association between overall flood risk and deprivation, with populations in deciles 1–5 disproportionately concentrated in both zone 2 and zone 3 flood risk areas (Table 4.3 and Figure 4.1). The CI values of 0.11 and 0.15 indicate an overall bias towards deprivation but not a strong one. However, this population is not concentrated in the most deprived deciles 1 and 2. The highest proportions are rather found in deciles 5 and 3. Indeed the CERI values indicate that people in deciles 1 and 2 are 16 per cent **less** likely to be living at risk of flooding than the rest of the population for zone 2, and 9 per cent less likely for zone 3.

Table 4.3 Population within zone 2 and 3 for all flood types by deprivation decile

Decile	Zone 2 population	%	Zone 3 population	%
1	31,718	9.53	25,601	10.67
2	25,764	7.74	18,757	7.82
3	49,758	14.94	40,538	16.90
4	39,179	11.77	28,188	11.75
5	67,441	20.25	51,443	21.44
6	26,329	7.91	15,618	6.51
7	27,218	8.17	18,301	7.63
8	34,938	10.49	22,003	9.17
9	15,894	4.77	10,079	4.20
10	14,746	4.43	9,409	3.92

Wales	332,986	100	239,938	100
CI value		0.11		0.15
CERI deciles 1 and 2		0.84		0.91
CERI deciles 1–5		1.80		2.18
CERI deciles 6–10		0.56		0.46

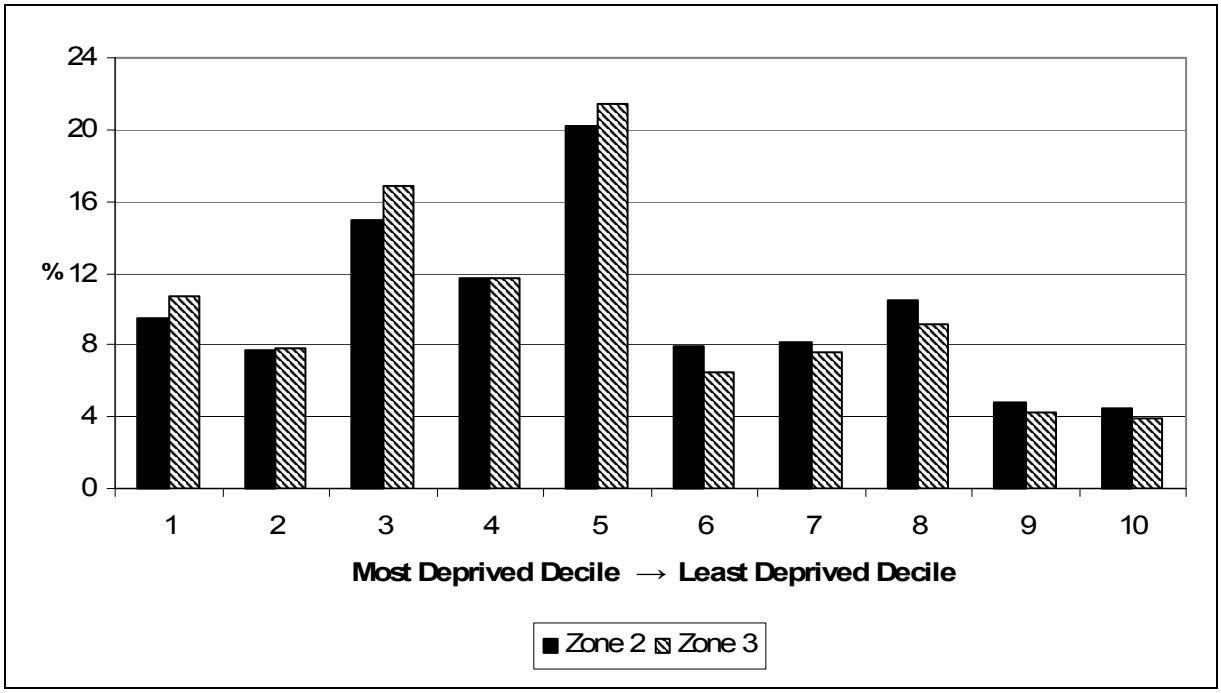


Figure 4.1 Percentage of total population within zones 2 and 3 for all types of flooding by deprivation decile

Is there a difference between river and sea flooding in the likelihood of deprived populations living within flood risk zones?
When the data are disaggregated into river and sea flooding zones, the broad pattern of a bias towards deprivation populations is maintained for both types of flooding, but again in neither case is the bias towards the most deprived populations.

The distribution is more acutely towards the deprived for sea flooding, with very low percentage populations in the least deprived deciles and CI values at 0.25 and 0.26 which are significantly higher than for all flooding (Table 4.5 and Figure 4.3). However, the highest percentage populations are in deciles 5 and 3 – again towards the middle of the deprivation range.

For river flooding, the distribution is flatter and CI values are much lower at 0.05 and 0.10 (Table 4.4 and Figure 4.2). Again the highest percentage populations are towards the middle of the deprivation range.

Table 4.4 Population within zones 2 and 3 for river flooding by deprivation decile

Decile	Zone 2 population	%	Zone 3 population	%
1	16,290	6.96	14,135	9.31
2	11,694	5.00	8,514	5.61
3	37,106	15.86	28,134	18.53
4	29,173	12.47	16,261	10.71
5	46,109	19.71	29,249	19.26
6	18,764	8.02	10,727	7.07
7	19,205	8.21	12,675	8.35
8	30,020	12.83	16,731	11.02
9	11,524	4.93	6,417	4.23
10	14,011	5.99	8,990	5.92
Wales	**233,896**	**100**	**151,834**	**100**
CI values		0.05		0.10
CERI deciles 1 and 2		0.545		0.702
CERI deciles 1–5		1.503		1.736
CERI deciles 6–10		0.665		0.576

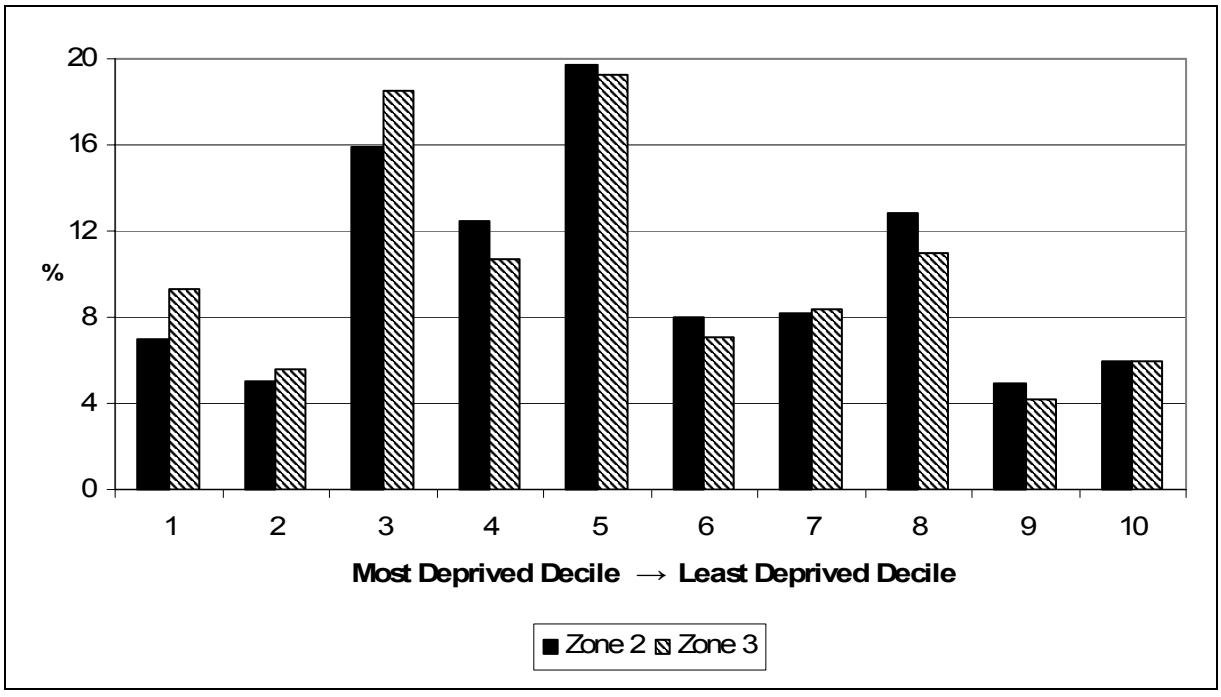


Figure 4.2 Percentage of total population within zones 2 and 3 for river flooding by deprivation decile

Table 4.5 Population within zones 2 and 3 for sea flooding by deprivation decile

Decile	Zone 2 population	%	Zone 3 population	%
1	19,813	12.82	15,098	12.61
2	15,393	9.96	10,295	8.60
3	30,848	19.97	26,119	21.82
4	16,545	10.71	13,739	11.48
5	36,259	23.47	29,841	24.92
6	8,563	5.54	5,341	4.46
7	8,764	5.67	5,848	4.88
8	12,500	8.09	8,868	7.41
9	4,595	2.97	3,816	3.19
10	1,220	0.79	759	0.63
Wales	**154,499**	**100**	**119,723**	**100**
CI values		0.25		0.26
CERI deciles 1 and 2		1.182		1.079
CERI deciles 1–5		3.339		3.865
CERI deciles 6–10		0.300		0.259

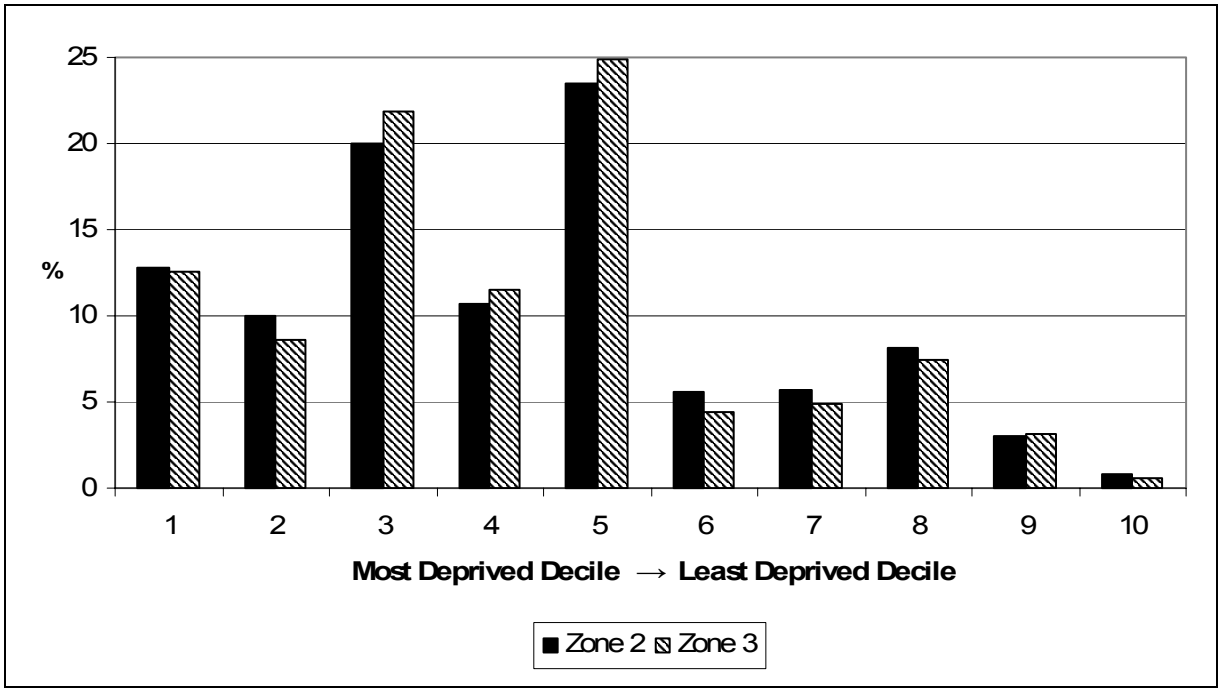


Figure 4.3 Percentage of total population within zones 2 and 3 for sea flooding by deprivation decile

4.6 Conclusion

The results provide evidence that the distribution of populations at risk when measured against deprivation is not equal for both river and sea flooding. There is evidence for both sea and river flooding that the least deprived are least at risk, but the highest proportions of

populations at risk are found towards the middle of the deprivation range rather than in the most deprived deciles. The low numbers at risk in the least deprived deciles is more marked for sea flooding than for river flooding, but any bias towards those who are deprived is less acute, less focused on the most deprived and less consistent than that found for England.

This conclusion does not negate the need for flood risk policy in Wales to take account of deprivation, but indicates that:

- the scale of the total additional vulnerability associated with deprivation is not that high;
- potential 'justice' concerns arising from a disproportionate bias of flood risk towards deprived communities are not likely to be significant.

These questions and implications are considered further in Section 7.1.

5 Waste management in Wales

5.1 Introduction

This section summarises the social impacts of waste management and discusses the context for waste management in Wales and the policies and strategies that are in place, highlighting aspects and issues of particular relevance to environmental inequalities. It then presents the methodology and results of an exploratory quantitative GIS-based analysis of the distribution of waste facilities and of the relationship between waste facility location and multiple social deprivation in Wales.

The data analysis should be considered in conjunction with the work described in the associated report on addressing inequalities in waste management in which preliminary and exploratory data analysis is undertaken for north-west England (Damery *et al.* 2006b). This work sought to further understand the problems of any analysis of waste facility siting and deprivation, and to test some ways of using available data. The numerous problems associated with methodology issues for environmental justice studies focused on waste facility locations mean that a simplistic analysis is likely to be insufficient and potentially misleading in the results it produces. The report concludes that a more sophisticated approach needs to be developed (e.g. seeking to differentiate between different types and scales of waste facility), though the limitations of the datasets available still apply.

The core results relating the locations of different types of waste facilities to the Index of Multiple Deprivation from the data analysis for Wales are presented below. The discussion of results and conclusions drawn emphasise the need to consider carefully the results produced and their implications for future analytical research.

5.2 The social impacts of waste management

The findings of the extensive literature review on the social impacts of waste management in the associated report on waste management (Damery *et al*. 2006b) are summarised here. Having pointed out that the impacts will vary extensively between types and scales of different waste management facilities, the review concludes that there is an extremely comprehensive literature on the potential social and environmental impacts of waste management facilities, including both UK-based studies and international research.

The health impacts have been widely debated and documented, particularly regarding landfill sites and incinerators. In addition to health impacts, the social impacts of waste facilities potentially relate to:

- nuisance impacts (e.g. odour, visual intrusion, noise, vermin, etc.). These are well-documented in the literature, but much of the evidence for impacts and the extent to which they might be experienced differentially by different social groups within a community is largely anecdotal – as is any assessment of impact magnitude;

- economic impacts (e.g. the potential reduction in value for housing stock in close proximity to waste sites);

- political impacts (e.g. the ability of communities to mobilise against future siting decisions and/or to engage in recycling activities).

The impacts of community perceptions cannot be ignored – not least because public perception has been accepted in UK case law to be a relevant material consideration in land use planning. Much work in the UK, Spain, Germany, France, USA and Canada has been carried out over at least a decade into perceptions of waste facilities (mainly landfills and incinerators).

