Tranquillity Mapping:

Developing a Robust Methodology for Planning Support

Technical Report on Research in the Northumberland National Park and the West Durham Coalfield

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Glossary of Abbreviations

ATK	Anti Tank (Rocket)
CA	Countryside Agency
CPRE	Campaign to Protect Rural England
CWD	Cost Weighted Distance
DCC	Durham County Council
DEM	Digital Elevation Model
DTM	Digital Terrain Model
GIS	Geographical Information System
GO-NE	Government Office North East
LFA	Low Flying Area
MoD	Ministry of Defence
NCC	Northumberland County Council
NNP	Northumberland National Park
NNPA	Northumberland National Park Authority
NSP	Northumberland Strategic Partnership
ONS	Office for National Statistics
OS	Ordnance Survey
OSCAR	Ordnance Survey Centre Alignment of Roads dataset
OTA	Otterburn Training Area
PA	Participatory Appraisal
PLA	Participatory Learning and Appraisal
PRA	Participatory Rural Appraisal
PRoW	Public Right(s) of Way
WDC	West Durham Coalfield
ZTV	Zone of Theoretical Visibility

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1.0 Introduction

1.1 Tranquillity

"Tranquillity" is a widely used term. At the time of writing the Northumberland National Park's website promises visitors to Kielder Water and Forest Park 'pure tranquillity in a truly stunning environment' and the Scottish Tourist Board was running a television advert with the strapline 'Scotland... Majestic, Tranquil, Serene, and just a little bit Wild...' which pans from quiet landscapes to hectic mountain sports. The Scottish Malt Whisky Glenmorangie is Gaelic for 'The Glen of Tranquillity', even though the Distillery is industrial in its setting and appearance, on a coastline with coniferous plantations running up the hillside to its rear. From a product and place promotional perspective tranquillity is clearly something of value. However, in few of its uses in the media are people invited to reflect on what tranquillity is, what it means to them and where it can be found. It is presented as something hard to find, and therefore valuable. In a 2001 survey reported by DEFRA[1] the most commonly mentioned reasons for visiting the countryside were tranquillity (58 per cent), scenery (46 per cent), open space (40 per cent), fresh air (40 per cent) and plants and wildlife (36 per cent). Yet all of these terms are relatively vague, certainly unscientific, and as such there is a risk that a poorly defined definition may lead to weak frameworks and policies to protect and enhance them.

The term tranquillity seemingly has something in common with terms such as wildness, remoteness and naturalness but it is distinctively different from, and more than, all of these. This research has established that tranquillity is important; it is something that contributes to quality of life, but defining it remains difficult as tranquillity is ultimately a state of mind rather than a specific environmental characteristic, or quality, *per se*. Results of the consultation for this research are reported in detail in section 3, but to draw on this, tranquillity was defined by countryside users as a 'state of mind when in nice surrounding' and 'areas you can visit to leave all your troubles behind [to] escape life's hustle and bustle'. The link between the experience and the environment is clear.

Flowing from this, tranquil areas are perhaps best defined in experiential terms as areas with the characteristics most likely to induce a state of tranquillity for people who are there. The problem with this approach is that, just as beauty is in the eye of the beholder, people will find tranquillity in ways and places that may be more or less specific to them. Peterken (1996) has argued that 'most terms seem to have a planetary structure, i.e. a solid core of meaning, surrounded by an 'atmosphere' of diminishing applicability, with edges so fuzzy that exact delimitation is impossible or arbitrary' (p.12). The extensive consultation work carried out during this project underscores this, and makes a precise and universally acceptable definition of the term very difficult. However, the fact that certain variables emerge strongly, repetitively, across many cases, allows us to build a picture of what characterises, and detracts from these tranquil areas, or areas that permit people to find tranquillity.

There is a widely held feeling that tranquillity is getting harder to find. The comparative work by CPRE (1995) establishes evidence for this over a thirty year period from the 1960s. Scottish Natural Heritage (SNH) (2003) notes that many of the features which people seek have been made more accessible through transport infrastructure developments, as well as the broader social changes of the past half century which have left many people with more time for recreation. Therein lies a paradox, as access to environments that promise a relatively tranquil experience has been made easier to the point that the landscape has apparently lost many of its valued characteristics, including the sense of isolation and remoteness. This includes wild land, the subject of SNH's policy paper, and tranquillity.

[1] Quality of life counts (2004) http://www.sustainable-development.gov.uk/sustainable/quality04/maind/04s.htm

This project was commissioned because the project sponsors shared an appreciation of the value of tranquillity. Tranquillity is a pervasive concept in the field of environment, countryside and landscape, as will be seen in section 1.2. This research has underscored the significance of tranquillity as a *personal level* to many of the respondents consulted during the study, citing a range of personal and internal reasons relating to 'personal balance', 'destress[ing]', achieving 'peace of mind' and 'getting away from it all'. This research grounds the concept of tranquillity in specific findings about what people value in the landscape and in their lives, findings that have implications for targets, indicators, policies and plans relating to quality of life, countryside quality, landscape strategies and environmental management.

The researchers on this project are not of course the first to tackle the concept of tranquillity, or to try and map it, and the literature review in section 2 sets the scene of what has been done before and the wider context within which this project was conceived. Definitions are rarely, if ever, universally acceptable and the diversity of responses from the consultation phase of the research makes a tight definition of tranquillity especially difficult. Underpinning this research is a belief that many of the concepts used in environmental management are relative, that is the characteristics or qualities exist on a spectrum, and that discrete, binary categories such as high/low quality, natural/unnatural, wild/managed or tranquil/non-tranquil fail to capture either the variability of human perception or the 'fuzzyness' of boundaries in space and time. For this reason this project is focused on the identification and mapping of relative tranquillity. Relatively tranquil areas are those where the physical and experiential characteristics of the landscape are more likely to provide countryside users with the space and conditions to relax, achieve mental balance and a sense of distance from stress. Relatively tranquil areas are characterised by a low density of people, minimal levels of artificial noise and a landscape that is perceived as relatively natural, with few overt signs of human influence.

1.2 Qualities, Quality and Indicators

This section establishes a context for tranquillity assessment. Tranquillity is defined as an environmental quality, but it is accepted that it is but one of many different qualities, or aspects and dimensions of overall quality. It is a quality that is engaged with and accessed through personal values and all of these are terms that need defining.

"Quality" is a pervasive concept in modern society. Public and private providers of goods and services alike are judged on performance and quality. However, assessing performance and quality is far from simple (Audit Commission, 2000) and heavy use is made of indicators. Such indicators provide a measure against which quality, performance and progress may be measured. Such measures may be direct (e.g. Biological Oxygen Demand in relation to freshwater quality), indirect (e.g. length of hedgerows per km^2 in relation to farmland birds) or even surrogate measures (e.g. proportion of children walking to school in relation to childhood obesity). They may also be input, output or outcome related. Input-related measures (e.g. government spending on the police) are now rarely used outside of political circles, output-based measures (e.g. number of police on the beat in a given area) remain relatively unsatisfactory, yet outcome-based measures (e.g. reductions in burglary) have their own problems of case and effect, quantification and reporting. So, indicators in general are relatively problematic and there is a need to define what their role is and what limitations they are subject to.

Quality:	a holistic term for the accumulated benefits that are experienced from a particular state of affairs.
Qualities:	specific aspects or attributes which have utility and / or meaning to communities and / or individuals.
Value:	values are social and individual judgements about relative worth.
Character:	character, specifically used here in relation to landscape, is a description of what comprises, defines and distinguishes a particular area.
Indicator:	a precise and technical term for a measure by which changes, developments, progress, gains and losses may be identified. When used precisely, indicators are independent of evaluations or judgements of significance; this is the process by which changes are accepted or defined as unacceptable and new actions are implemented to achieve existing targets or the selection of indicators and their relationship to targets is revised.

Box 1: the semantics of environmental, countryside and landscape quality: some definitions

Environmental indicators typically show the quality and/or availability of desirable environmental characteristics that relate to sustainability and/or quality of life. The definition of indicators is a technique to identify changes over time and contingent upon policies, plans and interventions, and to establish objectives for policy and management. Indicators are selected on a variety of criteria, including representativeness of the variable or process, meaningfulness to a range of stakeholders, and their manageability. In the absence of indicators that are truly representative, indicators may be selected on the basis that they are available at limited effort. This point is not made to undermine valuable work that has had to be pragmatic for reasons of brief, resources or time, but to identify how this work is different. Table 1 simply represents the way in which various dimensions of quality and progress interrelate.

So, environmental quality is the aggregate of a whole series of more specific qualities, including for instance air and water, soils, landscape, biodiversity, waste, energy and climate. Some of these qualities may be managed at a relatively local scale (e.g. nature conservation sites), others are more regional (e.g. landscape management), others are regional to international (e.g. air and water quality) and others are global (e.g. climatic change). Quality of life has significant overlap with environmental quality and many of the individual qualities have a significant bearing on people's day to day lives, such as attractive and accessible landscapes. Countryside quality then is *largely* a sub-set of environmental quality, although it must necessarily include non-environmental factors such as employment prospects and provision of services. Landscape quality is a sub-set of countryside quality and environmental quality (Figure 1).

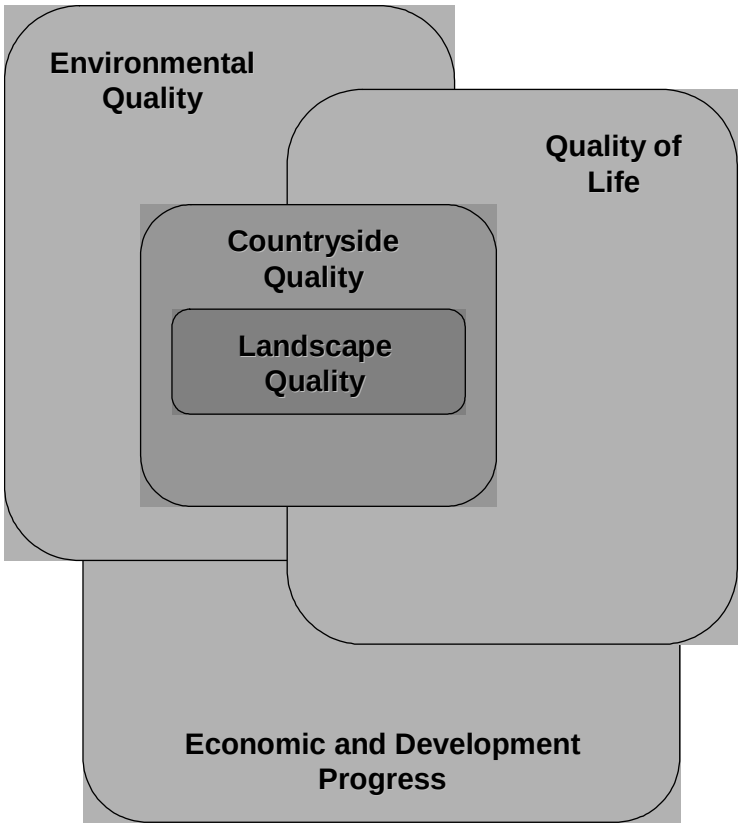


Figure 1: overlapping measures of quality, development and progress

As such indicators of one dimension may be partial or otherwise weak indicators of progress in another dimension. A reduction in noise for instance is, broadly defined, an environmental gain and something that contributes to countryside quality and also quality of life, although it is not relevant to landscape quality. The *experience* of landscape however, may be positively affected by a reduction in noise. Noise control (for instance through rejecting a planning application for a quarry) may, in turn, impose economic costs that are counter to conventionally defined development and associated indicators.

Tranquillity is perhaps conspicuous by its absence in figure 1. This research establishes its significance for quality of life, it is demonstrably significant as an environmental and a countryside quality, and it has the potential to enhance people's experience of landscape. Goosen and Langers (2000), in their assessment of the quality of rural areas (for recreational users) in the Netherlands, define tranquillity in terms of low noise and limited traffic. They use externally defined (i.e. by the researchers) indicators relating to fitness for use and perceptual qualities of the landscape. 'Fitness for use are those indicators which are functional and practical... Perception quality are those indicators which give an experiential quality' (p.242). Tranquillity emerged as one of the most significant quality indicators. Goosen and Langers go on to reflect the potential applications of such an indicator, something that is picked up here in the discussion.

In respect of economic and development progress, one example of a potential conflict between planning to enhance tranquillity and 'economic progress' is mentioned above. However, there are other ways in which tranquillity as a resource has the potential to boost the economic fortunes of certain areas. For instance if a sub-region or a designated area was able to make a claim to be the most tranquil area in a given region then this could attract more visitors. This is however a potentially dangerous application as this research has

established that one of the key factors that detracts from people's sense of tranquillity is other people and associated traffic, noise and related disturbance. Clearly careful thought is needed about how tranquillity indicators, assessments and maps are to be applied.

Tranquillity is one facet of what the Countryside Agency (CA) has termed 'Countryside Quality'. It is *an* indicator of what may all-embracingly be termed countryside quality, but it is not *the* quality indicator. The Rural White paper (DEFRA, 2000) envisaged a countryside quality indicator that 'should include issues such as biodiversity, **tranquillity**, heritage and landscape character' (Haines-Young *et al*, 2004, p.i) (our emphasis). The Countryside Quality Counts (CQC) process highlights knowledge gaps that hamper the development of indicators to support national policies for sustainable development. It is important of course to remember that sustainable development as a concept is now accepted to have environmental, economic and socio-cultural components; quality of life, equity of opportunity and environmental sustainability are intrinsically linked.

The CQC process focuses primarily on existing data sources relating to landscape elements such as woodland and settlement and development patterns, and recorded qualitative data on their condition. A range of experiential aspects such as remoteness, wilderness, welcoming feel, appropriate wildlife, and tranquillity are identified as being relevant to the countryside experience, which offers a series of benefits and services to countryside residents and users. The distinction between 'factual' and 'judgemental' indicators was identified, but a single, integrated indicator of quality remains the objective of the CQC project. However, data relating to the experiential aspects of landscape and the countryside are generally unavailable at the requisite spatial and temporal scale required. The CQC final report (Haines-Young *et al*, 2004) recommends that more robust ways be developed to map changes in tranquillity, which presupposes the existence of a methodology for assessing tranquillity in the first place. As existing approaches have been subject to a detailed critique, and the need to build upon them remains strong, there is a clear need to look again at how to approach this problem.

So, a range of environmental, countryside and landscape qualities and indicators exist in government, local government and stakeholder groups' visions, strategies, policies and plans. Tranquillity however has remained elusive as a defined quality and a specific indicator. Table 1 summarises some important indicators that appear in a range of central and local government documents, broken down into experiential and performance indicators. Table 1 necessarily generalises from the huge amount of work which each of the named bundles of indicators involved. The terminology is not consistent across the bundles and there are ongoing debates about terms such as 'quality' that some of the projects have progressed, others have not. Each of the approaches is intended to achieve different things, to highlight specific areas of concern, and they are very variable in respect of how precise and prescriptive the approach is. Some make reference to the need to consider a factor such as noise, others set targets and mechanisms to achieve them. So, the table is not intended to be taken as a definitive statement on how different agencies perceive and promote quality of life, environmental and sustainability indicators. It is, however, intended to identify the relative paucity of perceptual qualities that make it into such bundles, and in particular the very limited inclusion of tranquillity, even where it is externally defined.

	Experiential Indicators				'Performance' Indicators						
	Tranquillity	Remoteness	Perceived Naturalness[2]	Landscape quality	Noise	Light Pollution	Access to the Countryside	Air Quality	Cleanliness of public spaces	Water quality (rivers and canals)	Biodiversity
UK Govt Quality of Life Counts [3]	✗	✗	✗	✓	✓	✗	✓	✓	✓	✓	✓
UK Govt Local Quality of Life Counts	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓	✓
Local Govt Environmental BVPIs[4]	✗	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓
Countryside Quality Counts	✗	✗	✗	✓	✗	✗	✗[5]	✗	✗	✓	✓
State of the Environment (North East)	✓	✗	✗	✓	✓	✓	✓	✓	✗	✓	✓
State of the Countryside (England)	✗	✗	✗	✓	✗	✗	✓	✓	✗	✓	✓
SNH Wild land	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗
CCW Wildness	✓	✓	✓	✗	✓	✗	✗	✗	✗	✗	✗

Table 1: some of the primary bundles of UK environmental indicators and their range of variables

[2] As described in this report 'naturalness' has been defined in many different ways. It is used here to signify limited overt evidence of intensive human use of the land and a relative lack of modern artefacts and structures.

[3] http://www.sustainable-development.gov.uk/indicators/index.htm

[4] Audit Commission (2002) http://www.local-pi-library.gov.uk/library.asp

[5] To be assessed in 2006.

1.3 Tranquillity assessment and its applications

CPRE's previous work[6] was intended to identify (a) changes in tranquillity over a thirty year period to establish the context for campaigning work on this front, and (b) where significant 'reservoirs' of tranquillity remained. This work takes the methodology and the underpinning definition of tranquillity substantially forward. In so doing it does not provide an update to the CPRE maps of 1995 as the methodology is not precisely comparable. However it significantly advances our appreciation of what comprises tranquillity, what detracts from it and how to identify relatively tranquil areas within a given region. The emphasis of the work has been on identifying tranquillity on a relative scale rather than in more absolute terms. However, the shift from an absolute to a relative measure of tranquillity raises a series of conceptual issues around the identification and use of 'local' resources and a series of application issues around how the results are to be interpreted and used. These are raised and discussed through the report and especially in section 5.7.

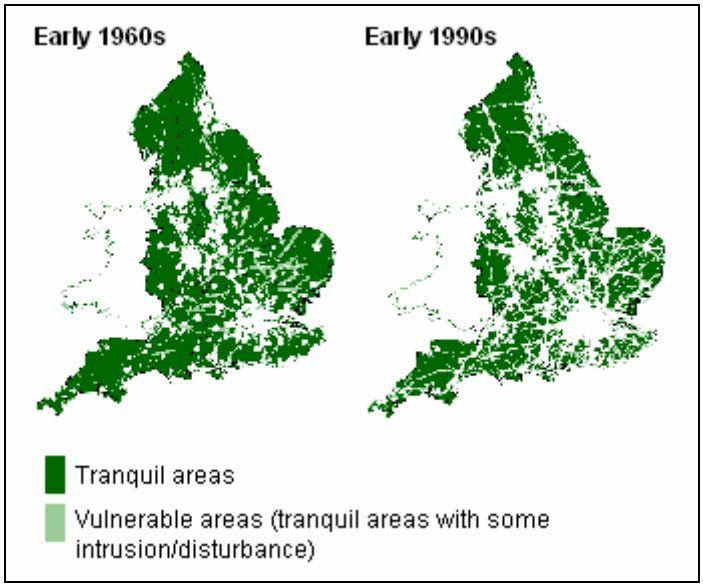


Figure 2: CPRE's Tranquillity Maps of 1995
(reproduced here with the permission of CPRE)

This project builds on and takes forward the CPRE (1995) work in four main ways:

a) Rather than starting with an expert definition of what comprises tranquillity, we have started with extensive consultation work to arrive at the definition. Consequently, a wider range of variables have been considered than in previous research, for instance incorporating night time skyglow and the perceived naturalness of landscape. In previous research the researchers defined the parameters and then applied the modelling and mapping from that point. This fails to accommodate the likelihood that a wider cross section of the population might have different, or divergent views on the subject.

b) Previous work focused exclusively on factors that *detract* from tranquillity, such as roads and airports. Our approach includes positive factors that contribute to, as well as negative factors that detract from tranquillity. For us, the glass is not just half empty, but subject to forces that both fill and drain it. We weight both these positive

[6] http://www.cpre.org.uk/campaigns/landscape-and-beauty/tranquil-areas/

and negative factors according to how important people think they are in determining how tranquil a place is.

c) More advanced modelling techniques allow us to map the diffusion of variables' impact over space. For example, noise levels decrease with distance from sources such as roads, but this is mediated by other factors such as vegetation and terrain and we have been able to take into account these effects. We have therefore been able to produce continuous surface maps of relative tranquillity, rather than zones of tranquil/non tranquil, or high/medium/low tranquillity.

d) In this research we have developed a conceptual framework of *relative* tranquillity. Relatively tranquil areas are those which have higher scores on the positive factors, and lower scores on the negative factors, than other areas. Our maps reveal areas, both large and small, where people are likely to experience tranquillity. But they do not identify absolutely tranquil areas, nor do they produce sharp lines dividing tranquil from non-tranquil areas. Relative tranquillity is something that is context dependent. For instance the most relatively tranquil areas within Tyne and Wear would still be judged relatively non-tranquil if considered alongside Northumberland and the North Pennines. This point about 'relative' tranquillity is critical, and will be addressed more fully at the end of this report.

The outputs from this process of tranquillity assessment and mapping are essentially (i) a methodology and (ii) maps of relative tranquillity in a defined study area. However, the way in which the process and its outputs can be applied for a variety of purposes is more complex. This theme is developed in more detail in the discussion but the points are outlined here.

As a campaigning tool

As identified earlier, tranquillity is identified as something valuable and increasingly elusive. Being able to identify, through consultation with countryside users, what comprises and detracts from relatively tranquil areas can inform campaigning for protecting and enhancing the positives, and in opposition to developments that are negatively associated with tranquillity.

As regional image / promotional tool

Place promotion may be defined as activities intended to foster a positive image of a specific place or area. Motivation for this may range from increasing inward investment through enhancing the external image of the North East as whole, to attracting more visitors to a specific part of the region. For both such applications, being able to claim that the region contains, or a specific area is, 'highly tranquil', or 'the most tranquil in England' (we should stress that no findings in this particular research support the latter claim) is a significant contribution to a positive image.

As a map on the wall

Maps on walls provide a valuable and frequently used point of reference for a whole range of decisions. However, maps are not in themselves decision support tools and final maps from a complex process often fail to communicate significant findings from the preceding research.

As a series of unpacked component maps which identify things that can be planned and managed to improve the situation as distinct from things that cannot

This is where the single map falls down, although in producing a series of individual maps, whether GIS or paper-based, you have lost the single view, the rapid point of reference that a single map can provide.

As an environmental assessment application

Computer-based systems offer the potential to support planning decisions through adjusting input criteria and modelling the consequences. GIS applications are now commonplace in a range of such environmental assessment processes, relating for instance to visual, noise, and air quality impacts of proposed developments. Technically, there is potential for the methodology to be developed here to be applied in the model of a positive planning tool[7], and the discussion offers a detailed commentary on this, concluding that tranquillity mapping, whether at the final map level or in disaggregated form, is an important element of the context for planning decisions.

1.4 Study Area

The study areas were to a large degree determined prior to the start of this research through the inclusion of the Northumberland National Park (NNP) Authority and Durham County Council as project sponsors. The NNP was included from the outset. The second study area, the West Durham Coalfield (WDC) was identified to a large degree to contrast with the National Park.

The NNP is England and Wales' least visited National Park and in recent years it has been promoted as a place which offers solitude, wildness and landscape quality. It is only sparsely populated and it is not heavily dissected by transport corridors, although few areas are more than 5km from any road. The NNP broadly breaks down into the Cheviot Hills to the North, the Simonside Hills to the East, the Upper Tyne Valley leading up to Keilder Forest and Water in the West and the Hadrian's Wall World Heritage Site in the Southernmost extent. Quite extensive areas of the Park are managed by the Forestry Commission. One of the most historically contentious aspects of the Park is the dominance of the Ministry of Defence (MoD) Otterburn Training Area (OTA) which is located in the central reaches of the NNP. The OTA is long established, having been a training range for over 90 years, but recent developments to facilitate training on more sophisticated and powerful weapons, especially self-propelled artillery and rocket systems, have highlighted what is at times an uncomfortable relationship between the MoD, the NNP Authority, local residents and countryside users.

The WDC study area is geographically much smaller than the NNP, and it is far more densely populated. Figure 6 highlights its dissection by numerous roads and a railway. Many of the settlements are of a significant population size, for instance Bishop Auckland (~25,000), Consett (~25,000), Stanley (~29,000) and Crook (~8,400). Much of the area thus exhibits typical characteristics of an urban fringe environment, with intense levels of pressure on a limited space. It is a relatively deprived former coalfield area, although land reclamation has usually been to a high standard. Access to the countryside is generally good, with a dense network of rights of way and the pattern of woodland is distributed. To the East of the WDC the land falls away to the densely populated coastal plain and the City of Durham itself. To the West it rises quite sharply to the North Pennines and the density of population and infrastructure declines.

[7] http://www.countryside.gov.uk/LivingLandscapes/PositivePlanning/Themes/toolkit/index.asp

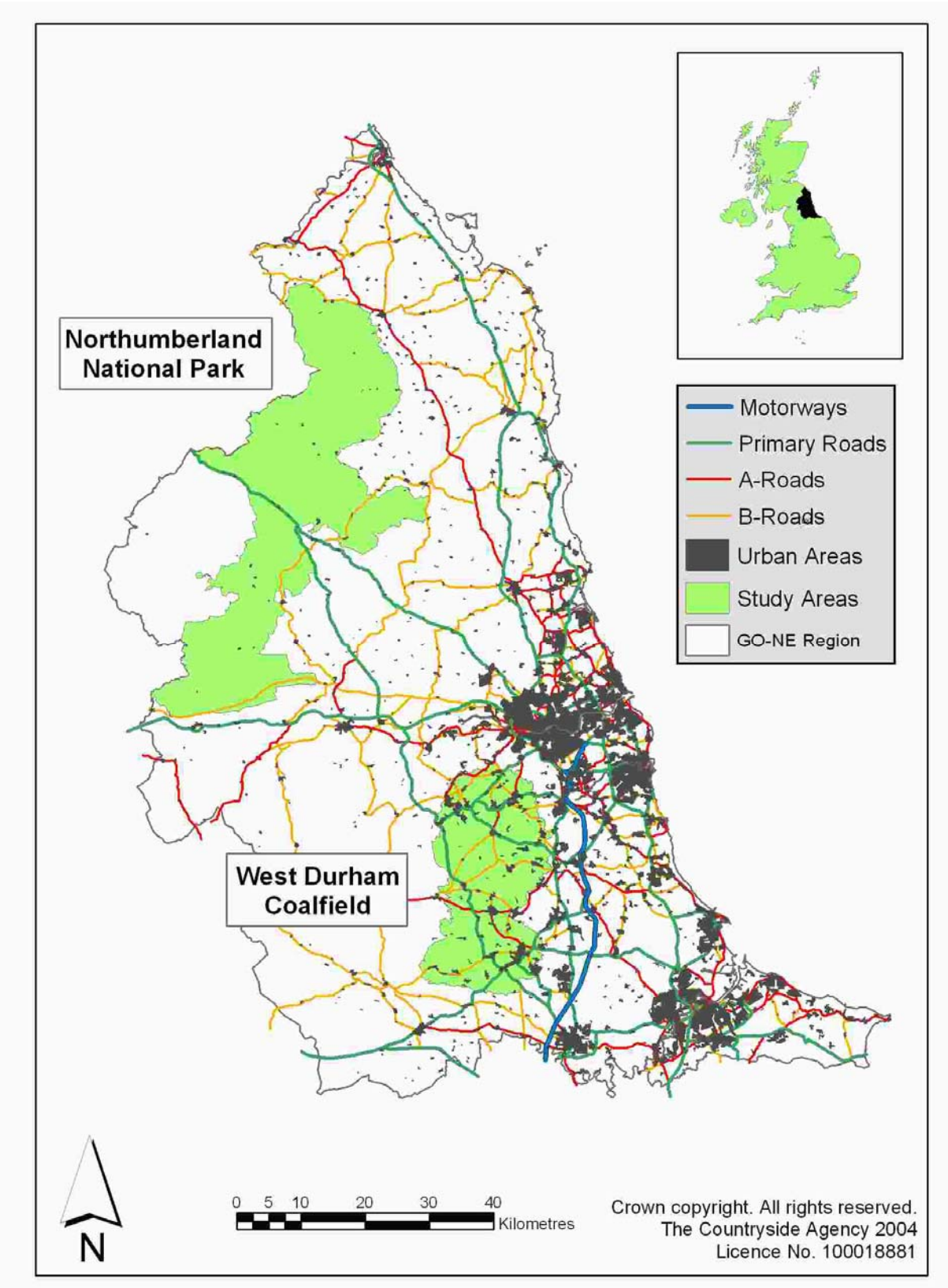


Figure 3: The Study Areas in a UK Context

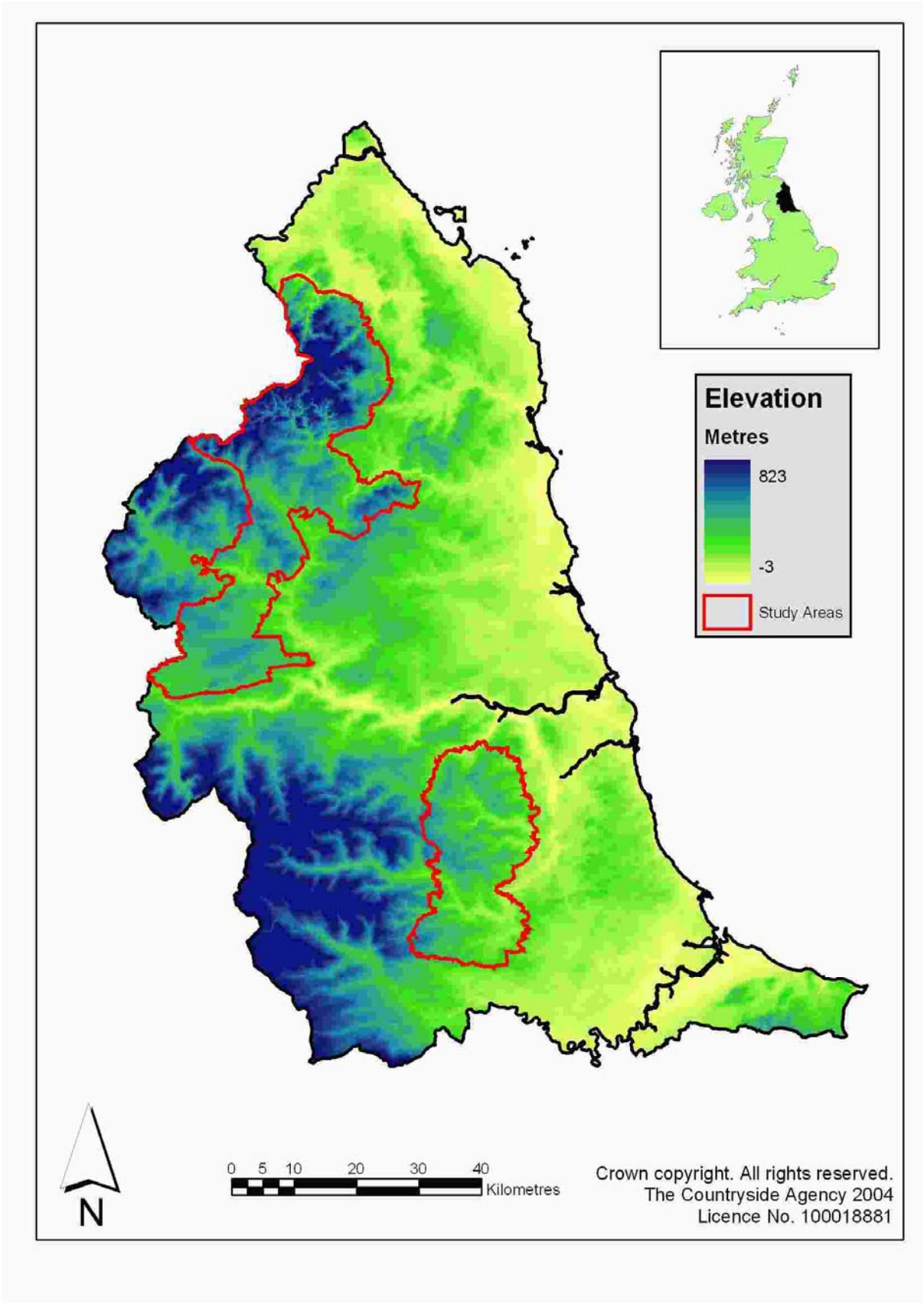


Figure 4: Elevation above sea level

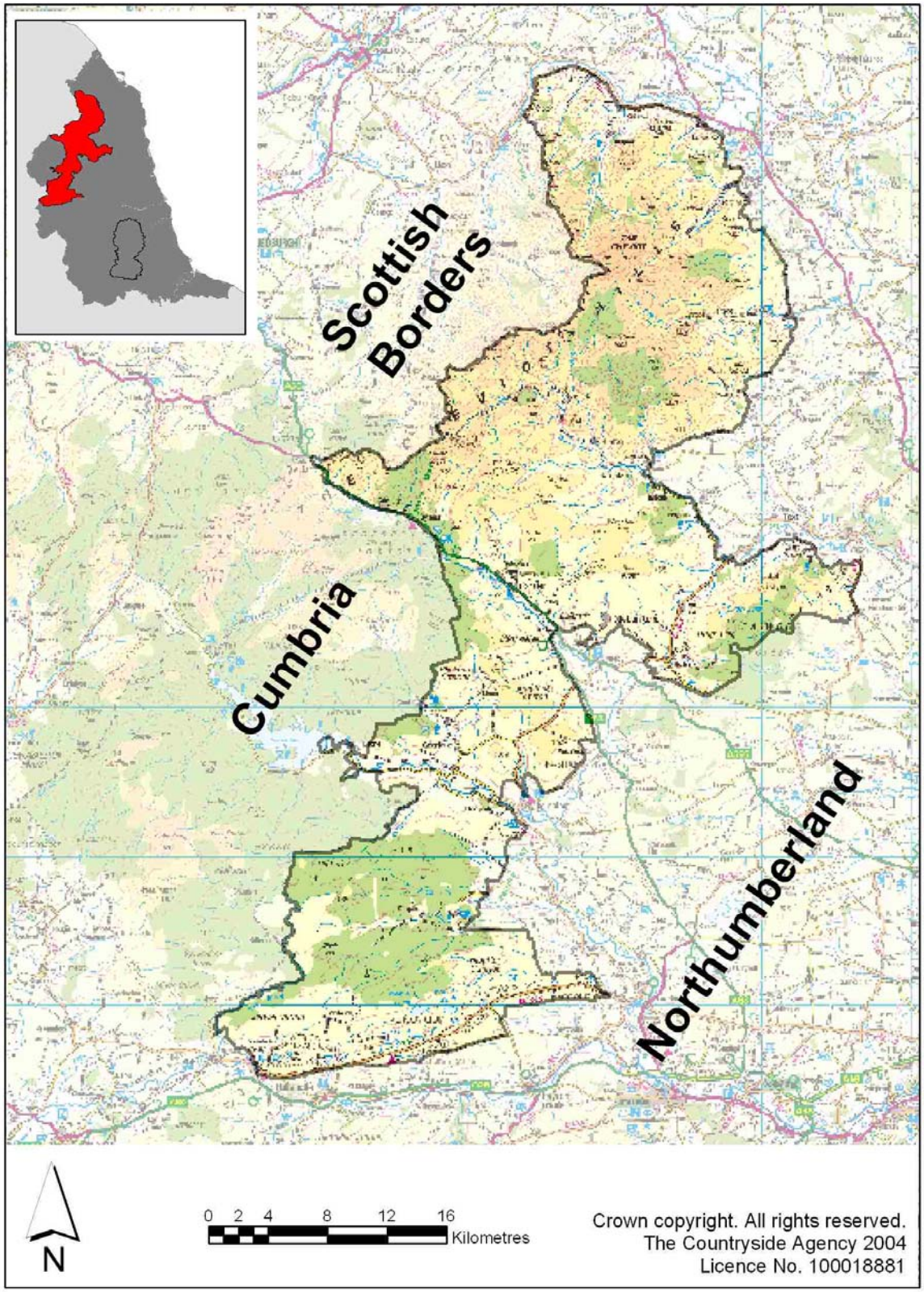


Figure 5: The Northumberland National Park (NNP) Study Area

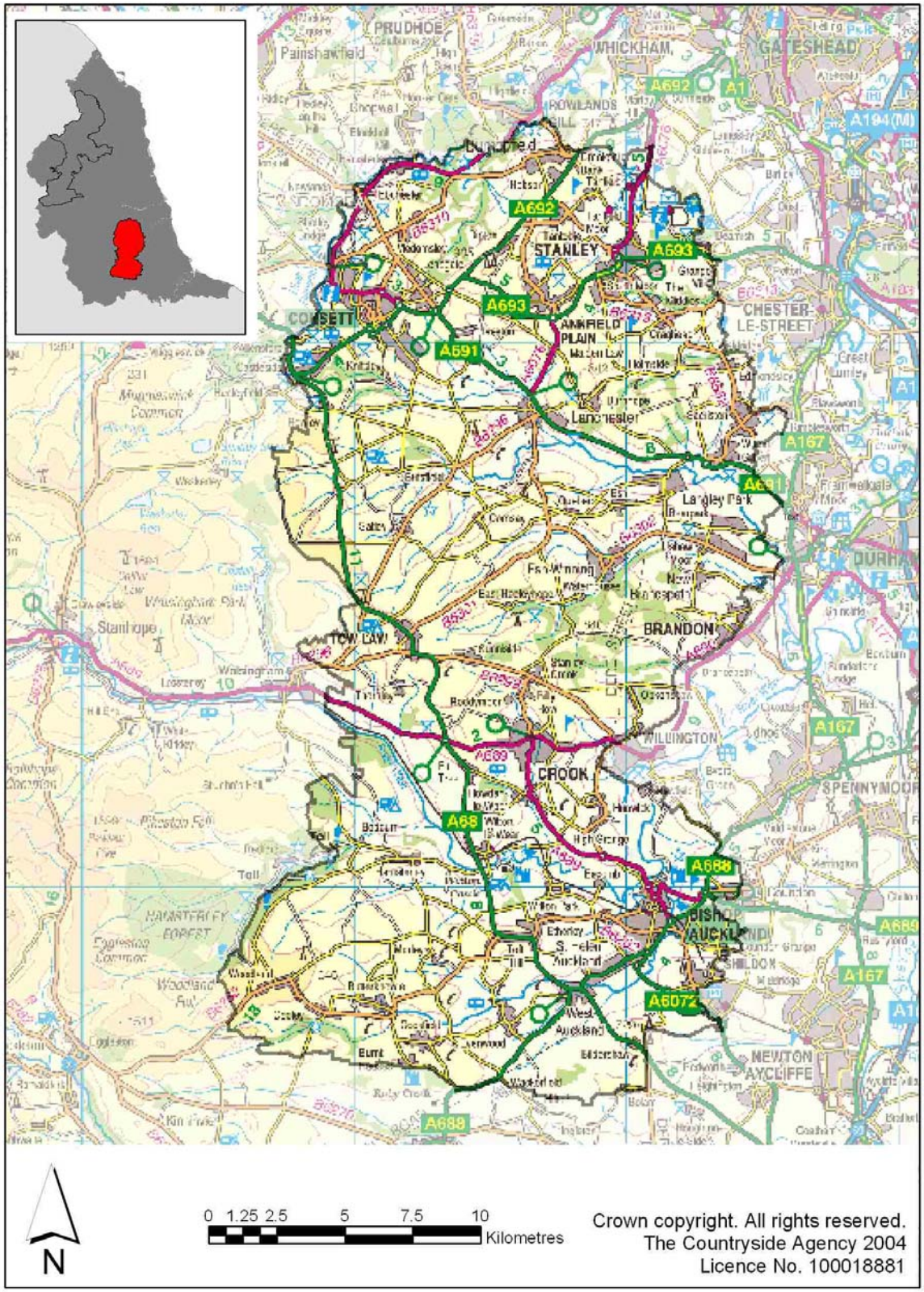


Figure 6: The West Durham Coalfield (WDC) Study Area

2.0 Literature Review

2.1 Introduction

> "Climb the mountains and get their good tidings. Nature's peace will flow into you as sunshine flows into the trees. The winds blow their freshness into you and the storms their energy, while cares drop off you like autumn leaves."
> John Muir (cited in Hartig et al, 1991)

This review draws together the previous studies relevant to this project. There are two key areas of research; on how people react to and feel about aspects of the environment; and on how these can be assessed and mapped. For the first time, this project incorporates both of these elements in mapping tranquillity.

Firstly therefore, this review will outline the previous work on tranquillity mapping. It will then consider the subjective nature of the concept, and how this has been addressed. Because of the limited amount of work on tranquillity, this will draw on research that has mapped other concepts such as 'wilderness' and 'naturalness' to illustrate some of the difficulties, challenges, and potential solutions to doing so. It will then discuss the importance of developing an approach that addresses peoples' values, perceptions, and experiences, by considering the literature on how people feel about and are affected by their environment. Finally, this review will outline how this project builds on some of this previous research to bring together mapping techniques in a real attempt to map the essential subjectivity of the concept of 'tranquillity'.

2.2 Mapping tranquillity

2.2.1 The work of Simon Rendel

It is important to acknowledge first of all the innovative and groundbreaking work by Simon Rendel of ASH consulting who originally developed the concept of tranquillity mapping. This was for a Department of Transport study in 1991 to examine the effect of a new transport corridor in Hertfordshire and Bedfordshire. The work was devised because although much of the countryside local to the proposed scheme was designated for landscape quality, significant tracts remained undesignated and were therefore vulnerable to development. The decision was made to therefore map all undisturbed countryside as a resource in itself. Commenting later on this work, Rendel (1996) states that it was remarkable that such a study had not been attempted previously, and also that it produced maps which were markedly different from those obtained by plotting landscape quality.

This original study led to the production of a set of Tranquil Area maps, produced by Rendel and ASH consulting, and published by CPRE and the Countryside Commission (1995). In these maps, 'Tranquil Areas' were defined as:

> 'places which are sufficiently far away from the visual or noise intrusion of development or traffic to be considered unspoilt by urban influences'

Such places were determined by calculating the distances from various disruptive factors, and it was decided that a Tranquil Area lay:

- 4km from the largest power stations.
- 3km from the most highly trafficked roads such as the M1/M6; from large towns (the size of Leicester and larger); and from major industrial areas.

- 2km from most other motorways and major trunk roads such as the M4 and A1, and from the edge of smaller towns.
- 1km from medium disturbance roads, i.e. roads which are difficult to cross in peak hours (taken to be roughly equivalent to greater than 10,000 vehicles per day), and some main line railways.
- beyond military and civil airfield/airport noise lozenges as defined by published noise data (where available) and beyond very extensive opencast mining.

The maps of Tranquil Areas were drawn with a minimum radius of 1km. Within the Tranquil Areas, the following linear elements were shown as creating a lower level of disturbance 1km wide:

- Low disturbance roads,
- 400kV and 275kV power lines.
- Some well trafficked railways.

The report on this work (1995) notes that various other sites also fell within this lower level of disturbance category, such as large mining or processing operations, groups or pylons or masts, settlements with populations greater than 2,500 people, some half abandoned airfields and most wind power developments. The maps were drawn at a regional level, and the report states that they ignore local effects, providing instead a "broad brush picture" of areas in the countryside which are free from urban intrusion. Drawing the maps with a minimum radius of 1km also eliminates local effects. Rendel (1996) notes that this approach makes "no claim to complete objectivity" but that it can be demonstrated on the maps that they are not radically altered by adjustments to the criteria.

2.2.2 Developing the methodology for Wales and Scotland

This original work was developed and applied in other areas, and the ASH Consulting Group was commissioned by the Countryside Council for Wales to carry out regional mapping for Wales (1997). While the scale for the regional maps of England was 1:250,000m and with a minimum unit of 1km, the mapping in Wales used a scale of 1:50,000 and a minimum unit of 100m. The report states that the reason for this was a need for greater detail in Wales where the expectation of tranquillity was higher than in England. The mapping also included an extra upper zone of tranquillity above that used in England. This 'very remote' zone represented complete removal from human activities, and was defined an absence of all skyglow effects. A further degree of remoteness was incorporated by showing areas of semi-natural vegetation within the higher zones, and noisy sports, quarries, and military training areas were overplotted on the map.

In 2000, the Association for the Protection of Rural Scotland (APRS) applied the concept of tranquillity mapping to areas of Scotland (from Inverness to Aberdeen). The study was a evaluation of the potential of the concept, and used the same factors and methodology as the original (1995) study by Rendel for ASH.

2.2.3 Bell's tranquillity mapping for forests

While Rendel for ASH consulting defined tranquillity in terms of absence of noise and visual impacts, Bell (1999) introduced the element of 'naturalness in the countryside' into the definition, and stated that tranquillity could be summed up as "the quality that allows us to feel that we have 'got away from it all'" in his study. He carried out tranquillity mapping for

the Forestry Commission at Sherwood Forest in Nottinghamshire, and demonstrated the differing degrees of tranquillity and the effect of woodland.

The approach used by Bell was in many ways similar to that devised by Rendel. Bell used a number of factors to assess impacts on tranquillity:

- Noise from roads, railways, airports, low-flying aircraft, powerboats, blasting and industrial sites;
- Visual intrusion from built-up areas, holiday/caravan parks, industrial sites, power stations, grid stations, overhead lines, mineral extraction activities, decommissioned airfields, derelict land, windfarms, glasshouses, dish aerials and masts;
- Recreational use: numbers of visitors, effects of facilities, car parking and associated noise and visual intrusion.

Having defined these, Bell calibrated their effects, and created buffers around them that represented the relative cover of their influence, which were then mapped. He notes that the cumulative effects of several lesser disturbances could be added together, which requires both professional judgement and local adjustment. Further, woodland is assumed in his work to have a positive effect by screening visual intrusion and baffling and masking some noise.

2.2.4 Levett's critique

The conceptualisation of tranquillity mapping and the development of it was novel, hugely influential, and demonstrated the value of such a concept. However, Levett from CAG Consultants for CPRE (2000) gives a detailed critique of this approach; his comments are directed at the original ASH work, but they largely apply to the developments of it as well.

Levett states that while basing the methodology on the notion of features that are sources of disturbance and producing defined zones of intrusion has the great advantage of simplicity, it neglects various potential effects that may influence the perception of tranquillity. These are various, and it will useful in terms of this project and the methodology used here to consider them fully.

Levett argues that these limitations are that:

1) the mapping uses a single threshold rather than a variation of levels of disturbance from distance from a source. He states that the discussion of threshold levels is generalised and lacks rigorous analysis and empirical evidence.
2) the mapping does not take account of varying conditions, notably topography, vegetation, and prevailing weather.
3) there is insufficient consideration of factors that may/may not occur on maps or where maps provide insufficient information to estimate effects.
4) there is a lack of detailed discussion of data sources and their limitations.
5) the mapping does not take account of cumulative effects.
6) there is limited consideration of intermittent and variable sources of disturbance.
7) no account is taken of interactions between factors and how they may effect the perception of tranquillity.
8) although the sources of disturbance chosen for inclusion appear entirely reasonable, their selection seems to have been based solely on expert judgement, with little discussion or explanation. No empirical evidence is presented that they represent

> either the most significant factors or a sufficient set of sources to be (reasonably) comprehensive or representative.

Levett considers how these issues might be addressed. The first four issues could be dealt with by more and better empirical testing and data collection. For example, noise diffusion in the context of different vegetation types could be measured and then mapped using GIS. Levett points out however that the costs of addressing all these data issues could be prohibitive, and that it would throw the second four issues into sharper relief. Crucially, these all relate to how people perceive and interpret different kinds of physical disturbance. As he says,

> "more precision in measuring and/or modelling physical disturbance will not help when it exceeds the precision of our understanding of how physical disturbance relates to perceptions of annoyance, intrusion or 'spoiledness', just as putting a more expensive lens on a camera will not improve the quality of the pictures taken though a smeared and distorted car window" (2000: no page number)

What is needed instead, Levett argues, is a measure of tranquillity that includes all, and only, those sources of disturbance which people feel actually damage tranquillity; and which weights them in proportion to peoples' perceptions of their relative impacts on tranquillity. The expert judgements used to select the disturbances and the different threshold distances applied to them in the previous studies mean that they do not meet either of these criteria, and alternatives are therefore required. Levett states that the first stage of any further work would be to test the notion that tranquillity is important to people; this has only been inferred so far. He goes on to say that he believes that "bespoke opinion research would be needed to establish first that the broad concept of tranquillity as absence from disturbance (visual and perceptual as well as audible) was recognised, and that people thought that it was important" (2000: no page number). The next stage would be to clarify which impacts affected tranquillity, how severely, and their relative importance. Importantly, as Levett notes, thresholds and sensitivities will vary enormously between different places.

Finally, Levett goes on to detail two ways to respond to this. The first would be to reframe the concept as "freedom from disturbance inappropriate to an area's character and functions" (2000: no page number). The second would be to switch from considering which areas have particular levels of tranquillity, to peoples' access to and opportunities to experience and enjoy tranquillity.

There are several key points here following Levett's critique. The previous work on mapping tranquillity has focused on intrusions from a relatively small number of sources, and has not taken account of any factors that add to tranquillity. The boundaries that have been drawn on maps have not been graded with enough sophistication to illustrate local effects. And the crucial point is that the work has been expert led, has not assessed whether tranquillity matters to people, what factors are relevant, and how important they are. This previous research on tranquillity mapping has highlighted the value and benefit of attempting to map such a concept. In this project, we are aiming to build on this. This is both in terms of the technical developments in geographical mapping that make increasingly advanced maps a possibility, and in terms of extending our understanding to incorporate what people think and why; we are concerned to address the 'experience' of tranquillity and how to map it.

2.3 Definitions and perceptions of a subjective experience

We are therefore interested in assessing and understanding people's values, meanings and experiences of tranquillity. This project has been designed to acknowledge and incorporate

the subjectivity of the concept and the factors that are associated with it. Because this has not previously been done in relation to tranquillity, we are drawing on other studies that have attempted to do this with other factors. From these it becomes clear firstly that it is important to incorporate this subjective element; but secondly that doing so is challenging and complex.

To start with, the need to take account of the subjective is clear. Other studies have attempted to do so with concepts that, like tranquillity, are not definable in strictly objective terms; it will therefore be useful to briefly detail these.

Firstly for example, work has pointed to the effect of cultural values on descriptions. For instance, Habron (1996:46) points to the differences in definitions of wild land between the USA and New Zealand and argues that "these and other countries have defined wilderness in their own terms and for their own purposes, showing the differences between cultures in the perception of 'wild land'". He points out for example that a Scottish version of the concept of wild land would have to take account of the long and complex cultural and ecological history of the Highlands landscape, areas of which have been occupied for thousands of years (1996:46). Macnaghten and Urry (2000:166) give another example of the importance of cultural values, and state that while there is the perception that "there is something natural about trees", this perception "varies from society to society".

'Trees' however come in all species, shapes and sizes, some of which are more acceptable to individuals, local communities and interest groups than others. One way in which the appropriateness of given forms of land cover, land use and land management has been judged is through reference to judgements about 'alien' and 'native' (Barker, 1996; Kendle and Rose, 2000; MacFarlane 2001). Lines have been drawn in different places at different times and places by various groups to define (only) certain groups of plants and animals (and people) as 'belonging' in a given landscape. Cause célèbres in the British Isles include the Sycamore and a whole raft of commercially grown coniferous species. This debate is not progressed here in pursuit of a definitive judgement of belonging, echoing Kendle & Rose (2000) who argue that 'in a complex environment superimposed with equally complex human history, culture, values and aspirations, it is impossible to characterise one group of plants as 'superior' to others. This is especially true when the classification system is as nebulous and as value-laden as our definition of native' (p.28).

Secondly, research has described the way that the certain conditions may create an experience for individuals – but that what this is may differ. Much work in this area has focused on the experience of 'wilderness'. Kliskey and Kearsley state that "while the environments in which wilderness might be found have an objective ecological reality [..] what makes that reality explicitly 'wilderness' rests very much with the individual, and her or his personal cognition, emotions, values, and experiences" (1993:203); this is a point echoed by Knopf (1983) in his work. There are examples of how and why experiences might differ. Olds (1989:28) believes that how people are affected by and experience natural surroundings is dependant on the contact they have with nature during childhood. Tarrant et al (1994) highlight the importance of visitor characteristics – recreation motives, past experience, attitudes – in determining their tolerance of aircraft overflights in wilderness areas, and Graefe et al (1996) found that visitors to a wilderness area with greater past experience of it prefer to see fewer people during a wilderness trip. Further, Virden and Schreyer (1988) showed that greater past experience leads to a preference for environments that are primitive and natural, with minimal evidence of human impacts.

Carver et al (2002:24) build on this notion of differential experiences to describe the difficulties of defining the places that can be designated as 'wilderness' - and cite Nash's (1982:1) call "to accept as wilderness those places people call wilderness". They go on to

state that wilderness "has more to do with perceptions than it does with ecological conditions" (Carver et al, 2002:24). Habron (1996:45) concurs with this and argues that wilderness "means different things to different people", and Kliskey (1998:80) takes this a stage further to argue that "a wilderness experience is a state of mind". Further, Shankey and Schreyer (1987) contend that it is not so much the case that the natural world 'gives' a wilderness experience, but that it is the catalyst for the expression of fundamental and inherent emotional states.

Both the Welsh Assembly and Scottish Executive have recognised the significance of 'wild lands' as an environmental resource. Scottish National Planning Policy Guidance (NPPG) 14 on Natural Heritage[8] states that 'Scotland's remoter mountain and coastal areas possess an elemental quality from which many people derive psychological and spiritual benefits. Such areas are very sensitive to any form of development or intrusive human activity and planning authorities should take great care to safeguard their wildland character. This care should extend to the assessment of proposals for development outwith these areas which might adversely affect their wildland character' (para16). Scottish Natural Heritage (SNH) has published a policy statement on 'Wildness in Scotland's Countryside'[9] which makes a distinction between 'wildness' which is an experiential quality which can be enjoyed irrespective of other factors, and 'wildlands' which are places where the factors that underpin that experiential quality are most concentrated. Arup, working for the Welsh Assembly (WAG, 2004)[10], have set out the criteria defined as being relevant to identifying wildlands (Table 2).

Qualities	**Wildlands should be:**
Physical qualities	
Remoteness and inaccessibility	5km from major roads above 10,000 vehicles/day 2km from A roads [say around 5,000-10,000 vehicles/day] 1km from B roads [say around 2,000-5,000 vehicles/day Very lightly travelled minor roads- no buffer 2km from mainline railway 1km from local railway
Lack of evidence of human use of the land	Grade 5 or similar, unenclosed open land, no intensive agricultural practices eg moorland, heathland. Forestry reduces wildness of an area but it can still feel remote.
Lack of modern artefacts or structures	No modern structures such as fences, buildings or masts- wildland is unlikely to run up to the mountain fence as at this point more settled areas will be visible and the area will not be perceived as wild.
Perceived naturalness	Evidence of natural processes, natural vegetation cover and wildlife. Forestry will reduce sense of wildness because of its planted nature.

[8] Scottish Executive (revised 2000) National Planning Policy Guidelines 14 – Scottish Natural Heritage

[9] Scottish Natural Heritage (2002) Policy Statement No. 02/03 – Wildness in Scotland's Countryside

[10] Welsh Assembly Government Facilitating Planning for Renewable Energy in Wales: Meeting the Target Final Report - Research Contracts 105/2002 and 269/200, ARUP

Perceptual qualities	
Solitude	Evidence of human activity should not be visible and few people should be seen over a prolonged period of time which give a feeling of remoteness.
Tranquillity	No noise of human related activity
Inspiration/Awe	Natural beauty or scale of the area may lead to feelings of inspiration, awe or spiritual awareness.
Threat	Perceived danger posed by terrain and or weather

Table 2: Criteria for defining Wildlands in Wales (WAG, 2004)

There are currently no maps of wildlands in Wales such as the one produced by SNH. Some early work by the Welsh Office on the construction of a national dataset[11] was reviewed by Arup 'but it was found to present a too analytical approach which ran counter to the wider perceptual elements needed for this purpose (WAG, 2004).

Naturalness is also a concept that has an essential perceptual quality. An interesting example of this comes from Mace et al (1999:236). They found that noise in natural environments had an effect beyond annoyance, with a derogatory impact on tranquillity and solitude, but also affect visual landscape quality. Technical noises impact on the perceived naturalness of a landscape, and the louder the noise is, the less a landscape is perceived as natural. It is not just about the volume of the noise, or the impact on peace and quiet that effects experience. Similar results were found by Tarrant et al (1994) when they studied the aural *and* visual impact of noise on visitors' perceptions of the naturalness of an area.

This is clearly relevant for considerations of tranquillity, which may be said to have even less of an 'ecological reality' than wilderness. Tranquillity might be found in 'natural' environments, but it may equally be found in urban areas – in a church, a library, a city centre park. Tranquillity is even more about the experience and the state of the individual. The point is that previous studies have not deemed that subjective concepts are rendered impossible to map; but that criteria can be developed that allow this.

Human relations with nature are the subject of a complex and extensive literature that is not reviewed here (but see Macnaghten and Urry, 1998). 'Nature' and 'natural areas' as terms have always been used by landscape researchers in a much less precise sense than by ecologists and allied sciences where semantic precision has been of greater concern. Kaplan and Austin (2004) for instance note that 'there is a sizeable literature that documents the desire for and benefits of having access to nearby **natural areas**... There is also indication that knowledge of the availability of **nature** plays an important role whether or not residents actively engage with it... and that having **natural elements** in the view from the window is a source of psychological benefits (p.236, our emphasis).

Peterken (1996), writing with specific reference to woodland management, discusses the way in which the term 'natural' is associated with a range of different meanings, but critically that it can be applied in ways that are both absolute and relative. Peterken sets out that his 'preferred route out of the dilemma [of defining what is, and is not, natural] is to retain the idea of 'natural' as separate from people, but to regard 'naturalness' as a continuous variable'

[11] Welsh Office Planning Services (1980) A Landscape Classification of Wales.

Thus ' 'natural' is precise as a concept, but imprecise as a descriptor...' (p.12). Tranquillity is more problematic than naturalness as it is not a single environmental characteristic that is identifiable in both absolute and relative forms on 'objective' criteria, but rather it is an experience that is more likely to be achieved or found where a number of different environmental characteristics are, to a greater or less degree, present.

2.3.1 Mapping the subjective

Some studies have therefore attempted to take account of the subjective element to experiences. Again, the area on which there has been most work is on mapping wilderness. This has focused on 'breaking down' the concept and developing a set of criteria, the presence or absence of which lead to a wilderness experience. For example, Kliskey and Kearsley (1993:203) state that they aim to show in their study of wilderness that "what might be regarded as very personal imagery can, in fact, be collected and used as a potential management tool". They outline how wilderness can be measured in terms of the artefacts of remoteness, naturalness, and solitude, and argue that quantifiable indicators for each of these wilderness properties can be devised.

A similar approach has been adopted in a number of other studies. For example, Carver et al (2002:25) devised a list criteria for wilderness: the natural state of the environment, the absence of human habitation, and the lack of other human-related influences and impacts. Lesslie (1994), and Miller (1995) also assessed wilderness on the basis of four factors: remoteness from settlement; remoteness from access; apparent naturalness; and biophysical naturalness. And while Kliskey (1998:80) emphasises the experiential quality of wilderness, he outlines the common characteristics that have emerged from studies of wilderness attributes. He argues that while there is detailed variation of personal interpretation, patterns of consistency do exist between different groups' perceptions of wilderness. Kliskey states that these common properties can be developed into a methodology whereby they can be mapped. He does this by giving each property of wilderness a number of indicators (for example, the property 'remoteness' was given the indicators of road access, maintained tracks, motorised travel). These indicators were then expressed in spatial terms for each of the different groups studied, allowing them to be mapped using GIS.

Further, Fritz and Carver (1998:2) describe the way they addressed the subjectivity behind some of these factors. The wilderness indicators they defined were remoteness from settlement, remoteness from access, apparent naturalness, and biophysical naturalness. They argue that in order to take the subjective nature of the wilderness concept into account, multicriteria evaluation techniques can be used to weight the wilderness indicators differently. This means using a simple weighted linear summation model to give different weightings to the data sets being used, to represent that they are not of equal weight and allow individual preferences to shape the model outcome. As well as being an improvement on previous work because of this, Fritz and Carver argue that this approach also produces a wilderness continuum that is relative and does not define the presence or absence of wilderness in terms of any threshold value.

Additionally, studies have addressed the subjective nature of their topics by asking people about them. For example, in developing wilderness criteria, Mace et al (1999:236) highlight the difficulty of doing so, given that definitions of wilderness for some mean a total absence of any human influence, but for others includes an acceptance or even requirement of certain basic facilities. Their method for studying this was to devise a wilderness purism scale. This was a list of criteria, such as 'maintained huts and shelters', 'commercial mining', 'remote from towns and cities'. People were then asked to rank the presence of these criteria in a wilderness setting on a five point scale from 'strongly desirable' to 'strongly undesirable'.

Similar approaches have been adopted, for example by Purcell and Lamb (1998) in their study of preference and naturalness, where respondents selected from predetermined options, and Tarrant et al (1994), who used a postal questionnaire to assess annoyance of aircraft overflights in wilderness areas. Hallikainen (2000) describes the need to determine what features of wilderness are used and appreciated by people; and his methodology was to devise questionnaires and landscape rankings to assess this. However, while these are valid approaches, they do not address the quality of the experience, or allow respondents to express their understandings in their own terms. In this way, such studies may be based on very limited input from people, and while stressing the importance of the subjective nature of the concepts, may do little to actually address this. Shultis (1999) does attempt to overcome some of these issues in his study. He used a postal questionnaire to assess attitudes towards the popular and political conceptions of wilderness. The first three questions addressed the public's unprompted conception of wilderness, as respondents were specifically asked to use their own personal definition of wilderness when answering the questions. Other questions in the survey assessed attitudes on a 12-item wilderness scale. Shultis concludes that the results from the survey "indicate that utilizing unprompted and prompted perceptions and attitudes to wilderness may prove to be a fruitful means of assessing public orientation towards the cultural construct of wilderness" (1999:402) – but he only carried out a limited part of his study addressing this.

To attend to some of these sorts of issues, Carver et al (2002) set up a simple and easy to use website to survey public perceptions of wilderness in Britain. Their aim with their web mapping system was to allow users to explore their perceptions of wilderness in the British landscape. They did this by displaying a series of attribute maps and descriptions, and allowing the user to experiment with weights applied to these maps, by moving simple slider bars. They could then draw their own wilderness continuum on screen. However, the participants still defined wilderness in the terms specified for them by the researcher.

2.3.2 Experts, perceptions, and people

As has been indicated, what is lacking with many of these studies is any real engagement with the subjective nature of the issues. If people are consulted, this may be to ask them about expert-devised indicators. The important point to be made about the development of criteria is that what is natural or wilderness of course varies between people, and crucially, between 'experts' and 'non-experts'; so what may seen a reasonable list of criteria to ask people about may not have much relevance for them. For example, Carver (2003:3) draws on the work of the Council for National Parks (1998:3) to describe the difference between 'semi-natural' and 'near-natural' areas. The former are "areas which appear natural but are in fact influenced by management for agriculture or forestry", while the latter are areas where "the land is totally divorced from agricultural or forestry use – in which natural processes are encouraged to maintain the diversity of habitats, and vegetation is free to vary naturally with variation in the physical environment". One of the key phrases here is that semi-natural areas may "appear" natural. Indeed, Lesslie et al (1988) point out that naturalness is complicated because it has both this perceptual and an objective content; what may seem natural due to the perceived absence of any intrusion may be significantly influenced, for example, by the introduction of exotic plants and animals. And an area that seems disturbed by structures such as tracks and power lines need not have suffered any significant biophysical damage. Coeterier (1996) therefore makes the important point that "how inhabitants perceive naturalness differs greatly from the ideas of biologists and other experts". He goes on to argue that "naturalness is not only or even primarily based on the presence of vegetation, but rather the way a landscape has grown organically, as a living organism. In this respect, old farms and sandy road are seen as 'natural' too" (1996:27).

Furthermore, neither Patterson (1977), nor Kaplan (1985) found much correspondence between the ideas of experts concerning landscape qualities and the ideas of non-experts, and Ingold and Kurttila (2000) point to the differences in perceptions of the environment between experts and local people. Shultis (1999) notes that there may be a distinction between the popular conception of wilderness embraced by the public, and the political conception created by special interest groups, bureaucrats, and politicians, and which manifests in policy and legislation. Finally, Hendee et al (1990:4), referring to the United States, draw a stark comparison and note that "at one extreme, wilderness can be defined in a narrow legal perspective as an area possessing qualities defined in Section 2(c) of the Wilderness Act of 1964. At the other extreme, it is whatever people think it is, potentially the entire universe, the terra incognita of people's minds". The point about all of this is that the definitions used by 'experts' may not be appropriate or applicable for 'non-experts', even if these non-experts are invited to be part of the research.

Three interesting studies that attempt to address these problems are worth noting here. Firstly, Fredrickson and Anderson (1999:22) point out that the preference scales frequently used to capture expressions of individuals' preferences for particular landscapes are "somewhat limited and unsophisticated with regard to capturing fully the more affective responses individuals have to particular landscapes". In their study, they asked participants to keep journals and make a running account of their wilderness experience over a number of days, but the intensive nature of the research meant that they had only a very small sample of participants.

Secondly, Coeterier (1996:29) describes the need to use a method which provides respondents with the opportunity to express their ideas and feelings about the landscape. He used semi structured interviews with photographs as prompts as a way of achieving this, and describes how the interviews were structured around the 'why?' question, which was frequently asked of participants as they gave their views. This was to try and understand not only what landscapes people prefer, but what it is about them that they valued.

Thirdly, Habron (1996:46) states that his work is attempting to provide a perceptual definition of wilderness, considering how particular areas are interpreted and classified by different sub-cultural groups. He argues that using this approach is a way of assessing "the value people attach to the range of landscape elements" (1996:46). Habron describes the need to move beyond sole reliance on written questionnaire answers to assess wilderness and landscape features, and he developed a method of defining the concept of wild land using a perceptual definition of wild land based on landscape features taken from photographs. While he asked respondents to rate the photographs in terms of wildness, beauty and naturalness, the definitions of these terms were left up to the participants.

2.4 People and their environment

What becomes clear from this is the importance of considering the subjective nature of the concepts being mapped, of assessing and understanding what makes up a tranquil experience, why people seek them out, and what elements are required for an experience to be tranquil. A key area of research to draw on here is from environmental psychology. A vast body of research has looked at the impacts on people of being in different environments, and the experiences they have in them - and have described how tranquillity can be found in natural places. For example, Mace et al (1999:228) point to over 100 studies that have uncovered convincing evidence of the importance of the natural environment in facilitating recovery from stress, and they highlight the research that points out that "the primary reasons for visiting natural environments include escape from the stress of urban areas and the attainment of tranquillity and solitude".

