Environmental RTDI Programme 2000–2006

Methodologies for the estimation of sustainable settlement size (2000–LS–4.3–M1)

Synthesis Report

(Please note that the main report relating to this project can be downloaded from the Research and Development webpages of the EPA website www.epa.ie)

Prepared for the Environmental Protection Agency

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Methodologies for the Estimation of Sustainable Settlement Size

Synthesis Report

1 Introduction

As part of the Irish Environmental RTDI Programme 2000–2006 (sub-measure of the Operational Programme for the Productive Sector), the Centre for Environmental Research (CER), University of Limerick, Ireland, in association with the Department of the Environment and Local Government (DoELG), the Irish Environmental Protection Agency (EPA) and the Centre for Urban and Regional Ecology (CURE), University of Manchester, has completed a project to meet the immediate needs of the Irish National Spatial Strategy (NSS) currently being prepared by the DoELG. In addition to providing an input into the NSS, the research also lays the foundation for longer-term work on understanding the relationship between settlement patterns and sustainable development in Ireland.

An important issue in relation to urban form and settlement patterns is the question of optimal settlement size. In relation to the issue of development patterns, the question of 'ideal size' for a sustainable settlement is of great interest. Herein, the effects of settlement size are estimated through the assessment of the efficiency of a range of settlements of varying size, functionality and geographical spread. Efficiency of settlements is assessed in terms of environmental and socio–economic sustainability, and through the identification of quantifiable indicators of sustainability.

The main objectives of the project are:

(a) to identify a set of sustainability indicators sensitive to settlement size,

(b) to identify gaps in the data being used for the assessment of settlement sustainability, and

(c) to review theoretical research undertaken elsewhere, to compensate in part for gaps in Irish data and to learn from experience elsewhere.

The main findings and recommendations are presented in this Synthesis Report. Further details and analyses are presented in Sections 1–3 of the Final Report.

2 Selected settlements

The final list of settlements (Table 1) is based on three important criteria: size, functionality and geographical spread. The list is selected from Appendices 1, 2 and 3 of the scoping document *Priority Environmental Research to Meet the Immediate Needs of the National Spatial Strategy (2000-LS-4-M1)* and was both modified and ratified at the preliminary assessment meeting in St. Martin's House, Dublin (26th April, 2001). Three of the 11 settlements form the basis of a qualitative assessment of towns with a population of less than 1500, for which few empirical data exist.

3 Indicator selection

In the Final Report, the candidate indicators are classified under the Driving Force–Pressure–State–Impact–Response (DPSIR) framework. Although this framework

Table 1. List of selected settlements.

Functionality	Towns with population over 10,000 in 1996	Towns with population less than 10,000 in 1996	Villages with population less than 1500 in 1996
Dormitory	Portlaoise		Pallasgreen
Tourism	Killarney	Westport	Freshford
Industry	Waterford		
Agriculture/Business	Athlone	Roscrea	Shinrone
Coastal	Sligo		
Gateway	Limerick		

has been criticised for its failure to capture the complexity and inter-relationships of the 'real world', it is nevertheless a useful conceptual system. Under the DPSIR framework, indicators are classed as environmental, social or economic. As this Report is intended to aid in the EPA's contribution to NSS planning, the primary focus here is on the development of environmental indicators. The development of environmental indicators is based on recommendations from a range of international and European agencies (UNCED, WHO, OECD), and in particular from the Irish EPA which has identified a number of strategic environmental themes in *Ireland's Environment – A Millennium Report* (EPA, 2000).

3.1 Gaps in the information base

The lack of available or accessible data had a significant impact on the number and quality of indicators. Consequently, a major implication of this report is the identification of the need for further research to tackle issues related to data availability, the uncertain definition of settlement boundaries and the need for a representative sample of settlements to allow more scientifically based quantitative analyses and modelling. The report points to gaps in the information base, and consequential weaknesses in the analyses presented here. The lack of available data has resulted in the use of proximate data and, therefore, some indicators selected are less than optimally informative. There are a number of important gaps:

Driving Force/Pressure Indicators

1. **Number of vehicles registered (Environmental)** – data for the number of vehicles registered were obtained from the National Roads Authority (NRA). These data exist at county level only and, therefore, provide only an indication of differences amongst settlements.

2. **Urban wastewater discharges (Environmental)** – data on Urban Wastewater Discharges were obtained from the *Urban Waste Water Discharges in Ireland* reports 1994/1995, 1996/1997 and 1998/1999. There are no data in these reports for the smaller settlements of Freshford, Shinrone and Pallasgreen.

3. **N and P loads (Environmental)** – data for total N and P discharged to rivers were obtained from the EPA. Total nitrogen was not analysed during 1997–1999. The mean of the ratio of total N (which was analysed each year) was, therefore, used to produce estimated total N loads for 1997–1999 for each individual river. Data were available for the Shannon Estuary and Waterford Harbour catchment areas only and could not, therefore, be used herein as indicators for the estimation of sustainable settlement size.

4. **Traffic growth (Environmental)** – data on traffic growth on national primary and national secondary routes were obtained from the *National Road Needs Study* report (NRA, 1998). Although it is generally agreed that this indicator ties in with the growth in number of vehicles registered per settlement, the lack of a representative time frame for annual daily traffic renders this indicator unsuitable for use in this study.

5. **Jobs gained/jobs lost (Economic)** – data on job numbers were obtained from Enterprise Ireland, and they relate to full-time jobs in companies under the remit of Enterprise Ireland, Shannon Development and Udarás na Gaeltachta. Data were available for all settlements (from 1991) with the exception of Freshford and Pallasgreen. Consequently, comparisons across smaller settlements were not possible.

State Indicators

1. **River water quality (Environmental)** – the biological quality of river water is assessed by the EPA at some 3200 locations on a 3-year basis. The chemical sampling of the rivers is significantly less extensive, with a total of 2100 monitoring locations. The data were obtained from various contacts within the EPA and from the EPA website. Chemical data exist for rivers in all settlements. However, these do not cover a representative time frame, so that trends are not evident, and are, therefore, unsuitable for application to settlement size.

2. **Conservation areas (Environmental)** – data on conservation areas were supplied by Dúchas in map format. These include National Heritage Areas, Special Protection Areas, Special Areas of Conservation, Nature Reserves and National Parks. However, this indicator is unsuitable for measuring

sustainable settlement size, due to the low number of settlements examined in this research project.

3. **Hospital activity (Social)** – data on hospital activity were obtained from the Health Statistics (Dept of Health, 1999) report. Only three selected settlements have hospitals located within their boundaries. Inhabitants of the remainder must travel to other settlements for treatment. Insufficient data and the limited time frame of data availability reduce the value of these data as indicators of sustainable settlement size.

4. **Number of pupils attending primary schools (Social)** – data on the number of children attending primary school were obtained from the Department of Education. The addresses of the schools were taken from the Primary School Database. Two schools were selected at random from each town (except Shinrone). The overall totals and totals by standard do not agree for schools that also have special needs pupils. Information was supplied for the following school years: 1993/1994, 1995/1996, 1997/1998 and 1999/2000. The lack of a representative sampling frame reduces the value of these data as an indicator of sustainable settlement size.