A complex multi-dimensional picture is evident in relation to perceptions pre-siting where the following are all evident, albeit to varying degrees:

- concern about physical and social impacts;
- trust in the operators and regulators;
- concern about the strategic need for new plant;
- concerns based on experience of old facilities and nuisance effects.

There are fewer studies with respect to perceptions post-siting but, in general, these show declining concerns and increasing 'acceptance'. However, this does not mean that where local problems arise (litter, dust, odour, etc.) that communities do not seek regulatory action. An increasing number of major operators in the UK have liaison groups linked to facilities; for example, Onyx (now Veolia) has 15 community liaison groups around energy-from-waste (EfW) facilities and landfills which act as ongoing, formal and informal, community monitoring networks.

The benefits of proximity to waste facilities must be included in any analysis as these may go some way to offsetting some of the perceived and potential negative social impacts associated with waste management facility siting in particular communities. The fact that there may be identifiable positive impacts associated with waste management facilities has often been overlooked in the academic and policy literatures. Not least, facilities are essential for dealing with waste arisings which, if insufficiently managed, could have serious negative environmental and social impacts. However, both impacts and benefits will vary considerably between different types and scales of waste facility.

The extent to which impacts may affect particular social groups is uncertain, with little specific evidence about the social differentiation of impacts from waste management. Some potential impacts that could vary among different social groups can be suggested. In deprived communities with elevated rates of bronchial illness, for example, individuals may be more vulnerable to some health impacts from living close to facilities with emissions to air than individuals with better health but the same level of exposure. However, more research on such potential health vulnerabilities is needed to produce a reliable evidence base.

5.3 Changing context of UK waste policy

Recent developments in UK waste management policy have been influenced significantly by EU directives – particularly the Landfill Directive (see Section 5.3.4), but also the End-of-life Vehicle (ELV) and Waste Electrical and Electronic Equipment (WEEE) Directives.

The EC Waste Framework Directive (75/442/EEC) and its subsequent amendment (91/156/EEC) set the overall policy context for waste management and disposal in EU Member States, though they do not prescribe the processes that should be adopted within

each Member State. The principles of the Waste Framework Directive were incorporated into:

- *Waste Strategy 2000* – which applied to England and Wales(DETR 2000);
- *Wise about Waste* – the specific waste strategy for Wales (WAG 2002b) and its supporting Technical Advice Note TAN 21 (WAG 2001b).

Both strategies aim to curb the growth in the quantity of waste produced and, where waste is produced, to encourage the recovery of value from it through increased recycling, composting and energy recovery. *Wise about Waste* sets out specific targets for Wales regarding the methods of waste management, while TAN 21 is intended to facilitate the introduction of a comprehensive, integrated and sustainable land use planning framework for waste management in Wales through the introduction of Regional Waste Plans (WAG 2001a).

5.3.1 Principles affecting waste management decisions

Both the UK and Welsh waste strategies emphasise that waste management decisions should be taken with three considerations in mind:

- the waste hierarchy
- the proximity principle
- the notion of self-sufficiency.

The waste hierarchy
The waste hierarchy offers a sustainable approach to waste management, viewing waste as a potential resource and the production of waste as a waste of resources. The waste hierarchy was first introduced to European waste policy in 1975 as part of the Waste Framework Directive. It was formalised into a hierarchy of management options in the 1989 EC Strategy for Waste Management (SEC(89)934 Final 1989) and further endorsed in the EC review of the strategy, which was adopted in July 1996.

The waste hierarchy takes the following form:

- prevent and reduce the amount of waste produced;
- reuse products wherever possible;
- recycle what cannot be reused;
- recover energy from waste that cannot be reused or recycled;
- dispose to landfill as a last resort and only if it represents the Best Practicable Environmental Option (BPEO) for the particular material involved.

The waste hierarchy has been fundamental in designing UK waste management policies and plans, particularly through the introduction of the Landfill Tax in 1996 (which will escalate steeply to a target level of £35 per tonne) and the setting of national recycling and recovery targets.

The proximity principle
This principle, which was established in the Waste Framework Directive, states that waste should generally be disposed of as near to its place of origin as possible. This is partly so that waste problems are not merely transferred to other regions/areas and partly because the transportation of waste is itself detrimental to the environment. The principle is also driven by

the belief that those who produce the waste should also bear the responsibility for, and the impacts of, its management (Petts 2003).

Self-sufficiency
The notion of self-sufficiency, in a similar way to the proximity principle, requires that most waste is treated or disposed of in the region within which it is produced. Each region should provide for facilities with sufficient capacity to manage the expected quantity of waste requiring management in that particular area for at least ten years. The principle again embodies the belief that the communities that produce the waste should be responsible for its management and that the problem should not be exported to other areas and other communities.

5.3.2 The impact of the Landfill Directive

Regulations to implement the Landfill Directive in England and Wales came into force in 2002, and in Scotland and Northern Ireland in 2003. Their overall objective is:

> 'to provide for measures, procedures and guidance to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from landfilling of waste during the whole life cycle of the landfill' (Landfill Directive 1999/31/EC, Article 1).

The main features of the Landfill Directive are:

- targets for the reduction of biodegradable municipal waste (BMW) to landfill (introduced in 2003);
- a ban as of July 2004 on the co-disposal of hazardous and non-hazardous wastes;
- a requirement for separate landfills for hazardous, non-hazardous and inert wastes;
- a ban of the landfilling of tyres;
- a ban of the landfilling of liquid wastes, infectious clinical waste and certain types of hazardous waste;
- provisions on the control, monitoring, reporting and closure of landfill sites.

These requirements will have the effect of significantly reducing the use of landfill in the UK. By 2020, the amount of BMW sent to landfill in the UK must fall to 35 per cent of that produced in 1995. Additionally, the Government has a target to reduce the amount of industrial and commercial waste sent to landfill by 2005 to 85 per cent of 1998–1999 levels.

5.4 Waste management policy and context in Wales

Waste management is a significant and growing problem in Wales, and is considered by the Assembly Government as Wales' biggest environmental problem (WAG 2002b).

Under the Environmental Protection Act 1990, the Assembly Government has powers to make regulations about the management of waste and its licensing, and may also give directions to the 'competent authority' in Wales.

Although there are a number of bodies involved in waste management, the lead on waste regulation in Wales is taken by Environment Agency Wales. Its main requirements in Wales in relation to waste management are to contribute to the successful implementation of the national waste strategy (WAG 2002b) (see Section 5.4.2), in particular to:

- ensure that waste is recovered or disposed of in ways that protect the environment and human health by regulating waste management operations;
- enforce waste management controls in a consistent manner across Wales;
- provide comprehensive monitoring data to enable the amount of waste arising and the final disposal method to be tracked and recorded for each significant waste stream;
- assist regional waste planning groups and Welsh local government in developing waste plans and strategies.

As such, Environment Agency Wales has statutory duties and powers to license, permit, register and regulate waste management activities to ensure that they do not cause pollution or harm to human health. The only exceptions are certain small-scale facilities regulated by Welsh local authorities under the Pollution Prevention and Control (PPC) regulations.

5.4.1 Waste arisings in Wales

Some 26 million tonnes of waste are produced annually in Wales. Most is produced by the industry, agriculture, mining and quarrying sectors (National Audit Office Wales 2004). Table 5.1 presents the tonnages of different waste streams (excluding municipal waste) managed at licensed waste facilities in 2002–2003 (the most recent year for which full data are available). Figures for 2002–2003 from Environment Agency Wales suggest that 7.1 million tonnes of waste was processed in Welsh waste management sites; the Welsh reliance on landfill as a means of waste disposal is shown by the fact that 4.6 million tonnes of this (64.7 per cent) went to landfill sites.

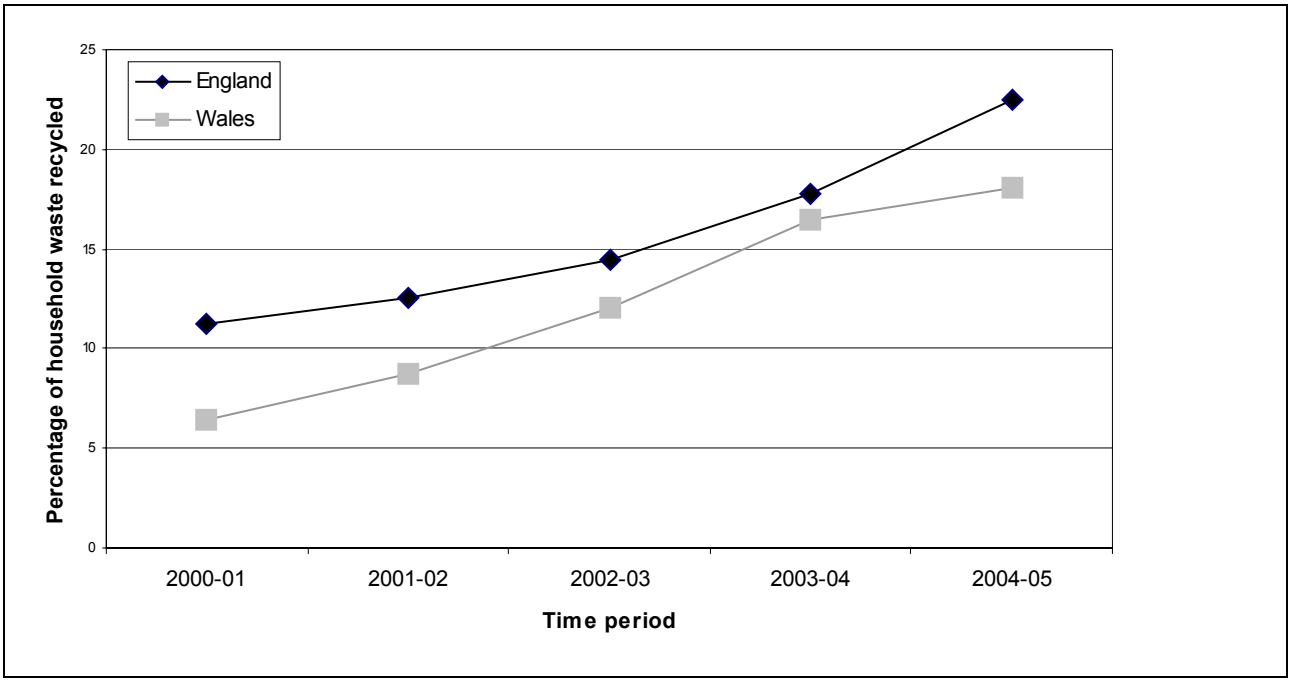
In terms of municipal waste, the most recent figures were published in 2006 and relate to 2004–2005 (Statistical Directorate, NAW 2006). These figures suggest that a total of 1.94 million tonnes of municipal waste were produced in Wales during 2004–2005 – up by around 6 per cent from the 2003–2004 figure of 1.83 million tonnes.

Wales lags behind England in terms of household recycling rates, although the gap has narrowed significantly in recent years (Figure 5.1). Welsh household recycling rates increased from just 6.4 per cent in 2000–2001 to 18.1 per cent in 2004–2005, with a significant increase over the past two years (Statistical Directorate, NAW 2006). Over the same time period, household recycling rates in England increased from 11.2 per cent to 22.5 per cent (Defra 2005c).

Table 5.1 Waste management at licensed sites in Wales, 2002–2003 (thousand tonnes)

Management method	Inert and C&D	Industrial and commercial	Special	Total
Landfill	1,527	2,992	94	4,613
Incineration	No data	No data	No data	–
Biological and physico-chemical	0	124	15	139
Transfer	435	760	5	1,200
Metal recycling facilities	15	460	9	484
Total managed	1,977	4,336	123	6,436
Total excluding transfer	1,542	3,576	118	5,236

Source: Environment Agency Wales
C&D = construction and demolition



Source: Statistical Directorate, NAW (2006) and Defra (2005c)

Figure 5.1 Household recycling rates in England and Wales, 2000–2005

5.4.2 Welsh waste policy

Waste management is devolved to the Welsh Assembly Government, which has a statutory responsibility to produce a national waste strategy for Wales. *Wise about Waste: the national waste strategy for Wales* was published in June 2002 (WAG 2002b), and provides policies and guidance on dealing with particular waste streams and in planning for waste facilities. The strategy recognised that Wales was currently at the bottom of the European league table in the way that it dealt with waste and presented a blueprint for major changes to the way that products should be manufactured and waste managed in the future. It established a challenging programme of change for the next ten years, designed to move Wales from an over-reliance on landfill to a position where it will be a model for sustainable waste management.

The two main objectives of the national waste strategy are to:

- make Wales a model for sustainable waste management by adopting and implementing a sustainable, integrated approach to waste production, management and regulation which:
  - minimises the production of waste and its impact on the environment;
  - maximises the use of unavoidable waste as a resource;
  - minimises, where practicable, the use of energy from waste and landfill.

- comply with the requirements of EU waste directives and UK waste legislation.

It is in these two objectives that the major contradiction emerges in what the Welsh Assembly Government would **like** to do in relation to waste management and what it has the **powers** to do. Although waste management is a devolved function, the Assembly Government's lack of primary legislative and fiscal powers limits its ability to implement policies in relation to waste management. The Assembly Government itself admits that it does not control some of the crucial levers required to make a fundamental change in the way that waste is managed in Wales and to ensure the more productive use of resources (National Audit Office Wales 2004). For example, the Assembly Government has general powers under the Government of Wales Act 1998 to introduce new or amend existing regulations (i.e. secondary legislation), providing it has the powers to make a change under primary acts. However, the Assembly Government must be designated under the European Communities Act 1972 or have powers devolved to it under primary acts before it can make or amend regulations implementing EC directives in Wales. Furthermore, UK ministers retain the ability to make subordinate legislation in Wales for the purpose of complying with EC regulations. *Wise for Waste* acknowledges that 'for a number of the Assembly Government's aspirations to be delivered, action has to be taken in conjunction with the UK Government' (WAG 2002b, p.23).

Despite having the power to issue secondary legislation in Wales that differs from the equivalent legislation in England, the Assembly Government has rarely chosen to do this in relation to waste management. Indeed, there would be major risks involved in establishing a different regulatory framework for waste management in Wales from that in England. Regulations that were more relaxed in Wales than in England might encourage more waste to be transported into Wales for deposition, while regulations that were stricter than those in England (and costlier to implement) could drive the waste management industry out of Wales. Additionally, substantial changes in charging regimes applying to waste management licence holders could have adverse implications for business in Wales due to the relatively high number of small and medium sized enterprises (SMEs) in Wales and the role of the agricultural sector in the Welsh economy (National Audit Office Wales 2004).

A number of waste streams pose particular problems for the Welsh context. Wales has a high dependency on landfill for the management of its municipal waste and faces a problem of rapidly diminishing capacity at available landfill sites. There are 71 landfills currently operating in Wales and existing landfill capacity has been calculated to be under severe pressure by 2007 (WAG 2005). This reliance on landfill means that Wales is placed towards the bottom of the European municipal waste recycling table.