Indeed, as Morris (2003) points out, the benefits of viewing greenspace or other nature goes beyond aesthetic enjoyment to include enhance emotional well-being, reduced stress, and, in certain situations, improved health. She goes on to describe that her review of the literature on health, well-being, and open space suggests that there are five key ways in which exposure to the natural environment is beneficial to human health:

- Enhanced personal and social communication skills
- Increased physical health
- Enhanced mental and spiritual health
- Enhanced spiritual, sensory, and aesthetic awareness
- Ability to assert personal control and increased sensitivity to one's own well-being

Theories from environmental psychology help to explain why this might be. Kaplan (2001:481) describes 'attention restoration theory' (ART). He goes on to describe the four features of ART that create a restorative environment (2001:482). These are:

1) 'Being away' – being distinct, either physically or conceptually, from the everyday environment
2) 'Fascination' – being in a place that hold one's attention effortlessly
3) 'Extent'– being in a place that has the scope and coherence that allow one to remain engaged
4) 'Compatibility' – everything in the environment fitting with and supporting what one wants or is inclined to do

It may be therefore that the restorative experience is enjoyed somewhere that is different to the everyday; and it is this difference, rather than the distance, that is the key factor. Kaplan and Kaplan (1988) for example point out that the distinctiveness and separateness of the natural environment from the everyday may be as important as the literal distance. Hartig et al (2001:593) build on this to argue that these four factors of ART are the "qualities of person-environment interactions: they do not exist in the environment or in the person in isolation" - it is therefore the experience of being in a place that is the important consideration here. Kaplan and Talbot (1983) go on to point out that all four factors are necessary for an environment to be restorative, a point reiterated by Hartig et al in their earlier study (1991). They highlight the empirical research which "provides strong evidence that experiences in natural settings have restorative outcomes" (1991:21).

Research has built on this work to emphasise that tranquillity is an important part of the experience of being in a natural environment. As Herzog and Chernick (2000) describe, the settings which engage effortless attention, or fascination, allow directed attention to rest. They state that "the phrase 'soft fascination' was coined to refer to the combination of moderate fascination and aesthetic pleasure that characterises the most effective restorative environments", and that others (such as Herzog and Bosley, 1992) have used the term 'tranquillity' to refer to the same theoretical combination. Herzog and Barnes (1999) argue that the two components of tranquillity – aesthetic pleasure and moderate fascination – make it an essential feature of optimally restorative environments, and from their study, Herzog and Chernick (2000) note that tranquillity was more prevalent in natural than in urban settings. Furthermore, sociological research has reached similar conclusions. Macnaghten and Urry found that the countryside was a used a space to escape to, and provided much-needed relaxation from the pressures of work. They also noted that the "desire for tranquillity" was very much a part of this (2000:172).

Taking this a stage further, Kaplan and Kaplan (1988) focus on what nature does, for whom, under what circumstances. They show that vegetation and nature reinforce our spontaneous

attention, allow our sensory apparatus to relax, and infuse us with fresh energy. Other work has highlighted particular aspects of a natural environment that aid this, and the factors of a landscape that are more or less preferred, such as that by Balling and Falk (1982); Purcell and Lamb (1984); and Purcell (1987). Fredrickson and Anderson (1999) highlighted the participants in their study who described the expansiveness of the landscape and an awareness of the sheer power of nature as contributing to a meaningful wilderness experience. Herzog and Bosley (1992) found that tranquillity had higher ratings in field and forest landscapes, large-waterscapes, and misty-mountains categories of landscape, and they suggest that the physical features of mistiness, unstructured openness, and surface calmness (such as the smooth surface texture of a large waterscape) help account for assessments of tranquillity. Interestingly, Powe and Shaw (2003) carried out a study of visitors to the Northumberland National Park and asked visitors to select the top three reasons for their visit. Tranquillity was the most popular response.

2.5 Our approach

How these previous studies have influenced this project will now be briefly considered. Firstly, the innovative idea of tranquillity mapping and the operationalisation of it have provided the basis for this current project. We are seeking to develop the work of Rendel and ASH Consulting using the techniques in social research and geographical mapping that are now available. Levett (2000) outlines that a fundamental problem for tranquillity mapping is that the choice of impacts is intrinsically subjective and has never been grounded in people's perceptions; this is exactly what this project is seeking to address.

We are doing so by unpacking the concept of tranquillity and extracting and operationalising the criteria that make it up; following the lead from other studies that have done so with similarly subjective concepts. Where our work differs is that these criteria will be solely developed from the responses of the people that we talk to. This project aims to both address and capitalise on the subjective nature of 'tranquillity' and the values of people who experience it by basing the research on them.

Previous research identified 'reservoirs' of tranquillity in the countryside. Reservoirs can of course grow and shrink with time and, to stretch the analogy, some may be of higher quality than others. However, reservoirs are essentially fixed categories; something either is a reservoir or it is not. Through consultation the concept of tranquillity has been unpacked into different factors, countryside and landscape attributes that contribute to tranquillity and those that detract from tranquillity. This enhanced understanding of what people mean by and seek in tranquil areas has permitted the application of GIS-based modelling tools to represent the spatial distribution of these attributes, both positive and negative. In so doing we have moved, both conceptually and in terms of the results, from reservoirs of tranquillity to relative tranquillity.

3.0 The Participatory Consultation Exercise

3.1 Participatory Appraisal and the PEANuT approach

3.1.1 Definitions and Key Principles

As noted in the Introduction, the exploration of 'tranquillity' within this project has been strongly based around the use of participatory appraisal. Alongside action research (Elliot, 1991) and participatory education approaches (Freire, 1985) participatory appraisal (PA) is one of a growing family of participatory approaches that contribute to 'a growing body of international work on community research methods through which the views of local people can be heard and by which they can consequently be involved directly or indirectly in defining policy' (Sellers, 1996: 1). In discussing the origins and practice of Participatory *Rural* Appraisal (PRA), Chambers (1994: 953) notes the 'fuzzy' and dynamic identities of these methodological forms and approaches, suggesting that 'the approaches and methods described as PRA are evolving so fast that to propose one secure and final definition would be unhelpful'.[12] Chambers identifies a number of traditions and antecedents that have impacted on the development of PRA, which have, 'like flows in a braided stream, intermingled more and more over the past decade, and each also continues in several forms; but directly or indirectly all have contributed to a confluence in PRA; and as with other confluences, the flow has speeded up, and innovation and change have accelerated' (Chambers, 1994: 954). These traditions include activist participatory research, agroecosystem analysis, applied anthropology, field research on farming systems, and rapid rural appraisal (see Chambers 1994 for more details). It is worth noting therefore that PRA lacks a precise and universally accepted definition.

If definitions of P(R)A are somewhat hard to pin down, the principles behind such approaches appear to be regarded with slightly more certainty, perhaps forming the more solid core of meaning within Peterken's 'planetary structure' referred to in section 1.1. For example, according to Sellers (1996: 1) 'principles of community research generally include valuing local knowledge, using an interactive rather than an extractive approach to information gathering, and verifying each stage of the process by using a variety of methods to elicit the same information. It requires the full involvement of local people and a regard for them by outsiders as the main subjects rather than objects of research'. Likewise, for Inglis, such principles include:

- respect for local perceptions and choices;
- sympathy for local problems;
- a focus on the application of the research for future improvements;
- humbleness on the part of external researchers;
- involvement of local people in planning the research;
- the use of visual material rather than written material only;
- enough time spent in the locality, nights included;
- importance given to establishing a good rapport with local people; and
- an emphasis on the importance of feed-back.

In addition, other key aspects of PA are considered to include:

- its *relevance*, through focusing on obtaining in depth information, verified and 'triangulated' locally to ensure reliability;

[12] Indeed, the omission of the 'rural' element from PA reflects more overt acceptance of the manner in which 'PRA represents a quiet methodological revolution applicable in a variety of environmental contexts (urban as well as rural)' (Inglis, 1995: 4).

- its *flexibility*, through mixing a variety of techniques and approaches to uncovering information that include as diverse a participant range as possible including, if not prioritising those deemed to be 'hard to reach');
- its *rapid and low cost* nature, with a trade off occurring between quantity and relevance of information, and an emphasis on accuracy and timeliness; and
- its *empowering* qualities, through a recognition that information elicited by the research process belongs to local people, which is then made more 'visible' and given validity through the research process, thereby promoting inter-group/sectoral dialogue and co-operation (Inglis, 1995).

In essence, therefore, PA (as one form of community research) is underlain by principles of 'valuing local knowledge, using an interactive rather than an extractive approach to information, and [a need for] verifying each stage of the process by using a variety of methods to elicit the same information' (Sellers, 1996: 1). These values underpin the PEANuT approach to PA.

Like other forms of community research, and closely corresponding to other forms/variants of PA, including PRA and PLA (Participatory Learning and Appraisal), the PEANuT approach to PA[13] is the sum of three inter-related activities (and more than the sum of each of these three individual parts) - research, education and collective action.

Research

A key aspect of PA concerns the involvement of local people within the research process, not as objects of research (as is perhaps the case in more 'traditional' forms of, and approaches to research), but as experts in the situation – as people who 'know how things really are'. PA is particularly effective in group situations (although it can work equally as well with individual respondents) as the potential for discussion is increased, with (through effective facilitation) opinions being voiced, issues being debated, and differences being noted. The type of information obtained through participatory appraisal is usually qualitative and in-depth, often providing an effective complement to data derived from other sources, and is specific and relevant to the community concerned. Data reliability is constantly checked and verified through triangulation (by using different 'tools and techniques' to ask the same question - see below), with all information being carefully and systematically recorded so that comparisons can be made throughout the process.

Education

Education occurs within the PA process at many levels:

- self-education – asking someone to think through their own issues and solutions, which they may not have had an opportunity to do;
- educating other local people – for example, when people participate within a group-based PA session, one person may talk about a specific problem that are experiencing; others in that group may have had that same problem and talk about how they dealt with it, or identify a local service that they found helpful; and
- educating service providers and policy makers – for example, via a group discussion between local people and service providers, or via the dissemination of 'research findings to those involved in the research, and all relevant and interested parties.

[13] See www.northumbria.ac.uk/PEANuT

Collective Action

Perhaps the most fundamental aspect within PA, the participatory nature of the PA approach enables respondents to be more involved with decision-making processes by actively contributing their knowledge of local needs, and suggesting appropriate solutions. The wider community can begin to gain a sense of empowerment from collective action and the experience of having their views taken seriously. Actions can then be identified, planned, owned and executed.

3.1.2 Tools and Techniques

In all understandings of participatory appraisal, emphasis is placed on the use of tools and techniques that are highly visual, and potentially more inclusive than approaches that rely solely on use of the written (and/or perhaps spoken) word. Chambers (1994: 959) notes how a distinctive aspect of PRA concerns 'the shared visual representations and analysis by local people'. PA 'session' work is normally undertaken in small peer groups, where participants are comfortable with each other, and in a location that is familiar to them (if not 'owned' and 'controlled' by them). The groups use large sheets of paper, coloured pens, sticky dots, 'post-it' notes and other visual materials to work through a sequence of tools. PA 'facilitators', who are trained in aspects of group-work, ensure that these skills are employed so that everyone who participates can do so to the level of their choice. During a 'session' one facilitator helps the participants to carefully address each issue that is raised, while the other makes notes of verbal comments and group dynamics. In effect, the participants are encouraged to move the direction of the session by talking about what is important to them and their situation(s). In some situations where it is more appropriate, or where participants feel uncomfortable in 'taking the pen', facilitators conduct structured and semi-structured interviews. The overall aim is to eliminate barriers in participation and include the views of as many different people as possible.

Figure 7: the use of post-it notes in the PA sessions (Photographer: Michelle Allen)

There are a wide variety of (so-defined) PA/PRA methods and tools, including mapping, timelines, oral histories and biographies, seasonal/daily calendars, spider/'brainstorm' diagrams, Venn diagrams, role-play, observation, photographs or video, matrix and pairwise ranking, flowcharts, transects, and pie charts. In addition, such tools might be adapted to suit specific needs/situations, and tools are constantly being 'invented' and disseminated. Crucially, the emphasis on verbal and visual tools/methods allows different types of people to contribute in a way that they feel comfortable, and to the level and extent chosen by them,

thereby being an effective route in allowing the views of those people who are usually most difficult to reach (by more traditional methods) to be represented. As an approach to consultation, therefore, one key advantage of PA is that it simultaneously produces verbal and written information, and has the flexibility to be accessible to all parts of society. It also has an element of immediate reflexivity through participants being encouraged to talk about what they contribute (known as 'interviewing the diagram'), thereby rapidly incorporating local expertise accessed during the sessions into the data collection process.

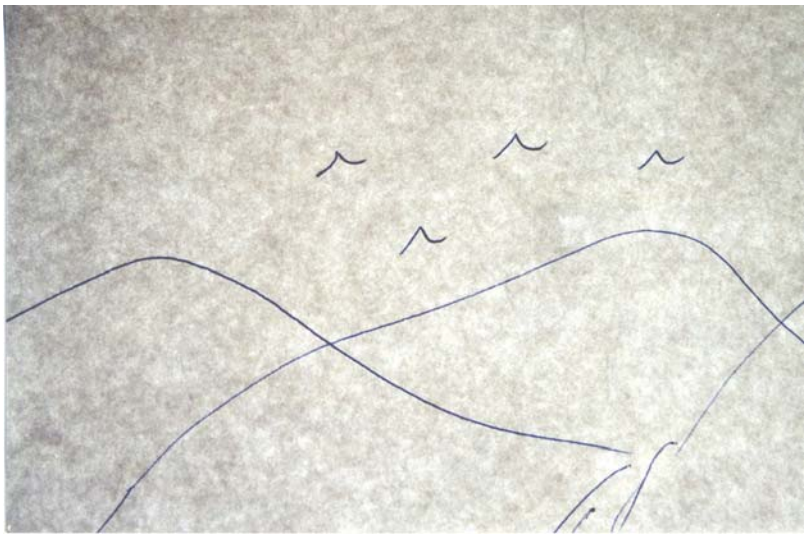


Figure 8: depictions of tranquillity in the PA sessions (Photographer: Michelle Allen)

3.1.3 Research Verification Events

Towards the end of any project, one or more research verification events are held. Throughout the research period, the project worker collects and logs all the responses made during the PA sessions, interviews, material derived from web-sites, emails and so on. At the verification stage these comments/contributions are then collated into different themes/topic areas, with a key aim being to highlight (to those attending the event) the breadth of comment within any given theme. This collation forms the basis of the 'writing up' of the research findings, essentially identifying the respondents aggregated key messages, themes and sections. These are then transferred onto flip chart or other media, and displayed at a convenient venue. Everyone who has been involved in the project to that point, local people and workers, are invited to view and comment upon both their own ideas and the ideas of others. They are asked if they agree with them, have anything to add, want to challenge any of them, or make suggestions for solutions. As such, verification events provide an opportunity for research respondents to verify, or 'check' the provisional research findings, whilst also allowing those who have not participated in the research to do so. A specific aim of the verification meetings is to try and identify more solutions to the issues raised.

3.1.4 Report writing, reading and dissemination

The 'writing up' stage of a PA-based project can be a complicated affair, not least because it is the writers role to convey the information uncovered during the research without manipulating its original meaning. All comments made during the research are utilised in their original form in the final report, with any spelling and/or grammatical errors left uncorrected. It is also the goal of the writer to limit the extent to which they evaluate or analyse the responses as to their significance or relevance, beyond what can be discerned by weight and/or repetition of comment. Despite this goal some degree of thought is obviously

often necessary on the part of the writer concerning where best to 'place' a particular comment, be it an individual word, statement, sentence, or longer piece of commentary (or part of). Clearly, when removed from its original context, the compiler may be unsure *exactly* what the original respondent meant by what was contributed, and where *they* would place it. However, experience suggests that on most occasions the degree of 'thought' required is of a fairly low cognitive level; that is, the degree to which comments are effectively 'analysed' or 'mulled over' is limited/minimal. Where the meaning of any comment is unclear (and this should have been avoided through vigilant observation and 'interrogation' of the flip-chart by the PA session facilitators), opportunities are also provided at the verification stage for misunderstandings to be rectified, and draft report copies are circulated for comment. Should the placing/context still be unclear, or be equally relevant to more than one section of the report, the comment/idea may appear in more than one place in the report.

Depending on the requirements of the project funders, PA-based research reports often come in multiple versions. The 'PA report' focuses on the research findings and comments made during the research, with larger, more accessible text, easy to read and understand language, and limited additional or superfluous material. This is distributed, and made available, as widely as possible, including to all who participated in the research (or the places where they were contacted). The research may also generate a longer, more 'traditional' report, which contains more details of the accompanying material (concerning methods, background, literature and so on). As noted above, the dissemination stage therefore also plays a key role in educating different sectors of the local community, whilst also forming a starting point for collective action, based on the needs and requirements of those in the best place to voice and understand them - the local experts - whilst also exposing any actions taken that run contrary to these.

3.2 A Participatory Project

Against this methodological background, a key aim of the consultation stage of the Mapping Tranquillity project was to make the consultation process as inclusive and participatory as possible, within given funding and time constraints. We discuss the extent to which this has been achieved, and identifiable limitations to this aim, later in this section.

During the early stages of the project planning a core PEANuT PA consultation team was established which comprised a project manager, a project coordinator, and six principal PA facilitators, all of which had previously taken part in the 'Introduction to Participatory Appraisal' training courses coordinated by the PEANuT project at Northumbria University. The overall (Mapping Tranquillity) project coordinator also provided considerable logistical assistance throughout the consultation period. Prior to the main research period a number of meetings were held. The main aim of these meetings was to develop and discuss the general scope of the consultation exercise, and the main themes, questions to be explored, and tools to be used during the PA sessions.

3.2.1 The scope of the consultation exercise

Discussions surrounding the scope of the consultation exercise essentially revolved around two main issues - who would be consulted, and where these consultations would take place. The programme for the consultation phase identified in the initial project proposal was as follows:

1. Interviews with agencies involved at a national level in developing policies and area strategies that draw on tranquillity and related concepts such as wildness and

naturalness (e.g. National Park Authorities, AONBs, planning authorities, NGOs, Countryside Agency, SNH);

2. Interviews with key stakeholders in the region (e.g. Northumberland National Park and Durham County Council staff, CPRE, English Heritage, Northumberland Wildlife Trust);
3. Focus groups involving parties nominated by the project steering group to work towards a set of characteristics that make areas tranquil, or detract from that state, and identify what characterises areas that individuals perceive as being more or less tranquil;

Prior to the outset of the consultation, and following discussion with the project steering group, however, it was decided that the consultation exercise should be substantially expanded to include actual *users* of both the Northumberland National Park and the West Durham Coalfield (alongside the various stakeholders identified in the earlier proposal). Reasons for this, and discussion of the scope of the consultation in general (such as why non-countryside users were not consulted) are discussed in the 'Limitations, issues and problems' sub-section.

3.2.2 Themes, questions and tools

The early planning meetings also explored the main themes, questions to be asked, and tools to be used within the consultation. At this stage the following main/key themes/questions were identified (displayed here in order of perceived importance for informing the subsequent GIS work):

- What is 'tranquillity'?
    - What makes an area 'tranquil'?
    - What does 'tranquillity' mean to you?
    - If an area were described as being 'tranquil', what features would it have?
    - When you are in what you consider to be a 'tranquil' area, what features does it have?
    - Where are 'tranquil' areas you know of, and what makes them 'tranquil'?

- What factors cause 'tranquillity'
    - What makes an area more 'tranquil'?
    - What makes an area less 'tranquil'?

- What impacts do 'tranquil' areas have?
    - When you are in what you consider to be a 'tranquil' area, how do you feel?
    - When you are in what you consider to be a 'tranquil' area, what impacts does it have on you?
    - What effects does a 'tranquil' area have?

- What does a 'tranquil' area look like?

- Do places become more/less 'tranquil' over time? (day/night, weeks, months, seasons, years...)
- How does seasonality affect perceptions of 'tranquillity'?
- How does respondent background affect perceptions of 'tranquillity'?
- How do perceptions of 'tranquillity' change over the life course?
- How do perceptions of 'tranquillity' differ between different respondents?

- Who uses 'tranquil' areas?

- What are barriers to using 'tranquil' areas?

For each of these questions, a range of tools was identified as potentially being the most fruitful for generating discussion. These are presented in the table below, in their preferred order of use within any session, along with the 'notes for facilitators' that were produced prior to the first PA session:

Question (theme)	***Tool***	**Notes for facilitators**
• What is 'tranquillity'?	Graffiti wall	- does whatever the participants want to do with it – maximises space for supporting details, either on the sheet or via post-its...
• What is 'tranquillity'? • Where are 'tranquil' areas you know of, and what makes them 'tranquil'? • What does a 'tranquil' area look like?	Visual interpretation	- may be more appropriate/useful/user-friendly in some circumstances, though preference is probably for graffiti wall initially...and of course participants could visually represent 'tranquillity' using the graffiti wall.
• What is 'tranquillity'? • Where are 'tranquil' areas you know of, and what makes them 'tranquil'? • What does a 'tranquil' area look like? • Who uses 'tranquil' areas? • What are barriers to using 'tranquil' areas?	Mapping	- 'draw a map outlining where areas you consider to be 'tranquil' are (at whatever scale)' / 'Map 'tranquil' areas you know of' / 'on this map of X, please identify where tranquil areas you know of are'. Participants should then be asked to identify details regarding what makes these areas tranquil, who uses them, barriers to their use... Tool only to be used after first exploring perceptions of 'tranquillity' via Brainstorm (participant can then draw on this to help with mapping)
• What is 'tranquillity'? • What factors cause 'tranquillity'	Force field analysis	- positive and negative impacts on tranquillity and tranquil areas – size of connecting lines highlighting some form of ranking...
• What is 'tranquillity'? • What factors cause 'tranquillity' • What impacts do 'tranquil' areas have?	Causal impact diagram	- causes and impacts of tranquillity – could be generic, or linked to specific places identified by the participant (with the diagram divided up accordingly)
• What is 'tranquillity'? • How does respondent background affect perceptions of 'tranquillity'? • How do perceptions of 'tranquillity' change over the life course? • How do perceptions of 'tranquillity' differ between different respondents?	Timelines	Exploring how notions of tranquillity may vary over time (during the life course) and between respondents (and maybe their contexts)

• What is 'tranquillity'? • Do places become more/less 'tranquil' over time? (day/night, weeks, months, seasons, years...) • How does seasonality affect perceptions of 'tranquillity'? • How does respondent background affect perceptions of 'tranquillity'? • How do perceptions of 'tranquillity' change over the life course? • How do perceptions of 'tranquillity' differ between different respondents?	Yearly / seasonal / daily 'tranquillity' and activity charts	For areas predefined as 'tranquil', explore how their degree of tranquillity changes over time... For areas predefined as 'tranquil', when are they used, and by whom?

Table 3: Summary of PA Tools employed in the Consultation

In discussion with the GIS team, it was also noted that each entry made by a participant would also need to be 'interrogated' so as to maximise any potential linkage (and degree of detail) to available GIS datasets. For example:

- Nice views – 'what's in them?'
- Trees – type, movement, leaves, size...?
- Rivers – size, speed, features (rocks, waterfalls), fish...?
- Wildlife – types?
- Noise/peace – any noise at all, loudness, proximity...?
- Roads – visibility, noise, distance...

3.2.3 The PA Sessions

The study progressed with two different forms of PA session, distinguished here as 'field', and 'non-field'-based sessions. In general terms the field-based work involved users of the study areas accessed at suggested (by other participants, and members of the steering group) outdoor locations within the two main project areas. These participants were unlikely to be aware of the project beforehand (although awareness clearly grew during the project time-span). The non-field-based sessions (involving participants with a 'professional' interest in the notion of tranquillity) were invited to a formal meeting/PA session.

Field-based Participation

In sum, there were a total of 14 field-based PA sessions undertaken during the study period:

Date	Place	No. of Facilitators	No. of Teams	Team Sessions undertaken
11th April	Alwinton	6	1	1
11th April	Housesteads	6	2	2
29th April	Bamburgh am	4	1	1
29th April	Bamburgh pm	4	1	1
1st May	Gibside (2 sessions)	2	1	2
2nd May	Ingram Valley	2	1	1
2nd May	College Valley	2	1	1
4th May	Northumberland	2	1	1
31st May	Northumberland Show	5	1	2
2nd June	Causey Arch	5	1	1
2nd June	Hamsterley	5	1	1

Table 4: Field Based PA Sessions during the Consultation

As noted in the above table, the first two sessions took place on the same day, at Alwinton and Housesteads in Northumberland National Park. The project steering group had recommended these two locations, suggesting that the PA team base their work at the main car park in Alwinton, to catch users as they set off/returned to their vehicles, and outside the visitor's centre at Housesteads (Hadrian's Wall) to question visitors as they passed through the centre.

Figure 9: field-based consultation (Photographer: Michelle Allen)

As these were the first two session undertaken by the team, they were used to explore the use of the PA tools and the appropriateness of potential questions. Two graffiti walls were used at both Alwinton and Housesteads, both asking the same question – 'what is tranquillity?' Two were used to ensure that as many users as possible were given the opportunity to participate. At Housesteads the second wall was used for younger participants. In both cases, they proved very successful in generating interest from potential participants. A spider diagram and a mapping tool were also used, but these proved less successful. This is

unsurprising given the nature of the sites, with people passing through with limited time, as both these tools are more time intensive and demanding of participants than graffiti walls.

Following these first two sessions, and in recognition of the differences in success between some of the planned tools in the field locations (and contexts) being used, a considerably paired down series of questions and tools was identified for all of the subsequent field-based sessions – all subsequent sessions relied solely on the use of the graffiti wall. The questions, and the way in which they were asked, became the most important distinguishing feature during these sessions. For all of the sessions, participants were asked what added to and detracted from tranquillity. In addition, participants were asked to identify a place that they considered tranquil.

As expected some of the sessions were more successful, in terms of participant numbers, than others. In particular, the Causey Arch session within the Durham Coalfield did not have as great a number of potential participants as others.

Non-Field Based Participation

Three non-field-based sessions took place:

Date	Place	Participants
21-April-04	Hexham	NNP Board Members – NNP Head Office
28-April-04	Newcastle	Project Steering Group – Countryside Agency Offices
30-April-04	Durham	Representatives from Durham County Council, DEFRA, North East Community Forests, and North Pennines AONB

Table 5: Non-Field Based PA Sessions during the Consultation

As a consequence of participants having some prior knowledge of the study (and its aims) in advance of these meetings, and with a potentially longer time scale available for discussion, these sessions provided an opportunity to use a greater number of PA tools in greater depth. The general approach employed was as follows, identified in the order they were explored in the sessions:

Question (theme)	*Tool*	Notes
• What is tranquillity?	Graffiti wall	- Participants were asked to comment and discuss as the session started....
• What is tranquillity? • Where are tranquil areas you know of, and what makes them tranquil? • What does a tranquil area look like?	Mapping/Visual interpretation	- Draw somewhere you consider to be tranquil. And add on Post-It notes: • What makes it tranquil? • What detracts from its tranquillity? • What would make it more tranquil?
• What is tranquillity? • Where are tranquil areas you know of, and what makes them tranquil? • What does a tranquil area look like?	Mapping	- Identify tranquil places on map of NNP/WDC. Again with post-it notes: ▪ What makes it tranquil? ▪ What detracts from tranquillity?

• What adds to tranquillity? • What detracts from tranquillity?	Bean voter (from graffiti wall)	- Positive and negative impacts on tranquillity and tranquil areas

Table 6: In-depth PA Tools employed during the Consultation

These sessions allowed for both individual and group based work. In addition, and prior to the verification events, they presented an opportunity to rank answers using the bean voter, primarily to inform the writing up process. An unplanned tool was also trialled at the first two sessions which contributed to the ranking/writing up process. Consisting of a number of concentric circles equal to the number of responses, each participant was asked to move any response one step closer to the centre circle if it was felt to be important - the closer a response ended up to the central circle, the higher its perceived level of importance. The level of participation, both as groups and individuals was high, and all sessions worked well, generating much discussion.

3.2.4 'Data' collection

From the outset of the consultation period a reporting procedure was put in place to ensure that all responses made during the PA sessions were recorded as wholly and accurately as possible. During the PA sessions themselves, comments associated with any response were also noted by the PA facilitators and coded to allow them to be matched to their responses at a later stage. Codes consisted of an alphanumeric, letters representing the researcher and number recording consecutive participants. In addition, reporting sheets were developed for session facilitators to provide an overview of the session, and to enable them to formalise their comment notes. Where necessary, a session overview was also produced which included appropriate information including, session details, its purpose, a description of tools used and any difficulties or successes encountered.

In addition to information related to the questions/responses, additional data about respondents was obtained, where possible. This included:

- Gender – male or female.
- Age group - kept intentionally broad (<20, >20<30, >30<50, 50+) and developed as the process continued. Age categorisation should be considered and set prior to work starting as split categories can result.
- Where participants were from - essentially to give some indication of the distance travelled to the area and whether from urban or rural area.
- Mode of transport used in accessing the site - some of the locations were isolated and in order to ascertain some idea of accessibility participants were asked how they had accessed the site.

3.2.5 Verification Events

The two verification events took place at:

21/22-June-04	University of Northumbria (Newcastle upon Tyne)
17-July-04	Durham County Show (Penshaw)

The two verification events were based on responses gathered during the previous field and non-field based sessions. All data was collated, in spreadsheet form, alongside any

additional comments and/or demographic data. Prior to the verification event, these responses were coded using a hierarchy of themes from the general to the specific. Four levels of coding were used. At the most general level each response was linked to whether it was broadly related to 'nature' or 'humans'. Below this (level 2) the responses were coded according to whether they were something 'you see', 'you hear', 'doing', 'of the mind', 'do not see', 'do not hear' and so on (loosely based on human senses, reflecting the positioning of humans at the centre of experiencing tranquillity). They were then coded again (level 3) according to more specific information (for example, as 'activity' or 'landscape'), and finally, for level 4 (if necessary) a more specific scale again (for example, 'walking', or 'river'). Following the coding, the spreadsheet was subdivided into the responses derived from the 'positive' questions (those that asked respondents to identify what tranquillity *is*) on the one hand, and those derived from the 'negative' responses on the other. The project manager then went through each spreadsheet and transferred all the main themes, and choice quotes onto flip chart paper, with these being presented at the venue within their relevant 'sense' category. In addition all named tranquil places were presented, as were any pictorial representations produced during the consultation period (and which are included throughout the next sub-section). This process produced over 70 sheets of flip chart.

Figure 10 (Photographer: Michelle Allen)

At each event, the participants were asked to move around the room and look at the comments. In most cases they were accompanied by a PA facilitator, to allow him/her to explain any points if necessary, and/or note any verbal comments. Participants were also asked to choose their top three responses within each sense category, according to their perceived level importance to tranquillity. The most important response was given a score of three sticky dots, the second most important two dots and the third a score of one dot. This particular system was chosen due to the large number of responses available overall, and the potential difficulty participants would have faced in identifying three top issues from over 500 possible choices. Participants also had the opportunity to provide additional responses to the comments via post-it notes. Following the events, all the responses (dots or notes) were collated on a spreadsheet and sorted according to score. It should be noted that there were not an equal number of responses in each sense category. The number of responses in each category from which participants were asked to identify their top three choices was as follows:

Category	What is tranquillity?	What is not tranquillity?
You hear...	19	16
You do not hear...	20	
Of the mind...	59	
Doing...	38	
You see...	120	82
You do not see...	38	
Experiencing...	18	

Table 7: Number of Responses from PA Sessions

In very general terms, this means there was a much lower probability of a response being chosen from some categories (such as 'you see') compared to others (such as 'you hear'). It also became clear that the extent to which participants had adhered to the instructions regarding allocations of dots (3-2-1) also varied. These issues, and their implications, are returned to in subsequent sections. However, in this section, the combined top 50 scoring responses are noted in terms of the number of dots they received, with the top 10 ranking responses being further specified.

Attendance at the two day Northumbria University session was low in comparison with the second, one day, Durham event. This was not unexpected given the nature of the two events, with a far greater number of potential participants at the Durham event per se. To a great extent participation at the Northumbria event was limited by its geography, time of day and the day itself. However, this did allow for a greater opportunity for discussion with those that did attend than was generally available in Durham.

3.2.6 Limitations, issues and problems

As with any piece of research, there are a number of issues that have arisen as the project has progressed. Perhaps the main concern relates to the extent to which the consultation has actually been 'participatory', particularly in the context of the ethics and principles of participatory appraisal highlighted at the outset of this section. Much of this relates in some way to the somewhat fuzzy notions of 'local' and 'community' embedded in the principles of PA outlined earlier. In this section we will identify what these concerns are, before responding to them.

Questions of the 'participatory' nature of the project revolve around three main themes. First, the actual project idea emanated from an (already seemingly powerful) group of stakeholders, rather than 'local' people (read 'normal, 'non-stakeholders'...). There was also limited input from outside the main steering group concerning how the study might be undertaken.

Secondly, despite the scope of the consultation being expanded beyond its initial focus on stakeholder groups and perceived 'experts' to incorporate countryside users, it still only focuses on perceptions of tranquillity from these users rather than a broader section of society. That is, it seems to suggest that 'tranquillity' only refers to countryside or rural areas, and that users of such areas are the only sector of society with any real (or valued) understanding of what it means. Thirdly, the review of the project included above infers that the project has only been participatory through its (rather extractive?) use of participatory appraisal tools, and lacks key elements of education and collective action.

It is fair to say that most of these issues have resulted due to: directions from/preferences of the project steering group and/or funders; and/or all too commonly cited project timescale and resources!

In response to the issue of where the project emanated from, we would concede that the desire to explore the concept of 'tranquillity' has been 'expert' or 'stakeholder'-led from the outset. However, as a member of the steering group commented, 'the project was originally set up to produce a robust methodology for measuring tranquillity, developing work done in the past: this is why it originated with powerful stakeholder groups. The idea of exploring the conceptualisation of tranquillity arose after the project was started, and this was where the PA work came in: so an important part of the limitations of the work was that it was not part of the original project'. The project sponsors distributed a call for tenders that the main project manager responded to, with the consultation project team becoming included at an even later date. Further, 'since the project was originally conceived as providing a planning tool for those involved in countryside planning, it was natural to focus on those who might be affected most by such planning...'. In addition, this work is both exploratory and relatively novel in its approach – comments from steering group members in particular have stressed that in the past such work would not have included any users and/or local people, suggesting that 'it is a big step that this was done'. It could also be argued that the 'stakeholders' are 'local' people – many of the steering group live in the surrounding areas and use the study areas; and the project also developed to include the local, non-stakeholder users (whether they lived 'locally' or not!). Finally, and due to its novelty and exploratory nature, it is highly unlikely that nothing that has been done cannot be improved upon in future studies!

Linked to the notion that a far broader cross-section of society could have been included in the consultation, and that this might have generated a broader conceptualisation of 'tranquillity' per se, such a broader (sociological) exploration of 'tranquillity' per se was never the aim of this work; a focus on perceptions of countryside users of 'tranquillity' in the countryside *was*, and, alongside the time and resources available, there was no opportunity to deviate from this. In relation to all of these issues solace was taken from the widening of the consultation exercise from the initial proposals to at least include countryside users.

Regarding the apparent absence of PA's education and collective action elements in the project we would argue that the education phase is still at an early stage. However, it has begun - within the group PA session work, outside in numerous locations throughout the study areas, at the verification events, and is about to gather pace as this, and other versions of this report are published and widely disseminated. As one of the PEANuT PA facilitators commented, 'Almost everybody had an opinion, it often aroused strong feelings, and personal stories - I think we found that in general participants took the questions surprisingly personally. Often the facilitators were questioning groups/families where we stimulated group discussion, and sometimes discussion/education took place between participants that were previously strangers...'.

Moreover, this education element is tied to the collective action element. One aspect of this that is already beginning to materialise concerns a growing awareness amongst the stakeholder groups involved in the steering group, and beyond, of the potential utility of the findings in working towards various aims surrounding tranquillity issues, countryside quality issues, and so on (outside this project) in the future. This planning tool is intended to generate information to be used by local people in responding to local planning issues, as well as by 'big' stakeholders. As a steering group member argued, 'now that the tool exists, it can be used more widely, and consideration can be given to the appropriate groups to consult when the tool is applied in other circumstances'.

More directly, however, and as noted above, this project was identified at the outset as being a first step, as being exploratory in attempting to produce a replicable methodology for exploring notions of tranquillity. With this is mind, the north-east work has already spawned a second phase – in the Chilterns AONB – in order to assess whether the same approach would generate similar or different findings in a different geographical setting and location. In simple terms this was also seen as an opportunity to embed the collective action element of PA more firmly in the project from the outset, primarily via the recruitment and training (in PA) of local recruits/volunteers who would undertake the PA work for this project, but subsequently be able to use it for their own local ends. Details of this project and reflections of the methodologies employed in both areas will be available in 2005.

Aside from these main conceptual issues, a number of more practical issues have arisen during the north-east project. In particular, the 'success' of the outdoor sessions varied considerably. Factors that affected the sessions were as follows:

- The locations themselves – despite consultation with the predominantly local steering group members (amongst others) some of the locations chosen for the outdoor PA sessions proved to be less successful than others in terms of the number of potential participants using the site when the facilitators were present (with, for example, very few people present at a weekday session at Causey Arch, whilst thousands attended the Northumberland Show at which sessions were conducted). In addition, and as noted above, the degree to which participants were willing and likely to participate differed according to location, and limited the types of tool that could be used. Tools requiring more concentrated or lengthy participation were inappropriate in many of the suggested locations;
- Weather – poor weather resulted in fewer people being out and about on some occasions when PA sessions were occurring, and the correlation between low participation and poor conditions remained throughout the project. To attempt to counter this, indoor locations were found wherever possible (when the weather was poor);
- Time of day - some locations were busy for specific and brief periods of the day, whilst at others visitor numbers would remain at the same level throughout the day irrespective of the time. For example, at Alwinton people arrived within relatively narrow time periods (mainly early in the day to set off for a walk, meaning many people were accessed in a short period of time; by contrast, and on the same day, visitors to Housesteads appeared to be arriving and departing throughout the session and well into the evening meaning that the flow of potential contributors was more evenly spread out.

3.2.7 Numbers and details

In total the PA team consulted 26 people during the indoor, non-field-based, 'stakeholder' sessions, and 418 during the outdoor, field-based PA work. In addition, 24 people attended the verification event held at Northumbria University, and 87 people contributed to the event held at the Durham County Show.

3.3 Findings

The findings section is organised, structured and presented in the following way. The first main section concerns responses to the 'positive' range of questions that were posed during the PA sessions – questions such as 'what *is* tranquillity'; 'what *adds* to tranquillity' and so on, that were explicitly asking for positive responses. This is followed by the responses that sought to explore participants' perceptions of negative impacts on tranquillity - factors that

reduce tranquillity, or impact negatively on it. The positive question responses are presented first simply because, overall, there were more of these than those which seek to identify what detracts from, spoils, or are not perceived to represent tranquillity.

As will be seen some respondents chose to identify what they believed tranquillity is not, even when the direction of the questioning was to identify those factors and/or issues that are perceived to add to, or positively represent their understanding of the term/concept. This probably reflects a sense that it is sometimes easier to identify what something is not, rather than identify what makes it valued, or what it actually is. These responses are noted at the end of the positive question sub-section.

We begin presentation of the responses made during the PA consultation, therefore, with the positive responses to the question 'what *is* tranquillity?'.

3.3.1 What is "tranquillity"?

Perceived links to 'nature'

A large proportion, and a wide range, of the responses made during the research linked 'tranquillity' to hearing, seeing and/or experiencing various aspects of perceived 'nature' and 'landscape'. Respondents suggested links to 'nature', and aspects of nature, in general 'experiential' terms. They noted the importance of 'nature, beautiful', 'Nothing just nature', 'Natural', 'natural countryside', 'Restful and natural scene', 'Natural place', 'nature', and 'natural. calm unspoilt', of 'being among nature' (which received 34 dots at verification), 'part of nature', and 'close to nature', in a 'more natural setting'.

These links to 'nature' had aural and visual aspects. Aurally, respondents noted the specific importance of 'Natural sounds', which received the second highest combined verification score with 95 dots (but which was added to at verification with 'depends a bit on what the natural sound is; tractor ploughing'). Participants suggested 'natural noises sea birds wildlife sounds', 'animal noises', 'hear wildlife', 'variety of quiet natural sounds', 'nature noise', 'Just natural sounds', 'sounds of nature', 'noises of nature', 'hearing natural noises of the countryside', 'just the noise of nature', 'quiet (but with natural sounds)', 'natural sounds', and 'natural sounds (water, birds)'. 'Wind though leaves' received 37 dots at verification.

For many experiencing 'the landscape' (which was supported at verification with 34 dots, a 'natural landscape', or elements of it, was a key idea, with a wide range of related aspects being suggested. Some respondents focused on general, abstract, or large-scale features, suggesting 'the landscape', 'countryside', 'Mainly countryside', 'In the country', 'Un-built-upon', 'wild landscapes', 'scenery', 'Alive scene', 'Beautiful scenery', 'visual beauty - babbling brook, sunlight through trees', 'Good scenery', 'lovely scenery', 'beauty', 'gentle scenery', 'All kinds of scenery in the park', 'beauty of surroundings', 'seeing the stars', 'sky changes all the time', 'unspoilt and traditional', and 'natural, unspoilt places Without any urban impact -inc. road signs'. The respondents who made this last comment argued that there are far too many signs in countryside (such as road signs, directions, and so on) meaning that it often 'looks like Northumberland Street'. They believed tranquillity to be 'fox hunting on high fells – the sound of nature taking place'. One respondent suggested that the 'CPRE logo has it all'.

Some respondents focused on elements of a 'Rolling countryside' as being key to their perceptions of tranquillity and tranquil places - 'hills', 'all of national park, high hills', 'Valleys and hill tops', 'Valley floors', 'hills', 'Rolling hills', 'valley –vast'. Others identified a range of additional landscape 'types' or key characteristics - 'parks', 'Interesting geology',

‘tidy farms’, ‘Fields’, ‘Beach in the Sun with a pint of lager’, ‘Peaceful little stream quiet valley country’, ‘a glade’, ‘Feeling safe walking on beach’, ‘moorland’, ‘High ground with feature - cairn/stone circles’, ‘natural stone formations’, ‘no trees, wind, water’, ‘Low unnatural elements’, 'Open Moorland’, ‘limestone cliffs’, ‘Soft lines in the landscape e.g. skylines, stones, rocks, vegetation, old vernacular buildings’, ‘moors, dales’, ‘mountain top scottish’, ‘lack of populated areas’, ‘not coastal erosion’, and ‘protected coastline’. For others, the landscapes envisioned were of a smaller scale - ‘Being in my garden’, ‘flowers in the garden’, ‘wild flowers’, ‘nice flowers’, ‘bench kept grass steps to beach’, ‘Wildflowers’, ‘Grass’, ‘Flowers’, ‘Wild Plants’, ‘Daisies’, ‘Wild flowers’, ‘wild plants’, ‘flowers’, and ‘Beautiful Flora and Fauna’.

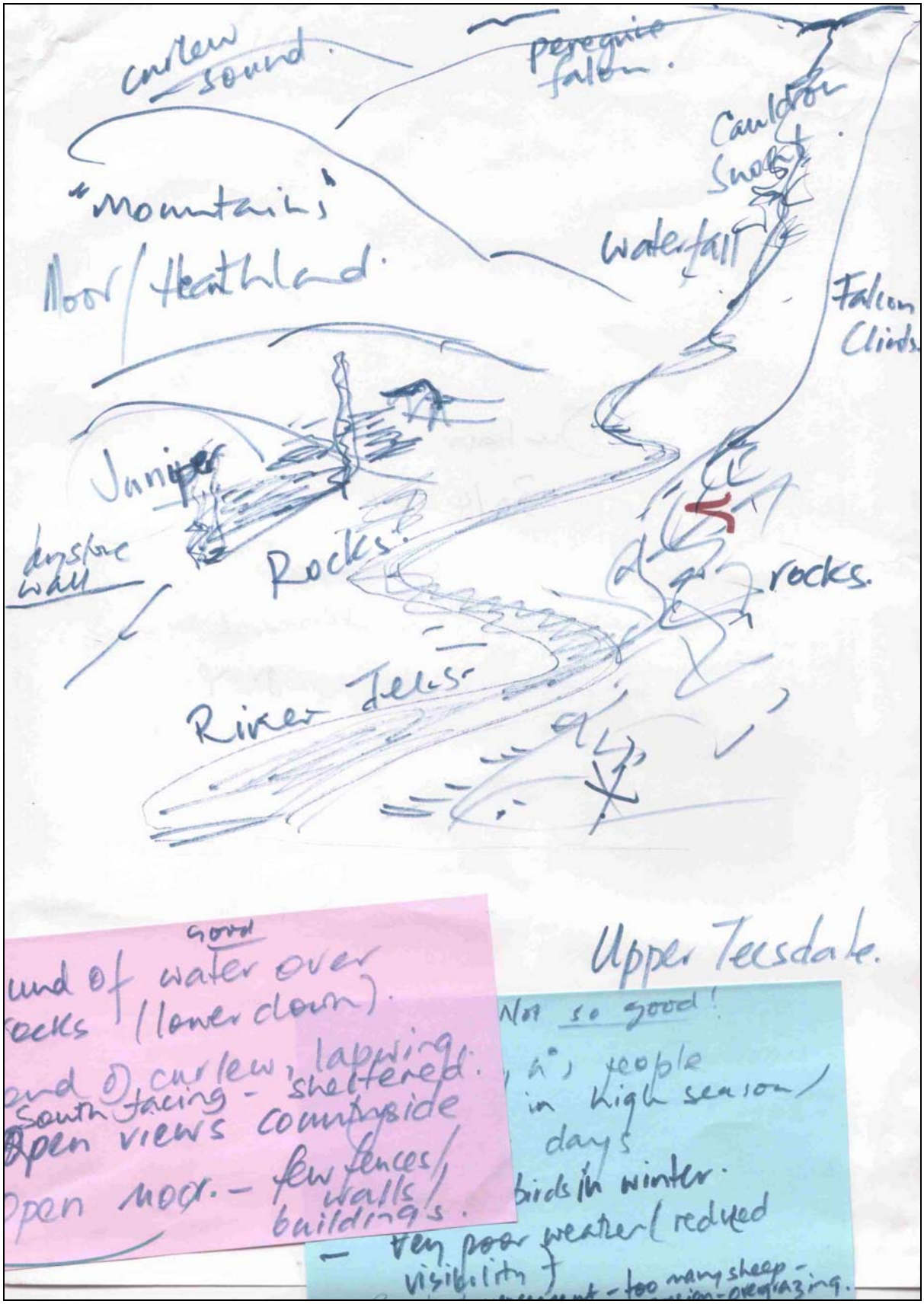


Figure 11: depictions of tranquillity in the PA sessions

The importance of 'Water' and related aspects was emphasised by many respondents. The 'sound of water, rivers, waves' was the highest ranked response at verification with 104 dots (and added to at verification with 'lapping sound – waterfalls not necessarily') and 'The sea' receiving 79 dots as something you hear in a tranquil place (ranked 6th) *and* 35 dots as something you see in a tranquil place. Participants suggested tranquillity is related to 'Lapping waves on shore -beach or lake', the 'action of water', 'water, wind, birdcall, animals esp. running beck', 'the sea', 'rough seas -fresh air (beach)', 'stream (slow flowing)', 'Gurgling Stream', 'stream over pebbles', 'natural noise of coast', 'Running water', 'Beach', 'Streams', 'Rivers, water', 'water', 'water (flowing stream running water (sound)', 'Rivers', 'Rippling water', 'Rivers', 'Streams', 'streams and rivers', 'riverbanks', 'sea', 'clean running water', 'Sea - wild waves wind', 'Calm sea (+seagulls)', 'rivers running', 'Watching raging (foam) sea (calming)', 'Babbling brooks', 'Rivers', 'Water', Stream', 'River', 'running water', 'water babbling brook', 'Running Water', 'Any sort of water -streams -water running over rocks -water falls', 'flow in a river -sound and vision', 'water trees wildlife', 'Sunset on water/trees', 'Swans on water in sunset'. Others focused on the sound of water, suggesting 'Gentle quiet sounds of water', 'sound of water', 'water quiet', 'sound of water (any water) gentle lapping', and 'Sound of rivers'. The respondent who suggested 'sound of water' also commented 'isn't it funny - you always think of sounds for a 'tranquil' place'. Another respondent argued that a smelly, dirty river is 'not good', with them preferring 'clean water'.

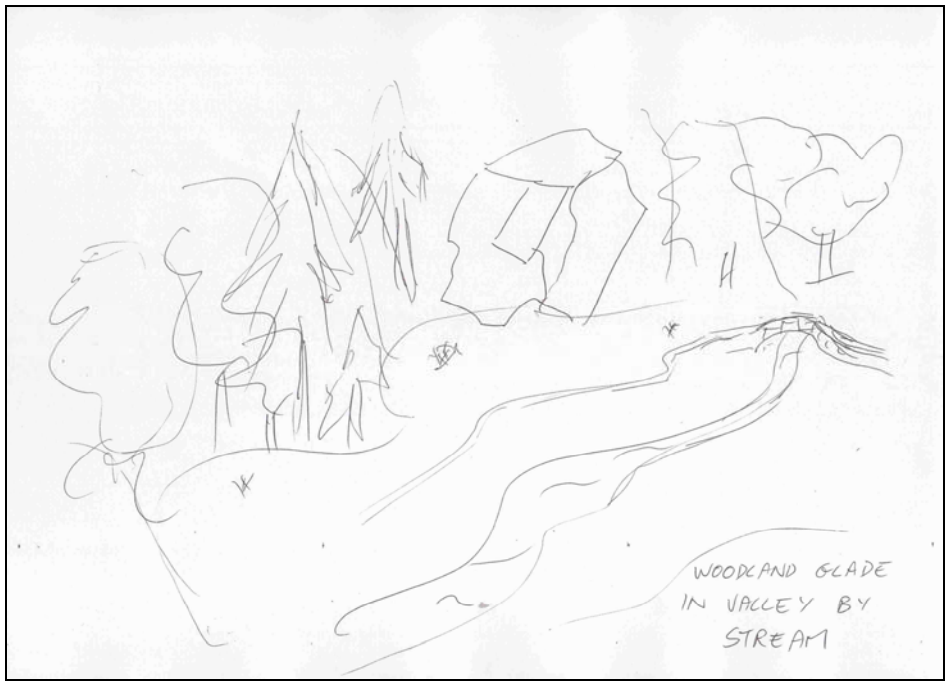


Figure 12: depictions of tranquillity in the PA sessions

Many respondents focused on greenery (or other perceived 'natural' related colours) as central to their understanding of tranquillity. They noted the importance of 'Green', 'Natural colours', 'green areas', 'white silver makes me feel calm', 'Green', 'Colours in gardens (grass)', 'Greenery', 'Plenty of greenery', 'Muted colours are tranquil. e.g weathered stone, colours changing with different weather conditions, browns, greys, greens ashed-out look', ' A green place -plants. Green makes me feel calm and at peace', 'contented blues and lilacs', 'colours', 'or small, peaceful green space', 'scenery', 'muted colours and blended', 'green', 'the green colours', and 'nice peaceful green'. One respondent suggested 'white silver makes me feel calm'. This respondent also noted, in discussion how white is

associated with panic, and silver with calm. They argued that dark is also calming. Other things they associated with tranquillity were candles, moon and stars, a flat sea, Open, .No cars – 'make them walk', and that forest is tranquil.

Linked to notions of greenery, participants in the research noted the importance of 'woodlands', 'deciduous woodland', 'Old block of geometric forestry', 'Glades', 'Mixed birch/sp woodland', 'Trees, woodland glade dampn musty earthy smells soft moss' 'Woods and fells', 'a wood', 'trees', 'breeze through trees', 'trees old English woodland', 'forest', 'movement of trees', 'greenery', 'wooded', 'Quiet in trees (conifer and B'L's)', 'hillsides where you only see trees', 'woodlands- mixed deciduous and higher levels', 'Forests', 'Sitka is too dark', 'All trees (every tree has its own character)', 'Woods', 'Older deciduous trees', 'greenery trees', deciduous trees not firs', 'Lots of trees', 'trees and forests', 'Deciduous trees', 'Deciduous trees not firs', 'trees - broad leaf not fir', ''trees and forests', 'Seats out of Tree Trunks', 'Forests and Moors', 'trees, flowers, NOT plantations, conifers', 'not open spaces -prefer woods and habitation nearby', and 'trees flowers'

Another range of comments related to the importance of 'Long vistas', 'See views', 'Landscapes and views', 'View to look at fields and hills', 'Plenty of sky', 'views', 'far horizons', 'on top of hill, looking down', 'Top of a hill', Rolling hills (a lunch with a view) {Long views}', 'Good to be high and look down', 'Something to focus on (monument in this case)', 'Long distance visability', 'distance', 'Open landscape -far horizons, flow of lines within the landscape', 'the view', 'sights', 'good view', 'altitude', 'View -area of natural beauty', ''green hills, distant mountains, long and open beaches'', 'hills', 'but also dead/lifeless', and 'quiet farming landscape'. One respondent went into some detail, noting 'Sat on a mountain top looking down on traffic and the world going about its business can add to the feeling of tranquility Try sitting on top of Blencathra in the Lakes and watching the traffic on the A66 (only minimal distant noise)'.

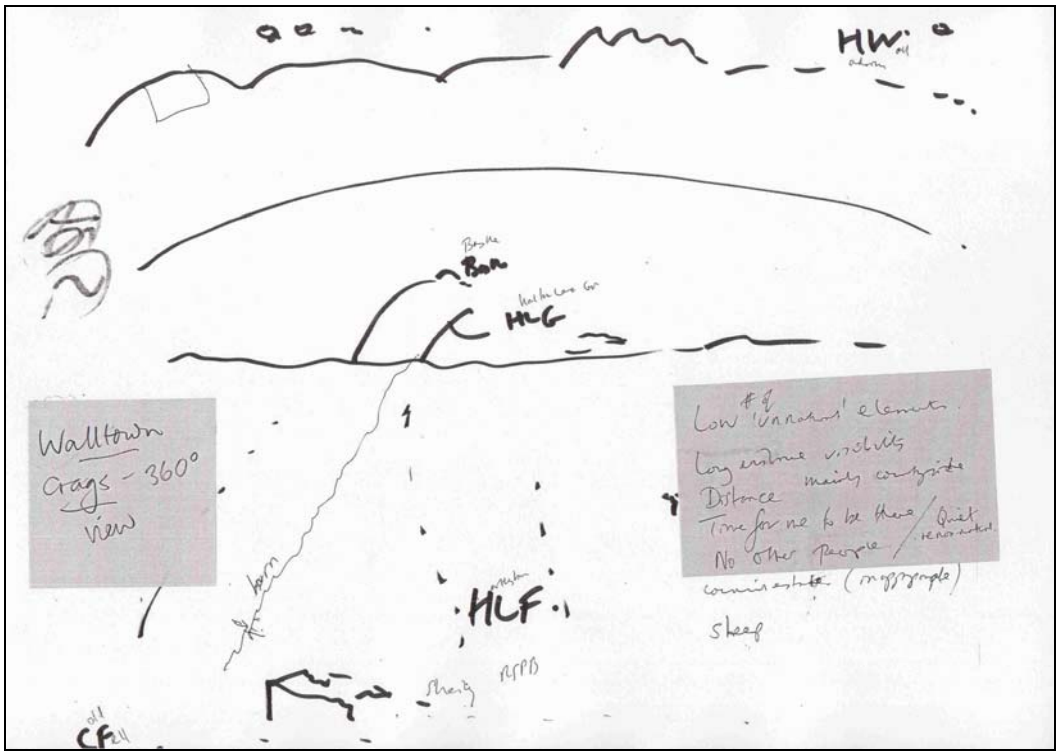


Figure 13: depictions of tranquillity in the PA sessions

Other focused on the notion of 'open space' and 'remoteness'. Participants noted the importance of being 'Away from civilisation', of 'space', 'Open spaces', 'openness', 'wide open spaces', 'Access to areas of open countryside', 'emptiness, low population density', 'lots of space for people to spread out, 'Open space without people', 'lots of space', of 'Emptiness - not -stuff' going on'. One respondent suggested 'Island of the Sun Lake Titicaca – Peru High altitude clear skys distant views of Andes V. little pollution Miles from anywhere Sunrise Sunset'. Others spoke of links to 'outdoors', 'Space to go strolling', 'off the beaten track', 'Nothing', 'remoteness', 'out of the city', 'open spaces', 'space', 'Space', 'open', 'Places to sit and enjoy', 'A place that suggests 'openess' expansive landscape and sky', 'open spaces', 'Could be wide, open space (countryside)', and 'wide open spaces'. One of the respondents who noted the importance of space also suggested that a tranquil place would be void of traffic and noise pollution, as roads were perceived to intrude. They also argued that a 'big sky' is important (that is, the Pennines), as would be a 'three-masted schooner with three sails, set in a seascape. For them, total darkness is also very tranquil. A participant who suggested 'going beyond the safe environment' argued that once a move was made 'beyond the safe zones' (for example areas close to facilities and tourists), then tranquillity could be found. He felt that there were zones which tourists/day trippers didn't venture beyond, thereby providing vast areas of countryside where there were few people.

Aspects of 'wildlife' were perceived by many respondents to also be very important to their notions of tranquillity, with 'the sight of wildlife behaving naturally (animal and plant)' receiving 49 dots at verification. Participants noted 'wildlife -bees -animals –badgers', 'skylarks', 'wildlife - birds, mammals, deer', Buzzards Ravens Meadow pippets', 'Wildlife/Natural/Birds', 'Sea Birds', 'Skylarks', 'sheep', 'more birds', 'otters, fish curlews', 'curlews –peewees', 'sparrows, tits, bird noise in the distance', 'wood peckers', 'Curlews', 'all kinds (of wildlife)', 'Close to wildlife', 'larks' 'fauna', 'lambs, waterfalls, springs', 'Peacefulness Rain Birds', 'rabbits', Wild birds Green', Fish', 'Photo swan, spring ripples around swan', 'Terns diving', 'watching wildlife', and 'living things'. One participant suggested 'thrushes', and also noted in discussion how they do not mind background noise, such as the sound of a heartbeat, but they do mind too much music.

A large number of respondents commented on the positive effects of 'hearing bird song', some in very specific terms. 'Sounds of curlew, lapwing, skylark' received 50 dots at verification, but was added to with 'this is seasonal - skylark its noise is; lying in the dunes or long grass and falling asleep listening to skylark'. Others noted 'a robin singing', 'Birds on moor', 'birds', 'birds singing', 'more bird song', 'none sound' that you can hear (e.g. Distant birdsong....), 'birdsong –blackbirds', 'Birdsong', 'Quietness but able to hear birds', 'small birds singing distant', 'Sound of birds', 'like to hear birds', 'Sounds of birds, crickets etc', 'hearing the birds', and 'bird song and bubbling water'. Other respondents suggested 'wind through leaves', 'noise of trees', and 'breeze rustling leaves'.

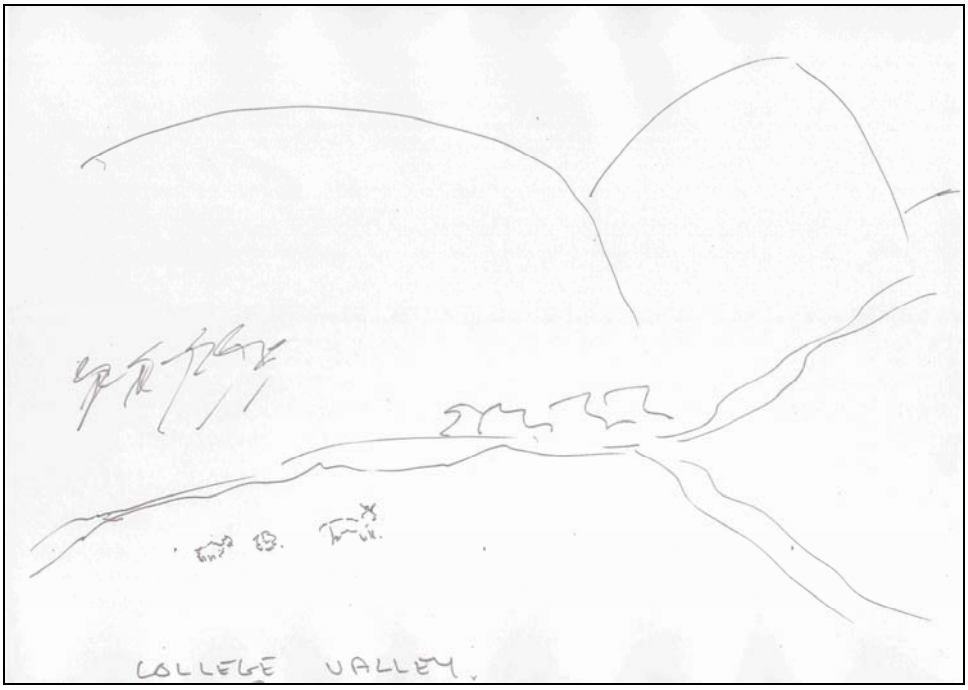


Figure 14: depictions of tranquillity in the PA sessions

Finally, in relation to perceived 'natural' elements, a focus for some respondents was the weather, and the difference it can make to a tranquil experience. Participants in the research noted the importance of 'Warmth, sun on skin soft sunshine (not burning sun)', which received 69 dots at verification (ranked 8th), and 'sunshine', which received 48 dots. Participants also commented on the importance of 'sunshine still', 'sunlight, 'Distant thunder in sea', 'rough windy and tranquil', 'cloud, windforce (weather)', 'late june', 'rainfall (soft) is tranquil', Not too much sunshine', 'weather can affect tranquillity', 'weather makes a difference - sun, warmth', 'Nice sunny', 'Weather -warm –still', 'gentle rain', ''Snow and rain', 'warm weather, fresh weather', 'sun shining', 'nice weather', 'in winter snow capped', 'sunshine', and 'stillness'. One respondent suggested 'Winter -wild, windy days on moor'. They noted how they would 'walk every weekend, 4-6 of us', and that company is very important to tranquillity, as was getting away from lots of people and traffic. They argued that a good place to go is the Cheviots, with lots of open spaces, as well as the end of the Pennine Way. It was suggested that it was best to go walking in winter, however, when it is wild, with winds and blizzards. These respondents argued that they don't like the Lake District as there are too many people all following paths. In contrast, Kielder Water was perceived to be tranquil, although it was felt that the forest can become boring and less tranquil because you have to follow set routes.

For others, smell was important, stressing 'Clean air', 'fresh air', 'air smells different', and 'smell of newly mown grass'.

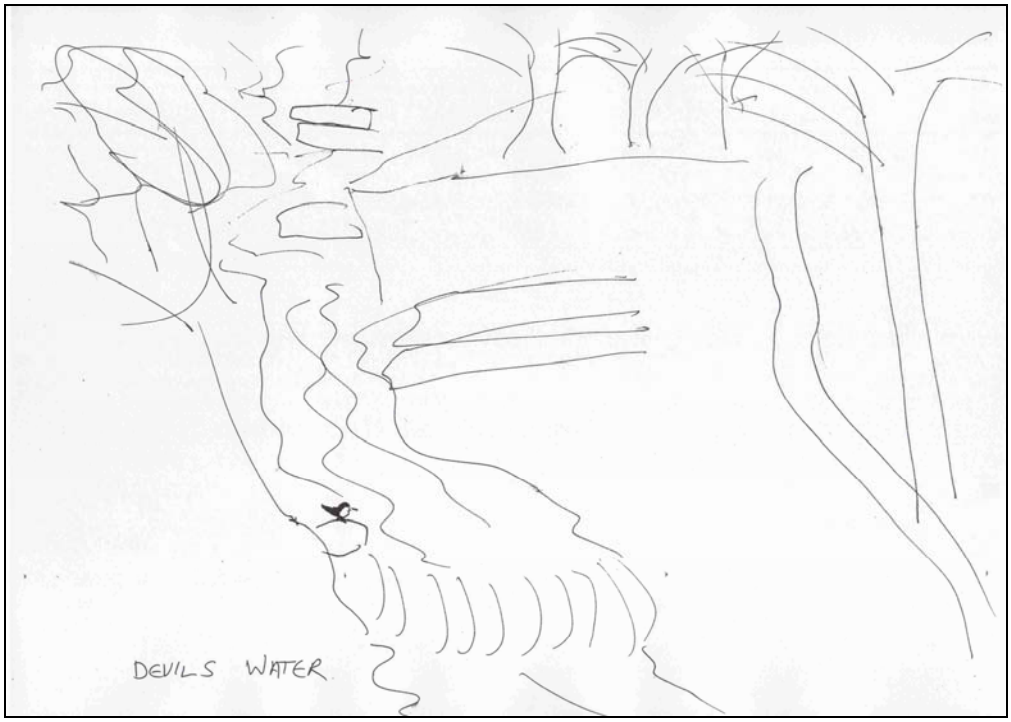


Figure 15: depictions of tranquillity in the PA sessions

Tranquillity 'of the mind...'

Whilst the many interrelated aspects of 'nature' were highly valued by many respondents during the research, another key aspect of tranquillity related to 'internal' as opposed to 'external' influences. Respondents argued that 'Perceptions of tranquillity and tolerance levels depend on what you're used to e.g NE "quiet" compared to say Lake 'District visitors from London to Lakes would view different'. Likewise, other respondents suggested that it ''Depends on your sense of 'pace' -how secure you feel etc.', that 'tranquillity is judged against a personal reference frame', and that it is a 'a relative concept'.

Tranquillity was considered to be very important by many respondents for a range of personal/internal reasons – many of which were well supported at verification. 'To restore personal balance' received 48 dots, 'to destress' received 45 dots, 'feeling like miles away from anywhere' received 44 dots, 'preserve areas if quiet wilderness' received 41 dots, 'at peace with myself' received 40 dots, 'no stress' received 40 dots, 'stillness' received 40 dots, 'feeling of well being' received 39 dots, 'calm mind and body' received 37 dots, 'peace of mind' received 33 dots, inner calm, not always external' received 33 dots, and 'the true meaning of recreation - giving people a chance to renew themselves' received 32 dots.

