Tranquillity and Place Sound Environment (Part 1)

Report No: 660

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Crynodeb Gweithredol

Cyd-destun yr astudiaeth

Comisiynwyd LUC gan Cyfoeth Naturiol Cymru (CNC) i ddatblygu adnodd Llonyddwch a Lle daearol cyson newydd sy'n nodi'r adnoddau strategol a lleol mewn ardaloedd anghysbell, gwledig, trefol ac o gwmpas trefi i'w ddefnyddio fel sylfaen dystiolaeth i lywio bwriad polisi, ymarfer a darpariaeth ar gyfer buddion lles.

Datblygwyd yr adnodd Llonyddwch a Lle newydd gan ddefnyddio 'themâu' wedi'u mapio sy'n cyfuno i greu map Llonyddwch a Lle cyffredinol. Mae'r themâu fel a ganlyn:

Thema 1 - helaethrwydd, canfyddiad neu brofiad cymharol o natur, tirweddau naturiol a mannau gwyrdd.

Thema 2 - rhyddid cymharol rhag amhariad gweledol a dylanwad pobl.

Thema 3 - awyr gymharol dywyll.

Thema 4 - amgylcheddau acwstig lle mae synau naturiol yn fwy amlwg na sŵn ac yn briodol i'w cyd-destun. Caiff Thema 4 ei rannu ymhellach fel a ganlyn:

- Rhan 1 – Synau eraill heblaw am sŵn rheilffordd.
- Rhan 2 – Adeiladu ar ran 1 i gynnwys mapiau sŵn ffyrdd a rheilffyrdd newydd i Gymru.

Cesglir y pedair thema yma ynghyd i ddatblygu dwy thema gyfunol:

Thema 5 – mannau o lonyddwch gweledol (themâu 1, 2 a 3).

Thema 6 – yr adnodd llonyddwch llawn (themâu 1, 2, 3 a 4).

Beth yw nod yr astudiaeth hon

Comisiynwyd yr astudiaeth hon i gydnabod pwysigrwydd llonyddwch fel mantais sy'n perthyn i dirwedd ac fel gwasanaeth diwylliannol pwysig. Mae llonyddwch yn cael ei werthfawrogi'n fawr ac mae'n cyfrannu at werth a hunaniaeth y dirwedd. Mae llonyddwch hefyd yn cyfrannu at iechyd, lles, budd ysbrydol ac ansawdd bywyd. Ond mae ei wydnwch yn gyfyngedig, a gall newidiadau cynnil o ran sŵn, amhariad gweledol a llygredd golau gael effaith amlwg ar leoliadau naturiol a llonyddwch.

Mae'n bwysig cael adnodd Llonyddwch a Lle sy'n gyson yn genedlaethol i'w ddefnyddio fel sail dystiolaeth i lywio bwriad polisi, ymarfer a darpariaeth ar gyfer buddion lles.

Er mwyn cyflawni hyn, roedd yr astudiaeth hon yn cynnwys creu'r canlynol:

- Setiau data a mapiau llonyddwch i Gymru gyfan ar gyfer thema 4 rhan 1.
- Set o fapiau ac ystadegau ar gyfer parthau penodol ar gyfer thema 4 rhan 1 yn erbyn amrywiaeth o gyd-destunau daearyddol.
- Methodoleg ac adroddiad ar ganfyddiadau.
- Ychwanegiad at y Map Stori Llonyddwch yn crynhoi'r canlyniadau.

Cynhaliwyd dau weithdy i randdeiliaid yn ystod y camau datblygu i gefnogi'r astudiaeth hon, gan sicrhau bod amrywiaeth o safbwyntiau ar gael i lywio'r gwaith o ddatblygu dangosyddion llonyddwch.

Beth mae'r adroddiad hwn yn ei gynnwys

Mae'r adroddiad hwn yn darparu manylion y dull a ddefnyddiwyd i greu haenau'r map ar gyfer thema 4 rhan 1. Darperir crynodeb o fewnbwn rhanddeiliaid fel cofnod o ganfyddiad pobl o ddangosyddion llonyddwch.

Lle bynnag y bo modd, cyflwynir y canfyddiadau'n weledol gyda mapiau a siartiau, ac ategir y rhain gan dablau â ffigurau allweddol. Cofnodir yr holl baramedrau manwl a ddefnyddir yn y modelau GIS er mwyn hwyluso'r broses o ddiweddaru'r mapiau yn y dyfodol.

Trosolwg o brif ganfyddiadau thema 4, rhan 1

Dim ond rhan 1 o thema 4 y mae'r astudiaeth hon yn ei chwmpasu. O'r herwydd, dylid cofio nad yw'r holl ganlyniadau a gyflwynir ond yn rhan o'r wybodaeth sydd ei hangen i ddangos amgylcheddau sain cymharol lonydd, lle gellir disgwyl i seiniau naturiol fod yn fwy amlwg na sŵn a'u bod yn briodol i'w cyd-destun. Oherwydd hyn, cyflwynir y canfyddiadau yn yr adroddiad hwn gyda sylwebaeth gyfyngedig, a dylid eu dehongli fel canlyniadau dros dro y bydd angen eu hintegreiddio â chanlyniadau rhan 2 cyn y gallant fod yn ddangosyddion gwell o amgylchedd sain Cymru o ran llonyddwch a lle.

Executive summary

Study context

Natural Resources Wales (NRW) commissioned LUC to develop a new nationally consistent terrestrial Tranquillity & Place resource that identifies the strategic and local resource in remote, rural, peri-urban and urban areas for use as an evidence base to inform policy intent, practice and provision for well-being benefits.

The new Tranquillity & Place resource has been developed using mapped 'themes' that merge to produce an overall relative Tranquillity & Place map. The themes are as follows:

Theme 1 - relative abundance, perception or experience of nature, natural landscapes and greenspaces.

Theme 2 - relative freedom from intrusive visual disturbance and human influence.

Theme 3 - relative dark skies.

Theme 4 – sound environments where natural sounds are more prominent than noise and are appropriate to context. Theme 4 is further subdivided into:

- Part 1 - Sounds other than road and railway noise.
- Part 2 - Building upon part 1 to incorporate new roads and railways noise maps for Wales.

These four themes are collated to develop two combined themes:

Theme 5 - visually tranquil places (themes 1, 2 and 3)

Theme 6 – the full tranquillity resource (themes 1, 2, 3 and 4).

What is the aim of this study

This study was commissioned out of recognition of the importance of tranquillity as a landscape asset and important cultural service. Tranquillity is highly valued and contributes to landscape value and identity. Tranquillity also contributes to health, well-being, spiritual benefit and quality of life. But it has limited resilience, and subtle changes in noise, visual intrusion and light pollution may have marked effects on natural settings and tranquillity.

It is important to have a nationally consistent Tranquillity and Place resource to use as an evidence base to inform policy intent, practice and provision for well-being benefits.

To achieve this, this study involved the creation of the following:

- A Wales-wide dataset and maps of tranquillity for theme 4 part 1.
- A set of maps and zonal statistics, for theme 4 part 1 against various geographical contexts.
- A methodology and findings report.
- An addition to the existing StoryMap for Tranquillity, summarising the results.

The study was supported by a stakeholder workshop during the development phases, ensuring that a diverse range of perspectives inform the development of tranquillity indicators.

What does this report cover

This report provides details of the method used to create the map layers for theme 4 part 1. A summary of stakeholder input is provided as a record of perceptions of tranquillity indicators.

Wherever possible, the findings are presented visually through maps and charts, supported by tables of key figures. The detailed parameters used in the GIS modelling are all recorded in order to facilitate future updates of the mapping.

Overview of key findings for theme 4 part 1

This study covers just part 1 of theme 4. As such, all the results presented should be understood to be only part of the information required to indicate relatively tranquil sound environments, where natural sounds may be expected to be more prominent than noise and are appropriate to context. Because of this, the findings in this report are presented with limited commentary, and should be interpreted as interim results that will need to be integrated with the part 2 results before they can more fully indicate the tranquillity and place sound environment of Wales.

Introduction

In September 2021, Natural Resources Wales (NRW) commissioned LUC to develop a new nationally consistent terrestrial Tranquillity & Place resource that identifies the strategic and local resource in remote, rural, peri-urban and urban areas for use as an evidence base to inform policy intent, practice and provision for well-being benefits.

Tranquillity is associated with the degree to which places and ecosystems deliver a state of quiet, calm, peace and well-being. This can be described as a relative abundance, perception or experience of nature, natural landscapes and features (e.g. birdsong, natural sounds, moving water, stars and perceived wildness) and/or a relative freedom from unwanted visual disturbance, signs of human influence and artificial noise (e.g. from people, transport, development, light pollution, power lines).

Tranquillity, as a landscape asset and important cultural service, is highly valued and contributes to landscape value and identity. Tranquillity also contributes to health, well-being, spiritual benefit and quality of life. This in turn can bring economic benefits from tourists and visitors to tranquil areas. Tranquillity has limited resilience in that subtle changes in noise, visual intrusion and light pollution may have marked effects on natural settings and tranquillity.

Tranquillity as a natural resource is most often experienced in the rural landscape. With continued expansion of the urban population, the importance of finding relatively tranquil places in urban parks and open spaces is growing. This can be possible where positive soundscapes outweigh sounds like traffic, where peace and quiet coincides with visual beauty/aesthetics and where there is a sense of nature, personal safety and freedom of access. Areas of urban tranquillity provide an important contrast and break from the built environment with benefits to quality of life.

Themes

The new Tranquillity & Place resource has been developed using mapped ‘themes’ that merge to produce an overall relative Tranquillity & Place map. The themes are as follows:

Theme 1 - relative abundance, perception or experience of nature, natural landscapes and greenspaces.

Theme 2 - relative freedom from intrusive visual disturbance and human influence.

Visit the Tranquillity & Place StoryMap for further information

Theme 3 - relative dark skies.

Visit the Dark Skies StoryMap for further information.

Theme 4 - sound environments where natural sounds are more prominent than noise and are appropriate to context. Theme 4 is further subdivided into:

- Part 1 - Sounds other than road and railway noise.

Part 2 - Building upon part I to incorporate new roads and railways noise maps for Wales.

These four themes are collated to develop two combined themes:

Theme 5 - visually tranquil places, which includes themes 1, 2 and 3.
Theme 6 – the full tranquillity resource, including themes 1, 2, 3 and 4.

This report covers the methodology and results for theme 4 part 1.

Aims and objectives

The aims of this study are to:

- Create a Wales-wide GIS dataset of Tranquillity & Place Sound Environment for theme 4 part 1.
- Generate a set of Wales-wide maps of Tranquillity & Place Sound Environment for theme 4 part 1.
- Generate a set of maps displaying Tranquillity & Place Sound Environment theme 4 part 1 data against the following geographies:
    - Local Authority areas
    - The 4 regions of Future Wales
    - Designated landscapes (Areas of Outstanding Natural Beauty (AONBs) and National Parks)
    - NRW Operational Areas / Area Statements
    - National Landscape Character Areas
- Create zonal statistics for the various geographical contexts listed above, plus LANDMAP Visual & Sensory aspect areas
- Document the findings in an evidence report which summarises the method and findings of the study.
- Update the interactive Tranquillity & Place StoryMap to provide a summary of the results in an intuitive and understandable way.