However, the Assembly Government's waste strategy sets challenging targets in relation to landfill. The Waste and Emissions Trading Act 2003 provides the legal framework to set up landfill and trading schemes in the UK as a means of significantly reducing the amount of BMW sent to landfill. The Landfill Allowances Scheme started in Wales in October 2004, six months ahead of England and is significantly different to the English case in a number of respects. Unlike in England, there will be no trading of permits in Wales. Instead, each local authority is allocated a tonnage allowance, which sets a limit on the amount of BMW that can be landfilled each year and which will reduce progressively until 2010. Environment Agency Wales monitors compliance with the scheme, and requires local authorities and landfill

operators to keep detailed records in relation to BMW in each year of the Scheme's operation.

Wales also faces increasing problems with the management of hazardous waste. As a result of EU waste legislation, more types of waste are now classified as hazardous and controls over its disposal are tighter. Since July 2004, the Landfill Directive has prevented the co-disposal of hazardous and non-hazardous waste in landfills (see Section 5.3.2). This increases the pressure for additional treatment facilities for hazardous waste in Wales, particularly since there are no commercially available landfill sites in Wales licensed to dispose of hazardous waste (National Audit Office Wales 2004).

For recycling and recovery, a series of targets have been put in place in Wales to try and improve on the current low levels of recycling (Table 5.2).

The effective regulation of waste management and the fulfilment of the Assembly Government's waste strategy objectives depend on the ability of the planning system in Wales to provide sites for the safe disposal of waste. It has been estimated that over 500 new waste management facilities will be required to achieve the Waste Strategy targets.

Table 5.2 Non-statutory targets for minimising waste in Wales

Deadline	Recycling/ composting of municipal waste (per cent)	Minimum rate (per cent)		Other requirements
		Composting	Recycling	
2003-4	15	5	5	All civic amenity sites to have facilities to store, prior to proper disposal, bonded asbestos sheets, oils, paints, solvents and fluorescent bulbs.
2006-7	25	10	10	
2009-10	40	15	15	Waste arisings per household to be no greater than those for 1997–1998.
2020	Waste arisings per person less than 300 kg per year			

Source: WAG 2002b

In 2003, the Assembly Government introduced three Regional Waste Planning areas covering the whole of Wales (North Wales, South West Wales and South East Wales). These areas have been set up to deliver the changes required in Wales in order to comply with objectives and targets in European legislation. The resulting regional waste plans aim to inform the policies of local authorities towards the use of their land over the next 10–15 years. The plans identify the need for future facilities across the region, but do not advise on suitable options for locations for potential facilities.

5.4.3 Waste policy issues and environmental inequalities

Various aspects of current Welsh waste policies raise issues with potential impacts on environmental inequality, particularly on deprived communities.

The embodiment of the waste hierarchy in the UK and Welsh waste strategies has undoubted potential positive impacts in reducing the burden of waste facilities sited in deprived communities. The reduced reliance on landfill as a result of the Landfill Directive and the associated drive towards significant increases in recycling and recovery rates are theoretically excellent propositions. However, both will require the development of infrastructure to support high-intensity recycling and composting schemes. New municipal EfW incinerators will be required, though smaller-scale 'community focussed facilities' are likely to be more attractive to local communities. If combined heat and power (CHP) can be included alongside modern technologies (e.g. gasification), then small capacity plant (<100,000 tonnes per year) could be highly beneficial to local communities through the provision of direct heating as well as electricity generation and inherently dealing with local waste.

Participation rates in recycling schemes are variable. Not only are recycling rates in metropolitan authorities across the UK on average about half those of non-metropolitan authorities (Defra 2005c), they are particularly low among those living in deprived areas.

There is a clear need to examine evidence about changing attitudes and behaviour towards recycling where uptake is currently low. McDonald and Oates (2003) argue that one of the most commonly cited barriers to participation in recycling schemes is the perceived amount of effort it entails. The context of recycling activity is important in accounting for low participation rates as, in a weak social context where recycling is not a 'visible' activity, there is little community expectation of behaviour and recycling is not perceived as the 'norm'. These views are echoed by Williams and Taylor (2004) who argue that the role of the local

authority and the actions of individual householders are paramount to the success of sustainable waste policies and, crucially, that it is not just about how many people participate in a scheme, but also how effectively they do so.

In theory, policy drivers away from landfill should in due course reduce any spatial inequalities associated with landfill waste disposal and deprived communities (Lucas *et al.* 2004). However, there are no specific UK policies to address inequalities in landfill site locations. The Landfill Tax Credit Scheme provides compensation to nearby communities through spending on local community projects, but these projects have been widely criticised for being poorly targeted and inadequate (Lucas *et al.* 2004).

Best Practicable Environmental Option was first outlined in the UK in the Fifth Report of the Royal Commission on Environmental Pollution (RCEP) on air pollution. This defined the concept as:

> 'the optimum combination of available methods so as to limit damage to the environment to the greatest extent achievable for a reasonable and acceptable total combined cost to industry and the public purse' (RCEP 1976).

BPEO was first applied to waste planning in 1995. However, there is rarely a single option that represents the 'best' option and various combinations of options may produce similar social, environmental and economic outcomes. Integrated waste management is accepted as a key policy strategy combining facilities in the optimum way to minimise waste impacts while at the same time optimising recovery and recycling. Due to the origin of BPEO in the field of environmental protection, BPEO estimates have tended to focus on environmental emissions and resource depletion rather than local environmental issues. In addition, they omit the socio-economic aspects of waste management.

With regard to environmental inequalities, these tensions within the concept of the BPEO and its application to waste management may have increased inequality in the past rather than avoiding it. For example, recycling would usually be preferred to landfilling under the BPEO. But in remote areas with dispersed and small populations, the collection and transport of recyclable materials to processing centres presents potentially significant environmental and cost disincentives. In such circumstances, it might be that direct landfilling of waste with minimal recycling is the BPEO.

Similarly, the practical operation of the proximity principle and notions of self-sufficiency may cause problems for those living in deprived communities. For example, most facilities require proximity to people and waste arisings, and good transport access. These locations are inevitably found in predominantly urban areas, where the majority of deprived communities are also found. New plant tends to be attracted to existing waste sites because of these transport links, so the operation of the proximity principle may contribute to a clustering of waste facilities in urban areas. As well as this facility clustering, the principle of self-sufficiency could promote arguments in favour of large-scale facilities to support a region and which achieve the economies of scale preferred by the waste industry. Such facilities might therefore be drawn to locate in deprived communities, thus enhancing environmental inequity. However, evidence suggests a tendency for public pressures for smaller-scale facilities, which are community rather than regionally focussed.

The principles and practice of public participation can serve to promote environmental equity for disadvantaged social groups and, crucially, can help us to gain a better understanding of where existing mechanisms are reinforcing environmental inequality.

The effectiveness of such practice in preventing or reducing environmental inequality depends on the use of participation methodologies that cater to the cultural and social needs

of the groups involved. To enable members of the public to understand policy issues and formulate preferences, these methods need to provide:

- appropriate forms of information;
- suitable venues for participation;
- access to expertise and education.

The extent to which public preferences are incorporated in policy decisions determines the worth of public participation programmes in promoting environmental equity (Hampton 1999). Petts (2005) argues that, despite recent government policy that reaffirms its desirability, there are barriers to promoting public participation. The principle at the heart of public participation (i.e. that the nature of risks and the assessments required need to be determined through discussion with the public at the earliest stage, rather than in advance of it) faces institutional challenges from decision-making cultures in authorities that incorporate ingrained technical–cultural perspectives.

In addition, one of the barriers to public engagement with issues of waste management and with options such as recycling is the 'culture of consumption', which determines attitudes towards waste production and disposal. It is clear that social responsibility needs to be fostered and people need to see themselves as the starting point for the creation of a stream of waste that has to be dealt with somehow. The policy of self-sufficiency and its emphasis on public and community involvement in waste-related matters is a step in the right direction, but such ingrained attitudes are likely to persist for a long time, with increases in waste production placing more pressure on waste management infrastructure as time progresses.

An associated issue is that of access to information and opportunities to participate in environmental decision-making as pre-requisites to environmental justice. The Aarhus Convention (UNECE 1999) stresses environmental justice as a right for every citizen. Yet, the poorest and most excluded communities are usually also those who are the least able to make use of existing participation mechanisms and can be difficult to involve in more deliberative engagement processes (Petts 2005).

5.5 Waste facilities in Wales

How many operational waste sites of what type are there in Wales?
The waste facility licence database for 2004 includes 438 sites for Wales. Table 5.3 shows the breakdown of these sites across the 24 Environment Agency site types (A1–A24) and seven grouped categories of these types. Use of these codes means that sites where multiple waste management activities take place are not recognised as such.

The largest numbers of sites fall into the 'waste transfer' category (with household, commercial and industrial sites dominant) followed by 'landfill' and 'recycling'. Remaining categories ('chemical', 'composting' and 'biological') are relatively small in number with no more than 5 per cent of the total number of licensed sites. The 'other' category includes licensed facilities excluded from later analysis).

Of these sites, 370 are recorded as operational in the OPRA database (see Section 3.4.1). The remainder are non-operational for various reasons (either pre-operational, post-operational or with operations suspended) and have no current input of waste. The proportions of operational and non-operational sites differ significantly between waste facility categories. Less than half the landfill sites are operational, reflecting the changes that have taken place in waste disposal away from landfill, as well as the need for longer term

regulatory attention in the non-operational phase than for other waste site types. For all other categories (apart from ‘other’) the proportions of non-operational sites are very low.

Table 5.3 All waste sites with OPRA Scores (operational/non-operational) in Wales by type of site and site category

Classification		Type of site	All sites				Operational sites				Not operational			
			Number		% of total		Number		%		Number		%	
Landfill	A1	Co-disposal landfill site	13		2.7		12		3.2		1		0.9	
	A2	Other landfill site taking special waste	14		2.9		8		2.2		6		5.3	
	A4	Household, commercial & industrial waste landfill	16		3.3		8		2.2		8		7.1	
	A5	Landfill taking non-biodegradable wastes	54		11.2		21		5.7		33		29.2	
	A6	Landfill taking other wastes	43	140	8.9	29.0	15	64	4.1	17.3	28	76	24.8	67.3
Recycling	A15	Material recycling treatment facility	6		1.2		5		1.4		1		0.9	
	A19	Metal recycling site (vehicle dismantler)	22		4.6		21		5.7		1		0.9	
	A20	Metal recycling site (mixed MRSs)	63	91	13.0	18.8	59	85	15.9	23.0	4	6	3.5	5.3
Waste transfer	A9	Special waste transfer station	19		3.9		15		4.1		4		3.5	
	A10	In-house storage facility												
	A12	Clinical waste transfer station	11		2.3		11		3.0		0		0.0	
	A11	Household, commercial & industrial waste transfer stations	142	172	29.4	35.6	133	159	35.9	43.0	9	13	8.0	11.5
Chemical	A16	Physical treatment facility	13		2.7		7		1.9		6		5.3	
	A17	Physico-chemical treatment facility	5		1.0		4		1.1		1		0.9	
	A18	Incinerator	3		0.6		3		0.8		0		0.0	
	A21	Chemical treatment facility	2	23	0.4	4.8	2	16	0.5	4.3	0	7	0.0	6.2
Biological	A22	Composting facility	1		0.2		1		0.3		0		0.0	
	A23	Biological treatment facility	7	8	1.4	1.7	5	6	1.4	1.6	2	2	1.8	1.8
Amenity sites	A13	Household waste amenity site	11		2.3		10		2.7		1		0.9	
	A14	Transfer station taking non-biodegradable wastes	11	22	2.3	4.6	10	20	2.7	5.4	1	2	0.9	1.8
Other	A3	Borehole												
	A7	Industrial waste landfill (factory curtilage)	19		3.9		14		3.8		5		4.4	
	A8	Lagoon	1		0.2		1		0.3		0		0.0	
	A24	Mobile plant	7	27	1.4	5.6	5	20	1.4	5.4	2	7	1.8	6.2
		Total:	483	483	100	100	370	370	100	100	113	113	100	100

5.6 Waste facilities and deprivation in Wales

For the purposes of analysis, those sites in the 'other' category (borehole, industrial waste landfill within the factory curtilage, lagoon, mobile plant) were excluded as an analysis of population proximity was considered difficult in these cases; for example, landfills within the factory curtilage were excluded because of likely confounding effects between landfill and industrial site impacts. A total of 350 sites were therefore included in the analysis.

What is the profile of deprivation of populations living within 300 m, 500 m, 1 km and 2 km of all waste sites

There is no satisfactory way of determining precise distances representing the impact that any one waste site or type of waste site will have on the nearby area. There are many variables involved that influence local impacts. This means that these can only be assessed properly by specific site-by-site analyses.

A proximity analysis using a standard distance drawn around each site can only seek to derive a **profile** or characterisation of the deprivation characteristics of the population within that distance. Using a number of different distances provides a way of testing out the sensitivity of the deprivation profile to the chosen distance. Table 5.4 and Figures 5.2–5.5 show that, for each of the distances chosen, there is a higher absolute number and a higher proportion of people living within the distance in the more deprived deciles compared with the less deprived. For every distance, the highest proportion of people is in the most deprived decile (decile 1) and the lowest in decile 8, 9 or 10. However, there is not a smooth graduation in between, with decile 5 consistently showing the second highest population level.

The overall nature of the association is therefore not sensitive to distance. But the proportional strength of the association does vary with differences between the deciles, becoming less acute as distance increases to the point where the distribution for 2 km is beginning to become relatively flat across the deciles. The declining CERI deciles 1–2 and 1–5 values also indicate this; at 300 m, people in deciles 1 and 2 are 79 per cent more likely to be living near to a waste site than others whereas, for 2 km, they are only 39 per cent more likely.

The distance of 500 m and, in a few cases, 1 km are used for simplicity in the following analyses. Though this choice is arbitrary to some degree, 300 m was felt to be too sensitive to potential inaccuracies in grid referencing, while 2 km was considered too large to characterise sensibly populations living near to many of the smaller facilities.