Respondents commented upon the beneficial consequences of being able to 'Get away from noise', 'An escape, like being in a different world, no stress', 'Getting away from everyday life and good to switch off ', 'Getting away from it all and to have a change of scene', 'Switch off from everything', 'De-stressed, restful, nice and calm', 'Feel good factor', 'The true meaning of recreation - giving people a chance to renew themselves', 'Nice to get away from it all - so much hassle the rest of the time', 'Not to be surrounded by noise - have a hectic life', 'Hectic life surrounded by noise', 'Preserving natural places and maintain heritage also to escape from the horrible hustle and bustle of daily life', 'Relaxed', 'Calm, relaxed, forget about work', 'Getting away from people', 'Takes away problems/worry', 'vital everyone needs some form

of tranquillity in their lives (even if they don't know it)', and 'not available to everyone. Tranq makes it easier to think'.

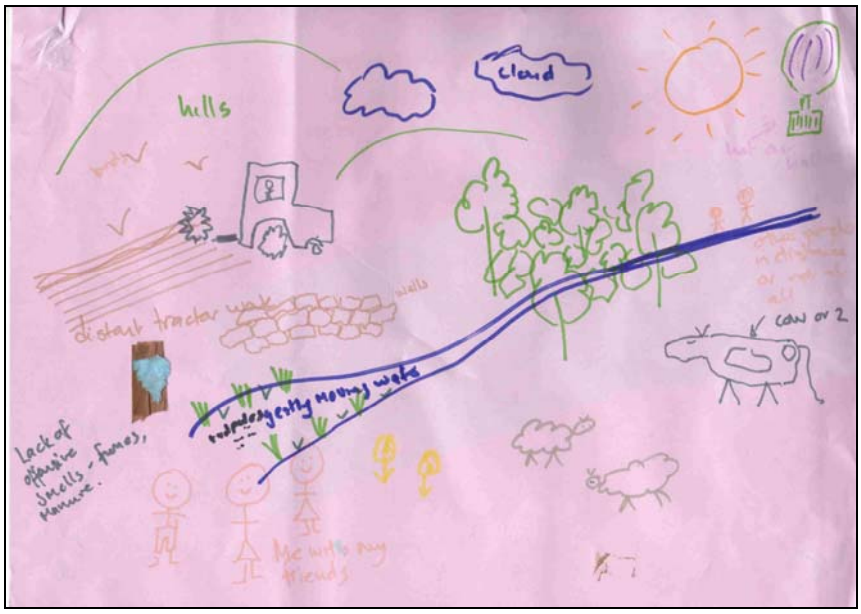


Figure 16: depictions of tranquillity in the PA sessions

Much of this reasoning was seemingly related to the ambiguous notion of (achieving) 'peace'. Peace can be used to refer to a complete lack of noise, with 'silence' receiving 43 dots at verification, and added to with 'complete silence can be very scary'. Alternatively, it could mean a lack of noise so that natural sounds can be heard, or, and moving beyond simple aural aspects, the notion of being 'at peace' – a mental or psychological feeling of well-being. As such, all such responses are identified below, but with comments made in conjunction with notions of 'quiet' (as in 'Peace and quiet', (which received 93 dots at verification)) coming first, followed by more implicitly or explicitly psychologically-nuanced comments.

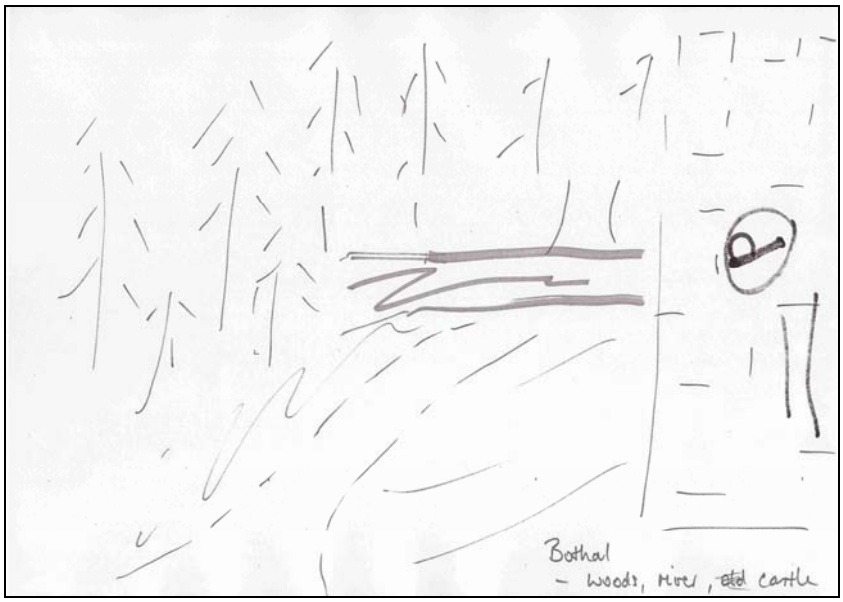


Figure 17: depictions of tranquillity in the PA sessions

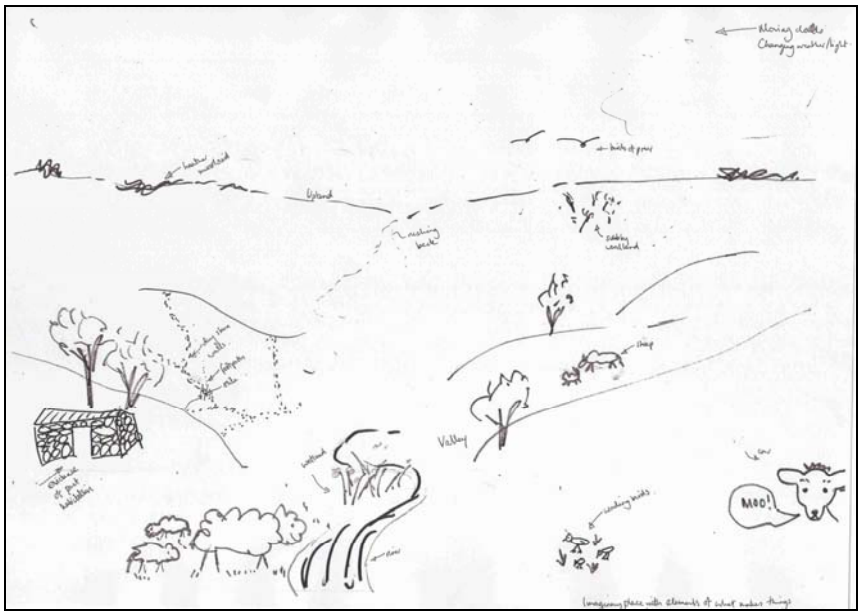


Figure 18: depictions of tranquillity in the PA sessions

Concerning a link between tranquillity and a lack of noise (to whatever degree), respondents noted the importance of 'quiet', 'silence', 'NO noise', 'periods of silence', 'periods of silence', 'peace, quiet', 'Silence', 'quiet', 'peace and quiet', 'Peace and quiet', 'quiet', 'peace and quiet', 'peace and quiet', 'quiet, ', 'silence', 'peace and quiet', 'Quiet -no wind in Trees', 'silence', 'Quiet', '-peace -quiet -no bugger about', 'Respect the place being quiet', 'peaceful and quiet', 'Peace and Quiet', 'Peace and quiet', 'Quietness', 'Peace and Quiet', 'Quietness', 'quietness', 'Peace and quiet', 'Peaceful -natural noise only', 'Peace and Quiet', 'Quietness and', 'Plants and peace and quiet', 'Quiet (lack of human noise)', 'Peace and quiet – solitude', 'quiet', 'quiet', 'Peace and quiet', 'Outdoors Quiet places', 'peace and quiet', 'peace and quiet', 'Noise intrudes', 'unobtrusive noise', 'peace and quiet', 'Quietness', 'quiet AND', 'NO noise', 'Peace and quiet', 'Quiet "Hear nowt"', 'Quiet', 'Quiet', 'quietness', 'No noise so you can hear nature', 'quiet', 'Hear a penny drop"', 'quiet 'Hear a pin drop"', 'Quiet', 'quiet', 'Quiet', 'Gentle noise is ok', 'Stillness', 'silence and birdsong', 'peace –space', 'lack of extraneous noise', 'quiet spots' (with 'York is too flat, needs woods' added in discussion, 'Quiet', 'Peace and quiet', 'unhurried', 'stillness', 'silence to think, just be....', 'Relaxing Peaceful Quiet', 'quiet, calm', 'quiet, calm', 'peaceful, calm, quiet', and '-Peaceful Stream -Quiet Hill'. This last respondent identified, in discussion, 'Regulation/Laws Aircraft/Traffic Military planes' as disturbing tranquillity. Hexham Mart, Durham Cathedral, Holy Island and Cragside Gardens were considered to be tranquil places, featuring birdsong, being away from traffic, calm and peaceful. Others also focused on 'Quiet and relaxed', 'Peace and quiet Alone Forests, woods, hill', 'countryside, when peaceful and quiet', 'Walk around in peace and quiet', and 'quiet serenity'. One respondent did suggest that 'Boring too quiet'. One of the respondents who noted the importance of 'periods of silence' added that they like to walk together, but enjoy not talking for some periods; that they like to spend some time in silence whilst looking at plants/birds/mammals. Another, who responded with 'quiet' added in discussion that although it is possible to be with others, others have the potential to spoil tranquillity mainly by being noisy.

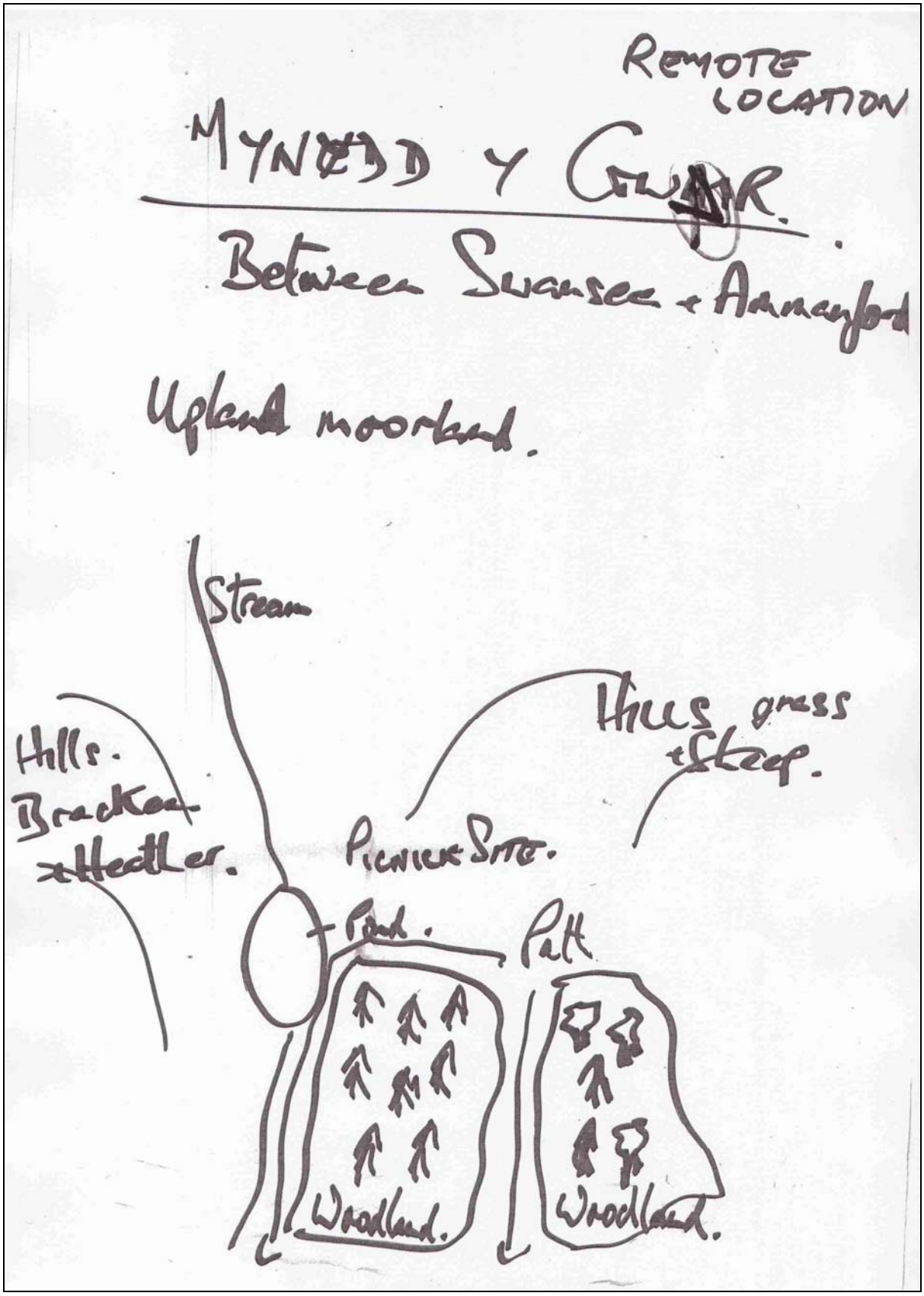


Figure 19: depictions of tranquillity in the PA sessions

As noted above, other responses including the notion of peace could be considered to infer meaning beyond an absence of noise, or as one respondent argued, 'It's a place where you feel at peace i.e. 'feeling' rather than absolute peace'. Many respondents highlighted an 'internal' element to tranquillity – ''Stillness a sense of calm, both internal and external. One is response to the other' – essentially, tranquillity as 'peace of mind' in a range of ways. Hence they talked about 'peace', 'Peace and calmness', 'feeling restful, at peace with myself', 'From within Calm', 'In mind (peace of)', and 'NO stress'. One participant suggested 'The presence of "calm" What makes things "calm"? -Mood -Naturalness -Space -Enclosure closing out external 'xtrusions –Solitude', and 'peace, calm alone with my dog'. In discussion a particular concern of the last respondent was to be away from noise, especially music. Others suggested 'Peace and Calm', 'peace', 'peaceful', 'calm', 'peace', 'calm, peaceful', 'peace', 'calms -you down -peaceful –come every week', 'Calm and peaceful', 'Somewhere peaceful calm No stress', 'Peace, stillness', '-Relaxing same as tranquillity -traffic (not)', 'perfect peace', 'Peace', 'My garden, peaceful -it has everything you need to be tranquil', 'peace, other people around', 'Peaceful', 'calm', 'calm', 'Stillness a sense of calm, both internal and external. One is response to the other', 'calm, peaceful', 'Peace', 'Peace', 'Peaceful on the tops', 'Peace, feeling of well-being', and 'Real Peace', 'Peaceful', 'Peace without outside interference -not necc. alone, but people can irritate you'. The respondent who made the last comment noted that it was not necessarily the number of people that is important in detracting from tranquillity, but 'particular type of people'. For him, tranquillity was 'making things with wood/metal/any materials'.

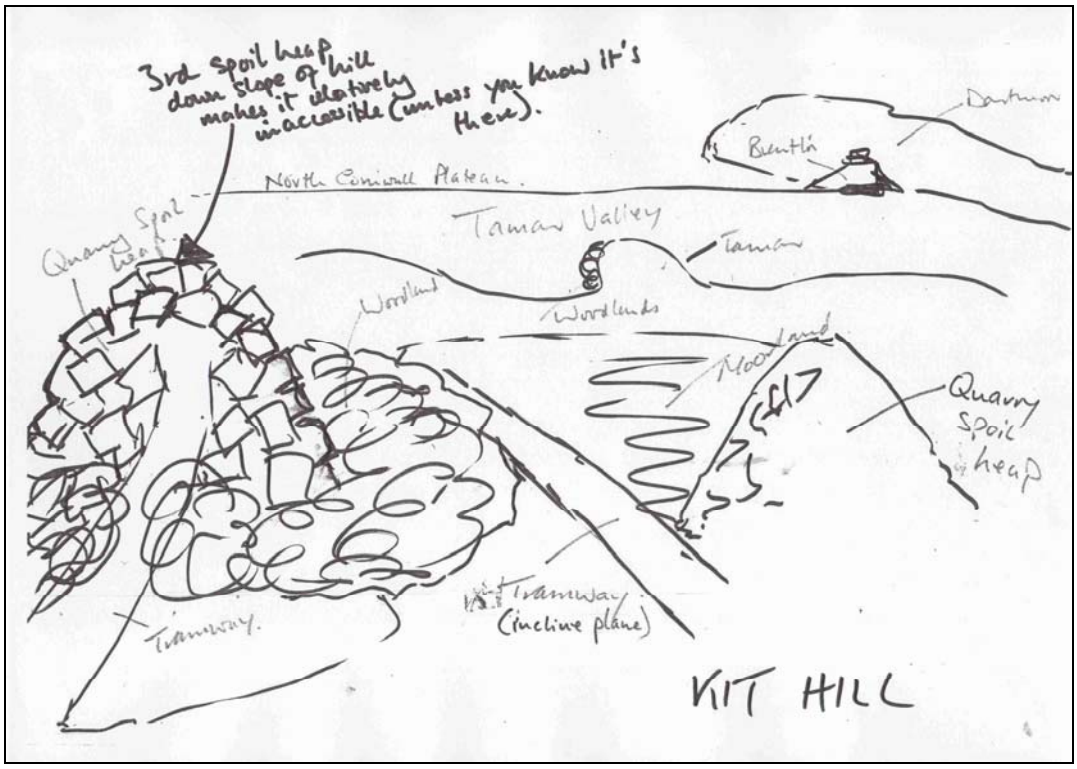


Figure 20: depictions of tranquillity in the PA sessions

Others noted the need for 'space to reflect', 'empathy with surroundings', 'time for thoughts', tranquillity as a 'state of mind when in nice surrounding', 'Quietness (in the spirit)', 'sit in the quiet and listen to God speak', 'calm mind and body', 'Calm and Karma', 'peace -serenity within not outside Everything can contribute', 'A feeling of peace with natural env in background birds/bees', 'calm -quiet -peaceful –relaxing', 'Nothing to worry about Peace, quiet Spinning', 'Calm, relaxing State of mind', 'alone, silence, nature', 'Difficult to describe - a feeling, not specific space -calm, still (state of mind)', 'calm relaxation with others/alone',

'Home', 'Time for me to be there/ Quiet re non-natural', 'An emotional response rather than a physical description', 'tranquillity is a dream peace of mind and freedom of spirit', 'Being in the moment an absence of time and space', 'sense of well being, thinking space', 'time to think', 'feelings thoughts', 'Being comfortable', 'Time to yourself', 'sense of history', 'absence of influences', 'space to reflect', 'fulham winning by 4 goals', 'internal not external', 'pleasant thoughts', 'different rhythm to urban life', 'spiritual awareness', 'Driving long distances on my own -do all my thinking', 'Quality of Life', 'feels like going back in time', and 'A safe place to be'. One of the respondents who suggested 'peace of mind' also noted in discussion how she hated tourists, and hated being one – 'they all fuck it up'. Another respondent suggested 'switched off'. They also noted in discussion the potential for night fishing in the wind and rain to be a tranquil experience, and that excitement can be needed in order to get tranquillity – 'just lying around is boring not tranquil'. The respondent who suggested 'perfect peace' also referred to the following in discussion - 'Blanchland, a July evening, out with dogs, no other people around.... Game keeper is allowed. See nothing but heather all around. –magic'.

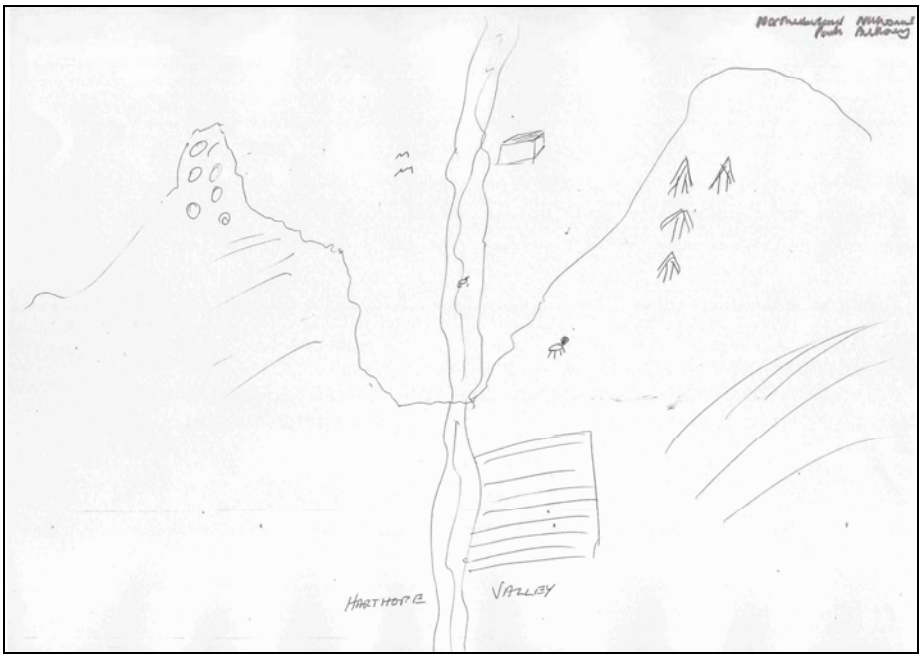


Figure 21: depictions of tranquillity in the PA sessions

Others equated tranquillity with 'getting away from it all (which received 57 dots at verification, but which was added to with 'I've been really away from it and it can be really frightening! e.g. glaciers, mountains in bad weather'), particularly other people - 'away from noise with birds', 'Anywhere away from noise –TV', 'Feeling like miles away from anywhere', 'away from it all', 'Feeling far away from town', 'getting away from it all', 'Hustle and Bustle (away from it)', 'away from everyday life no detailed planning', 'An area you can visit to leave all your troubles behind -escape life's hustle and bustle', 'About escape -being away from the bustle of normal life', 'everything you cant get at home', 'Away from stress of work and day to day pressures', 'Escape from people -human interference', 'No one', 'Getting away from speed', 'Peace and Quiet away from stress', 'Not being bothered', 'Can sleep Not disturbed', 'Being alone', 'lack of people unspoilt live nearby', 'Away from everyone else', 'no people', 'not too many people', 'lack of people', 'This without people and dogs', 'Lack of people', 'Just Me', 'No too many people (here today is too many)', 'alone', 'seclusion', 'Secluded', 'atmosphere. cordial people', 'few people', 'alone....', 'Absence People and their moods (taking it out of you)', 'Solitude on Cheviot', 'away from people -noise and rubbish', '(no) Other people - distract from contemplation; feel need to interact', 'Solitude', 'Not lots of people in crowded

place', 'Lack of fast man made movement e.g.vehicles, like slow pace e.g. grazing animals', 'Absence of man made sound Elitist view -I should be the only person there.', 'solitude', 'solitude', 'no people', 'tranquillity = less people = more peace', 'being alone', ' Alone or with others', 'Lack of people', 'no people', 'No people', 'solitude', 'with few people around', 'NOT too many people', 'Lack of people', 'No people', 'not too many people', 'No other people', 'not many people ', 'not many people', 'not too many people', 'lack of people', 'not too many people', 'It is good hardly to see another soul', 'Lack of people (and want to keep it that way)', 'not a lot of people', 'Being a long way from other people', 'not too many people', 'No other people', 'Not being bothered by surveys', and 'few people (not hoards of teeming people)'. One respondent suggested 'get away from people'. This respondent noted how he worked on the Tyne and Wear Metro system, and liked to get away from work, people and the city and go walking. Another respondent suggested 'NO bigots' (supported at verification with 33 dots). In discussion he noted that he had gay friends who had lived in the countryside who had not had a good experience due to the attitude of other locals. One of two female respondents (a mother and daughter) suggested 'having a place that belongs to you -can keep people out -own space'. In discussion, the daughter noted how she liked her bedroom as it was 'her space' – it belonged to her and she could keep people out.

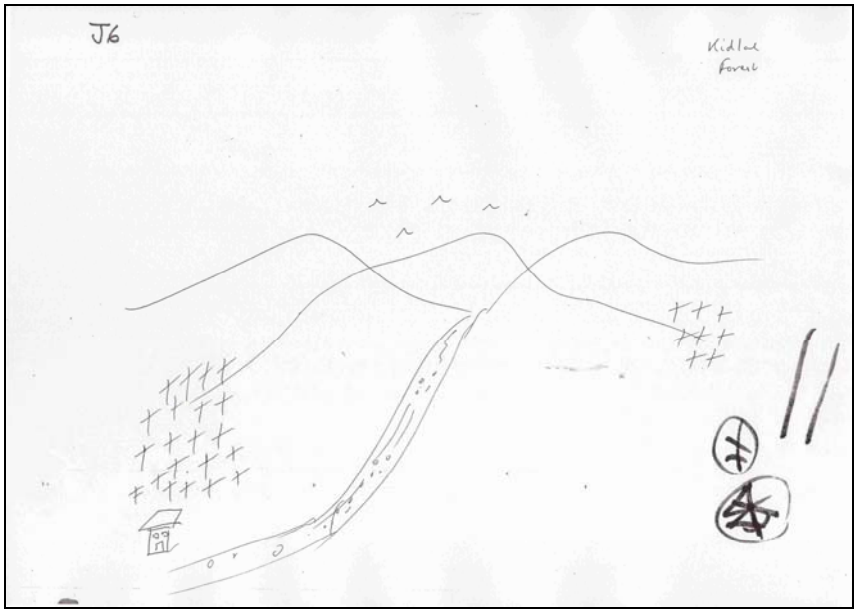


Figure 22: depictions of tranquillity in the PA sessions

For others, tranquillity related to 'The history of places', 'remembrance of a special place and special moment', 'Drawn here by bridge/history', and 'history recall',

Doing things

Many respondents identified particular activities that they considered added to their experiencing of tranquillity. Of these, a particular focus emerged around 'walking' (which received 64 dots at verification) – 'somewhere you have to walk to but when you get there, the rewards are tremendous', 'Pleasant Walk', 'quiet hill walking', 'nice walk', 'long walks', 'hiking/walking either alone or with somebody else but more so when alone', 'ability to move to other areas to retain tranquillity', 'Walking dogs in woods', 'long walks', 'Walking through woods.', 'dawn organised walks', 'being able to enjoy a nice walk', 'valley walks (bad back) {Ingram valley is ideal}', 'to walk all day and not see anyone', 'not going to work lie-in on Sunday morning No stress, no hangover', 'Nice relaxing walk', 'Making things with wood or metal, anything', 'Horse ride alone', 'walking in the countryside free as a bird'. One

respondent suggested ‘organised walks - like dawn 'bat walk''. In discussion this respondent argued that guided walks are good so you can take other walks away from where these walks go. Another respondent suggested ‘walking in woods near home, with dog/family -anytime of year its beautiful’. In discussion this respondent noted the combination of open and enclosed spaces, and that there is a stream there. The respondent preferred to walk with dog and her husband, with litter and motocross bikes spoiling tranquillity.

Figure 23: depictions of tranquillity in the PA sessions

A range of other activities was also suggested. ‘Things i enjoy with friends and family’ received 45 dots at verification, and was added to with ‘with husband always tensions in a group so only alone or with husband’, and ‘enjoying the landscape’ received 35 dots. Other responses were: ‘curtains closed and a nice fire’, ‘a consuming novel’, ‘Sitting still/lying down in comfortable place with background sound (not motor traffic or roads)’, ‘good sex’, ‘naturism’, ‘I am tranquil when I’m with wood working with it outdoors in natural environment’, ‘Being in a rowing boat, sailing dingy rocking slowly or steadily in breeze. No fast motor boats whizzing past’, ‘bed’, ‘Bird watching at scott nature reserve’, ‘I am tranquil when im playing horses outside by myself’, ‘Fox hunting on high fells -sound of nature taking place.’, ‘out cubbing at 6am’ (with the respondent adding that ‘I like hunting foxes in the morning especially cubbing’, and ‘You have to be quiet in case the victim is disturbed’), ‘floating in a calm sea surrounded by nothing but flat horizon’, ‘On a seat having a quiet beer’, ‘Watching world go by pint of beer’, ‘glass of beer’, ‘sitting by fire’, ‘family’, ‘Yoga -cut yourself off’, ‘More tree planting’, ‘relaxing in garden, alone –afternoons’, ‘Going into countryside away from traffic and people -river walks’, ‘fishing (no work)’, ‘Ice cream (9 yr old)’, ‘gardening’, ‘People working in landscape ok e.g. walkers, farmers etc’, ‘Camping Holiday’, ‘Fishing’, ‘(Gardening) Satisfaction of growing things yourself. Space/time to be by self.’, ‘Gardening/bird watching -quiet -away from tv.’, ‘doing things I enjoy, friends and family’, ‘Knowing God (through Jesus Christ)’, ‘archaeology’, ‘traditional activities’, ‘BBQ by river’, ‘on a mountain bike’, ‘watching a wedding can enhance’, ‘nice view from a beer garden’, ‘no particular thing to do’, ‘in the car alone on a dry road at night when the heater, radio and all other sounds are off and there isnt another car in sight – it doesn't last for long but is a great sensation when it happens’, ‘Walks in the hills when the weather is just right and the company is good’, ‘On an airbed in the middle of a pool, glass of wine in one hand,

book in the other', 'Swimming in a remote lake', and a 'Single malt whisky drank in a quiet glen in Scotland Glen Lyon'. One respondent argued that he/she 'Need(s) excitement to be tranquil (lying on the sofa is just boring)'. Another added 'a good book', also suggesting that 'jet skis should have their own place, I place in UK'.

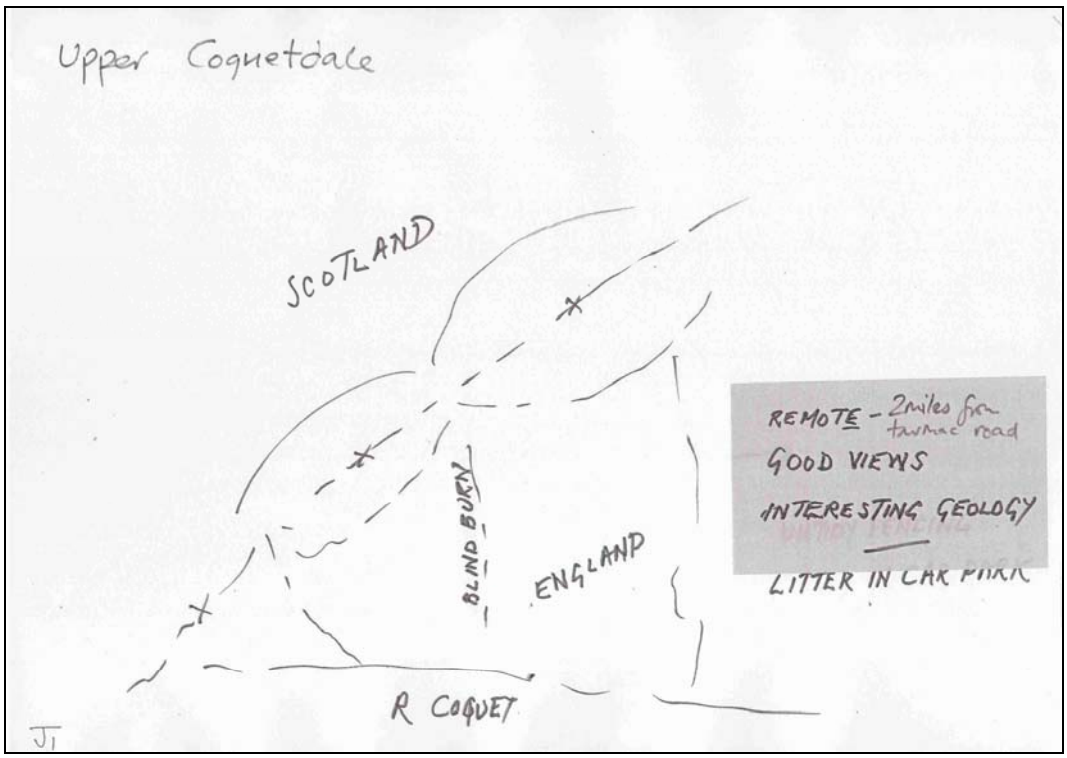


Figure 24: depictions of tranquillity in the PA sessions

Perceived human related benefits

Whilst much of the focus of participants comments concerned perceived 'natural' factors, some respondents suggested certain human-related aspects could also be important in heightening the experiencing of tranquillity. Some participants suggested that some human-related developments (and humans themselves) in the landscape added to their sense of tranquillity. These were 'old buildings', 'well maintained', 'suble blending in services', 'No to the exclusion of man made landscape or noise', 'Appropriate development (tea rooms in farm houses, etc', 'Children -Crowds -Pleasant surroundings', 'doesn't have to be solitude', 'Doesn't have to have absence of vehicles', 'Company - 4 to 6 people walking every weekend Important', and 'Wind turbines are OK'. One respondent suggested 'Need more windmills (no oil in 15 years)' – this participant argued that people need to protect tranquillity and speak up for wind power. Others suggested tranquil places would be

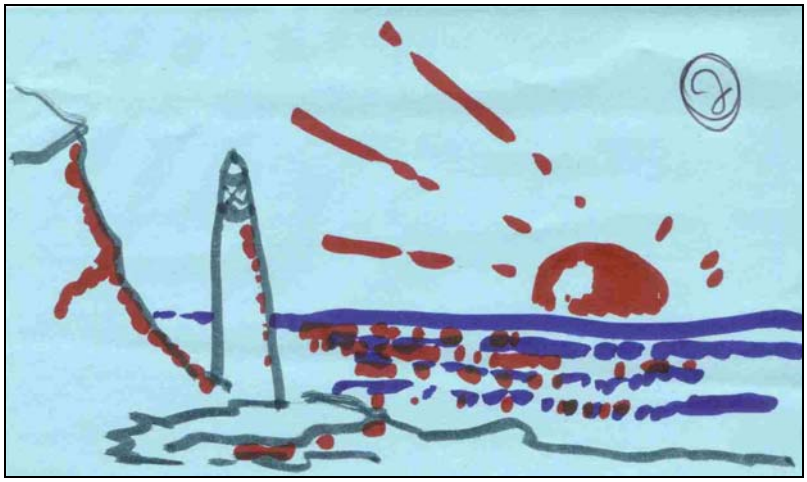


Figure 25: depictions of tranquillity in the PA sessions

'safe for kids', having 'seats', 'clean places to eat', 'maintained areas', 'free from play grounds', 'clean areas', church history scenery', 'more garbage bins', 'Open space for children', 'Safe places to run around (9 year old)', 'Hill forts, settlements, roman ruins', and 'cared for hedgerows'.

Some respondents noted benefits of certain human-related sounds, linking tranquillity to 'beethoven's last 4 quartets', 'music', 'music', 'music classical', 'nice music', 'vaughn-williams', 'Gentle quiet converstion –yes', ' murmuring conversation', and 'quiet roads'.

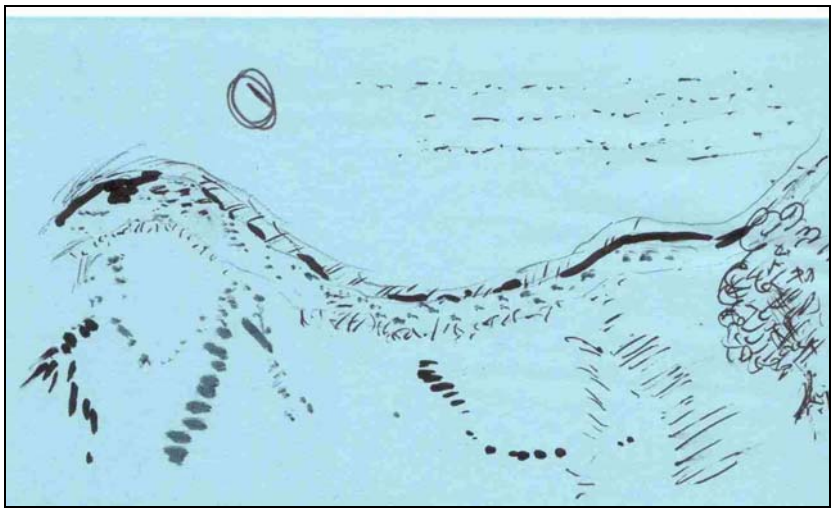


Figure 26: depictions of tranquillity in the PA sessions

Tranquillity is...what it is not!

Most of the human related aspects that participants suggested as representing what tranquillity *is* actually focused quite clearly on perceptions of what it is *not*. Participants suggested 'NOT technology', 'lack of unnatural noise', 'Absence of industrial noise', 'NO army firing', 'no mobile phones - own phone, fact that I cant get away phone - feel like I have to carry it with me.', 'no phones', 'lack of unnatural noise', 'Absence of industrial noise', 'NO army firing', 'no mobile phones - own phone, fact that I cant get away phone - feel like I have to carry it with me.', 'no phones', 'NO human noise'. Some people focused on issues

surrounding various forms of transport - 'lack of people traffic', 'NO aircraft noise', 'NO car noise', '(no) Noisy off-shore boats etc.', 'Distant traffic noise', '(no) Low flying jets', 'Traffic Noise (lack of)', 'Traffic none (little) no waiting', 'Not military jets screaming past overhead (unfortunately they are usually in otherwise "tranquil" areas)', 'not any traffic, aeroplanes', 'lack of traffic noise', 'Place free of man made noise', 'The absence of "disturbance" What makes things "disturbing"? -Intrusiveness -Character -Volume -Prevalence –"Mood" crowds Absence of activity e.g. traffic, people etc. "things going on" -artifacts that sit uncomfortably in the wider scene', 'lack of traffic', 'no traffic', not too much traffic', 'No traffic', 'No cars or aeroplanes', 'No cars or aeroplanes', 'No traffic', '(-) aeroplanes -military aircraft practising', 'NO traffic', 'NO traffic', 'NO planes or trains', 'Cannot see roads' 'NO motors', 'no cars ', 'away from traffic', 'Cars (detract) hustle and bustle', ' (-) traffic -motorbikes (clubs) en masse', 'away from traffic', 'Northumberland is tranquillity -no motorway -whole county', 'No motorbikes', 'few (or no) cars', 'LESS traffic', 'NO traffic', 'NOT many cars', 'NO cars', 'NO traffic', 'RESTRICTIONS on quad bikes', 'no traffic', 'No cars', 'No motorbikes', 'no traffic AND', 'NOT traffic', 'No cars', 'No motors on path', 'no passing traffic', 'not near a road', 'lack of car alarms', 'no cars', 'Anywhere where cars not allowed', and 'car parks, signs in keeping -encourage -awareness –respect', and 'No Main Roads'. Two respondents suggested 'mountain bikes (NO)'. They focused on mountain bikes or quad bikes, particularly those used off road, because of their effect on the land, which could be 'cut to death', and because they destroyed the footpaths and trails. The two respondents said that they were often forced to walk on the heather because of the state of the paths and were concerned that they were destroying the heather as a result. Another respondent suggested 'No motorbikes', adding in discussion that benches and places for children to play are important as well. One of the respondents who suggested 'no cars' noted how they were most concerned about traffic noise, and that too much traffic makes it less safe for children.

Other noted tranquillity as related to 'no national trust signs or heritage', 'few (low) fences', '"Visually" tranquil -lack of man made structures e.g. powerlines, cables.', 'no traffic signs', 'reduced level of human impact', 'no barbed wire', 'NOT modern straight edged fences, buildings etc.', 'wind turbines', '(no) Council estate', 'no artificial smells', 'NOT -funfairs –noises', 'Absence of human "recreation" ', '(no) 76 Hikers in bright cagoules, 'Not keen on the adders (for their dog)', 'Not keen on the adders', 'no dogs', 'kids', 'Children', 'lack of children's noise', 'lack of child centred activities (bouncy castle etc)', 'NO churches', 'NO plastic cups, NO litter, NO pop drinks', 'LESS people, NO litter', 'unspoilt (no pubs etc)', 'unspoilt by development', 'unspoilt by development', 'lack of industry or obvious signs of capitalism', and 'parking restrictions'. One respondent noted the negative impact of 'interruptions when reading in bath (my daughter)'. In discussion the respondent noted specific negative interruptions of builders and drill noise. Another respondent suggested 'NO technology', saying in discussion that they preferred natural landscapes. Another participant suggested 'no churches'. The walker was part of the Gay Men's Walking Group and argued that he personally found churches to be particularly offensive because of his sexuality. He associated churches with persecution of gay people and didn't want to see them when out walking and wanting peace to enjoy the countryside.

One respondent suggested '<u>not</u> litter on beach <u>not</u> housing in green areas' – in discussion they also suggested that church and history are linked to tranquil memories.

3.3.2 What is not "tranquillity"?

The impact of humans

As might be expected following the last set of responses, a large majority of the responses to the question 'what is *not* tranquillity' (and some responses to being asked what is) focused on the impact of humans in a variety of different forms.

On a general level, it was the mere presence of humans that detracted from tranquillity for many respondents. Participants suggested that tranquillity is not 'Too many people', 'Too many people', 'Too many people', 'Too many people', 'Too many people', 'Too many people', 'Too many people', 'Too many people', 'big crowds of people (rowdy)', 'too many people', 'too many people' 'Too many people', 'Too many people', 'Too many people', 'Too many people walking the paths', 'Too many people', 'too many people', 'Density of population', 'too many people', 'Crowds', 'shoulder to shoulder', 'Human noise and business', 'too many people', '(lots of) people -noise/disruptive', 'Busy/lots of people', 'People -like to be there alone with dogs, although gamekeeper is allowed', 'Irritation -people, particular people, not all', 'People -> Lake District -too many people, tourists', 'people', 'lots of people you don't know', 'Human beings', 'Tony Blair', and 'Uninvited people'.

Certain types of behaviour and/or activities undertaken by humans were considered as detracting from tranquillity, much of which revolved around the issue of unwanted noise and/or disturbance (both visual and aural). At verification 'Mobile phones' received 65 dots as something you hear when not in a tranquil place, and 79 dots as something you do not hear when in a tranquil place (ranked 7th and 10th!); 'ghetto blasters/radios' received 65 dots as something you do not hear (ranked 9th) and added to at verification with 'but walkmans ok', 'noisy people' received 54 dots, 'sound of blasting music' received 39 dots, 'loutish behaviour received 50 dots, 'unnecessary noise; received 47 dots, 'the alarm' received 45 dots, 'people shouting' received 38 dots, 'hooligans received 38 dots.

Participants commented on the negative impacts of people 'not respecting an area', 'drunken teenagers', 'loutish behaviour', 'lack of respect', 'people screaming and shouting', 'Irritating Drunks', 'Sister -coming in bedroom -making mess', Attitude of people (to area) who live hear', 'Anger, people fighting and arguing', 'Being at everyone's beck and call, no time to self', 'inconsiderate people', 'inconsiderate people', 'Un-natural noises', 'noisy rowdy people', 'Noisy people', 'noisy neighbours', 'Noisy kids', 'Noisy children', 'Noisy kids', 'Grandchildren –Noise', 'Radios loud', 'not natural noise', 'unnecessary noise', 'man made noise', 'Noise - machinery irritating', 'Noisy people (Radios)', 'Unnatural noise -prefer jets to crowds -hate crowds', 'Noisy neighbours', 'noise', 'Excessive noise', 'Noise', 'mobile phones', 'Mobile phones', 'mobile phones', 'people's radios mobile phones', '-sound of blasting music', 'background noise -jazz music', 'Loud Music', 'Noise -manmade esp. music', 'Un-natural noises especially loud car radios', 'Noise -other peoples music', 'loud music, out of cars', 'loud music', 'Radios', 'Radios loud', 'prolonged noises e.g. chainsaws', 'Noise -machinery -dogs - not natural noises', 'Noise', 'Noise', '(-)Dogs Barking', 'Shouting loud children, ghetto blasters -no!', '(-) Noise -loud music. (young kids driving)', '(-) noise intrusion too many people', 'people shouting', 'BBQs', 'Picnics, BBQs', 'A shoot (but understand need)', 'Builders digging our patio', 'interrupting when spinning', 'building works', '(in Bedroom) Cats and Dog -> lie on bed dog chases cat', 'hooligans, young people loud music.', 'Too many children', 'Kids playing (scream all the time) kids noisier and louder these days –don't play quietly.', and 'Children running about disturb peace'.

Some respondents identified how being in the wrong frame of mind can detract from perceived tranquillity - 'Lads stress!', 'stress', '-Problems -things outside your control -can only control your own stuff', 'Interruptions -like stresses, kids, etc.', and 'worry'.

A key issue concerned the perceived spoiling of tranquillity through litter (31 votes), rubbish (88 votes – 5th rank, and added to at verification with 'rubbish/litter') and pollution received 34 votes at verification. Participants noted the negative effects of 'Rubbish', 'rubbish' 'litter/dog dirt (beach)', 'Rubbish', 'litter', 'mess', 'beer cans', 'commercial rubbish', 'Rubbish', 'litter', 'rubbish out of place things', 'Litter', 'Rubbish', 'Rubbish, plastic bags and fly tipping', 'Litter', 'Rubbish', 'Rubbish', 'Litter', 'Litter', 'dog dirt', 'dog dirt', 'dogs should be controlled', 'litter', 'Mess', 'Rubbish -allsorts fly tipping', '-too many people -dropping rubbish', 'litter, crosser? bikes in summer', 'Pollution', 'litter', 'litter', 'litter/hoardings', 'Litter', '(-) litter', 'litter', 'burnt out cars', 'people –litter', 'Pollution', and 'Litter'.

The negative impacts of various forms of transport and vehicles was commented upon by a number of respondents, with 'traffic' receiving 93 votes at verification as being something not seen in a tranquil place (and added to at verification with 'not ok if its parked -still has to get there cars are ugly', 'ok if parked not moving (driving in it)', '4 wheel drives on green lanes', and 'don't mind a bit of traffic'), 'car noise' receiving 54 dots as something you do not hear in a tranquil place and 47 dots as something you hear in a non-tranquil place (added to at verification with 'especially a constant roar e.g. motorways trunk roads'), 'motorbikes' 46 dots, and aircraft noise, 31 dots. They noted the negative impacts of the following on tranquil experiences – 'traffic, too much, cars, skunks, wolves', 'Quad Biking', 'motorways aircraft children cars car parks motorbikes', 'traffic -stops it being safe for children', 'traffic -danger to children', 'cars', '-burger vans -traffic -litter –graffiti', '-national grid pylons -light pollution -cars/traffic (noise) -radios (i.e. RAP)', 'Motorbikes', 'Motor bikes and trail bikes (exhaust smell + noise)', 'Motor Bikes', 'Too much accessibility for cars', 'Long wait for public transport to tranquil place', 'Loud traffic', 'motor cycles', 'Jets (but not too disturbing comes and goes)', 'traffic –motorbikes', 'aeroplanes', 'Jet skis', 'off road motorbikes', 'Motorbikes', 'Military Planes', '-motor bikes -airplanes -people -> angry offensive', 'Cars', 'Roads, mobiles, industry, human infrastructure', '-Lots of people –motorbikes', 'motorbikes, jet skis', 'Cars', 'cars/traffic', 'too much traffic cars close to you', 'aircraft noise', '-roads ->car noise ->traffic noise', 'Motorbikes – Noise', 'Hate microlights noise', '(-) low flying aircraft', 'Noise levels -difficult to get away from roads/aircraft. Some levels acceptable/inevitable.', 'engine sounds, cars', 'Noisy M. Bikes', 'b/ground noise -traffic -aircraft in certain areas', 'Road noise (not the roads)', 'traffic noise', 'traffic noise', 'Traffic noise (no new car parks), Fighter planes', 'Cars with noisy radios', 'Jet noise (Thursday is low flying day)', 'Traffic noise', 'road noise', 'traffic noise', 'traffic noise', 'Noise –motors', 'Traffic noise', 'traffic noise. Cars with loud music (boom boom)', 'Aircraft and traffic noise', 'Cars and radios too many people shouting', 'Noise of a road', 'Noise from -motor bikes -light aircraft -low aircraft', '-motorbikes in countryside -scrambling bikes in countryside', 'Roads outside our house Noise', 'Noise -e.g. jet going over', 'Traffic -noise pollution not natural noises', 'Noise –traffic', 'Cars Noisy People', 'Developments Noise Motorbikes', 'Traffic noise Litter Intensive farming', 'Jets coming over from newcastle airport', '-low flying jets -trial bikes -noisy vehicles –noisy', 'jets noise', 'car radio noise', 'traffic noise', 'Army on manoeuvres', 'Burger van', 'Loads of coaches', 'Traffic', 'Quad bikes', 'Caravans', 'Exhaust fumes'

A more general form of negative human impact concerned various forms of 'development' in the landscape, particularly any that was perceived to be 'Too commercialised' or 'Incongruous things like -Fun Fair in a village green -moto scramble?'. 'Vandalism' received 51 dots at verification, and 'industrial sounds' received 35 dots as being things not seen or heard in a tranquil place. Participants commented on the perceived negative impact of 'Cafes, car parks with facilities and stalls', 'over management', 'over commercialisation (Supermarkets, etc)', 'over commercialisation (Supermarkets, etc)', 'Commercialisation', 'Any encroachment', 'Commercialisation (holiday villages, etc)', 'any industry', 'Over development', 'Don't change anything', 'Obvious development', 'Development of any kind', 'Any development', 'Too much commercialisation eg cafes, etc', 'Too much development -

buildings, houses, etc. Too commercialised', 'Too large visitors centre, car parks', 'Too commercialised', 'Big building sites', 'machinery', 'Noise, pollution -> machinery, cars, other people', 'Quarry noise', 'factories', 'new housing areas', 'Keep facilities at the edge', 'Anything manmade', 'Modern Lifestyle', 'too much of everything', 'Industry, Ghetto Blasters ->noise/pollution', 'Industrial Sounds', '-too built up -traffic (noise) (fumes) -city living -graffiti/rubbish -less pathfinders -hikers less -less people', 'Something that intrudes', 'big city commercialisation', 'burning tyres', 'people -modern manmade things', '-pylons -windfarms (not sufficiently efficient)', '-Industry', 'Technology', 'Power cables', 'Smoke from industrial areas', 'High rise buildings', 'Too much building', 'Housing estates', 'Industry (unless picturesque like Cornish Tin mines', 'Pylons', 'Wind turbines on the top of hills - but ok out to sea', 'Mobile telephone masts', 'Over management', 'Anything unnatural', 'Modern buildings', 'All pylons and masts', 'Lots of houses', 'Anything modern', 'Multi-story car parks', 'Big Windmills', 'Ugly Buildings', 'Ugly farm buildings, sheds, etc', 'Masts', 'Electric pylons', 'Wind Turbines (Not effective for visual pollution created)', 'restricted access', 'Tarmac' paths', 'Army restricted access', 'Sterile tarmac paths', 'Army restricted access', 'Old buildings', 'Destruction', 'Big billboards', 'Tarmac on paths', 'Graffiti', 'Graffiti', 'Signs -makes it look like Northumberland St', 'asphalt paths', 'Tree planting which denies access', 'Signs of mans interference', 'Artificial management', 'Prefer here to the Lakes as it is less commercialised', Insufficient information', 'Un-natural smells', 'Un-natural smells', and 'bad smells'. The participant who suggested 'Un-natural objects that draw your eye' added in discussion that it is not just the size or the proximity of the object, but rather its visual impact and the issue of whether it can be ignored that is important.

Finally, some respondents identified seemingly 'natural' factors as detracting from tranquillity. These were - 'midges', 'sea (rough) detracts ', 'Bad Weather', 'bad weather', 'The weather wind rain "really bad weather"', 'Too many conifers', that 'open areas not necessarily tranquil (whilst walking ok when stopped)', and 'wood pigeons (spoils)'.

3.3.3 Tranquil Places

During the research a number of perceived 'Tranquil places' were suggested by the research participants, either as a result of being asked to identify such places directly, or by volunteering them as representing or illustrating what tranquillity meant to them. The suggested named places are as follows: 'Bay Horse, Ulvaston', 'Kirkwhelpington', 'Keilder', 'Wallridge our garden', 'Avington Right proportions -valley -river -quiet enclosed but outdoors', 'Druridge Bay', 'Home (between Wark and Bellingham)', 'Blanchland', 'Chatton', '(Cumbria) St John the Vale? (overlooks valley of Keswick)', 'Bamburgh Beach', 'Hadrian's Wall -away from it -beautiful views –nature', 'Dukes House, Hexham. (woodland, big, atmospheric, familiar.) Can go off beaten track and not be threatened with 'getting lost.', 'Hexam Mart -quiet hill -Durham Cathedral -Holy Island', 'Cragside Gardens', 'Holy Island', 'Cheviots', 'Riverside Near Water and Birds', 'Hareshaw Lyn', 'Loch Lomand', 'Loch Garten?', 'Wensleydale, Allen Banks on the tops', 'Butterburn Flow?', 'Heddon Hall (Just Peaceful)', 'Bridlepath, Ponteland', 'North York Moors', 'Tow Law area (wooded, quiet)', 'Forest -Kielder –sculptures', 'varies depending on me. Walltown? Quarry -combo of weather, time of day, etc.', 'Coastline –Bamburgh, Wallington hall garden -lots of places in Northumberland', 'Northumbrian Moors', 'area like Lake District –Garden', 'Ford and Etal', 'North York Moors', 'Blanchland -look around and see nothing but heather, July evening with pointers –magic', 'Ingram Valley Thrunton Woods early morning -visual –quiet', 'Derwent Valley -not bothered about weather', 'Sunderland Park gardens, trees, plants, nature', 'Cheviots -open spaces -End of pennine way, Scottish Border Kielder -lake although forest is boring', 'Hareshaw Lyn -waterfall early a.m. visual, sound, smell enclosed -first thing Sunday -everything is perfect', 'Walking in Fells alone or with few people -at home', and 'National Trust properties'. One respondent noted how they are 'None near us'. Two respondents

suggested 'North York Moors', also arguing that somewhere to get a cup of coffee is important.

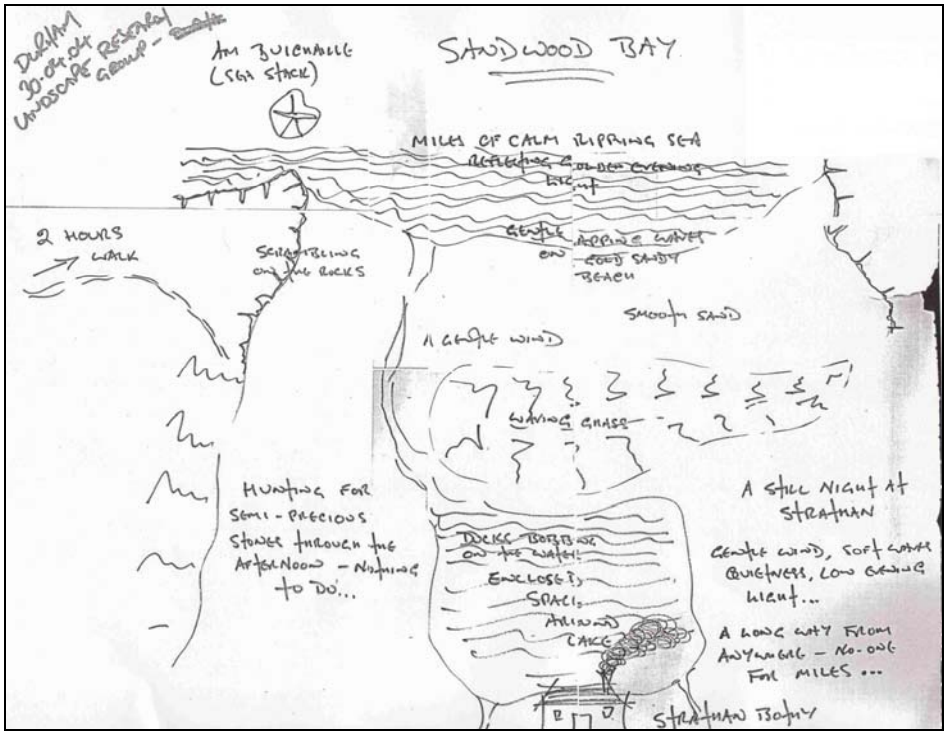


Figure 27: depictions of tranquillity in the PA sessions

Other respondents identified a wide range of unnamed places of varying sizes/scales/specificity which they associated with having a tranquil experience - 'The garden. Countryside.', 'Outdoors/countryside away from hustle and bustle.', 'In house with animals', Computer -shut everyone out of room and go on computer', 'Any river with fishing -Derwent type', 'On the golf course', 'Our Garden', 'Outside', 'My Garden', 'My house in the winds', 'At home', 'House in France –rural', 'Beach after dark in winter -fishing for cod', 'in the bath', 'Out on the Hills', 'Down the Woods', 'Bed at night (electric blanket)', 'Church Yards', 'Countryside', 'Fields', 'The woods and hills', '-At home (esp. when birds are singing)', 'In the hills', 'Out at sea in a boat by self', 'Bedroom', 'Garden/gardening', 'Bedroom (-its mine -keep everybody out)', 'In garden -lovely garden', 'Pigeon Loft -with nature', 'Home', 'My Garden Spinning - utter tranquillity My home', 'Garden -sunny or cold, crisp own space Weardale', 'my bedroom', 'Sitting at bottom of my garden -alone or with others -just being there', '-Garden -somewhere with water', 'Walking around natural parks -other people with me', 'Walking around natural parks -other people with me', 'top of hill -soothing -space all around', 'Coastal -boats, mariners etc. Fishing villages, watching people fishing.', 'Countryside -lake, hillside -visual, scenery -natural sounds, sounds of nature', 'Ancient woods mixed', 'Woods near home -peace and quiet -open space and enclosed -stream -has everything', 'Home -its ours, family home', 'Woodland Dream? -Spring April/May -alone/family', and 'River'.

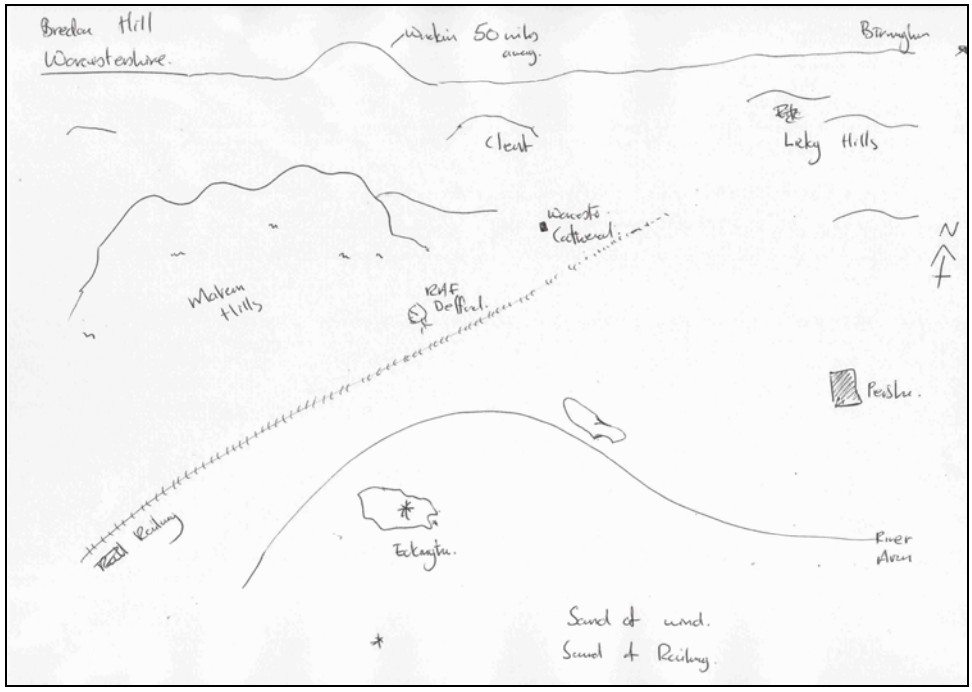


Figure 28: depictions of tranquillity in the PA sessions

Others suggested 'I know when I need to be tranquil and it might only need to be for ten minutes – I can go to the park I can go to my back yard I can sit in my attic and look at the sky', 'top of a tree with a nice view countryside – fields (tree surgeon) –this is my job', 'in my bedroom in the morning in bed', sunny and warm seaside or countryside – quiet happy on my own', at home – there is no traffic "taking off the tie is symbolic" have a helter skelter job so at home and relax – animals – horses vdogs and chickens – its quiet', 'I am tranquil when im in the fields and trees countryside – sitting warm, sun shining', 'I am tranquil when I am in the countryside streams fields and hills, not mountains – with husband', 'I am most tranquil when I am asleep', 'at home playing with friends, 'school – I work in a school I am calm and relaxed at school when kids are there', 'peace and quiet in the fields – sitting in green field – hear the birds singing', 'my bedroom anytime', in the tub when children asleep, and 'in the spa alone'.

4.0 GIS Methodology

4.1 Introduction

Tranquillity is, as has been referred to previously, a complex concept. It does not lend itself to a neat and universally acceptable definition. The approach adopted in this project has been to conduct highly qualitative consultation work (using the Participatory Appraisal approach, as set out in section four) which has ultimately provided information that can be grouped under the following headings:

- Whether tranquillity is important
- Why tranquillity is important
- What state of mind and experiences tranquillity is associated with
- What activities tranquillity is most associated with
- What visual things are positively associated with tranquillity
- What visual things are negatively associated with tranquillity
- What noises are positively associated with tranquillity
- What noises are negatively associated with tranquillity
- What specific geographical areas are identified as being relatively tranquil

The information from the PA consultation was highly differentiated and very qualitative, reflecting (a) the highly personal nature of judgements about environmental quality and meaning, and (b) the fact that scaled, quantitative or categorical responses usually require the researcher to use some external frame of reference such as a Likert Scale[14], something which the PA approach rejects. Instead, respondents were encouraged to express their judgements about the composition and value of tranquil areas in terms that were meaningful to them, through their own expression. GIS, however, requires that data are both geographically referenced and expressed in terms that are categorised or quantified in some way. This necessarily meant that the researchers had to make judgements about how to group and categorise responses, in order for them to inform the GIS model. This external manipulation of PA data does not necessarily fit comfortably with the PA approach. Despite this tension, however, it represents a significant step forward from previous tranquillity mapping approaches which did not connect the methodology with the views of countryside users and key stakeholders.

4.2 Overview of the GIS Model

4.2.1 Some Comments on GIS Modelling in this Context

GIS models are driven by the datasets that are included, the operations that are performed on them and the parameters that are set for those operations. As such they are constructed and driven by their users, and there is an extensive literature on the political aspects of GIS applications in decision support. The literature review has set out one of the criticisms of previous work in this area, that the models (both the conceptual models of tranquillity and GIS-based models of how to map it) were constructed on expert judgements alone. This study has used the results of the PA consultation work, wherever possible, to directly inform the parameters of the model, but it is inescapable that there have been a series of judgements about how best to 'operationalise' the consultation results, through the selection of data and the operations or tools to work on them. Our response to this problem is one of transparency; this report aims to set out precisely what we did, thereby permitting a debate to adapt the methodology for future work as required.

[14] A rating scale measuring the strength of agreement towards a set of statements.

Theory building and model building necessarily require a level of abstraction and generalisation from the complexity and the diversity of the real world.

> *A model may be thought of as a simplified conceptualised representation of reality. In its simplest form, a model may be considered a classification system... Scientific investigation, however, usually requires the use of more elaborate model concepts, the aim of which is to develop a structural representation of reality of sufficient accuracy to allow experimentation and a more penetrating analysis of the relevant variables in any real life situation* (Harvey, 1966, p.373).

Flowerdew (1989), reviewing a number of definitions of the term 'model', concludes that the most fundamental characteristic of a model is selectivity. 'Modelling is therefore a method of representing a complex state of affairs by reducing it to something simpler which embodies as many as possible of what the modeller sees as its most important characteristics' (p.245). The significance of what Flowerdew terms 'the modeller' is all-important in making decisions about how to interpret, classify and apply data in a model. This runs counter to one of the underpinnings of PA as a consultation approach, that individuals' 'voices' should be treated as they are recorded and be subjected to a minimum of external interpretation.

When the subject of the model is human interpretation of, or behaviour in, the landscape, the difficulties are more acute. Writing nearly 40 years ago, with specific reference to models of economic and transportation behaviour, Haggett suggested that 'perhaps the biggest barrier that model builders... will have to face in the immediate future is an emotional one. It is difficult to accept that... as individuals we suffer the indignity of following mathematical patterns in our behaviour' (1965, p.109). This model is not predictive, so the problems are not those of trying to abstract diverse behaviours into robust and reliable models of aggregate behaviour. However, it experiences the same essential difficulty, that of deciding how to classify diverse responses into a more general set of abstracted judgements about environmental qualities.

It is important to recognise that this methodology does not identify tranquil areas, but rather a spectrum or continuum of more or less tranquil areas, in common with previous research in related areas (Fritz and Carver, 1998). It identifies areas which have relatively more or less of the important characteristics that are associated with tranquillity, but drawing a line on the maps and stating that the area inside is tranquil and the area outside is not is to take a leap that is not justified on the basis of the consultation data on which the GIS model is based. It may be the case that there is pressure to identify such areas, and there are a range of reasons why this may be the case, as has led to the identification of 'wild land' elsewhere in the UK (Carver *et al.*, 2002), but this methodology does not provide a quantified 'answer' to the question of what is tranquillity. It does however establish a basis for identifying the most tranquil areas of a defined study area.

The point of a *defined study area* is important. Final results of the analysis appear in section 4.7, but it is perhaps predictable that the NNP 'scores' more highly, is rated as being relatively more tranquil overall, and certainly in places, than the WDC study area. Reference to Figure 75 quickly show that the potential to escape noise, other people and find a 'more natural' landscape (the three main parameters of the GIS model) is much greater within the NNP than in the WDC. Although the calculations sought to include, wherever possible, relevant factors from outside of the study area boundaries (for instance visibility of artificial structures, distance to urban areas or noise from railways), the fact is that the most highly tranquil areas are judged relative to and only to the remainder of a defined study area. Figure 29 outlines some of the implications of this. If, for instance the NNP and WDC study areas had been contrasted (using the same parameters and datasets in the GIS model) with the urban fringe of Birmingham or the Flow Country in Northern Scotland their *absolute* values

would have been the same, but their *relative* values may have been rather different. This is both a cartographic issue (Monmonnier, 1996) and a decision-political issue in respect of how such maps and associated information are used.