Methodology

This section sets out the method followed to create the data and subsequent maps that comprise this study. This method is designed to be easily replicated. The approach taken to develop the mapping methodology followed the stages set out in Figure 1.

Figure 1 Summary of approach

Previous studies

It was agreed at the inception of this project that this study should have as much parity with the previous stages as possible. This would allow for a more seamless integration of theme 4 with the other themes that have already been developed. The full detail of the methodology developed for the previous stages of this study can be found in the report *Green C, Manson D, Chamberlain K 2022. Tranquillity and Place. NRW Report No: 569, 185 pp, NRW.* The report can also be viewed and downloaded online.

Rural/all-Wales and Urban split

As this study is examining relative tranquillity, there is a need to recognise that pockets of tranquillity within urban areas are important, even if they are not truly tranquil by rural standards.

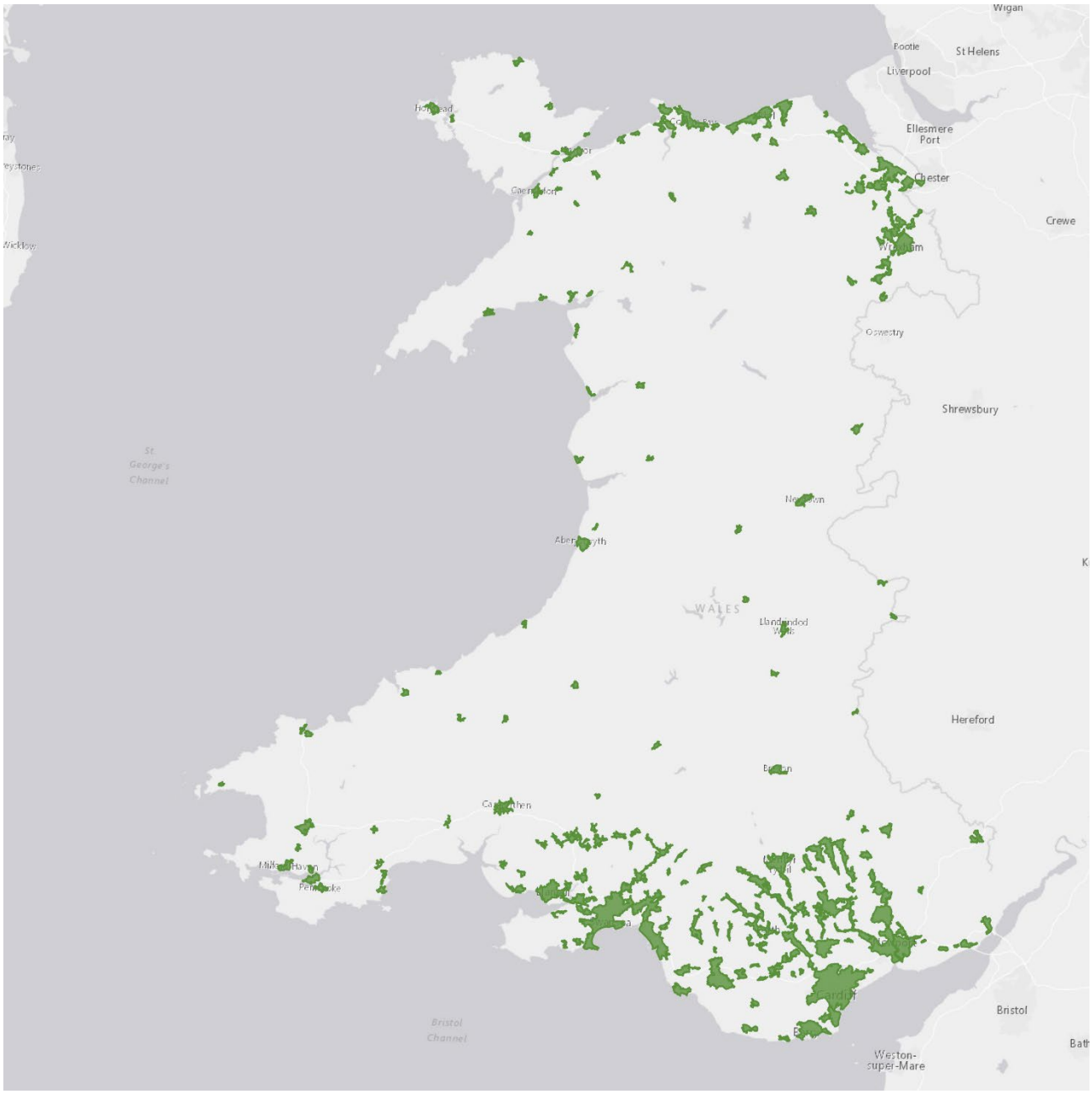
In order to do this, whilst maintaining consistency between the urban and rural areas, a two level approach was taken for the analysis. Both levels of analysis draw on the same aspects of tranquillity (for example, the sound of moving water), but some of the data used to represent/model the indicator and the spatial resolution of the data differs between them.

The rural analysis covers the entirety of Wales, including those areas covered by the urban analysis, to allow for consistent comparisons between different geographies. The urban analysis is in addition to this, but only covers the urban areas.

A note on the term “rural analysis” – this aspect of analysis covers the entirety of Wales, including the urban areas. For consistency, and to avoid any confusion when it comes to combining theme 4 with the other themes, this naming convention has been preserved in this report, however it is recommended that the final theme 6 mapping refers to this as the all-Wales analysis. This is to avoid the impression that it only covers the rural areas.

Urban areas have been defined using the extent of the study areas mapped in the Urban Tree Cover data from the Tree Cover in Wales’ Towns and Cities project, as shown in Figure 2. To align with previous work, the analysis has been run out to 6km from these urban areas.

Figure 2 Urban areas from Urban Tree Cover data



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Consultation

LUC and NRW held a workshop in February 2023 to provide key stakeholders the opportunity to comment on and shape the proposed methodology, whilst considering the need to align with the previous stages of the study. As such, much of the focus of this workshop was around factors that could be included (or excluded), and the data that could be used.

The workshop included discussions on:

- What makes a tranquil sound environment for each participant;
- What detracts from a tranquil sound environment for each participant;
- The relative importance of different factors influencing tranquillity associated with sound; and
- Potential differences in the experience of tranquillity associated with sound between rural and urban areas.

Stakeholders included representatives from the following organisations:

- LUC
- Natural Resources Wales
- Welsh Government
- Cadw
- Natural England
- National Trust
- Eryri National Park Authority
- Pembrokeshire Coast National Park Authority
- Clwydian Range and Dee Valley AONB
- Landscapes Wales
- Landscapes for Life
- Ceredigion County Council
- Swansea City Council
- Caerphilly County Council
- Pembrokeshire County Council
- Isle of Anglesey County Council
- Monmouthshire County Council
- Cardiff University
- Cambrian Mountains Initiative

The workshops identified a considerable number of potential factors that could be included as part of this study, however analysis of the feedback received shows that sound is extremely subjective and complex to measure. Many of the comments deal with the appropriateness of a sound to context, an individual's perception of the sound, as well as one's own preferences. Extracts from the breakout discussion sessions from the February 2023 workshop are included in Appendix 1.

Many suggested sound 'sources' were challenging or impossible to map. As a result, only those suggestions that were objective and likely to be able to be supported by available data were considered to indicate relatively tranquil sound environments where natural sounds may be expected to be more prominent than noise and are appropriate to context. This is covered in more detail in the Limitations and future enhancements section.

Indicators

Theme 4 part 1 was further broken down into 'indicators', with each indicator looking at a specific component of tranquillity associated with the sound environment. These indicators

formed the building blocks of the theme, but are not designed to be viewed in isolation as a measure of tranquillity.

A number of factors influenced the development of the final list of indicators taken forward for assessment including:

- Natural and non-natural sounds and noise (excluding roads and railways)
- Stakeholder feedback
- Availability of data
- Consistency and robustness of data

The following is the final list of indicators used in the assessment. A full breakdown of the indicators and the way in which they were modelled is included in the Indicator details section.

- Indicator T4-01 – Hearing moving water
- Indicator T4-02 – Hearing the sea
- Indicator T4-03 – Hearing nature
- Indicator T4-04 – Hearing low flying aircraft
- Indicator T4-05 – Hearing lots of people
- Indicator T4-06 – Hearing non-natural sounds

Data sourcing

A key requirement for this study was to design the methodology to be repeatable. As such, all datasets used needed to be easily accessible, and wherever possible, freely available.

The data also needed to cover the whole of Wales, so as to give a fair measurement across the whole country. Data was also required for England where there is an equivalent dataset available, so as to not understate its presence along the border.

Data processing

This study is intended to be brought together with previous work, and so for consistency in approach, and to allow the results to be easily combined at a later stage, the results of this study have been aligned with those produced for earlier themes.

The rural and urban components of the study are again being assessed separately, and so the rural/all-Wales analysis has been run at a resolution (pixel size) of 50 metres. This is based on the surface produced previously for the visibility analysis using OS Terrain 50. The urban analysis has been run at a resolution of 10 metres, based on the resampled surface from OS Terrain 5.

Decibel is the measurement unit used for indicating the intensity of a sound as perceived by the human ear. The more intense a sound is, the higher up it will be on the decibel scale.

For this study, sound measurements and advice have been collected from a variety of sources including NRW, LUC and Welsh Government. It is important to note that a best

case has been assumed for the indicators considered to contribute to tranquillity, and a worst case for those considered to detract.

Sound is expected to drop by 6 decibels each time the distance from the source is doubled *Collman (2015)*, not accounting for any reductions due to other reasons such as barriers, vegetation, weather conditions etc. For example, a sound that is 60 decibels (dB) at 5 metres from the source would fall off as per Table 1. For reference, an increase of 10 dB corresponds to a tenfold (ten times) increase in sound intensity and is perceived as twice as loud.

Table 1 Sound fall off with distance

Distance (m)	5	10	20	40	80	160	320	640
Sound (dB)	60	54	48	42	36	30	24	18

The analysis expects that, in rural areas, there would be an ambient background noise level of 30 dB *Mehta et al (1999)*. Sounds below that level would simply contribute to that background noise, rather than being distinct sounds in and of themselves. As such, the analysis only measures out to a distance where sounds would be above 30 dB. For instance, in the example above, the analysis would only extend out to 160m.

The same process was applied to the urban analysis, where the ambient sound is expected to be higher than that in rural areas and is likely to have variations in background levels. King *et al* (2012) suggest that in an urban area, once a sound is below approximately 40 dB it becomes indistinguishable from the general sounds associated with an urban area*.*.

Scoring

Scores were applied using a scale of 0 – 10, with sounds that contribute to tranquillity getting a higher score, decreasing with distance from the source. Sounds that detract from tranquillity were given a lower score, increasing with distance from the source.

For sounds that contribute to tranquillity, the higher the decibels the higher the score. For detracting factors to tranquillity, it is the absence of them that gives rise to higher scores For example it's not the sound of low flying aircraft, but rather the absence, that scores well, whereas it is the contributing sounds to tranquillity where they are present that scores well.

For sound indicators that are expected to detract from tranquillity, if they are likely to not be present and are therefore not mapped in part 1, then each pixel is awarded a default score of 10, indicating tranquillity associated with the absence of that sound.

For detracting sounds above 30db in the rural/all-Wales analysis and 40db for urban then lower scores are attributed at source where the expected tranquillity associated with an indicator is likely to be lower, the score increases with distance from the source.