Table 5.4 Population within 300 m, 500 m, 1 km and 2 km of all waste sites in Wales and percentage of each deciles population within each distance

Decile	Decile population	300m	%	500m	%	1km	%	2km	%
1	295,756	12,679	21.43	25,095	20.95	76,964	15.32	222,051	13.30
2	303,561	5,596	9.46	8,912	7.44	57,422	11.43	208,087	12.46
3	300,369	4,512	7.63	12,136	10.13	59,474	11.84	182,254	10.91
4	299,361	5,531	9.35	12,310	10.28	47,764	9.51	162,225	9.71
5	300,428	10,290	17.39	15,913	13.28	62,777	12.49	186,749	11.18
6	301,111	6,166	10.42	13,462	11.24	55,400	11.02	149,467	8.95
7	297,988	4,041	6.83	7,501	6.26	32,981	6.56	129,561	7.76
8	299,734	3,449	5.83	8,097	6.76	31,639	6.30	129,772	7.77
9	294,134	4,142	7.00	10,260	8.56	39,066	7.77	153,954	9.22
10	308,241	2,768	4.68	6,112	5.10	39,018	7.76	145,795	8.73
Wales	**3,000,683**	**59,174**	**100**	**119,798**	**100**	**502,505**	**100**	**1,669,915**	**100**
CERI deciles 1 and 2			1.790		1.588		1.463		1.390
CERI deciles 1–5			1.879		1.639		1.538		1.358
CERI deciles 6–10			0.532		0.610		0.650		0.736

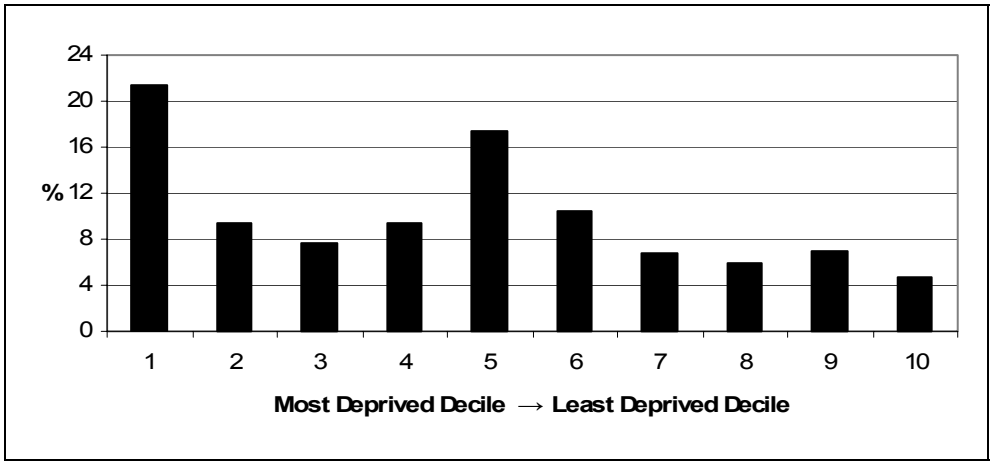


Figure 5.2 Percentage of total population in Wales within 300 m of all types of waste site by deprivation decile

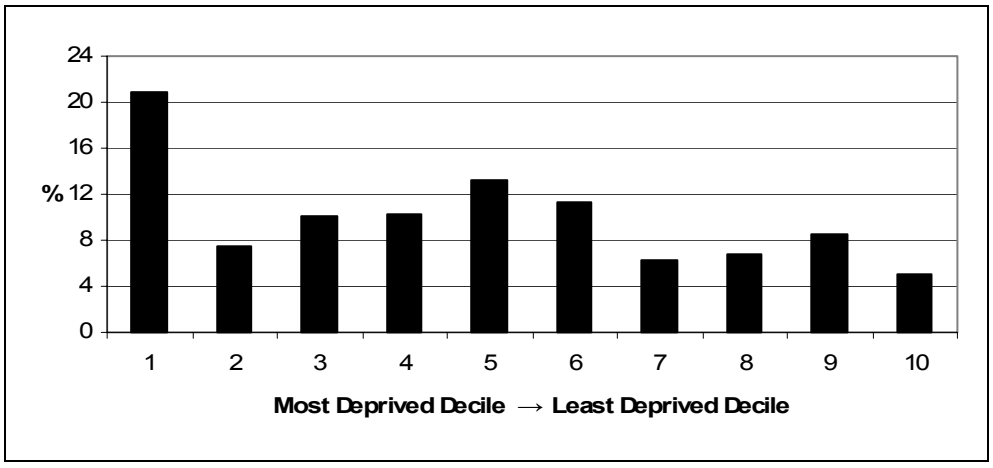


Figure 5.3 Percentage of total decile population in Wales within 500 m of all types of waste site by deprivation decile

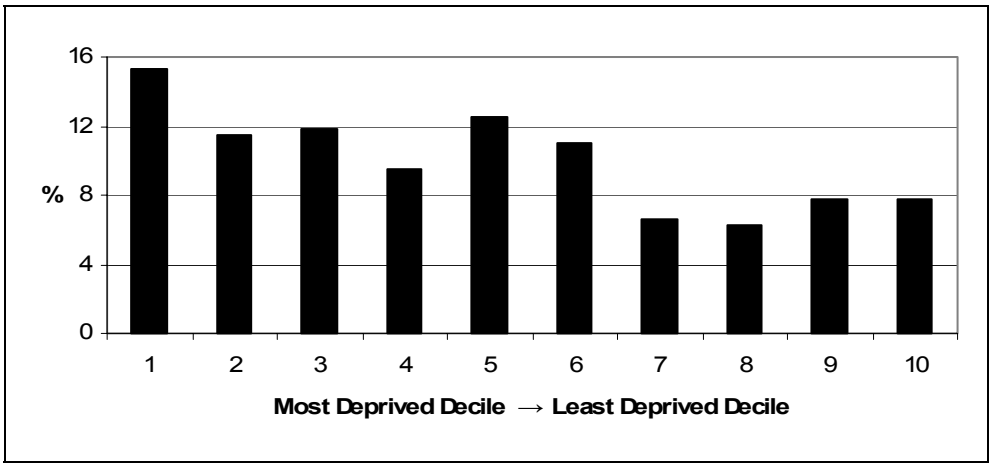


Figure 5.4 Percentage of total decile population in Wales within 1 km of all types of waste site by deprivation decile

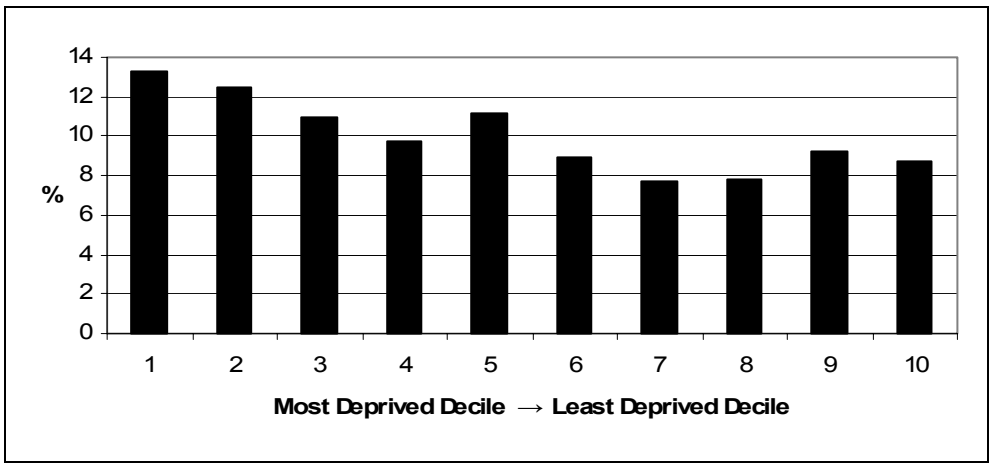


Figure 5.5 Percentage of total population in Wales within 2 km of all types of waste site by deprivation decile

What is the profile of deprivation of populations living within 500 m of different categories of site type?
Differentiating the waste sites by type begins to show some marked differences and the limitation of treating all sites as the same. Table 5.5 shows the total population within 500 m of each site type and derives an average number of people per site for each site type category.

This highlights the low numbers of people living near to landfill and chemical facilities compared with all other types of facility – indicating their typical locations away from major urban settlements. Amenity, waste transfer and recycling sites in contrast have high average population figures reflecting their need to be close to where people live and where waste is generated and collected. In this respect the proximity of local people may be considered a 'good' rather than a 'bad'.

There will be some double-counting due to some sites being very close to each other. For example, some amenity and recycling facilities are on landfill sites but have separate operating licences.

Table 5.5 Numbers of people living within 500 m of waste sites by site type category

	Wales	All sites	Landfill	Recycling	Waste transfer	Chemical	Biological	Amenity
Total population	3,000,683	119,798	8,395	57,728	108,598	1,943	2,051	13,245
% of total population	100	3.99	0.28	1.92	3.62	0.06	0.07	0.44
Number of sites		350	64	85	159	16	6	20
Mean population per site		342.3	131.2	679.2	683.0	121.5	341.8	662.2

Deprivation profiles show some distinct and related variations between site types (Table 5.6 and Figure 5.6).

- For recycling and waste transfer sites, the proportions of people living within 500 m are highest in the most deprived decile, consistent with the pattern for all waste sites. The absolute populations for these site types are much higher than for other site types (particularly for waste transfer sites), which explains their close linkage to the overall pattern.

- For other site types, the absolute levels of population are much lower and the pattern against deprivation is very different.
  - For landfill and chemical facilities, the numbers of people involved are very low, but the highest percentage population is found in decile 6.
  - For amenity and biological sites, total numbers of proximate people are very low but these are clustered towards the least deprived deciles.

Table 5.6 Population in Wales within 500 m of categories of waste site type by deprivation decile

Decile	Decile population	Total 500 m	Population within 500 m of a waste site of type					
			Landfill	Recycling	Waste transfer	Chemical	Biological	Amenity
1	295,756	25,095	1,028	10,799	28,598	150	0	0
2	303,561	8,912	8	7,579	7,462	5	0	627
3	300,369	12,136	494	4,867	11,261	99	0	0
4	299,361	12,310	727	6,708	10,978	42	143	1,013
5	300,428	15,913	289	9,624	15,700	403	539	1,368
6	301,111	13,462	2,846	4,443	10,194	958	19	3,378
7	297,988	7,501	688	4,042	6,692	92	373	227
8	299,734	8,097	1,322	4,905	4,248	22	558	1,491
9	294,134	10,260	349	3,407	7,532	112	416	2,952
10	308,241	6,112	644	1,353	5,933	60	2	2,188
Wales	**3,000,683**	**119,798**	**8,395**	**57,728**	**108,598**	**1,943**	**2,051**	**13,245**

Percentages of each decile's population within 500 m

Decile	Population	500 m	Landfill	Recycling	Waste transfer	Chemical	Biological	Amenity
1	295,756	20.95	12.24	18.71	26.33	7.71	0.00	0.00
2	303,561	7.44	0.10	13.13	6.87	0.25	0.00	4.73
3	300,369	10.13	5.89	8.43	10.37	5.08	0.00	0.00
4	299,361	10.28	8.66	11.62	10.11	2.17	6.99	7.65
5	300,428	13.28	3.44	16.67	14.46	20.75	26.26	10.33
6	301,111	11.24	33.90	7.70	9.39	49.30	0.95	25.50
7	297,988	6.26	8.20	7.00	6.16	4.73	18.21	1.71
8	299,734	6.76	15.75	8.50	3.91	1.16	27.20	11.26
9	294,134	8.56	4.16	5.90	6.94	5.79	20.30	22.29
10	308,241	5.10	7.67	2.34	5.46	3.08	0.09	16.52
Wales	**3,000,683**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
CERI deciles 1 and 2		1.588	0.564	1.871	1.992	0.346	0.000	0.199
CERI deciles 1–5		1.639	0.436	2.183	2.141	0.562	0.499	0.294
CERI deciles 6–10		0.610	2.294	0.458	0.467	1.780	2.005	3.399

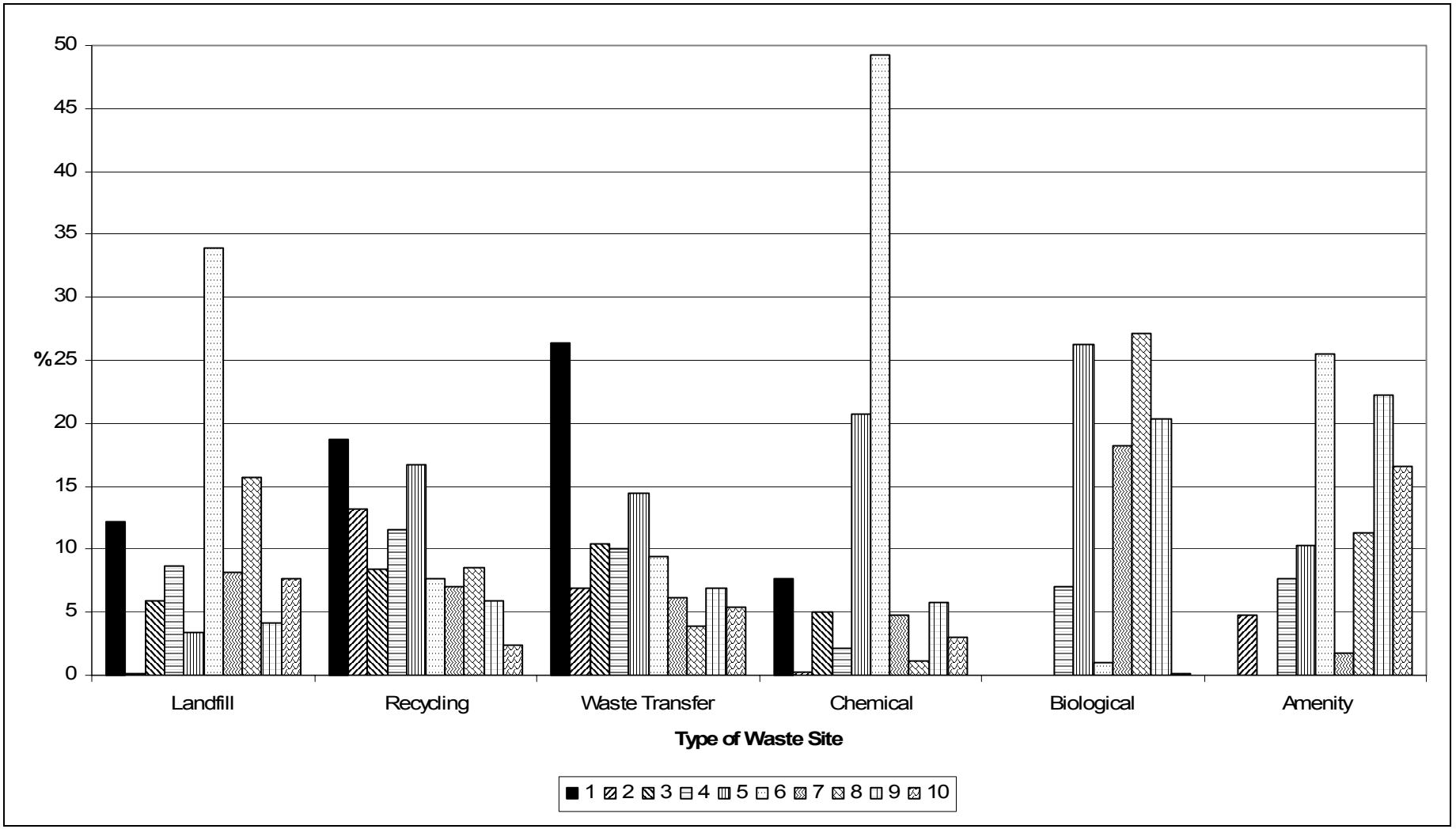


Figure 5.6 Percentage of total population in Wales within 500 m of categories of waste site by deprivation decile

5.7 Conclusion

It is important to acknowledge the methodological problems in the analysis approaches used:

- There is the fundamental problem that proximity, as indicated by the drawing of a circle around a grid reference, can only be a crude and inadequate surrogate for 'social impact'. It would therefore be wrong to use the results this gives to indicate numbers of people who are suffering environmental harm or who are at risk in some way from a nearby waste site.

- Grid reference points are poor representations of waste sites which, in reality, vary enormously in their size and shape.

- Waste sites are highly diverse in other operational respects, with major implications for their potential social impact. The analysis in this study has only partially represented this diversity.

- The IMD data are generalised across electoral divisions. In some locations this may hide smaller pockets of deprivation or affluence.