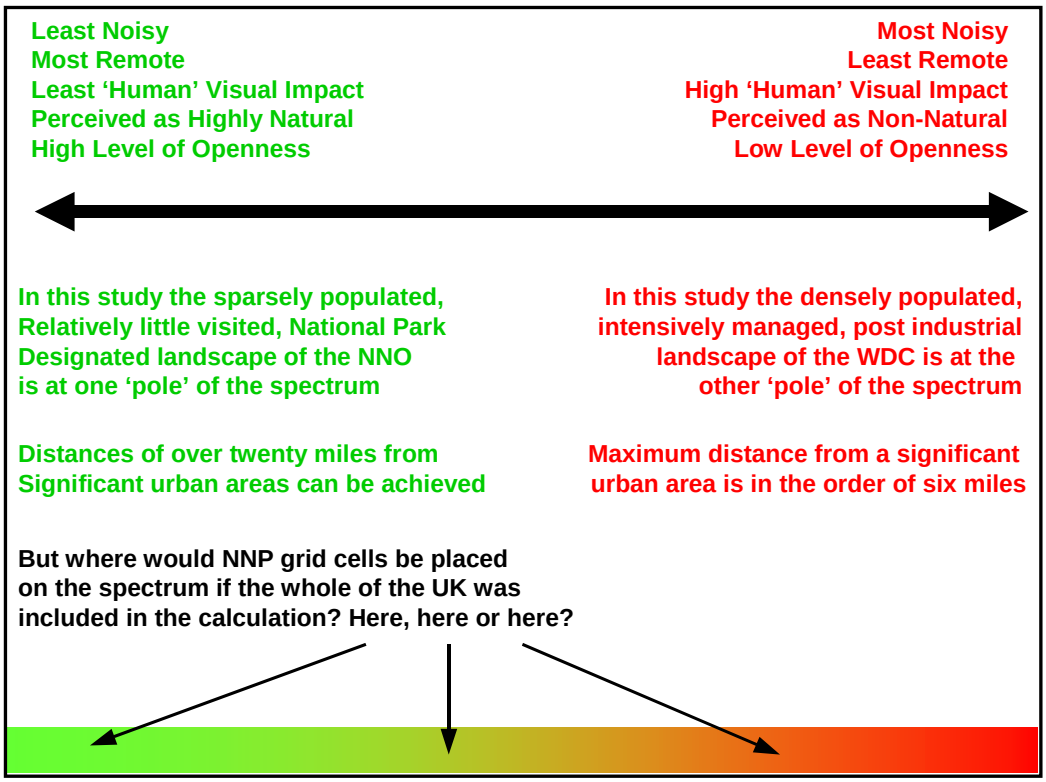


Figure 29: The Significance of Relative Values on the Tranquillity Spectrum

So, relatively tranquil areas are judged relative to the range of available data. If data were available for the whole of the UK it would reasonable be expected that the final relative tranquillity maps from this research would look rather different for both the WDC and the NNP. In order for readers to better appreciate this issue, final maps of relative tranquillity have been created (see section 4.7) for:

a) both study areas: the least tranquil areas are in the WDC and the most tranquil are in the NNP, so relative tranquillity is identified on a scale from these maximum and minimum values. This implication is that the NNP is, on aggregate, a much more tranquil area than the WDC. Although this is likely to be accepted as a reasonable result, it is very difficult to identify the relatively most tranquil areas within the WDC especially.

b) the West Durham Coalfield: the fact the other areas (restricted in this study to the NNP) may be relatively more tranquil than the WDC, analysing only those results for the WDC area permits the relatively most and least tranquil areas *within* the WDC to be identified. This is important, for instance in identifying the locally most significant areas where tranquillity is most likely to be experienced.

c) the Northumberland National Park: in common with (b) this identifies the relatively most and least tranquil areas within the NNP area alone. This is important, for instance in identifying the specific areas and associated causes (as determined in the GIS model) of diminished tranquillity.

4.2.2 General Structure of the GIS Model

Both positive and negative factors are considered in this approach, that is factors that contribute to and factors that detract from tranquillity. The GIS model is comprised of a series of different components and sub-components. These are introduced here and detailed in full in the remainder of section 4. The methodological description of the model is organised around three main themes:

- People and Tranquillity
- Landscape and Tranquillity
- Noise and Tranquillity

However these are thematic categories and the reality is that the negative and positive factors cut across these categories. For instance the landscape category includes positive elements such as perceived naturalness and negative elements such as skyglow and visibility of overt human development. Figure 30 provides a general overview of the interaction of the positive and negative elements in the model.

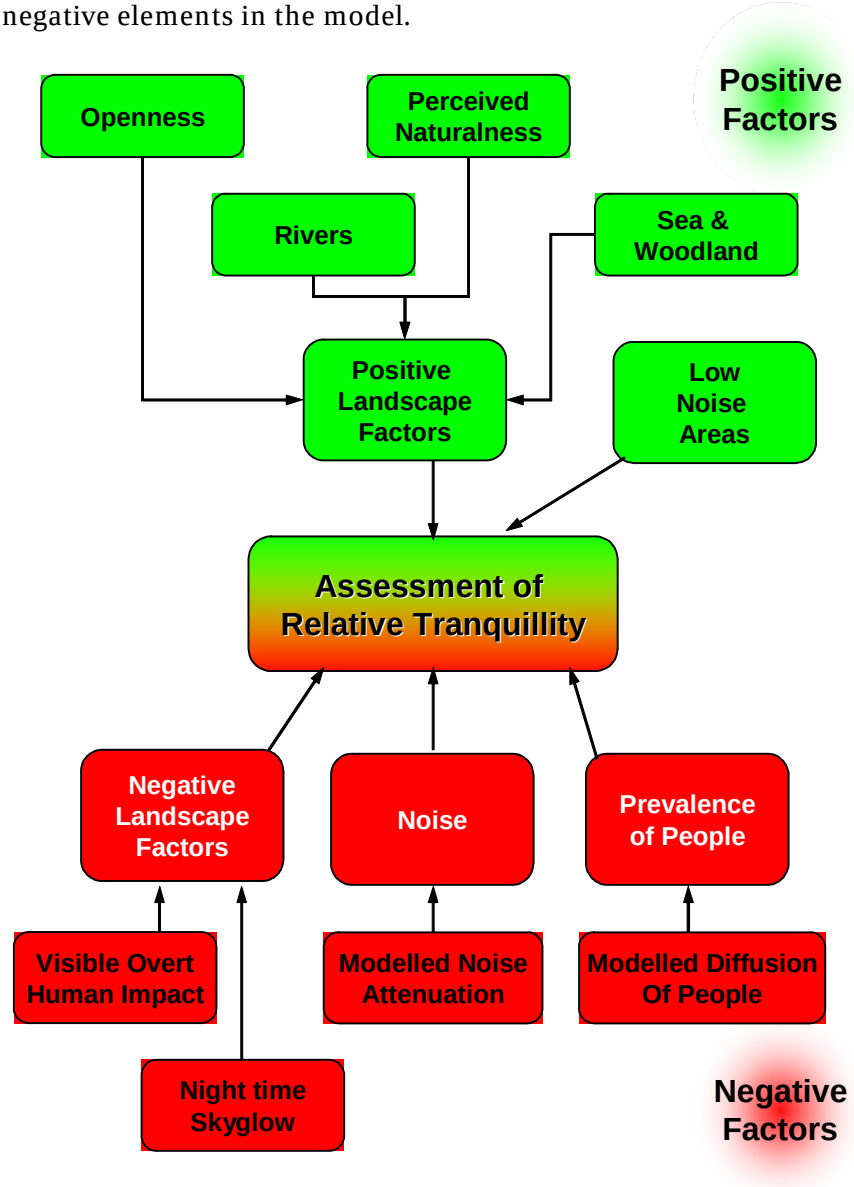
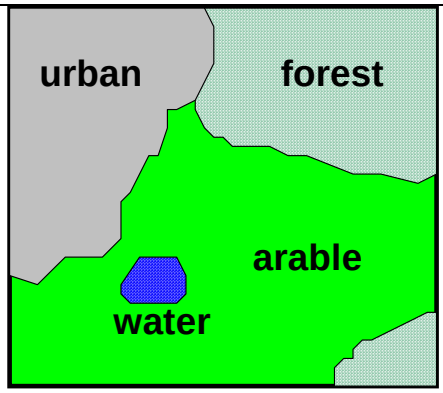


Figure 30: General Overview of the GIS Model

Behind each component of the model there were a range of datasets and a series of techniques and operations were applied to the data using the ArcGIS 8.3 system with the Spatial Analyst extension. The key GIS terms and tools that were used in the model are set out below, and they are explained more fully in the text where it is appropriate. However, readers are encouraged to consult a GIS text such as Longley *et al.* (2001) if further details are required.

<table>
<tr><td>Vector</td><td>A data format in which spatial features are represented by points, lines and areas (see right). Each feature (e.g. a section of road, a power pylon or an area of woodland) can be associated with a range of attributes such a length, class, usage level, age or species mix.</td><td> 
</td></tr>
<tr><td>Raster</td><td>A data format in which spatial features are represented through values on a regular grid framework. The grid is made up of grid cells, or pixels, which have a defined spatial resolution or size. In this study the pixel size for all data was 250m x 250m. Raster data tend to be less geographically precise (see right) that vector data, but they have the key advantage of being able to support a range of continuous values rather than sharply bounded binary or multiple classifications.</td><td><table>
<tr><td>U</td><td>U</td><td>F</td><td>F</td></tr>
<tr><td>U</td><td>U</td><td>A</td><td>F</td></tr>
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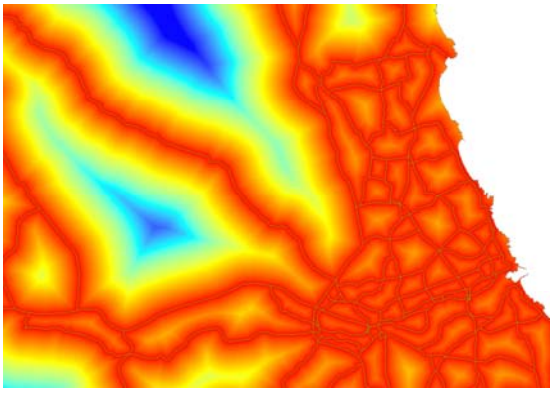
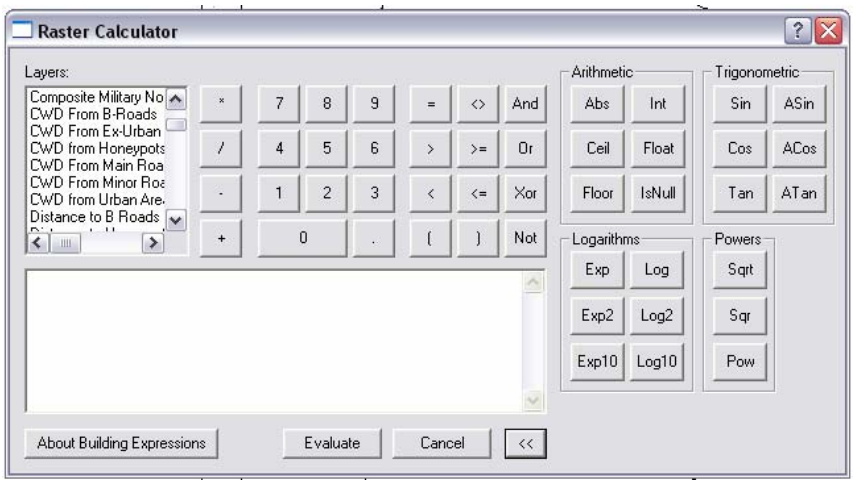
<tr><td>A</td><td>A</td><td>A</td><td>F</td></tr>
</table></td></tr>
<tr><td>Reclassification</td><td colspan="2">Reclassification is a technique whereby one set of values can be replaced by another set of values. It was extensively used in this project to convert a spread of raster cell values (say from 1 to 19,076) to a standard data range of one to ten. Equal interval classification was used throughout this project.</td></tr>
<tr><td>Distance Calculations</td><td colspan="2">Distance calculations using the raster format calculate values for each grid cell which represent the distance that grid cell is away from the nearest of the defined start layers. For instance the map below shows a distance calculation away from primary and A roads in Tyne and Wear and South Northumberland.
  </td></tr>
</table>

Cost Weighted Distance (CWD) Calculations	CWD calculations are described in 5.6.3, but in essence they calculate the cost of getting to a grid cell where the cost is a function of both the absolute distance and also the characteristics of the underlying landscape, which is in turn represented by a second raster layer.
Inter-Visibility Analysis	IVA is described in section 5.7.7. It is a technique which used a Digital Terrain (or Elevation) Model to calculates whether cells can be seen from each other. This can be extended to calculate the relative visibility of features such as roads or urban areas in the surrounding landscape or indeed the relative openness of the landscape as a whole.
Weighting	Not all factors are considered as equal in determining the final tranquillity map, and a process of weighting was used to different their relative priority in the GIS model. As a simple example if two variables were scored from one to ten but the second variable was judged to be twice as important, the values would be reclassified as follows: 1 reclass as 2 2 reclass as 4 3 reclass as 6 4 reclass as 8 5 reclass as 10 6 reclass as 12 7 reclass as 14 8 reclass as 16 9 reclass as 18 10 reclass as 20 This could be achieved by simply multiplying the originally scaled factor by two in the raster calculator (see below).
Raster Calculator	The Raster Calculator is a tool within Spatial Analyst and ArcGIS 8.3 that permits individual raster layers to be operated on mathematically (e.g. multiplied by a given number) or combined (e.g. layer one plus layer two). This process is sometimes termed 'mapematics' and when a series of such combination and/or mathematical operations are combined in a structured format the process is termed a cartographic model. The interface for the ArcGIS 8.3 Raster Calculator appears below. 

Key GIS Terms and Techniques used in the Report

The raster cell resolution adopted for this study was 250m x 250m. This was judged to be a tradeoff between a higher level of spatial resolution which would have given rise to more finely grained results, and the computing demands of carrying out all of the component calculations and classifications that result in the final model. Although 250m x 250m is a significant size on the ground it is worth bearing in mind that there are sixteen such cells in a 1km x 1km cell, the spatial resolution of previous research in this area.

4.3 Linking the PA Results and GIS Model

4.3.1 Overview

GIS are tools for the management, analysis and mapping of quantitative or categorical data. Most of the data used in this research fall comfortably within this description, for instance terrain, landcover, population and infrastructure datasets. However, these are just the source data for the model and what is done to and with the source datasets is driven, in aggregate, by the value judgements of consulted individuals. PA is a consultation approach that usually generates highly qualitative data, and the ethos of the approach is that analysis that infers meaning from the data or otherwise imposes externally (i.e. not by the person(s) whose views are being considered) generated categories is at best undesirable. At face value linking the two would seem problematic to the point that it is not viable. What has been termed 'Qualitative GIS' (Aitken, 2001) has made some inroads into these kinds of problems of aggregating and analysing individuals' 'voices', and there is an ongoing debate into whether 'data rich' or 'meaning-rich' approaches are the most fruitful for GIS applications in planning and related activities. As discussed previously this research is premised on a rejection of expert judgements as the *sole* basis for defining tranquillity. Therefore a wider evidence base was developed through consultation and it was a pragmatic decision to "analyse" the PA data, apply categories to them and then use this evidence to construct the GIS-based model. The model has been informed as far as possible by the PA data, but additional judgements were needed to inform the precise requirements of the GIS model.

The linkage between the PA results and the GIS model is twofold:

1. defining what GIS datasets (e.g. digital elevation model and transport network) and derived datasets (e.g. relative visibility of the road network from the landscapes of the study areas) are applicable in the identification of relatively tranquil areas;
2. defining the relative weighting that is accorded to each dataset, or component of the model. As a point of principle, 'expert' decisions about what to include and what relative weightings to allocate have been kept to an absolute minimum and the results of the consultation work are used to define the parameters of the model wherever possible.

Although table 9 is extremely lengthy it is included in this main technical report for the sake of completeness. It sets out all of the summary information from the verification events, ranked from the most significant variables at the top, to those which were judged to be the least significant at the bottom.

Section 4.1 sets out in general terms how the PA data from consultation events are "thematised", collated and organised. Described here in more detail are the stages which were employed in the stages following the PA verification, primarily revolving around recognising that those responses or themes that recorded very high scores (number of dots) may have done so because verification event 'voters' had less options to choose from in some categories than others (see Table 8).

In essence, calculations had to be made to identify the relative significance of different scores when judged against the range of options that were open to those allocating scores within the verification events.

Calculating the probability of options to dots combinations

The probability relationship between the variable number of options within categories and the fixed number of choices people had to make (6 dots) needed to be accounted for. The ratio of options (variable) to choices (fixed) was different between categories, so the number of possible combinations was very different, something that needed to be quantified using a factorial equation to assess the probability of any given choice being made. The equation is:

$$^{n}C_{r} = \frac{n!}{(n - r)!}$$

Where

C is the number of combinations
r is the number of permitted choices (in this case three per category at verification)
n is the number of options to choose from per category at verification
! indicates factorial (e.g. 5! Is 5 x 4 x 3 x 2 x 1 = 120)

This gave a yardstick against which the actual distribution of choices could be measured and the most significant variables could be identified.

Calculating the expected number of dots per option

Following this, the number of dots that would be expected per option if they were evenly distributed, for the known (111) number of verification participants was calculated. This then provided a yardstick against which the actual scores allocated per option could be measured.

Category	What is tranquillity?	Coefficient (Dots per item)	People scoring	Expected dots per option	What is not tranquillity?	Coefficient (Dots per item)	People scoring	Expected dots per option
You hear…	19	0.32	111	36	16	0.38	111	42
You do not hear…	20	0.3	111	33				
Of the mind…	59	0.1	111	11				
Doing…	38	0.16	111	18				
You see…	120	0.05	111	6	82	0.07	111	8
You do not see…	38	0.16	111	18				
Experiencing…	18	0.33	111	37				

Table 8: Calculating expected dots per item

Associating specific scored responses with datasets

The individual scored responses were then associated with specific datasets, wherever possible. In table 9 the final column shows which dataset was associated. The blank entries are those which were judged not possible to associate with any specific dataset. Necessarily a level of judgement was required in this process of dataset association and in doing so a level of potential error is introduced for the reason that the assumption of the analyst about the

meaning of the original consultee may be wrong. Further information on this appears in subsequent sections, but for instance under the (remoteness from) people element a large number of responses that related not to the presence of people *per se*, but to behavioural characteristics and things that are caused a sub-set of any group of people. Thus vandalism, loutish behaviour, litter and dog dirt are all associated with people, based on the assumption that such signs and behaviours are wholly associated with people, and as the distribution of the more antisocial countryside users is known the crude association between all people and the actions of a few is taken.

Question	Theme	Answer	Total Score	Expected dots per option	Weighted Score	DATASET
What is not Tranquillity?	You see....	Vandalism	51	8	6.38	People
What is not Tranquillity?	You see....	Loutish behaviour	50	8	6.25	People
What is tranquillity?	You see...	the sea	35	6	5.83	Visibility Sea
What is tranquillity?	You see...	the landscape	34	6	5.67	Openness
What is tranquillity?	You do not see...	traffic	93	18	5.17	Visibility roads
What is tranquillity?	You do not see...	rubbish	88	18	4.89	People
What is not Tranquillity?	You see....	Hooligans	38	8	4.75	People
What is tranquillity?	You see...	countryside	27	6	4.50	Openness
What is not Tranquillity?	You see....	Pollution	34	8	4.25	People
What is tranquillity?	You see...	wildlife	25	6	4.17	
What is tranquillity?	You see...	rivers	24	6	4.00	Rivers
What is not Tranquillity?	You see....	Litter	31	8	3.88	People
What is tranquillity?	You see...	wild landscapes	23	6	3.83	Perceived naturalness
What is tranquillity?	You see...	natural landscape	22	6	3.67	Perceived naturalness
What is tranquillity?	Of the Mind....	At peace with myself	40	11	3.64	
What is tranquillity?	Of the Mind....	No stress	40	11	3.64	
What is not Tranquillity?	You see....	Dog dirt	29	8	3.63	People
What is tranquillity?	Doing....	Walking	64	18	3.56	
What is tranquillity?	Of the Mind....	Feeling of well being	39	11	3.55	
What is tranquillity?	You see...	open spaces	21	6	3.50	Openness
What is tranquillity?	Of the Mind....	Calm mind and body	37	11	3.36	
What is tranquillity?	You see...	lots of trees	20	6	3.33	Perceived naturalness
What is tranquillity?	You see...	babbling brooks	20	6	3.33	Rivers
What is tranquillity?	You see...	lapping waves on shore	20	6	3.33	Rivers
What is tranquillity?	You see...	sunset/sunrise	20	6	3.33	
What is tranquillity?	Of the Mind....	Being among nature	34	11	3.09	Perceived naturalness
What is tranquillity?	You see...	nature	18	6	3.00	Perceived naturalness
What is tranquillity?	Of the Mind....	Peace of mind	33	11	3.00	
What is tranquillity?	You Hear....	Sound of water, rivers and waves	104	36	2.89	Rivers
What is tranquillity?	You see...	stream (slow flowing)	17	6	2.83	Rivers
What is tranquillity?	You see...	greenery	17	6	2.83	Perceived naturalness
What is tranquillity?	You see...	wild flowers	17	6	2.83	Perceived naturalness
What is tranquillity?	You see...	open space without people	17	6	2.83	People
What is tranquillity?	You see...	rolling countryside	16	6	2.67	Openness
What is tranquillity?	You see...	woodlands	16	6	2.67	Perceived naturalness
What is tranquillity?	You see...	the stars	16	6	2.67	Light pollution
What is tranquillity?	You Hear....	Natural sounds	95	36	2.64	Quiet areas
What is tranquillity?	You Hear....	Peace and quiet	93	36	2.58	Quiet areas
What is tranquillity?	Of the Mind....	Can sleep, not disturbed	28	11	2.55	
What is tranquillity?	Doing....	Things I enjoy with friends and family	45	18	2.50	
What is not Tranquillity?	You see....	Fly tipping	20	8	2.50	People
What is not Tranquillity?	You see....	Rubbish	20	8	2.50	People

What is tranquillity?	Of the Mind....	Empathy with surroundings	27	11	2.45	
What is tranquillity?	You see...	a beautiful rainbow	14	6	2.33	
What is tranquillity?	You see...	forest	14	6	2.33	Perceived naturalness
What is tranquillity?	You Hear....	The sea	79	36	2.19	
What is tranquillity?	You see...	emptiness – not "stuff" going on	13	6	2.17	People
What is tranquillity?	You see...	stillness	13	6	2.17	Quiet areas
What is tranquillity?	You see...	quiet farming landscape	13	6	2.17	Quiet areas
What is tranquillity?	You see...	flowers in my garden	13	6	2.17	
What is tranquillity?	You see...	no sign of civilisation	13	6	2.17	Perceived naturalness
What is tranquillity?	You see...	birds	13	6	2.17	
What is tranquillity?	You see...	country villages	13	6	2.17	
What is tranquillity?	You see...	waterfalls	13	6	2.17	Rivers
What is not Tranquillity?	You see....	Multi-story car parks	17	8	2.13	Perceived naturalness
What is tranquillity?	Of the Mind....	Having a place that belongs to you	23	11	2.09	
What is tranquillity?	Of the Mind....	Silence to think, just be...	23	11	2.09	Noise
What is tranquillity?	You see...	hill forts, settlements, roman ruins	12	6	2.00	
What is tranquillity?	You see...	no main roads	12	6	2.00	Visibility roads
What is tranquillity?	You see...	valleys and hilltops	12	6	2.00	Openness
What is tranquillity?	You Don't Hear....	Ghetto blasters/radios	65	33	1.97	People
What is tranquillity?	You Don't Hear....	Mobile phones	65	33	1.97	People
What is tranquillity?	Doing.... Additional	enjoying the landscape	35	18	1.94	
What is tranquillity?	Of the Mind....	Sit in quiet and listen to god speak	21	11	1.91	
What is tranquillity?	Of the Mind....	Unhurried	21	11	1.91	
What is not Tranquillity?	You hear...	mobile phones	79	42	1.88	People
What is not Tranquillity?	You see....	Drunken teenagers	15	8	1.88	People
What is tranquillity?	Experiencing...	warmth, sun on skin, soft sunshine (not burning sun)	69	37	1.86	
What is tranquillity?	You do not see...	bigots	33	18	1.83	People
What is tranquillity?	You see...	animals	11	6	1.83	
What is tranquillity?	Of the Mind....	Away from it all...	20	11	1.82	People
What is not Tranquillity?	You see....	Motorways	14	8	1.75	Visibility roads
What is not Tranquillity?	You do not see...	vehicles	14	8	1.75	Visibility roads
What is tranquillity?	Doing.... Additional	doing what I want to do	30	18	1.67	
What is tranquillity?	You see...	pleasant surroundings	10	6	1.67	
What is tranquillity?	You see...	remoteness	10	6	1.67	People
What is tranquillity?	You see...	far horizons	10	6	1.67	Openness
What is tranquillity?	You Don't Hear....	Car noise	54	33	1.64	Road noise
What is tranquillity?	Of the Mind....	Serenity within	18	11	1.64	
What is tranquillity?	Of the Mind....	An area you can visit to leave all your troubles behind	18	11	1.64	
What is tranquillity?	Of the Mind....	Away from stress of work and day to day pressures	18	11	1.64	
What is tranquillity?	Of the Mind....	Remembrance of a special place and special moment	18	11	1.64	
What is tranquillity?	Of the Mind....	Time for thoughts	17	11	1.55	
What is tranquillity?	Of the Mind....	Space to reflect	17	11	1.55	
What is tranquillity?	Experiencing...	getting away from it all	57	37	1.54	People
What is not Tranquillity?	You see....	Plastic bags	12	8	1.50	People
What is not Tranquillity?	You see....	Anger	12	8	1.50	
What is tranquillity?	You see...	soft lines in the landscape e.g. skylines, stones. Rocks. Vegetation, old vernacular buildings	9	6	1.50	Perceived naturalness
What is tranquillity?	Of the Mind....	A feeling, not specific space	16	11	1.45	
What is tranquillity?	You do not see...additional	pylons/mobile phone masts (not tranquil at all)	26	18	1.44	Visibility structures
What is tranquillity?	Doing....	Camping	26	18	1.44	

What is tranquillity?	You Don't Hear....	Motorbikes	46	33	1.39	Road noise
What is tranquillity?	You Hear....	Sounds of curlew, lapwing, skylark	50	36	1.39	Quiet areas
What is not Tranquillity?	You see....	Over commercialisation	11	8	1.38	Visibility urban
What is not Tranquillity?	You see....	Too many people	11	8	1.38	People
What is not Tranquillity?	You see....	Irritating drunks	11	8	1.38	People
What is not Tranquillity?	You see....	Something that intrudes	11	8	1.38	Perceived naturalness
What is tranquillity?	You Don't Hear....additional	the alarm	45	33	1.36	
What is tranquillity?	Of the Mind....	Perfect peace	15	11	1.36	Quiet areas
What is tranquillity?	Of the Mind....	Stillness	15	11	1.36	Quiet areas
What is tranquillity?	Of the Mind....	Getting away from it all	15	11	1.36	
What is tranquillity?	You see...	beach in the sun with a pint of larger	8	6	1.33	
What is tranquillity?	You see...	unspoilt and traditional	8	6	1.33	Perceived naturalness
What is tranquillity?	You see...	long distance visibility	8	6	1.33	Openness
What is tranquillity?	You see...	a green place	8	6	1.33	Perceived naturalness
What is tranquillity?	Experiencing... additional	the sight of wildlife behaving naturally (animal and plant)	49	37	1.32	
What is tranquillity?	Experiencing...	sunshine	48	37	1.30	
What is not Tranquillity?	You hear...	noisy people	54	42	1.29	People
What is tranquillity?	Doing....	Gardening	22	18	1.22	
What is tranquillity?	Doing....	Hiking	22	18	1.22	
What is tranquillity?	You Hear....	Silence	43	36	1.19	Quiet areas
What is tranquillity?	Experiencing...	feeling like miles away from anywhere	44	37	1.19	People
What is tranquillity?	Of the Mind....	Calm relaxation with others/alone	13	11	1.18	People
What is tranquillity?	Of the Mind....	Being comfortable	13	11	1.18	
What is tranquillity?	You do not see...	burning tyres	21	18	1.17	
What is tranquillity?	Doing.... Additional	having access to tranquil places	21	18	1.17	
What is tranquillity?	Doing.... Additional	no particular thing to do	21	18	1.17	
What is tranquillity?	You see...	old buildings	7	6	1.17	
What is tranquillity?	You see...	safe places to run around	7	6	1.17	
What is tranquillity?	You see...	scenery	7	6	1.17	Perceived naturalness
What is tranquillity?	You see...	rivers running	7	6	1.17	Rivers
What is tranquillity?	You see...	to see my friends where I'm going	7	6	1.17	
What is tranquillity?	You see...	a job well done	7	6	1.17	
What is tranquillity?	You Don't Hear....	People shouting	38	33	1.15	People
What is not Tranquillity?	You see....	Cars	9	8	1.13	Visibility roads
What is not Tranquillity?	You see....	Light pollution	9	8	1.13	Light pollution
What is not Tranquillity?	You see....	Pylons	9	8	1.13	Visibility structures
What is not Tranquillity?	You see....	House estates	9	8	1.13	Visibility urban
What is not Tranquillity?	You see....	Sister coming in bedroom – making mess	9	8	1.13	
What is not Tranquillity?	You hear...	car noise	47	42	1.12	Road noise
What is not Tranquillity?	You hear...	unnecessary noise	47	42	1.12	Noise
What is tranquillity?	Doing....	Sitting by the fire	20	18	1.11	
What is tranquillity?	Of the Mind....	Relaxing	12	11	1.09	
What is tranquillity?	Of the Mind....	Escape from people – human interference	12	11	1.09	People
What is tranquillity?	Experiencing...	stillness	40	37	1.08	Noise
What is tranquillity?	You Don't Hear....	Industrial sounds	35	33	1.06	Noise
What is tranquillity?	Doing.... Additional	pottering in the garden	19	18	1.06	
What is tranquillity?	You Hear....	Wind through leaves	37	36	1.03	
What is tranquillity?	Doing.... Additional	whatever gives time to think – calm mind	18	18	1.00	
What is not	You see....	Beer cans	8	8	1.00	People

Tranquillity?						
What is not Tranquillity?	You see....	Commercial rubbish	8	8	1.00	Visibility urban
What is not Tranquillity?	You see....	Over management	8	8	1.00	Perceived naturalness
What is not Tranquillity?	You see....	Things outside your control	8	8	1.00	
What is tranquillity?	You see...	open space for children	6	6	1.00	
What is tranquillity?	You see...	single malt whiskey drank in a quiet glen in Scotland	6	6	1.00	
What is tranquillity?	You see...	lots of space	6	6	1.00	Openness
What is tranquillity?	You see...	sky larks	6	6	1.00	
What is tranquillity?	You see...	distant mountains	6	6	1.00	Openness
What is tranquillity?	You see...	dales	6	6	1.00	Openness
What is tranquillity?	You see...	clean areas	6	6	1.00	
What is tranquillity?	You see...	protected coastline	6	6	1.00	
What is tranquillity?	Of the Mind....	Sense of well being	11	11	1.00	
What is tranquillity?	You do not see...	signs of man's interference	17	18	0.94	Perceived naturalness
What is tranquillity?	You do not see...	development	17	18	0.94	Perceived naturalness
What is tranquillity?	Doing.... Additional	resting in a relaxed manner	17	18	0.94	
What is tranquillity?	Doing.... Additional	good sex	17	18	0.94	
What is tranquillity?	Doing....	No work	17	18	0.94	
What is tranquillity?	You Don't Hear....	Aircraft noise	31	33	0.94	Aircraft noise
What is not Tranquillity?	You hear...	sound of blasting music	39	42	0.93	People
What is tranquillity?	Of the Mind....	Not being bothered	10	11	0.91	
What is tranquillity?	Of the Mind....	An emotional response rather than a physical description	10	11	0.91	
What is tranquillity?	Experiencing... additional	inner calm, not always external	33	37	0.89	
What is tranquillity?	Doing.... Additional	cycling in the country	16	18	0.89	
What is tranquillity?	You Don't Hear....	Loud music	29	33	0.88	People
What is not Tranquillity?	You see....	Industry	7	8	0.88	Perceived naturalness
What is not Tranquillity?	You see....	High rise buildings	7	8	0.88	Perceived naturalness
What is tranquillity?	You Don't Hear....	Dogs barking	28	33	0.85	People
What is tranquillity?	Doing.... Additional	(reading) a consuming novel	15	18	0.83	
What is tranquillity?	Doing.... Additional	drinking wine on a hillside in the sun	15	18	0.83	
What is tranquillity?	Doing....	Knowing god (through Jesus Christ)	15	18	0.83	
What is tranquillity?	You Hear....	Music	30	36	0.83	People
What is tranquillity?	You see...	otters	5	6	0.83	
What is tranquillity?	You see...	wilderness	5	6	0.83	Perceived naturalness
What is tranquillity?	You see...	seats out of tree trunks	5	6	0.83	
What is tranquillity?	Of the Mind.... Additional	having done all I could and being satisfied I can't do any more	9	11	0.82	
What is tranquillity?	Of the Mind....	Escape life's hustle and bustle	9	11	0.82	
What is tranquillity?	Of the Mind....	Thinking space	9	11	0.82	
What is tranquillity?	Of the Mind....	Different rhythm to urban life	9	11	0.82	
What is tranquillity?	Experiencing... additional	pure enjoyment of surroundings	29	37	0.78	
What is tranquillity?	You do not see...	barbed wire	14	18	0.78	
What is tranquillity?	You do not see...	council estate	14	18	0.78	Visibility urban
What is tranquillity?	Doing....	Bird watching	14	18	0.78	
What is tranquillity?	You Don't Hear....additional	loud engine noise	25	33	0.76	Noise
What is not Tranquillity?	You see.... Additional	charvas	6	8	0.75	People
What is not Tranquillity?	You see....	Mess	6	8	0.75	
What is not Tranquillity?	You see....	Mobile telephone masts	6	8	0.75	Visibility structures
What is tranquillity?	Of the Mind....	From within calm	8	11	0.73	
What is tranquillity?	You do not see...	motorbikes	13	18	0.72	Road noise

What is tranquillity?	Doing.... Additional	floating in a calm sea	13	18	0.72	
What is tranquillity?	You Hear....	Wildlife	25	36	0.69	Quiet areas
What is tranquillity?	You do not see...	other people	12	18	0.67	People
What is tranquillity?	You see... additional	a beautiful rainbow	4	6	0.67	
What is tranquillity?	You see...	deciduous trees not firs	4	6	0.67	Perceived naturalness
What is tranquillity?	You see...	the green colours	4	6	0.67	
What is tranquillity?	You see...	deer	4	6	0.67	
What is tranquillity?	You see...	you see no threats	4	6	0.67	
What is tranquillity?	You see...	low population density	4	6	0.67	Visibility urban
What is tranquillity?	You see...	church history scenery	4	6	0.67	
What is not Tranquillity?	You hear...	noisy motorbikes	27	42	0.64	Road noise
What is tranquillity?	You Hear....	Birds	23	36	0.64	Quiet areas
What is tranquillity?	Of the Mind.... Additional	safe (mentally)	7	11	0.64	
What is tranquillity?	Of the Mind....	Home	7	11	0.64	
What is tranquillity?	Of the Mind....	Switched off	7	11	0.64	
What is not Tranquillity?	You see.... Additional	traffic rather than individual vehicles	5	8	0.63	Visibility roads
What is not Tranquillity?	You see....	Exhaust fumes	5	8	0.63	Visibility roads
What is tranquillity?	Experiencing... additional	knowing you have done it well and couldn't do it any better – so can now move on to something new	23	37	0.62	
What is not Tranquillity?	You hear... additional	bad music	26	42	0.62	
What is tranquillity?	You do not see...additional	supermarkets	11	18	0.61	Visibility urban
What is tranquillity?	You Don't Hear....	Loud children	20	33	0.61	People
What is not Tranquillity?	You hear...	radios loud	24	42	0.57	People
What is tranquillity?	You do not see...	funfairs	10	18	0.56	
What is tranquillity?	Doing.... Additional	snorkelling and looking at coral reefs	10	18	0.56	
What is tranquillity?	Doing.... Additional	cooking	10	18	0.56	
What is tranquillity?	Doing.... Additional	swimming (anywhere warm sea)	10	18	0.56	
What is tranquillity?	Of the Mind....	Solitude	6	11	0.55	People
What is tranquillity?	Of the Mind....	Being in the moment – an absence of time and space	6	11	0.55	
What is tranquillity?	Of the Mind....	Judged against a personal reference frame	6	11	0.55	
What is tranquillity?	Experiencing...	gentle rain	20	37	0.54	
What is tranquillity?	You Hear....	Animals	19	36	0.53	Quiet areas
What is tranquillity?	You do not see...additional	enforced tidiness/order	9	18	0.50	Perceived naturalness
What is tranquillity?	You do not see...	child centred activities(bouncy castle etc)	9	18	0.50	
What is tranquillity?	You do not see...	cars	9	18	0.50	Visibility roads
What is tranquillity?	You do not see...	man made structures	9	18	0.50	Perceived naturalness
What is not Tranquillity?	You see....	Kids noisier and louder these days – don't play quietly	4	8	0.50	People
What is tranquillity?	You see...	cared for hedgerows	3	6	0.50	
What is tranquillity?	You see...	other people	3	6	0.50	People
What is tranquillity?	You see...	no urban impact	3	6	0.50	Visibility urban
What is tranquillity?	You see...	interesting geology	3	6	0.50	
What is tranquillity?	You see...	raging (foam) sea (calming)	3	6	0.50	Visibility Sea
What is tranquillity?	You see...	buzzards	3	6	0.50	
What is tranquillity?	You see...	alive scene	3	6	0.50	
What is tranquillity?	You see...	well maintained	3	6	0.50	
What is tranquillity?	You see...	river banks	3	6	0.50	Rivers
What is tranquillity?	You see...	low unnatural elements	3	6	0.50	Perceived naturalness
What is tranquillity?	You see...	sky changes all the time	3	6	0.50	
What is tranquillity?	Experiencing...	the weather	18	37	0.49	
What is tranquillity?	You Don't Hear....additional	two stroke engines	15	33	0.45	Noise

What is tranquillity?	You Don't Hear....additional	low flying aircraft	15	33	0.45	Aircraft noise
What is tranquillity?	Of the Mind.... Additional	balance, tolerance, faith in god, peace with others	5	11	0.45	
What is tranquillity?	Of the Mind....	Calm and karma	5	11	0.45	
What is tranquillity?	Of the Mind....	Feeling restful	5	11	0.45	
What is tranquillity?	Of the Mind....	State of mind when in nice surroundings	5	11	0.45	
What is tranquillity?	You do not see...	seventy-six hikers in bright cagoules	8	18	0.44	People
What is tranquillity?	You do not see...	aeroplanes	8	18	0.44	
What is tranquillity?	Doing....	Traditional activities	8	18	0.44	
What is tranquillity?	Doing....	Driving long distances on my own, do all my thinking	8	18	0.44	
What is tranquillity?	You Hear....	Music classical	16	36	0.44	
What is tranquillity?	Experiencing... additional	a natural discovery	16	37	0.43	
What is tranquillity?	You do not see...	human 'recreation'	7	18	0.39	People
What is tranquillity?	You do not see...	dogs	7	18	0.39	People
What is tranquillity?	You do not see...	traffic signs	7	18	0.39	Visibility roads
What is tranquillity?	You do not see...	artificial management	7	18	0.39	Perceived naturalness
What is tranquillity?	Doing.... Additional	rowing/sailing	7	18	0.39	
What is tranquillity?	Doing....	Having an ice cream	7	18	0.39	
What is tranquillity?	You Hear....	A robin singing	14	36	0.39	
What is not Tranquillity?	You hear...	noisy children	16	42	0.38	People
What is not Tranquillity?	You hear...	machinery	16	42	0.38	Noise
What is not Tranquillity?	You see....	Ugly farm buildings, sheds etc	3	8	0.38	
What is not Tranquillity?	You see....	Aircraft	3	8	0.38	
What is not Tranquillity?	You see....	Motorbikes	3	8	0.38	Visibility roads
What is not Tranquillity?	You see....	Burger vans	3	8	0.38	Visibility roads
What is not Tranquillity?	You see....	Caravans	3	8	0.38	Visibility roads
What is not Tranquillity?	You see....	Kids playing (scream all the time)	3	8	0.38	People
What is not Tranquillity?	You see....	Power cables	3	8	0.38	Visibility structures
What is not Tranquillity?	You see....	Graffiti	3	8	0.38	People
What is tranquillity?	Of the Mind....	Quietness (in spirit)	4	11	0.36	
What is tranquillity?	Of the Mind....	Internal and not external	4	11	0.36	
What is tranquillity?	Of the Mind....	Pleasant thoughts	4	11	0.36	
What is tranquillity?	Of the Mind....	A safe place to be	4	11	0.36	
What is tranquillity?	Of the Mind....	Depend(s) on what you're used to	4	11	0.36	
What is tranquillity?	Of the Mind....	Part of nature	4	11	0.36	
What is tranquillity?	Of the Mind....	Like going back in time	4	11	0.36	
What is tranquillity?	You do not see...	quad bikes	6	18	0.33	
What is tranquillity?	You Don't Hear....	No army firing	11	33	0.33	Military noise
What is tranquillity?	You Don't Hear....	Noisy off-shore boats	11	33	0.33	
What is tranquillity?	Doing....	Fishing	6	18	0.33	
What is tranquillity?	Doing....	Bbq by river	6	18	0.33	Rivers
What is tranquillity?	You Hear....	Blackbirds	12	36	0.33	
What is tranquillity?	You see...	(need) more windmills	2	6	0.33	
What is tranquillity?	You see...	grass	2	6	0.33	
What is tranquillity?	You see...	gurgling stream	2	6	0.33	Rivers
What is tranquillity?	You see...	tidy farms	2	6	0.33	
What is tranquillity?	You see...	ravens	2	6	0.33	
What is tranquillity?	You see...	thrushes	2	6	0.33	
What is tranquillity?	You see...	swans on water at sunset	2	6	0.33	
What is tranquillity?	You see...	moors	2	6	0.33	Perceived naturalness
What is not Tranquillity?	You hear...	aircraft noise	12	42	0.29	Aircraft noise
What is tranquillity?	You do not see...	children	5	18	0.28	People

What is tranquillity?	You do not see...	car parks	5	18	0.28	Visibility roads
What is tranquillity?	Of the Mind....	Spiritual awareness	3	11	0.27	
What is not Tranquillity?	You hear...	dogs	11	42	0.26	People
What is not Tranquillity?	You hear...	not natural noise	11	42	0.26	Quiet areas
What is not Tranquillity?	You see.... Additional	4 by 4's especially in towns	2	8	0.25	Visibility roads
What is not Tranquillity?	You see....	Joy of place things	2	8	0.25	
What is not Tranquillity?	You see....	Jet skis	2	8	0.25	
What is not Tranquillity?	You see....	Too large visitor's centre	2	8	0.25	People
What is not Tranquillity?	You see....	Restricted access	2	8	0.25	
What is not Tranquillity?	You see....	Tony blair	2	8	0.25	
What is not Tranquillity?	You see....	Too many conifers	2	8	0.25	Perceived naturalness
What is not Tranquillity?	You see....	Midges	2	8	0.25	
What is tranquillity?	You do not see...	modern straight edged fences, buildings etc.	4	18	0.22	Perceived naturalness
What is tranquillity?	Doing.... Additional	swimming in the sea, bobbing up and down in the waves	4	18	0.22	
What is tranquillity?	Doing....	Archaeology	4	18	0.22	
What is tranquillity?	Doing....	More tree planting	4	18	0.22	
What is tranquillity?	Experiencing...	snow and rain	8	37	0.22	
What is not Tranquillity?	You hear... additional	unnatural sounds	8	42	0.19	Noise
What is tranquillity?	Experiencing... additional	huge thunderstorm with gentle rain	7	37	0.19	
What is tranquillity?	Of the Mind.... Additional	being intellectually interested in what you hear (land formation) etc	2	11	0.18	
What is tranquillity?	Of the Mind....	Quiet "hear nowt"	2	11	0.18	Low noise areas
What is tranquillity?	You do not see...	mountain bikes	3	18	0.17	People
What is tranquillity?	You do not see...	housing	3	18	0.17	Visibility urban
What is tranquillity?	You do not see...	pubs	3	18	0.17	
What is tranquillity?	You see...	national trust properties	1	6	0.17	
What is tranquillity?	You see...	parks	1	6	0.17	
What is tranquillity?	You see...	a glade	1	6	0.17	
What is tranquillity?	You see...	natural stone formations	1	6	0.17	
What is tranquillity?	You see...	muted colours and blended	1	6	0.17	
What is tranquillity?	You see...	mammals	1	6	0.17	
What is tranquillity?	You see...	sheep	1	6	0.17	
What is tranquillity?	You see...	curlews	1	6	0.17	
What is tranquillity?	You see...	daisies	1	6	0.17	
What is tranquillity?	You see...	high ground with feature – cairn/stone circles	1	6	0.17	Openness
What is tranquillity?	You see...	muted colours and blended	1	6	0.17	
What is tranquillity?	You see...	rabbits	1	6	0.17	
What is tranquillity?	You see...	spring ripples around swan	1	6	0.17	
What is tranquillity?	You see...	living things	1	6	0.17	
What is tranquillity?	Experiencing...	distant thunder in sea	6	37	0.16	
What is not Tranquillity?	You see....	Asphalt paths	1	8	0.13	
What is not Tranquillity?	You see....	Anything unnatural	1	8	0.13	Perceived naturalness
What is not Tranquillity?	You see....	Modern buildings	1	8	0.13	Perceived naturalness
What is not Tranquillity?	You see....	Quad biking	1	8	0.13	
What is not Tranquillity?	You see....	Tree planting which denies access	1	8	0.13	
What is not Tranquillity?	You see....	Holiday villages	1	8	0.13	
What is not Tranquillity?	You see....	Tarmac paths	1	8	0.13	
What is not Tranquillity?	You see....	Bill billboards	1	8	0.13	Visibility roads

What is not Tranquillity?	You see....	Bad weather	1	8	0.13	
What is tranquillity?	Doing.... Additional	naturism	2	18	0.11	
What is tranquillity?	You Hear....	Quiet murmuring conversation	4	36	0.11	
What is tranquillity?	You Hear....	Quiets roads	4	36	0.11	Road Noise
What is tranquillity?	You Don't Hear....additional	trains esp. horns	3	33	0.09	Train Noise
What is tranquillity?	You Don't Hear....additional	small motor bikes/scooters	3	33	0.09	Road Noise
What is tranquillity?	You Don't Hear....	Micro lights	3	33	0.09	
What is tranquillity?	Of the Mind....	Yoga – cut yourself off	1	11	0.09	
What is tranquillity?	Of the Mind....	Depends on your sense of 'pace' – how secure you feel etc	1	11	0.09	
What is tranquillity?	You Hear....	Vaughn Williams	3	36	0.08	
What is tranquillity?	Experiencing...	late June	3	37	0.08	
What is tranquillity?	You Don't Hear....additional	speed boats in the lake district	2	33	0.06	
What is tranquillity?	You do not see...	national trust signs	1	18	0.06	
What is tranquillity?	You do not see...	wind turbines	1	18	0.06	Visibility Wind Turbines
What is tranquillity?	You do not see...	technology	1	18	0.06	
What is tranquillity?	Doing.... Additional	mountain biking	1	18	0.06	
What is tranquillity?	Doing....	Watching people working in the landscape	1	18	0.06	
What is tranquillity?	Doing....	Going beyond the safe environment	1	18	0.06	
What is tranquillity?	You hear.... Additional	wind	2	36	0.06	
What is tranquillity?	Experiencing...	cloud	2	37	0.05	
What is not Tranquillity?	You hear...	quarry noise	2	42	0.05	Noise explosions
What is tranquillity?	You see...	appropriate development	0	6	0.00	
What is tranquillity?	You see...	vehicles	0	6	0.00	
What is tranquillity?	You see...	cpre logo has it all	0	6	0.00	
What is tranquillity?	You see...	winter – wild, windy days on moor	0	6	0.00	
What is tranquillity?	You see...	altitude	0	6	0.00	
What is tranquillity?	You see...	bees	0	6	0.00	
What is tranquillity?	You see...	badgers	0	6	0.00	
What is tranquillity?	You see...	meadow pipits	0	6	0.00	
What is tranquillity?	You see...	sea birds	0	6	0.00	
What is tranquillity?	You see...	fish curlews (?)	0	6	0.00	
What is tranquillity?	You see...	peewees	0	6	0.00	
What is tranquillity?	You see...	sparrows	0	6	0.00	
What is tranquillity?	You see...	tits	0	6	0.00	
What is tranquillity?	You see...	woodpeckers	0	6	0.00	
What is tranquillity?	You see...	clean places to eat	0	6	0.00	
What is tranquillity?	You see...	white silver makes me feel calm...	0	6	0.00	
What is tranquillity?	You see...	limestone cliffs	0	6	0.00	
What is tranquillity?	You see...	old block of geometric forestry	0	6	0.00	
What is tranquillity?	You see...	dead/lifeless	0	6	0.00	
What is tranquillity?	You see...	terns diving	0	6	0.00	
What is tranquillity?	You see...	(no) car parks – sign in keeping	0	6	0.00	
What is tranquillity?	You Hear....	Beethoven's last four quartets	0	36	0.00	
What is tranquillity?	You do not see...	trains	0	18	0.00	
What is tranquillity?	You do not see...	heritage	0	18	0.00	
What is tranquillity?	You do not see...	coastal erosion	0	18	0.00	
What is tranquillity?	You do not see...	churches	0	18	0.00	
What is tranquillity?	Of the Mind....	Fulham winning by 4 goals	0	11	0.00	
What is tranquillity?	Of the mind... General Comment		0	11	0.00	
What is tranquillity?	Of the mind... General Comment		0	11	0.00	

What is tranquillity?	Experiencing...	wind force	0	37	0.00	
What is tranquillity?	Doing.... Additional	watching a wedding	0	18	0.00	
What is tranquillity?	Doing... General Comment	tranquil doesn't 'do' anything	0	18	0.00	
What is not Tranquillity?	You see.... Additional	things/people out of context	0	8	0.00	
What is not Tranquillity?	You see....	Big windmills	0	8	0.00	
What is not Tranquillity?	You see....	Any encroachment	0	8	0.00	
What is not Tranquillity?	You see....	Loads of coaches	0	8	0.00	
What is not Tranquillity?	You see....	Wood pigeons	0	8	0.00	
What is not Tranquillity?	You see....	Wind farms	0	8	0.00	
What is not Tranquillity?	You see....	Technology	0	8	0.00	
What is not Tranquillity?	You see....	Skunks	0	8	0.00	
What is not Tranquillity?	You see....	Wolves	0	8	0.00	
What is not Tranquillity?	You see....	Rough sea	0	8	0.00	
What is not Tranquillity?	You see....	BBQs / picnics	0	8	0.00	
What is not Tranquillity?	You see....	A shoot (but understand need)	0	8	0.00	
What is not Tranquillity?	You see....	Builders digging our patio	0	8	0.00	
What is not Tranquillity?	You see....	Adders	0	8	0.00	
What is not Tranquillity?	You see....	Children	0	8	0.00	
What is not Tranquillity?	You see....	Young people	0	8	0.00	
What is not Tranquillity?	You see....	Cafes	0	8	0.00	
What is not Tranquillity?	You see....	Army restricted access	0	8	0.00	
What is not Tranquillity?	You see....	Army on manoeuvres	0	8	0.00	
What is not Tranquillity?	You see....	Old buildings	0	8	0.00	
What is not Tranquillity?	You see....	Destruction	0	8	0.00	
What is not Tranquillity?	You see....	Dogs	0	8	0.00	
What is not Tranquillity?	You see....	Signs	0	8	0.00	
What is not Tranquillity?	You see....	Incongruous things like funfair in a village green – moto scramble?	0	8	0.00	
What is not Tranquillity?	You hear...	background noise – jazz music	0	42	0.00	

Table 9: the association of datasets, where possible, to scored PA data from the verification events

Although a key principle is one of limiting the number of decisions that cannot be tightly and directly linked back to the PA results, it is clear that a number of such decisions have been taken, and for the sake of transparency these are elaborated in the following sections. However, it is important to establish at a general level why such decisions were necessary before moving onto specifics. As identified above, linking qualitative data with GIS is fraught with difficulties. Our response to both the conceptual and the technical problems has been one of transparency: nothing is hidden away, either in terms of why decisions were taken or how they were carried through. Decisions on what PA data to use in the model and how to apply them were necessary to bridge between qualitative, individually meaningful responses and the need for aggregate categorised or quantified data for the numerical operation of the GIS model. It was neither possible nor viable to verify every decision made in the modelling process with those whose values were being modelled, nor would it have ultimately worked to do so as the aggregation and classification of data, numeric operations and quantitative weighting are necessarily a process of generalisation; the inevitable consequence of this is

that the final results cannot be acceptable to all those consulted. The ambition is that the final results will have resonance with the majority at least.

The PA data varies greatly in terms of its (technically defined) precision. For example, while being able to see power cables is very specific and precise, being able to see "lots of trees" is less specific and leaves questions about species, proportions, areas and distance from the viewer unanswered. Further along this spectrum are responses such as "wild landscapes" and "natural landscapes". To be able to utilise these relatively imprecise responses in constructing the GIS model requires a level of interpretation of the data. As it is not possible to 'drill into' the PA responses and it is not possible to work with highly imprecise responses such as a "natural landscape", more specific datasets must be attached to such responses. As a point of principle there is a tension here with PA as there is no way of knowing whether the interpretation would be acceptable to the respective respondents. In the absence of guidance from the respondents themselves there is a need for another frame of reference in this process of moving from the general (imprecise PA responses) to the specific (GIS datasets and their place in the model). The literature review has identified previous research into the recurrent themes from the PA work, primarily noise, (remoteness from other) people, perceived naturalness and landscape character. Through reference to published sources are imprecise terms such as a "natural landscape" connected with specific datasets, and this process is documented and referenced as appropriate. It is important to note that use of this frame of reference (published work) is used as a complement to the PA data *only* where additional guidance was needed in moving from the general to the specific. Where a direct association between PA data and GIS datasets could be made (for instance in the case of things you cannot see ➔ traffic which identified a need for visibility analysis of roads) no external frame of reference was needed.

However, specific decisions about how to interpret the data and apply them in the GIS model has to be made by the research team, in consultation with the project steering group and with reference to published best practice. For example, a decision had to be made about the various distances at which the affective impact of being able to see roads and traffic increased or decreased. Visibility calculations identify (a) those cells from which a road and associated traffic can be seen, and (b) the amount of road than can be seen from each cell, working out to a defined radius, the Zone of Theoretical Visibility (ZTV). However, to account for the relatively more significant affective impact of roads that are closer over roads that are further away, thresholds and relatively weightings had to be introduced. There was no specific guidance in how to achieve this from the PA data (although see the discussion for a proposal on how to address this in future research) and the approach taken is described in Section 4.4.

The operation of the GIS model is structured around three overarching categories, which in descending order of significance in the model are:

- landscape and tranquillity
- noise and tranquillity
- people and tranquillity.

4.4 Landscape and Tranquillity

4.4.1 Introduction

The PA consultation data identify a number of attributes of the visual landscape as being highly significant to the experience of tranquillity. These may be either positive or negative. The positive factors include the openness of the landscape, the ability to take in wide views of the countryside, the presence of rivers and the perceived naturalness of things that could be seen and thereby detracted from tranquillity and an experiential quality of landscape. These negative factors can be summarised as signs of overt human impact, including skyglow at night.

4.4.2 The PA Results

The entries in the spreadsheet of PA results following the verification events was thematically organised as described. In summary the following are identified as key characteristics associated with tranquillity as an experiential quality of the visual landscape:

Positive	Negative
• the openness of the landscape • the presence of rivers • the perceived naturalness of the land cover mix within each 250m x 250m cell • the perceived naturalness of the immediate land cover context for each 250m x 250m cell • the ability to see the sea • the relative visibility and proximity of broadleaved and mixed woodland as a positive factor in the landscape	• the relative visibility and proximity of human developments such as roads, urban areas, telecommunication masts, camping and caravan parks, windfarms and power pylons • the overhead skyglow (or light pollution) attributable to urban concentrations of artificial light sources. • the relative visibility and proximity of coniferous plantations as a negative factor in the landscape

Table 10 lists the full set of responses categorised as being associated with landscape.

Question	Theme	Answer	Total Score	Expected dots per option	Weighted Score	DATASET	Positive or Negative Factor
What is tranquillity?	You see...	the stars	16	6	2.67	Light pollution	Negative
What is not Tranquillity?	You see....	Light pollution	9	8	1.13	Light pollution	Negative
				Sub-total	**3.79**		
What is tranquillity?	You see...	the landscape	34	6	5.67	Openness	Positive
What is tranquillity?	You see...	countryside	27	6	4.50	Openness	Positive
What is tranquillity?	You see...	open spaces	21	6	3.50	Openness	Positive
What is tranquillity?	You see...	rolling countryside	16	6	2.67	Openness	Positive
What is tranquillity?	You see...	valleys and hilltops	12	6	2.00	Openness	Positive
What is tranquillity?	You see...	far horizons	10	6	1.67	Openness	Positive
What is	You see...	long distance	8	6	1.33	Openness	Positive

tranquillity?		visibility					
What is tranquillity?	You see...	scenery	7	6	1.17	Openness	Positive
What is tranquillity?	You see...	lots of space	6	6	1.00	Openness	Positive
What is tranquillity?	You see...	distant mountains	6	6	1.00	Openness	Positive
What is tranquillity?	You see...	dales	6	6	1.00	Openness	Positive
What is tranquillity?	You see...	high ground with feature – cairn/stone circles	1	6	0.17	Openness	Positive
				Sub-total	**25.67**		
What is tranquillity?	You see...	wild landscapes	23	6	3.83	Landcover	Positive
What is tranquillity?	You see...	natural landscape	22	6	3.67	Landcover	Positive
What is tranquillity?	Of the Mind....	Being among nature	34	11	3.09	Landcover	Positive
What is tranquillity?	You see...	nature	18	6	3.00	Landcover	Positive
What is tranquillity?	You see...	greenery	17	6	2.83	Landcover	Positive
What is tranquillity?	You see...	wild flowers	17	6	2.83	Landcover	Positive
What is tranquillity?	You see...	a green place	8	6	1.33	Landcover	Positive
What is not Tranquillity?	You see....	Over management	8	8	1.00	Landcover	Positive
What is tranquillity?	You see...	wilderness	5	6	0.83	Landcover	Positive
What is tranquillity?	You do not see...additional	enforced tidiness/order	9	18	0.50	Landcover	Positive
What is tranquillity?	You see...	moors	2	6	0.33	Landcover	Positive
				Sub-total	**23.26**		
What is tranquillity?	You see...	no sign of civilisation	13	6	2.17	Overt Human Impact	Negative
What is tranquillity?	You see...	soft lines in the landscape e.g. skylines, stones. Rocks. Vegetation, old vernacular buildings	9	6	1.50	Overt Human Impact	Negative
What is not Tranquillity?	You see....	Something that intrudes	11	8	1.38	Overt Human Impact	Negative
What is tranquillity?	You see...	unspoilt and traditional	8	6	1.33	Overt Human Impact	Negative
What is tranquillity?	You do not see...	signs of man's interference	17	18	0.94	Overt Human Impact	Negative
What is tranquillity?	You do not see...	development	17	18	0.94	Overt Human Impact	Negative
What is tranquillity?	You do not see...	man made structures	9	18	0.50	Overt Human Impact	Negative
What is tranquillity?	You see...	low unnatural elements	3	6	0.50	Overt Human Impact	Negative
What is tranquillity?	You do not see...	artificial management	7	18	0.39	Overt Human Impact	Negative
What is tranquillity?	You do not see...	modern straight edged fences, buildings etc.	4	18	0.22	Overt Human Impact	Negative
What is not Tranquillity?	You see....	Anything unnatural	1	8	0.13	Overt Human Impact	Negative
				Sub-total	**10.00**		
What is tranquillity?	You see...	rivers	24	6	4.00	Rivers	Positive
What is tranquillity?	You see...	babbling brooks	20	6	3.33	Rivers	Positive
What is tranquillity?	You see...	lapping waves on shore	20	6	3.33	Rivers	Positive

What is tranquillity?	You Hear....	Sound of water, rivers and waves	104	36	2.89	Rivers	Positive
What is tranquillity?	You see...	stream (slow flowing)	17	6	2.83	Rivers	Positive
What is tranquillity?	You see...	waterfalls	13	6	2.17	Rivers	Positive
What is tranquillity?	You see...	rivers running	7	6	1.17	Rivers	Positive
What is tranquillity?	You see...	river banks	3	6	0.50	Rivers	Positive
What is tranquillity?	Doing....	Bbq by river	6	18	0.33	Rivers	Positive
What is tranquillity?	You see...	gurgling stream	2	6	0.33	Rivers	Positive
				Sub-total	**20.89**		
What is tranquillity?	You see...	lots of trees	20	6	3.33	Visibility: BLW	Positive
What is tranquillity?	You see...	woodlands	16	6	2.67	Visibility: BLW	Positive
What is tranquillity?	You see...	forest	14	6	2.33	Visibility: BLW	Positive
What is tranquillity?	You see...	deciduous trees not firs	4	6	0.67	Visibility: BLW	Positive
				Sub-total	**9.00**		
What is not Tranquillity?	You see....	Too many conifers	2	8	0.25	Visibility: Conifers	Negative
				Sub-total	**0.25**		
What is tranquillity?	You do not see...	traffic	93	18	5.17	Visibility: Roads	Negative
What is tranquillity?	You see...	no main roads	12	6	2.00	Visibility: Roads	Negative
What is not Tranquillity?	You see....	Motorways	14	8	1.75	Visibility: Roads	Negative
What is not Tranquillity?	You do not see...	vehicles	14	8	1.75	Visibility: Roads	Negative
What is not Tranquillity?	You see....	Cars	9	8	1.13	Visibility: Roads	Negative
What is not Tranquillity?	You see.... Additional	traffic rather than individual vehicles	5	8	0.63	Visibility: Roads	Negative
What is not Tranquillity?	You see....	Exhaust fumes	5	8	0.63	Visibility: Roads	Negative
What is tranquillity?	You do not see...	cars	9	18	0.50	Visibility: Roads	Negative
What is tranquillity?	You do not see...	traffic signs	7	18	0.39	Visibility: Roads	Negative
What is not Tranquillity?	You see....	Motorbikes	3	8	0.38	Visibility: Roads	Negative
What is not Tranquillity?	You see....	Burger vans	3	8	0.38	Visibility: Roads	Negative
What is not Tranquillity?	You see....	Caravans	3	8	0.38	Visibility: Roads	Negative
What is tranquillity?	You do not see...	car parks	5	18	0.28	Visibility: Roads	Negative
What is not Tranquillity?	You see.... Additional	4 by 4's especially in towns	2	8	0.25	Visibility: Roads	Negative
What is not Tranquillity?	You see....	Bill billboards	1	8	0.13	Visibility: Roads	Negative
				Sub-total	**15.71**		
What is tranquillity?	You see...	the sea	35	6	5.83	Visibility: Sea	Positive
What is tranquillity?	You see...	raging (foam) sea (calming)	3	6	0.50	Visibility: Sea	Positive
				Sub-total	**6.33**		
What is tranquillity?	You do not see...additional	pylons/mobile phone masts (not tranquil at all)	26	18	1.44	Visibility: structures	Negative
What is not Tranquillity?	You see....	Pylons	9	8	1.13	Visibility: structures	Negative

What is not Tranquillity?	You see....	Mobile telephone masts	6	8	0.75	Visibility: structures	Negative
What is not Tranquillity?	You see....	Power cables	3	8	0.38	Visibility: structures	Negative
				Sub-total	**3.69**		
What is not Tranquillity?	You see....	Multi-story car parks	17	8	2.13	Visibility: urban	Negative
What is not Tranquillity?	You see....	Over commercialisation	11	8	1.38	Visibility: urban	Negative
What is not Tranquillity?	You see....	House estates	9	8	1.13	Visibility: urban	Negative
What is not Tranquillity?	You see....	Commercial rubbish	8	8	1.00	Visibility: urban	Negative
What is not Tranquillity?	You see....	Industry	7	8	0.88	Visibility: urban	Negative
What is not Tranquillity?	You see....	High rise buildings	7	8	0.88	Visibility: urban	Negative
What is tranquillity?	You do not see...	council estate	14	18	0.78	Visibility: urban	Negative
What is tranquillity?	You see...	low population density	4	6	0.67	Visibility: urban	Negative
What is tranquillity?	You do not see...additional	supermarkets	11	18	0.61	Visibility: urban	Negative
What is tranquillity?	You see...	no urban impact	3	6	0.50	Visibility: urban	Negative
What is tranquillity?	You do not see...	housing	3	18	0.17	Visibility: urban	Negative
What is not Tranquillity?	You see....	Modern buildings	1	8	0.13	Visibility: urban	Negative
				Sub-total	**10.22**		
What is tranquillity?	You do not see...	wind turbines	1	18	0.06	Visibility: Wind Turbines	Negative
				Sub-total	**0.06**		

Table 11: Sorted Useable PA Responses relating to Landscape and Tranquillity

As perceived naturalness is multi-faceted, a number of different elements comprise this section of the GIS model. These are:

- **Openness (positive factor):** the ability to take in wide views of the countryside
- **Rivers (positive factor)**: the presence of absence of rivers of any class in each 250m x 250m grid cell
- **Landcover (positive factor)**: a scored value of perceived naturalness that is attached to each class of the LCS 2000 dataset
- **Visibility (negative factor)**: the relative level of visibility of features perceived as relatively unnatural from each 250m x 250m grid cell
- **Skyglow (negative factor)**: the overhead skyglow (or light pollution) attributable to urban concentrations of artificial light sources.

These characteristics are then used to help define parameters and scores associated with the processing of data in order to map naturalness using the following datasets:

Name	Description
Land Cover Map (LCM) 2000	A thematic classification of satellite imagery (year 2000) into types of Landcover, provided by the Centre for Ecology and Hydrology .
Digital Elevation Model (DEM)	A raster dataset providing elevation data.

OS Strategi	1:250,000 scale OS dataset of urban areas, transportation infrastructure and key environmental features such as rivers and woodland.
OS Address Point	A point dataset representing every postal address in the UK, although it does not differentiate between residential, business and other types of address.