The use of positive and negative scoring, and the potential to cancel one another out, has been avoided. As all areas not associated with a detracting sound are awarded a score of

10 this means that areas that do experience a detracting sound environment from a particular indicator will gain a numerical score less than 10, this will be combined with the scores from the indicators that contribute to tranquillity. So although it may look like a detracting sound may add to the tranquillity score what in effect is happening is the optimum score of 10 is being reduced (relating to distance from the score).

It is important that the results for the currently available indicators are taken as an indicative whole rather than regarded as absolute in isolation. The addition of part 2 data, and the consideration of all indicators associated with theme 4 will be important in identifying where a relatively tranquil sound environment is likely, where natural sounds may be expected to be more prominent than noise and are appropriate to context.

This is shown visually for sounds that contribute to tranquillity using the hearing moving water indicator as an example, in Figure 3. For sounds that detract from tranquillity, this is shown in Figure 4 using hearing non-natural sounds as an example.

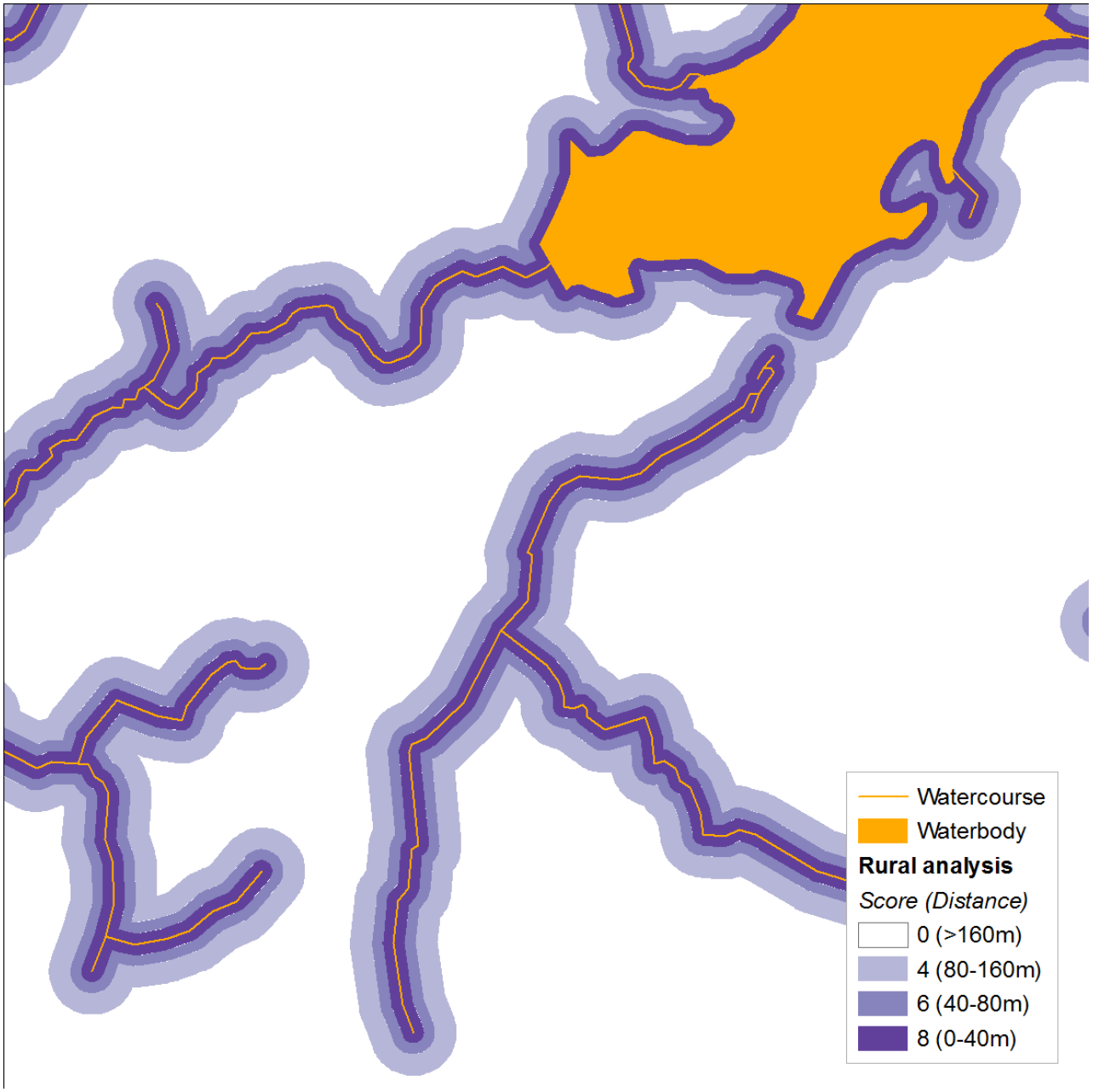


Figure 3 contributing buffer distances and scores

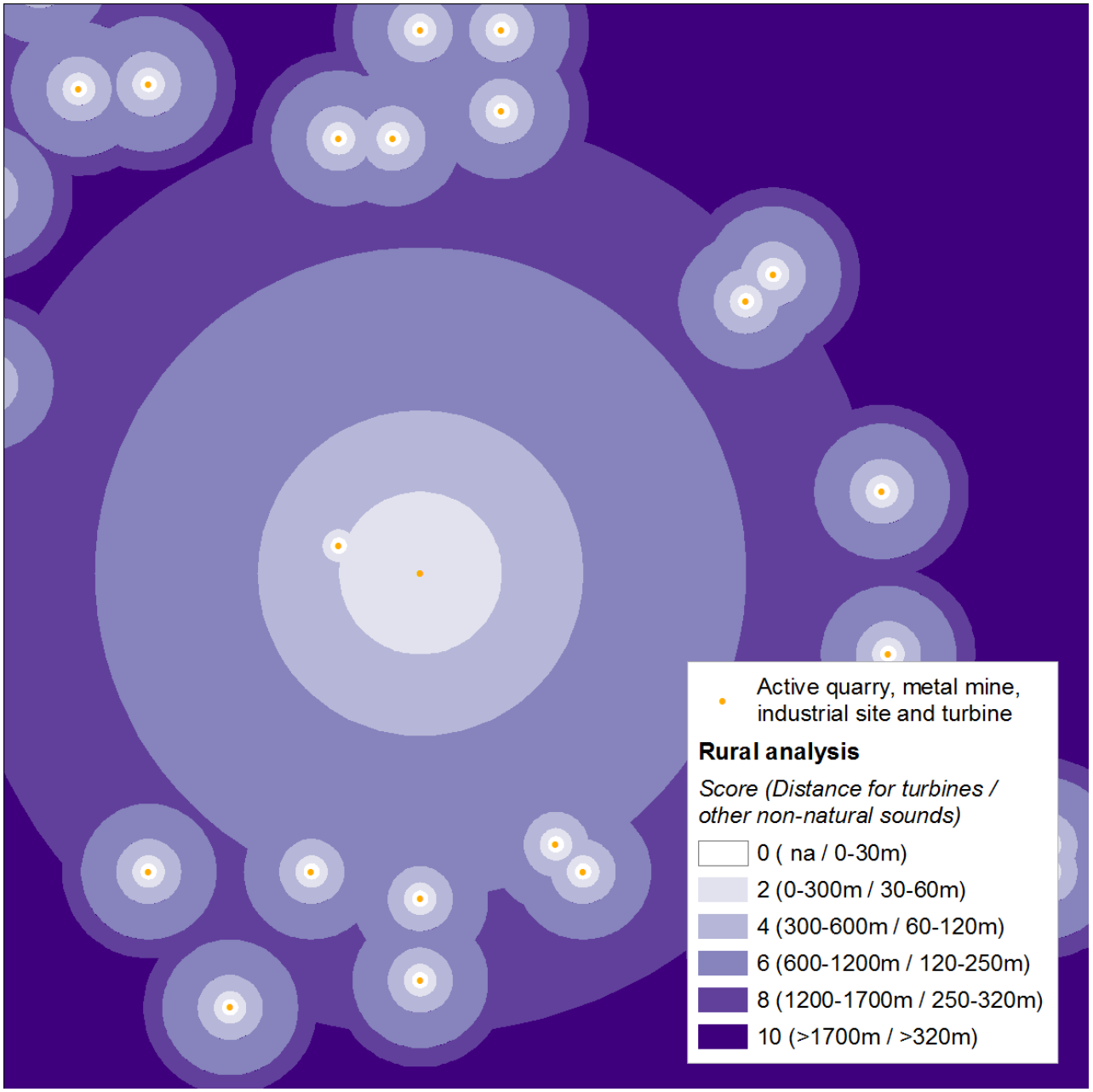


Figure 4 detracting buffer distances and scores

Where sounds had reliable or sourced levels, scores were based on bands of 5 decibels. The thresholds for sounds that contribute to tranquillity can be seen in Table 2, and scores for sounds that detract from tranquillity can be seen in Table 3.

Table 2 Thresholds for sounds that contribute to tranquillity in rural locations

Score	0	2	4	6	8	10
Decibels (dB)	< 30	30-35	35-40	40-45	45-50	> 50

Table 3 Thresholds for sounds that detract from tranquillity in rural locations

Score	10	8	6	4	2	0
Decibels (dB)	< 30	30-35	35-40	40-45	45-50	> 50

Table 4 shows an example of applying these scores to an indicator using the example from above:

Table 4 scores for a sound contributing to tranquillity of 60dB at 5m

Distance (m)	**5**	**10**	**20**	**40**	**80**	**160**	**320**	**640**
Sound (dB)	60	54	48	42	36	30	24	18
Score	10	10	8	6	4	2	0	0

Urban areas were scored in a similar format, but with the 5 band thresholds stopping at 40 dB to align with the expectation mentioned previously that ambient background noise is on average much higher than that in rural areas. Table 5 shows the scores for sounds contributing to tranquillity, and Table 6 those detracting.