5. **Stock of jobs (Economic)** – data on the stock of jobs in each settlement were obtained from Enterprise Ireland, and relate to full-time jobs in companies under the remit of Enterprise Ireland, Shannon Development or Udarás na Gaeltachta. Data were available for all settlements (from 1991) with the exception of Freshford and Pallasgreen. Consequently, comparisons across smaller settlements were not possible. This indicator does not display sensitivity to settlement size for larger settlements.

6. **Occupations (Economic)** – data on the number of persons working in each occupation were obtained from the 1996 Census, but for larger settlements only. Consequently, comparisons across smaller settlements were not possible.

Impact Indicators

1. **Average house prices (Economic)** – all house prices were obtained from selected auctioneers and are based on housing developments sold recently and over a range of time periods in the past. No prices were available for Freshford, Shinrone or Pallasgreen. Insufficient data were available and the time frame was limited, thus reducing the value of these data in supporting an indicator of sustainable settlement size.

Response indicators

1. **B&Bs, guesthouses, hotels (Environmental)** – the number of B&Bs, guesthouses and hotels are used as a proxy for tourist numbers in each settlement between 1990 and 2000. Bord Fáilte were able to provide tourist numbers, at county-level only, from 1997 to 2000. The accommodation data were obtained from *Hotels and Guesthouses Ireland 2001* (Irish Hotels Federation, 2001) and *Bed & Breakfast Ireland 2001* (Town and Country Homes, 2001) and are only representative of the current status (2001) of tourist accommodation in Ireland. It is acknowledged that not all B&Bs, guesthouses or hotels may advertise in these guides and so the data are not fully representative of inter-settlement differences.

2. **Lotto payments to tourism (Social)** – data on lottery expenditure were obtained from the Department of Finance. The 1997 report listed the names of each organisation in receipt of funding but did not specify the settlements in which the organisations were located. Insufficient data and the limited time frame reduce the value of these data in providing an indicator of sustainable settlement size.

3. **Road improvement needs (Economic)** – data on expenditure on national road improvements were obtained from the *National Road Needs Study* report (NRA, 1998). Insufficient data and the limited time frame reduce the value of these data in supporting an indicator of sustainable settlement size.

3.1.1 Summary of major problems encountered

- Lack of generally agreed definitions of (a) sustainable development and (b) settlement boundaries.

- Lack of available or accessible data, which limited both the numbers and quality of indicators for inclusion in the study.

- Inclusion of too-few settlements in the analysis, reducing the information gained and preventing quantitative analyses.
- The 6-month period available for research and report writing restricted data collection, limited the number of settlements included in the analysis, greatly reduced opportunities for modelling, and limited the number of relevant indicators identified.

4 List of ideal indicators

The research team considers the indicator list given in Table 2 to be optimal. If these data were available, disaggregated to settlement level, then the relationship between settlement size and sustainability might be fully analysed. It is recognised that this represents an ideal situation and that, in practice, all these data are unlikely to be available in the foreseeable future.

5 Indicators and sensitivity to settlement size

In relation to indicators found to be sensitive to settlement size, initial analysis suggests that some indicators signal that larger settlements are more sustainable, while others suggest that smaller settlements are more sustainable. The purpose of this section is to evaluate the significance of these indicators so as to arrive at an overall assessment of the relationship between settlement size and sustainability. Analysis here is based solely on Irish data collected by the research team and is restricted to indicators found to be sensitive to settlement size. Other indicators were developed as part of this research but were not found to be sensitive to settlement size. These are indicated in Table 3 but are not considered further herein.

5.1 Environmental indicators

5.1.1 Driving force/pressure

5.1.1.1 Municipal waste/capita

What the analyses show

Data on municipal waste production per District Electoral Division (DED) were obtained from the *National Waste Database* reports 1995 and 1998. Research findings show an increase in the total amount of municipal waste produced/settlement from 1995 to 1998. Graphical analyses show linear relationships, with the total number of tonnes of waste produced increasing with population size. Little variation is evident in the total tonnes of commercial and street waste produced/ settlement, with the exception of the larger urban centres, Limerick and Waterford. The same applies to the per-capita production of municipal waste/settlement, with Limerick and Waterford as clear outliers. However, the per-capita production of household waste in 1998 is almost uniform for both the larger and smaller settlements. In 1995, Limerick and Waterford again show a greater per-capita production of household waste than the other settlements. Little variation exists between settlements (except the outlier Limerick) for the per-capita production of commercial and street cleaning waste.

Why this indicator is relevant to sustainable development

Waste arises as a consequence of the use of non-renewable resources and energy generation: the greater the waste production, the less efficient the use of resources. Waste disposal creates many environmental problems. Landfill remains the primary means of waste disposal in Ireland where, in 1998, 91% of municipal waste was landfilled. Landfill sites not only consume space, which is a non-renewable resource, but they also create pollution problems such as the generation of biogas, leachate, odour, and are aesthetic nuisances. In a sustainable society, a primary objective must be to reduce, reuse or recover waste. As indicated in *Changing Our Ways* (DoELG, 1998), Ireland should aim to divert 50% of household waste and 65% of biodegradable waste away from landfill.

An objective of the *National Sustainable Development Strategy* (DoE, 1997) is to achieve a 20% reduction in the volume of municipal waste disposed to landfill by 2010. By ensuring that polluters pay for the cost of waste collection, treatment and disposal, public attention can be focused on the problems associated with current levels of waste generation and the importance of sustainable waste management, to ensure a better quality of life for future generations. Therefore, waste arising is an important indicator of sustainable development.

Table 2. List of 'Ideal Indicators'.

Ideal indicator	Additional data required
Waste (municipal solid waste, hazardous waste, waste treatment/ disposal)	Data on each category of waste collected/settlement/year from local authorities.
Water (quality of drinking water, level of wastewater treatment, surface and groundwater quality, % population connected to wastewater treatment plants)	Data on each category of water quality/settlement from local authorities and the EPA. Data from annual field-based studies.
Transport (range of public transport services, cycle ways, pedestrianisation, quality and network of roads, travel control measures, travel time and distance to services and work)	*Census Reports* to include data on smaller settlements. Additional data from field studies.
Energy (source – renewable energy share, per-capita usage, industrial usage, presence of CHP, energy efficiency rating of housing)	Data on energy supplied from renewable and non-renewable sources. Data on energy use by sector/settlement/year. Additional data from field studies on conservation measures.
Renewable and non-renewable resource consumption (food, water, construction materials, etc.)	Data from Department of Agriculture, Food & Rural Development, Department of Energy, Bord Bia, Bord na Móna/ settlement/year Additional data from field surveys.
Air (quality, emissions to air, greenhouse gases)	Data on ambient levels for each type of air pollutant/settlement/ month. Data on greenhouse gas emissions/settlement/month. From local authorities, the EPA and Regional Health Boards. Additional data from field studies.
Noise (loudness, type, frequency, duration)	Data on noise complaints from local authorities and additional field-based research.
Biodiversity (sensitive species – number and frequency, special protection areas)	Data on indicator species/settlement/year from Dúchas. Additional data from NGOs and field work.
Education (access, number of children per teacher, school-leaving age, number attending third level)	Department of Education data reported to settlement level.
Income (per-capita income, percentage claiming social welfare assistance, percentage in top and bottom 10% of earners, sources of income)	Department of Social Welfare data to settlement level.
Housing (quality, cost, ownership, number of people per square metre of floor space, rent costs)	*Housing Bulletin* data to settlement level. *Census Reports* to settlement level. Additional field-based data.
Employment (type, foreign or indigenous owned business, average working life, average age starting work and retiring)	IDA and Enterprise Ireland data to settlement level/year. *Census Reports* to settlement level. Additional field-based surveys on annual basis.
Access to basic services (type and range of services provided)	Chambers of Commerce data/settlement/year. Additional field-based surveys on annual basis.
Health (mortality, health services, type and frequency of diseases requiring medical aid)	Data from Regional Health Boards, HIPE Data Unit (ESRI) to settlement level/year. Additional field-based surveys on annual basis.