With these important caveats in mind, the study found that waste sites in Wales have a highly differentiated geography. The urban locations of recycling and waste transfer sites mean that the total numbers of people that live near to them are high, but that they also tend to have higher proportions of deprived people living near to them than the less deprived. Other sites, and in particular landfills, are located further away from populations; the total number people living in their vicinity is low and not biased towards the deprived. The implications of these differentiated patterns are considered in Section 7.2.

These results provide only an initial exploration of patterns of association between waste site locations and social deprivation without assuming any evidence of actual impact or cause/effect relationship. The ways in which a more sophisticated analysis could be developed (e.g. through using OPRA data on site performance) are discussed and exemplified in the associated waste report (Damery *et al*. 2006b).

6 River water quality in Wales

6.1 Introduction

This section outlines research on the social impacts of poor river water quality and how these may be differentiated between different social groups. It then discusses the context for river water quality policy and management in Wales and presents the methodology and results of a quantitative GIS-based analysis of the association between the water quality of classified rivers and multiple social deprivation in Wales.

6.2 The social impacts of river water quality

The associated report on water quality reviews the available literature on the social impacts of water quality and how these may be socially differentiated (Damery *et al*. 2006a). This review concludes that there is very little literature specifically on these topics. What research does exist has emphasised the extreme difficulty in establishing clear and direct causal relationships between deprivation and poor water quality. Much of the literature presents anecdotal or postulated links, rather than evidence of causal relationships verified by data analysis.

Despite the lack of specific literature, enough research exists to allow the potential social impacts of proximity to poor river water quality to be postulated and summarised. As shown in Table 6.1, these impacts relate to:

- the health effects of coming into contact with contaminated river water;
- the economic impacts associated with poor river water quality (and conversely the economic **benefits** that come in areas where water quality is good);
- aesthetic and nuisance impacts;
- geographical and community impacts;
- the positive benefits associated with recreational use of the river environment.

Table 6.1 Matrix showing potential effects of poor water quality

Category of impact	Type of impact
Health	• Gastroenteritis from contact or immersion in polluted water • Flu symptoms, skin complaints from contact or immersion in polluted water • Stomach ailments from contact or immersion in polluted water • Death or illness to domestic animals from contact with polluted water bodies • Rat infestations and potential disease transmission
Economic	• Reductions in property values • Increased levels of neighbourhood deprivation • Lack of investment in residential and commercial property • Reduction in revenues from tourism
Aesthetic and nuisance impacts	• Unpleasant odours • Poor visual amenity caused by litter, foams and scum on water surface and river banks • Creation of a poor and undesirable environment
Geographical and community impacts	• Stigmatisation of community • Decreased neighbourhood pride and reduced levels of community cohesion • Spiral of decline may develop (fly-tipping, crime, vandalism, graffiti)
Recreation and well-being	• Lower levels of well-being and mental health, increased levels of stress • Loss of recreational opportunities and amenity value of the surrounding area • Physical and social barriers to use of water resources • Fears for safety and security by visitors

Some dimensions of the relationship between deprivation and water quality are more significant than others since, to a large extent, it can be argued that the worst impacts of poor water quality can be avoided. For example, the positive benefits to amenity of high ecological status of a river or canal will be more important than any negative health issues arising from poor water quality. This differentiates the issue of water quality from waste management and flood risk; the impacts associated with these other issues are largely unavoidable for communities living in close proximity to waste management facilities or for those living in areas at risk from flooding.

There is little clear evidence available on the social differentiation of these impacts. Research on the use made of 'natural environments' and green spaces shows that, despite natural places having a high level of attraction for all age groups and ethnic groups, levels of use vary from site to site. While some age groups and social groups are well represented, others are not. This is particularly significant from an equity point of view, as it is increasingly recognised that those who live in deprived areas or who form part of deprived social groups

are more in need of the recreational and well-being benefits that may come from their proximity to water resources, but less likely to be able to take advantage of those benefits.

There are limits of what can be concluded from any association between river quality indicators and deprivation. The difficulty in overcoming methodological and conceptual issues might go some way towards explaining the lack of research into the links between deprivation and river water quality, and the social impacts of living in close proximity to poor quality river environments. The GIS analysis undertaken in this report attempted to take account of these complexities, while generalisations and assumptions had to be made to enable a national-scale analysis to be undertaken. The consequent limitations in the analysis are emphasised later in the report.

6.3 Context for river water quality

Environment Agency Wales monitors around 4,500 km of rivers and canals, and nearly 500 km of estuaries. Its primary responsibility regarding water quality (as directed by the Assembly Government) is to protect, enhance and restore the environmental quality of water covering inland and coastal surface waters and groundwaters. In particular to:

- address point source and diffuse pollution;
- support the Assembly Government in the implementation of the Water Framework Directive (WFD);
- ensure that all quality standards are met;
- plan to secure the proper use of water resources through strategic planning and effective resource management, taking into account environmental, social and economic considerations;
- ensure that the abstraction of water is sustainable;
- develop and maintain a framework of integrated water resources planning for the Environment Agency and others;
- implement the actions assigned to the Environment Agency in its Welsh water resources strategy.

The annual river quality survey for 2003 carried out by Environment Agency Wales shows water quality in Wales to be among the best in the UK. Average quality attainment is significantly higher than that achieved in England (WAG 2004b); 98.2 per cent of rivers had good or fair chemical quality, and 99.2 per cent had good or fair biological quality.

The 2000 aesthetics survey shows that 20 per cent of monitored river sites in Wales were classed as good quality, 36 per cent at fair quality, 24 per cent poor quality and 20 per cent bad (WAG 2003).

6.4 River water quality policy and context

Water management policy in the UK has changed significantly over the past decade and particularly since the introduction of the Water Framework Directive. The WFD recognises

the importance of holistic river basin management to provide an integrated management policy that takes into account all the pressures and user groups affecting the river basin. Linked to this is the UK government's commitment to sustainable development and, in this case, the sustainable management of water resources. This has led to the implementation of many river restoration schemes in recent years, some of which have been targeted towards socially deprived areas. These schemes aim to capture the regional and community benefits that can follow from water quality improvements such as economic regeneration and neighbourhood renewal.

6.4.1 Important legislation

The primary legislation relating to the UK is the Water Resources Act 1991, which contains provisions for classifying water quality, protecting groundwater and controlling discharges. This legislation applies in the same way to Wales as it does to the rest of the UK. In addition, the Assembly Government has statutory and policy responsibility for matters relating to the water industry in Wales, although there are special powers for the Secretary of State to intervene in matters which concern the main cross-border rivers (Severn, Dee and Wye).

The main drivers for policy relating to the water environment and water quality come from numerous European Directives, particularly the WFD. This Directive applies equally to Wales as to the rest of the UK both in terms of its requirements and the timetable for their implementation. The WFD will have far-reaching consequences for:

- the way in which water quality standards are set;
- the manner in which compliance with these standards is assessed;
- the way that water quality improvements are targeted.

Its adoption is widely considered to represent an important shift in the way that water bodies are managed across the European Union. The WFD places greater emphasis on catchment-focused management and the interdependency between biological and physico-chemical elements and processes. It begins to view river management according to a systems approach, with the river ecosystem as the interaction of ecology, hydrology and geomorphology.

The driving force of the WFD is the ecological status of water bodies. All Member States are required by 2015 to 'protect, enhance and restore all bodies of surface water' not designated as artificial or heavily modified with the aim of achieving 'good surface water status' – a state defined by a number of ecological, morphological and chemical parameters.

An important key feature of the WFD is the introduction of a new definition of water status, which is concerned with the ecological health of surface water as well as with chemical standards. The main requirements are to:

- establish a holistic approach to managing the water environment based on river basins, integrating water quantity with quality considerations;
- set quality objectives for all water bodies and to meet those objectives by 2015 in most cases;
- establish a quality classification system for surface water that includes chemical, hydromorphological and ecological parameters using criteria set out in the Directive;
- have statutory controls in relation to the pollution of water bodies from point and diffuse sources;
- promote sustainable water use based on long-term protection of water resources;
- achieve environmental objectives in a cost-effective way.

Other important legislation relating to water quality management in England and Wales include:

- **Environmental Protection Act 1990** – established statutory provisions for a range of environmental protection purposes, including Integrated Pollution Control for dangerous processes;

- **Environment Act 1995** – established the Environment Agency and introduced measures to enhance the protection of the environment, including further powers for the prevention and remediation of water pollution;

- **EC Freshwater Fish Directive (78/659/EEC)** – aimed to protect the health of freshwater fish populations by designating waters in need of protection and setting quality standards for those waters;

- **EC Urban Waste Water Treatment Directive (91/271/EEC)** – sets requirements for the provision of collecting systems and the treatment of sewage according to the size of the discharge and the nature of the receiving water;

- **EC Nitrates Directive (91/676/EEC)** – requires the reduction of nitrate pollution in waters that arises from agricultural inputs. Member States must identify polluted waters, designate those areas of land which drain into them as Nitrate Vulnerable Zones (NVZs), and establish and implement programmes of remedial action;

- **EC Dangerous Substances Directive (76/464/EEC)** – on pollution caused by certain dangerous substances discharged into the aquatic environment.

As a requirement of the WFD, the Freshwater Fish and Dangerous Substances Directives will be repealed in 2013, along with several other water-related directives.

6.4.2 Holistic river basin management

Environmental management policy is increasingly encompassing a broader view of what counts as 'water management', which goes wider than the traditional responsibilities of the water utilities (Defra 2002). During the past decade, it has been recognised that effective water resource management must be holistic and integrated, and policy approaches have been changed accordingly. In England and Wales, for example, the Environment Agency has introduced catchment abstraction management strategies which explicitly recognise that:

- rivers have multiple users;
- the needs of all users must be addressed in order to identify the optimal solutions for river management (McDonald *et al*. 2004).

Similarly, the WFD requires the management of river basins as a whole. The first stage towards fulfilling these requirements is river basin characterisation. Whereas GQA water quality assessments focused on classifying rivers and other water bodies in terms of chemical and biological quality, river basin characterisations are required as a measure of assessing and managing pressures on the water environment in an integrated and holistic way. A greater variety of criteria need to be assessed, particularly in terms of pollutant discharges.

River basin characterisation is a two-stage assessment of water bodies under the WFD.

- The first stage entails identifying water bodies and describing their natural characteristics.

- The second stage is the assessment of the pressures and impacts of human activities on the water environment.

The assessment identifies those water bodies that are at risk of not achieving the environmental objectives set out in the WFD, and allows targeted monitoring programmes and improvement schemes to be implemented in order to achieve the good ecological status for all water bodies demanded by the WFD.

The first stage of the characterisation process has been undertaken in England and Wales (http://www.defra.gov.uk/environment/water/wfd/article5/index.htm). Risk assessments have shown that 23.1 per cent of rivers in England and Wales are at risk of not achieving WFD objectives in terms of point discharges, and 82.4 per cent in terms of diffuse pollution.

The WFD also requires the production of the first River Basin Management Plans (RBMPs) for all major rivers in all European Member States by the end of 2009 (Environment Agency 2006). An important benefit of introducing an integrated and holistic approach towards river basin management is in achieving better integration of the large number of separate local or regional river plans, including those covering environmental improvements, abstraction and flooding. Such an approach will also have major benefits in allowing improvements to be achieved in the most cost-effective way.

The main reporting unit for the RBMP is the River Basin District (RBD), defined as a river basin or several river basins, together with stretches of coastal waters. RBMPs are based on these districts and set out how the objectives for the RBD will be achieved. There are 11 RBDs in England and Wales – nine wholly in England and two spanning the England/Wales administrative boundary (see http://www.environment-agency.gov.uk/wfd).

Integrated River Basin Management will achieve the WFD objectives through six-yearly cycles of planning and action. The river basin planning process currently being implemented aims to:

- make environmental and economic assessments;
- establish monitoring programmes and means of analysing results;
- set environmental objectives;
- develop improvement programmes to achieve those objectives.

6.4.3 River restoration

A key policy intervention related to water quality in England and Wales is river restoration, which has been increasingly attempted in recent years. Historically, more effort was put into protecting good quality water rather than improving poor quality water. But, increasingly, ecologically based restoration activities are being undertaken in order to improve degraded waterways. It is now recognised that returning rivers to their 'natural' state can bring widespread benefits, not just to biodiversity, but in terms of wider regeneration and renewal (Eden *et al*. 1999, 2000).

Despite little agreement as to what constitutes a successful river restoration effort (McDonald *et al*. 2004, Palmer *et al*. 2005), river restoration and river habitat enhancement schemes are now widespread in North America, Australia and in a number of European countries. The UK River Restoration Centre (http://www.therrc.co.uk) had a database of more than 800 restoration projects undertaken in the UK only four years after its establishment in 1998 (Janes and Phillip 2002).

Floodplain restoration has been influenced by the concepts of sustainability and sustainable development (Adams *et al*. 2004). In the UK, most river restoration projects – usually undertaken by or in conjunction with the Environment Agency – have been relatively modest, involving limited attempts to restore elements of the structure or function of river systems, and to increase aquatic or riparian diversity. Most UK projects were initially confined to river channel improvements or changes to the immediate banks of rivers. These have been gradually extended to the wider floodplain.

Once restored, a river can bring far-reaching changes to the surrounding area. Apart from the environmental and biodiversity benefits, a restored river can give local people an accessible, high-quality natural space within walking distance from their homes. River corridors can contribute to sustainable transport strategies by providing safe walking and cycling routes, and can encourage people to appreciate their local environment. Attractive rivers can also become a focal point for local people and help to promote a sense of community, as well as helping local economic development by attracting new businesses (Vivash *et al.* 1998, Tunstall *et al*. 1999, Pedroli *et al*. 2001).

6.5 Issues specific to the Welsh context

Despite the generally good quality of river water in Wales relative to the rest of the UK, there are still some pressing water quality issues. Indeed, the initial characterisation of water bodies in Wales as part of the WFD suggests that about 90 per cent of Welsh water bodies may be at risk of not meeting its environmental objectives (WAG 2005).

Water quality in Welsh watercourses, particularly in terms of biological quality, has fluctuated significantly in recent years. Major programmes of investment in water quality in Wales (by the then Department of the Environment and the water companies) lead to significant improvements in Welsh water quality between 1990 and 1995.

However, the biological quality of Welsh rivers declined between 1995 and 2000, reversing many of the earlier gains. This is thought to be due to several issues affecting water quality in Wales which, although not unique to Wales, nevertheless proved to be significant.

One such issue is the problem of diffuse pollution and overflows from sewerage systems, which have caused harmful nutrient enrichment in Welsh rivers and streams. As 79 per cent of land in Wales is used for agriculture, agricultural run-off (particularly the detrimental effects of sheep dip chemicals) is a significant source of diffuse pollution. The Organisation for Economic Co-operation and Development (OECD) has identified this as a major concern in the attempt to maintain water standards and the Assembly Government is committed to tackling diffuse pollution in Wales through better monitoring and education on good practice land management.

In addition, many Welsh rivers and streams are affected by acidification – perhaps up to 40 per cent of the total length (WAG 2005). Finally, the legacy of heavy and extractive industry in Wales has been responsible for many failures in water quality standards. The Assembly Government has developed a Metal Mines Strategy (WAG and Environment Agency 2002) to tackle some of the most problematic sites such as Parys Mountain on Anglesey and the Cwn Rheidol metal mine in south-west Wales. This work is partly funded by the Assembly Government and partly from the EU through Objective 1 structural funds.