Table 5 Thresholds for sounds that contribute to tranquillity in urban locations

Score	0	2	4	6	8	10
Decibels (dB)	< 40	40-45	45-50	50-55	55-60	> 60

Table 6 Thresholds for sounds that detract from tranquillity in urban locations

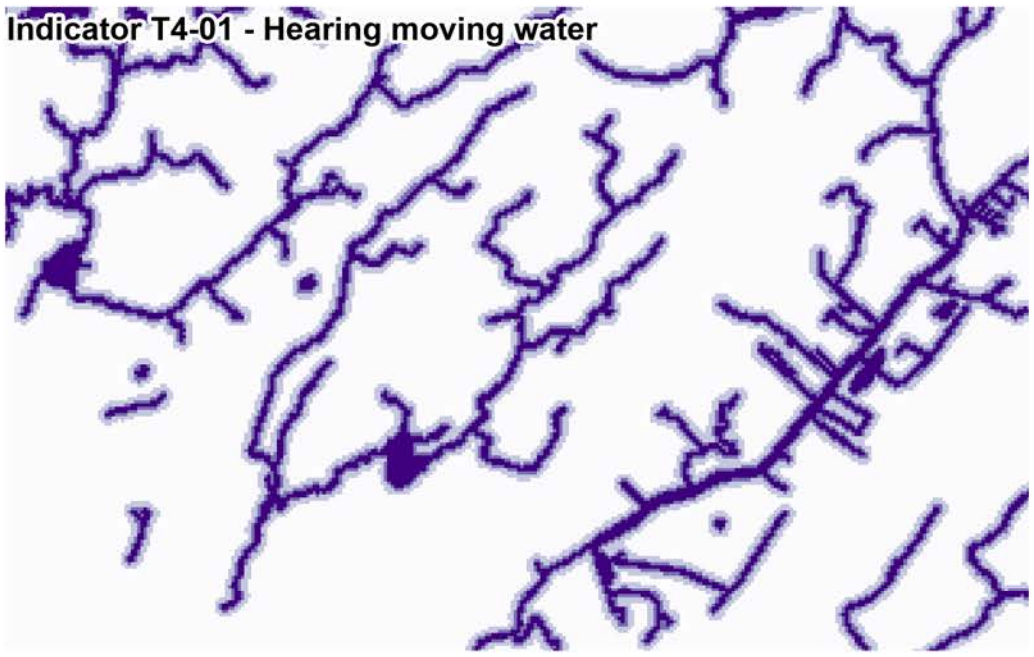
Score	10	8	6	4	2	0
Decibels (dB)	< 40	40-45	45-50	50-55	55-60	> 60

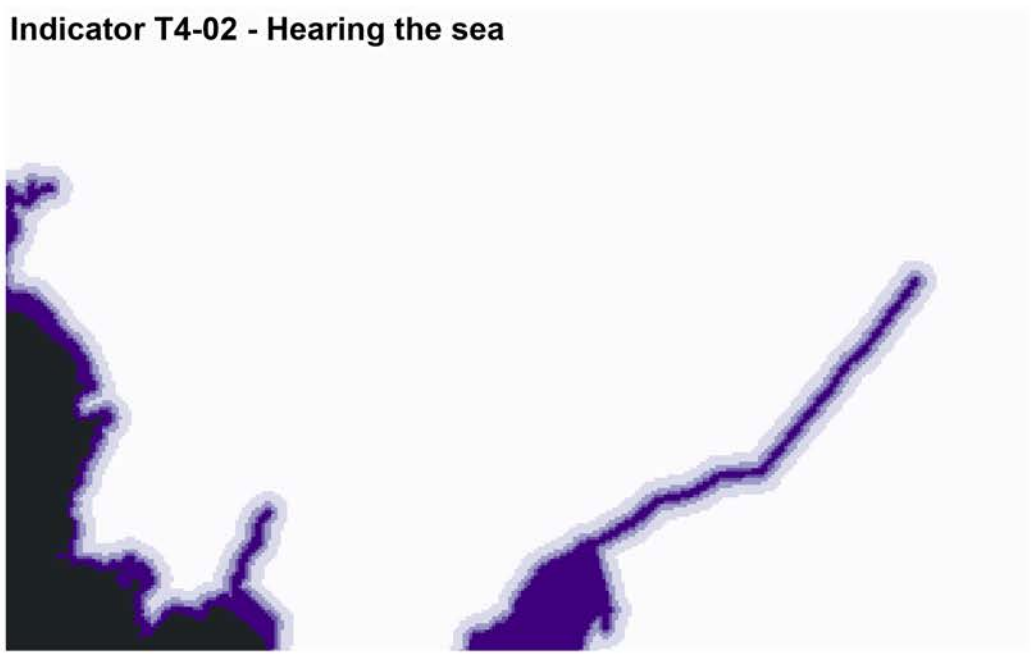
Some indicators didn't use buffers, instead recording either the presence or absence of a sound source within that pixel. An example of this is T4-03 Hearing nature. The scores for these indicators were still determined using expected decibel recordings where available, or otherwise based on assumptions in agreement with NRW. More information on each of these is covered in the indicator details section.

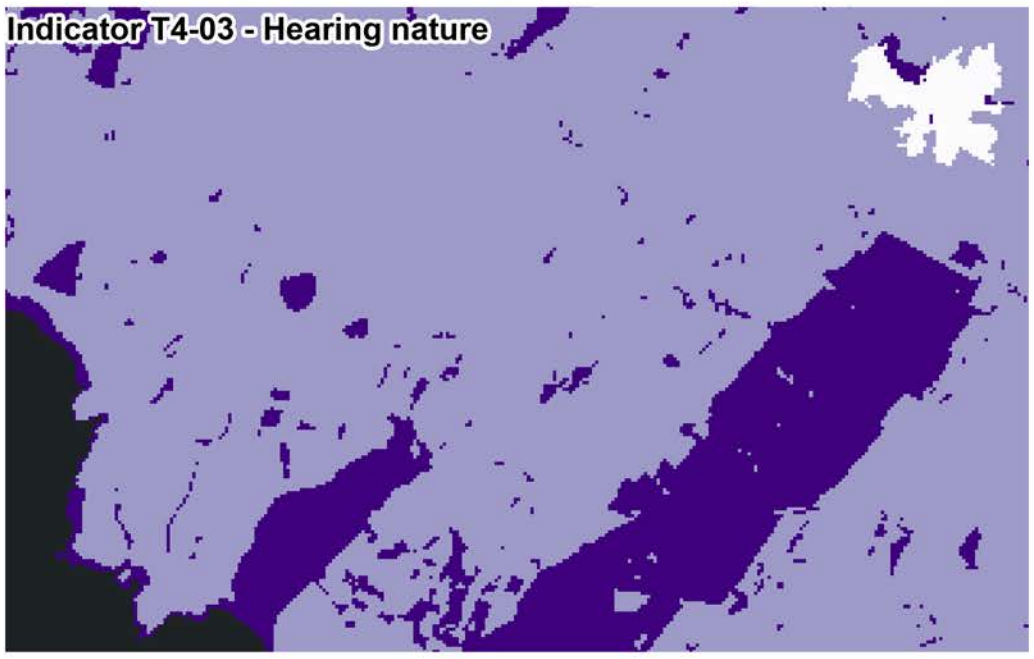
Combination of indicators

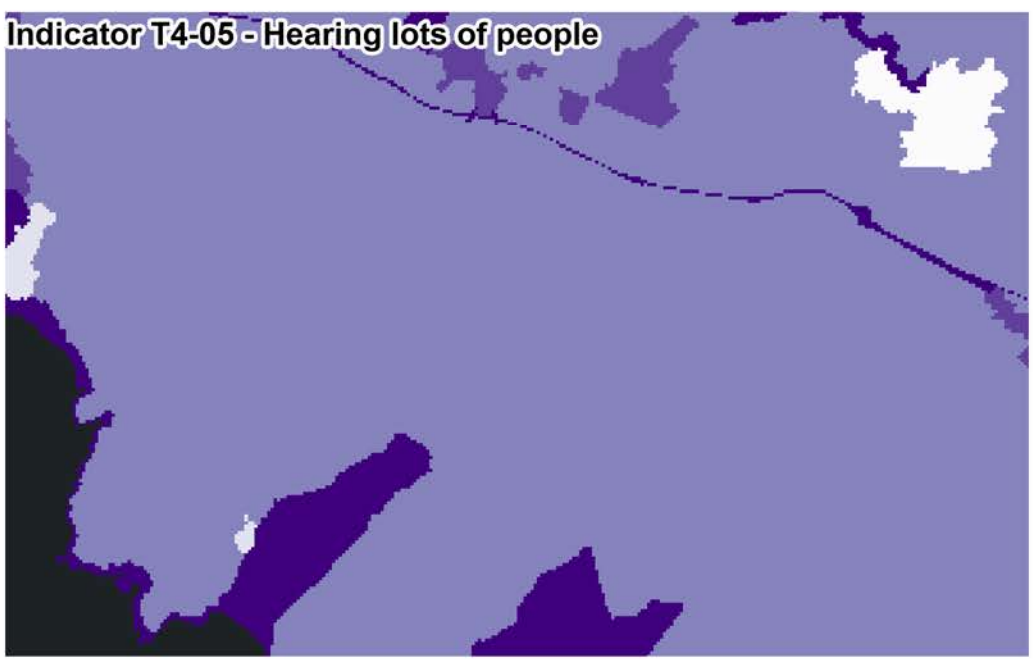
Once all of the indicators had been scored for each theme, they were combined together to give a total score for each pixel. See pages 19 and 20 for an explanation and the example below.

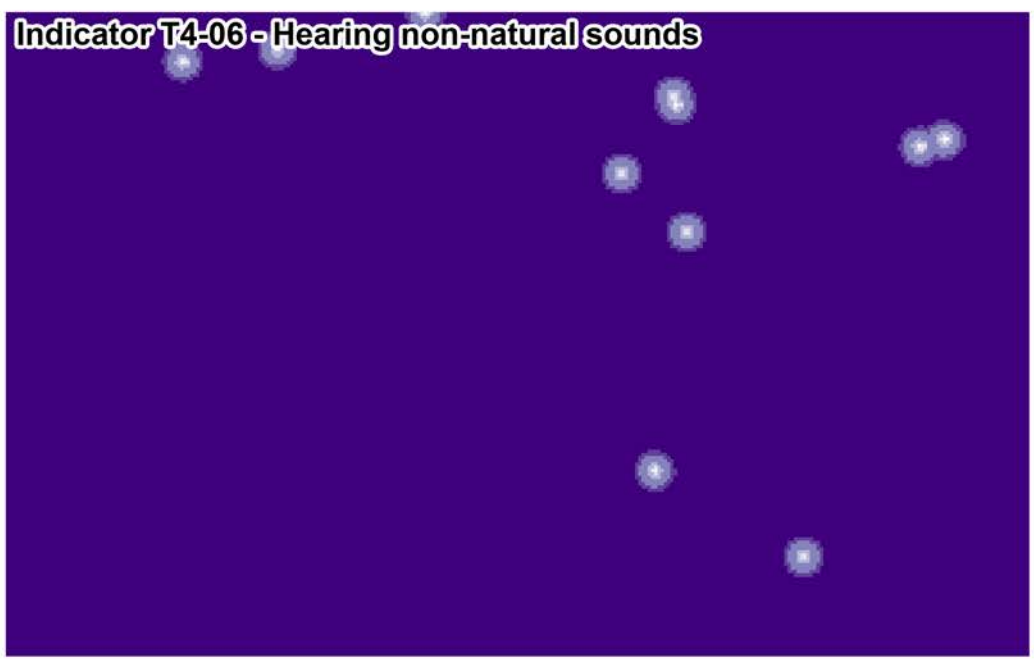
The rural and urban analysis was combined separately. The urban analysis covers only those urban areas identified in the Urban Tree Cover dataset, and the rural/ all-Wales analysis covers the whole country, including the areas covered by the urban analysis.