4.4.3 Modelling the Positive Attributes of Landscape

Openness of the Landscape

Openness of the landscape, and environmental characteristics that were judged to be captured by this term, emerged from the PA consultation as being significantly associated with the experience of tranquillity. Of course this is a double-edged characteristic in that the ability to view a wide area is more likely, all other things being equal, to include views of features such as roads, urban areas and power lines, which are not positively associated with tranquillity. However, these are separately included elsewhere; openness is therefore a simple function of terrain, rather than what is built or growing on it.

Technically, the foundations of modelling openness are very similar to those described in detail in relation to the visibility of specific features such as roads and power pylons, relating to the visibility of specific features. Openness is calculated in essentially the same way but instead of the question being, for example, 'how many observation points along a road can be seen from this cell?', the question is 'how many 250m x 250m grid cells can be seen from this grid cell?.' This process is then iteratively applied for each grid cell within the study areas. The result gives a measure of how much land can be seen, which equates to openness of the landscape, for each individual grid cell.

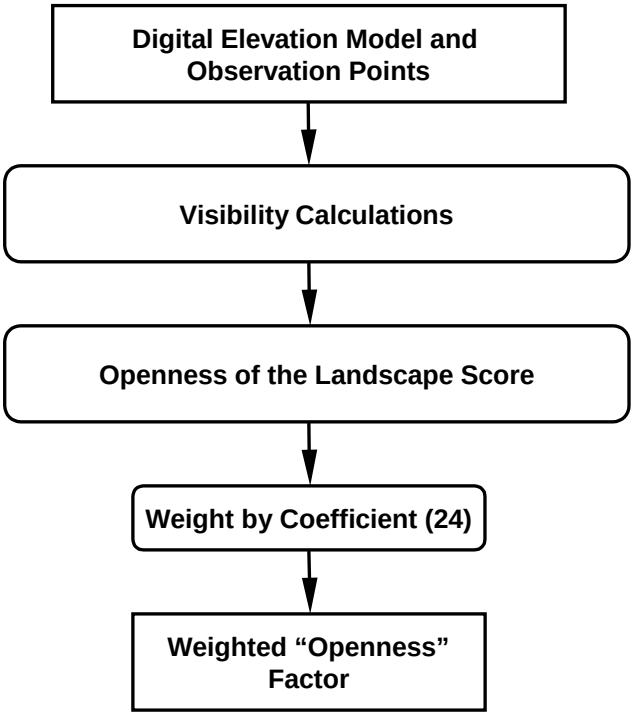


Figure 31: Summary of the Openness Element of the GIS Model

As well as being able to determine the visibility of roads, urban areas and caravan parks it is possible to obtain the relative visibility of the land surface. Using the basic principles of

visibility analysis outlined in section 4.4.7 it was possible to derive the relative openness of areas within the NNP and WDC and the surrounding landscape. This is achieved by covering the whole of the NNP and WDC in a blanket grid of points. The points were generated by overlaying the areas with 250 grid squares and generating a central point – the centroid – which forms the cells observation point. The parameters given below were applied.

Criteria	Parameter	Description
Subject Height	0m	Ground surface
Viewing Height	1.72m	Average height of a person
Radius (ZTV)	30km	Theoretical limit of visibility*
Azimuth	360°	Complete field of view
Output Grid Size	250m	The output visibility surface is the same as the 250m grid used throughout this study.

Cumulative visibility is then calculated for each individual point as illustrated in Figure 32.

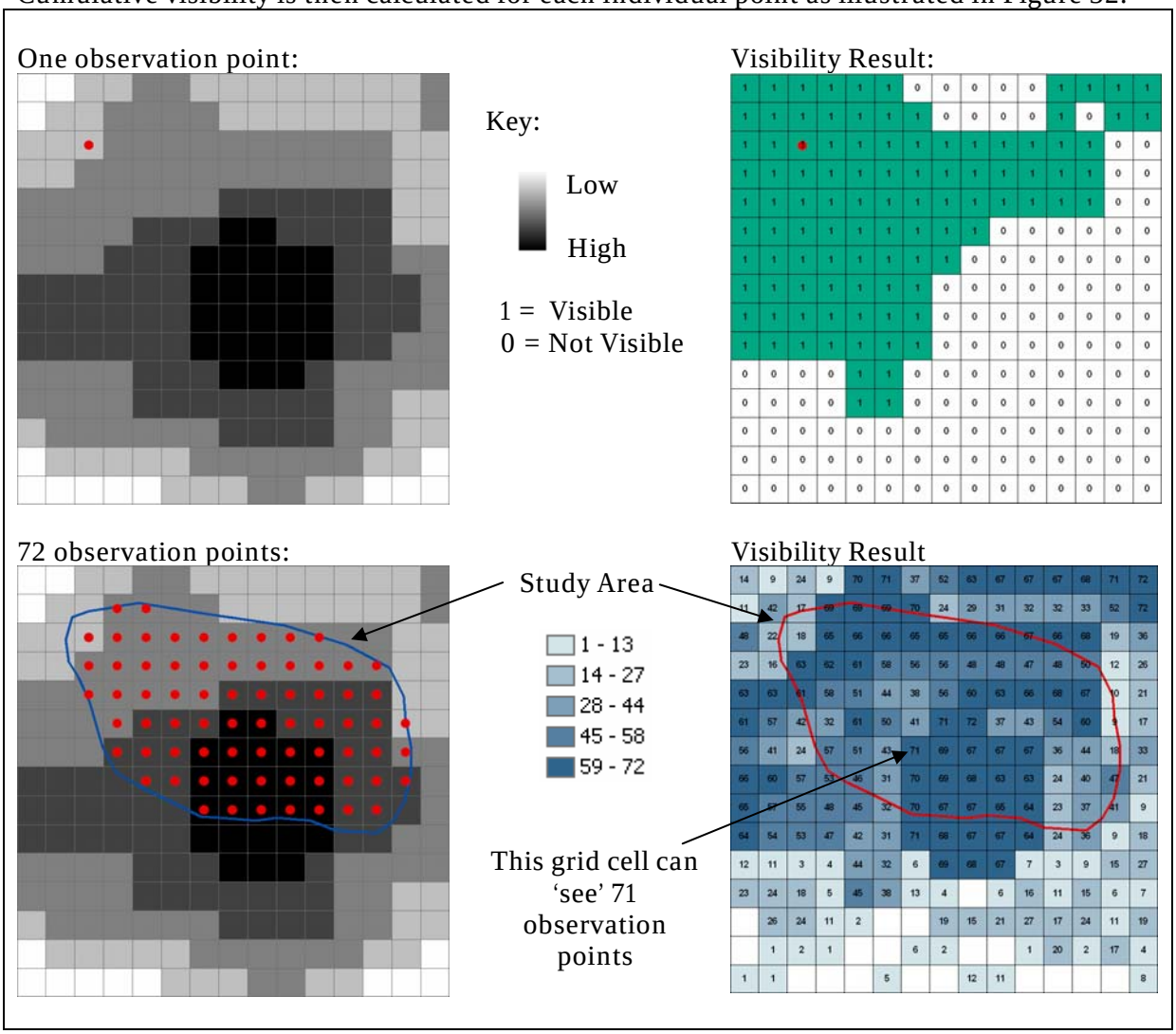


Figure 32: Single and Multiple Observation Points in IVA

The resulting visibility score acts as a relative proxy for openness – the higher the visibility the more 'open' an area is perceived to be (Figure 33).

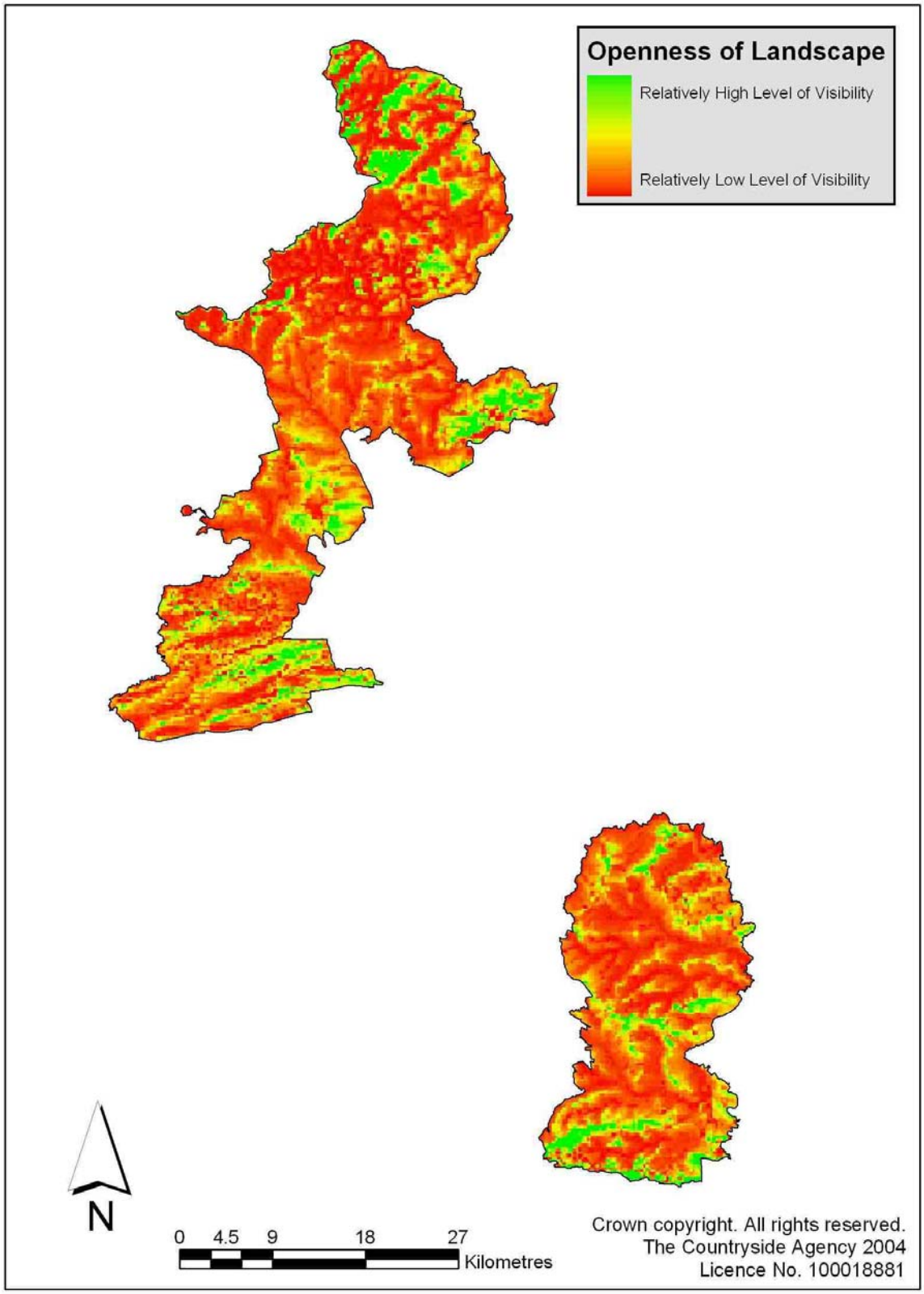


Figure 33: Relative Landscape Openness

4.4.4 The Presence of Rivers

Rivers from the OS Strategi dataset were rasterised so that cells containing a river of any class were identified. These were then reclassified so that cells containing river received a value of ten and all others a value of zero. The weighting coefficient of 19.6 was then applied to the reclassified dataset to give cells containing a river a value of 196.

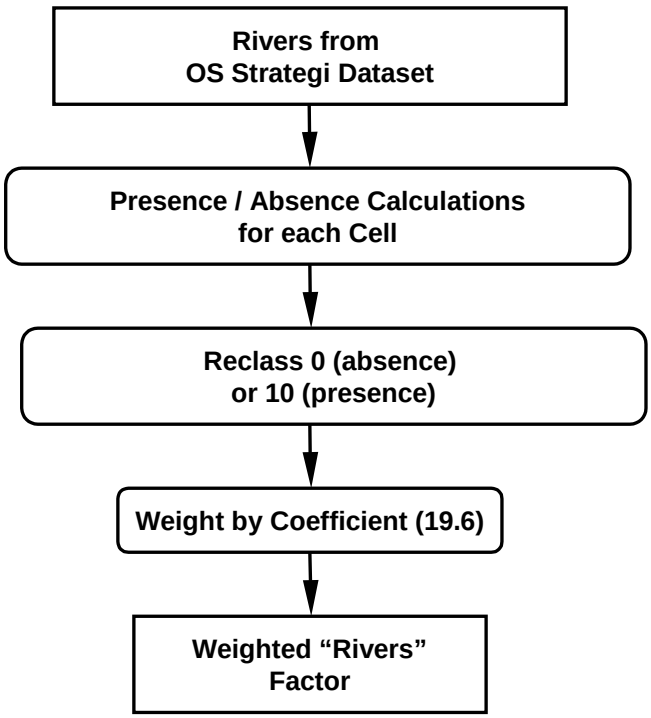


Figure 34: Summary of the Rivers Element of the GIS Model

4.4.5 The Visibility of Rivers

Using visibility analysis techniques (please refer forward to 4.4.8 for a more technical and detailed description of this process) those cells from which a river could be seen were identified. Cells were then allocated a score on the basis of three parameters:

1. whether a river could be seen from the cell (a score of zero was recorded for those from which no part of any river or stream could be seen) out to a search radius (Zone of Theoretical Visibility – ZTV) of 6km.
2. if any part of (a) river(s) could be seen, how much could be seen. Thus, cells that could see significant lengths of rivers and/or streams in the surrounding landscape were calculated as having a higher value than cells which could only see shorter lengths of river/stream. The scores were proportional, so a cell which could see 2,000m of rivers/streams would be allocated a score twice that of a cell from which a total length of only 1,000m could be seen.
3. As set out in table 13, a distance weighting element was included, so that rivers close to, and visible from, individual grid cells, 'contributed' a higher score than rivers further away, all other things being equal.

The final score allocated was thus a function of both visibility of, and proximity to, rivers and streams from each of the individual grid cells.

4.4.6 The Visibility of the Sea

Using visibility analysis techniques (please refer forward to 4.4.8 for a more technical and detailed description of this process) those cells from which the North Sea could be seen were identified. Cells were then allocated a score on the basis of three parameters:

1. whether the Sea could be seen from the cell (a score of zero was recorded for those from which no part of the coastline or Sea could be seen) out to the defined ZTV of 35km.
2. if any part of the Sea could be seen, how much could be seen. Thus, cells that could see significant amounts of the Sea (either in terms of length of coastline or amount of sea out to the defined ZTV of 35km) were calculated as having a higher value than cells which could only see smaller amount of the Sea. As with rovers, the scores were proportional.
3. As set out in table 13, a distance weighting element was included, so that close to, and with a view of, the sea, received a higher score than cells further away, all other things being equal.

The final score allocated was thus a function of both visibility of, and proximity to, the sea from each of the individual grid cells.

4.4.7 Perceived Naturalness of Landcover

Purcell and Lamb (1998) summarise previous research into 'naturalness as an attribute of preferred scenes [as relating to] 'natural' elements such as vegetation in urban scenes..., to the absence of overt human-induced change in a scene..., to vegetation generally..., but not excluding some man-made elements... and to the presence of trees... In summary, previous research has shown that a major factor in preference for landscape appears to be the naturalness of a scene with naturalness being associated with vegetation and the type and amount of human-induced change present in a scene' (p. 57-58).

Individuals' responses to the type and intensity of both vegetation and human artefacts are however very variable. There are geographical and cultural determinants (for instance, expectations of what is 'normal') as well as more individual factors such as ecological knowledge and the ability to discriminate and appreciate the significance of different species and their patterning in the landscape. The approach adopted here is not to take an absolute definition of naturalness (Peterken, 1996) but rather a relative one that is more aesthetic than ecological in its interpretation of particular landscapes.

There are two elements to this component of the model, the perceived naturalness of individual cells and the perceived naturalness of the immediate context, which are then combined into a single map layer. This is complemented in the model by visibility calculations of positive (broadleaved and mixed woodland) and negative (e.g. roads, urban areas, coniferous forest and vertical structures such as power pylons and VHF transmitter masts) features

Perceived Naturalness of Landcover of Individual Cells

Landcover is defined in the Centre for Ecology and Hydrology Land Cover Survey 2000 dataset, using improved grassland broad habitat as an example, with the hierarchy illustrated in Figure 35.

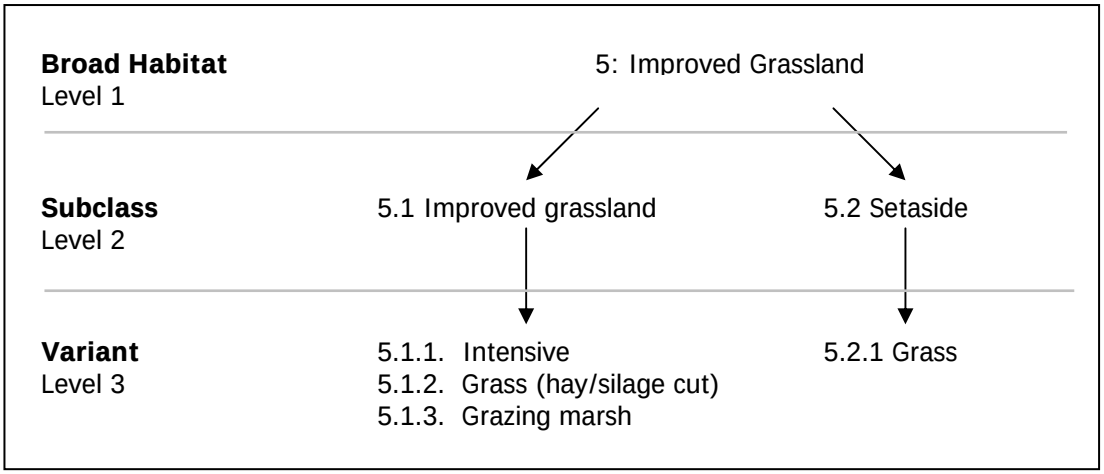


Figure 35: the Basic Structure of the LCS 2000 Dataset

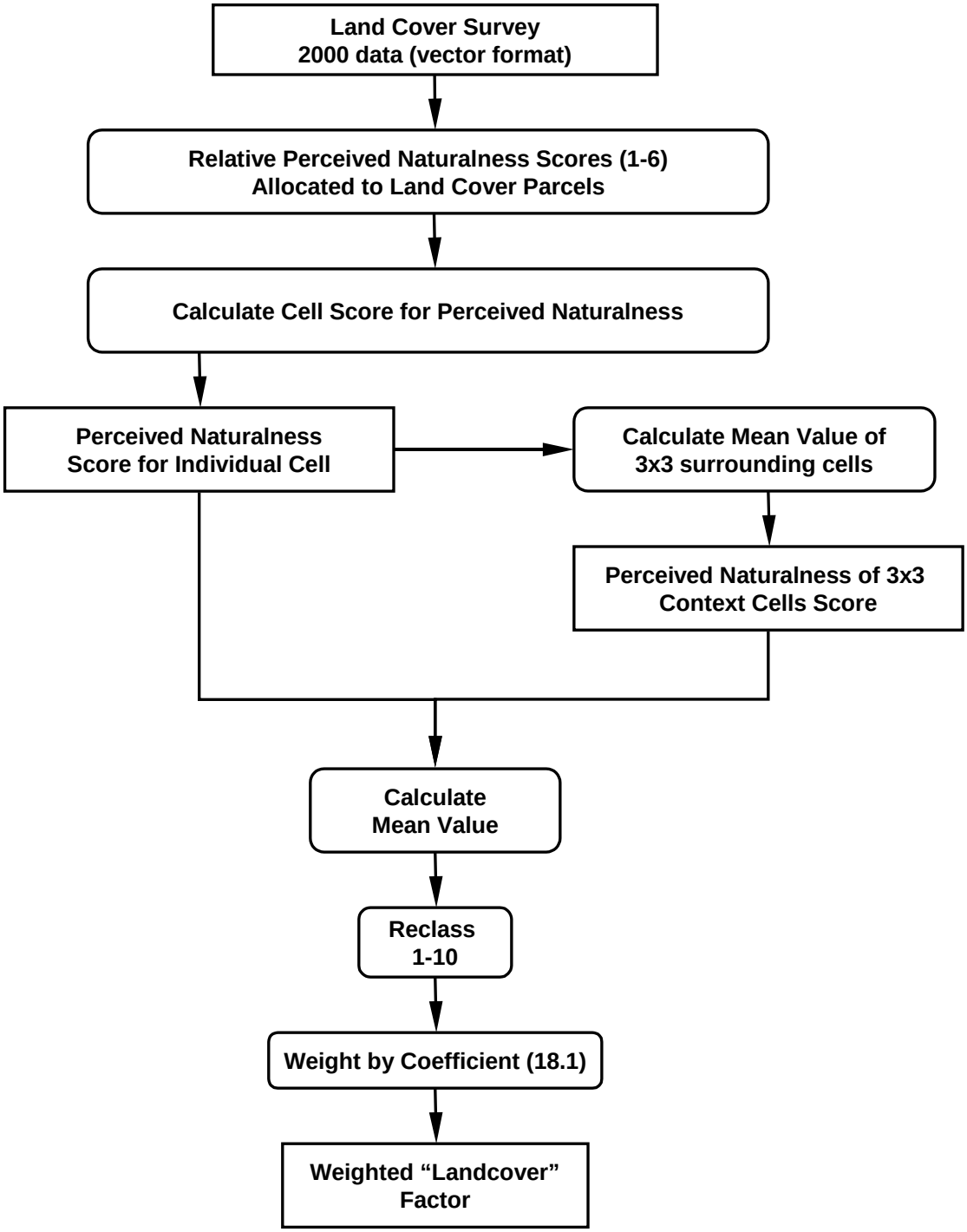


Figure 36: Summary of the ‘Perceived Naturalness’ Element of the GIS Model

A score of relative naturalness was assigned at the subclass level, to all subclasses that fall within the study areas. This was a judgement made with reference to the PA data, but a direct quantitative basis for this scoring was not available from the PA results, so the scale was determined by the researchers and appears in table 12.

Subclass	Name	Score
1.1	Broad-leaved woodland	6
10.1	Dwarf shrub heath – dense	6
10.2	Dwarf shrub heath – open	6
11.1	Fen, marsh and swamp	6
12.1	Bog	6
13.1	Standing water / canals	6
5.2	Setaside	5
6.1	Neutral Grass	5
7.1	Calcareous	5
8.1	Acid Grass	5
9.1	Bracken	5
16.1	Inland Rock	5
5.1	Improved Grassland	4
2.1	Coniferous woodland	3
4.1	Arable – cereals	3
4.2	Arable – horticultural	3
4.3	Non – rotational horticulture	3
17.1	Built up areas, suburban /rural developed	2
17.2	Built up areas, urban residential / commercial urban industrial	1

Table 12: the Perceived Naturalness Scores allocated to LCS Sub-Classes

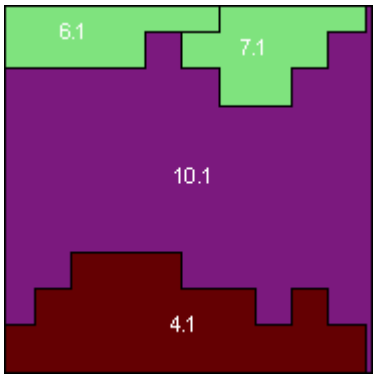
Using these scores a score of relative naturalness for each 250 grid cell was calculated by:

1. Obtaining the relative area of each Landcover type that lies within it as a percentage of the whole grid 250m grid cell
2. Multiplying the percentage area by the score to give an area weighted figure of relative naturalness
3. Obtaining a total for each 250m grid cell.

An example of this process for two 250m grid cells is given below.

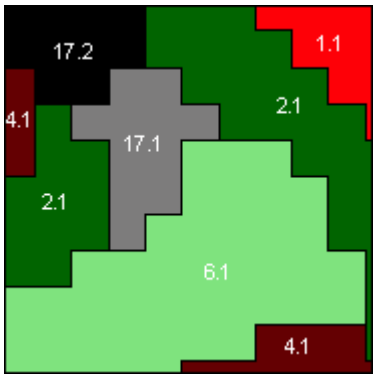
Example Calculation of Perceived Naturalness Score for Raster Grid Cells

Grid Cell A



250m by 250m

Grid Cell B



250m by 250m

Grid cell A

Subclass	LCM Subclasses	Score	Area m²	Percentage Area	Relative Naturalness
4.1	Arable Cereals	3	14278.91	22.85	68.55
6.1	Rough Grass / Grass	5	4911.78	7.86	39.3
7.1	Calcareous grass	5	5481.29	8.77	43.85
10.1	Dwarf shrub heath	6	37827.96	60.52	363.12
				Total =	514.82

Grid cell B

Subclass	LCM Subclasses	Score	Area m²	Percentage Area	Relative Naturalness
4.1	Arable Cereals	3	2869.58	4.59	13.77
6.1	Rough Grass / Grass	5	23833.54	38.13	190.67
2.1	Coniferous woodland	3	6546.89	10.48	31.43
4.1	Arable Cereals	3	1546.89	2.48	7.43
17.1	Built up areas, suburban /rural developed	2	6875.04	11	22.00
17.2	Built up areas, suburban /rural developed	1	5296.09	8.47	8.47
2.1	Coniferous woodland	3	11954.68	19.13	57.38
1.1	Broad-leaved woodland	6	3577.29	5.72	34.34
				Total =	365.49

Please note the analysis was carried out to 10km beyond the boundary of the NNP. However, the LCM 2000 dataset provided does go beyond the administrative boundary of Government

Office North East. Along the North-west boundary of the NNP the dataset does not extend to 10km (see Figure 37).

Figure 37: the 'Boundary Problem' Relating to LCS 2000 Data Availability

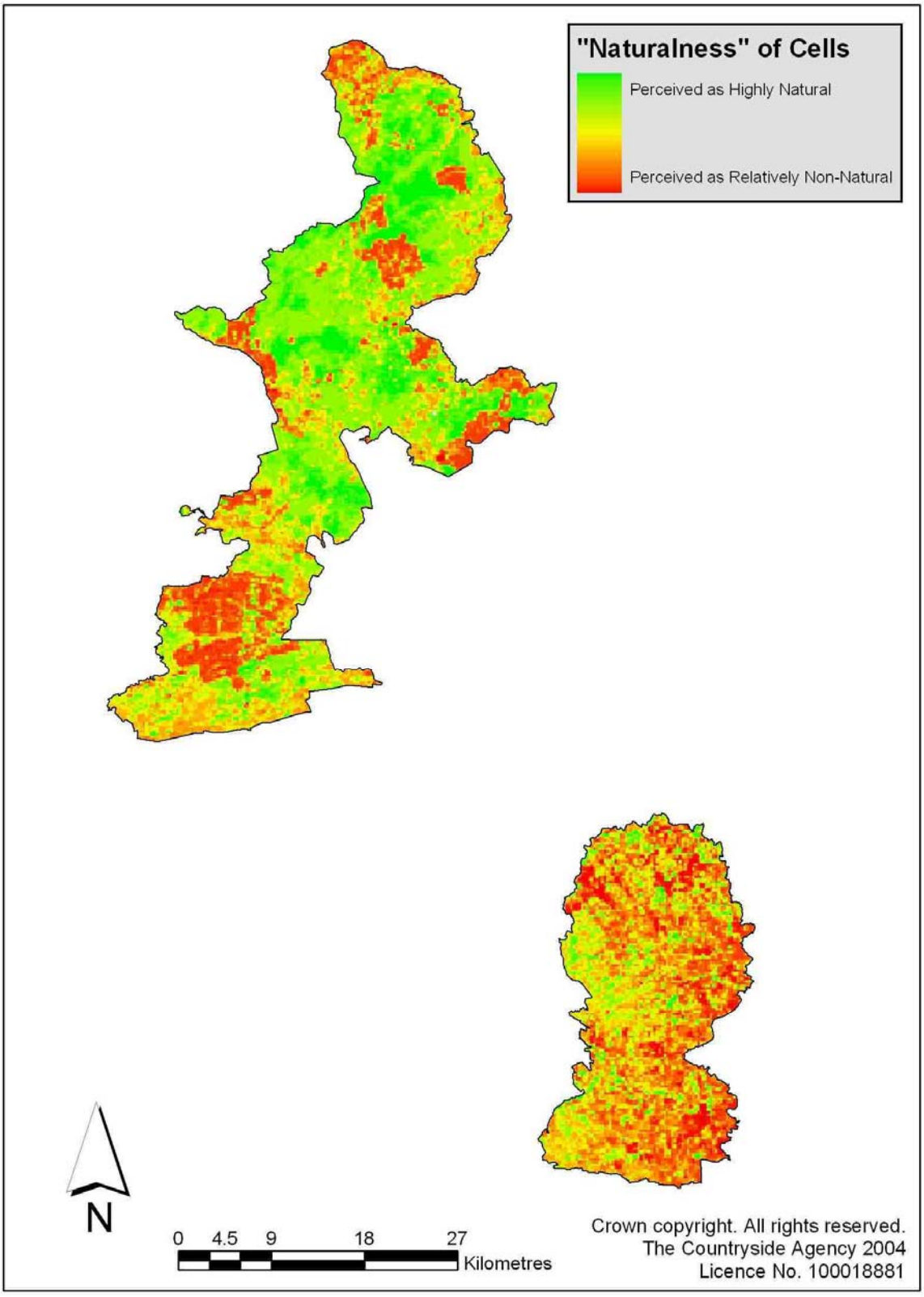


Figure 38: the perceived naturalness of individual cells

Perceived Naturalness of Landcover of Contextual Cells

Through the process described above each 250 grid cell was allocated a score of relative perceived naturalness. However, this value does not take into account the score of its surroundings cells – the relative naturalness of the surrounding landscape. The mean score of the eight surrounding cells in all directions was calculated for each individual 250m grid cell as illustrated in Figure 39.

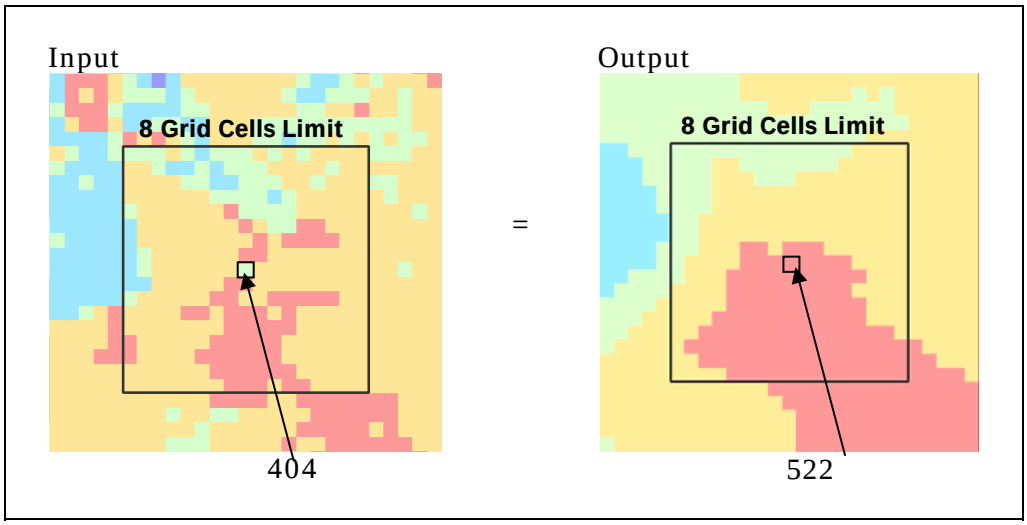


Figure 39: Calculating the Mean score for a 3 x 3 Context of Raster Grid Cells

The resulting output draws attention to those 'areas' within the landscape with similar scores of perceived naturalness, both high and low.

Note that along the North West boundary of the NNP the mean value is calculated using less than eight cells in a westerly direction.

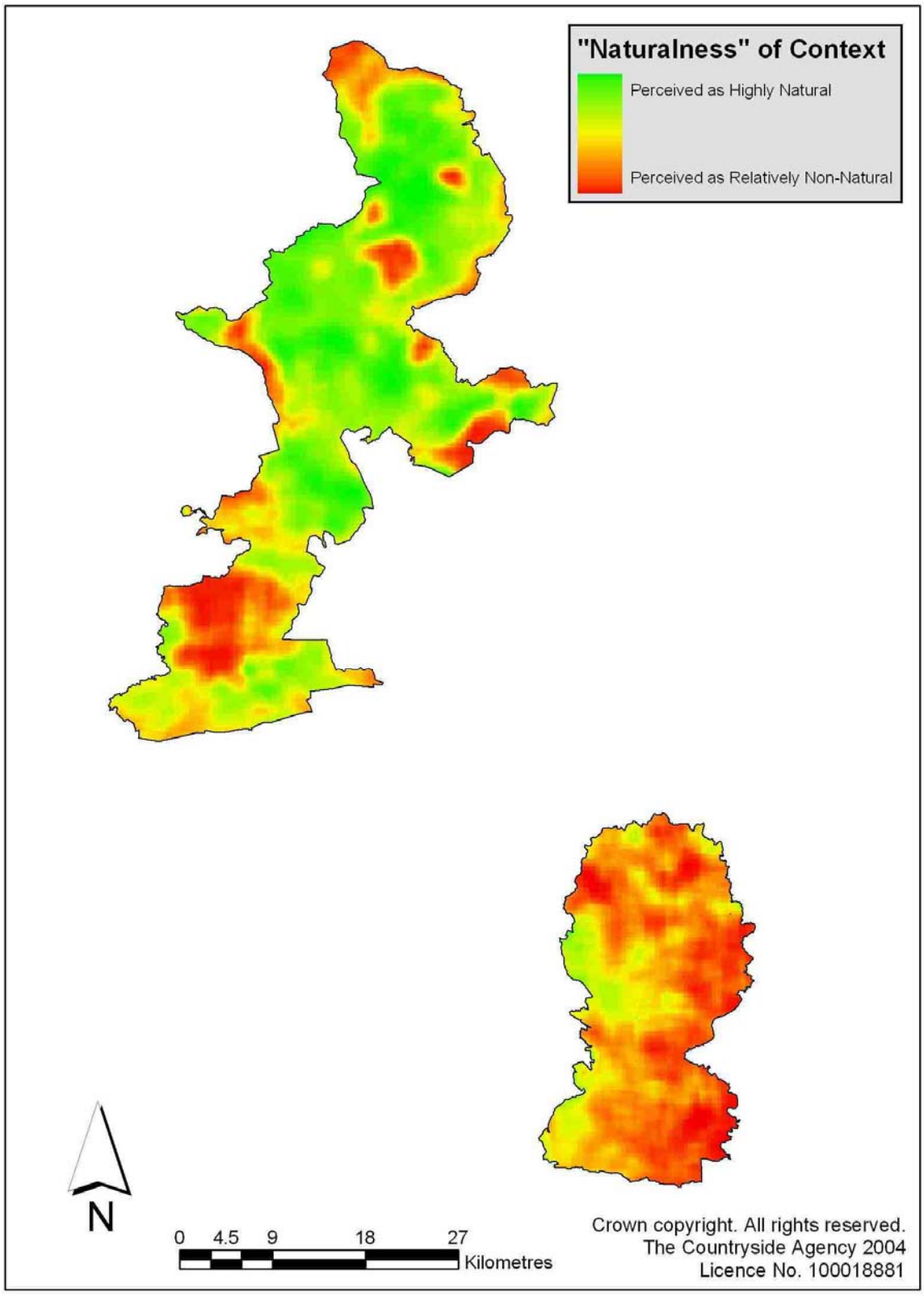


Figure 40: the perceived naturalness of context, the neighbouring cells

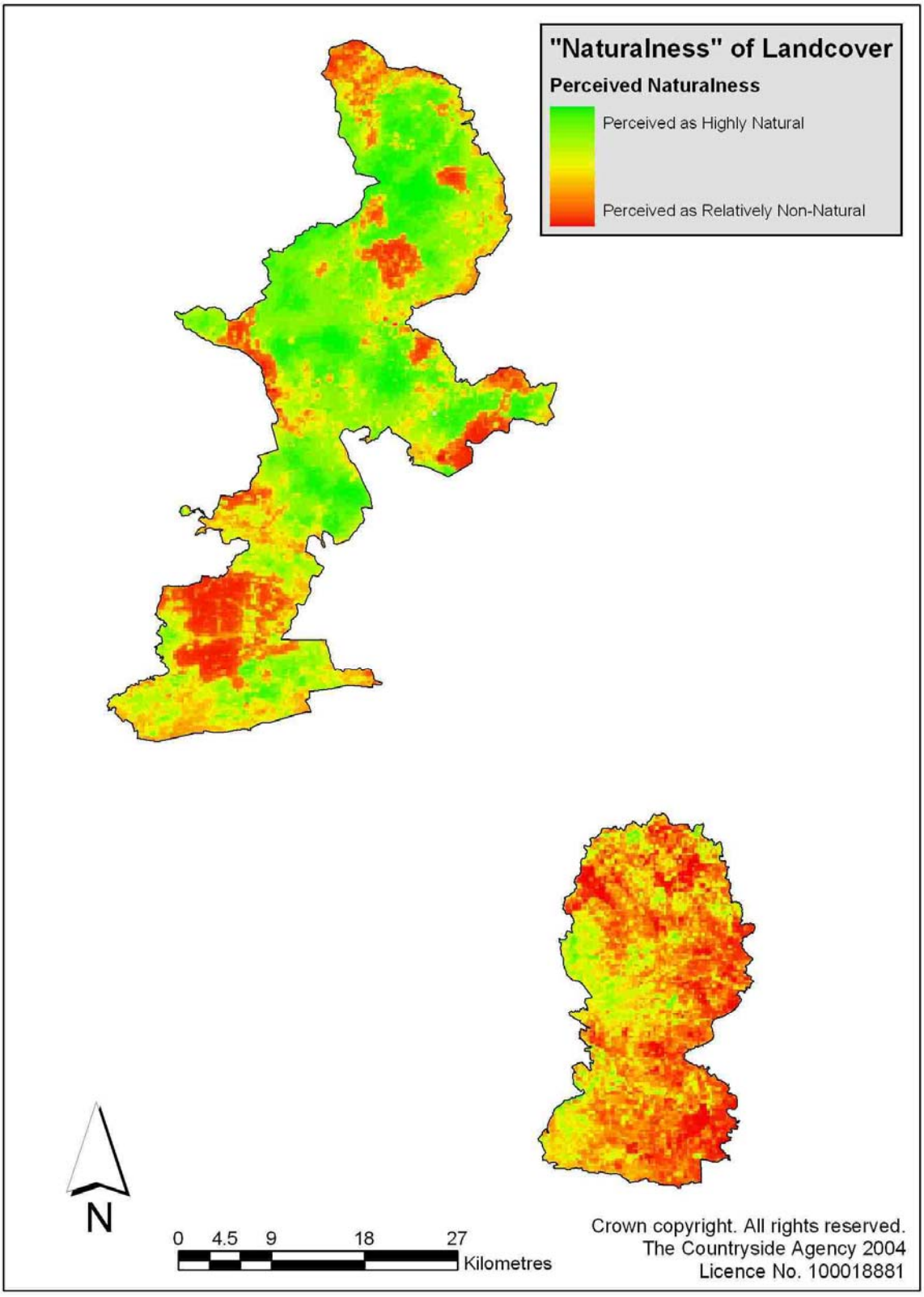


Figure 41: Final Score for Perceived Naturalness

4.4.8 Negative Attributes of Landscape

The visibility of non-natural features in the surrounding landscape

The results of the PA consultation highlighted the visibility of a series of what are classified as non-natural features within the landscape as a detractor from a feeling of tranquillity. The non-natural features identified and used in this study are:

- Roads: motorways and primary roads, A roads, B roads and minor roads
- Railways
- Urban Areas
- Isolated Properties
- Camping and Caravan parks
- Vertical structures: e.g. power pylons and telecommunications masts
- Windfarms

The visibility of these features within the landscape has been calculated individually and then combined to provide a spatial score of non-natural visibility for each 250m grid cell.

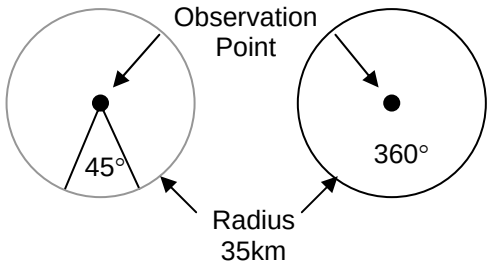
Visibility Analysis identifies those areas on a map that can see a single or many specified objects, for example, pylons. In this study the in-built viewshed function, part of the Spatial Analyst extension in ArcGIS v8.3, has been used to carry out the visibility analysis. Viewshed is one of many in-built functions within GIS software that are available for this type of analysis. There is no single description of visibility analysis, various software packages implement it differently. The type of datasets required in a visibility analysis and parameters that can be applied to them are summarised below:

- A Digital Elevation Model (DEM), that describes height over a topographic surface.

- A data set of predefined **observation points** can be used in the analysis. Observation points can take the form of any feature such as ferry routes or viewpoints or the whole land surface. For an area, a grid of observer points that covers the surface has to be created.

- For each observation point it is possible to set the field of view or **azimuth**, i.e. complete at 360° or at a defined azimuth of 45°.

Azimuth and Radius:



- In any visibility analysis, it is possible to set a distance limit beyond which visibility is no longer calculated. This **radius** can be set at any specified distance or is not set i.e. limitless. This brings in the issue of zones of theoretical limits of visibility (ZTV), which is the maximum distance over which research indicates objects of different sixes can be seen in clear conditions. ZTVs are therefore specific to different ojects.

- Heights are then chosen above the height given by the DEM for the observation points being analysed. This is the **subject height**, for instance, the height of pylons. This is known as a height offset.

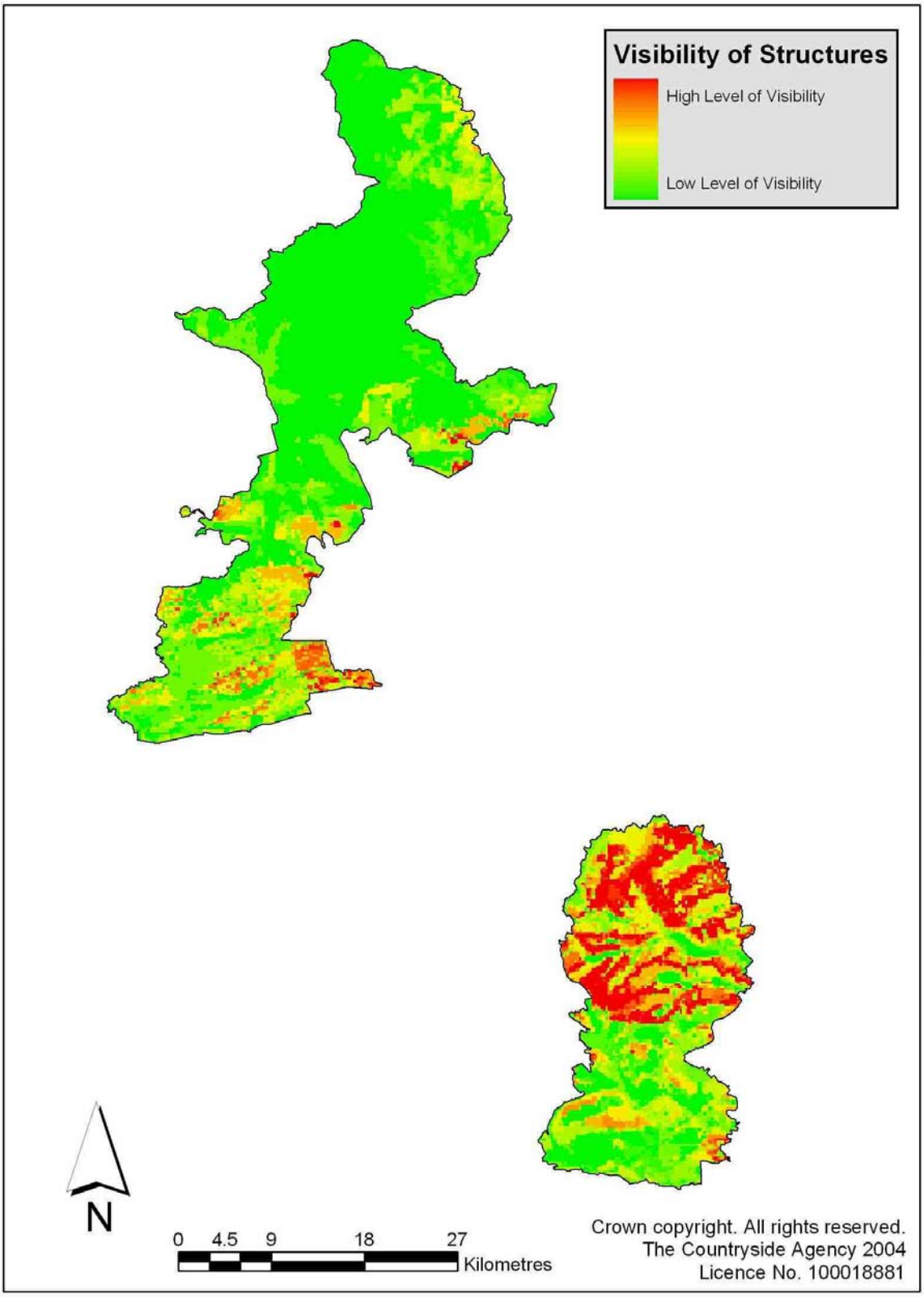
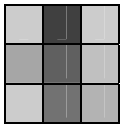


Figure 42 : the distance weighted relative visibility of all vertical structures that data were available for in this study

- An offset height for the observer is also essential, and is known as a **viewing height** – an individual standing within a National Park.

- The output or results of the analysis, a **visibility surface**, are usually recorded in Raster format.

Raster Format:



1	5	1
2	4	1
1	3	2

Uses a grid structure to store geographic information.

Calculating visibility identifies those cells in an input DEM that can be seen from one or more than one observation point subject to predefined parameters. Using one observation point as an example the output visibility map would contain cells that are classed as:

- A cell that can see the given observer point = 1
- A cell that cannot see the given observer point = 0

For each observation point the calculation is repeated individually. Each grid cell accumulates the cumulative score of visibility and it is equal to the number of observation points that that grid cell can 'see'. This number is controlled by the parameters set for the subject height, viewing height, location and number of observation points and resolution (grid size) of the output visibility surface. The higher the number of observation points a grid cell can 'see', the more visible that given grid cell is.

To summarise there are five key parameters that can be defined:

- subject height: the object being observed
- viewing height: the observer
- radius: distance limit of visibility calculations
- azimuth: field of view
- output grid: resolution of the visibility surface

These visibility calculations were then distance weighted to reflect the greater visual impact of features close to the viewer than those further away. This weighting was not explicitly derived from the PA data, but was based on judgement by the researchers and reference to good practice in the landscape field.

Distance	Weighting
>250 m	25
251 m-1 km	20
1 km – 6 km	15
6 km – 12 km	10
12 km – 20 km	5
20 km – 30 km	1

Table 13: the distance weighting of visibility calculations

The following sections describe how the requirements of the project are reflected in the specification of parameters given above. The method of data capture is also described along with an explanation of the results.

The visibility of Roads

A point has been generated every 100m along all motorways, primary roads, A roads, B roads and minor roads that lie within a 6km radius of the boundaries of the Northumberland National Park (NNP) and the Western Durham coalfield (WDC). The parameters below were applied.

Criteria	Parameter	Description
Subject Height	3m	Worst case scenario representing the height of a lorry on a road
Viewing Height	1.72m	Average height of a person
Radius (ZTV)	6km	Theoretical limit of visibility for an object less then 15m in height*
Azimuth	360º	Complete field of view
Output Grid Size	250m	The output visibility surface is the same as the 250m grid used throughout this study.

Source: Benson *et al.* (2000)

Cumulative visibility is then calculated for each separate road type. The visibility score represents the relative visibility of, worst-case scenario, lorries up to a height of 3m at any point along any road within the study area.

The visibility of Railways

A point has been generated every 100m along all types of railway that lie within a 6km radius of the boundaries of the NNP and the WDC. The parameters given below were applied. The visibility score represents the relative visibility of trains from within the NNP and WDC.

Criteria	Parameter	Description
Subject Height	2m	Average height of trains
Viewing Height	1.72m	Average height of a person
Radius (ZTV)	6km	Theoretical limit of visibility for an object less then 15m in height*
Azimuth	360º	Complete field of view
Output Grid Size	250m	The output visibility surface is the same as the 250m grid used throughout this study.

Source: Benson *et al.* (2000)

The visibility of Urban Areas

Urban areas were covered in a blanket grid of points. These points were generated by first overlaying all large urban areas with 100m grid squares. Each grid square is then converted to a central point – the centroid – which forms that cells observation point. The parameters given below were applied. Cumulative visibility is then calculated for all large urban areas within 6km of the boundaries of the NNP and the WDC.

Criteria	Parameter	Description
Subject Height	5m	Average height of buildings in built up areas
Viewing Height	1.72m	Average height of a person
Radius (ZTV)	6km	Theoretical limit of visibility for an object less then 15m in

		height*
Azimuth	360º	Complete field of view
Output Grid Size	250m	The output visibility surface is the same as the 250m grid used throughout this study.

Source: Benson *et al*. (2000)

The visibility of Isolated Properties

The boundaries that define large urban areas were used to select points from the Ordnance Survey Address Point dataset that lie outside large urban areas. These points are taken to represent isolated properties. The parameters given below were applied. Cumulative visibility is then calculated for all isolated properties that lie within 6km of the boundaries of the NNP and the WDC.

Criteria	**Parameter**	**Description**
Subject Height	5m	Average height of buildings in built up areas
Viewing Height	1.72m	Average height of a person
Radius (ZTV)	6km	Theoretical limit of visibility for an object less then 15m in height*
Azimuth	360º	Complete field of view
Output Grid Size	250m	The output visibility surface is the same as the 250m grid used throughout this study.

Source: Benson *et al*. (2000)

The visibility of Camping and Caravan Parks

The point location of all camping and caravan parks within the NNP and WDC were digitised. The parameters given below were applied. The visibility score represents the visibility of all caravan parks within the NNP and WDC.

Criteria	**Parameter**	**Description**
Subject Height	5m	Average height of buildings in built up areas
Viewing Height	1.72m	Average height of a person
Radius (ZTV)	6km	Theoretical limit of visibility for an object less then 15m in height*
Azimuth	360º	Complete field of view
Output Grid Size	250m	The output visibility surface is the same as the 250m grid used throughout this study.

Source: Benson *et al*. (2000)

The visibility of Quarries

Areas designated as quarries (supplied by Durham County Council) were covered in a blanket grid of points. These points were generated by first overlaying all quarries with 100m grid squares. Each grid square is then converted to a central point – the centroid – which forms that cells observation point. The parameters given below were applied. Cumulative visibility is then calculated for all quarries within 6km of the boundaries of the WDC.

Criteria	**Parameter**	**Description**
Subject Height	0m	Ground surface
Viewing Height	1.72m	Average height of a person
Radius (ZTV)	6km	Theoretical limit of visibility*

Azimuth	360º	Complete field of view
Output Grid Size	250m	The output visibility surface is the same as the 250m grid used throughout this study.

Source: Benson *et al.* (2000)

The visibility of Vertical Structures

The visibility of point locations of all VHF masts, pylons and telecommunications masts that lie within 15km of the study area boundary were calculated using the parameters given below.

Criteria	**Parameter**	**Description**
Subject Height: VHF Mast Pylons Cellnet Masts	 45m 45m 15m	Height of vertical structures.
Viewing Height	1.72m	Average height of a person
Radius (ZTV) VHF Mast Pylons Cellnet Masts	 15km 15km 6km	Theoretical limit of visibility for structures between 15 and 50m in height*
Azimuth	15º	Complete field of view
Output Grid Size	250m	The output visibility surface is the same as the 250m grid used throughout this study.

Source: Benson *et al.* (2000)

Windfarms

The point location of all windfarms were obtained from the BWEA website (http://www.bwea.com/). The grid reference obtained is accurate to within 100m. The parameters given below were applied.

Criteria	**Parameter**	**Description**
Subject Height: **NNP:** Kirkheaton **WDC:** Great Eppleton Holmside Hall Tow Law High Headly Hope	 56.5 61m 80m 51.75m 58.5m	Rotor Height of turbine.
Viewing Height	1.72m	Average height of a person
Radius (ZTV)	20km	Theoretical limit of visibility for structures between 50 and 100m in height*
Azimuth	360º	Complete field of view
Output Grid Size	250m	The output visibility surface is the same as the 250m grid used throughout this study.

Source: Benson *et al.* (2000)

4.4.9 Composite Visibility of Negative Elements

Visibility of all of the following features were combined into a single map layer (Figure 43), visible overt human development:

- Roads: motorways and primary roads, A roads, B roads and minor roads
- Railways
- Urban Areas
- Isolated Properties
- Camping and Caravan parks
- Vertical structures: e.g. power pylons and telecommunications masts
- Windfarms

This was done to capture responses from the consultation which were relatively non-specific, yet clearly related to visibility of such negatively classed features, for instance ‘signs of man’s interference’, ‘man made structures’ and ‘anything unnatural’.

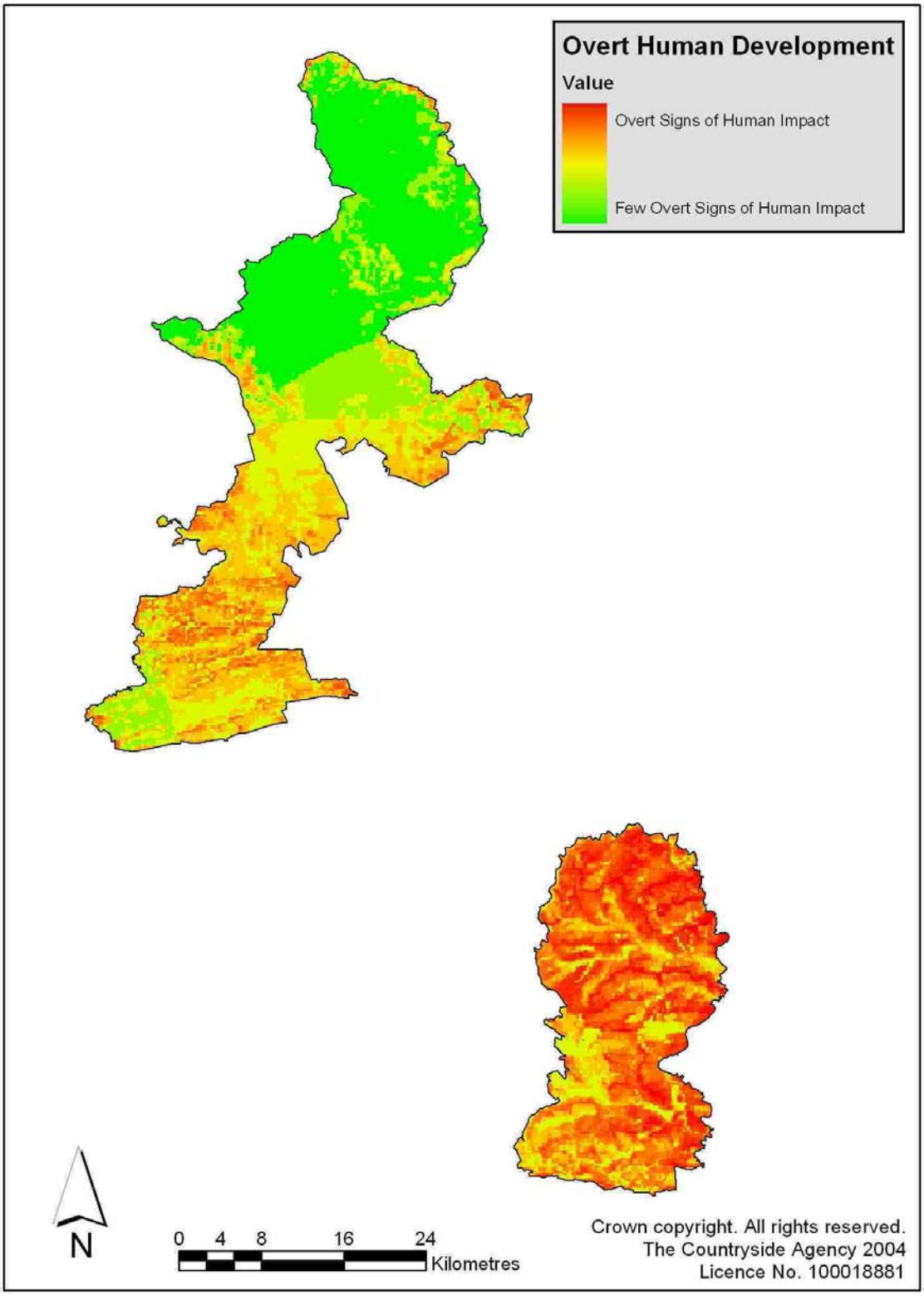


Figure 43: the composite visibility of overt human influence in the landscape

4.4.10 Night time sky glow from urban areas

Light pollution is a negative externality, that is an unwelcome side effect from one person / group/ area's private use of light than effects wider public interests that may be better served by an absence of light. Clearly there are social values implicit in the term 'light pollution' and there is clear potential for conflicts between interest groups. However, light pollution did emerge from the PA data as being of limited significance as a factor that detracted from the tranquillity of landscape. CPRE has previously published a report on the problem[15], but existing methodological research on quantifying overhead skyglow is limited. Skyglow is a term for the brightness of the night sky from diffused artificial light. Albers and Duriscoe (2001) quantitatively define skyglow as a function of distance from urban area and size of urban area. The equation used to identify the relative contribution of skyglow from settlements of different sizes was drawn from Albers and Duriscoe (2001).

$$\text{Skyglow in Nanolamberts} = 11300000 \times (\text{population} \times \text{distance}^{-2.5})$$

The research underpinning this is drawn from the USA where cities are much larger and the population density of rural areas is generally far lower. No account is taken of sparsely distributed light sources as skyglow results from the cumulative effect of concentrations of light sources. However, from an experiential point of view visibility of isolated lights or concentrations of lights in the distance (see Figures 44 and 45 overleaf) may have a negative impact. However, only skyglow is considered here.

Data from the Office for National Statistics[16] which classified settlements of a population greater than 1000 into four separate classes were combined with the remaining urban polygons from Strategi on the assumption that these has a population of less than 1000. The mid point of each range was then used in the equation from Albers and Duriscoe (2001) in Excel (Table 14).

Population Classes for Urban Areas	Midpoint used for Skyglow Modelling
< 1000	500
1067 – 3225	2146
3269 – 8691	5959
8694 – 25461	17077
26238 – 189150	107694

Table 14: Median values of population classes used skyglow calculations

Values in Nanolamberts were calculated for each 250m in distance away from each of the classes of urban areas. A cut-off of 1000 Nanolamberts was used as the lower limit of the calculations. The exponential nature of the unit of measurements is clear from table 14, as is the *relatively* localised effect of skyglow from urban settlements.

[15] http://www.cpre.org.uk/resources/pub/pdfs/landscape/light-pollution/night-blight-leaflet-a3.pdf
[16] http://www.statistics.gov.uk/geography/urban_rural.asp

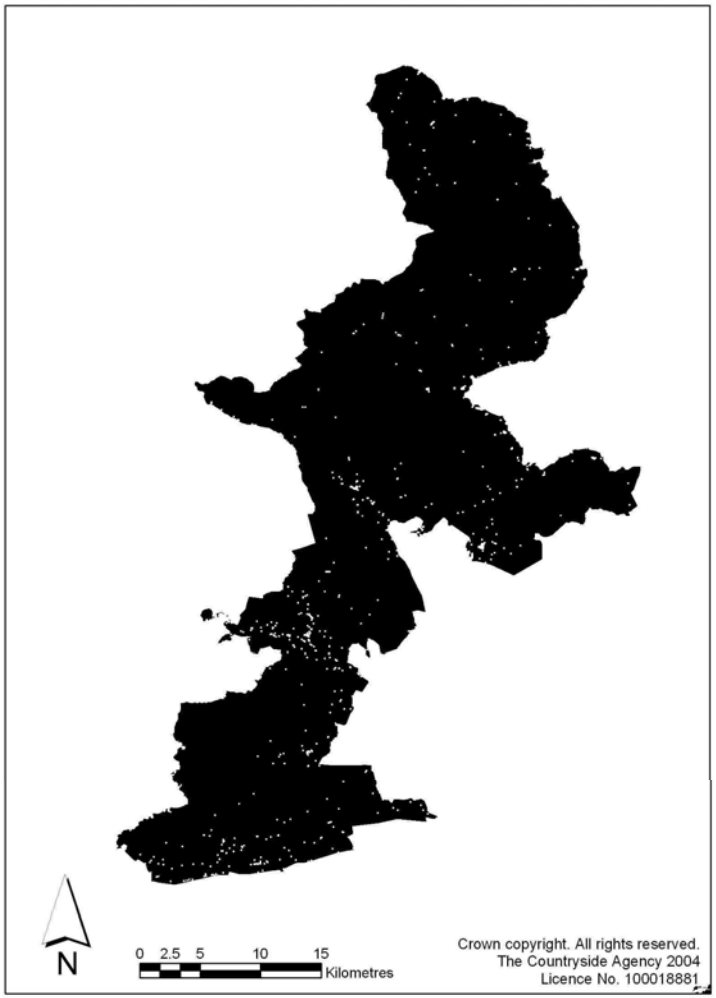


Figure 44: actual night time light sources (as white points) in the NNP

Figure 45: actual night time light sources (as white points) in the WDC

Distance (Metres)	Population 500	Population 2146	Population 5959	Population 17077	Population 107694
	Skyglow in Nanolamberts				
250	5,717	24,539	68,140	195,272	1,231,459
500	1,011	4,338	12,046	34,520	217,693
750	367	1,574	4,371	12,527	78,998
1000	179	767	2,129	6,102	38,483
1250	102	439	1,219	3,493	22,029
1500	65	278	773	2,214	13,965
1750	44	189	526	1,506	9,499
2000	32	136	376	1,079	6,803
2250	24	101	280	804	5,068
2500	18	78	215	618	3,894
2750	14	61	170	487	3,069
3000	11	49	137	391	2,469
3250	9	40	112	320	2,021
3500	8	33	93	266	1,679
3750	7	28	78	224	1,413
4000	6	24	67	191	1,203
4250	5	21	57	164	1,033
4500	4	18	50	142	896
4750	4	16	43	124	783
5000	3	14	38	109	688

Table 15: Distance, population and skyglow in Nanolamberts

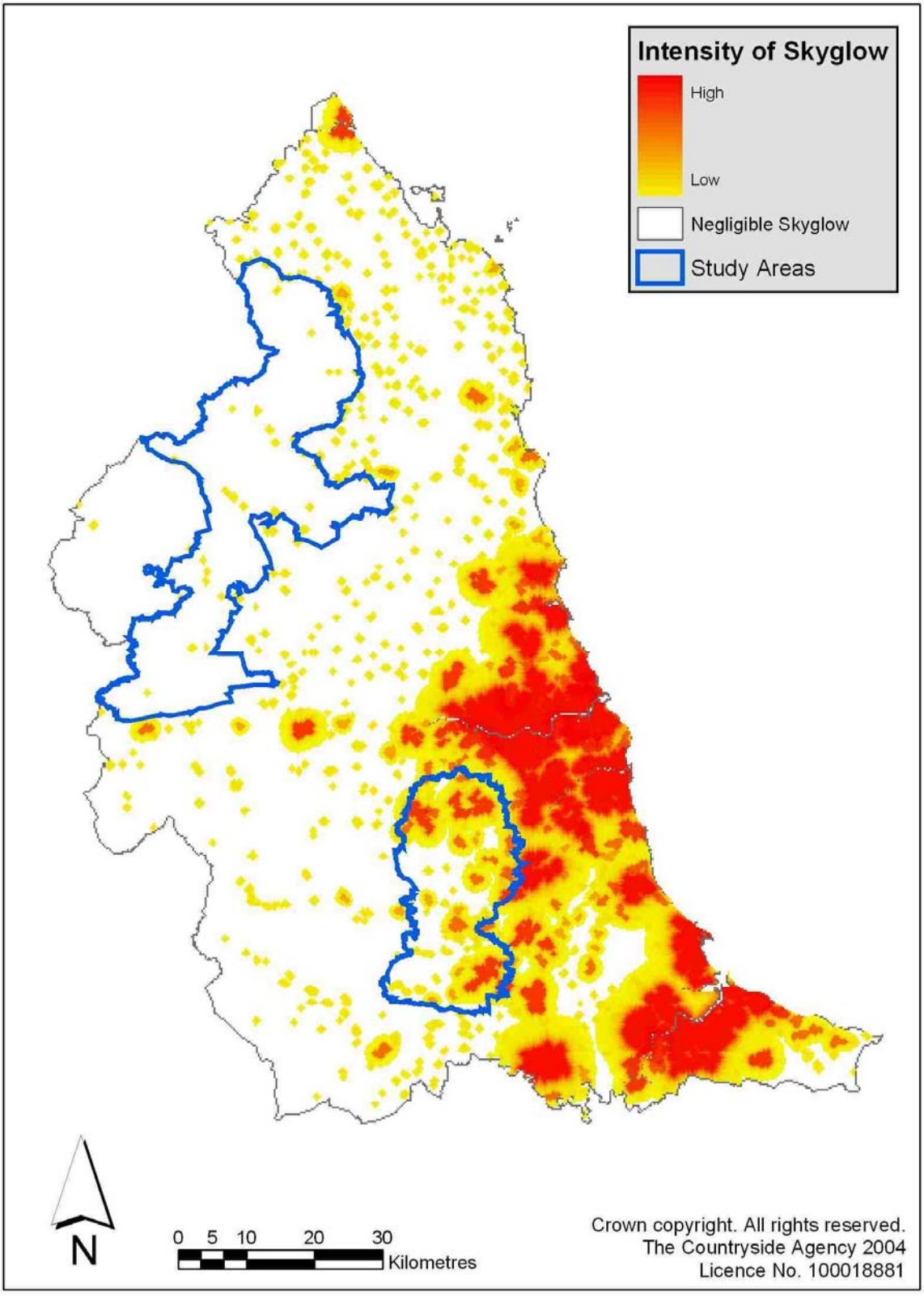


Figure 46: modelled skyglow for the North East of England

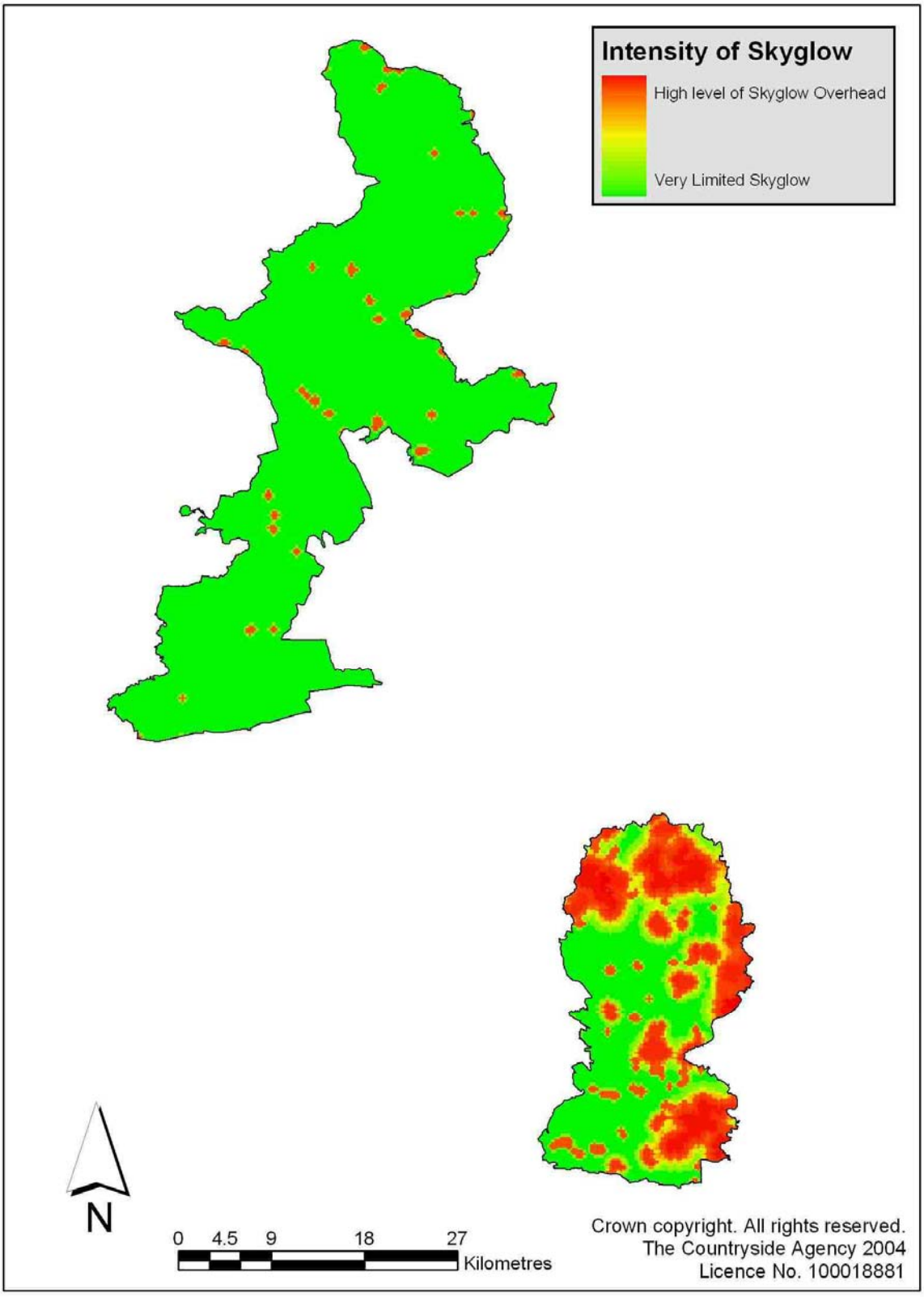


Figure 47: modelled skyglow for the study areas

4.5 Modelling the Impact of People

4.5.1 Introduction

Ultimately people are the source of almost all of the factors that detract from tranquillity, or the potential to achieve tranquillity. Human action also underlies some of the factors that contribute to tranquillity, for instance through land management that results in landscapes that are perceived as being relatively highly natural.