Table 3. Sensitivity of indicators to settlement size.

Indicator	Sensitivity	
	Yes	**No**
Driving Force/Pressure Indicators		
Municipal waste/capita (Env)	√	
Number of passengers/car (Soc)	√	
Means of travel (Econ)	√	
State Indicators		
Goldfinch numbers (Env)	√	
Population density (Env)	√	
Forest cover (Env)	√	
Number of GPs (Soc)	√	
Public transport (Soc) urban bus service Settlement connectivity	√	
Distance travelled to work <2 miles (Econ)	√	
Response Indicators		
IPC (Cumulative) (Env)	√	
Recycling (Env)	√	
Driving Force/Pressure Indicators		
Number of vehicles registered (Env)		√
Urban wastewater discharges (Env)		√
N and P loads (Env)		√
Traffic growth (Env)		√
Road fatalities (Soc)		√
House prices (Soc)		√
Jobs gained/jobs lost		√
State Indicators		
River water quality (Env)		√
Conservation areas (Env)		√
Hospital activity (Soc)		√
Number of pupils attending primary schools (Soc)		√
Population size trends (Soc)		√
Stock of jobs (Econ)		√
Occupations (Econ)		√
Response Indicators		
B&Bs, guesthouses, hotels (Env)		√
Roads/expenditure NDP (Env)		√
Lotto payment to tourism (Soc)		√
Road improvement needs (Econ)		√

Are larger or smaller settlements more sustainable?
Although results suggest that smaller settlements produce less waste per capita, this finding is difficult to interpret as data were available at DED-level only and, therefore, had to be extrapolated to settlement size. This may present a somewhat misleading picture in favour of smaller settlements, which typically occupy only parts of DEDs.

5.1.2 State indicators

5.1.2.1 Goldfinch numbers

What the analyses show
Birds were selected as indicators of biodiversity, as data on species present in urban gardens were provided by BirdWatch Ireland, generated through the Garden Birds Census that has operated since 1994. The help provided by BirdWatch Ireland is acknowledged. Here, the data for the years 1994–2000 are aggregated, and gardens in all settlements are included (i.e. not only the 11 sample settlements), with the exception of Dublin and its environs, which were considered a special case. An analysis of total number of species recorded in gardens showed no relationship between total species number and the size of the settlement in which the garden was located. The analysis was then taken a stage further, during which individual species were considered. The goldfinch was selected because it is less common (recorded in a total of 169 gardens outside of Dublin), and has particular habitat requirements (arboreal nesting, more specialist winter feeding requirements). Therefore, goldfinches might be considered representative of less abundant species with narrower niches. It was established that goldfinches were more likely to be found in gardens within smaller settlements.

Why this indicator is relevant to sustainable development
Maintenance of biodiversity is an important component of sustainability. It is not possible to quantify total biodiversity, as too many taxa are present. Therefore, selected taxa may act as indicators of biodiversity. While the total number of species of birds in gardens was not related to settlement size, goldfinches were more likely to be observed in gardens in smaller settlements. The goldfinch is a brightly coloured, easily identifiable and somewhat uncommon species with well known habitat requirements, particularly the availability of trees for nesting in summer and plant seed heads for food in winter. It is, therefore, a more specialist, or narrow-niched species, sensitive to the availability of particular habitats, especially woodland and rough ground. These habitats are perhaps less likely to be present in built-up areas. The goldfinch, therefore, represents a less common, more specialist species, and for that reason it may be considered a useful indicator of biodiversity.

Are larger or smaller settlements more sustainable?
Goldfinches are more likely to be recorded in the gardens of smaller settlements, though differences between gardens of larger and smaller settlements were not significant, and data on numbers of individual goldfinches were not available. Moreover, considering all common bird species together, community diversity is not any lower in the gardens of larger settlements. While data for eight species were examined, it was not possible to identify any others that displayed a relationship with settlement size similar to that of the goldfinch. Therefore, use of the goldfinch as an indicator of biodiversity is somewhat problematic, as the interpretation of findings is uncertain. On the other hand, in the absence of any other data, this indicator deserves some attention.

5.1.2.2 Population density

What the analyses show
Data on population density were obtained from the *Census of Population* (1996) and from the Ordnance Survey of Ireland 1:50,000 discovery series maps, and are quantified using the superimposition of a grid pattern. Here, the population of a settlement is taken to be the combined figures for the borough and its environs. One smaller settlement (Pallasgreen) was not mapped as a shaded area, and the extent was estimated by field measurements. To facilitate comparisons, areas are given in square kilometres and population density in numbers of people per square kilometre. As a rule, smaller settlements have lower densities. Shinrone has the lowest population density. Killarney has the second highest density, which may be surprising given that much of the settlement takes the form of hotels and other tourism infrastructure. Freshford has a higher population density than other comparable settlements in the sample. The extent of Waterford is greater than that of Limerick, but

the population density of Limerick is considerably greater.

Why this indicator is relevant to sustainable development

In Ireland, the average population density is low, by European standard, at 51 persons per km^2. However, this figure ranges from over 100 persons per km^2 in the East and South to less than 25 persons per km^2 in the West. Ireland's settlement fringe housing development is often characterised by one-off detached residences or low-density suburban-type housing. In the mid-1920s, Dublin's inner city housed 250,000 people. This figure has since been reduced to 73,000. Low density suburban housing provides insufficient numbers of passengers to support public transport, resulting in increased dependency on private transport, which in turn leads to increased energy usage, emissions of air pollutants and congestion. Low numbers of passengers and congestion in turn lead to reduced effectiveness of public transport infrastructure.

Higher-density housing also increases the efficiency of other services, such as waste collection, recycling and reuse of materials, CHP and district heating and the reduction in travel distances so as to allow walking and cycling. It has been argued that a low population density is characterised by a low level of environmental awareness, while countries such as the Netherlands, which has one of the highest population densities in Europe, perform best in terms of civic responsibility and environmental consciousness. In general, it is considered that the compact city model is more sustainable, though contrary opinions have been expressed. Therefore, population density is an important indicator of sustainable development.

Are larger or smaller settlements more sustainable?

Research findings indicate that population density increases with settlement size. Many authors have cited population density as fundamental to planning for sustainability, as this is crucial to, *inter alia*, the efficient provision of services, maintenance of public transport systems, area heating schemes, collection of waste for recycling, and the replacement of purchasing by hiring. The DoE report *Sustainable Development – Strategy for Ireland* states that priority is to be given to promoting higher residential densities in proximity to town centres and public transport modes, in consultation with local authorities, architectural and planning professions and the house-building industry (DoE, 1997).