EB:Chamberlain_K LUC 12298_Rural_Overview_Figures 24/03/2023

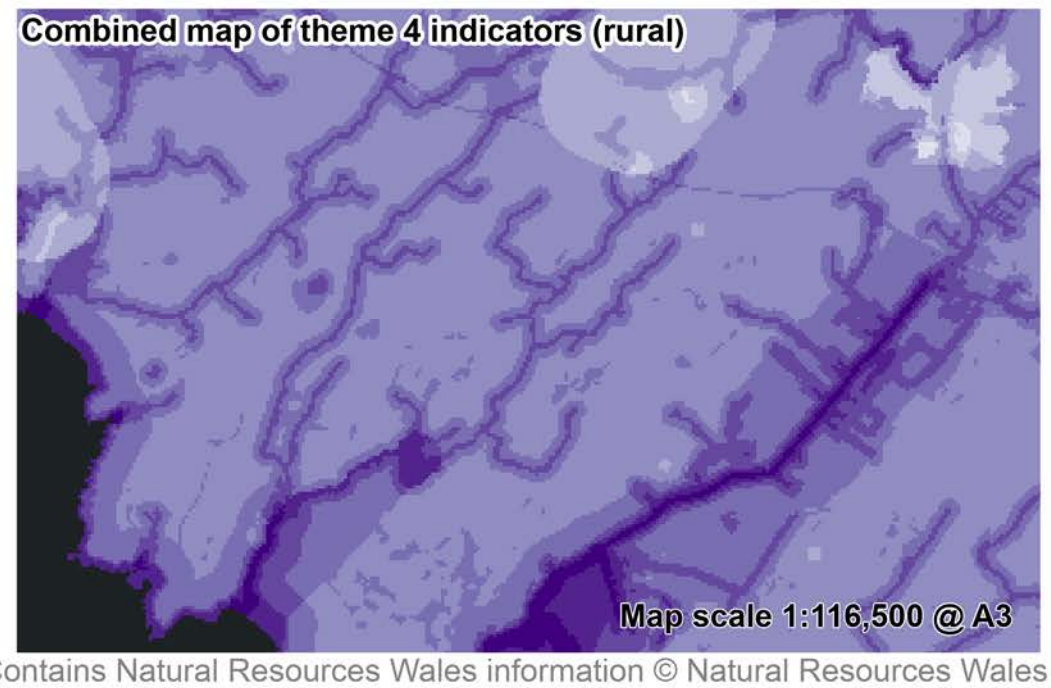


Figure 5: Example of combination of indicators

Score (for 6 indicator maps)
- 0 - lowest tranquillity
- 2
- 4
- 6
- 8
- 10 - highest tranquillity

Category (for combined map)
- 1 (least tranquil)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (most tranquil)

Theme 4 part 1 Indicator details

This section gives the full details of the data used, the process followed and any assumptions made, for each indicator in theme 4 part 1.

Each indicator is presented with the following structure:

- Datasets – setting out the data sources used for both rural and urban analysis;
- Method – setting out the way in which the indicator has been modelled for the rural and urban analysis. This includes any relevant scoring; and
- Result – maps of the raw input data and results of the analysis for rural and urban areas.

Indicator T4-01 – Hearing moving water

This indicator considers all sounds associated with moving water to contribute to tranquillity. The louder the sound the more it increases tranquillity, therefore closer to the source receives higher scores as they are expected to be more tranquil and lower scores are attributed to areas further away as the sound of moving water is expected to be less tranquil.

Initially running and lapping water were being considered separately, however feedback from the stakeholder workshop was that this seemed unnecessary as the contributing effect of both was felt to be similar. Topography was suggested as a means of applying different scores, impacting on height and speed of rivers. More information can be found in Limitations and future enhancements as to why this was not implemented.

Sound measurements were ground truthed with indicative records taken of 62 dB at Bala lake edge and 63 dB 1 metre away from a stream.

Datasets

Rural – OpenRivers, Lle Lakes Inventory

Urban – OpenRivers, Lle Lakes Inventory (the OSMM water network was too detailed for the resampled 10m surface)

Method

Rural – Distances from the water course or non-tidal water body calculated using straight line distance. These were scored as below, note that the scores do not go up to 10 for this indicator as the contribution of moving water wasn't felt to be significant enough through feedback from the workshop.

Distance	40m	80m	160m	>160m
Sound level (dB)	60-42	42-36	36-30	<30
Score	8	6	4	0

Urban – Distance from water course or static water body calculated using straight line distance as with the rural analysis, but using more detailed buffer distances to account for the higher resolution being used for the urban analysis. These were scored as follows:

Distance	10m	20m	40m	50m	>50m
Sound level (dB)	60-54	54-48	48-42	42-40	<40
Score	8	6	4	2	0

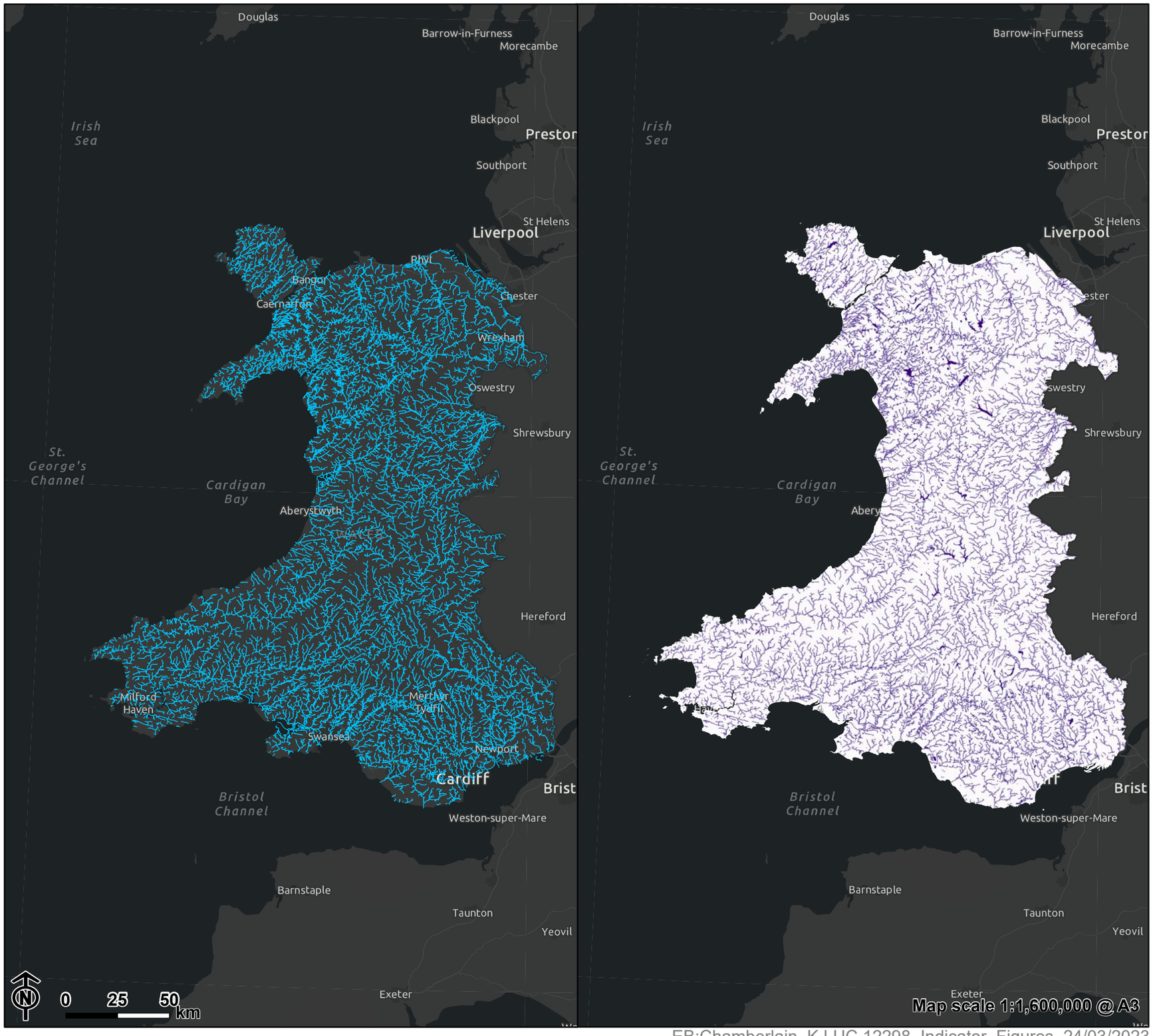
Result

The results of this analysis are shown in Figure 6 and Figure 7 below.

Figure 6 - T4-01 - Hearing moving water rural data and map of results

Data

Result



Data

- Watercourse
- Waterbody

Result

Score

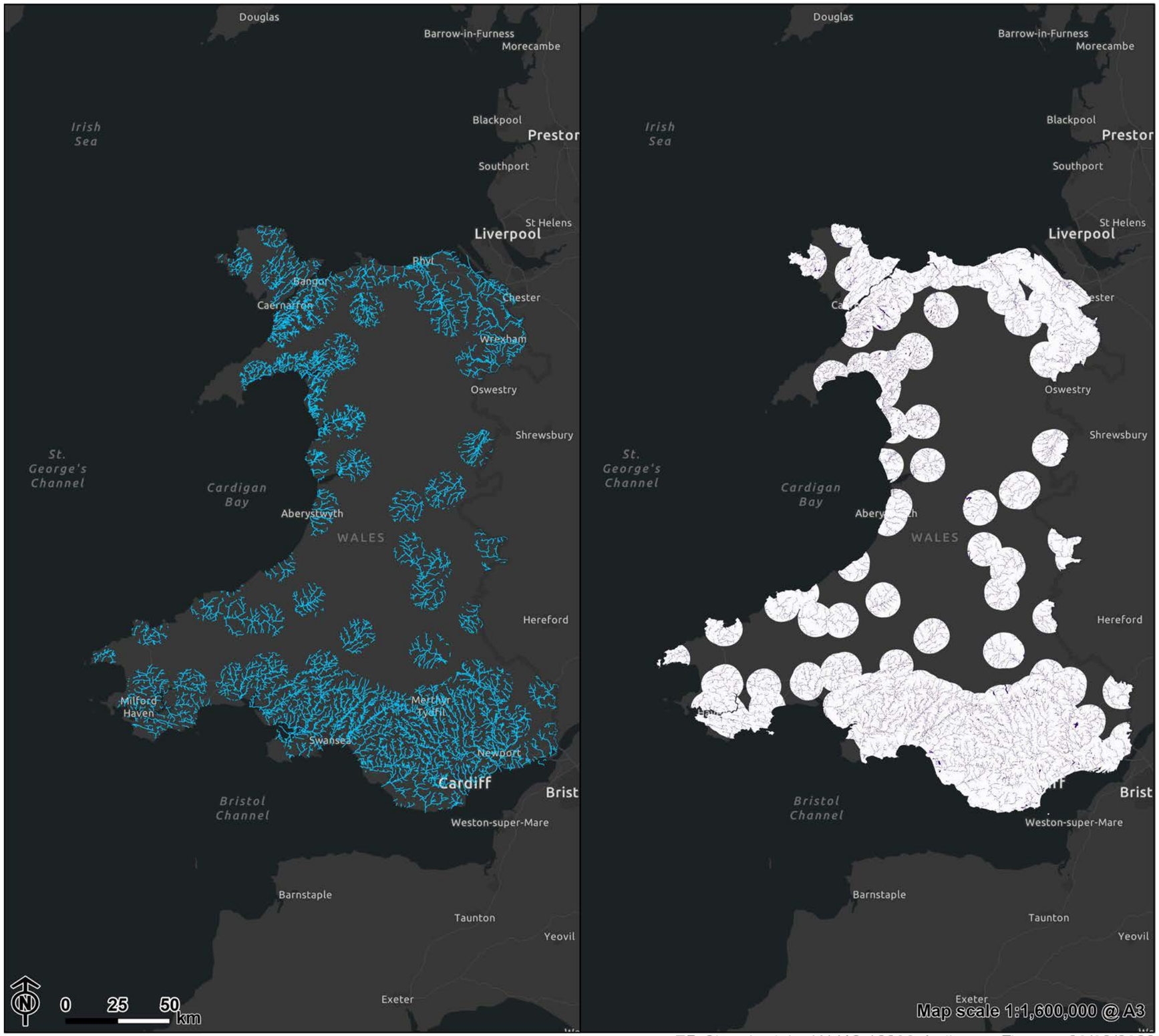
- 0 - lowest tranquillity
- 4
- 6
- 8 - highest tranquillity

EB:Chamberlain_K LUC 12298_Indicator_Figures 24/03/2023

Figure 7 - T4-01 - Hearing moving water urban data and map of results

Data

Result



Data

- Watercourse
- Waterbody

Result

Score

- 0 - lowest tranquillity
- 2
- 4
- 6
- 8 - highest tranquillity

EB:Chamberlain_K LUC 12298_Indicator_Figures 20/03/2023

Indicator T4-02 – Hearing the sea

This indicator considers all sounds associated with hearing the sea that are expected to contribute to tranquillity. It is acknowledged that there is likely to be significant variation due to a multitude of parameters, it is beyond the scope of this work to be able to reflect this variation, this is intended as indicative, a specific local tranquillity assessment could account and measure this variation if required.