On a smaller scale, and as part of its commitment to raise and maintain water quality standards in Wales, the Assembly Government and other bodies have launched specific water quality initiatives. A partnership between Keep Wales Tidy, Local Groundwork Trusts

and Environment Agency Wales is working with local volunteers in 34 'Rivercare' groups to clean up rivers in the South Wales valleys and to keep the environment clear of litter.

6.6 River water quality in Wales

The GIS analysis undertaken in this report had to consider the complexities involved in the relationship between water quality and people living near to rivers. As discussed in the associated report (Damery *et al*. 2006a), there are a number of problems over methodological issues for environmental justice studies on river water quality. For example:

- Rivers can have both negative and positive impacts on people who live near to them.
- Some negative impacts may be eliminated by avoiding contact with the river water.
- Some positive and negative impacts (e.g. various forms of recreation) rely upon access to the river corridor which may or may not be possible along any one river stretch.
- Different impacts will extend different distances from each water body (which vary substantially in physical size), depending upon their severity and local contexts and contingencies.
- There is no one measure of river water quality that can adequately provide an indicator of the range of positive and negative impacts which river water quality and the wider river environment may have on the local population.

For these reasons (particularly the last) while the analysis in this study is, in some respects, more sophisticated than previous studies, it does not provide a definitive or entirely satisfactory account of the relationship between river water quality and deprivation. Generalisations and assumptions have had to be made to enable a national-scale analysis to be undertaken. The discussion therefore emphasises the need to consider carefully the results produced and their implications for future analytical research.

6.6.1 Total numbers of people living near to rivers

How many people live near to river stretches of different water quality grades?
Nearly 1.5 million people in Wales (a third of the total population) live within 600 m of at least one stretch of the classified river network (Table 6.2). As would be expected, this total is divided unevenly across the different water quality grades (see Section 3.5.1) as different total lengths of river falling within each of the six grades.

Very few stretches of river fall into the lowest quality grades E and F (only 0.7 and 0.4 per cent of the total network respectively) and nearly half the river length is in grade B. The differences in percentage population within 600 m of each quality grade do not at all match directly the differences in percentage river length across the quality grades, indicating that there is a population density difference between the grades. For example, grade A rivers account for 31 per cent of the river length, but only 21 per cent of the proximate population; Grade D rivers account for 2.5 per cent of the river length but 4.4 per cent of the proximate population. Overall, however, over 95 per cent of the people living within 600 m of a river are near to a very good, good or fairly good quality river stretch. This is significantly higher than for England.

Table 6.2 Total populations living within 600 m of river stretches with biological grades A–F and lengths of rivers within each grade

	All rivers	A	B	C	D	E	F
Total population (best grade)	1,145,737	244,308	564,473	282,777	50,116	4,049	14
% of Wales population	100	21.3	49.3	24.7	4.4	0.4	0.0
Total river length (km)	4559.2	1402.9	2200.1	795.4	114.6	30.4	15.7
% of river length	100	30.8	48.3	17.4	2.5	0.7	0.4

The total population living within 600 m of the different grades of rivers does not equal the total population for all rivers, as some people live within 600 m of more than one river stretch with different grades

6.6.2 River water quality and deprivation

Are deprived populations more likely to be living near to rivers with poor water quality than others?

There is a consistent and clear gradient in the total numbers of people within each deprivation decile living within 600 m of a classified river stretch in Wales. People in the most deprived deciles are more likely to be living near to a river than people in the least deprived. As shown in Figure 6.1, 14.3 per cent of the people living within 600 m of a river are in decile 1 compared with only 6.7 per cent in decile 10. This suggests that deprived populations may potentially be able to benefit more from the proximity of a river – although, as previously discussed, in practice there are a large number of factors which will influence whether or not these potential benefits are realisable or realised.

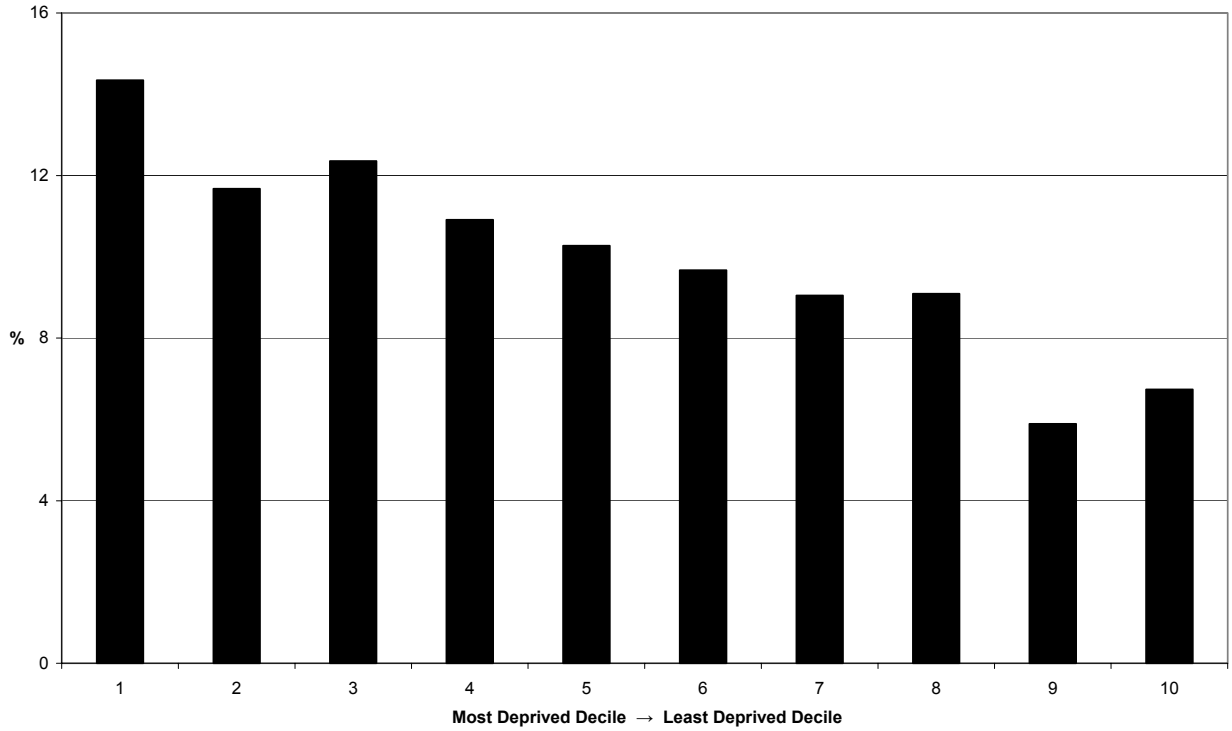


Figure 6.1 Percentage of people within each deprivation decile living within 600 m of a classified river

If the water quality grades of these river stretches are examined, this overall pattern shifts to some degree. Two sets of data are provided here;

- the first counts all people within 600 m of river stretches of different quality (so that any one person may be counted more than once if they live near to more than one river stretch of different qualities);
- the second takes account only of the best quality river stretch that any one person lives near to (avoiding double-counting and focusing on the potential benefits that each person may be able to realise by living near to a good quality river).

Both analyses show broadly similar patterns.

The 'all river' data (Table 6.3 and Figure 6.2) show that, while for grades B, C and D, the overall pattern of highest proportions of population is in the least deprived decile, the concentration on the least deprived gets greater as river water quality worsens. The CI value for grade D is 0.47 compared with 0.14 for grade B. For grade A rivers, the overall pattern of proximity to rivers is not reproduced such that there are higher proportions of people in the upper and middle deprivation deciles than for other river quality categories – the CI value is just negative at –0.03.

This suggests that, as river water quality worsens, it tends to become more concentrated in deprived areas. Grade E stretches have only about 8,000 people living near to them, but this population is concentrated in deciles 2 and 3 – which to an extent backs up this picture. However, there are hardly any grade F rivers in Wales.

Table 6.3 Totals and percentages of people living within 600 m of river stretches with biological water quality grades A–F by deprivation decile

Decile	All rivers A to F	A	B	C	D	E	F
1	164,398	15,982	84,159	69,633	27,085	164	0
2	133,765	25,422	66,567	49,938	22,500	3,198	0
3	141,595	13,882	95,503	46,111	14,703	2,973	0
4	125,008	32,821	76,547	31,913	6,403	0	0
5	117,681	20,259	66,841	45,182	10,047	279	0
6	110,791	36,868	58,588	27,111	2,838	1,360	0
7	103,650	31,030	60,464	25,048	720	18	14
8	104,182	36,994	46,047	36,279	2,796	0	0
9	67,463	11,300	35,950	29,776	1,762	0	0
10	77,205	19,750	44,232	16,326	2,650	0	0
Total	**1,145,737**	**244,308**	**634,898**	**377,317**	**91,504**	**7,993**	**14**
			Percentages				
1	14.35	6.54	13.26	18.45	29.60	2.05	0.00
2	11.68	10.41	10.48	13.24	24.59	40.02	0.00
3	12.36	5.68	15.04	12.22	16.07	37.20	0.00
4	10.91	13.43	12.06	8.46	7.00	0.00	0.00
5	10.27	8.29	10.53	11.97	10.98	3.49	0.00
6	9.67	15.09	9.23	7.19	3.10	17.01	0.00
7	9.05	12.70	9.52	6.64	0.79	0.23	100.00
8	9.09	15.14	7.25	9.62	3.06	0.00	0.00
9	5.89	4.63	5.66	7.89	1.93	0.00	0.00
10	6.74	8.08	6.97	4.33	2.90	0.00	0.00
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**
CI values		**–0.03**	**0.14**	**0.19**	**0.49**	**0.47**	**-0.30**
CERI deciles 1 and 2		1.41	0.818	1.247	1.859	4.740	2.91
CERI deciles 1–5		1.47	0.798	1.590	1.807	7.508	4.81
CERI deciles 6–10		0.68	1.253	0.629	0.554	0.133	0.21

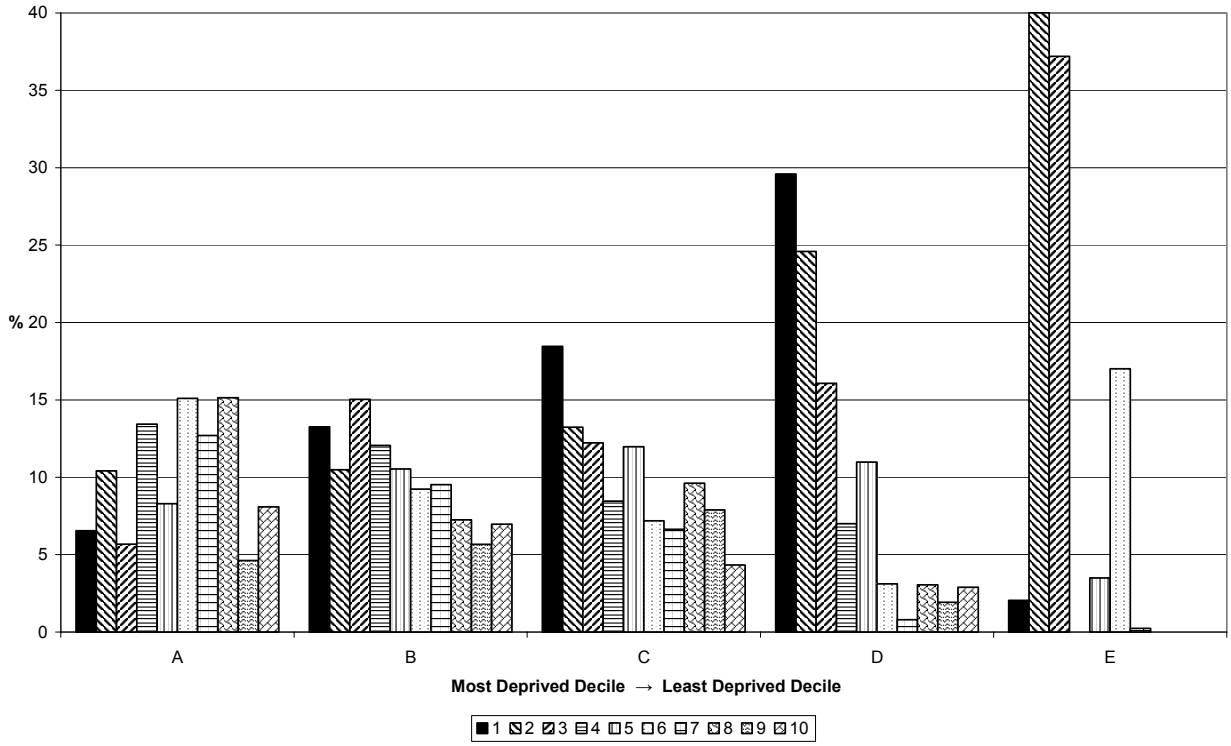


Figure 6.2 Percentages of people living within 600 m of river stretches with biological water quality grades A–F by deprivation decile

The 'best grade' data are shown in Table 6.4 and Figure 6.3, and displays similar patterns to the 'all river' analysis. There are largely only marginal differences in the proportions of people within each decile living near to rivers of different grades, and only small changes in the CI and CERI indicators of degree of inequality. Any general direction of difference that can be identified is towards the distribution across the deciles being marginally more unequal for the 'best grade' data – this is particularly evident for grade D rivers.