In a report published in 1998, it was concluded that Irish residential densities are low and that most residential developments in the past 20 years were in the form of back-to-back detached or semi-detached dwellings (Peter Bacon & Associates, 1999). The report recommended that the Minister for the Environment and Local Government, by the powers vested in him under Section 7 of the Planning and Development Act 1982, should direct planning and development issues, in order to adopt a more proactive approach in encouraging increased density developments (MacCabe, 2000).

5.1.2.3 Forest cover

What the analyses show

Data on changes in forest cover were obtained from Coillte and the Forestry Service under the FIPS Inventory System for each DED. Data were unavailable for Shinrone and Pallasgreen. The figures supplied relate to 1997 and were compiled using satellite imagery. This means that some recently planted forests may not have been identified and, therefore, may not be included in the data. Smaller settlements compare very favourably with larger urban areas for both area under forest and classes of forest (494.01 ha under forest in Roscrea compared to just 8.87 ha in Limerick). Killarney rates highest with 689.33 ha under forest, although a considerable area of Killarney is within a National Park. In relation to the classes of forest planted, the smaller settlements again score higher than larger urban centres.

Why this indicator is relevant to sustainable development

Forested areas are important providers of habitats for wildlife and are valuable amenity/recreational areas. Forests located close to urban centres act as important carbon sinks for the large quantities of carbon dioxide produced, particularly by the transport and domestic heating sectors. Woodlands act as effective barriers to noise pollution. Approximately 9% of Ireland is under forest. A target of 17% of land area under forest has been set for 2035. The EU average is ca. 35% of total area under forest. In Ireland, 78% of forest cover is Sitka

spruce. The possible negative impacts of forestry, including the effects on land drainage, the dominance of exotic conifers, impacts on landscape and cultural heritage, isolation of rural dwellings and acidification of waters, require consideration. However, in the urban and urban-fringe zones, forestry has many more positive than negative impacts so increasing the area under forestry enhances sustainability. Therefore, area under forest is an important indicator for sustainable development.

Are larger or smaller settlements more sustainable?
Research findings favour smaller settlements, as most planting to date has taken place close to smaller settlements in rural areas. However, data were available at DED level only. DEDs for larger settlements are fully urbanised. For smaller settlements, only part of the DED may be built-up.

In addition, the greater occurrence of planting in smaller rural settlements may be due to the significant increase in urban land prices in recent years as a consequence of Ireland's unprecedented rate of economic growth. This may present a misleading picture in favour of smaller settlements. In addition, current policy focuses on farm forestry, which is now the largest single component of the forestry programme. Farmers, most of whom live close to smaller rural settlements, accounted for 89% of private afforestation in 1998. Therefore, results are difficult to interpret; there is a bias in favour of smaller settlements resulting from the method of data collection necessarily adopted. Again, however, in the absence of many other data on biodiversity, this indicator deserves some attention.

5.1.3 Impact indicators

5.1.3.1 Means of travel to work

What the analyses show
The 1991 and 1996 Censuses provide data on means of travel. Travel by car is the dominant mode of transport in all settlements. Relatively low values recorded for smaller settlements in 1991 were not replicated in 1996, with the possible exception of Killarney, so that by 1996, car use was similar in all settlements. Travel by foot was lowest in Limerick, the largest settlement by population in the sample, but other than this, no clear relationship with population size was evident. Bicycle use was marginally lower in larger settlements (Limerick and Waterford), and bicycle use declined everywhere between 1991 and 1996, though by very little in Killarney. Bus use was greatest in the larger settlements (Limerick and Waterford), and smallest in smaller settlements, though values for Sligo were the exception to this pattern. However, bus use declined in Limerick between 1991 and 1996, presumably reflected in the increase in car use.

Why this indicator is relevant to sustainable development
Transport accounts for a growing proportion of consumption of non-renewable energy resources. All modes of mechanised transport have important environmental impacts at global, national and local levels. Use of the car for single-purpose journeys is particularly unsustainable. Almost 80% of people employed in Ireland travel to work by car. Buses are used by 6.9% of the workforce, with just 1.6% using the train or DART. Eleven percent of the workforce walk to work and 2% cycle. However, more than 40% of the workforce in the Dublin and Mid-East region regard public transport as not being a practical option, while 13% prefer private transport irrespective of public transport provision. Road transport contributes substantially to the production of atmospheric carbon dioxide, nitrogen oxide, volatile organic compounds (VOCs) and particulates. A car with driver uses twice as much energy per person/distance as a commuter train and more than 10 times as much energy as a full double-decker bus. Choice of means of travel has implications for air quality, road safety, access to basic services and land quality. Sustainable development must aim at improving public transport availability and accessibility, thereby reducing public dependence on private transport. Additional incentives may be required to encourage switching from private to public transport use. Therefore, mode of travel is an important indicator for sustainable development.

Are larger or smaller settlements more sustainable?
Evidence from the Irish case studies appears to be contrary to what would normally be expected. Distance travelled tends to be highest for the larger settlements, with travel of less than 2 miles also low in comparison to the smaller settlements (urban shape/land use may better account for these results). Data presented on workplace/

education and the mode of transport to workplace/ education do not present a very clear picture of differences between settlements of varying sizes. Although travel by private car is the dominant mode of transport in all settlements, smaller settlements rely heaviest on private transport. Larger settlements utilise public transport to a significantly greater extent. Larger settlements have:

(a) a greater proportion of the workforce using buses for the journey to work/education (public transport provision and use are again central to planning for sustainability);

(b) a greater proportion of the workforce travelling as car passengers (indicative of greater car-pooling).

5.1.4 Response indicators

5.1.4.1 Number of IPC licenses issued

What the analyses show

The cumulative number of IPC licenses for industry issued by the EPA over a 6-year period starting in 1994 is directly proportional to population size. That is, settlements with larger populations have the greatest number of IPC licenses, with the exception of Portlaoise. No reasons are offered here as to why Portlaoise has a greater number of IPC licenses than Sligo, Killarney, Athlone, Westport and Roscrea. Several factors may be at play including, *inter alia*, functionality, historical development, geographical location and proximity to national roads.

Why this indicator is relevant to sustainable development

The main purpose of IPC licensing is the reduction of industrial wastes and emissions. By 1999, 409 IPC licenses were issued by the EPA within Ireland, and in future all new and existing industrial facilities with significant pollution potential will be subject to the IPC process. IPC licensing is a powerful tool for encouraging more sustainable production in manufacturing processes. In the case where industries fail to meet all the conditions attached to the license, the EPA may take appropriate measures to bring that industry back into compliance by serving summary notices or, ultimately, through prosecution. Industrial developments with IPC licenses are, therefore, taken to be more sustainable than those without. Therefore, the cumulative number of IPC-licensed industries in a settlement represents an important indicator of sustainable development.

Are larger or smaller settlements more sustainable?

Although IPC licenses versus population size show no definite or distinguishable relationship to settlement size, this does not apply to cumulative numbers of licenses issued. Cumulative IPC licenses favour larger settlements, with Waterford (20 licenses) and Limerick (12 licenses) faring better than all other settlements. This suggests that larger settlements are able to attract consistently more modern, cleaner manufacturing. Again, this is a strong indicator and the data are reliable.