The variation in the scoring reflects the drop off distance of the sound. With proximity to the source, the louder the sound, the more it is expected to contribute to tranquillity. Therefore the higher scores are more tranquil and lower scores are less tranquil.

It was discussed in the workshop, and furthered through an element of ground truthing, that the sound of the sea carries out to some distance. Indicative measurements recorded at Ynyslas were 70 dB at sea edge with low wind, 48 dB at 60m away in the dunes and confirmation the sea was still audible with a recording of 53 dB at a distance of 400m.

Whilst the sound of the sea can't often easily be distinguished from the sound of the wind, using the sound level data we have of a 'calm sea' and the formula of sound dropping off 6 dB as distance doubles it is expected to be audible in rural areas up to approximately 320m away.

Datasets

Rural – OS Boundary Line for coastline, OS OpenData for tidal water

Urban – OS Boundary Line for coastline, OS OpenData for tidal water

Method

Rural – Distance from the coastline calculated using straight line distance. These were scored as follows:

Distance	**40m**	**80m**	**160m**	**320m**	**500m**	**>500m**
Sound level (dB)	70-52	52-46	46-40	40-34	34-30	<30
Score	10	8	6	4	2	0

Urban – Distance from the coastline calculated using straight line distance. These were scored as follows:

Distance	**10m**	**20m**	**40m**	**80m**	**150m**	**>150m**
Sound level (dB)	70-64	64-58	58-52	52-46	46-40	<40
Score	10	8	6	4	2	0

Result

The results of this analysis are shown in Figure 8 and Figure 9 below.

Data

Result

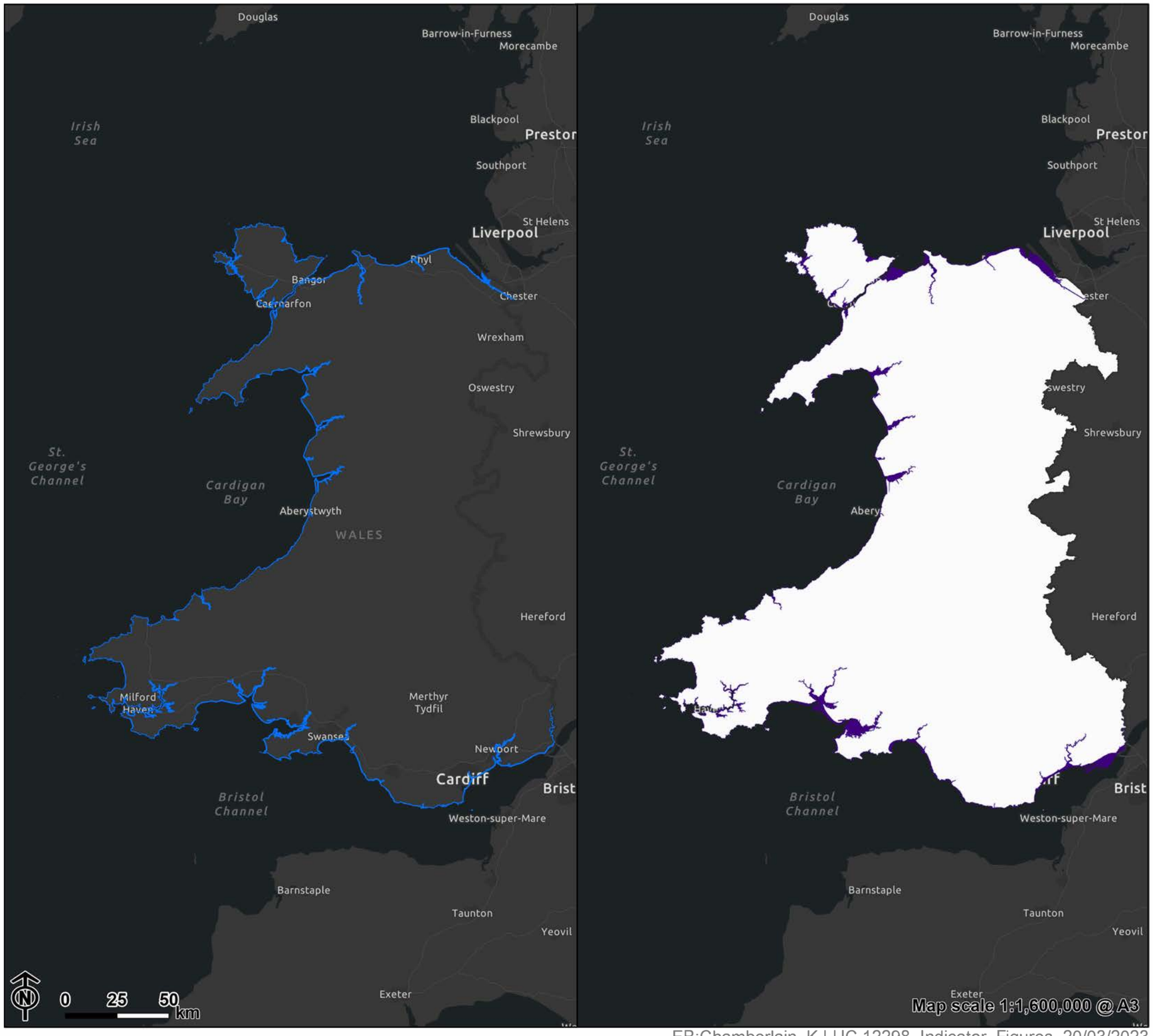


Figure 8 - T4-02 - Hearing the sea rural data and map of results

Data

High water

Result

Score

- 0 - lowest tranquillity
- 4
- 6
- 8
- 10 - highest tranquillity

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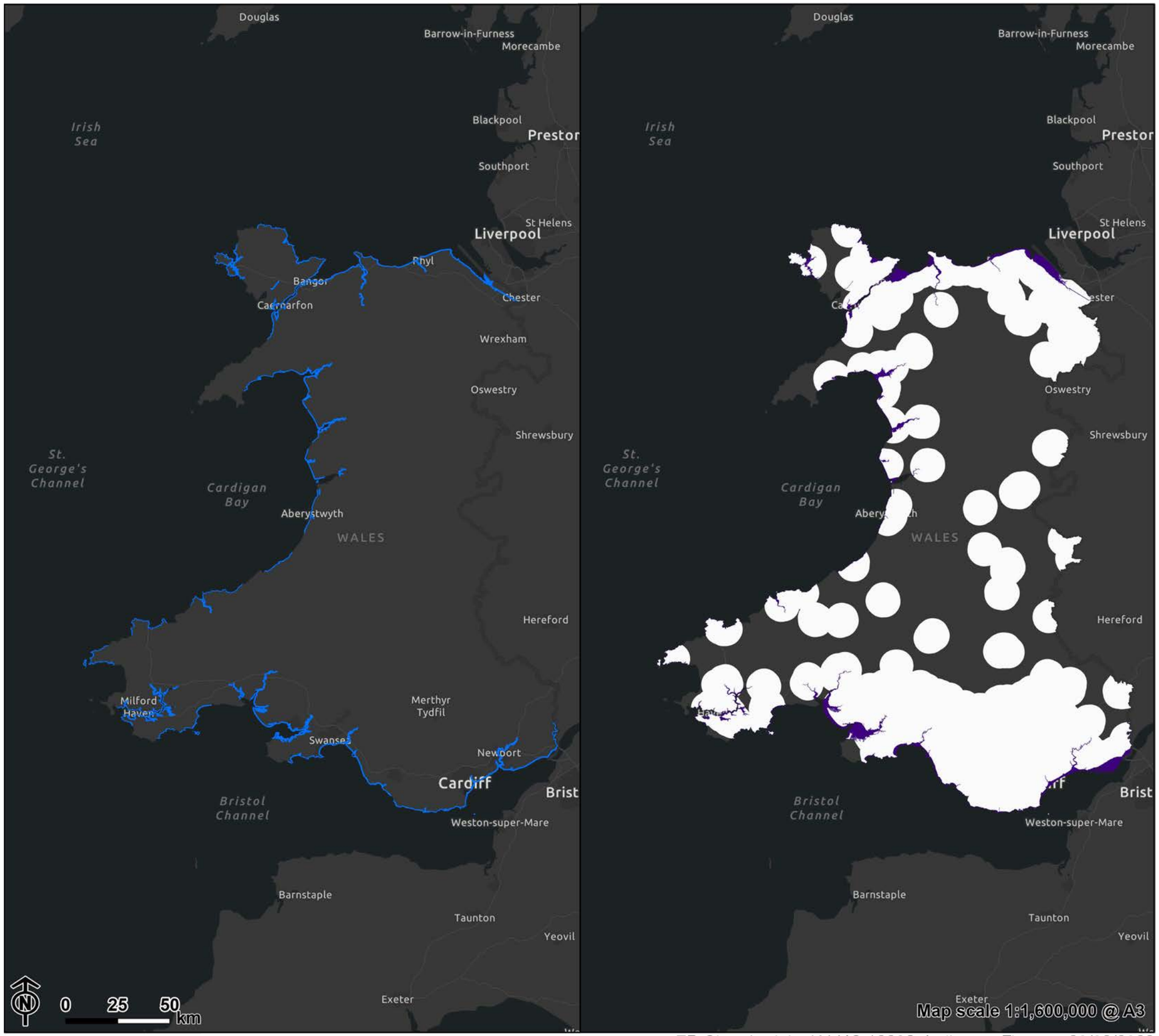
Figure 9 - T4-02 - Hearing the sea urban data and map of results

Data

Result



Data

High water

Result

Score

- 0 - lowest tranquillity
- 2
- 4
- 6
- 8
- 10 - highest tranquillity

Indicator T4-03 – Hearing nature

This indicator considers sounds of nature to contribute to tranquillity. The louder the sound the more it is expected to increase tranquillity, therefore higher scores are more tranquil and lower scores have a lower contribution to tranquillity from hearing nature and natural sounds.