This is an example of what may be perceived as 'double counting'. For example, roads are a source of noise, a visual intrusion into the perceived naturalness of a landscape and they can act as a source of people in their diffusion into the surrounding countryside. To try and merge all these effects into a single 'roads' indicator was judged ultimately unhelpful in that (a) there was no sufficient basis in the PA results to theme the model by objects as distinct from the *associated* intrusions into tranquillity, and (b) it could lead to complexity and a loss of transparency in the model, and the description of how and why it was developed in this way.

The term 'remoteness' is one that was not heavily used by respondents so it is not used as the headline for the category here, has previously been used in research into the mapping of wild land (Kliskey,and Kearsley, 1993). The approach in this study does not use Naismith's Rule as used by Carver et al (2002), but instead adopts an approach known as Cost Weighted Distance Modelling. In effect, through not precisely, what is calculated is a probability of seeing, hearing, or being in close proximity to (other) people in different parts of the study areas.

4.5.2 The PA Results

The entries in the spreadsheet of PA results following the verification events were thematically organised as described. Unlike the themes of 'Noise' and 'Landscape' it was not judged possible to differentiate the overall theme into sub-components which could be represented by different datasets. The relevant entries from the PA results spreadsheet appear in Table 4, and it can be seen that there is a great deal of diversity in the precise responses, but what they have in common is an association with the presence of people, especially in large numbers. The notion that certain activities and 'types' of people, for instance 'hooligans', 'loutish behaviour', 'quad bikes', 'bad music' and 'seventy six hikers in orange cagoules', comes through strongly. However, attempting a breakdown to accommodate specific responses was not attempted as this would have introduced a great deal of complexity. What the responses were judged to have in common was that the perceived nuisance was likely to increase with the number of people in view, earshot and proximity. This is of course an assumption and it will not capture the specific nature of all of the responses.

Question	Theme	Answer	Total Score	Expected dots per option	Weighted Score	DATASET	Positive or Negative Factor
What is not tranquillity?	You see....	vandalism	51	8	6.38	People	Negative
What is not tranquillity?	You see....	loutish behaviour	50	8	6.25	People	Negative
What is tranquillity?	You do not see...	rubbish	88	18	4.89	People	Negative
What is not tranquillity?	You see....	hooligans	38	8	4.75	People	Negative
What is not tranquillity?	You see....	pollution	34	8	4.25	People	Negative
What is not tranquillity?	You see....	litter	31	8	3.88	People	Negative
What is not tranquillity?	You see....	dog dirt	29	8	3.63	People	Negative
What is tranquillity?	You see...	open space without people	17	6	2.83	People	Negative
What is not tranquillity?	You see....	fly tipping	20	8	2.50	People	Negative
What is not tranquillity?	You see....	rubbish	20	8	2.50	People	Negative
What is tranquillity?	You see...	emptiness - not "stuff" going on	13	6	2.17	People	Negative
What is tranquillity?	You Don't Hear....	ghetto blasters/radios	65	33	1.97	People	Negative
What is tranquillity?	You Don't Hear....	mobile phones	65	33	1.97	People	Negative
What is not tranquillity?	You hear...	mobile phones	79	42	1.88	People	Negative
What is not tranquillity?	You see....	drunken teenagers	15	8	1.88	People	Negative
What is tranquillity?	You do not see...	bigots	33	18	1.83	People	Negative
What is tranquillity?	Of the Mind....	away from it all...	20	11	1.82	People	Negative
What is tranquillity?	You see...	remoteness	10	6	1.67	People	Negative
What is tranquillity?	Experiencing...	getting away from it all	57	37	1.54	People	Negative
What is not tranquillity?	You see....	plastic bags	12	8	1.50	People	Negative
What is not tranquillity?	You see....	too many people	11	8	1.38	People	Negative
What is not tranquillity?	You see....	irritating drunks	11	8	1.38	People	Negative
What is not tranquillity?	You hear...	noisy people	54	42	1.29	People	Negative
What is tranquillity?	Experiencing...	feeling like miles away from anywhere	44	37	1.19	People	Negative
What is tranquillity?	Of the Mind....	calm relaxation with others/alone	13	11	1.18	People	Negative
What is tranquillity?	You Don't Hear....	people shouting	38	33	1.15	People	Negative
What is tranquillity?	Of the Mind....	escape from people - human interference	12	11	1.09	People	Negative
What is not tranquillity?	You see....	beer cans	8	8	1.00	People	Negative
What is not tranquillity?	You hear...	sound of blasting music	39	42	0.93	People	Negative
What is tranquillity?	You Don't Hear....	loud music	29	33	0.88	People	Negative
What is tranquillity?	You Don't Hear....	dogs barking	28	33	0.85	People	Negative
What is tranquillity?	You Hear....	music	30	36	0.83	People	Negative
What is not tranquillity?	You see.... Additional	charvas	6	8	0.75	People	Negative
What is	You do not see...	other people	12	18	0.67	People	Negative

tranquillity?							
What is tranquillity?	You Don't Hear....	loud children	20	33	0.61	People	Negative
What is not tranquillity?	You hear...	radios loud	24	42	0.57	People	Negative
What is tranquillity?	Of the Mind....	solitude	6	11	0.55	People	Negative
What is not tranquillity?	You see....	kids noisier and louder these days - don't play quietly	4	8	0.50	People	Negative
What is tranquillity?	You see...	other people	3	6	0.50	People	Negative
What is tranquillity?	You do not see...	seventy-six hikers in bright cagoules	8	18	0.44	People	Negative
What is tranquillity?	You do not see...	human 'recreation'	7	18	0.39	People	Negative
What is tranquillity?	You do not see...	dogs	7	18	0.39	People	Negative
What is not tranquillity?	You hear...	noisy children	16	42	0.38	People	Negative
What is not tranquillity?	You see....	kids playing (scream all the time)	3	8	0.38	People	Negative
What is not tranquillity?	You see....	graffiti	3	8	0.38	People	Negative
What is tranquillity?	You do not see...	children	5	18	0.28	People	Negative
What is not tranquillity?	You hear...	dogs	11	42	0.26	People	Negative
What is not tranquillity?	You see....	too large visitor's centre	2	8	0.25	People	Negative
What is tranquillity?	You do not see...	mountain bikes	3	18	0.17	People	Negative
					Sub-total	**80.66**	

Table 16: Sorted Useable PA Responses relating to People

4.5.3 Cost Weighted Distance Modelling

Working from the conclusion that people-related nuisance declines with a reduction in the concentration of people, this component of the GIS model needed to define, all things being equal, a raster surface which was in effect the probability of people being present in any given grid cell. There are two caveats here (a) the results are not expressed as a statistical probability, but rather as a graded level of likelihood of being close to other people, with all the attendant intrusions on tranquillity that this is seen to be associated with, and (b) that this necessarily excludes people *working* on the land. The Cost Weighted Distance (CWD) model calculates the relative likelihood of people arriving at a given cell from a set of defined source points, lines or areas, as elaborated below. The likelihood of people working on the land, whether agricultural, forestry-related, military or other, has not been factored in as the PA results were dominantly focused on recreational users of the countryside. Technically this is quite possible, with a relative likelihood of non-recreational countryside users being calculated and factored into the GIS model, although additional research would be required to calibrate this input.

CWD models are a variant of simple distance calculations in GIS. Figure 48 illustrates output from such a calculation. In this the calculation is solely one of how far one cell is from a given starting point, in this case a single point at the centre of the image.

CWD calculations were developed to calculate the cost of moving goods from a source to a delivery point. Instead of assuming an isotropic plain in which there is an equal cost incurred in passing over each cell, and total cost is a simple function of distance travelled, users can define variable costs for cells with different characteristics.

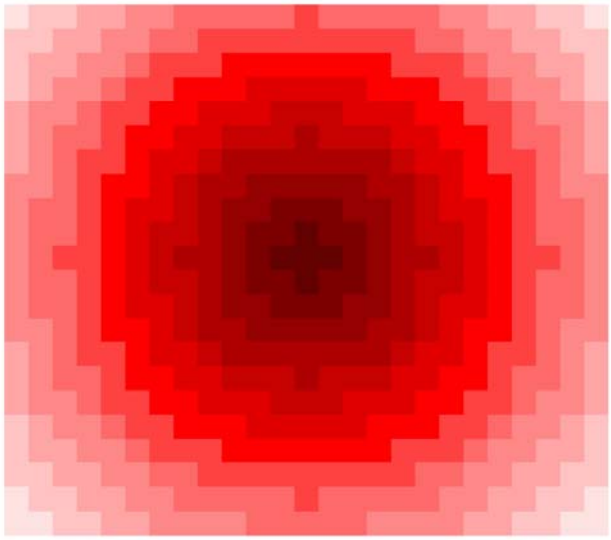


Figure 48 : output from a simple raster distance calculation, from the central point

CWD models require two inputs:

i. the source from which the diffusion is to start. This can be a point, a set of points, a line or an area;

ii. the relative friction of the landscape over which movement is to be modelled. In this case private, enclosed land was allocated a high frictional value, or cost, and open access areas and linear countryside routes were allocated lower values.

The following layers were defined as sources of people:

- Urban areas (polygons from the OS Strategi dataset and attributed with population and stratified into five categories from Office for National Statistics data)
- Buildings outside of urban areas (from OS Addresspoint)
- Roads (from OSCAR dataset)
- Honeypot sites, comprised of:
    - Car parks (digitised from 1:25,000 base maps)
    - Caravan and Camping Sites (georeferenced from yell.co.uk search and cross-referenced against 1:25,000 base maps)
    - Picnic Sites (digitised from 1:25,000 base maps)
    - Visitor Centres (digitised from 1:25,000 base maps)

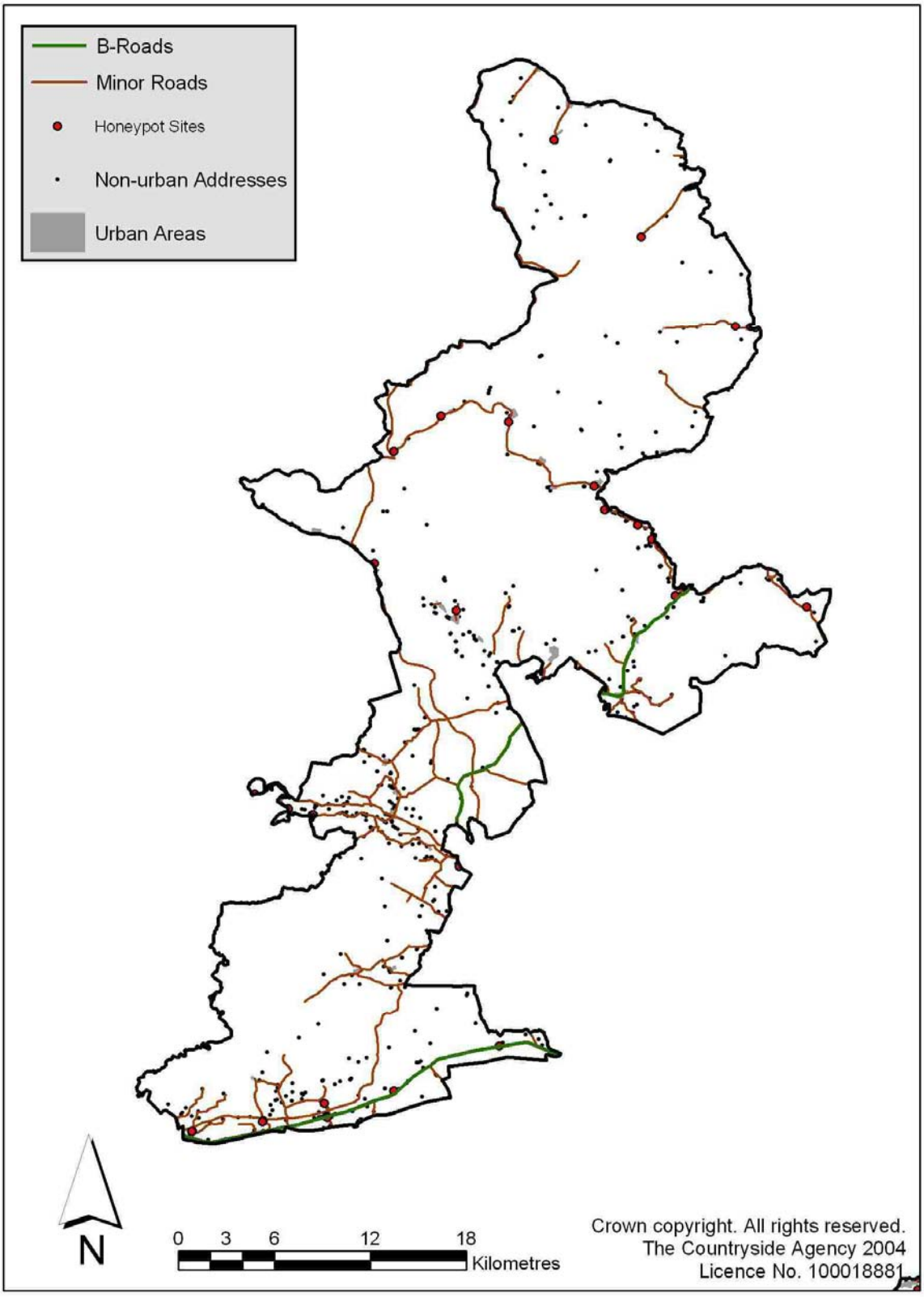


Figure 49: Sources of People in the NNP Study Area for the CWD Model

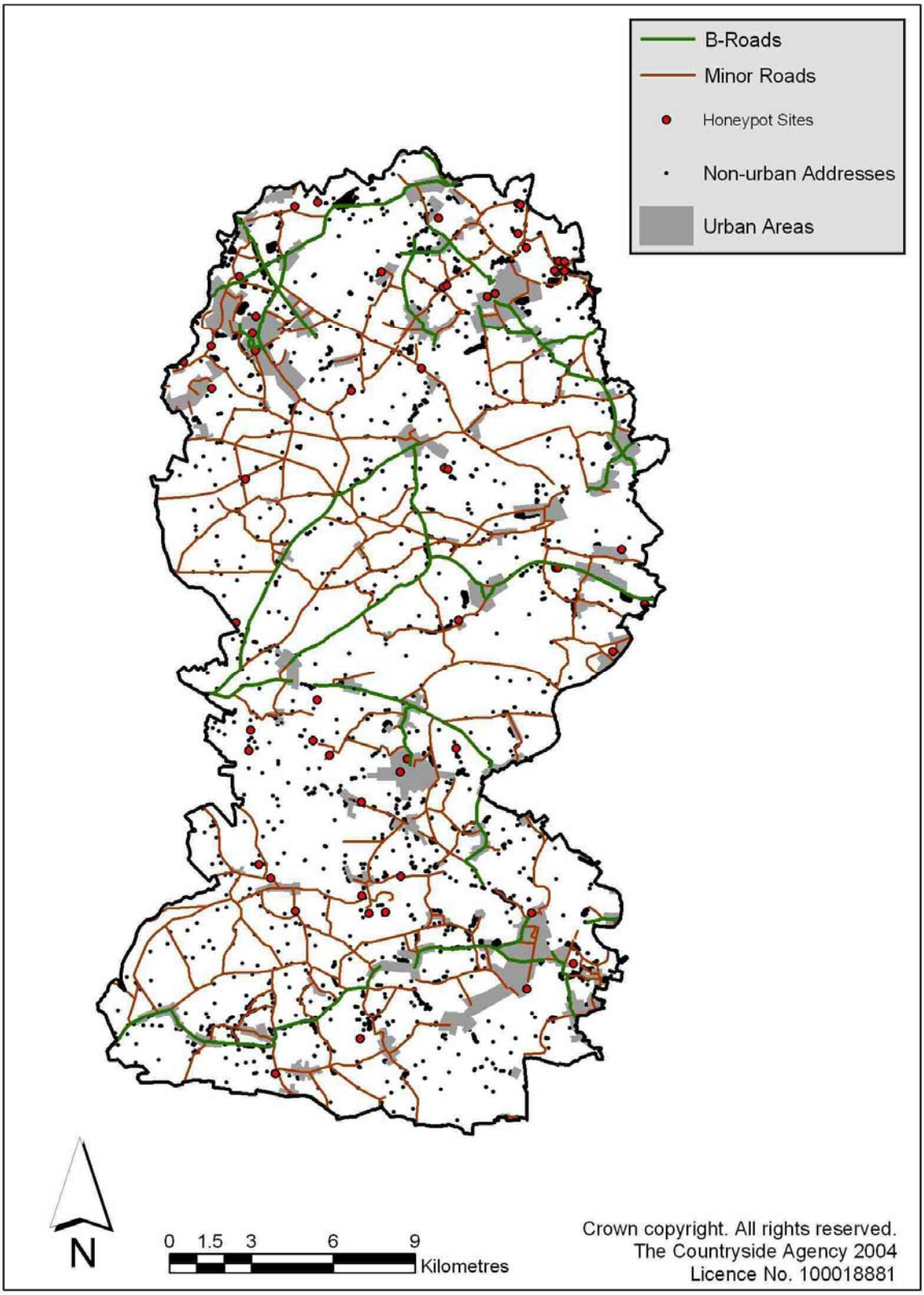


Figure 50: Sources of People in the WDC Study Area for the CWD Model

The following layers were defined as having relative levels of resistance, or friction, to the spread of people through the countryside:

- Open access areas (digitised from the hard copy 1:25,000 maps)
- Public Rights of Way (supplied by the County Council Highways Authorities)
- Forest Tracks (supplied by the Forestry Commission).

These are illustrated in Figure 51, for the NNP Study Area.

The vector layers were rasterised at the 250m x 250m grid cell level, and the following values were allocated to each of the classes:

Area	**Level of Friction**
Open Access Area	1
ProW	3
Forest Track	10
Remaining Area	20

Table 17: relative frictional levels allocated for CWD calculations

The relatively high frictional level accorded for forest paths reflects the relatively absorptive capacity of woodland in both a noise and visual sense.

At present there is no differentiation between footpaths to reflect relative use levels. Different paths have very different use levels and if data on these levels were available then specific routes could be allocated a lower value that others to reflect their higher popularity.

It is important to remember that these values are not units of anything in particular, but rather they represent the *relative* level of resistance to passage over cells with these respective values. As Fig 46 illustrates, some of these factors are overlain. Where this was the case the lowest level of friction was recorded in the composite layer.

Figure 52 illustrates the operation of the CWD model.

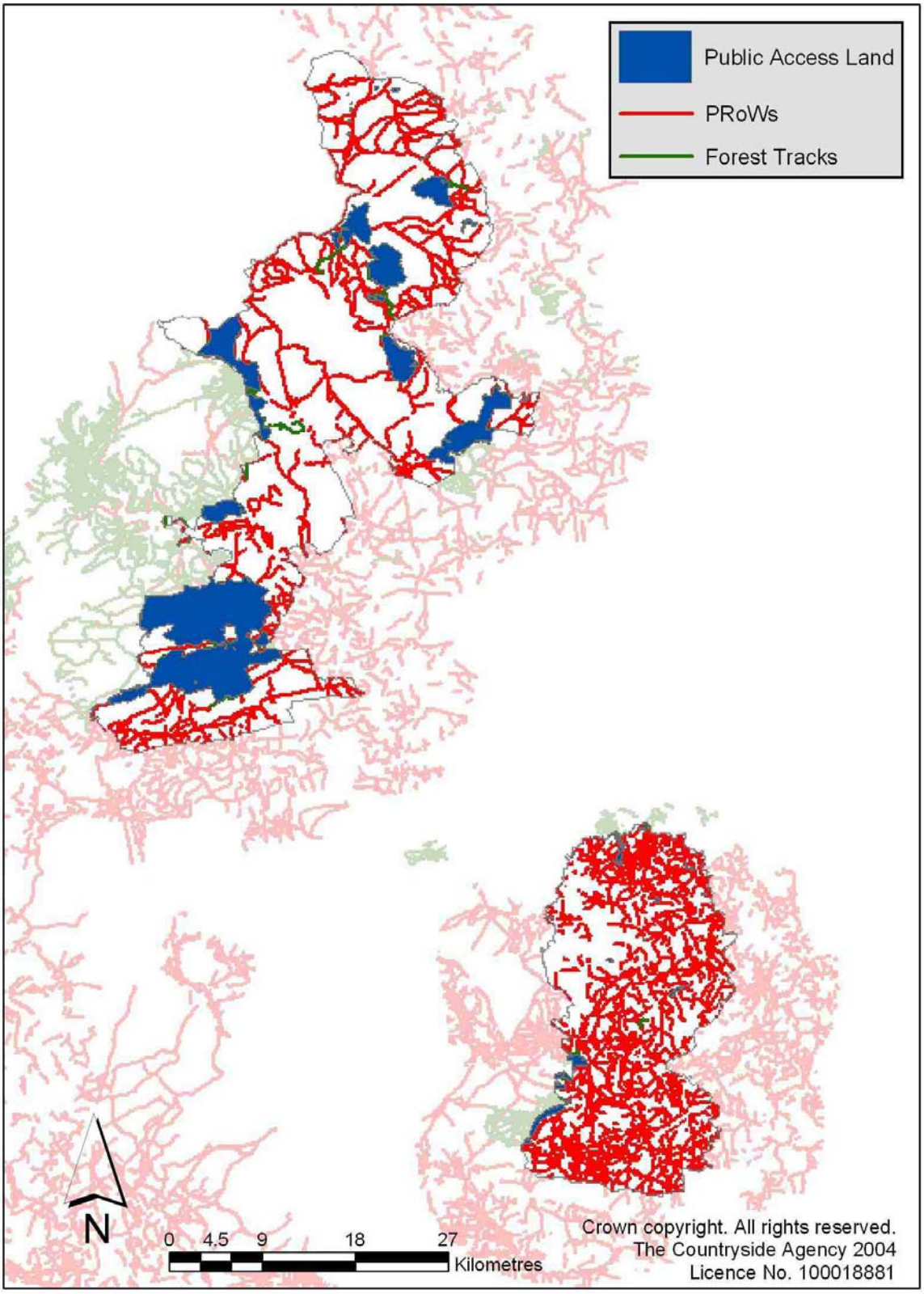
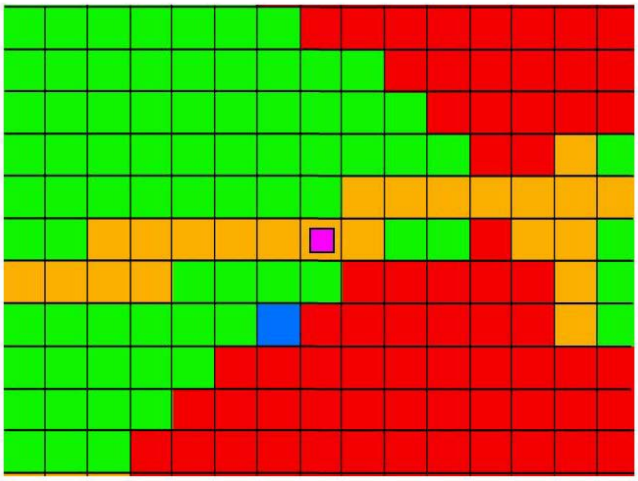
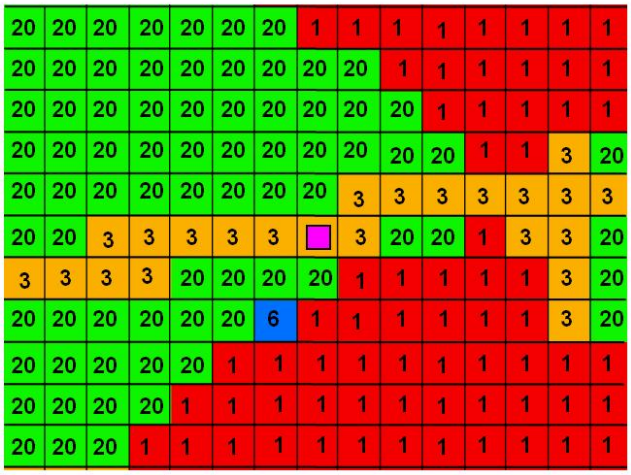


Figure 51: Vector inputs to the Raster Frictional Surface for CWD Modelling. This map uses a semi-transparent mask to show data availability surrounding the study areas. The absence of data from Scottish Borders is clear, although the legal status of countryside access is different under Scottish Law.

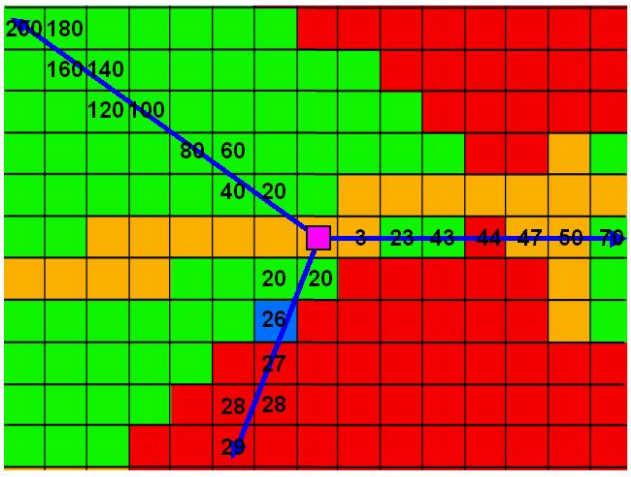


The source point for the CWD model is the purple square in the centre of this image.

The different colours in the other cells represent different frictional or cost values associated with that cell.



In this image the numeric value represents the frictional or cost values associated with that cell.



Three lines of travel are identified in this image and the cumulative cost of travelling along them, cell by cell, is illustrated. In the CWD calculations for the study area the maximum cell value for the main roads calculation was 100,595, and for Honeypots the maximum was 76,156. This is the 'cost' of getting to the cell with the maximum value, with highest 'cost' equating to maximum difficulty and maximum difficulty equating with lowest likelihood of being near to recreational users of the countryside in that cell[17].

Figure 52: explanation of the CWD Approach

[17] This is slightly simplified for illustrative purposes, In reality the cells values created in a CWD calculation are the resolution of the cell x the frictional surface cell values. This is then spatially cumulative. So, if the cell size was 100m x 100m and the frictional surface was set to 2, the cell values moving away from the source would be 200, 400, 600, 800 and so on.

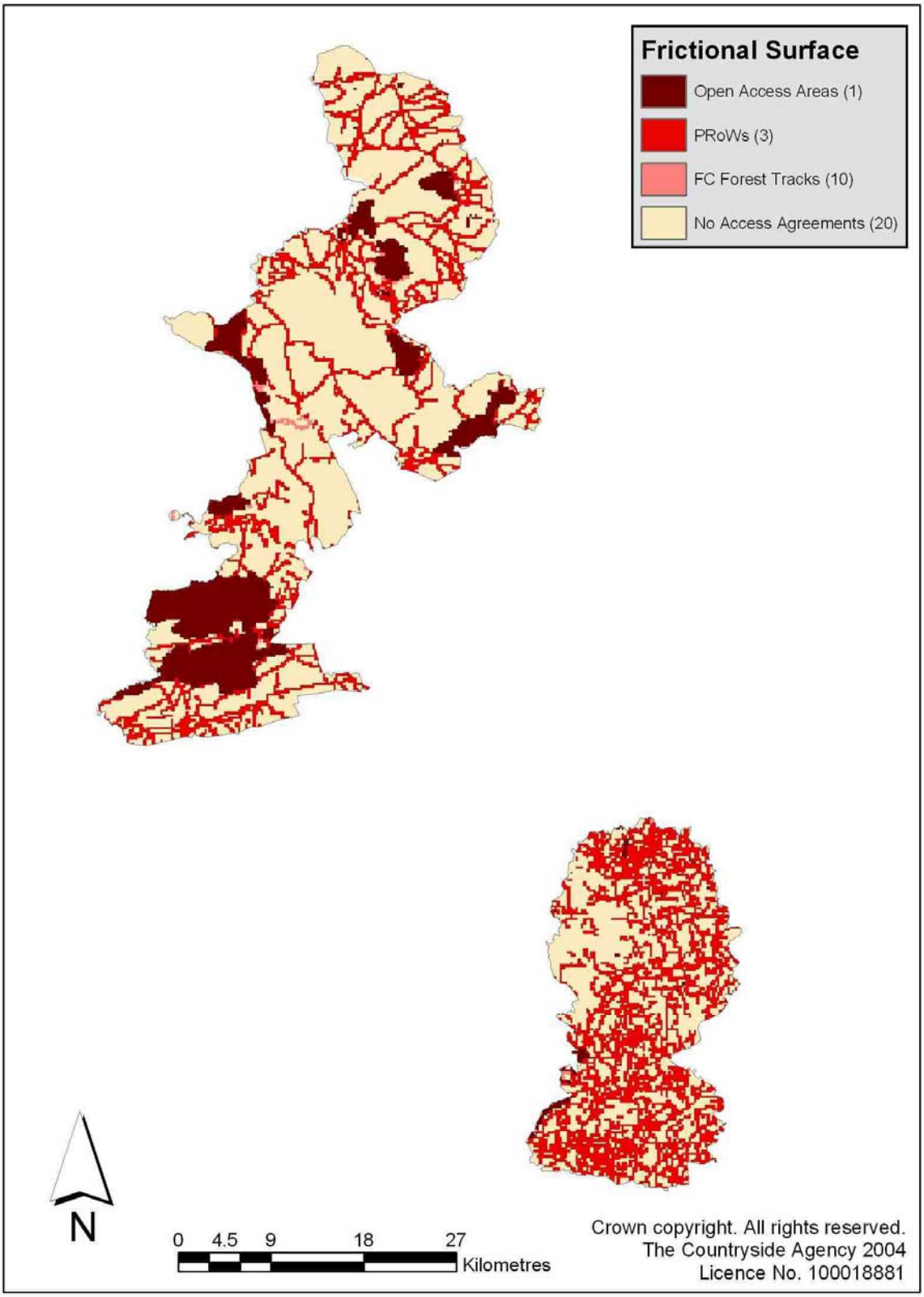


Figure 53: the Frictional Surface for CWD Modelling

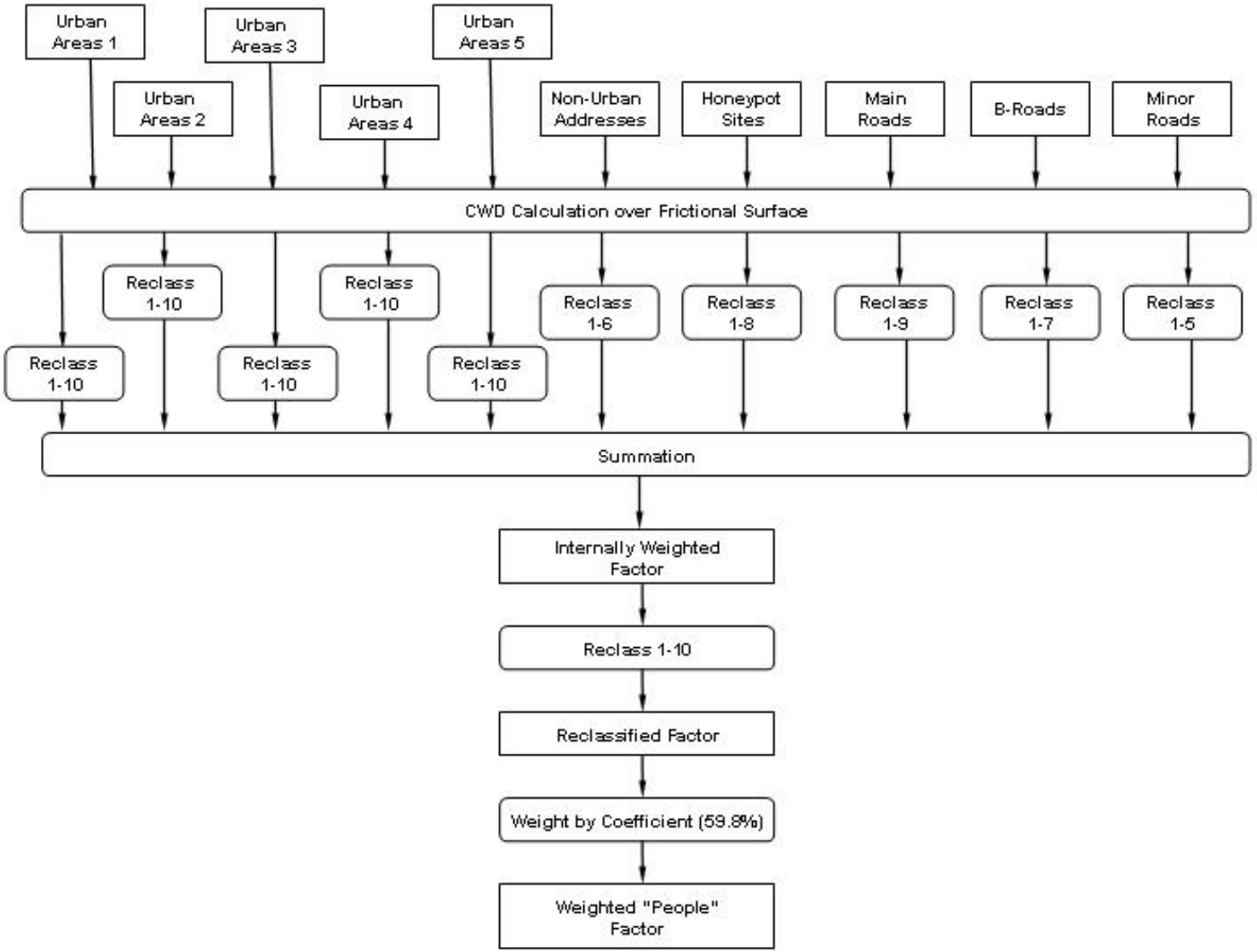


Figure 54: Summary of the 'People' Element of the GIS Model

Figure 54 provides an overview of this element of the GIS model. The CWD technique has been described. CWD models were run over each of the identified 'people sources'. As each of these sources of people are judged to have different levels of significance in distributing people into the countryside, a level of weighting was included at this stage. Rather than reclassifying the spread of minimum to maximum values for each input layer on a range of zero or one to ten, different maxima were used for different inputs, as illustrated in Table 18.

Cost Weighted Distance Dataset	**Value out of Maximum of 10**
Distance from Urban Areas population 26,328 – 189,150	10
Distance from Urban Areas population 8,694 – 25,461	9
Distance from Urban Areas population 3,225 – 8,691	8
Distance from Urban Areas population 1,067 – 3,225	6
Distance from Urban Areas population under 1,000	5
Distance from Properties outside Urban Areas	4
Distance from Honeypot Sites	8
Distance from B Roads	5
Distance from Minor Roads	5

Table 18: internal weighting used in the People Element of the GIS Model

These values were judgements about the relative significance of the different factors as sources of people. There are two dimensions to this, however. Firstly busy roads are clearly sources of people passing through an area and as such a sense of remoteness close to, and in view of, such a road is unlikely to be achieved. Although a minor road is much quieter in terms of traffic, cars can more easily be parked alongside such roads as people go for a walk, picnic or similar.

As illustrated in figure 54 a series of individual CWD calculations were carried out. However, as data outside of the specific study areas were included in these calculations as factors outside would have an effect on the values within, the results had to be clipped to the study areas. This was a three stage process:

1. the results for each CWD calculation were clipped to include both the NNP and the WDC. This gave the spectrum of values that related only to these areas.
2. the results for each CWD calculation were clipped to include only the NNP. This gave the spectrum of values that related only to the area of the National Park.
3. This was repeated for the WDC area, thereby calculating the relative spectrum of values that related to this area alone.

This process gave rise to nine weighted layers which were then combined through summation in the raster calculator and the resultant layer was weighted by the coefficient of 59.8% (rounded to 60% - see section 4.7) to give the final people element layer of the GIS model.

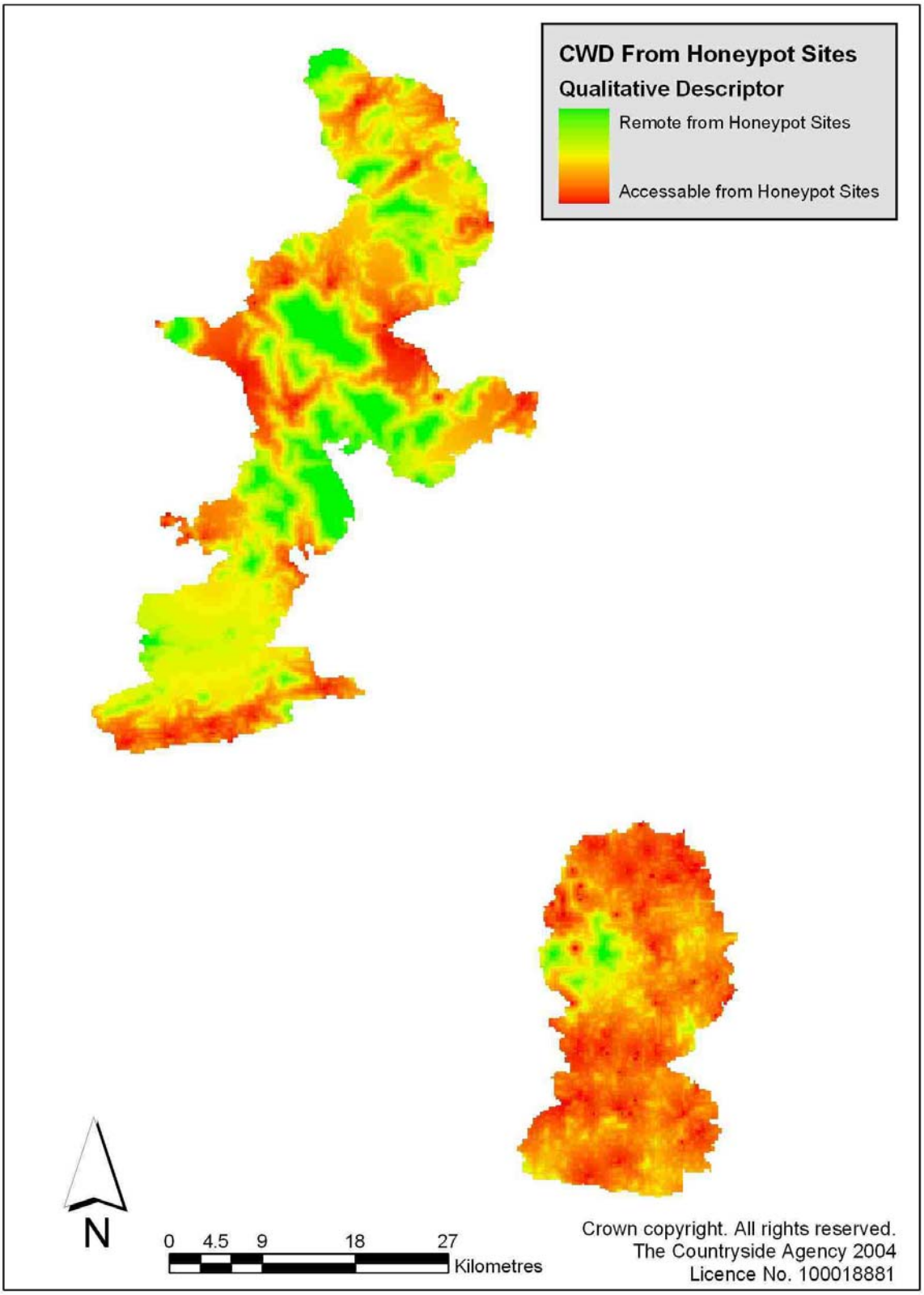


Figure 55: CWD from Honeypot Sites

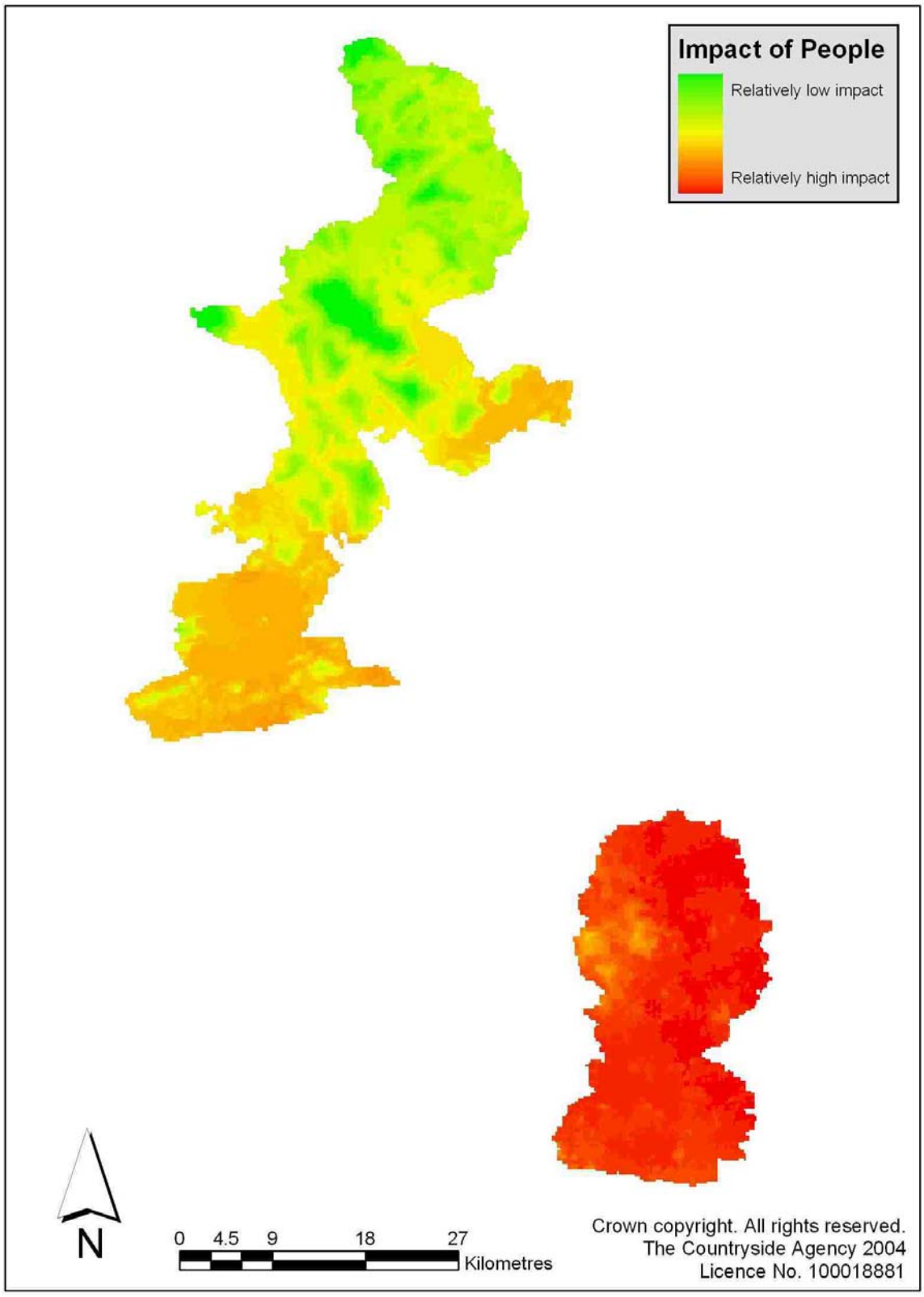


Figure 56: People Component Weighted Score

4.6 Modelling the Impact of Noise

4.6.1 Introduction: Sound and Noise

Sound is energy that is perceived by people in different ways according to characteristics of the sound (primarily volume and frequency) and the people themselves, upon whom sound has an affective in addition to a literal, physical impact. This affective impact depends on a range of factors such as their ability to perceive the sound (acuteness of hearing), their sensitivity to the sound (for instance people can become relative desensitised to sounds through repeated exposure) and their emotional response to the sound (for instance a military jet may be an exciting or reassuring sound to some, but to others it is associated with unwelcome forces in society).

Sound	Physical energy in an audible form, although it exists within and outside of the human ability to perceive it as sound.
Noise	Usually used to identify unwanted sounds.
Affective impact	The non-physical, emotional and mental impact of noise. This is related to people's perception of the noise and is associations and acceptability to them as individuals.
dB	A measurement unit for sound that identifies relative power. It is a logarithmic (to base ten) scale.
L_{eq}	Equivalent Continuous Noise Level: a measurement of noise energy over a given time period. A constant level of noise over ten seconds would be the same as a single second's burst of noise that was ten times as loud, when measured over the same ten seconds. Accurate time-series data are required to calculate L_{eq}
Ambient Noise	The all-encompassing noise associated with a given environment at a specified time. Ambient noise is usually taken to be a composite of many different noise sources with no single noise source being dominant.

Table 19: a definition of key terms in relation to sound and noise

Noise as a term is used to define unwanted sound and as such it depends upon human perception. However what we have modelled is the diffusion of sound; the selection of what sounds constitute noise is made on the basis of the consultation data. Noise volume is measured in Decibels (dB). As the human ear is capable of measuring a huge range, in the order of a billion-fold range, of noise levels, a logarithmic scale of measurement ($\log_{10}$) is employed. Table 20 illustrates the decibel levels of commonly experienced sounds to establish a context for figures that are used later, and figure 57 illustrates how people with 'normal' acuity of hearing can identify differences in loudness as measured using decibels.

Activity	Sound Level (dB)
Jet aircraft taking off nearby	150
Rock concert	120
Busy building site	110
Accelerating motorcycle nearby	110
Ambulance siren	95
Loud shout	90
Pneumatic drill	80
Vacuum cleaner	75
Normal conversation	60
Quiet office	50
Whispered speech	40
Average rural sound level at night	35
Library	30
Broadcasting studio	20
Normal breathing	10
Threshold of human hearing	0

Table 20: examples of decibel levels of commonly experienced sounds

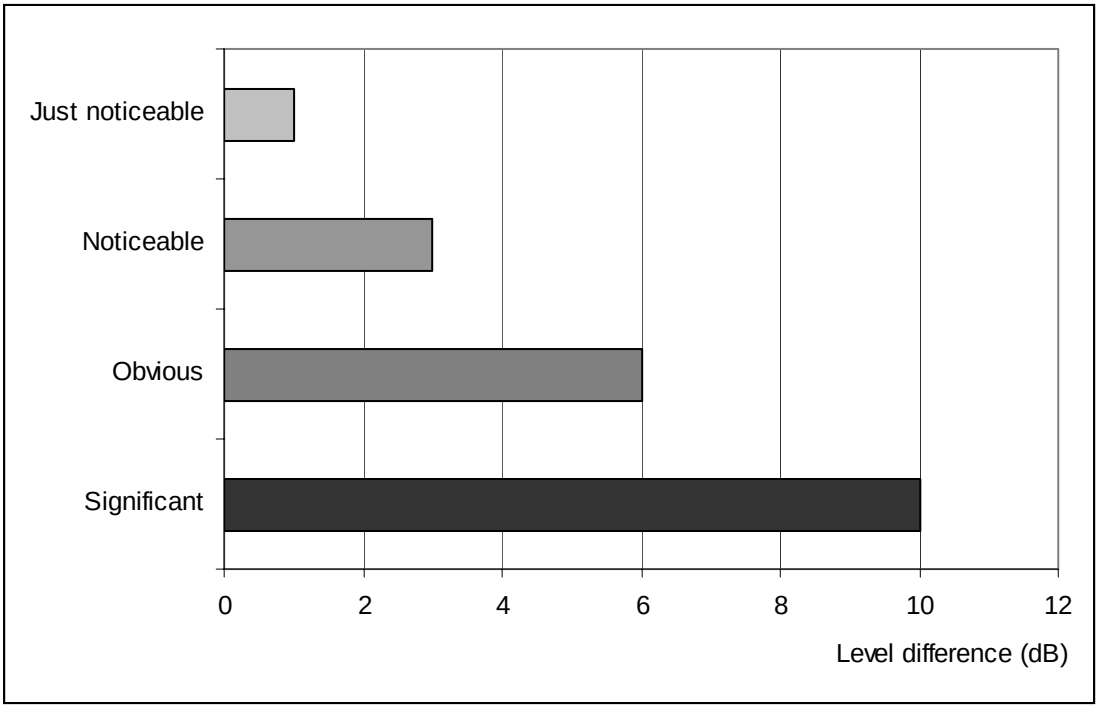


Figure 57: the ability of a person with normally sensitive hearing to discern relative differences in volume

4.6.2 The PA Results

The entries in the spreadsheet of PA results following the verification events were thematically organised as described and are presented in Table 21. Although it may be perceived as double counting of the same coin by including both sides, both the effect of

noise sources and the identification of areas of low (below 25dB) noise sources are included in the model and negative and positive impacts respectively. At an early stage of the PA work one respondent, speaking of what is important in making an area tranquil, answered

Silence so you can hear natural sounds.

Initially this was treated as oxymoronic, but it came to represent one of the variables that people most valued in identifying tranquil areas; not necessarily absolute silence, but something different from the urban experience, something where there was an opportunity to hear non-human sounds that would be drowned out, or unavailable where most people spend most of their lives.

The actual noise sources that were identified as being most significant in detracting from tranquillity were:

- road noise
- aircraft noise
- urban noise
- military training
- other human associated noises such as explosions or railways

Given the geographical significance of the military Otterburn Training Area (OTA) within the NNP, it is noteworthy than ground-based (as distinct from aircraft-related) military training is relatively insignificant. Given the extremely high volumes and consequently widespread diffusion of these, albeit quite sporadic, noises this is interesting and it could be speculated that this is a positive reflection of the military policy of avoiding weekends for live firing wherever possible.

Question	Theme	Answer	Total Score	Expected dots per option	Weighted Score	DATASET	Positive or Negative Factor
What is tranquillity?	You Hear....	natural sounds	95	36	2.64	Low noise areas	Positive
What is tranquillity?	You Hear....	peace and quiet	93	36	2.58	Low noise areas	Positive
What is tranquillity?	You see...	stillness	13	6	2.17	Low noise areas	Positive
What is tranquillity?	You see...	quiet farming landscape	13	6	2.17	Low noise areas	Positive
What is tranquillity?	Of the Mind....	silence to think, just be...	23	11	2.09	Low noise areas	Positive
What is tranquillity?	You Hear....	sounds of curlew, lapwing, skylark	50	36	1.39	Low noise areas	Positive
What is tranquillity?	Of the Mind....	perfect peace	15	11	1.36	Low noise areas	Positive
What is tranquillity?	Of the Mind....	stillness	15	11	1.36	Low noise areas	Positive
What is tranquillity?	You Hear....	silence	43	36	1.19	Low noise areas	Positive
What is not tranquillity?	You hear...	unnecessary noise	47	42	1.12	Low noise areas	Positive
What is tranquillity?	Experiencing...	stillness	40	37	1.08	Low noise areas	Positive
What is tranquillity?	You Hear....	wildlife	25	36	0.69	Low noise areas	Positive
What is tranquillity?	You Hear....	birds	23	36	0.64	Low noise areas	Positive
What is tranquillity?	You Hear....	animals	19	36	0.53	Low noise areas	Positive
What is not tranquillity?	You hear...	not natural noise	11	42	0.26	Low noise areas	Positive
What is not tranquillity?	You hear... additional	unnatural sounds	8	42	0.19	Low noise areas	Positive

What is tranquillity?	Of the Mind....	quiet "hear nowt"	2	11	0.18	Low noise areas	Positive
					Sub-total 21.65		
What is tranquillity?	You Don't Hear....	aircraft noise	31	33	0.94	Noise: Aircraft	Negative
What is tranquillity?	You Don't Hear....additional	low flying aircraft	15	33	0.45	Noise: Aircraft	Negative
What is not tranquillity?	You hear...	aircraft noise	12	42	0.29	Noise: Aircraft	Negative
					Sub-total 1.68		
What is not tranquillity?	You hear...	quarry noise	2	42	0.05	Noise: Explosions	Negative
					Sub-total 0.05		
What is tranquillity?	You Don't Hear....	no army firing	11	33	0.33	Noise: Military	Negative
					Sub-total 0.33		
What is tranquillity?	You Don't Hear....	car noise	54	33	1.64	Noise: Roads	Negative
What is tranquillity?	You Don't Hear....	motorbikes	46	33	1.39	Noise: Roads	Negative
What is not tranquillity?	You hear...	car noise	47	42	1.12	Noise: Roads	Negative
What is tranquillity?	You Don't Hear....additional	loud engine noise	25	33	0.76	Noise: Roads	Negative
What is tranquillity?	You do not see...	motorbikes	13	18	0.72	Noise: Roads	Negative
What is not tranquillity?	You hear...	noisy motorbikes	27	42	0.64	Noise: Roads	Negative
What is tranquillity?	You Hear....	quiets roads	4	36	0.11	Noise: Roads	Negative
What is tranquillity?	You Don't Hear....additional	small motor bikes/scooters	3	33	0.09	Noise: Roads	Negative
					Sub-total 6.47		
What is tranquillity?	You Don't Hear....additional	trains esp. horns	3	33	0.09	Noise: Trains	Negative
					Sub-total 0.09		
What is tranquillity?	You Don't Hear....	industrial sounds	35	33	1.06	Noise: urban	Negative
What is tranquillity?	You Don't Hear....additional	two stroke engines	15	33	0.45	Noise: urban	Negative
What is not tranquillity?	You hear...	machinery	16	42	0.38	Noise: urban	Negative
					Sub-total 1.90		

Table 21: Sorted Useable PA Responses relating to Noise

4.6.3 Modelling the attenuation of noise for tranquillity mapping

This is not a detailed noise modelling project in itself, which would be a huge undertaking and one that is expensive of time and resources. Noise modelling is a highly complex area, and in this model a level of generalisation has been adopted due to the level of spatial resolution and the wide variety of noise sources involved. Previous highly detailed studies of noises, for instance those associated with planning applications for roads, airports and other significant noise sources have tended to focus on either just a single noise source or multiple noise sources within a relatively small area. When modelling noise diffusion over much larger areas the level of uncertainty and contingency on a range of ephemeral environmental conditions (such as humidity, precipitation and wind direction and strength) is considerable so precise predictions are had to make and indeed precision is unhelpful as the range of possible noise levels is high.

The primary noise sources identified in this project are:

- Urban-related (industry, machinery, etc)
- Transport-related:

    - General Traffic Flows on Specific Classes of Roads
    - Railway trains
    - Motorcycles
- Military-related:
    - Explosions and Artillery fire
    - Anti-Tank Rockets (ATK)
    - Large calibre weapons (e.g. heavy machine guns)
    - Small calibre weapons (e.g. rifle and light machine gun fire)
    - Helicopters
    - Fixed wing aircraft

While specific noise sources such as Anti-Tank Rockets have documented noise characteristics that can be associated with spatially specific firing points, there is a level of variability and uncertainty relating to others. The noise characteristics of a stretch of road is a function of volume of traffic, and also the mix of traffic (cars, light goods, HGV, agricultural, motorcycles, etc), the gradient of individual sections, the road surface and weather conditions. This is both spatially variable (e.g. gradient and road surface) and temporally variable (e.g. traffic mix, with recreational motorcyclists being concentrated at weekends).

The spatial and temporal distribution of noise levels reflect human activities that are predictable to a point. Military training, traffic flows and recreational activities are documented but nonetheless a series of assumptions are made in the modelling of noise, relating to both the noise sources and the physical attenuation of noise away from the source. The principal assumptions are:

- For the purposes of this study only noise between 7am and 7pm has been considered. Noise levels during weekdays and weekends are not differentiated, and night time noise levels are not considered.
- Noise attenuation over distance is a function of many variables. These have been held constant in many cases, most notably through the assumptions that *average* temperature and humidity are experienced the year round.
- In many cases the temporal frequency of noise from specific sources is only known at the aggregate level (for instance, 15,699 artillery rounds fired at OTA over an average of 80 days firing) so an assumption that the firing is distributed equally over the year, between the hours of 7am and 7pm is made. This is not the case, and on the OTA both ground and air training may be heavily concentrated above mean values when a large exercise is underway. Tranquillity on such days may be hard to find, but the corollary might be much lower than average levels for quite long periods at other times.
- Noise attenuation where the source is not visible in line of sight is taken from the literature as being subject to an attenuation, over and above that from other effects, of 12dB. However, as this is due to the attenuation of physical energy as it moves over vertical terrain, it may be assumed that successive hills will further attenuate the energy. This is not accommodated within the model at present, although the issue is picked up in the discussion.
- The mix of noise sources, most critically on roads, is not considered. The decibel level and modal frequency at source is modelled, but both are generalised figures. For instance motorcycles are much louder than cars, especially when accelerating hard. As much motorcycle use is recreational use, and concentrated on relatively minor roads and at weekends, far higher and more widespread noise may be episodic rather than constant. The use of average figures in this study does not accommodate such variability, although it would be a relatively simple extension to the existing

methodology to model the consequences of changing input parameters, for instance through including 10% of motorcycles on a given road.

- The cumulation of noise from different sources is not simple. It is not additive (e.g. 60dB overlapping with 40dB does not give a total noise of 100dB), nor is it a case of the loudest sound 'drowns out' the quieter (e.g. 87dB and 77dB does not give 87dB). The reality for the second example is that total sound would increase by approximately 3dB. However, in this project it is assumed that the greater of several modelled sound levels would represent the maximum noise level in any given cell.

The levels at source of the different noise generating activities within the study areas were identified from a wide review of the literature and on-line resources and are summarised in Table 22.

Noise Source	dB at Source
A road and above	70
B road	66
Minor Road	62
Industrial	60
Urban	50
Railway	87
Explosions	180
Artillery	180
Anti-Tank / Rockets	182
Large calibre weapons (e.g. heavy machine gun)	150
Small calibre weapons (e.g. rifle and light machine gun)	157
Helicopters	104
4x4 vehicles off-road driving	95
Watersports (e.g. jet skis)	80
Motorcycles	95

Table 22: Noise Levels at Source in Decibels

The following section details how these noise levels at source are attenuated by distance and other factors.

4.6.4 Modelling the attenuation of noise: theory

Modelling the diffusion and attenuation of sound energy is complex. There are a number of specific pieces of software which have been developed to model sound diffusion around sources such as roads, military equipment and aircraft. Such software tends however to focus on relatively small geographical areas, especially in the case of roads, and their applicability at the landscape scale where an understanding of likely diffusion over kilometres and not just tens to hundreds of metres is required, is less clear. For this reason, coupled with the expense of such products, this research focused on applying models of sound diffusion from acoustics theory, within GIS.

Einstein's maxim that 'things should be kept as simple as possible, though no simpler' was observed; the use of a 250m x 250m grid cell to model noise is crude and variability within a cell this size may be significant, so a level of generalisation was accepted while working within the parameters defined in the literature.

Noise diffusion or the rate of attenuation away from its source is a complex function of a number of variables, including:

- whether the sound is generated in the air or on the ground
- the volume (measured in dB) of the sound
- the frequency (Hz) of the sound
- the distance between receptor and source which gives a predictable level of reduction with geometrical divergence
- the characteristics of the ground between the source and the receptor, including
    - whether there is line of sight between the source and receptor
    - whether the ground is hard (e.g. tarmac, concrete or compacted earth) or soft (e.g. un-compacted soil, crops) or very soft (e.g. wet vegetation or snow)
    - whether there is an extensive belt of high vegetation such as trees in place between source and receptor
- the existence of any structures or surfaces which may reflect, deflect or absorb sound energy
- atmospheric variables such as temperature and humidity, which affects atmospheric absorption of sound energy in different ways for different frequencies
- weather conditions such as rain or wind strength and direction

It should be clear from the above that modelling sound is contingent on a great many variables, many of which are not constant. Accounting for inter-visibility (i.e. line of sight) between source and receptor is relatively straightforward and will not change over time unless engineering, tree planting or similar works are carried out. However, accounting for the affect of wind, for example, is extremely complex. Wind can 'carry' sound further under certain conditions and orientations of source and receptor, or it can accelerate the rate of attenuation. Further to this, wind generates sound around structures, vegetation and even around people that can be louder than other sounds. No model, however carefully constructed, finely grained or tightly calibrated can hope to accommodate the full range of acoustic, environmental and human variables.

A model of sound attenuation is given by Piercy and Daigle (1991) as:

$$A_{total} = A_{div} + A_{air} + A_{ground} + A_{misc}$$

where

A_{total} is the total attenuation for the defined set of parameters

A_{div} is the attenuation from geometrical divergence over distance

A_{air} is attenuation resulting from air absorption

A_{ground} is attenuation by the ground

A_{misc} is attenuation from other effects including reflection from surfaces, foliage and buildings.

Each of these variables is elaborated below in the detail that is necessary to establish the methodology for this study. For more details refer to Piercy and Daigle (1991).

Attenuation from geometrical divergence over distance (A_{div})

Sounds that are generated in the free field, or in the air and not in contact with the earth (e.g. aircraft) attenuate by between 6dB and 7.5 with each doubling of distance. So, for a sound such as an airbursting artillery shell with a volume of approximately 180dB, the attenuation rate (at the lower level of 6dB per doubling of distance) would be:

Distance (m)	75	125	250	500	1000	2000	4000
Volume (dB)	170	164	158	152	146	140	134

This rate of 6 to 7.5dB reduction per doubling of distance is also applicable to point noise sources such as quarry blasts and artillery or small arms fire.

Sounds from linear sources that are generated in contact with the earth (e.g. traffic on roads or railways) attenuate at a more gradual rate of 3dB with each doubling of distance, unless over soft surfaces in which case the rate is 4.5dB per doubling of distance.

To calculate sound levels at various distances away from specified sources an equation was needed. Using *Mathematica* software the dataset shown below was entered and a curve and equation fitted to predict sound values at specified distances.

Distance (m) from source	Attenuation at a rate of 3dB decrease per doubling of distance	Attenuation at a rate of 4.5dB decrease per doubling of distance	Attenuation at a rate of 6dB decrease per doubling of distance	Attenuation at a rate of 7.5dB decrease per doubling of distance
125	12.8	14.3	15.8	17.3
250	15.8	18.8	21.8	24.8
500	18.8	23.3	27.8	32.3
1000	21.8	27.8	33.8	39.8
2000	24.8	32.3	39.8	47.3
4000	27.8	36.8	45.8	54.8
8000	30.8	41.3	51.8	62.3
16000	33.8	45.8	57.8	69.8
32000	36.8	50.3	63.8	77.3
64000	39.8	54.8	69.8	84.8
128000	42.8	59.3	75.8	92.3
256000	45.8	63.8	81.8	99.8

Table 23: dataset used in Mathematica to calculate distance attenuation equations

The equation for the attenuation rate of 3dB per doubling of distance is:

$$12.8 + 3x\left(\text{Log}_2 \, x \, \frac{\text{distance}}{125}\right)$$

where

12.8	is the sound attenuation at 75 metres from source
3	is the attenuation in dB per doubling of distance
distance	is distance from the sound source
125	is a constant

The equation for the attenuation rate of 4.5dB per doubling of distance is:

$$14.3 + 4.5x \left(\text{Log}_2 x \frac{\text{distance}}{125} \right)$$

The equation for the attenuation rate of 6dB per doubling of distance is:

$$15.8 + 6x \left(\text{Log}_2 x \frac{\text{distance}}{125} \right)$$

The equation for the attenuation rate of 7.5dB per doubling of distance is:

$$17.3 + 7.5x \left(\text{Log}_2 x \frac{\text{distance}}{125} \right)$$

It is very clear from this that unimpeded sound could travel great distances. However, this level of sound diffusion is not experienced as atmospheric, terrain, vegetation, built environment and weather related factors serve to absorb and otherwise attenuate the theoretical distribution of energy. These variables and the way they are represented in the GIS model are discussed below.