5.1.4.2 Recycling facilities

What the analyses show

Analyses show an inverse relationship between the number of recycling banks/1000 population and settlements ranked in order of population size. Availability of recycling banks/1000 population increases as settlement size reduces, but with important exceptions where no recycling facilities are available. Although the actual number of recycling facilities is greater in the larger settlements, the number of recycling banks /1000 figures indicate the inverse, with Killarney, Freshford and Pallasgreen scoring highest. Data on the actual volumes of municipal waste recycled over a given time scale were unavailable at settlement level. In general, there has been an increase in Ireland's level of recovery since 1995 with glass recovery, for example, increasing from 28,500 t/annum in 1995 to 36,000 t/ annum in 1998.

Why this indicator is relevant to sustainable development

Following government policy on waste management, the next best environmental alternative, after waste prevention and minimisation, is reuse and recover. Recycling of waste reduces the use of virgin materials and the need for resource-intensive and polluting processing.

Under the Waste Management (Packaging) Regulations 1997, producers of packaging waste have a choice either to participate in a waste recovery activity operated by an

approved body, or otherwise take steps to comply with the Regulations by recovering packaging waste.

There is increasing pressure on the private sector to deliver a 27% recovery target for packaging waste by the year 2002. The policy statement *Changing Our Ways* (DoELG, 1998) calls for recycling of 35% of all municipal waste and 50% of construction and demolition waste. Progress in Irish recycling rates was made between 1993 and 1995, with an increase from 10.3% to 15.6%. The effectiveness of recycling largely depends on the provision of facilities for the public. Consequently, access to recycling banks is an important indicator of sustainable development.

Are larger or smaller settlements more sustainable?

In general, larger settlements have a greater number of recycling facilities. The overall capacity for recycling is highest in larger settlements. The apparent greater per-capita provision of recycling banks in the smallest settlements is largely a statistical artefact, and some smaller settlements have no banks at all. Clearly, recycling is crucial within the definition of sustainability.

In addition, no indication is given of the proximity of recycling facilities to smaller settlements. As dependency on the private car is greatest in smaller settlements, the nearest recycling facility may be located at a distance of several kilometres away. When considering the net impact to the environment, the saving that may be accrued from recycling must be balanced against the cost to the environment in terms of energy usage and pollution that may arise from private transport to the nearest recycling facilities.

5.2 Social indicators

5.2.1 Driving force/pressure

5.2.1.1 Number of passengers/car

What the analyses show

Data on the number of passengers/car were obtained from the 1996 Census using figures on the number of car drivers and number of car passengers for each of six larger settlements. No data are available for Westport, Roscrea, Freshford, Shinrone or Pallasgreen. Little variation exists between settlements for the number of passengers/car vs. population and workforce, with the exception of Waterford, where car-pooling practices are greater than for any other settlement in this study. It may be assumed that car-pooling operates more frequently in larger urban centres such as Limerick. However, the number of passengers per car is almost equal to that of Athlone and Sligo, which have considerably smaller populations and available workforce. This may be due to greater reliance on public transport in Limerick.

Why this indicator is relevant to sustainable development

Although travel by private car is the least sustainable mode of transport, car-pooling (i.e. increasing the number of passengers per car journey) may contribute to reduced environmental impacts and increased energy efficiency through a reduction in the number of cars in use. In cases where members of the workforce live in rural areas or areas with poor public transport infrastructure, car-pooling is, at present, probably the most feasible and sustainable option. Therefore, number of passengers per car is an important indicator of sustainable development.

Are larger or smaller settlements more sustainable?

The level of car sharing in the journey to work/education category is greater in larger settlements. Again, data are reliable, and the more effective use of transport is central to planning an approach to sustainability, so as to reduce resource use and pollution, and combat congestion.

5.2.2 State indicators

5.2.2.1 Number of GPs

What the analyses show

Data on the number of General Practitioners per settlement were obtained from the *Golden Pages*. Data were not available from the Department of Health at a suitably disaggregated level. Data collected suggest a linear relationship, showing the number of GPs increasing with population size. However, the number of GPs/capita is greater in smaller settlements, with Pallasgreen (smallest population size) scoring higher than all other settlements in the study.

Why this indicator is relevant to sustainable development

Sustainable development embraces the concept of social welfare; it is argued that a society with a welfare deficit is likely to be characterised by unrest and will not, therefore, be sustainable. Welfare is a broad concept, not easily quantified. One very important facet of welfare is access to health care. An indicator of the availability of health-care facilities is the number of GPs per 1000 people.

Are larger or smaller settlements more sustainable?

Data presented indicate that smaller settlements have larger numbers of GPs per capita. At the time of information gathering, the only source of data available was the *Golden Pages*, and it is acknowledged that GPs select to be listed. Furthermore, it is clear that GPs resident in smaller settlements may service a number of other villages and have patients who reside in surrounding rural areas. Consequently, the interpretation of the data is problematic.

5.2.2.2 Public transport (urban bus service/ settlement connectivity)

What the analyses show

Smaller settlements show lower connectivity (that is, number of routes serviced from the settlement). In relation to the number of urban bus routes, larger settlements have significantly more than do smaller settlements. None of the smallest settlements have urban public transport systems.

Why this indicator is relevant to sustainable development

As the majority of people work in the same place every day, these repeated and predictable journeys to and from work are ideally suited to public transport. Policies such as the provision of bus lanes in Dublin, and the construction of the light rail network (LUAS), are designed to increase the provision of public transport. The greater the provision of public transport, the greater choice individuals have in selecting travel modes other than the private car. Therefore, the availability of public transport provides a meaningful sustainability indicator.

Are larger or smaller settlements more sustainable?

Larger settlements have the greatest numbers of urban bus routes (important for reduction in dependence on car transport) and also score highest in terms of inter-settlement connectivity through public transport (potentially important to economic sustainability).

5.2.3 Impact indicators

5.2.3.1 Road fatalities and injuries

What the analyses show

Data for the total number of persons killed and injured on Irish roads from 1990 to 1998 were available from the NRA at county level only and, therefore, provide a guide to deaths and injuries at settlement scale only. In general, the total number of fatalities or injuries/settlement increases with population size. This is particularly true in the case of injuries, which show an almost directly proportional linear relationship.

Why this indicator is relevant to sustainable development

Data on road fatalities and injuries were obtained from the NRA. Each year the NRA produces a comprehensive analysis of all reported road accidents involving fatalities, personal injury or material damage that occur on Irish public roads. This report is based on road accident information recorded by the Garda Síochána and supplied to the NRA for processing and analysis. The numbers of both fatalities and injures on Irish roads are increasing exponentially. According to the *National Roads Needs Study* (NRA, 1998), 40% of accidents and 64% of fatal accidents occurred in rural areas, while 26% of injury accidents and 38% of fatal accidents occurred on national routes. The occurrence of deaths and injuries on the roads detracts from social and economic sustainability; therefore, the number of deaths and injuries represents an important indicator of sustainability.

Are larger or smaller settlements more sustainable?

Although research findings indicate that the number of fatalities and injuries per settlement increases with population size, national figures suggest the opposite, with the majority of fatal and non-fatal accidents occurring in rural areas. As data were available at county-level only, their interpretation is problematic and may

present a misleading indication in favour of smaller settlements.