Variations in land cover mean varying degrees of opportunity to hear sounds associated with nature. This was pointed out by stakeholders at the workshop held, but a lack of information to support this meant it was too difficult to implement accurately in deciding scores. More information on this can be found in the Limitations and future enhancements section.

Datasets

Rural – National Forest Inventory (NFI), Urban Tree Cover, Special Area Conservation (SAC), Special Protection Area (SPA), Ramsar (wetlands of international importance), Site of Special Scientific Interest (SSSI), Local Nature Reserve (LNR), National Nature Reserve (NNR) and Royal Society for the Protection of Birds (RSPB) sites.

Urban – NFI, Urban Tree Cover, SAC, SPA, Ramsar, SSSI, LNR, NNR, RSPB sites, green flag sites and open space features from green infrastructure dataset.

Method

No consistent sound levels could be sourced to cover a wide enough spectrum of sounds considered to be associated with nature or ‘natural’ sounds. For this reason scores were instead applied to locations depending on their likelihood of being able to hear enhanced sounds of nature and natural sounds. For example, in an urban area it may be more unlikely to hear nature and natural sounds than it would be outside an urban area, so the score would reflect this. Higher scores were also given for pixels within nature conservation related designations and sites. This is based on the assumption that within these designated areas, management and conservation of nature is prioritised, and so the chances of having an opportunity to hear nature and natural sounds are likely to be higher.

Rural – All pixels outside those covered by urban extents are given a score of 8. Any pixels within the datasets listed above are given a score of 10. This does mean that smaller towns and villages outside of the urban areas dataset will be given high scores, however excluding these would require a definition for how big these need to be before they cause a decrease in the likelihood of hearing nature, and so they were left in.

Urban – All pixels outside the urban extent are given an 8, those within a dataset listed above are given a score of 10. Areas within the Wales green and blue infrastructure dataset were also given a score of 10, as they are the most likely places to hear nature or natural sounds.

Result

The results of this analysis are shown in Figure 10 and Figure 11 below.

Tranquillity and Place
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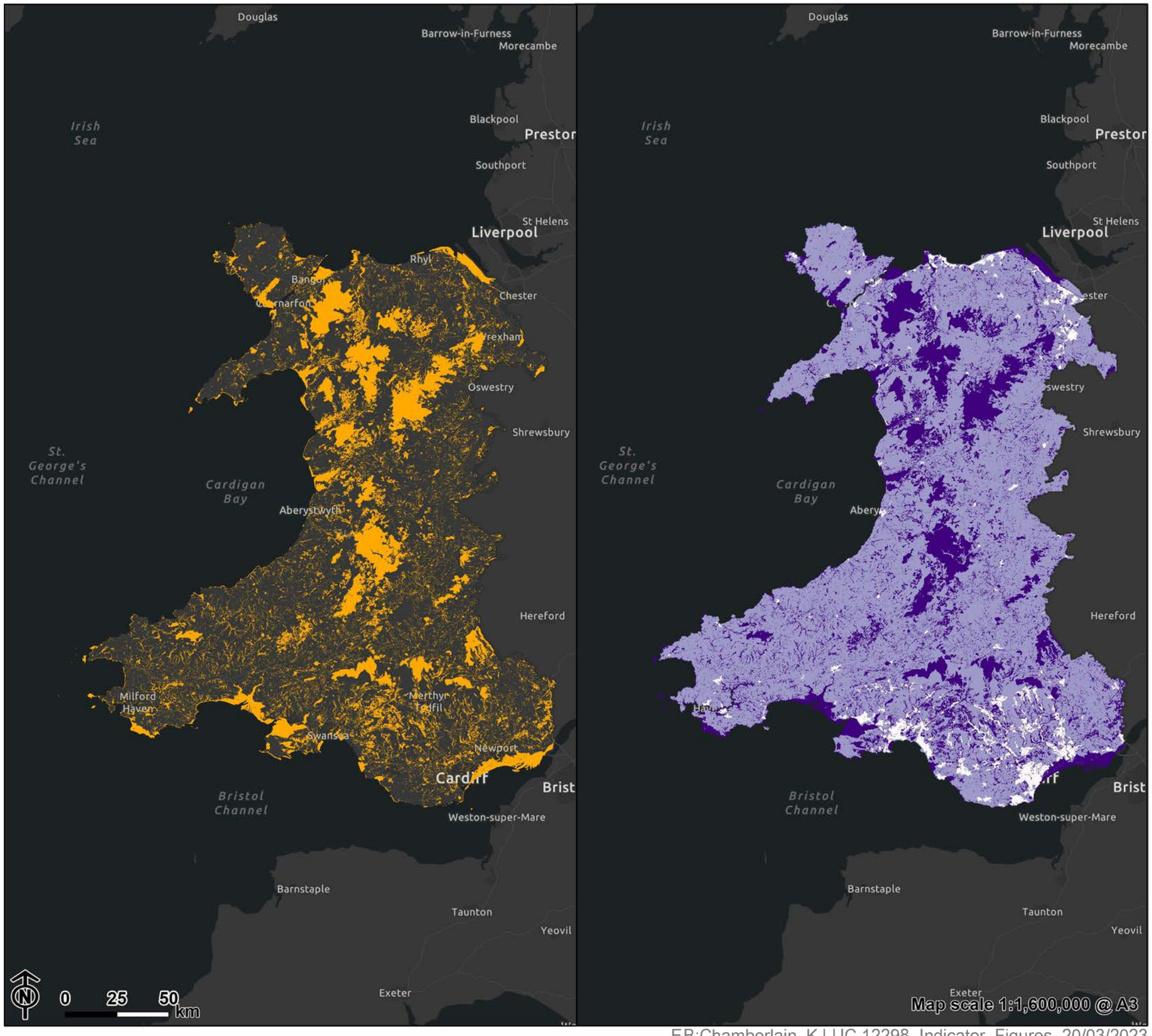
Figure 10 - T4-03 - Hearing nature rural data and map of results

Data

Result



Data

SAC, SPA, Ramsar, SSSI, LNR, NNR, NFI and RSPB

Result

Score

- 0 - lowest tranquillity
- 8
- 10 - highest tranquillity

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Data

Result

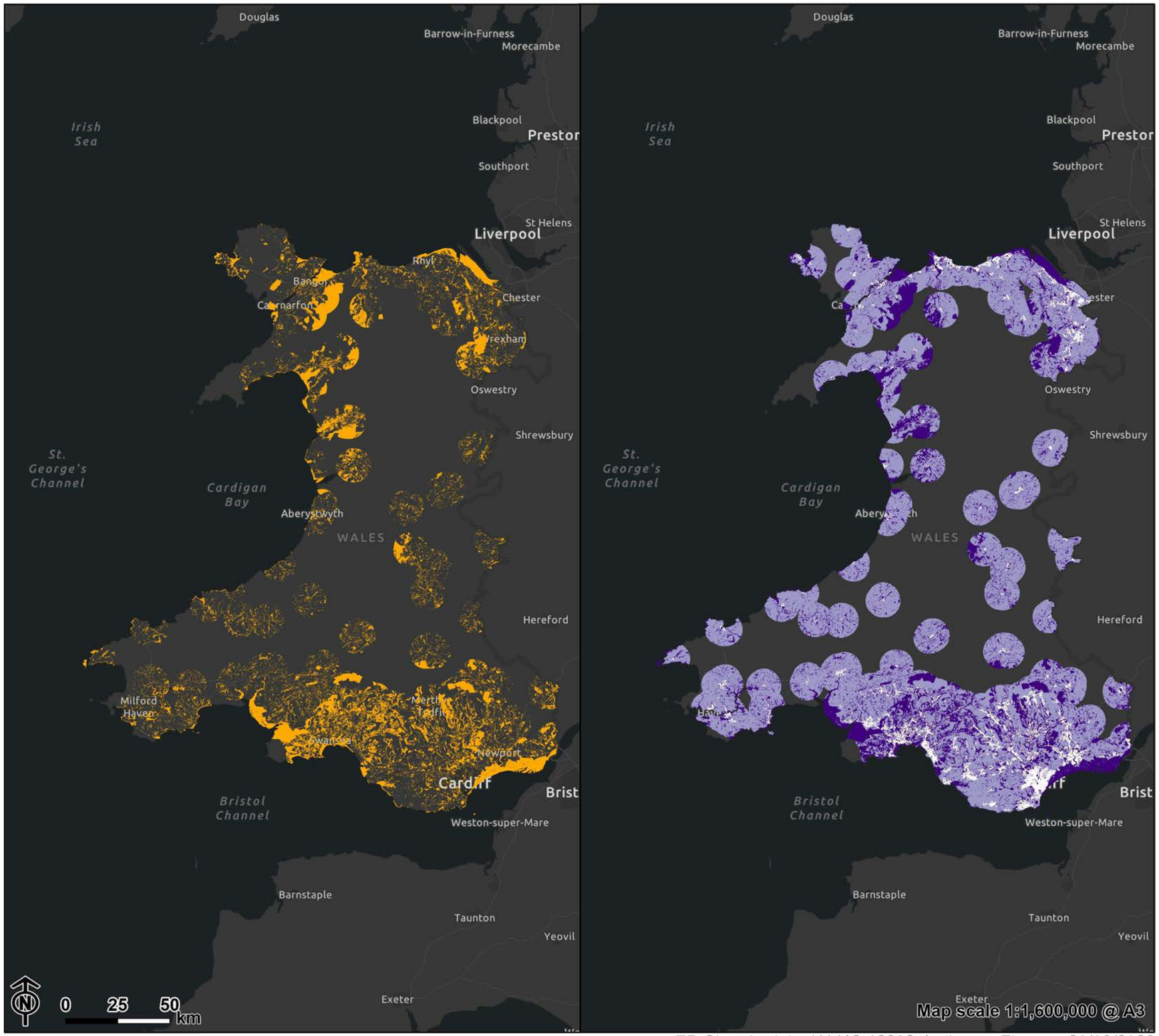

Figure 11 - T4-03 - Hearing nature urban data and map of results

Data

SAC, SPA, Ramsar, SSSI, LNR, NNR, NFI, RSPB, Green Flag Award site, Wales Green Infrastructure

Result

Score

- 0 - lowest tranquillity
- 8
- 10 - highest tranquillity

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Indicator T4-04 – Hearing low flying aircraft

This indicator is considered to detract from tranquillity. The louder the sound the more it is expected to detract from tranquillity. Sounds that detract from tranquillity were given a lower score, therefore lower scores are less tranquil and higher scores are more tranquil.

Feedback from the stakeholder workshop suggested scoring helicopters differently based on their temporal aspect. The finding was that when compared to a constant sound from an airport, the more infrequent sound was more detracting. This study has not looked into temporal aspects, more information on this can be found in the Limitations and future enhancements section.

Datasets

Rural – OS OpenMap for Airports, Airfields and Helicopter landing areas

Urban – OS OpenMap for Airports, Airfields and Helicopter landing areas

Method

Rural – The linear drop off of sound as height increases or decreases is too complicated for the same formula to be applied to this indicator. This can be seen in the sound buffers for Cardiff airport (*Figure 18, Cardiff Airport Area Navigation Consultation Document, 2014)*. These buffers were used as a proxy for the other location data, as more detailed information such as this could not be easily sourced. The average distance of the outermost buffer from the runway was calculated as 1km. This has been used as the extent of sound impacts for this indicator, in lieu of more accurate sound data for the other airports. Further detail is given to this in the Limitations and future enhancements section.