Attenuation resulting from air absorption (A_{air})

The rate at which the atmosphere attenuates sound energy is variable and depends upon the frequency of the sound, the temperature and the humidity of the air. Within approximately 700m of a sound's source, atmospheric attenuation is insignificant, although it can be extremely significant at increasing distances and especially for higher frequencies (>2000Hz).

Tables N to N illustrate average temperature and relative humidity for Newcastle upon Tyne, the nearest point of recording to both study areas.

	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
°F	**48**	38	38	42	44	50	55	59	59	54	49	43	40
°C	**8**	3	3	5	6	10	12	15	15	12	9	6	4

Years Charted: 18 Source: International Station Meteorological Climate Summary, Version 4.0

Table 24: Average Temperature for Newcastle upon Tyne

	Annual Average	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
%	**85**	84	83	84	84	86	86	86	88	86	86	85	84

Years Charted: 13 Source: International Station Meteorological Climate Summary, Version 4.0

Table 25: Average Morning Relative Humidity for Newcastle upon Tyne

	Annual Average	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
%	**71**	81	76	69	65	64	64	65	64	67	73	78	82

Years Charted: 15 Source: International Station Meteorological Climate Summary, Version 4.0

Table 26: Average Afternoon Relative Humidity for Newcastle upon Tyne

Table illustrates the atmospheric attenuation levels for a temperature of 15°C and a relative humidity of 75%, which are judged to be representative of the study area, for sounds at variable frequency levels.

	Frequency (Hz)					
	125	250	500	1000	2000	4000
Example Sound Source (Central Frequency)		Large calibre weapons		Landing Passenger Jet		
Air Attenuation (dB/km)	0.41	1	1.9	3.7	9.7	33

Table 27: Air Attenuation Coefficients (dB/km) at a sea level ambient pressure, for a temperature of 10°C and a relative humidity of 70%

Another aspect of the complexity of modelling noise diffusion is the fact that the sounds categorised for example as 'traffic noise' and 'aircraft noise' are comprised of a whole set of individual sounds such as tyre noise, engine noise and airflow over the moving object. These individual sounds exist across a wide range of frequencies. For example traffic sounds typically range from below 100Hz up to 8,000Hz with the latter being outside the range of human hearing. The modal or central frequency of the main noise sources within the study area appear in Table 28.

Noise Source	Central frequency (Hz)
Explosions	~50
Small arms fire (rifle & machine guns)	~250
Low flying aircraft	~500
Lorries	~700
Cars	~1000
Railway trains	~1000
Fast industrial machinery (e.g. power saws)	~1000
Helicopters	~4000 +

Table 28: the central frequency (modal value) of noises in the study area

The rate of attenuation per kilometre was disaggregated (per km attenuation x 0.25) to the level of 250m cells and a value for each ring of 250m increasing distance away from the source in Excel. The resulting table was then joined to the GIS data.

Attenuation by the ground (A_{ground})

Sound attenuates over hard ground (such as concrete, tarmac and compacted earth) at a slower rate than over more energy absorbent surfaces such as wet earth, snow or vegetated ground. As described for *(A_{div})* this varies between 3dB and 4.5dB per doubling of distance (Hendricks, 1995). Given the dominantly rural nature of both study areas, and also the need

for generalisation at a resolution of 250m x 250m the rate for representing (A_{div}) was set at 4.5 dB per doubling of distance for linear sources and 7.5dB for point sources.

Distance (m) from source	Attenuation at a rate of 3dB decrease per doubling of distance	Attenuation at a rate of 4.5dB decrease per doubling of distance	Attenuation at a rate of 6dB decrease per doubling of distance	Attenuation at a rate of 7.5dB decrease per doubling of distance
75	10	10	10	10
125	13	14	16	17
250	16	19	22	25
500	19	23	28	32
1000	22	28	34	40
2000	25	32	40	47
4000	28	37	46	55
8000	31	41	52	62
16000	34	46	58	70
32000	37	50	64	77
64000	40	55	70	85
128000	43	59	76	92
256000	46	64	82	100

Table 29: options for ground attenuation rates

Sound energy is not just absorbed by the ground, it can also be transmitted through it (Harris, 1991). Vegetated ground, especially by trees and shrubs, maintains a more porous soil that attenuates sound energy more rapidly. This effect was not included in the model, but it is referred to here to emphasise the positive effect of planting on noise attenuation.

Attenuation from other effects (A_{misc})

Sound energy does not depend upon a clear line of sight to be received, although if the receptor is in 'dead ground' that has no line of sight to the sourc,e a significant level of attenuation is observed. Note that line of sight in this specific context relates to the effect of the terrain alone; it does not include an obstructed view due to vegetation, trees, buildings or other structures. As the DEM used in all visibility calculations in this study is 'bare ground', that is to say no account is made of buildings, woodland or other vertical extrusions from the ground surface, no account is taken of such features in the visibility calculations.

Modelling the attenuation of noise: calculating the expected noise levels

This section sets out, and illustrates where appropriate, how attenuation of each of the major noise sources within the study areas was modelled. However all followed the same basic stages which are set out below, and they are all related to the theoretical context set out above.

(a) calculate attenuation from geometrical divergence over distance in Excel

Using Excel the equations for 4.5dB attenuation per doubling of distance for linear noise sources and 7.5 dB attenuation per doubling of distance for point noise sources were implemented and the values for 250m increments away from the respective noise sources were calculated. This was based in the assumption of attenuation of soft rather than hard ground.

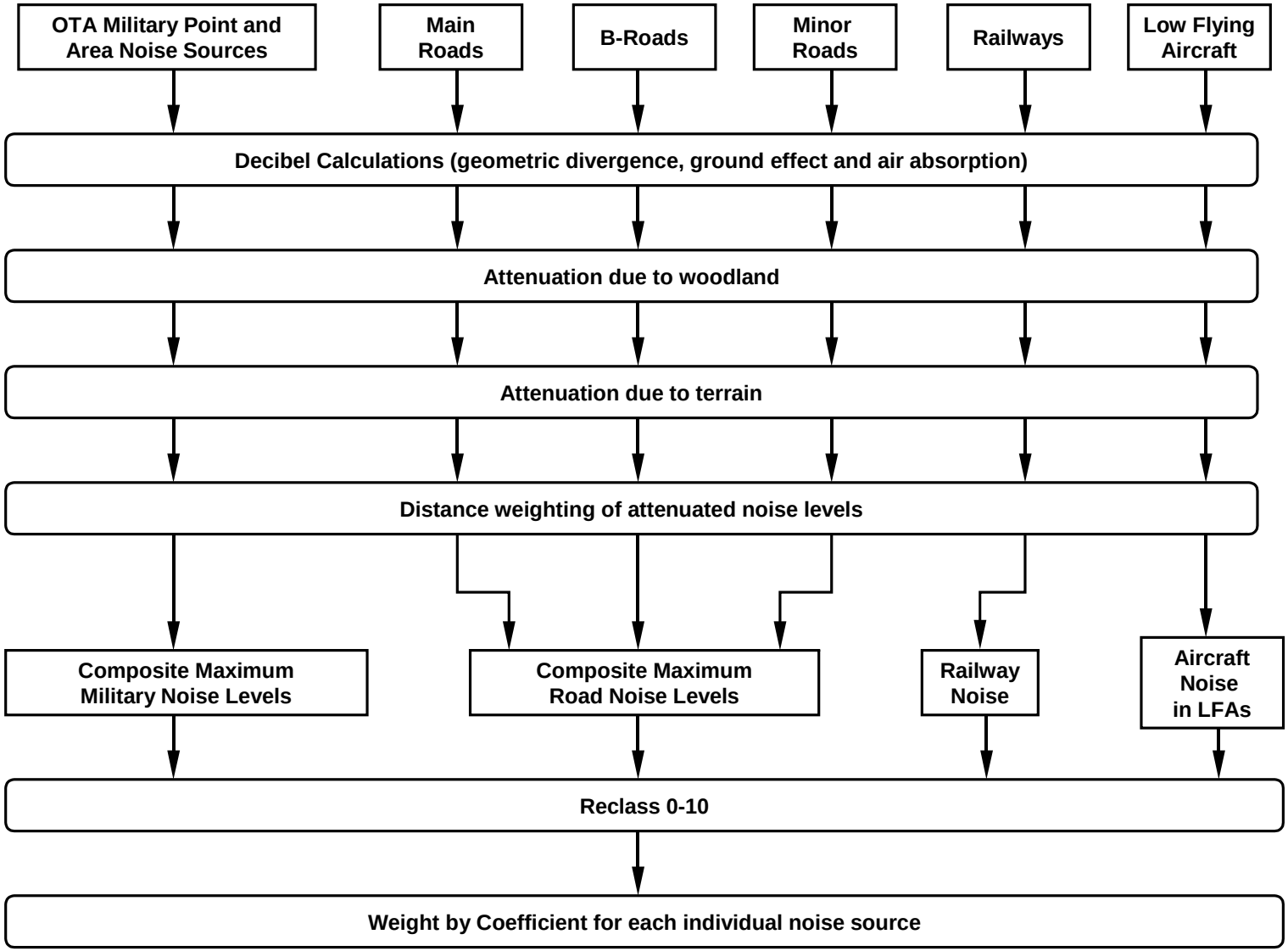


Figure 58: overview of the Noise Modelling Component

(b) calculate attenuation resulting from air absorption in Excel

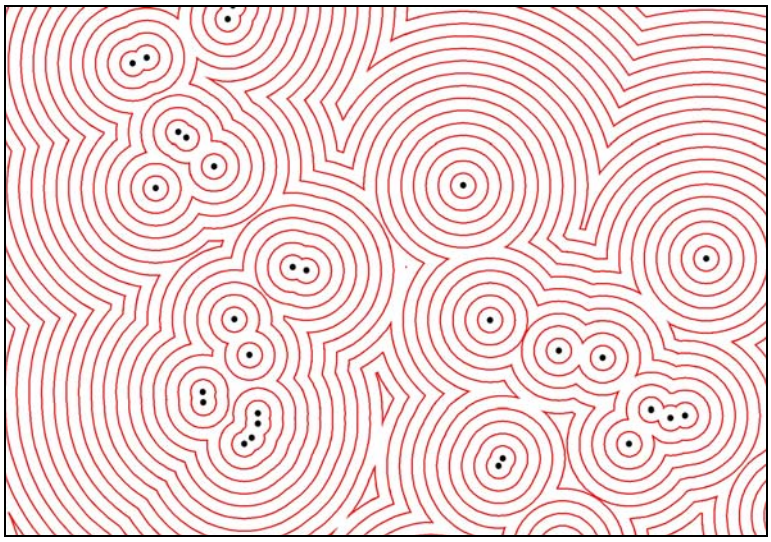
Following the average humidity and temperature values in tables 24 to 27 and the approximate modal frequencies of relevant noise sources, the attenuation per for 250m increments away from each respective noise source was calculated in Excel.

(c) calculate distance away from each feature class in buffers of 250metres

The 250m increments away from each respective noise source was spatially represented through buffers developed around each of the noise sources.

As illustrated right, these were set to merge where they overlapped.

The attribute table for each buffer associated each feature with the its distance (as multiples of 250m) away from the nearest noise source.



(d) append the table of the buffer file with the modelled attenuation

The attenuation from geometrical divergence over distance at increments of 250m was added to the attenuation resulting from air absorption in Excel. Then the total attenuation resulting from distance and atmosphere was exported into ArcGIS. For each noise source (e.g. main roads or artillery, anti-tank and explosions) the noise attenuation at increments of 250m was joined to the attributes of the 250m buffer theme around the relevant spatial features. This then mapped out the level of noise attenuation over space prior to the consideration of terrain and vegetation effects. Note that at this point the mapped values are maximum values in dB, with no consideration of their temporal frequency.

(e) convert the vector buffers into raster grid format

The vector file representing total attenuation from each noise source from stages (c) and (d) was then converted into raster format at a cell resolution of 250m x 250m.

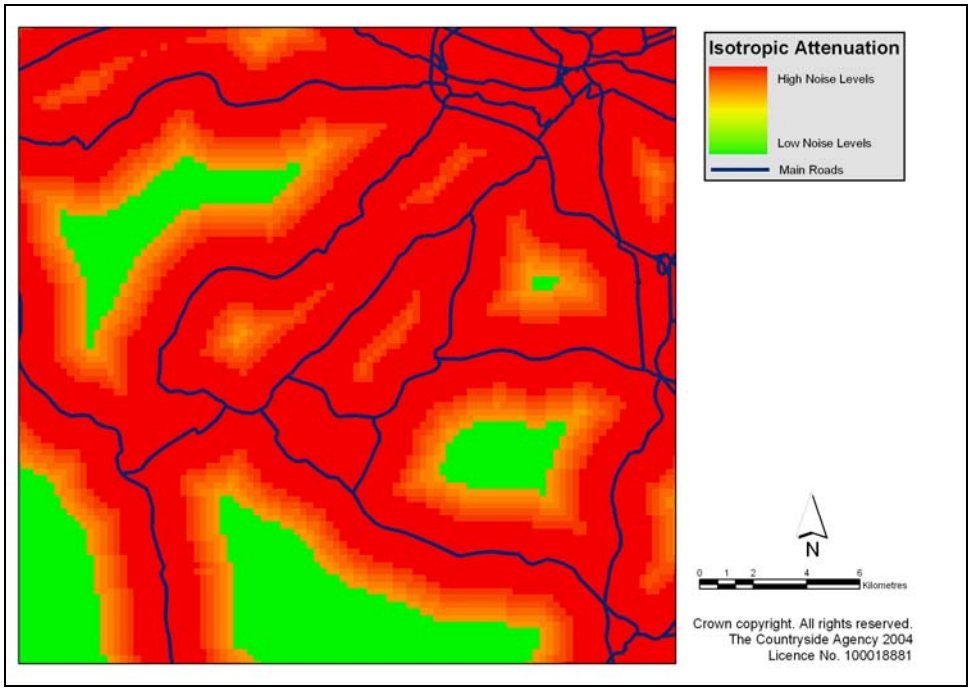


Figure 59: an example of road noise attenuated by geometrical divergence and air absorption

(f) apply a frictional surface for attenuation by terrain

Following (Peippo *et al.*, 2000) an adjustment of -12dB on the $A_{div} + A_{air}$ value was made to account for the 'line of sight' effect although this was subsequently developed to represent the progressive attenuation effect of multiple terrain barriers. (Figure 60).

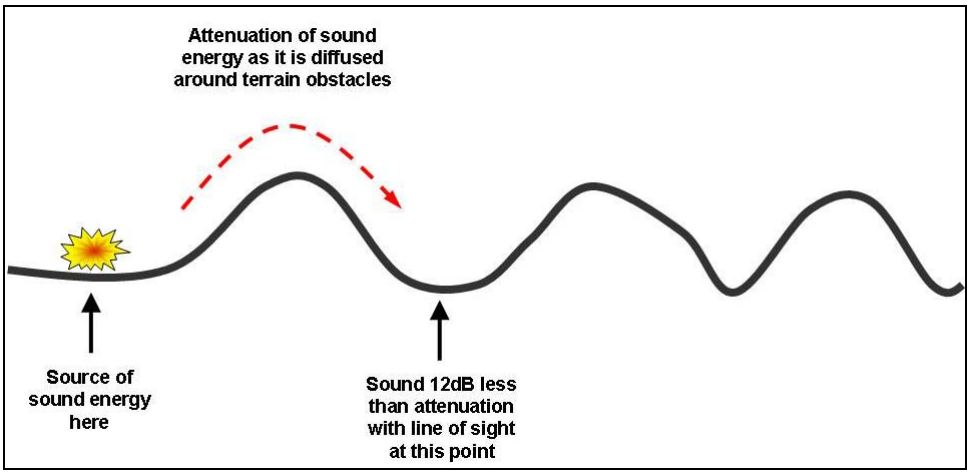


Figure 60: noise attenuation and simple intervisibility

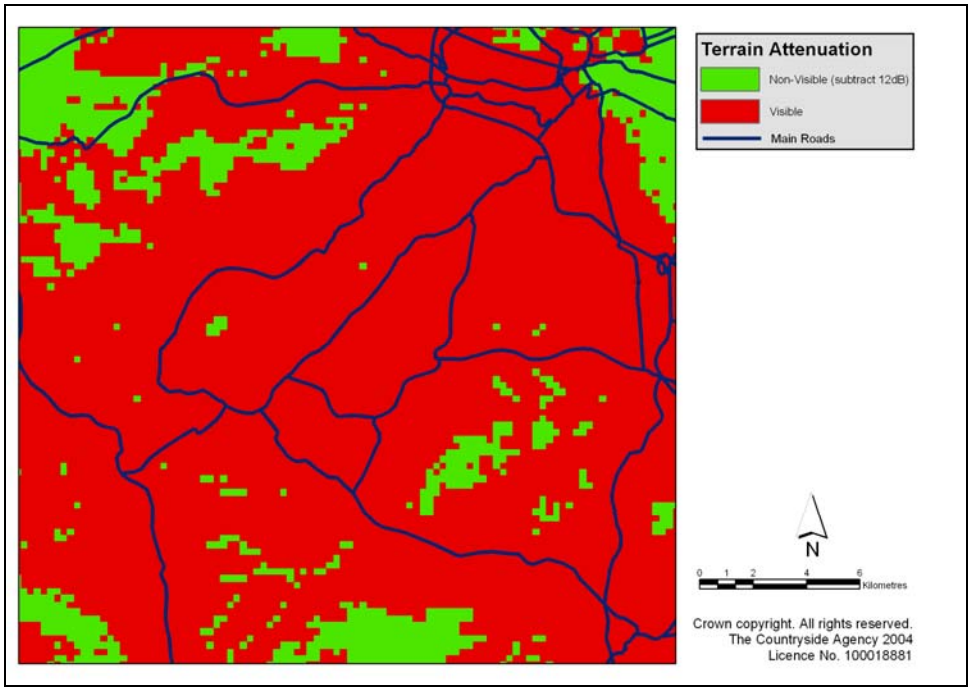


Figure 61: the noise attenuation effect of terrain

(g) apply a frictional surface for attenuation by woodland

A similar approach to terrain was taken to modelling the effect of woodland on noise attenuation (Figure 57). Various figures are cited for the attenuation effect of different depths of woodland, but a figure of 3dB attenuation for every 25 to 30m of woodland is widely accepted[18]. The Centre for Ecology and Hydrology Land Cover Survey 2000 data were used for this calculation. The CEH data are supplied in vector format, but as they are derived from raster data they remain organised in grid format, with a cell size of 25m x 25m. All cells classified as woodland were extracted and allocated a value of 3dB. All other cells were allocated a value of zero. These were then used as a frictional surface over which a CWD calculation was run.

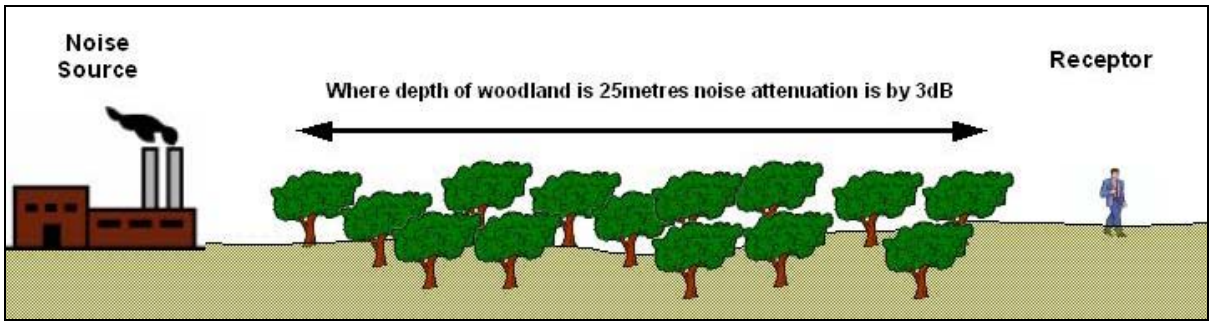


Figure 62: Trees and noise reduction

The CWD calculation was run with the noise producing feature classes as the source and the woodland dataset as the frictional surface. This represents the cumulative attenuation of woodland on noise as it moves away from the source. The spatial resolution for the output from this operation was set at 250m x 250m.

[18] http://www.fhwa.dot.gov/environment/htnoise.htm

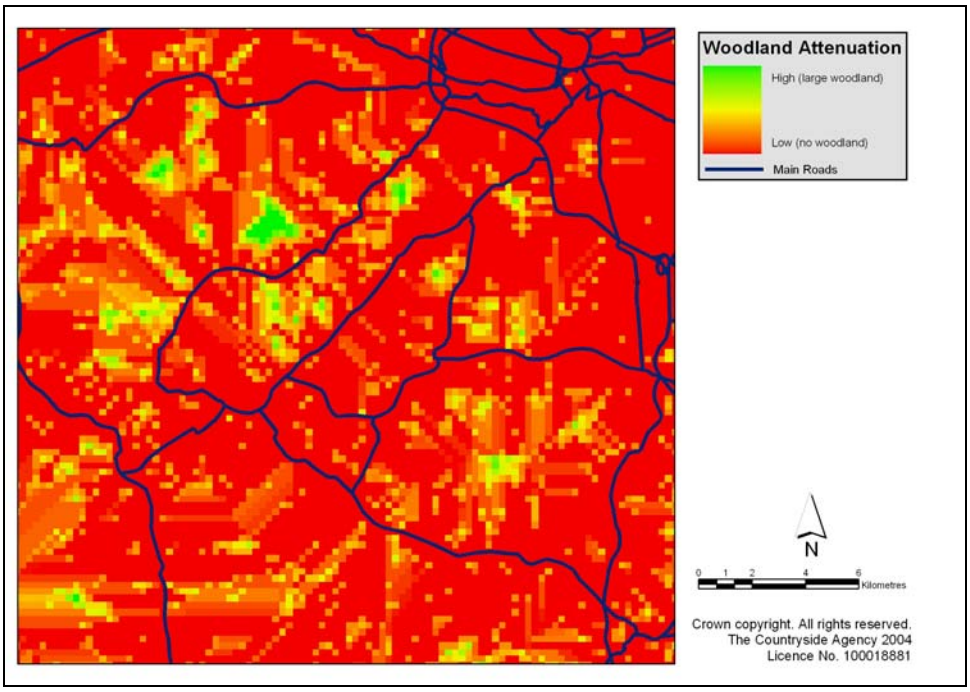


Figure 63: the noise attenuation effect of woodland

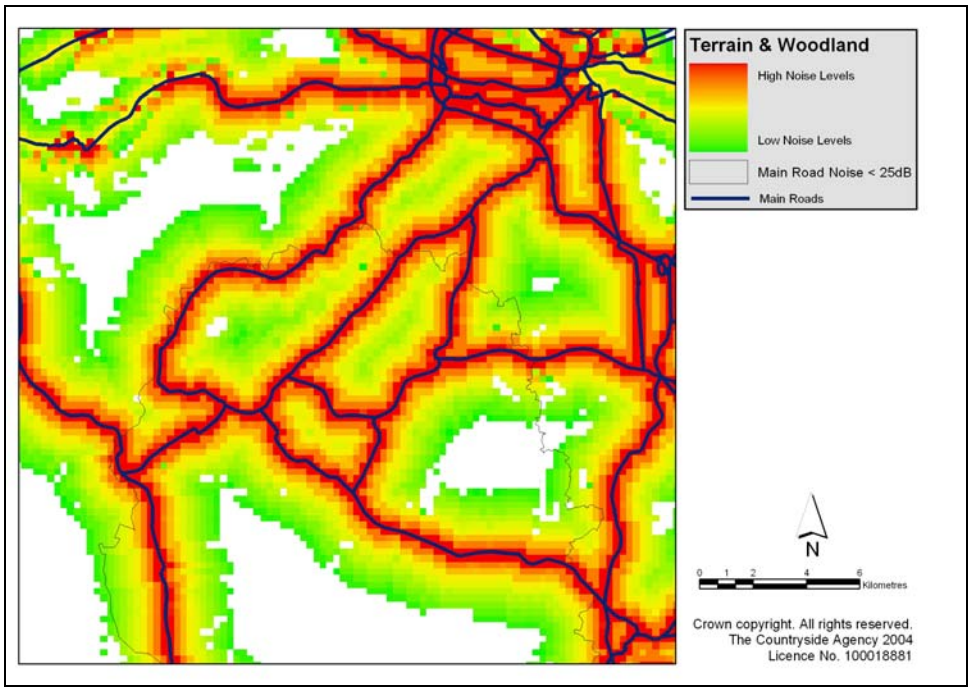


Figure 64: an example of road noise attenuated by geometrical divergence, air absorption, terrain and woodland

Raster layers were calculated for each of the noise sources and the maximum decibel level that may be experienced in each individual cell is recorded for the combined noise surface. This surface is illustrated in Figure 67, following examples of road and military noise as specific components of this composite map.

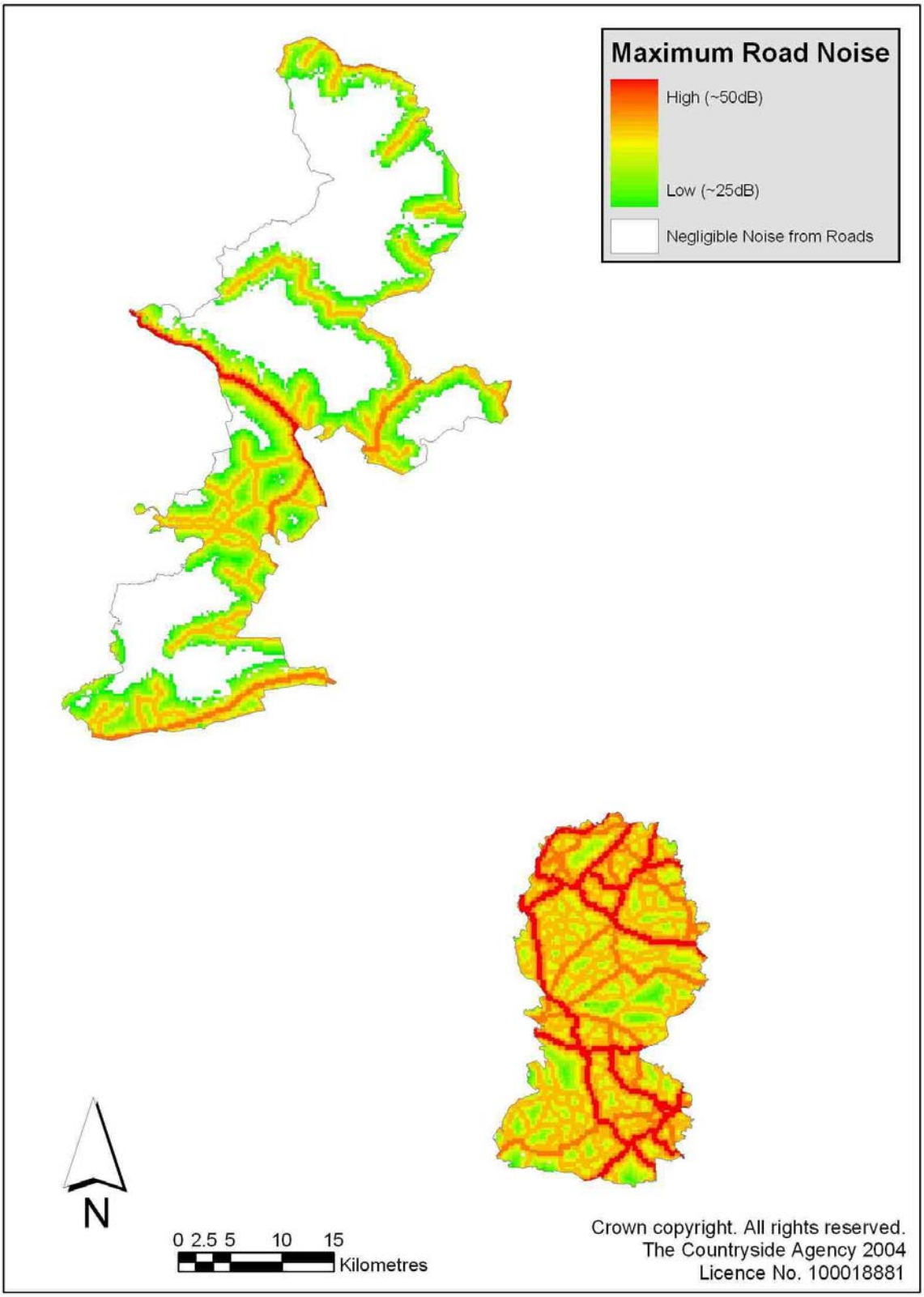


Figure 65: Map of Maximum Potential Noise from All Roads

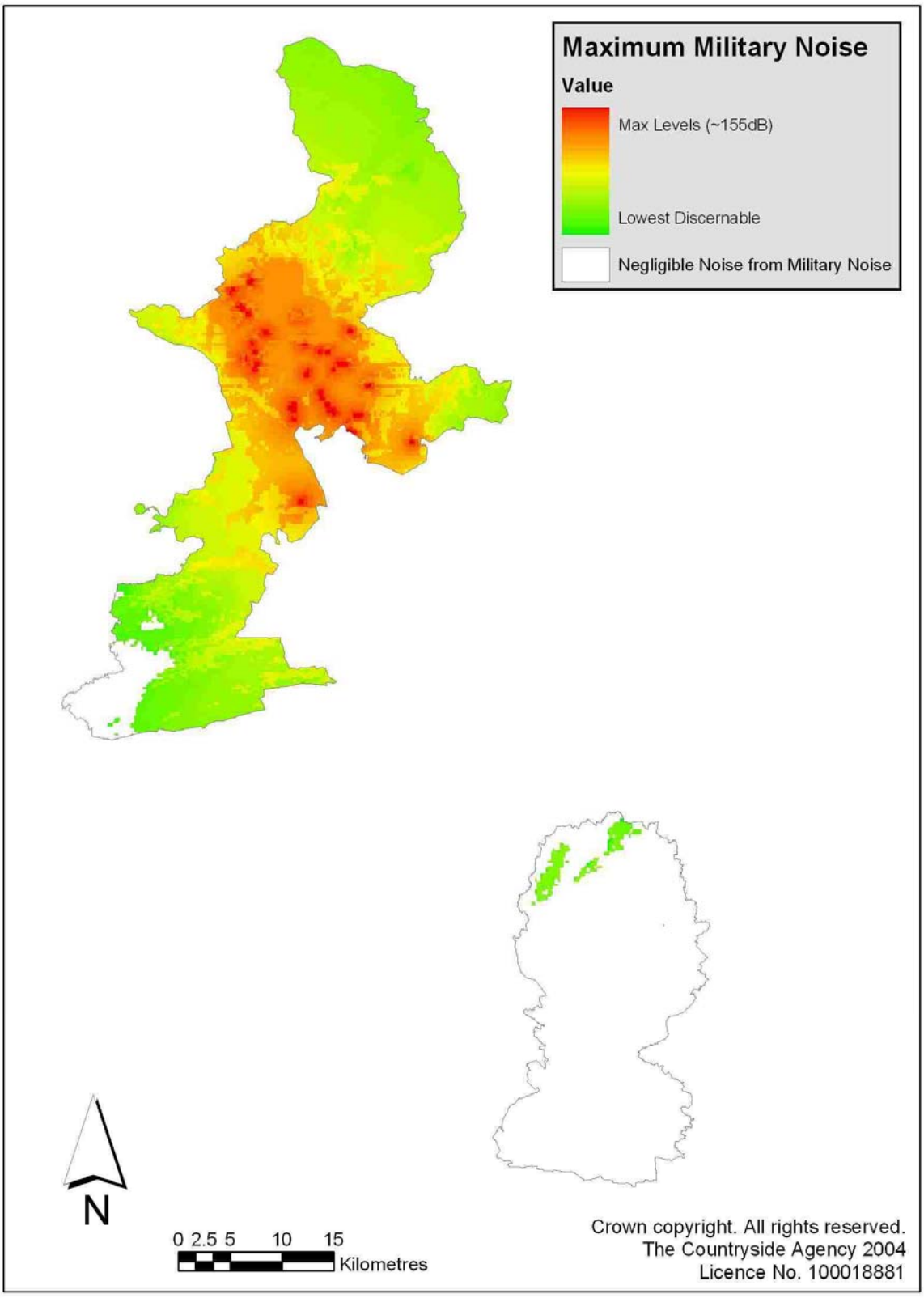


Figure 66: Map of Maximum Potential Noise from Ground-Based Military Training
Note: no aircraft noise is considered in this figure as the available data relate to the entirety of both study areas

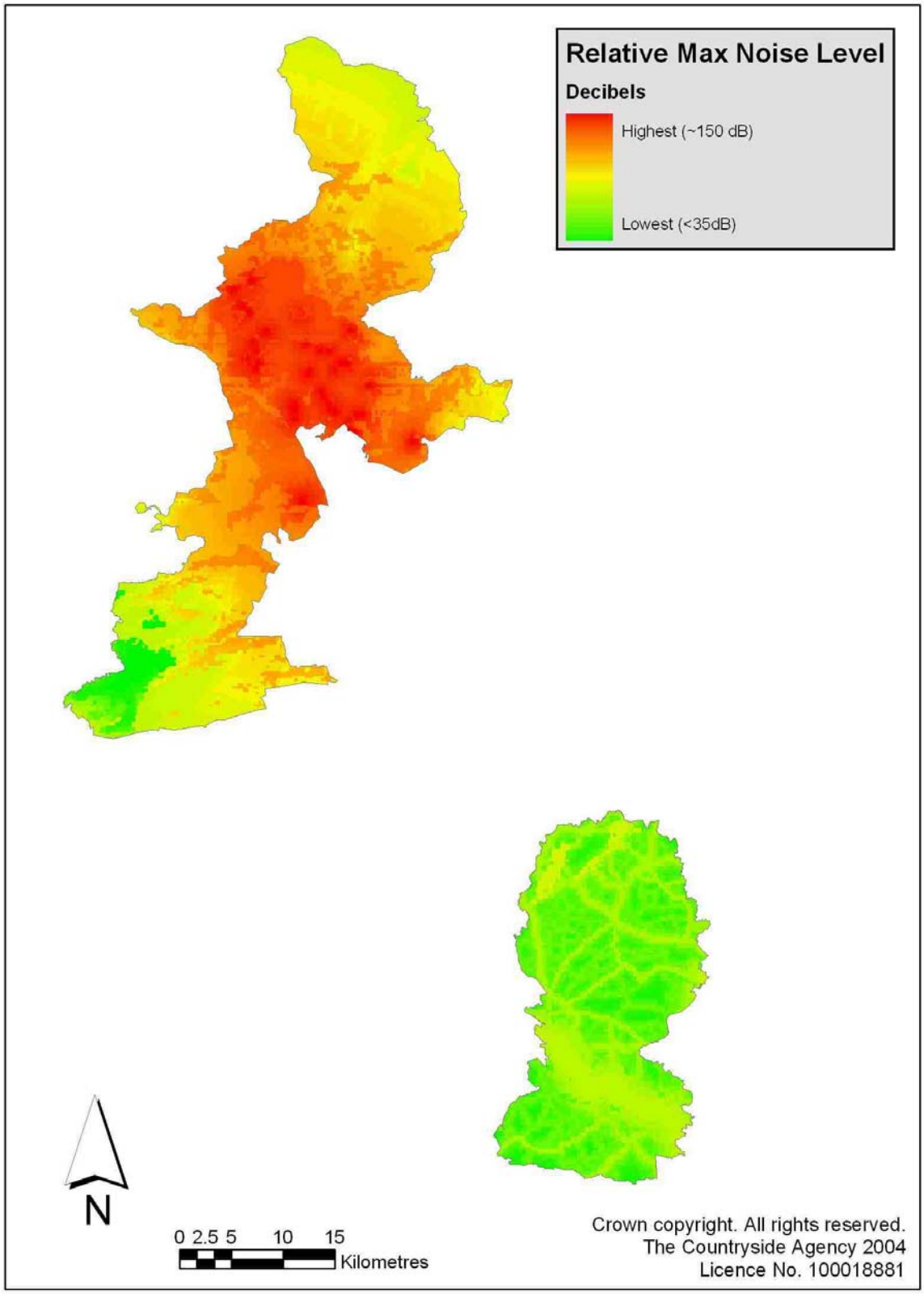


Figure 67: Map of Maximum Potential Noise
Note: no aircraft noise is considered in this figure as the available data relate to the entirety of both study areas

Although the map of maximum potential noise is helpful, it lacks an immediate sense of affective impact. This is summarised in table 30 and mapping in Figure 63.

Sound Banding (L_{eq} dB)	Association
>100 dB	Hearing impairment if sustained sound at this level
76-100 dB	Very loud sounds, typical of a busy road in major city centre
66-75 dB	Moderately loud to loud sound levels
56-65 dB	Conversation at normal volumes impeded
46-55 dB	Moderate noise levels, outdoors in suburban environment
36-45 dB	Average indoor home sound levels
26-35 dB	Defined as silent rural areas in Finland (Peippo *et al.*, 2000) and quiet (<30dB) rural areas in Sweden (Elvhammar, 2000)
<25 dB	Only faint ambient sound levels

Table 30: likely affective impacts of classified noise levels

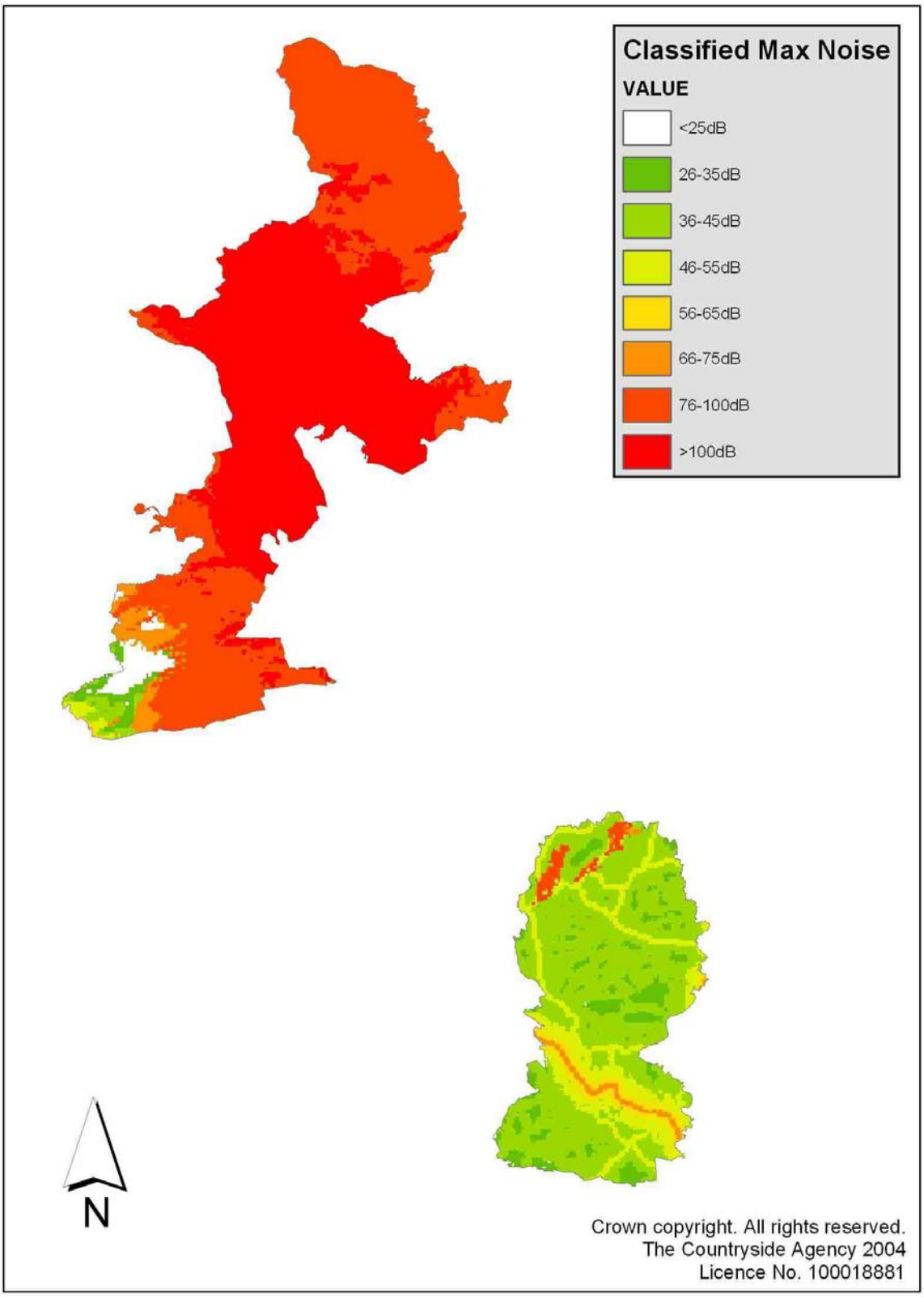


Figure 68: Map of Maximum Potential Noise Classified as for Table 30.
Note: no aircraft noise is considered in this figure as the available data relate to the entirety of both study areas

(h) quantitatively represent the effect of temporal frequency

Figure 69 sets out a framework for assessing the impact of different sorts of noise. The function of the colours will be returned to later but the basic point is that noise sources differ in essentially three ways:

1. how loud they are, and from this how far away from the source they may be heard;
2. how frequent they are, and as a secondary issue, how regular or otherwise they are;
3. how the receptors (those affected by the noise) perceive it and deal with it.

The first and second of these can be modelled with GIS. This affective impact of noise is something that has been examined in the literature (for example Ouis, 2002) and studies have demonstrated the way in which predictable, regular noises are more readily accepted than those that are irregular and unpredictable, and the way in which people can become desensitised to constant and regular noise in a way that people who are unaccustomed to them are not. However, this is outside the realm of GIS.

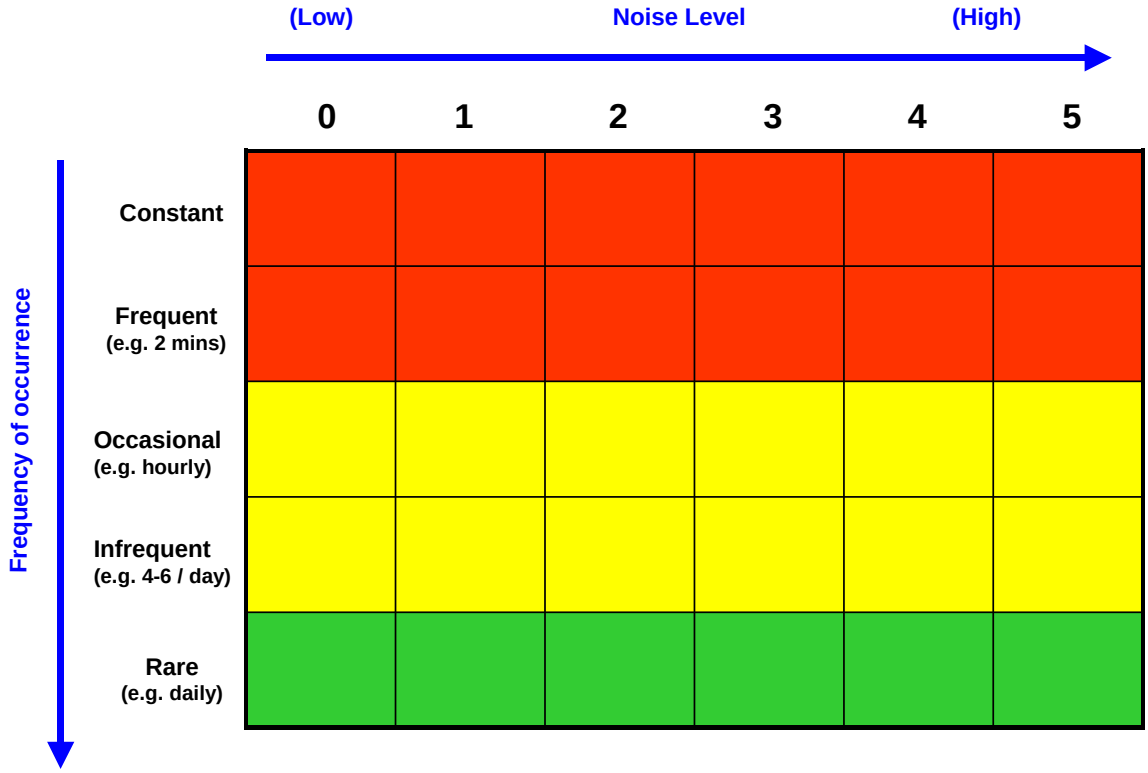


Figure 69: table of noise source volume and frequency

In affective terms, peoples' experience of an otherwise quiet area can be adjusted by a sudden, unexpected noise such as a military rocket salvo, a low flying jet or an explosive blast in a quarry. There is no simple answer to these problems as modelling physical noise diffusion is complicated by temporal frequency of the source and a range of environmental variables that affect attenuation away from the source. Modelling the affective impact of noise on individuals is only possible at the general level, crudely defining certain noises as more or less significant than others. The 'handle' for this comes from the PA data.

Figure 69 sets out a simple framework for the assessment of how different cells experience different types of noise. The affective impact of an increase in noise level (for instance up to

80dB) set against a constant volume (for instance at 65dB) is very different to a 'spike' of noise at 80dB from an ambient noise level of only 30dB.

What is important for this study is the ability to accommodate, within the methodology, the impact of noises that are variable in both noise volume, and in temporal frequency. The PA results do not offer any real evidence for differentiating between noise sources on the basis of their frequency, other than by defining the type of noise, from which frequency can be inferred. We know that low flying aircraft are relatively infrequent (measured in number per day rather than per hour under most circumstances, road noise is much more constant and motorcycles being driven at speed are much less frequent than cars, and much more temporally concentrated at weekends. Following from this, it becomes a question of how these different kinds of noise should be treated within the GIS model. The primary objective of this research is the development of a methodology for tranquillity assessment and mapping. However, the primary output of this methodology is a map, a single composite map of relative tranquillity. A difficulty is, and this is much more relevant to noise than other factors than affect tranquillity, is that the 'picture' will be different at different times, for instance at weekends (usually no artillery but more motorcycles in the NNP) and at night time (fewer trains and less frequent traffic in the WDC).

To represent the 'temporal averaging' effect a simple L_{eq} measure is constructed by applying a coefficient to areas where noise diffuses down to 25dB from each of the feature classes. As the various noise sources vary a great deal in respect of the temporal frequency of the noise at the modelled volume (for instance busy roads compared with occasional aircraft low flights) the coefficient is an estimate, for each noise source of the percentage of the day (7am to 7pm) for which the noise can be heard at the predicted volume. Thus a constant noise would get a coefficient of 1 (equating to 100%) and a noise than can only be heard 2-3 times a day for periods of a few seconds would get a coefficient of 0.001 (equating to 1%). There is clearly a high level of estimation in this and it also takes no account of the affective impact of different types of noise, only quantifying the temporal frequency of their occurrence.

Noise source	Temporal frequency (% of time noise can be heard within max noise range)
Main Roads (M-way, Trunk and A Roads combined) (See note 1)	90%
B Roads	65%
Minor Roads	10%
East Coast Main Railway (See note 2)	5%
Secondary rail links (e.g. Sunderland - Newcastle – Carlisle)	3%
Minor rail link through WDC (See note 2)	0.5%
Heritage and tourist railways (See note 3)	n/a
Urban areas	100%
Military Artillery, Explosions and Rocket fire (See note 4)	1.4%
Large and Small Calibre Weapons (e.g. rifles and machine guns) (See note 5)	2.5%
Military Fixed Wing Aircraft (low flying <2000 ft)	1.5%
Military Helicopters (low flying <2000 ft)	1.5%
Civilian aircraft (See note 6)	n/a
4x4 vehicles off-road driving (See note 7)	n/a
Watersports (e.g. jet skis) (See note 8)	n/a

Table 31: temporal frequency assumptions for time-weighted calculations

Notes:

1	Although individual roads and different classes of roads within this category will carry different levels and mixes of traffic, a single value is assumed for all roads in this category. This could be differentiated in a future application of the model.
2	The four different classes of railway identified carry different levels and mixes of traffic. Timetable information was used where possible to estimate traffic levels
3	Heritage and tourist railways are not included in these calculations.
4	These are the highest volume noise sources within the OTA. They are not all precisely the same but ~180dB is used as a single figure for all these point noise sources. The 19991-2000 average number of days firing per year was 80 days. In those 80 days an average of 15,699 rounds of ammunition for the 105mm, 155mm and MLRS artillery systems were fired.
5	Large calibre machine gun fire is quieter than smaller calibre rifle and light machine gun fire. As they are both used in the same training areas, the louder figure is used in the model. No number of the rounds of ammunition fired within the OTA danger area was available, but there were an average of 269 training days on the OTA between 1991-2000.
6	Civilian aircraft are not considered in this study. Overflights relating to both study areas are generally at a high level and therefore the noise is low. However, this would not necessarily be the case in any other study area and the method here can easily accommodate additional noise sources.
7	Although these can be quite locally significant as noise sources, they were not considered in this study for reasons of data availability.
8	In common with 4x4 driving, although these can be quite locally significant as noise sources, they were not considered in this study for reasons of data availability.

The temporal frequency weighed noise levels is in effect a surrogate for L_{eq} measures (see table 19 for definitions). The data required for L_{eq} calculations (in effect sound energy averages over a given time period which supports the direct comparison of high volume and infrequent noises with constant but lower volume noises) were not available for this study, but Table 33 identifies the banding used in this study, although the L_{eq} measure is estimated rather than precisely calculated. Figure 70 illustrates the result of the time-weighted calculations.

A note on aircraft noise

Aircraft noise, especially from low flying military jets and larger helicopters is known to have a significant affective impact and repeated exposure is associated with health problems in some people (Bronzaft et al., 1998, Morrell et al., 1997, Stansfield et al., 2000). A low flying jet (<500 feet) is associated with noise levels of up to ~150dB and low flying helicopters <200 feet) with noise levels of up to ~105dB. Noise levels from commercial jets around airports are comparable, but in the case of the present study areas, not relevant and high level flight generates limited noise. For this reason the sole focus in this research was on military aircraft (fixed and rotary wing), although the techniques are equally applicable to civilian aircraft of different types and at different altitudes.

Accessing data on the spatial distribution of military low flying operations took several months, and the data that were provided were not dis-aggregated beyond the defined UK Low Flying Areas (LFA) as the Ministry of Defence (MoD) does not centrally record the distribution of flights within each LFA. All of the WDC study area falls within LFA12 and although most of the NNP also falls inside LFA13, the Western extent of the Park is covered by LFA 13. Aggregate hours of low flying operations within each LFA appear in Table 32.

Low Flying Area 12	
Fixed Wing	2,676 hours
Helicopters	852 hours
Total	3,528 hours
Low Flying Area 13	
Fixed Wing	573
Helicopters	108
Total	108

Table 32: aggregate hours of military low flying within LFAs 12 and 13 during 2003/2004[19]

As each study area is only a proportion of the LFAs and there is no available data on the internal distribution of flights within each LFA, either formal or anecdotal, the assumption was made that the pattern of flights was even across the study area. This is almost certainly inaccurate, as the OTA and the NNP as a whole is subject to a greater number of overflights than the WDC. However, the methodology exists to accommodate spatially disaggregated data on the relative concentrations of a given level of low flying.

Identifying Low Noise Areas

Nowhere within the study area is not exposed to noise, sometimes at high volume. For this reason the time-weighted noise levels rather than the maximum noise levels are used in the model. Most of the entries under the category noise are negative, but there were also a series of relatively general statements about noise in general, that were not specific to individual noise sources. To accommodate these PA data, for instance the ability to hear 'natural sounds', 'peace and quiet', 'stillness' or be unable to hear 'unnatural sounds', there was also a positive element, low noise areas.

The time-weighted calculations (figure 70) were then classified into quartiles, with the following qualitative descriptors being attached to each quartile:

Quartile	Qualitative Descriptor
1 (highest level of time weighted noise)	Constant to Highly Frequent Noise
2	Frequent Noise
3	Infrequent, but may be high volume noise
4 (lowest level of time weighted noise)	Infrequent Noise

Table 33: qualitative descriptions for time-weighted noise bands

The 4th (lowest) quartile was then extracted and defined as low noise areas (Figure 71).

[19] Source: MoD (1004). *The pattern of Military Low Flying across the UK 2003/2004*, Directorate of Air Staff, Ministry of Defence.

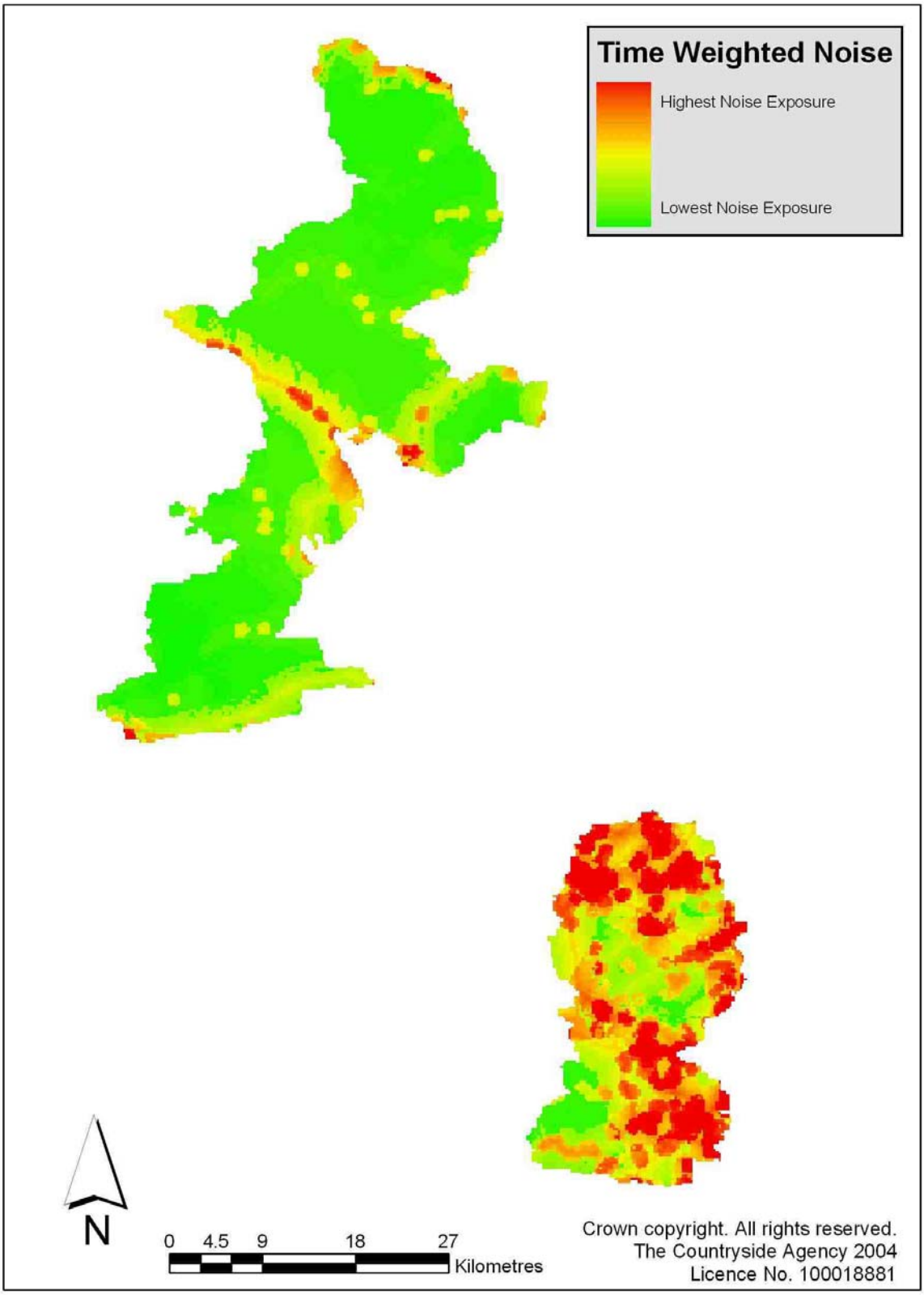


Figure 70: Map of Time Weighted Noise Exposure, conceptually equivalent to the L_{eq} measure. Note: no aircraft noise is considered in this figure as the available data relate to the entirety of both study areas

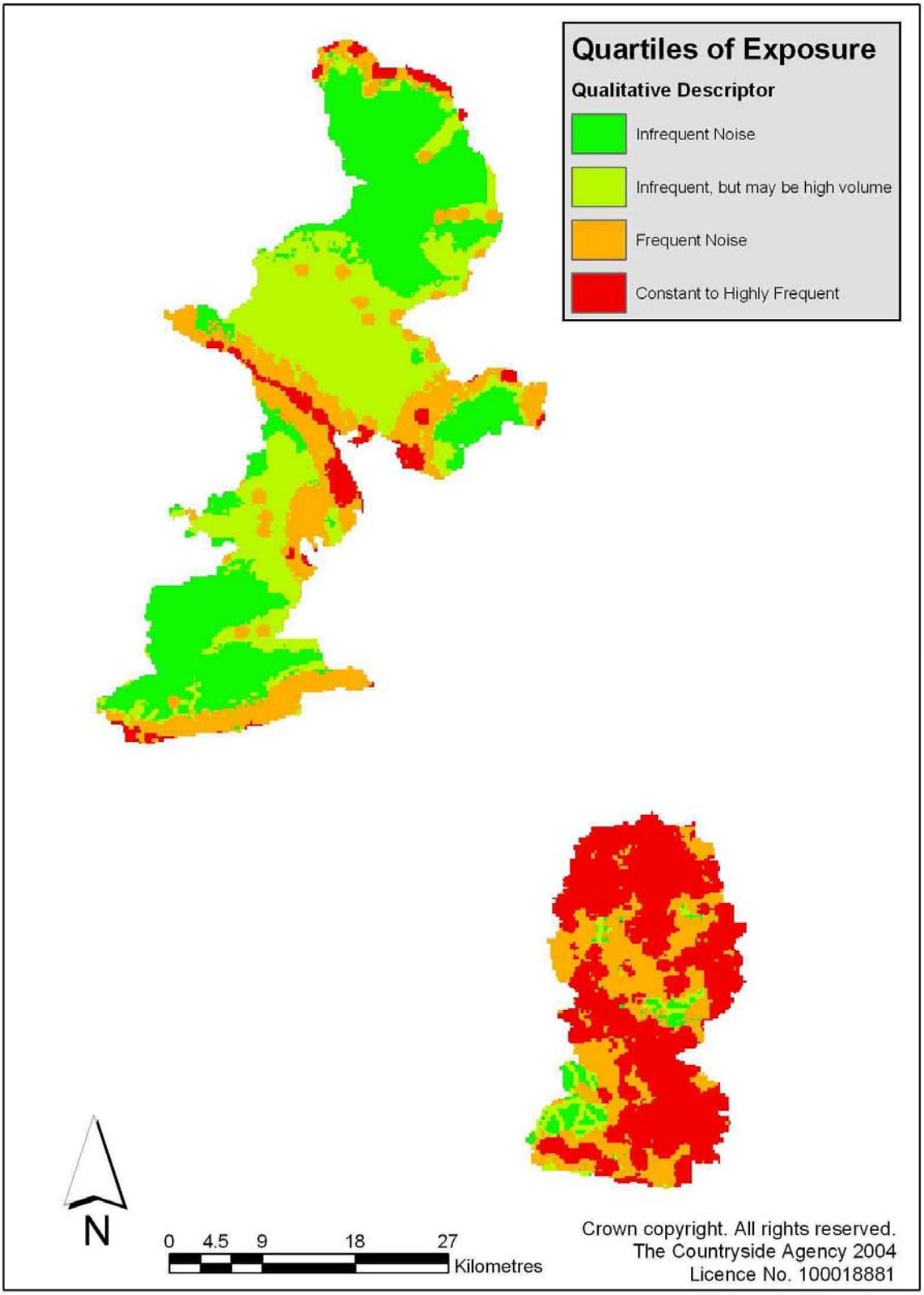


Figure 71: Map of Temporal Frequency of Noise Exposure in Quartiles
Note: no aircraft noise is considered in this figure as the available data relate to the entirety of both study areas

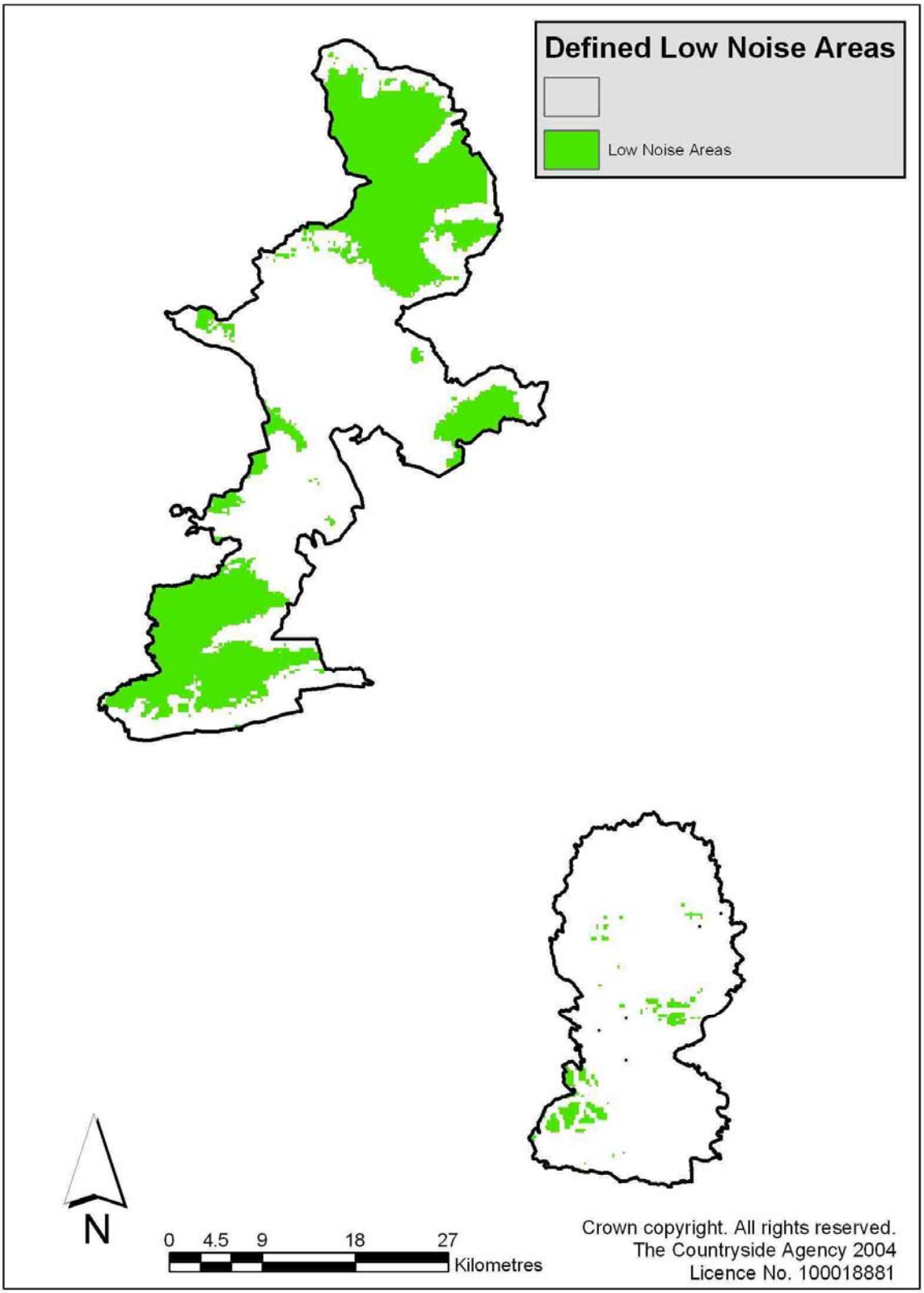


Figure 72: Map of Defined Quiet Areas (Bottom Quartile of Noise Exposure Level, see Map 71) Note: no aircraft noise is considered in this figure as the available data relate to the entirety of both study areas

4.7 Combining the Individual Components of the Model

There were six stages in putting together the final, appropriately weighted GIS model:

- The PA data was associated with a specific dataset where possible.
- The input datasets were classified as being either positive or negative.
- All of the input datasets were classified and weighted so that their relative significance was established.
- These positive and negative weighted component datasets were then combined through a process of summation to give a total score for the positive and negative components.
- Each of these sum layers was then multiplied by a coefficient (0.56 for negative and 0.44 for positive) to weight their aggregate contribution to the model. Figures 73 and 74 illustrate the weighted negative and positive factor maps respectively.
- The two weighted (positive and negative) layers were then combined ((Total Positive x 0.44) – (Total Negative x 0.56)) to give the final map which is illustrated in Figure 75.