5.3 Economic indicators

5.3.1 Driving force/pressure

5.3.1.1 Distance travelled to work <2 miles

What the analyses show

The 1991 and 1996 Censuses provide data on distance of daily travel. While it is recognised that, on a national scale, the average distance to work/school/college tends to increase in a zone surrounding larger settlements, no such pattern was evident for the sample of settlements considered herein. The percentage increase between 1991 and 1996 in number of people travelling 10 miles or more was 23.9% for Limerick, 31.1% for Sligo, 37% for Athlone, 64.2% for Killarney, 70.7% for Portlaoise, and 77.4% for Waterford. The comparable percentage increases for people travelling 5 miles or more are 10.5% for Waterford, 10.9% for Sligo, 14.4% for Athlone, 16.8% for Killarney, 25.5% for Limerick and 25.9% for Portlaoise. Data for other settlements were not available. On the basis of this sample of settlements, it is not possible to point to a clear relationship between settlement size and temporal trends in length of journey to work/education for those travelling relatively longer daily journeys.

Larger settlements had smaller proportions of people travelling relatively short daily distances. As a rule, smaller settlements contained a greater proportion of people travelling shorter journeys, but there was a relatively greater reduction between 1991 and 1996 in some of these settlements. Values calculated for journeys of up to and including 3 miles failed to show a similar pattern.

Why this indicator is relevant to sustainable development

The greater the distance travelled each day, the greater the per-capita use of resources and generation of pollution. Distance travelled to work has a major impact on the mode of transport most frequently used. Typically, the longer the journey, the greater the reliance on private cars, with resultant greater inefficiencies. In 1996, workers travelled on average 10.7 km to their place of work (an increase of 7.6 km since 1991). Secondary school children travelled on average 6.2 km in 1998, and third-level students travelled 7.3 km in 1981 and 11.6 km in 1996. Trends, therefore, suggest that Ireland is moving counter to sustainable development: planning has resulted in greater distances between places of work and places of residence. The distance of journey to work/ education is, therefore, an important indicator of sustainability.

Are larger or smaller settlements more sustainable?

A reduction in the need to travel long distances to workplace/education is significant in planning for sustainability, as travel uses resources and generates pollution. Congestion reduces urban quality of life. Data presented on distance to workplace/education and the modes of transport to workplace/education do not present a clear picture of differences between settlements of varying size. The sample size of settlements was perhaps too small to provide adequate data. While in larger settlements a smaller proportion of people walked to work/education, this was offset by the larger number of people using buses. Within larger settlements, it is perhaps not surprising that fewer people live within walking distance of work/education. Clear differences in daily distances travelled within settlements between 1991 and 1996 were recorded for six settlements only. No clear pattern emerged which allowed straightforward analysis. People in some smaller settlements generally travelled shorter distances, but such differences were less apparent in 1996 than in 1991. Thus, it could not be shown that smaller settlements offer significant long-term benefits in relation to daily movements of people.

5.4 Conclusion of empirical analysis

In conclusion, in the context of the empirical findings reported herein, for reasons offered in each case, it is reasonable to place a greater weighting on those indicators that identify larger settlements as being more sustainable. For these, data are more reliable, interpretation is more secure, and the relevance to sustainability is more clear-cut. On this basis, the results of our analysis of indicators suggest collectively that larger settlements show more signs of approaching sustainability. However, two indicators of biodiversity, while both flawed to some degree, suggest that larger

settlements score lower than do smaller settlements. This suggests that the trade-offs inherent in our process of selection of larger settlement size as preferable may not take adequate account of biodiversity preservation. If this is confirmed by additional research, then a proactive approach to biodiversity preservation within larger settlements is indicated.

6 Theoretical analyses and the experience of other countries and the application of results in NSS planning

The primary aim of this section is to identify ways in which results reported herein, and insights gained from experience elsewhere, may be applied within NSS planning. The methodology, based on indicators described in previous sections, does not in itself provide a full analysis of the relationship between settlement size and sustainability. Studies elsewhere (reviewed in Section 1, Literature Review, of the main report) have tackled cognate issues, and used alternative methodologies and identified differing settlement parameters as crucial. Size (as indicated in earlier sections) might mean population number, or areal extent. Areal extent is not necessarily easily measured as there are often problems in defining boundaries. Density is considered by some to be more significant than population size, and studies elsewhere have aimed at the identification of threshold values for optimal settlement size, not achievable herein because of the limited Irish data available to date. The relevance of these studies to Irish data is explored.

A review of such studies is also undertaken herein to facilitate the identification of the wider context of Irish data collected in relation to indicators, and the qualitative assessments, particularly those of Freshford and Limerick. Such a review is aimed at helping to answer the questions ‘which of the Irish data are most significant?’ and ‘what is the best use that can be made of the limited Irish data?’. A review of studies elsewhere provides insights into what might be expected to be found if more complete Irish data were available for analysis.

In addition, a review of experience elsewhere aims to cast light on a further important consideration.

In this document so far, settlements have been considered largely as discrete entities located in space. An alternative view is that settlements are not independent entities, but rather collectively form spatial patterns and hierarchies. Consequently, sustainability might be better approached through spatial planning based on such patterns and hierarchies. A review of other studies provides important insights into how this might be achieved, and what results may be anticipated. It was hoped initially that models published for other countries might be adapted for Irish conditions, and that Irish data might be substituted, so as to provide at least indicative results relevant to Ireland. The paucity of Irish data, the focus on settlement size alone, and the time constraints frustrated attempts to achieve this goal.

6.1 Review of other research on the implications of settlement size for sustainability

6.1.1 Transport and travel distances within and between settlements

Transport has received much attention in other studies, both because transport is seen as very important in affecting environmental quality from local to global scales, and because it is considered likely that behaviour in relation to selection of transport options may be altered readily. However, not all studies have arrived at similar conclusions. Some suggest that transport distance may be minimised through planning for hierarchical provision of services so that each locality within a settlement has access to services that are required on a daily basis (schools, supermarket, public house, post office, newsagent, open space), and that higher-order functions are more easily accessible by public transport.

Patterns of car ownership are not easily related to urban form, however, and correlate strongly with socio–economic factors. To reduce car usage, studies suggest that the following conditions are necessary: that the inner city/town be revitalised, that development be linked to public transport provision, that peripheral sprawl be discouraged, and that peripheral areas be linked to public transport systems. Proximity of residences to transport systems reduces travel distance. Some research indicates that smaller settlements result in larger travel distances,

though other work found no clear relationships (as was the case in general for Irish data). Much depends on the objective of the journeys. Provision of public transport is crucial in reducing travel distances, as is ensuring that residences in peripheries are not separated by long distances to workplaces in centres. However, some studies suggest that a central location for workplaces, allied to good public transport, is optimal for a reduction in energy expenditure. Pedestrianisation, bus and bicycle lanes, traffic-calming measures and control of parking places may all contribute to a reduction in car dependence. Relatively high densities contribute to lower travel distances, though this is challenged as over-simplistic by some researchers. As a rule, it is found that the available types of planning actions that might aid in the reduction in travel distances are more likely to be practicable within larger settlements. Based on an analysis of limited Irish data, a larger settlement in this context might have a minimum population of 25,000, but rather larger settlements appear to be more effective in increasing density. A problem is that the limited Irish data do not reflect findings from research based in other EU States.