Table 6.4 Totals and percentages of people living within 600 m of river stretches with the best biological water quality grade by deprivation decile

Decile	All rivers A to F	A	B	C	D	E	F
1	164,398	15,982	76,633	48,709	23,074	0	0
2	133,765	25,422	56,294	36,706	13,849	1,494	0
3	141,595	13,882	91,840	31,033	3,931	908	0
4	125,008	32,821	67,051	23,166	1,969	0	0
5	117,681	20,259	62,045	30,545	4,561	271	0
6	110,791	36,868	49,923	21,722	920	1,357	0
7	103,650	31,030	51,635	20,493	459	18	14
8	104,182	36,994	35,717	30,516	954	0	0
9	67,463	11,300	32,375	23,775	12	0	0
10	77,205	19,750	40,959	16,111	385	0	0
Total	**1,145,737**	**244,308**	**564,473**	**282,777**	**50,116**	**4,049**	**14**
			Percentages				
1	14.35	6.54	13.58	17.23	46.04	0.00	0.00
2	11.68	10.41	9.97	12.98	27.63	36.90	0.00
3	12.36	5.68	16.27	10.97	7.84	22.44	0.00
4	10.91	13.43	11.88	8.19	3.93	0.00	0.00
5	10.27	8.29	10.99	10.80	9.10	6.69	0.00
6	9.67	15.09	8.84	7.68	1.84	33.52	0.00
7	9.05	12.70	9.15	7.25	0.92	0.45	100.00
8	9.09	15.14	6.33	10.79	1.90	0.00	0.00
9	5.89	4.63	5.74	8.41	0.02	0.00	0.00
10	6.74	8.08	7.26	5.70	0.77	0.00	0.00
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**
CI values		**-0.03**	**0.15**	**0.14**	**0.65**	**0.34**	**-0.30**
CERI deciles 1 and 2		0.818	1.234	1.734	11.215	2.34	0.00
CERI deciles 1–5		0.798	1.682	1.513	17.367	1.95	0.00
CERI deciles 6–10		1.253	0.594	0.661	0.058	0.51	0

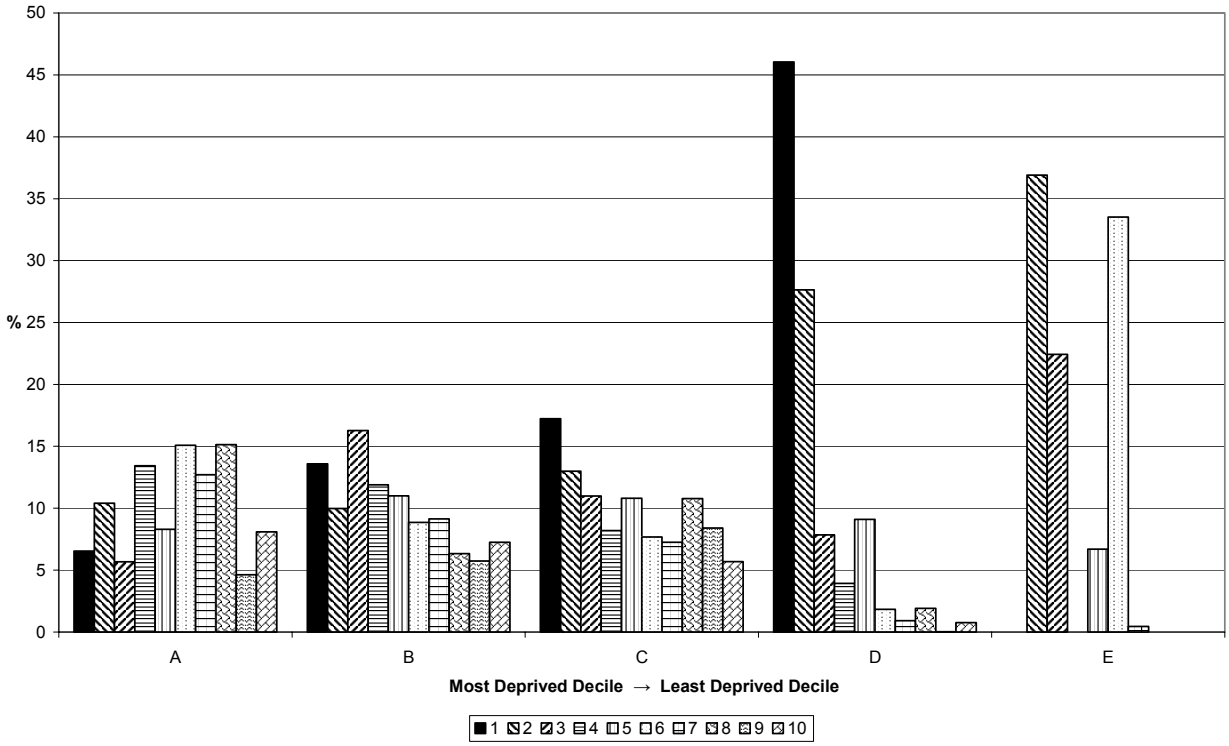


Figure 6.3 Percentages of people living within 600 m of river stretches with the best biological water quality grade by deprivation decile

6.6.3 Conclusion

The analysis has important methodological limitations relating particularly to:

- the use of the biology water quality indicator;
- the choice of 600 m as a buffer distance;
- its application to all rivers regardless of size;
- the lack of data on access to the river environment.

The analysis must therefore be taken to some degree as preliminary and exploratory. It is also important not to simplistically equate numbers of people living near to rivers with numbers of people experiencing good or bad impacts on their quality of life.

River water quality in Wales is generally good and the lengths of poor quality rivers are very low. With these caveats in mind, the analysis has found that deprived people are more likely than others to live near to a river in Wales. However, within this overall pattern there is some evidence that, as river water quality worsens, the concentration towards deprived people increases. The implications of these results are discussed in Section 7.3.

7 Recommendations

This section presents both generic recommendations regarding environmental inequalities and how these should be addressed in policy, and recommendations specific to the situation in Wales. The recommendations draw on both the specific findings of this report and the broader analysis and reasoning laid out in the accompanying four reports. Where appropriate, there is repetition of recommendations made in these reports.

Overall in Wales the commitment to sustainable development and addressing deprivation provides a supportive context for addressing environmental inequalities. Though it is also important to recognise the constraints on the legislative actions that can be adopted by the Welsh Assembly Government, there are in practice many ways in which policy can be shaped, implemented and prioritised to pursue particular outcomes for people and the environment in Wales.

7.1 Flood risk

Any attempt to tackle inequalities in the social distribution and impacts of flood risk needs to consider the implications of climate change for future flooding. The Foresight report, *Future Flooding*, considered the economic, social and environmental consequences of future patterns of flooding (DTI 2004). It concluded that impacts would not be felt equally:

> 'The socially disadvantaged will be hardest hit. The poor are less able to afford flooding insurance and less able to pay for expensive repairs. People who are ill or who have disabilities will be more vulnerable to the immediate hazard of a flood and to health risks due to polluted floodwaters' (DTI 2004, p.20).

The report also noted that, while social impacts are hard to quantify, the analysis showed a large increase in social risks in all of the scenarios considered, commenting that: 'unless these risks are managed, significant sections of the population could be blighted' (DTI 2004, p.24).

In the main report on environmental inequalities and flooding (Walker *et al.* 2006), it was concluded that there is evidence to suggest that deprived neighbourhoods are likely to be particularly hard hit by the social impacts associated with flooding. However, it was also emphasised that deprived neighbourhoods are not all the same. Some of the dimensions of difference, which may influence how they are impacted by flooding, include:

- local social relations;
- relationships with emergency services;
- ethnic and cultural make-up;
- type of housing;
- age profile of residents.

It is also the case that vulnerable people do not all live in deprived communities. Not all poor people will live in poor neighbourhoods and vulnerable people are not necessarily poor; vulnerabilities associated with age, gender and disability do not map simply onto measures of socio-economic status. In a number of respects, not enough is known about how different types of neighbourhoods are affected by flooding.

The analysis of the deprivation profile of people at risk from flooding in Wales contained in this report does not indicate that the most deprived are more at risk – in absolute and relative numerical terms – than other population groups. The least deprived **are** least at risk, but the highest proportions of people in flood risk areas are from the middle of the deprivation range.

For this reason, flood management policy in Wales does not have to face up to the situation of having very large numbers of people already experiencing social and economic deprivation in flood risk zones – as is the case in England for sea flooding. However, where deprivation and flood risk do coincide in Wales, there is still a need for socially sensitive policies to be applied, even if the total numbers of deprived people at risk are not that high.

A number of factors need to be borne in mind when considering the scope for, and nature of, policy interventions, and in developing policy and research recommendations.

- The analysis undertaken largely confirms the relationships between flood risk and deprivation found in previous studies. It used a more sophisticated methodology than previous work and enhanced datasets. However, this study was not able to take account of the level of flood protection provided for communities in the risk zones used, which may change the patterns of distribution identified; it may, for example, be that the most deprived are least protected by flood defences.

- Section 4.3 outlined a number of ways in which flood policy and management in Wales is already seeking to take account of social issues. Most of these interventions are relatively recent, including the prioritisation of flood defence investment in Wales in Objective 1 areas, and it is difficult therefore to evaluate their significance. It was not possible to undertake a systematic assessment of the ways in which past and current policy measures may be producing outcomes which either positively or negatively impact on patterns of inequality – raising questions of procedural and policy justice.

- The Flood Map used in the data analysis defines areas and the people within them as ‘at-risk’ or ‘zoned as risky’. Though necessary for flood management purposes and land use planning, this potentially affects the cost of insurance and, possibly, people’s ability to move house. This ‘label’ may also have a differential impact on different populations and may create a polarisation of communities. The accuracy of these maps is of vital importance to those who become labelled as ‘at-risk’.

A number of recommendations follow from this and earlier discussions.

Recommendation 1
Flood risk policy and management at national, regional and local levels should continue to develop in directions that recognise that the impacts of flooding are socially differentiated in a range of sometimes complex ways. However, vulnerability and wherever it arises should be factored into:

- flood management planning;
- priority setting;
- option analysis;
- work before, during and after flood events.

Particular attention needs to be paid to differences between urban and rural areas, as discussed in a parallel report by Twigger-Ross (2006).

Recommendation 2
Flood risk policy at a strategic level should take account of likely future change in climatic, economic and social variables following the approach adopted in the Foresight report. In particular, interactions between processes of environmental, social and economic change, and how these may increase vulnerabilities for certain parts of society should be identified.

Recommendation 3
There should be sustained monitoring of the effectiveness of policy measures designed to take account of:

- the social impacts of flooding;
- the vulnerability of different social groups.

As a priority, the impact of changes made to the appraisal methodology for targeting flood protection investment should be monitored in order to evaluate equity implications and the sufficiency of the changes that have been made.

Recommendation 4
Opportunities should be identified for tackling environmental and social issues together – building local capacity and tackling flood risk problems and social exclusion simultaneously.

As Few (2003, p.54) comments:

> 'Action to counter vulnerability to flood hazards needs to work hand in hand with action to reduce poverty and promote sustainability. Indeed, sustainable development in the context of a flood prone area arguably implies supporting people's capacity to 'live with' floods rather than attempting to engineer away the problem.'

This recommendation is particularly relevant to local authorities and agencies involved in local flood hazard management and catchment flood management planning.

Recommendation 5
As the Environment Agency's Flood Map is refined, further data analysis of the relationship between deprivation and flooding should be undertaken that takes account of flood defences. This should consider:

- the impact that flood defences have on the social distribution of flood risk;
- the extent to which past flood investment decisions have afforded a greater degree of protection to the 'better off' due to the primacy of economic losses in investment appraisal.

Recommendation 6
Targeted information and advice to vulnerable groups on flooding should be developed in collaboration with:

- national and local agencies;
- organisations that work with particular social groups and have local knowledge.

Recommendation 7
Further research is needed to understand:

- how neighbourhoods as a whole are affected by flooding;
- the experience of formal and informal Flood Action Groups in different kinds of neighbourhoods;

- the age and ethnicity dimensions of vulnerability;
- differences in profiles of vulnerability between urban and rural areas, and the ways in which policy measures should be developed to take account of these differences;
- case studies comparing different policy interventions to manage flood risk and the equity implications of these.

7.2 Waste management

The management of waste is a growing problem in Wales and of acute policy importance. Many more waste facilities are going to be needed as the transition away from landfill as the dominant waste management method takes place. Questions of impacts on local people and equity in the location of new facilities are likely to become highly relevant and potentially problematic in managing this transition.

Waste facilities present a range of potentially negative and/or positive impacts to people living near to them. However, their significance is highly variable between size and types of site and there is much uncertainty, particularly in relation to impacts on health.

The data analysis undertaken in this study relating the location of waste facilities to patterns of social deprivation suffers from a number of methodological limitations, particularly:

- there is the fundamental problem that proximity, as indicated by the drawing of a circle around a grid reference, can only be a crude and inadequate surrogate for 'social impact';

- grid reference points are poor representations of waste sites which, in reality, vary enormously in their size and shape;

- waste sites are highly diverse in other operational respects, with major implications for their potential social impact. The analysis undertaken in this study has only partially represented this diversity.

With these important caveats in mind, our analysis has found that waste sites in Wales have a highly differentiated geography. The urban location of recycling and waste transfer sites means that a large number of people live near to them. However, they also tend to have higher proportions of deprived people living near to them compared with the less deprived. Other sites, and in particular landfills, are located further away from populations; the total number of people living in their vicinity is low and not biased towards the deprived.

The outcomes of this analysis and the discussion relating to waste management and environmental inequality in Section 5 suggest that further attention to environmental inequality issues would improve the evidence base for causation between risk and geographical proximity of deprived communities. This is still weak. The analysis undertaken in this project has demonstrated and re-emphasised the complexities involved, and indicated possible approaches for developing a more involved analysis. However, vital questions relating to the geography of risk and impact cannot be resolved by a simple proximity analysis.

Recommendation 8
Further research is needed to improve our understanding of the social impacts and risks relating to geographical proximity to environmental impacts/hazards. This research should

build on the exploratory analysis undertaken in this and other projects. It should include detailed longitudinal case studies to understand how and why waste facilities have been more likely to be located closer to deprived communities over time and how this situation might change in the future. A number of organisations could be involved in funding such research including the Environment Agency.

An important issue relates to cumulative impacts and the extent to which these are considered adequately in current waste management policy, siting and licensing decisions. An individual site may be deemed to have insignificant impacts under the planning and licensing regimes, but problems could still arise with the synergistic or cumulative effects of the aggregation of impacts from multiple sources. This is not least because it is recognised that individuals in more deprived communities may be more vulnerable due to poorer health profiles.

Recommendation 9
A programme of research based on cumulative impacts and particularly the extent to which they can be (a) identified, (b) assessed, and (c) incorporated into meaningful policy is urgently needed. This would be particularly appropriate for joint funding involving government agencies, charities and research councils.

This project has not been able to produce definitive evidence that waste facilities are disproportionately situated close to deprived communities. However, the initial exploratory analysis for Wales suggests this is the case in relation to **some** types of waste facilities, including those that are likely to be required in greater numbers in the future.

The reasons why or how such circumstances may have arisen over time (many decades) are not understood (hence Recommendation 8). But given the number of new waste facilities that will be required in Wales, it is important that existing environmental assessment tools and approaches used at both planning and licensing stages consider adequately the environmental and social characteristics of areas where waste facilities are to be located. It is not apparent that existing tools fulfil this requirement in practice.

Approaches that bring sustainability into the heart of government policy and which aim to explicitly consider issues of inequality and community at local and regional scales (as in Wales) are an important step in overcoming some of the shortcomings of established assessment tools and appraisal instruments.

Recommendation 10
There is a need to better understand how environmental equity is taken into account in waste planning, siting and licensing decisions – particularly through existing assessment approaches – and to identify how decisions in this context could be enhanced. Such research could explore a number of recent case examples of different decisions with the aim of identifying limitations and barriers to the integration of equity considerations in decision-making. Various government departments and agencies, including the Welsh Assembly Government could fund such research.

The operation of the proximity principle in reality may lead to a tendency for new waste facilities to be sited in areas that are already home to other waste sites. Because urban areas produce the most waste and because they have the best transport systems, the proximity principle and the self-sufficiency principle will inevitably drive waste sites to locate in these areas, not withstanding other policies to protect rural and Green Belt areas. This suggests that there will continue to be a spatial co-location between waste sites and deprived communities.

In addition, the operation of the waste hierarchy and the recommendation that waste should be reduced, reused, recycled or recovered in preference to disposal may promote certain types of responses over others. For example, the increased reliance on recycling as a means of managing waste has its own potential consequences with regard to site location and operation. Not only will there potentially be a greater spatial dispersal of smaller sites. It is important to remember that recycling is of benefit only if the environmental impacts and resources needed are lower than those associated with providing equivalent virgin material (Lave *et al*. 1999). Welsh household recycling rates are still low, especially in major urban areas where most household waste is produced.

Recommendation 11
There is a need for better understanding of public attitudes and behaviours towards different waste management options such as recycling, rates of which are lowest in deprived and low-income areas.