POSITIVE			***NEGATIVE***		
LANDSCAPE			***LANDSCAPE***		
	SCORE	*% OF +VE SCORES*		*SCORE*	*% OF -VE SCORES*
			Visibility Roads	15.71	11.6
Openness	25.67	24.0	Visibility Urban	10.22	7.6
Perceived Naturalness Land Cover	23.26	21.8	Visible Overt Human Impact	10	7.4
Visibility of Rivers	14.33	13.4	Light Pollution	3.79	2.8
Presence of Rivers	6.56	6.1	Visibility Structures	3.69	2.7
Visibility Sea	6.33	5.9	Visibility Conifers	0.25	0.2
Visibility BLW	9	8.4	Visibility wind turbines	0.06	0.0
NOISE			***NOISE***		
Low Noise Areas	21.65	20.3	Road Noise	6.47	5.2
			Aircraft Noise	1.68	1.3
			Urban Noise	1.9	1.5
			Military Noise	0.33	0.3
			Train Noise	0.09	0.1
			Explosions	0.05	0.0
			PEOPLE		
				80.66	60
TOTAL POSITIVE	**106.8**		**TOTAL NEGATIVE**	**134.9**	
% OF TOTAL	**44.19%**		**% OF TOTAL**	**55.80%**	

Table 34: the Empirical Basis for Weighting the Elements of the GIS Model

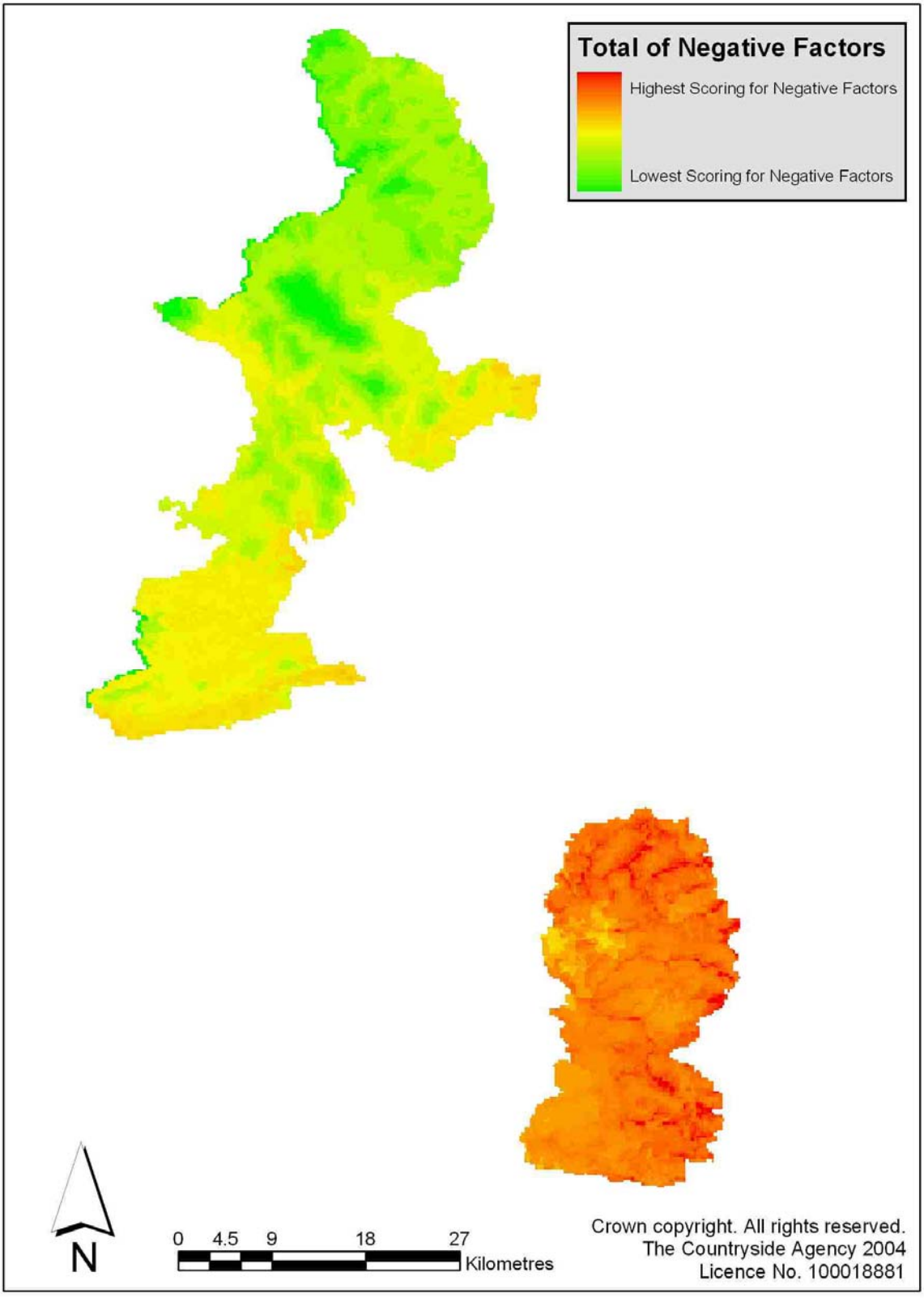


Figure 73: Composite Map of Negative Factors

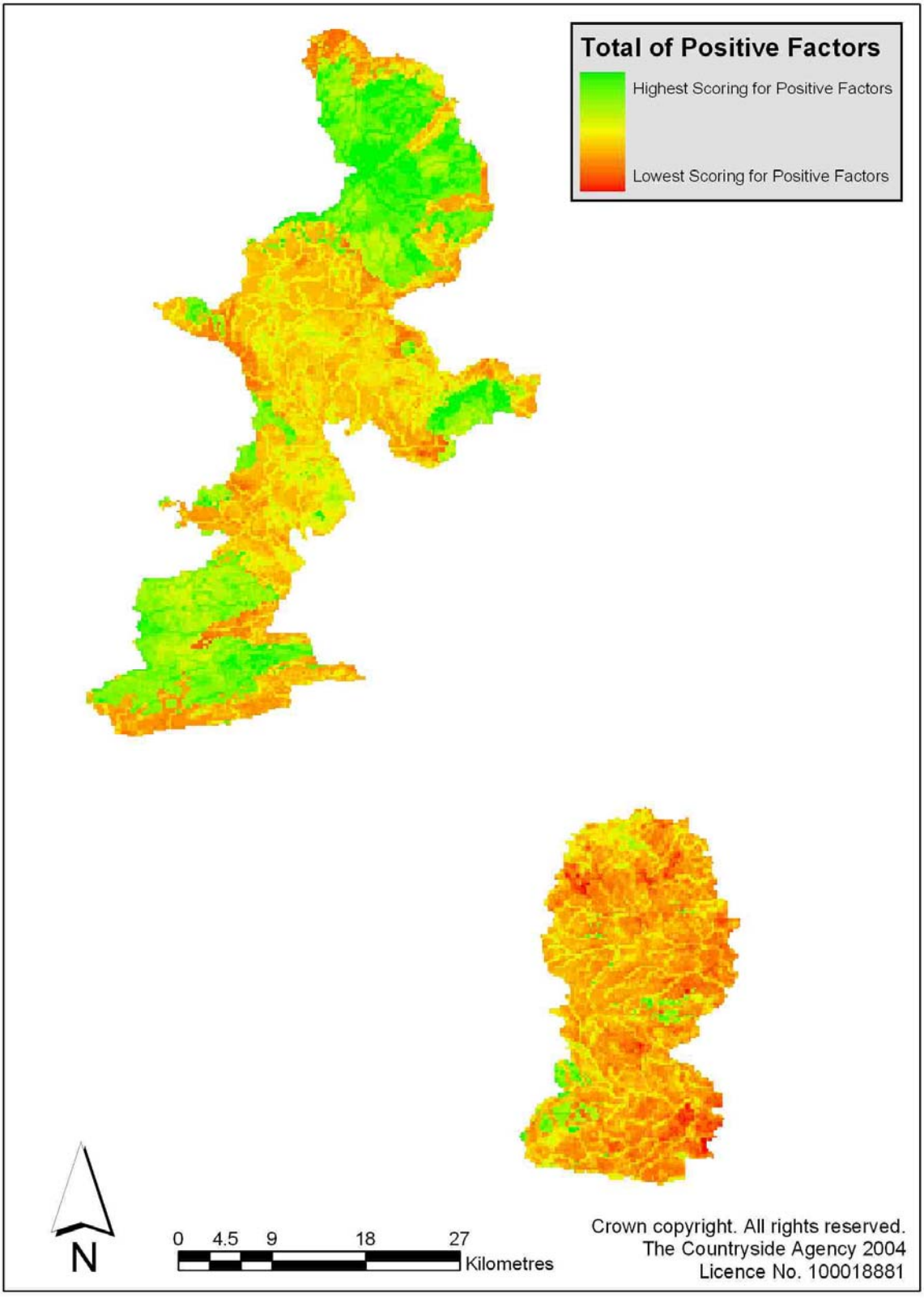


Figure 74: Composite Map of Positive Factors

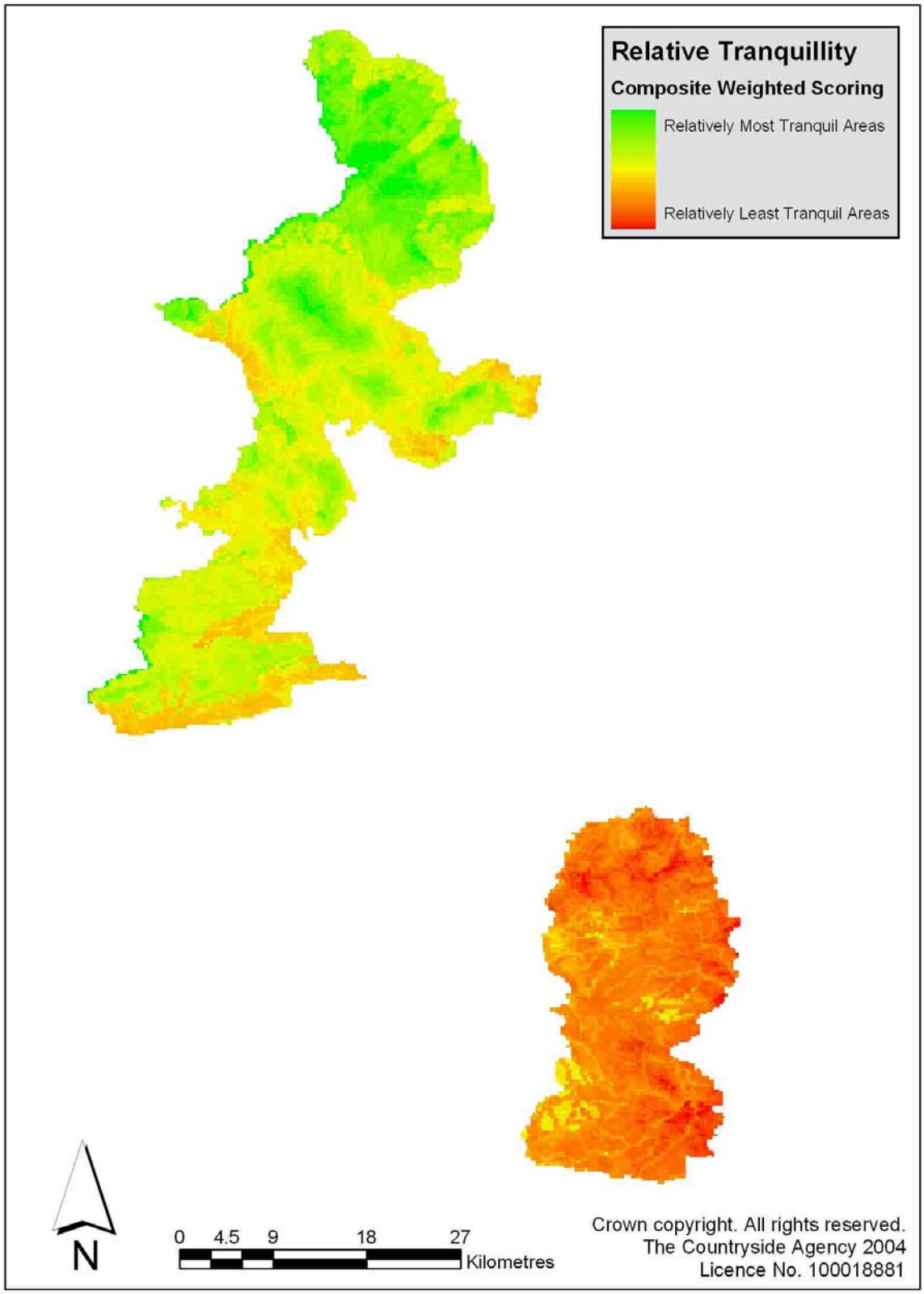


Figure 75: Composite Tranquillity Map

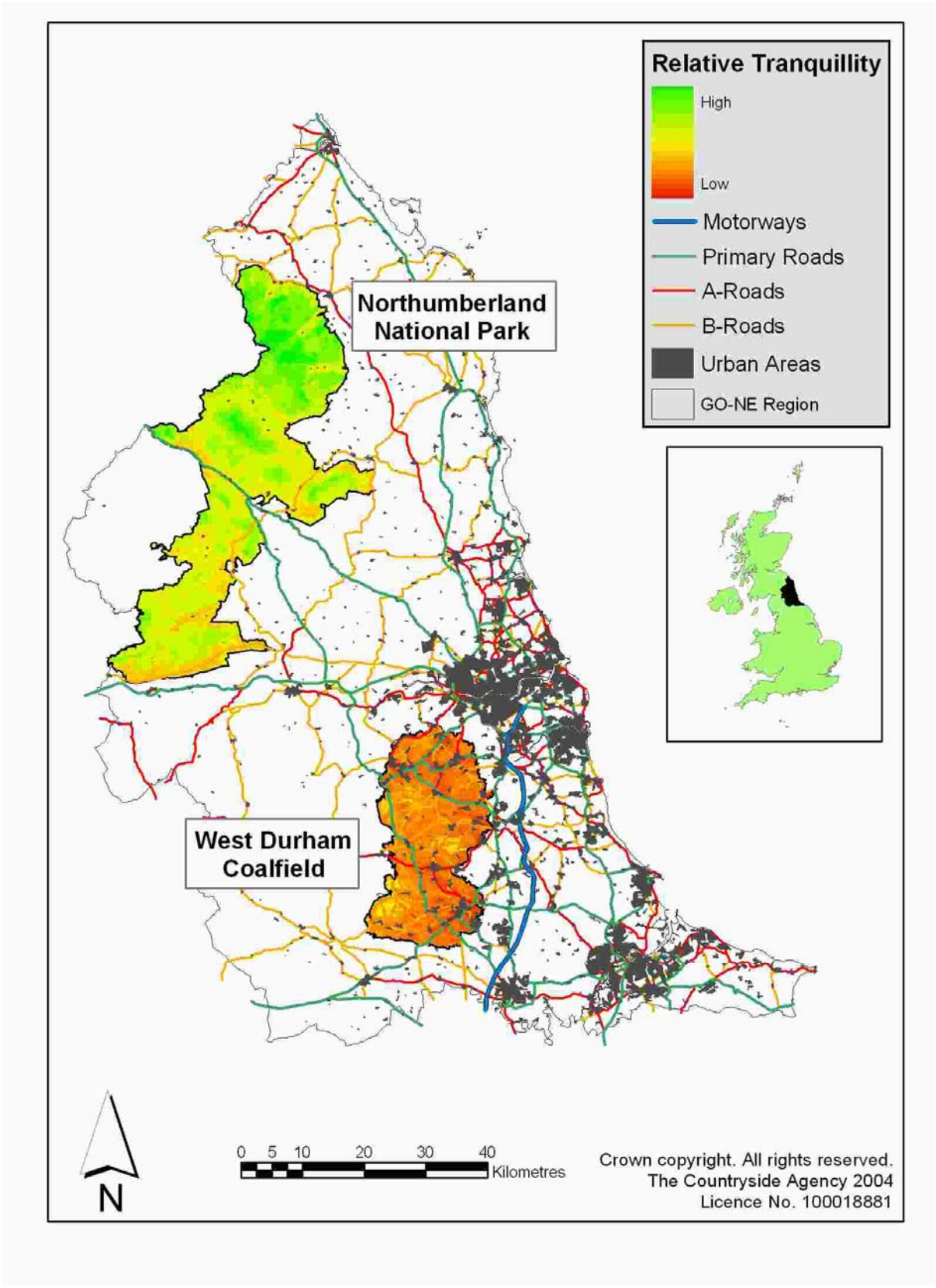


Figure 76: Composite Tranquillity Map with Infrastructure Context

5.0 Discussion

This section is broken down into three elements:

a) A general discussion of the methodology

b) A discussion of the findings and their implications for countryside policy, planning and management

c) A commentary on how this methodology could be taken forward to a regional and a national scale, reflecting in detail on ideas around relative and absolute tranquillity.

5.1 A general discussion of the methodology

This research was commissioned to take forward previous work in tranquillity mapping and develop a methodology that was sufficiently robust that its results (tranquillity maps) would have credibility amongst relevant practitioners. As a secondary objective the methodology should be able to be used in what may be termed an environmental assessment mode, whereby the impact of proposed developments (visual, noise and perception related) could be measured to test for negative impacts on areas that are judged to be tranquil and worth of protection in that. The GIS model developed in this project meets both these requirements, but there are issues arising from the project that need to be set out clearly as these are relevant to any future development or application of the methodology.

5.2 Reflections on Levett's Critique

First of all however, it is appropriate to reflect back on Levett's (2000) critique of previous approaches to tranquillity mapping, and gauge the level of progress that this research can now claim.

In summary, Levett (2000) argued that the limitations are as follows. The degree to which we think this project has addressed these shortcomings is noted.

a) the mapping uses a single threshold rather than a variation of levels of disturbance from distance from a source. This project has addressed this in full but utilising a continuum of relative degrees of tranquillity rather than a sharply bounded or binary set of high/medium/low or tranquil/non-tranquil areas.

b) the mapping does not take account of varying conditions, notably topography, vegetation, and prevailing weather. Topography and vegetation are explicitly considered in some of the variables modelled. Weather is relevant to many people's experience of tranquillity and the PA results are evidence of this. However considering weather in a spatial sense would be highly complex and variables such as visibility in different weather conditions has been simplified through the assumption of high levels of atmospheric visibility.

c) there is insufficient consideration of factors that may/may not occur on maps or where maps provide insufficient information to estimate effects. This is a very significant issue and one where the use of PA techniques permits information about people's perception of tranquillity to be presented alongside the maps of tranquillity. Levett is entirely correct that many indicators are too complex to model spatially or are essentially aspatial, but this does not mean that they should not be sidelined or overlooked.

d) there is a lack of detailed discussion of data sources and their limitations. This report has aimed to be as full and transparent as possible in relation to both data and the processes that were carried out.

e) the mapping does not take account of cumulative effects. Cumulation of visible, noise and people-related nuisance has been included in this study.

f) there is limited consideration of intermittent and variable sources of disturbance. This is a very complex area and reconciling variable levels of nuisance with a single composite map would require a set of additional scoring and weighting which there is no PA data to directly support. However, this or an alternative approach which is to produce a set of separate maps for different scenarios (e.g. night time, weekend of winter) is possible through development of this methodology.

g) no account is taken of interactions between factors and how they may effect the perception of tranquillity. The use of PA results to underpin the GIS model means that the model is structured to represent held perceptions of tranquillity. The relative significance of factors is thus accommodated. However the interaction between factors is a step beyond this and testing people's responses to interacting factors such as a certain landscape with or without people, quarry blasting noise and a chilly North wind would require a different approach.

h) *The selection of sources of disturbance seems to have been based solely on expert judgement, with little discussion or explanation. No empirical evidence is presented that they represent either the most significant factors or a sufficient set of sources to be (reasonably) comprehensive or representative.* Basing the model not on expert judgements but on more widely held perceptions of tranquillity was a key point of principle and practice in this project.

5.3 Boundaries: from Sharp to Fuzzy

Sharp boundaries are those where values, categories, names or other attributes change across a defined line. In many cases, for instance Census data, administrative area names or watersheds these are acceptable representations of the underlying phenomena. However, many environmental variables are much harder to represent using such discrete or sharp boundaries. Landscape character, soil type and noise levels are good examples of these where values tend to be spread across a continuum, and although classes, thresholds and breakpoints can be set, these can be points of convenience rather than true meaning in respect of the spread of the data.

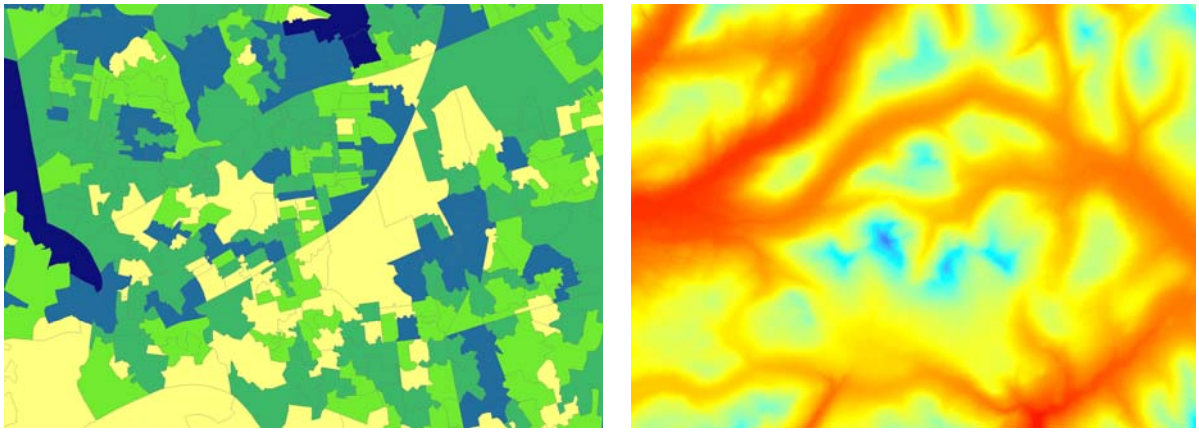


Figure 77: Sharp and Fuzzy Boundaries (not relating to the same dataset)

Many of the raster-based calculations used in this project resulted in a spectrum of values that had to be classified to apply differential weighting across a common scale, but the final map is one which illustrates relative tranquillity rather than tranquil areas.

5.4 Defining and Weighting the Variables

As briefly mentioned in response to Levett's critique and as elaborated elsewhere this approach this methodology is rooted in non-expert judgements about the nature of tranquillity. However, just as previous researchers have made judgements about distance thresholds (for instance Rendell's definition of areas > 4km from the largest power stations and > 1km from medium disturbance roads) we have had to make a series of judgements for instance about what datasets may be represent specific variables or the scale over which to reclassify data ranges. This is unavoidable in a GIS model that is based on survey data as distinct from a GIS that is on-line and available for people to interact with directly (Kingston, 2002), although even then the system designer has made a series of choices about how, and between what, the system user will make their choices. The emphasis must be on transparency.

5.5 Tranquillity, local areas and local people

Tranquillity as a resource has a complicated relationship with people. It is a quality of local environments that has the potential to contribute to people's quality of life. It is an experiential aspect of landscape that is interpreted and valued by individuals. However, too many people and other human imprints on the landscape have a significant effect in detracting from that experiential quality. As a consequence of this it follows that more highly developed, urbanised, intensively managed and densely populated landscapes are, all other things being equal, less likely to have that experiential quality. This poses some problems for the management of tranquillity as a *local* resource. When mapped on a common scale the WDC appears are being relatively less tranquil than the NNP, where much larger tracts of land are scored by the model as being highly tranquil. These areas within the NNP are amongst the most remote in the North East, and the NNP itself is a sparsely populated area. Thus, the tranquillity resource of the NNP is a local resource for a relatively small number of people, itself a major reason for its experiential quality. The WDC in contrast is a much more densely populated area, so there are more local countryside users as a consequence of this. However, the relative accessibility of the WDC countryside drives down its tranquillity score. As the methodology is intended to identify relative tranquillity, the model was re-run specifically and individually for the NNP and the WDC alone. Figures 78 to 81 illustrate the results of this, comparing the results for each study area for the all-area (both study areas together) calculations with the results for each area when modelled separately.

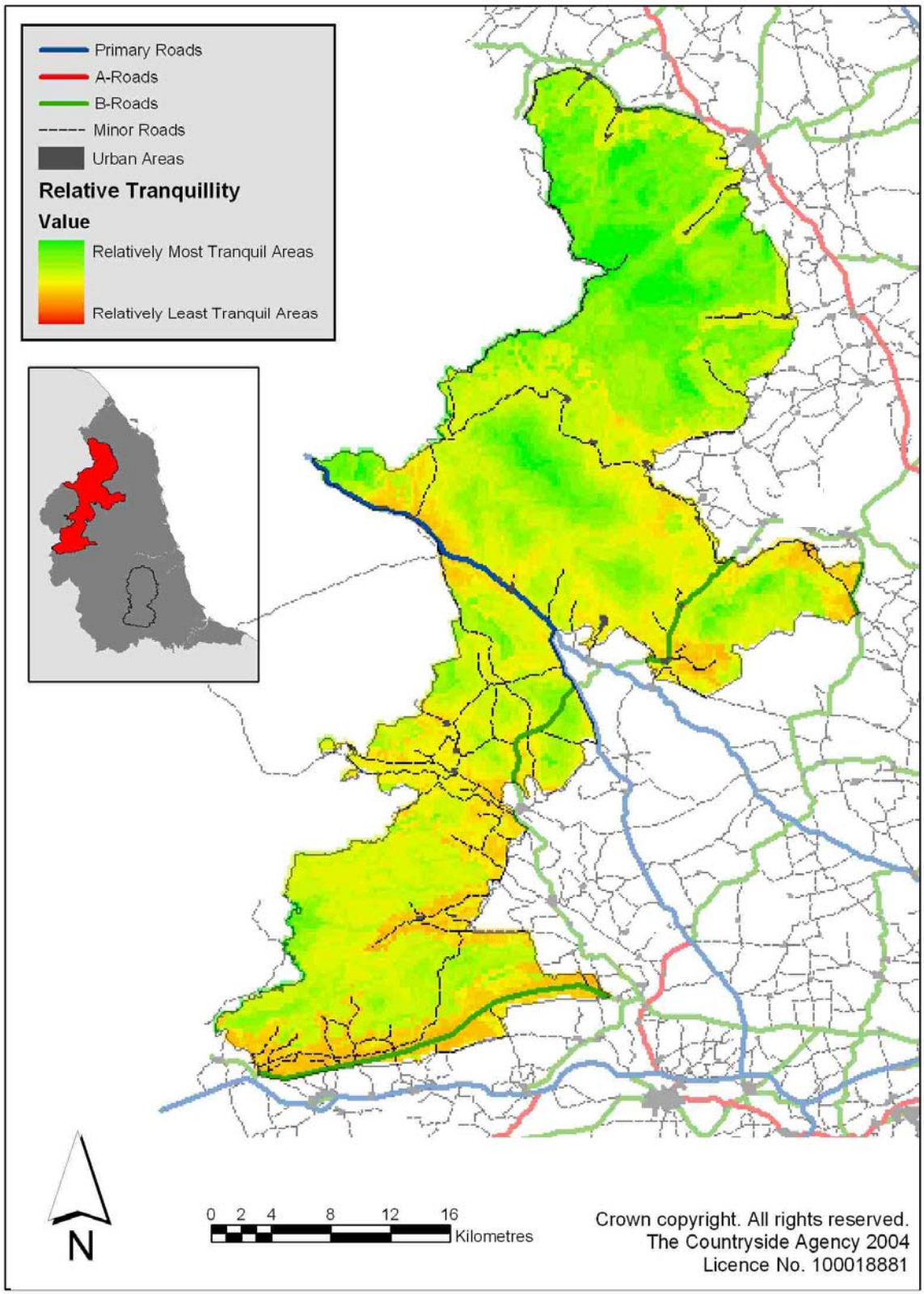


Figure 78: the relative tranquillity composite map when the model is run for both study areas but zoomed in on NNP

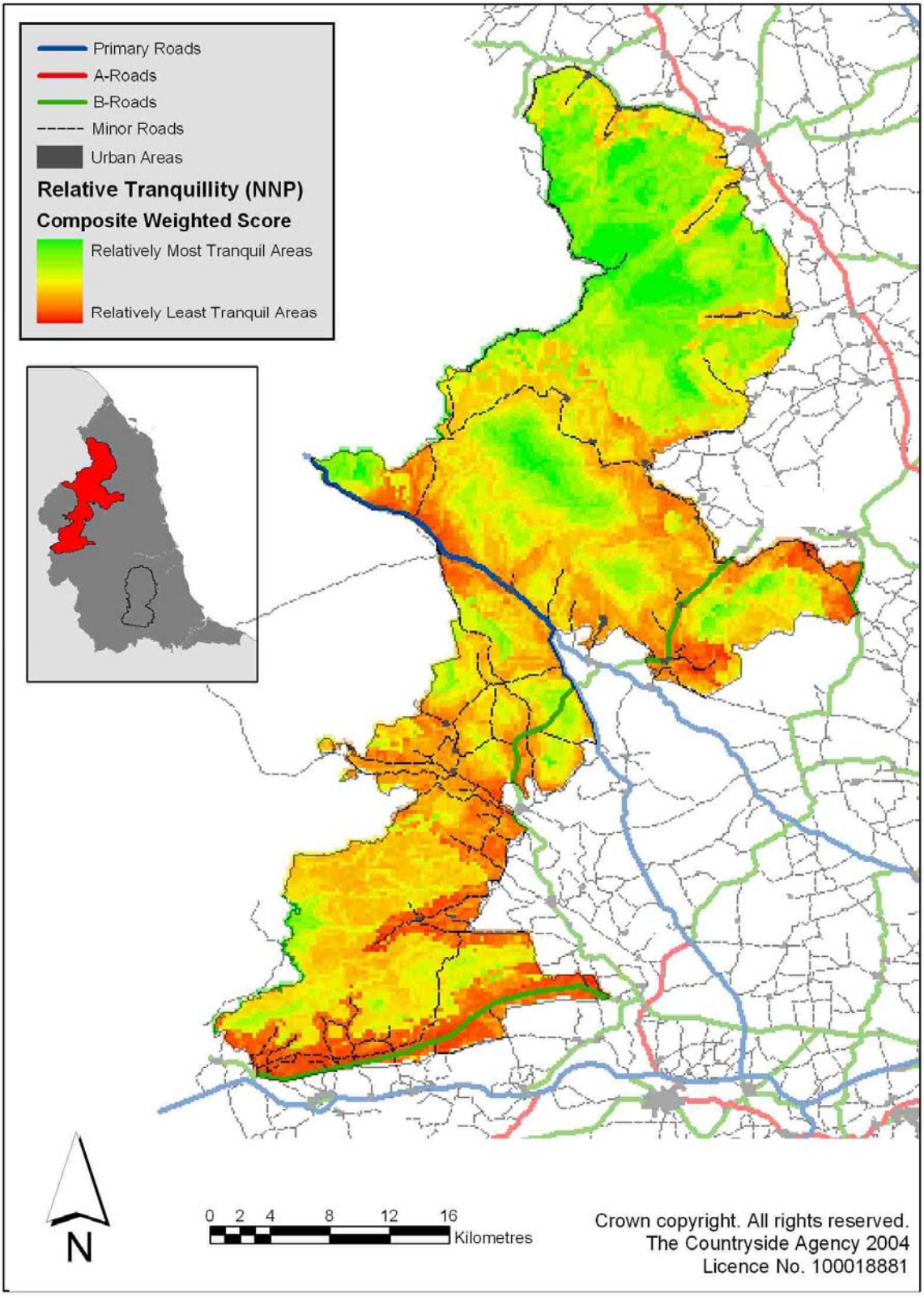


Figure 79: the relative tranquillity composite map when the model is run for the NNP alone

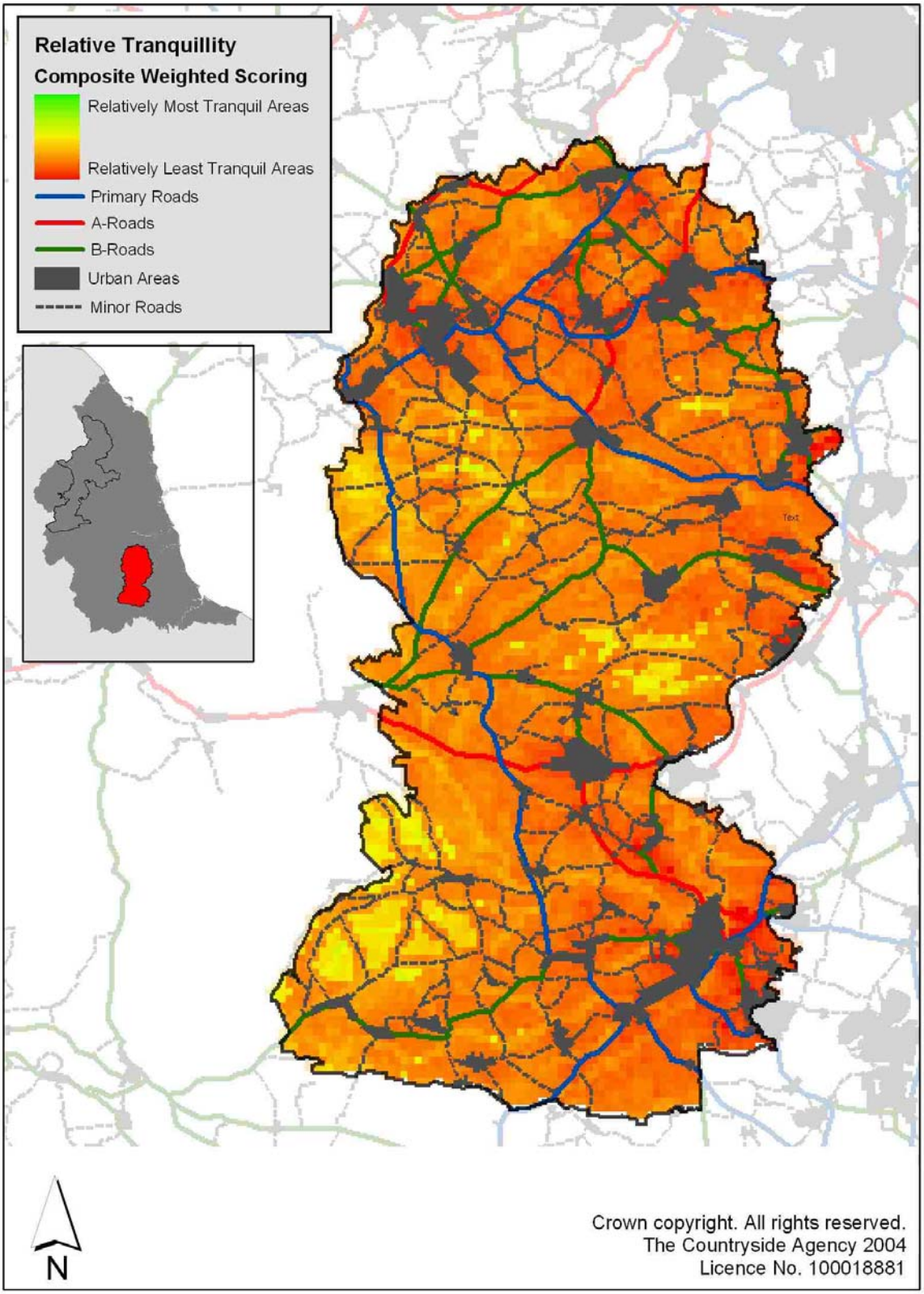


Figure 80: the relative tranquillity composite map when the model is run for both study areas but zoomed in on WDC

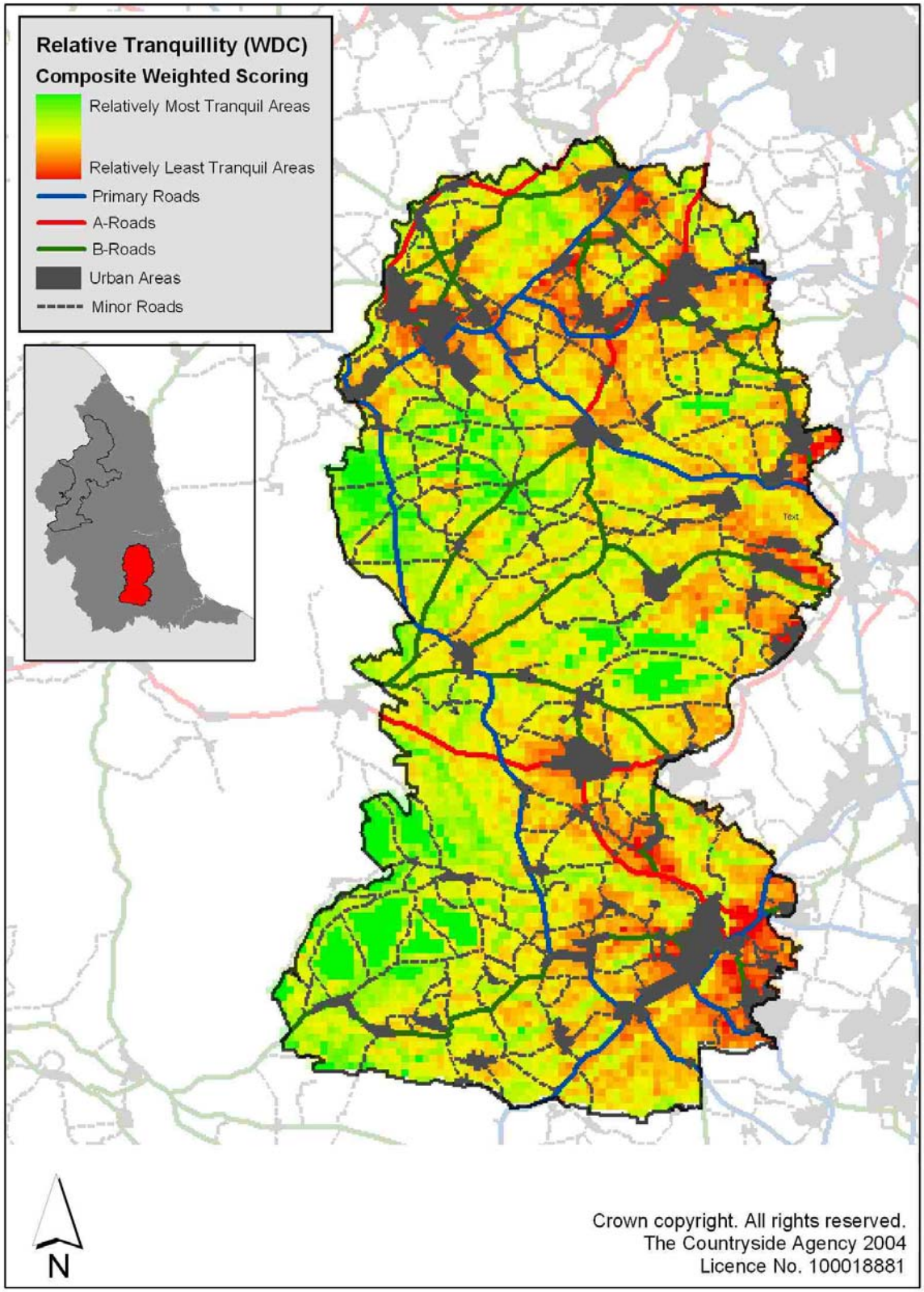


Figure 81: the relative tranquillity composite map when the model is run for the WDC alone

Rendell's work was done at a more crude spatial scale than this study. The approach tended, as has been discussed in the literature review, to eliminate local effects. One consequence of this however can be to 'overlook' small areas which have a *relatively* tranquil character, even through they are set in a context which militates against the attainment of higher tranquillity scores.

Figure 80 clearly identifies areas within the WDC which are relatively tranquil, relative that is to the spectrum of NNP and WDC values. The stretching effect of running the model for each individual study area introduces much more red into the NNP and more green into the WDC but the effect is more than just cartographic: it identifies the relatively most tranquil areas, which are local resources, within the WDC. This is pertinent information in the context of urban fringe area management as well as strategies for the wider countryside. As SNH (2003) have observed 'Some green enclaves within our cites can act as vital sanctuaries from adjacent noise and urban congestion, and can have a sense of wildness **relative to their setting** (p.2, our emphasis). This issue of relative (as distinct from absolute) tranquillity is a critical issue in considering how to extend this work (a) to a national scale and (b) to underpin the development of a positive planning tool to account for and promote tranquillity as a landscape quality in policy, planning and management decisions at a variety of different scales. It is returned to in some detail in 5.7.

5.6 A discussion of the findings and their implications for countryside policy, planning and management

Section one introduced the potential application of the tool in as:

- a campaigning tool
- a regional image / promotional tool
- a map on the wall
- a series of unpacked component maps which identify things that can be planned and managed to improve the situation as distinct from things that cannot
- an environmental assessment application

Maps have a clear value in campaigning, having the potential to be visually impressive, attractive and attention-grabbing and to communicate a great deal of information through a graphical medium. However, maps are the end product of a process. Critically this research has been to develop a process for tranquillity assessment and mapping and although the maps are in no way incidental to the project any application of the process much be careful and rigorous, or the map product could be erroneous, misleading or simply unimpressive. The maps from this project are more visually impressive that the ASH consulting maps of the 1990s, but the main progress has been with the process. That said, where the process is sound, robust and applied for the right reasons, the maps could have real significance as a place promotional tool. Care would be needed in how precisely to use such maps as advertising relatively tranquil areas could result in the degradation of is valued characteristics as ever greater number of people seek them out.

From a planning and management perspective the disaggregation of the model into a series of component maps that draw attention to what is valued and should be protected and what is problematic and could be mitigated is of very real value. Figures 82 to 85 provide a set of examples of potential applications of individual mapped components of the overall model.

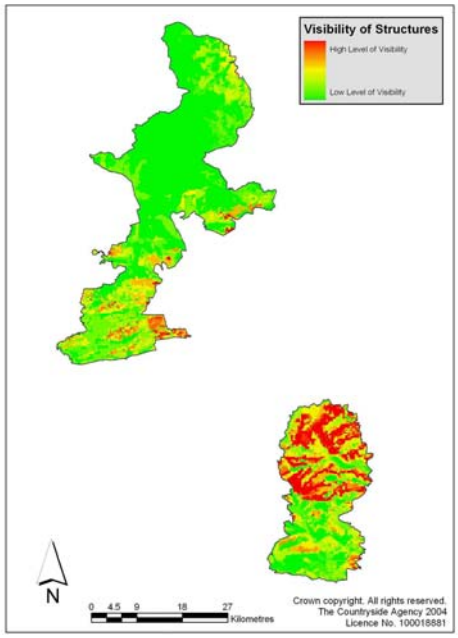


Figure 82: visibility assessments of new structures should be aware of existing high levels of visibility. It becomes a planning decision as to whether diffusion or concentration of visual impact is preferable.

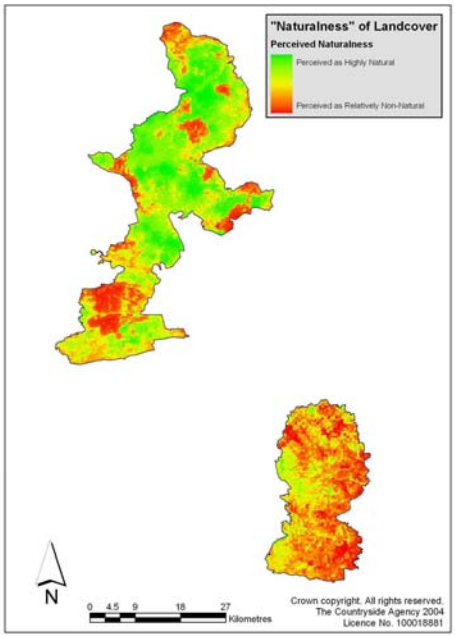


Figure 83: developments such as coniferous plantations, although unlikely in the current policy climate, could take account of perceived naturalness of land cover.

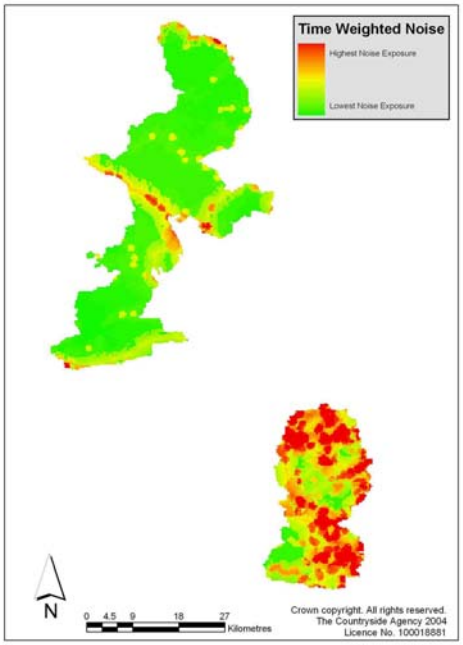


Figure 84: areas that experience low levels of time-weighted noise exposure may be protected against new sources of noise and measures to mitigate noise such as tree planting could be considered

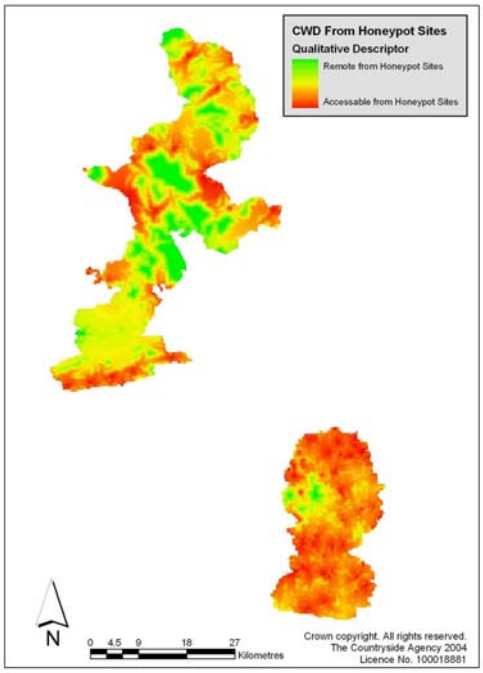


Figure 85: the main countryside gateway sites in the study areas determine the cost weighted distance from Honeypot sites. This map does not make the decision about whether certain areas should be kept free from such access points, but it provides useful background information to the decision.

Underpinning many such planning applications of the methodology are decisions about whether concentration of negative effects or their diffusion over space is most desirable. This is a social judgement, and the application of an approach such as this in an environmental assessment mode could at present identify the relatively most, and least, tranquil areas on a spectrum for a defined study area. However, many decisions require more information than this, and typically a planner or a planning inspector may want to know about the tranquillity of a given area when compared with other areas, and indeed on a national scale.

5.7 Relative and absolute tranquillity: a commentary on how this methodology could be taken forward to a regional and a national scale

Technical issues for an extension

This research has established a methodology that could be applied with only limited development to the regional (e.g. the North East or the South West) level. The PA and verification data relate to the North East and ongoing work in the Chilterns AONB will shortly provide a handle on how applicable the parameters and rules of the model are to other areas in England. To apply the model as it stands to the whole of the North East would require accessing and processing of the source data (e.g. noise sources, traffic levels, Honeypot sites, urban area populations) for the regional as a whole. In computing terms it would require some investment as many of the hundreds of calculations that combined to create the model as a whole ran for between 12 to 48 hours, and in some cases up to three days. Thus scaling the approach up to a national level would (a) either have to be disaggregated to a regional level and run separately for each or (b) be run at a coarser scale of resolution at a national level, even accepting the currently exponential increase over time in desktop PC processing power.

Bearing in mind that as you move up from a 250m x 250m to a 500m x 500m grid cell size the file sizes and length of processing fall to 25% with each decrease in scale. However, for it to be viable at a national (England) level a 1km x 1km scale would have to be the starting point. This would however have implications for the information produced, with a degradation in the ability of the process to identify locally significant area of relative tranquillity.

Data issues for an extension

Access to data for this project was generally good and undoubtedly helped by the support of steering group members and their organisations. Gathering data from multiple sources is very time consuming, and although we accepted from the start that we would have to use only national (e.g. Ordnance Survey or CEH Landcover data) or nationally repeated (e.g. lighting sources or Public Rights of Way, PRoW) datasets there would be significant time costs in assembling a national dataset. Where problems were experienced in this project was when access to data from outside the study areas was required. It took a period of months to access the ProW dataset from Cumbria County Council, and the original request was for a rather wider range of data. Scottish Borders were ultimately unable to supply any data to the project, and it is understandable in the climate of limited resources that a project relating to a neighbouring area is granted a low priority. One potential solution to this would be to budget specifically for time costs for agencies to extract licensed data.

Conceptual issues for an extension: from relative to absolute tranquillity, and back again

Following the previous discussion of qualities, quality, values and indicators in section 1.2 it is important to revisit some of the implications of an approach that identifies the relative

tranquillity of all areas, rather than the areas defined in absolute terms as tranquil, or by default, non-tranquil. This is done within the specific context of considering how this methodology might be extended to a national level.

Tranquillity as it is defined in this research is not a 'factual' characteristic of landscape in the way that certain other characteristics, such as percentage of woodland or the presence of certain species are. It is an experiential quality of landscape that flows from the valuations of individuals, reflecting a range of physical (aural and visual) characteristics, and emotional and cultural associations. At the personal level tranquillity is identified by many people as something of value, and therefore it is appropriate at the aggregate level as one measure or indicator of broader countryside and environmental quality. However, for both conceptual and methodological reasons, this research does not identify specific thresholds, above which absolutely tranquil areas are identified. The evidence (a) supports the concept of tranquillity as being complex and multi-dimensional, and (b) does not support or warrant the identification of sharp (both spatially and in respect of ranges of values) boundaries. Furthermore, just as there are technically no absolutely natural areas left within the British Isles, no areas are entirely free from the factors that detract from what the survey work has allowed us to define as the experience of tranquillity. Thus, both the individual components of the model and the final maps themselves show only ranges of values; it is of course technically possible to define thresholds above which, it is judged, tranquillity is high, medium or low, but these would be based on essentially arbitrary judgements if this was to be done at the present time.

There is a tension here between the conceptual framework and some of the potential applications of the model and the tranquillity maps. Many activities around planning and environmental assessment require defined boundaries. Limits of Acceptable Change (Cole and Stankey, 1998) for instance require limits to be defined in appreciable terms beyond which change becomes unacceptable. Land-use planners (broadly defined) require specific zones to be defined by sharp spatial boundaries, for instance National Parks, AONBs, SSSIs, Areas of Great Landscape Value and Green Belts; the implication is that rules which apply inside these boundaries do not apply, or are different to the rules that do apply, outside of them.

As previously stated, tranquillity is an identified indicator, most commonly of countryside and environmental quality, in a range of reports and documents from government agencies, local government and NGOs. Aspirations and more concrete policies that emerge from these include the protection of tranquillity and the enhancement of tranquil areas. For instance in RPG1 (Regional Planning Guidance for the North East 1, November 2002), ENV9 (Tranquil areas) indicates that 'Development Plans and other strategies should:

- Identify those areas where the maintenance of tranquillity is both important and practical; and
- Protect and, where appropriate, increase tranquil areas throughout the region when formulating policies for land-use, transport and traffic management' (GO-NE, 2002, p, 51-51)

However, our critique has identified a number of shortcomings in the utilisation of tranquillity in this way, including:

- A lack of conceptual clarity about what tranquillity actually is, reflecting a narrow, expert-based, definition of key characteristics;
- A failure to identify how tranquillity can be assessed or identified on the ground.

Indicators are most useful when associated with thresholds. An indicator, against which progress or change may be judged, is most effective when targets (quantified levels of achievement, change or progress) are established. Responsible authorities then have an aiming point, and stakeholders have a yardstick against which to assess the actions and outcomes taken to achieve that aiming point. However, an adherence to *relative* tranquillity, both conceptually and methodologically, fails to service the demand of planners, related professionals and other stakeholders for:

- Spatially discrete zones of tranquillity (either absolute for graded high/medium/low)
- Sharply defined thresholds for quality assessment or compliance testing purposes
- SMART[20] Objectives for environmental enhancement projects

This is not to say that such crispness cannot be implemented at a technical level. The failure to identify such crisp boundaries in this project is not a symptom of vagueness of thought, but rather an appreciation of, and conceptual commitment to reflect, the diversity of experience and expectation that underpins people's interaction with their environment. It might reasonably be noted of course that the same logic could be applied to nature reserves (where much conservation theory emphasises the beneficial effect of buffer zones and sympathetic management of the wider countryside (Adams et al, 1994)) and landscape designations where the in/out nature of boundaries has been associated with the 'halo' effect of a ring of development around the designated area that would not be permitted within it. Identifying appropriate boundaries is often a matter of professional debate and issues of landownership and public finances are often crucial in the way they are finally drawn.

We have not approached the assessment and mapping of tranquillity with a single purpose in mind. Our objective throughout has been to arrive at a fuller appreciation of tranquillity as a concept and develop from this a more representative, thorough and rigorous methodology for assessing the relative tranquillity of defined areas. The results from this methodology allow the relatively most and least tranquil parts of the area to be identified, but it does not support the identification of *absolutely significant* thresholds. The only absolutely significant points are the minimum and maximum values, which themselves reflect the character of the defined study area[21]. If the study area is changed than the values, both absolute and relative, change for the methodological reasons described. This is therefore both a technical point (relative location on the range of values depends on the minimum and maximum values, and what these values are depends on the study area) and a conceptual point (areas defined as relatively highly tranquil when considered in a local context may be relatively non-tranquil when considered in a regional context). This is relevant to the question of whether, and if so how, this methodology could be scaled up to a regional or national level, and if so what the results would tell decision makers and other stakeholder groups.

The technical point can be addressed in a number of different ways:

i. Running the model at a national level (England or UK, not necessarily using the same level of spatial resolution – it may necessarily be more coarse) will identify, based on the defined criteria, the absolute maximum and minimum values for all the components of the model (e.g. remoteness from people, time-weighted noise and perceived naturalness of the landscape) and therefore for the composite map. This would thereby permit relative tranquillity scores of local areas to be appreciated against a yardstick of known dimensions. The success of this approach is of course wholly contingent upon methodological consistency throughout (see point iii below).

[20] **S**pecific, **M**easurable, **R**ealistic, **A**greed and **T**imed

[21] The absolute range of values for the NNP & WDC study areas is from a maximum of 274 to a minimum of -483.

ii. Running the model at a regional or local scale (ideally at the level of resolution employed in this study) identifies, as this research has done, the relatively most tranquil areas within a defined area. However, these quantitative tranquillity scores exist in what may be described as a limbo, without an appreciation of what a score of, for instance 119 or -232 actually means. They are interval data, not dissimilar to the way in which temperature is measured; just as 10°C is not twice as hot as 5°C the difference is broadly understood in terms of what it means and feels like. In respect of tranquillity the challenge is to ensure that through future development that the quantitative tranquillity scores are understood, and the implications of differences in those scores can also be appreciated.

iii. Underlying the tranquillity scores are PA data. The PA data for the NE study were gathered through consultation within the NE Region, and mostly within the defined study areas. Early results from PA work recently completed in the Chilterns supports our view that consultation in different regions will identify different perceptions of tranquillity, what it is, what it is not and how to find it. The detailed analysis of these data are not yet available, but our preliminary conclusion is that different areas have different perceptions of what makes, detracts from and qualifies as tranquil areas. This means that underpinning a model of relative tranquillity for one region, say the East Midlands, with data from another region, say the North East, will not result in a model or maps that reflect local-regional perception of a local-regional resource. For the results to reflect local perceptions they have to reflect local inputs. This would seem to undermine the achievement of a nationally scaled approach. However, if PA work was carried out in a number of regions, broadly representative of the national landscape character areas, then these data could support both regional maps and be aggregated up to form a national rule base. This two-stream approach could then accommodate both the identification of an absolute national scale within which relative tranquillity (based on nationally aggregated data) of localities, areas and regions could be identified and also extract from this specific areas and identify the relatively most and least tranquil areas within them, based on the respective regional sub-set of PA data.

The conceptual point is less easily addressed, but the key issues are:

i. If the methodology is applied at a national scale, the results will identify the absolute maximum and minimum values for all of the components of the model and the final composite map. These results are of significance in identifying the nationally most tranquil areas. By their very nature it is likely that these areas are some of the most remote from centres of population.

ii. The high scores allocated to such areas by no means makes them irrelevant to people in those centres of population just because that are relatively distant, and certainly different from their everyday environment. However, we argue that attention in recognising, protecting and enhancing the characteristics which underpin the tranquillity of such places should not exclude a recognition of the value of areas, often much smaller in size, that are closer to the centres of population. Such areas would rate, in absolute and national terms, a low tranquillity score, but when considered in their local to regional context, their have real significance for a great many people.

iii. Therein of course lies a paradox that has long concerned agencies with an interest in tranquillity: if such areas are identified and even publicised as being tranquil, consequent levels of interest may degrade its underlying characteristics and qualities. However, this is an issue for the management of those areas and the publicity of the results of any study, not the methodology of it.

iv. The ASH (1995) work illustrated that tranquillity changes over time, when measured against a defined yardstick. However, yardsticks of what is desirable, acceptable or achievable may also change over time, so there is an issue about measuring such change. If a rule base for a GIS-based tranquillity model is rooted in a robust and accepted methodology then it can generate results that are themselves broadly accepted within the decision-making process. However, the model is ultimately based on processed consultation data, gathered at specific points in space and time. The issue of spatial variation of results and its implications for the mapping exercise has been discussed above. The question for temporal variation is one of whether change between time A and time B should be based on the consultation data for time A and updated spatial datasets describing the key parameters for tranquillity at time B, or whether the consultation should also be re-run for time B. It is our judgement that the latter option (updating both the data and the consultation) would not be effective over time periods of ten years or less, for the problems of disentangling objectively measured environmental change (i.e. using the available spatial datasets) and the socially constructed assessment of the significance of these parameters. Over longer time periods research into changing perceptions and valuations of tranquillity should be considered.

This research was based on two defined study areas within a single region of the country. Part of our remit in this project was to consider how this methodology may be scaled up to address requirements for tranquillity information at both a regional level (taken here to equate with each of the English government offices and the devolved parliaments and assemblies) or a national or UK level. For extension to a national level our proposal is as follows:

- Seek funding for primary research into thresholds of nuisance (visual, aural and experiential) to then feed into PA exercise. This would provide stronger evidence and an enhanced understanding of where the thresholds lie above which people's perception of the nuisance effect of various stimuli changes.
- Run PA in additional regions to analyse for regional differences in the perception of tranquillity. What sampling approach to use in this would have to be carefully determined, to reflect the different regions and also national landscape character areas. The underlying rationale here is to gain an appreciation, and be able to reflect, local values about locally distinct conditions, in the approach.
- Develop a rule base for each region to produce regional maps of relative tranquillity.
- Aggregate the regional consultation data into a national rule base for a national study. This would identify the absolute range of tranquillity, and would thereby support a national tranquillity mapping exercise, much enhanced from the 1995 ASH work, as described in this document.
- This approach would provide for:
    - Spatial comparisons (e.g. Cumbria with Devon)
    - Inter-temporal comparisons (2010 with 2004 provided that we maintain the same rule base as updating both the rule base and the data would be introduce unnecessary cause-effect complexity as described above).
    - National studies which could support various places making claims, or having claims made of them, for instance as 'the most tranquil National Park in England' or being in the 10% most tranquil areas within the country. While we have reservations about the use of such quantitative thresholds we recognise, as discussed above, that there are demands for more quantified, categorised and precise frameworks for assessing environmental resources.

- Local to regional studies, for instance the ability for National Parks, AONBs, County Councils, etc to identify the relative distribution of both nationally rated tranquillity and the relative distribution locally/regionally rated most or least tranquil areas within that specific area alone.

Thus what we are proposing here is an approach that consults in a number of regions than then uses this to construct a national, as well as regional, evidence base. This provides, through a single exercise, the foundations for a national study that can be defended as *representative* of the country as a whole, and also for regional studies based on regional data (where they exist) that permit issues around local conditions to be reflected.

5.8 Future technical research

Although a full retrospective appraisal of the project will follow after its formal completion, we have identified some specific areas where a future application of the methodology might be improved.

Improving the terrain attenuation effect on noise

The terrain effect on attenuation of noise was limited to the subtraction of 12dB for areas which were not visible from the source, as illustrated in Figure 86.

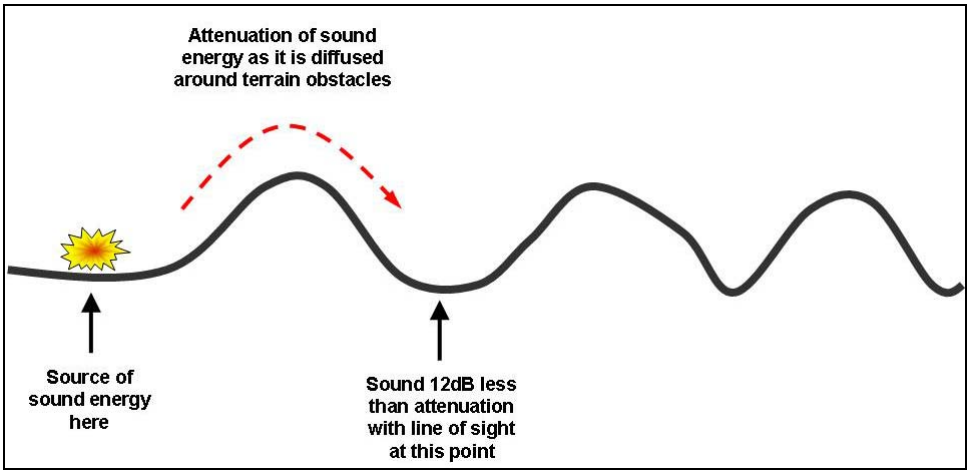


Figure 86: noise attenuation and simple intervisibility

However, as sound energy is attenuated as it moves over terrain that is vertically between the source and the receptor, it may be assumed that it will be further and progressively attenuated as it has to move over further terrain that prevents direct line of sight (Figure 82).

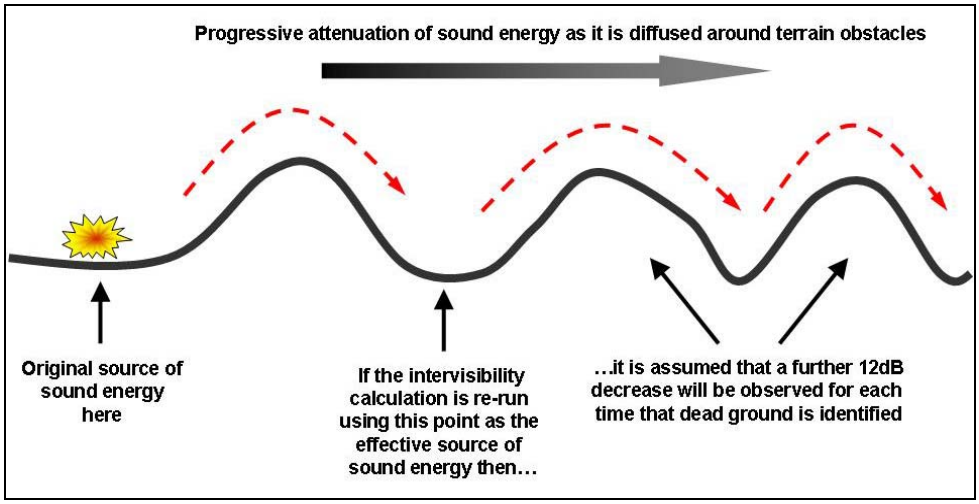


Figure 87: progressive noise attenuation over multiple breaks in line of sight

However, ArcGIS cannot currently accommodate such complex, 'rolling' intervisibility calculations and a surrogate approach may be required. Although we experimented during the course of this research, the results were inconclusive and unsupported by the literature. Terrain analysis was applied to identify breaks of slope. These were used to create a frictional surface, and the cells representing breaks in slope were attributed with a further attenuation value of –12dB.

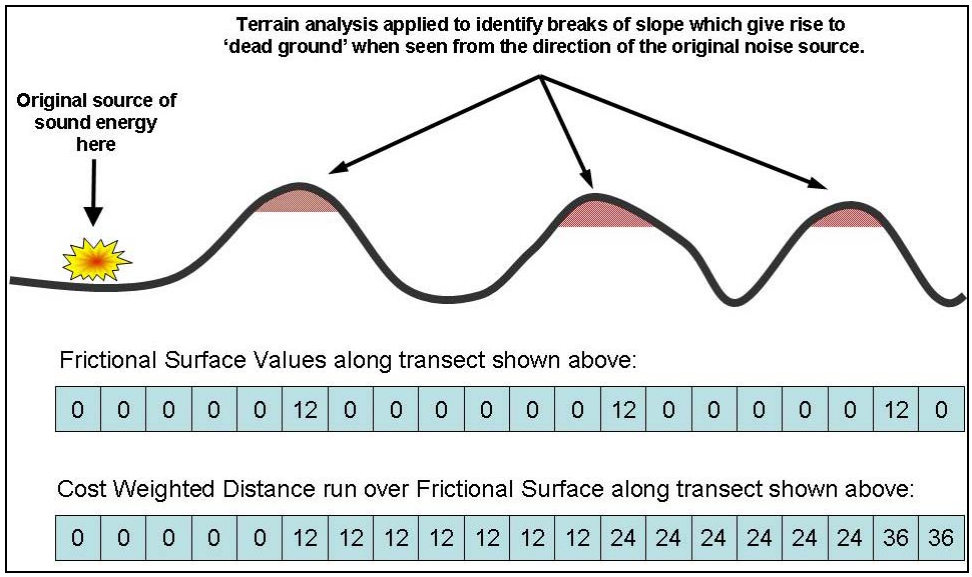


Figure 88: modelling progressive noise attenuation over a frictional surface representing breaks of slope

As illustrated in figure 88 a Cost Weighted Distance (CWD) calculation was then run over this frictional surface. Using the simple transect example in figure 83 the progressive noise attenuation is shown to increase from 12bB, through 24dB and then to 36dB. As there is no literature on long distance attenuation of noise due to terrain this would require further research as part of any future project, including the gathering and analysis of actual field measurements of noise levels.

Establishing an evidence base for the effect of distance on visual disturbance

There is an existing literature on Zones of Theoretical Visibility (ZTV). However, these relate to the ability to visually discern an object rather than say anything about its affective impact. As discussed in relation to the affective impact of noise this is a huge and complex field, but it is suggested that as a component of any further projects some research is carried out to identify if there are any significant visual thresholds around which people's perception of the nuisance value of specific negative (and indeed positive) features in the landscape alters.

6.0 *Conclusion*

This research set out to develop a methodology that was robust and had the potential to support a range of activities, with land-use and landscape planning foremost amongst them. Our approach meets these requirements and satisfies many of the criticisms that have been made of previous tranquillity mapping. Robustness is not just about processes, but it is also about premises and our approach is founded in broad-based consultation of countryside users as well as expert and stakeholder groups. This breadth of consultation is as critical to the robustness of the methodology as the PA to GIS connections and the GIS techniques.

This methodology is significant as tranquillity is significant and although it currently merits a mention in a wide variety of significant documents, policies and reviews, unless the experiential aspects of landscape are considered alongside more easily quantified and indicated characteristics, landscape, countryside and environmental quality can only be partially safeguarded into the future.

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