Accessibility to transport systems is also a very important issue in relation to movement between settlements: the network effect of access to national and global-scale functions. The network effect is found to be most effective for larger settlements, at city size.

6.1.2 Water quality

There is a strong consensus in the literature that settlements below 1000 population equivalents (p.e.) are too small to sustain efficient tertiary wastewater treatment plants, and that the use of septic tanks with soakaways is not recommended for clusters of greater than 100 houses. Increasing density reduces the connection costs to main drainage systems, and a compact shape increases the viability of such systems. At a certain point, the increasing growth of a settlement creates more waste water than can readily be absorbed by the surrounding ecosystem (soils, surface and groundwater quality suffer as a result). There is no clear consensus as to the most environmentally efficient mode of sewage treatment, and this may be determined on a case-by-case basis only. Nothing in the literature or arising from available Irish data provides a guide to settlement p.e. at which inefficiencies (for a given mode of treatment) begin to take effect.

Contemporary thinking in Ireland seems to be based on the notion of waste disposal as the final stage in a linear process of material creation and usage, rather than based on systems thinking and studies on resource flows and life cycles. A change to the latter mode of thinking might result in a reduction in the creation of waste, and might direct more attention to alternative modes of treatment, such as composting.

6.1.3 Waste arising and urban metabolism

There is a degree of consensus in the literature that the collection of materials for recycling, and the processing of collected materials, is more energy efficient and cost efficient within larger settlements, and higher densities enhance the viability of material collection and processing. Good transport networks also enhance the efficiency of recycling. Thresholds exist for activities such as composting and thermal treatment; however, no data are available to indicate where these thresholds may lie in the Irish context. Clearly, smaller settlements will not create a viable base for some options. Care must be taken in forming generalisations; in small settlements waste is safely disposed of through informal composting and feeding of organic waste to animals not intended for human consumption. Such practices are invisible unless residents are interviewed in some depth.

The re-use of wastes through the application of industrial ecology concepts (whereby the waste products of one industry become the raw material for another) requires the presence of a cluster of suitable industries, more likely to be feasible within a larger settlement with a larger workforce.

6.1.4 Biodiversity and green spaces

There is no clear relationship reported in the literature on the association between settlement size and landscape and habitat heterogeneity and quality. It is noted in some studies that larger settlements do not necessarily have more negative impacts on biodiversity than do smaller settlements, as much depends on functionality and planning actions. For larger settlements to be benign in

terms of impacts on biodiversity, however, planning must facilitate the preservation of habitat remnants at a high level of quality, and establish habitat corridors connecting remnants, to allow the movement of wildlife and act against local extinctions. Green open spaces also have high amenity value (often found to be critical in terms of aesthetics and community well-being), sequester carbon dioxide, reduce surface runoff (and perhaps flooding), reduce noise and enhance air quality. They reduce the heat island effect, and may enhance soil quality and reduce lotic sedimentation rates. The obtaining of data on green spaces requires the analysis of remote sensed images, especially aerial photographs, which were not available to the research team.

6.2 The application of findings within NSS planning

6.2.1 Key factors in the urban structure of Ireland

Ireland has made a rapid transition from a primarily rural–agricultural society to one that is now 66% urban, and it appears that these trends will continue for the foreseeable future. The *Urban Structures* study (Brady Shipman Martin, 2001) summarises this structure (see Table 4).

(a) There is a good size distribution of urban centres below 40,000 in population. However, there is a bias in their geographical distribution towards the East and the South-East. In particular, there is strong clustering of urban centres in the 10,000–39,999 category in the East and South-East of the country. Some of these centres, such as Bray, Swords, Malahide, Leixlip, Celbridge and Greystones, have grown very rapidly in recent years and are now part of the Dublin Metropolitan Area. Other centres in this size category have also been influenced by the economic and employment growth of the Dublin region, including Dundalk, Drogheda, Naas, Newbridge, Navan, Mullingar, Tullamore, Carlow and, probably to a lesser extent, Athlone.

(b) Four of the centres in the 10,000–39,000 population category – Tralee, Sligo, Killarney and Letterkenny – are located in relatively isolated parts of the country, where they are the most important towns and act as ‘sub-regional’ centres.

(c) The relatively well-developed urban structure of the East, South and South-East is contrasted to the less developed structure to the west and north-west of a line that runs approximately from Limerick to Dundalk. Here, urbanisation levels are lower than for the rest of the country and there are fewer large towns. As a consequence, many smaller centres provide a level of function far greater than their population would indicate.

(d) The distribution of centres below 10,000 in population is more evenly spread across the country, but there is a greater density of all urban settlement sizes in the East and South.

(e) Nearly half of all urban centres with populations of 5000 and over are located on or near the coast.

This provides a context for the question of ‘sustainable settlement size’.

Table 4. Key issues in the NSS.

Key issues in the National Spatial Strategy	Case study settlements (satellite villages in parentheses)
The increasing economic dominance of the Greater Dublin area	Portlaoise (+ Freshford)
Increasing influence and emerging interaction between the other four existing gateway cities and their catchments	Limerick (+ Pallasgreen), Waterford
Areas on the west coast, on the Border, in the South-East and South Midlands where relationships between different towns are emerging	Killarney, Westport, Sligo
Other, largely rural areas in the North-West, through parts of the Midlands and into the South-West where the agricultural employment base is declining and where the urban structure is quite broken, with no dominant element	Roscrea (+ Shinrone), Athlone

6.2.2 Factors relating to sustainable settlement size

6.2.2.1 Functional settlement size

Clearly, the urban socio–economic profile of a settlement is a key determinant of its environmental performance, and hence of its 'environmental sustainability'. For instance, a dormitory suburb of Dublin is likely to have a very different profile to that of a market town in the Mid-West, even if their overall populations and densities are the same. Where the functional profile can be classified effectively, it should provide a sound basis for cross-comparison of environmental and other indicators between different settlements of varying size and location. However, the functional profile is not a simple question and there is no single way to provide this classification.

This perspective looks not so much at the internal profile of the settlement itself, but at its place in the inter-urban and inter-regional pattern and hierarchy, in economic and functional terms.

Another perspective that applies to some settlements, if not all, is to place the urban area within its rural context. Here, the NSS report on *Irish Rural Structure* provides a ready typology with detailed quantitative analysis (Fitzpatrick Associates, undated).

Common specifications and/or indicators of 'functional' settlements/regions would include, together with the data sources in this study:

(a) effective travel to work radius: proxies drawn from rural studies mapping;

(b) position of settlement in urban hierarchy: from NSS data on health/education services;

(c) position/distance of settlement to next higher hubs, i.e. small towns, major towns, Dublin;

(d) position/distance of settlement in relation to strategic transport networks;

(e) general socio–economic profile of rural hinterland: from *Rural Typologies* study (Fitzpatrick Associates, undated);

(f) general socio–economic profile of settlement urban area: various sources;

(g) general development prospects and pathways: from NSS draft framework.