Recommendation 12
Future waste management scenarios should be developed that take account of:

- the implications of different waste management options;
- their social impacts;
- implications for environmental equity under different resource use and waste generation conditions.

The principles and practice of public participation can serve to promote environmental equity for disadvantaged social groups and, crucially, can help us to gain a better understanding of where existing mechanisms are reinforcing environmental inequality. Public participation and community involvement in waste management strategy and siting decisions is essential to enhance the effectiveness of waste management policy and to deal explicitly with community impacts. The formation of neighbourhood strategic partnerships is one means of enhancing policy effectively. The effectiveness of such practice in preventing or reducing environmental inequality depends on the use of participation methodologies that cater to the cultural and social needs of the groups involved. An associated issue is that of access to information and opportunities to participate in environmental decision-making as pre-requisites to environmental justice. The Aarhus Convention (UNECE 1999) stresses environmental justice as a right for every citizen.

In addition, one of the barriers to public engagement with issues of waste management and with options such as recycling is the ‘culture of consumption’, which determines attitudes towards waste production and disposal. It is clear that social responsibility needs to be fostered and people need to see themselves as the starting point for the creation of a stream of waste that has to be dealt with somehow.

Recommendation 13
Marginal groups and communities will require access to additional resources and support if they are to make effective use of public participation mechanisms. Such support mechanisms rarely exist. Consideration therefore needs to be given to the nature of the support mechanisms required and the means to bring these into operation. This recommendation is relevant for many governmental and NGOs involved in the waste field.

A major problem with environmental equity or justice studies, including the analysis undertaken in this project, is that finding an association between the location of waste facilities and the location of potentially vulnerable communities does not necessarily prove that there is a risk of adverse impact associated with that proximity.

Despite the recent increase in concern and research interest in issues of environmental equity, the evidence for causation in the UK remains weak. This is a particularly important point when considering potential policy changes to address environmental inequalities.

In addition, nearly all evidence for causation that does exist relates only to levels of deprivation as measured by the Index of Multiple Deprivation. There is little attempt (or possibility given the available data sources) to disaggregate this index to allow consideration of aspects such as gender, ethnicity, disability, etc.

Recommendation 14
Research is needed to make it easier to disaggregate existing data sources and to identify ways in which new datasets can be created to help to develop a more refined understanding of environmental inequity in relation to waste management.

7.3 River water quality

The relevance of issues of water quality to concerns about environmental inequality and injustice are little examined in the literature and have not, as yet, featured significantly in policy. The social impacts that may be experienced when poor river water quality exists are multidimensional. Their scale and severity is, to some degree, uncertain and they are likely to be experienced differently rather than equally – but not necessarily along conventional lines of social differentiation (e.g. in terms of deprivation, ethnicity, gender, disability, etc.) or related to area-based social characteristics.

For example, some of the impacts of poor water quality (particularly those experienced by individuals rather than neighbourhoods as a whole) depend entirely on the use made of the river environment. If the river environment is avoided, these impacts will not be experienced. The propensity or ability to use the river environment may be related to social characteristics, but also to interests and leisure choices – which cut across social groupings.

For these reasons the development of policy recommendations is not as straightforward as for the related area of flood risk (where the physical relationship between impacts/risks and social differentiation is more direct and established). There is a need for the relationship between river water quality and social inequality and its policy significance to be carefully considered and discussed both within and beyond the Environment Agency.

Recommendation 15
The multidimensional social impacts of a poor river environment as identified in this report and their relationship to issues of inequality need to be further considered and evaluated by a stakeholder group.

The data analysis in this report concentrated on one social parameter and measured the physical association between people living in these areas and river stretches classified at different levels of biological water quality. There are methodological limitations in the analysis undertaken relating particularly to:

- the use of the biology water quality indicator;
- the choice of 600 m as a buffer distance and its application to all rivers regardless of size;
- the lack of data on access to the river environment;
- the necessary assumption that deprivation does not vary within a electoral division.

The analysis must therefore be taken as preliminary and exploratory. It is also important not to simplistically equate numbers of people living near to rivers with numbers of people experiencing good or bad impacts on their quality of life.

River water quality in Wales is generally good. With these caveats in mind, the analysis has found that deprived people are more likely than others to live near to a river in Wales. Within this overall pattern there is some evidence that, as river water quality worsens, the concentration towards deprived people increases.

Although the association has been shown to exist, its significance in policy terms needs to be evaluated carefully. Just because it exists does not necessarily mean that it is important, either for the management of water quality or for the lived experience of deprived people living near to poor quality rivers. This evaluation needs to take account of:

- the complex characteristics of the relationships between river water quality and social deprivation;
- the methodological limitations of the analysis;
- the multiple drivers for intervention to protect or improve river water quality.

The management of river water quality is pursued on a number of grounds including to:

- protect habitats and the intrinsic ecological value and biodiversity of rivers;
- contribute to the provision of good quality drinking water;
- protect the quality of fisheries, including for economic reasons;
- provide a functional, attractive and aesthetically pleasing environment for those people who experience the river and river corridor in various ways.

These drivers engage with populations and social characteristics to different degrees; for example, a driver involving habitat protection will be far less concerned with social concerns and issues of inequality than one focused on multifunctional recreational amenity.

Recommendation 16
The policy significance of the evidence identified in this report of an association between poor biological river water quality and deprivation needs to be evaluated carefully.

As soon as evidence of an inequality has been established, it is usual to ask why it might exist. What causal factors may have led to this unequal situation? Finding causal factors to explain the association between poor river water quality and deprivation was not within the remit of this research project. However, it is possible to conjecture the following:

- Heavily urbanised and industrial areas impose a heavy pollution load on rivers. These are also the areas where most deprived populations tend to be concentrated. Conversely, the best quality rivers are found in rural areas where population densities and (some) pollution inputs are typically much lower and where significant deprivation (as measured by the IMD) is rarely found.

- Housing markets may have developed over time to reflect local environmental quality, including the quality of the river environment, such that better quality housing is found near to good quality river environments.

- Decisions on interventions to protect and/or improve river water quality may have, for various reasons, not valued river environments in urban deprived areas as highly as those in other areas.

This last factor is particularly speculative, but it raises potentially significant questions about how decisions on the deployment of management resources are made and how equitable these are (including the use of policy or investment appraisal techniques). Further work could be undertaken to explore these and related issues.

Recommendation 17
Further work should be undertaken to explore the factors that may explain the association between poor river water quality and deprivation, including the role of processes of decision-making in river water management

If the evidence of inequality in the social distribution of river water quality is considered to be strong and significant in policy terms (as outcomes of Recommendations 15 and 16), the need for additional policy interventions to respond would need to be considered. In what ways might the management of river environments need to change to incorporate justice concerns? One argument might be that if the poorest quality rivers are to be targeted for improvement (including through the implementation of the Water Framework Directive), then deprived communities are going to benefit the most as they are living near to these prioritised river stretches. If this **is** the case, then justice concerns are simply added alongside other drivers, which are already directing attention towards the worst quality river environments. If, however, processes of prioritisation are not already working in this way, then the case for further targeting of interventions in deprived areas needs to be considered.

It is important to recognise the limits of what can be achieved through policy. Despite some river restoration projects targeting poor water quality in deprived urban areas, urban rivers are affected by their surroundings in terms of the way they have been engineered. They are often in culverts and channels, but cannot be extensively remodelled due to the knock-on effects that the change would have (e.g. for flood risk control functions).

Recommendation 18
The case for targeting policy interventions on poor quality rivers in deprived areas and the form that this could take needs to be examined.

Arguably, the main challenge is to improve the quality of public spaces in disadvantaged neighbourhoods and ensure that people are not excluded from enjoying the benefits of high quality local environments. In the past, tackling such issues in deprived areas has too often resulted in short-term, unsustainable investment in patched-up solutions rather than dealing with the underlying problem. The Social Exclusion Unit (2001) states that the joined-up nature of social problems is a key factor underlying social exclusion, but often the joined-up nature of social problems does not received a joined-up response. The best results can be achieved only when all the different sectors and interests work together. This includes the development of Community Strategic Partnerships involving the community, public, private, voluntary sectors and all those with an interest to:

- allow the voices of local communities to be heard;
- foster a sense of shared objectives.

The Water Framework Directive and related policy measures emphasise the need for the participation of stakeholders and communities living within river catchments. Improving the level of community engagement is particularly important, given drivers such as the Aarhus Convention (UNECE 1999) and the considerations of environmental justice embodied within it. Participatory processes need to be appropriate to the challenges involved in enabling effective participation within deprived communities.

Recommendation 19

The sustainable development and inequality agenda in relation to river water quality needs to be pursued in a manner that provides realistic and 'joined-up' solutions in which key partnerships between a range of stakeholders, including members of the public can be successful.

The literature and evidence base on the social impacts of water quality and its social distribution are less developed than for the other topics examined in this project. Thus there is a need for further research building on the review and analysis undertaken in this project.

Recommendation 20
Further research is needed to:

- improve our understanding of the social impacts of water quality and their differential impacts on different social groups (including disaggregation beyond simple measures of deprivation);

- explore to what extent other forms of poor water quality, including drinking water and bathing water, have impacts that are experienced unequally by different social groups (such research may need to develop new datasets rather than rely on those which already exist);

- develop more sophisticated methodologies for analysing patterns of inequality that take account of:
  - different indicators of the quality of the river environment;
  - different measures of social difference;
  - different physical relationships/distances that might apply across the range of positive and negative impacts that exist for a river stretch;

- analyse how improvements in river water quality have over time been distributed socially and how future quality objectives may affect some groups more than others.

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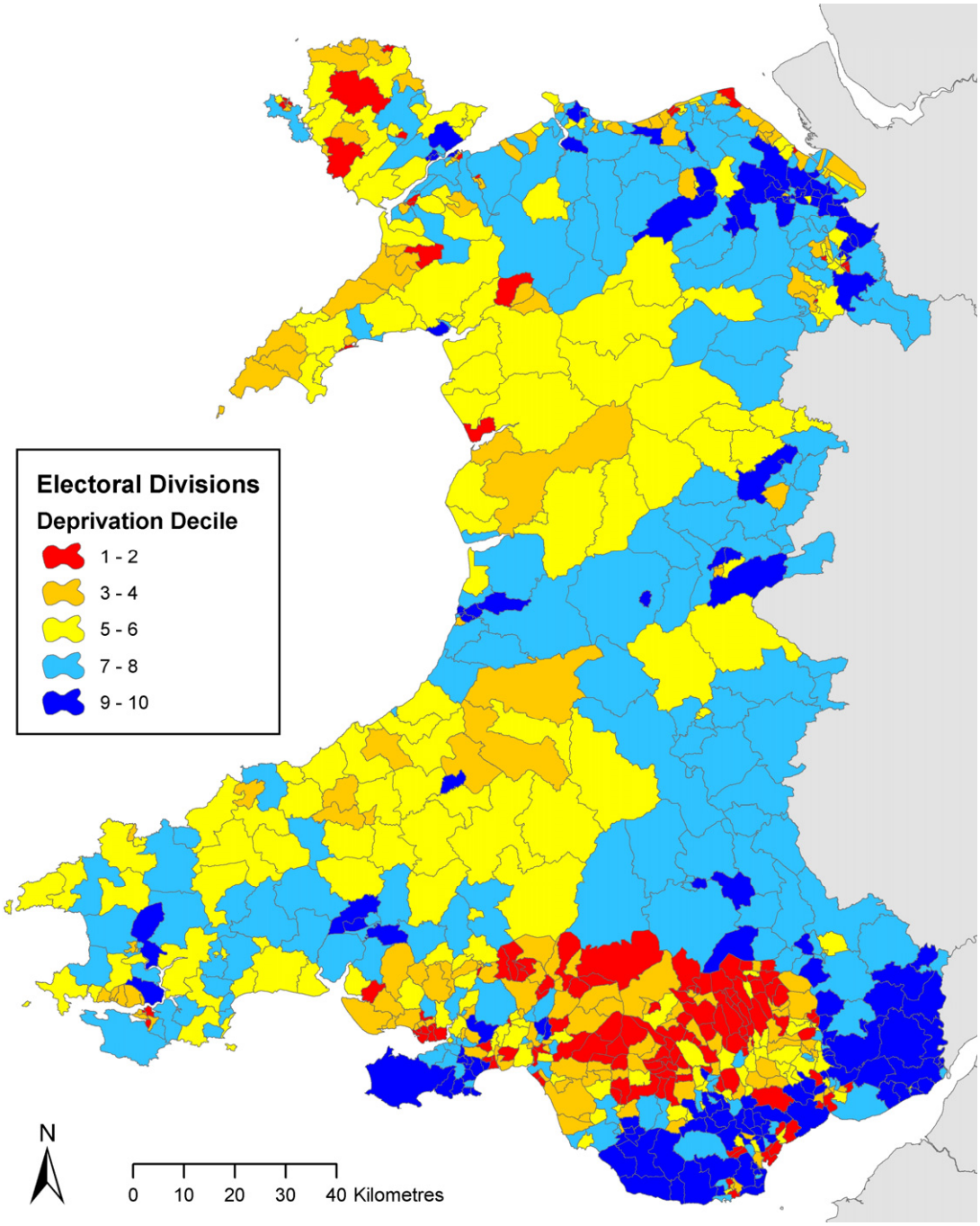
List of abbreviations

ASPB	Assembly Sponsored Public Body
BMW	biodegradable municipal waste
BOD	biochemical oxygen demand
BPEO	Best Practicable Environmental Option
C&D	construction and demolition
CERI	Comparative Environmental Risk Indicator
CFMP	Catchment Flood Management Plan
CHP	combined heat and power
CI	Concentration Index
Defra	Department for the Environment, Food and Rural Affairs
DTI	Department of Trade and Industry
EC	European Community
EfW	energy from waste
ELVs	end-of-life vehicles
EU	European Union
FoE	Friends of the Earth
GDP	gross domestic product
GIS	geographical information systems
GQA	General Quality Assessment
IDB	Internal Drainage Board
IFPM	Indicative Floodplain Map
IMD	Index of Multiple Deprivation
LDP	Local Development Plan
LFDC	Local Flood Defence Committee
MDSF	Modelling and Decision Support Framework
NAW	National Assembly for Wales
NGO	non-governmental organisation
NGR	National Grid Reference
NRU	Neighbourhood Renewal Unit
ODPM	Office of the Deputy Prime Minister (now Department for Communities and Local Government)
OECD	Organisation for Economic Co-operation and Development
OPRA	Operator and Pollution Risk Appraisal
PPC	Pollution Prevention and Control
PPG	Planning Policy Guidance
RBD	River Basin District
RBMP	River Basin Management Plan
RCEP	Royal Commission on Environmental Pollution
RFDC	Regional Flood Defence Committee
RIVPACS	River InVertebrate Prediction and Classification System
SDRN	Sustainable Development Research Network
SFVI	Social Flood Vulnerability Index
SME	small and medium enterprise
SMP	Shoreline Management Plan
TAN	Technical Advice Note
UDP	Unitary Development Plan
WAG	Welsh Assembly Government
WEEE	waste electrical and electronic equipment
WFD	Water Framework Directive

Appendix 1: Map of the index of multiple deprivation 2000 in Wales



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