6.2.2.2 Density

In general, density increases with population size and this was true for the Irish case studies. The claimed advantages of the compact city have been well documented. They include: conservation of the countryside, less car travel and associated emissions, better support for public transport and walking and cycling, increased access to services and facilities, more efficient utility and infrastructure provision, and the revitalisation and regeneration of inner urban areas. On the other hand, intensification may include loss of greenery in towns, upgrading of the local built and natural environment brought about by new buildings and high quality design, and increased environmental wear and tear.

Adversely, although higher densities may have the potential to reduce trips by car, the subsequent loss of urban open space may actually result in a reduction in ecologically important land, and a loss of space for trees and other greenery. This is an important issue for Ireland, which exploits its 'green' image as a tourist attraction. Similarly, whilst reduced travel leads to energy savings, the opportunities for developing renewable energy sources may be hindered if increased density is not properly managed. Higher densities alone may not be the solution; a combination of higher densities and mixed land uses are required to maximise the potential for sustainability.

6.2.2.3 Land use

Reshaping the environmental profile of resource use in settlements (flows) through the reordering of land uses, the layout of areas, and building design, is suggested as the dominant discourse in urban sustainability debates. The level of mixed land use may contribute to travel demand, particularly through the decentralisation of less specialised employment. Alternative urban forms can be categorised as: dispersed city, compact city, edge city, corridor city, and fringe city. Research by Reneland (2000) on Swedish towns suggests that although the

smaller towns do have advantages, they do not offer adequate accessibility to all services, in comparison to larger towns.

6.2.3 National Spatial Strategy options

Several different approaches can be taken towards developing a national spatial structure. The most significant of these different approaches could be described as:

(a) to continue with present trends;

(b) to slightly adjust present trends;

(c) the Traditional Solution (Approach (b) + New Town);

(d) complete dispersal.

Each of these has benefits and disadvantages, either for national, regional or local concerns. Therefore, a combination of these is suggested as the preferred spatial approach for the NSS, with its main features as follows (Brady, Shipman, Martin, 2001):

(a) Build on and consolidate the strengths of Dublin as a capital city with a population tending towards 2 million, emphasising the areas of activity to which it is particularly suited.

(b) Other existing gateway cities could be brought to a level, probably by effective interconnection, where in combination, they would be able to play a national role in counterbalancing Dublin. Individual cities could end up with populations in the 200,000–300,000 range with a potential combined population of 1 million. The benefits that accrue from this would be associated with as wide a 'sphere of influence' as possible, such as neighbouring 'county towns' or local economic hubs but without urban sprawl.

(c) Develop the potential of regional centres with emerging strong links to adjacent towns and associated hinterlands as the new development opportunities best guaranteed of success, particularly in the Midlands and North-West and parts of the South and South-East.

Establishing methodologies for the estimation of sustainable settlement involves consideration of how such settlement sizes may be generated over a period of time, in light of rapid growth in population, numbers of dwellings and also sizes of dwellings. There is a limited range of options available (Breheny and Rockwood, 1993):

(a) new freestanding settlements;

(b) enlargement of freestanding settlements;

(c) urban extensions (in the sense of planned medium- to large-scale developments);

(d) corridor development (particularly related to the transportation strategy);

(e) large-scale urban infill (this will be rare anywhere outside the Dublin conurbation);

(f) small-scale urban infill (this last constituting the majority of development on the ground).

The implication is that such 'sustainable settlement size' is not necessarily an ideal target to be created on a blank slate, but a process of ongoing development that will apply to the growth of existing settlements probably more than new settlements. Therefore, the case study settlements are investigated, not only for their current profile, but their prospects and potential for growth and restructuring.

7 Synthesis, conclusions and recommendations

7.1 Overall findings

Three distinct methodologies were adopted in relation to assessing the relationship between Irish settlement size and ability to approach sustainability. Indicators of sustainability were developed and data were collected to quantify these. Qualitative studies on selected settlements were undertaken, in which a description of events and processes took the place of a search for numerical data. Finally, an attempt was made to learn from experiences in other countries through a review of literature and to apply the findings to the Irish situation. It is necessary to emphasise that time was limited, data were very hard to find, and the question posed made it difficult to relate international experience to the Irish situation. However, given these caveats, the results of all three forms of analysis provided essentially the same result in broad terms, i.e. larger settlements are more likely to support processes that have to date allowed them

to move towards enhanced sustainability and will continue to do so in the future. Qualitative evaluation clearly indicated that Limerick was better placed to tackle problems, and was making more progress than Freshford. Indicator analysis showed that a preponderance of indicators sensitive to settlement size signalled that larger settlements were more sustainable, and that those suggesting the opposite were perhaps more difficult to interpret. A review of work carried out in other countries showed that, at least some of the time, the picture emerging from an analysis of Irish data was similar to or at least showing the same general trend as those collected elsewhere.

It is not possible to quantify optimal Irish settlement size: there is no single threshold value in p.e. that can be quoted as the minimum size likely to enhance settlement sustainability. We have suggested a figure of 25,000, but this pertains to some issues only, and even in this context it is necessarily an estimate. The literature review (main report) was designed to provide as many concrete examples as possible, e.g. in relation to services that should be available nearby to avoid lengthy daily journeys. It is hoped that this information may be of value in informing NSS planning as it complements the very considerable experience and expertise of NSS staff. In the absence of Irish data that might be used to test models published for other countries, it was the maximum that could be achieved within the 6-month duration of this study.

7.2 Settlements as the units of study

A fundamental issue that has arisen is the fact that size is not easily quantified and, even if it were, it might not be the most important, or only important, parameter affecting sustainability. The need to place settlements in regional and national contexts, and indeed in international contexts, emerged as a strong theme. Within an open economy, export reliant, and in an age of increasing globalisation, no settlement can hope to sustain itself without developing effective means of interacting with other settlements in Ireland and abroad. In a situation where regions within EU States compete with one another for inward investment, no settlement can thrive without building strong links with others in the region and beyond.

7.3 Data availability now and in the future

A second fundamental issue is the paucity of available data. In many instances these data exist, or have existed. If data are published at county or vice-county scale, then a process of aggregation has occurred. What needs to happen is that access to data is facilitated lower down in the aggregation process. In other cases data were there, but agencies were unable to deliver them because of lack of resources. In further cases, data were held by bodies that refused to release them on grounds of confidentiality. In many cases, however, the problem is more fundamental: data are simply not collected. In other instances, data are destroyed; the Ordnance Survey, for example, when updating digital maps, overwrites the older maps. This prevents the accumulation of data in a time series, which would allow the identification of trends that are often more important than the point values recorded for a single time period. We have attempted to identify a ‘wish-list’ of data, together with likely sources, which, if available, would make possible a full analysis of the sustainability of settlements. All these data need to be accumulated over time, to allow the identification of trends.

7.4 What is needed to allow a more complete analysis?

To facilitate a more complete analysis of the relationship between settlement patterns and sustainability, a larger study is clearly required. More time is needed to collect available data and, in many cases, capture data through fieldwork. To facilitate generalisations on a 26-county basis, a far greater sample of settlements will need to be included in the sample frame. The focus of the study might be directed more at planning on a regional or national basis, so that inter-relations between settlements could be factored into the investigation. This would enable the development and application of forecasting models, which are useful for examining the alternative futures possible for Irish settlements under different sustainable development strategies. These models would then act as decision support systems for all policy makers.

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