Any pixels within 1km of airports, airfields and helicopter landing areas has therefore been scored a 0, and everywhere else a 10.

Urban – Because of the complexity of this indicator, and in order not to produce falsely accurate results, the score was applied in the same way for both rural and urban analysis.

Result

The results of this analysis are shown in Figure 12 and Figure 13 below.

Data

Result

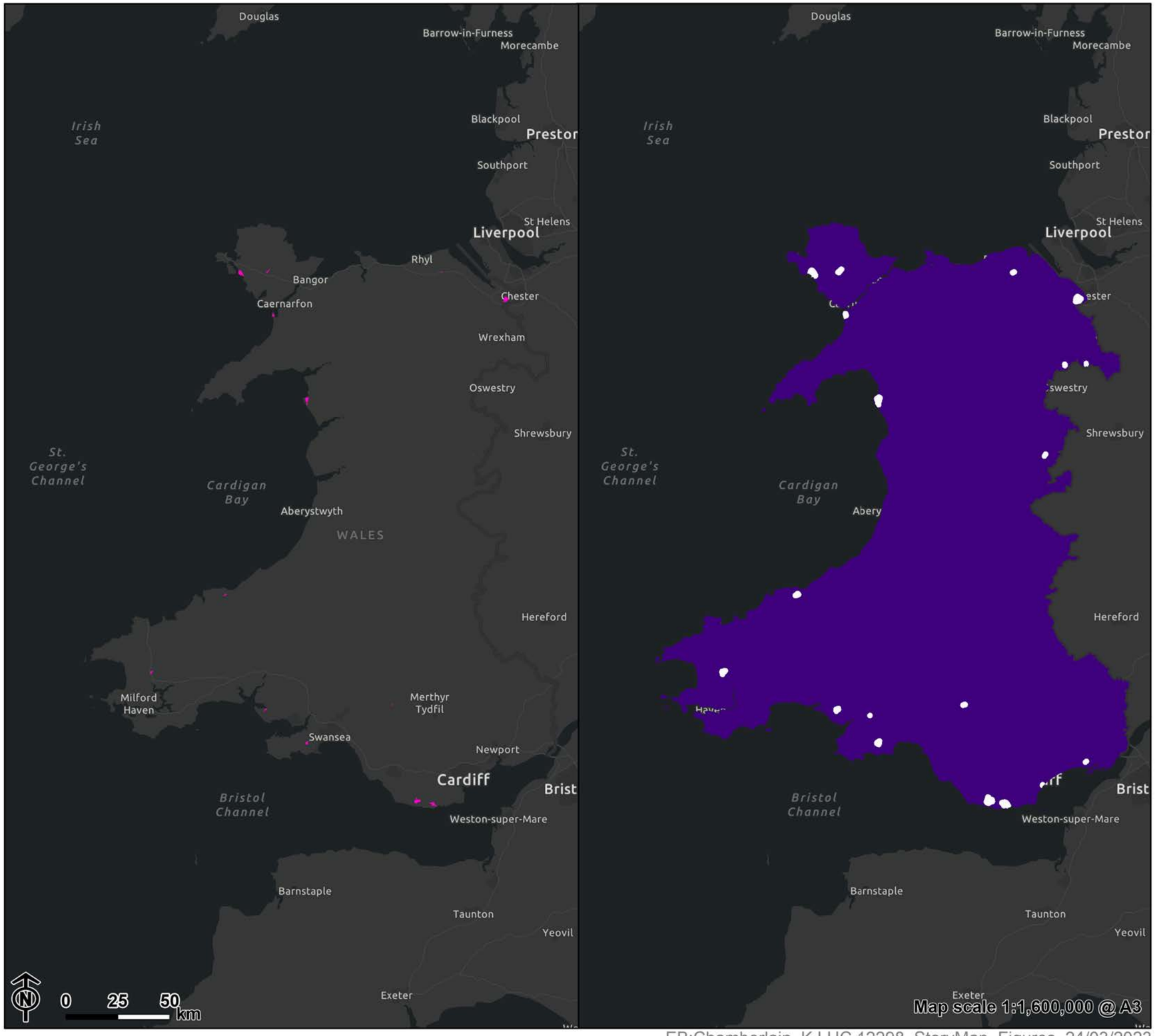


Figure 12 - T4-04 - Hearing low flying aircraft rural data and map of results

Data

Airport, airfield and helicopter station

Result

Score

0 - lowest tranquillity

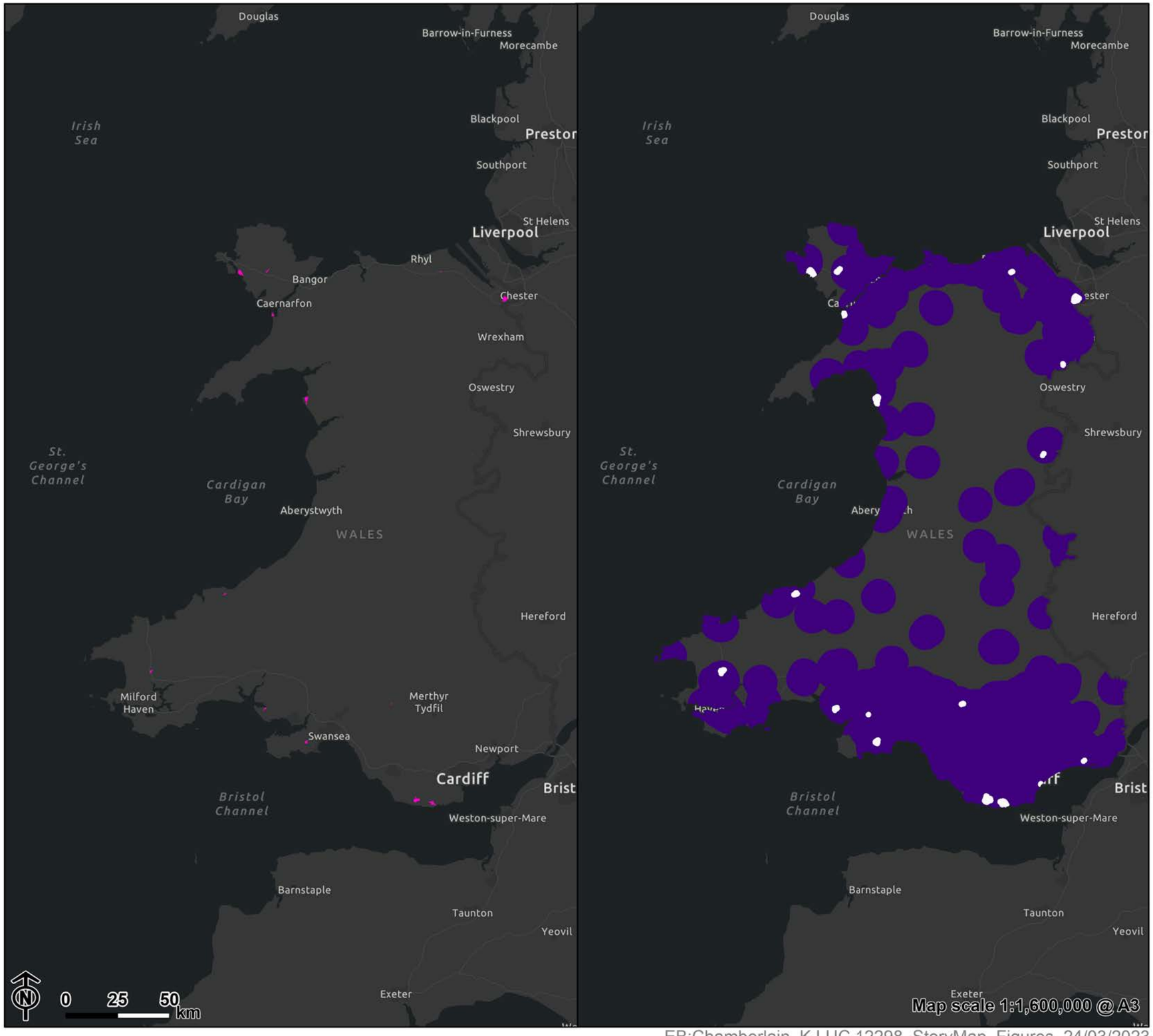
10 - highest tranquillity

EB:Chamberlain_K LUC 12298_StoryMap_Figures 24/03/2023

Figure 13 - T4-04 - Hearing low flying aircraft urban data and map of results

Data

Result



Data

Airport, airfield and helicopter station

Result

Score

0 - lowest tranquillity

10 - highest tranquillity

EB:Chamberlain_K LUC 12298_StoryMap_Figures 24/03/2023

Indicator T4-05 – Hearing lots of people

This indicator considers that hearing lots of people is detracting from tranquillity. The National Survey for Wales (2021-22) indicated that 26% of people are bothered by noise from outside their homes. The sound of lots of people can relate to a number of activities, from a general hubbub, to recreational noise from stadiums etc. This study does not account for this nuance and has expected that the louder the sound the more it is anticipated to detract from tranquillity, therefore lower scores are less tranquil and higher scores are more tranquil.

This scoring of this indicator could be applied differently with various temporal aspects, so to maintain consistency the LANDMAP data has been used as a proxy. More information on temporal aspects can be found in the Limitations and future enhancements section.

Datasets

Rural – LANDMAP Visual and Sensory – filtered on question VS6 Settlement pattern

Urban – LANDMAP Visual and Sensory – filtered on question VS6 Settlement pattern

Method

Rural – With only measurements for urban and rural ambient sound, and nothing more detailed for settlement types or population numbers, scores were based on the settlement pattern as classified in the LANDMAP Visual and Sensory data using the assumption that the higher up the settlement hierarchy an aspect area is, the 'busier' the settlement will be, and the more detracting the sound is from tranquillity.

Settlement pattern	LANDMAP definition	Score
Urban	Substantial, large-scale development associated with a town or city; includes urban fringe development which may be geographically detached from the main body of the host city/town	0
Village	Single, small-scale development associated with traditional rural settlement cores; likely to include other community features such as church, school, shops, market square, village green	2
Linear	Individual, clustered developments typically following existing elements such as main roads; archetypally likely to be commercial or residential development on urban arterial transport corridors	4
Scattered Rural/Farm	Individual, dispersed rural settlements such as isolated small farms and residences	6

Settlement pattern	LANDMAP definition	Score
Mixture	Complexity of settlement patterns.	6
Clustered	Multiple small-scale developments gathered around individual community activities, such as hamlets or large farms with many residences and associated buildings, but also may be late 20th c. Commercial development around major road junctions (excludes linear development)	8
No settlements	No significant settlement currently in use	10

Urban – Because of the lack of more detailed data, it was more consistent to keep the scores the same for the urban analysis, acknowledging that most areas would get the lower score of 0 being within an urban area.

Whilst it is possible that some locations within these urban areas may be likely to have less people in them to create sound, it's also possible that those same locations will, at times, also attract a large number of people. For example, green spaces may have a lower density of people through some of the day, but a much higher population at lunchtimes, after work hours, and at weekends. More research would be required to determine which areas within an urban area would be suitable to be considered more audibly tranquil than others.

Result

The results of this analysis are shown in Figure 14 and Figure 15 below.

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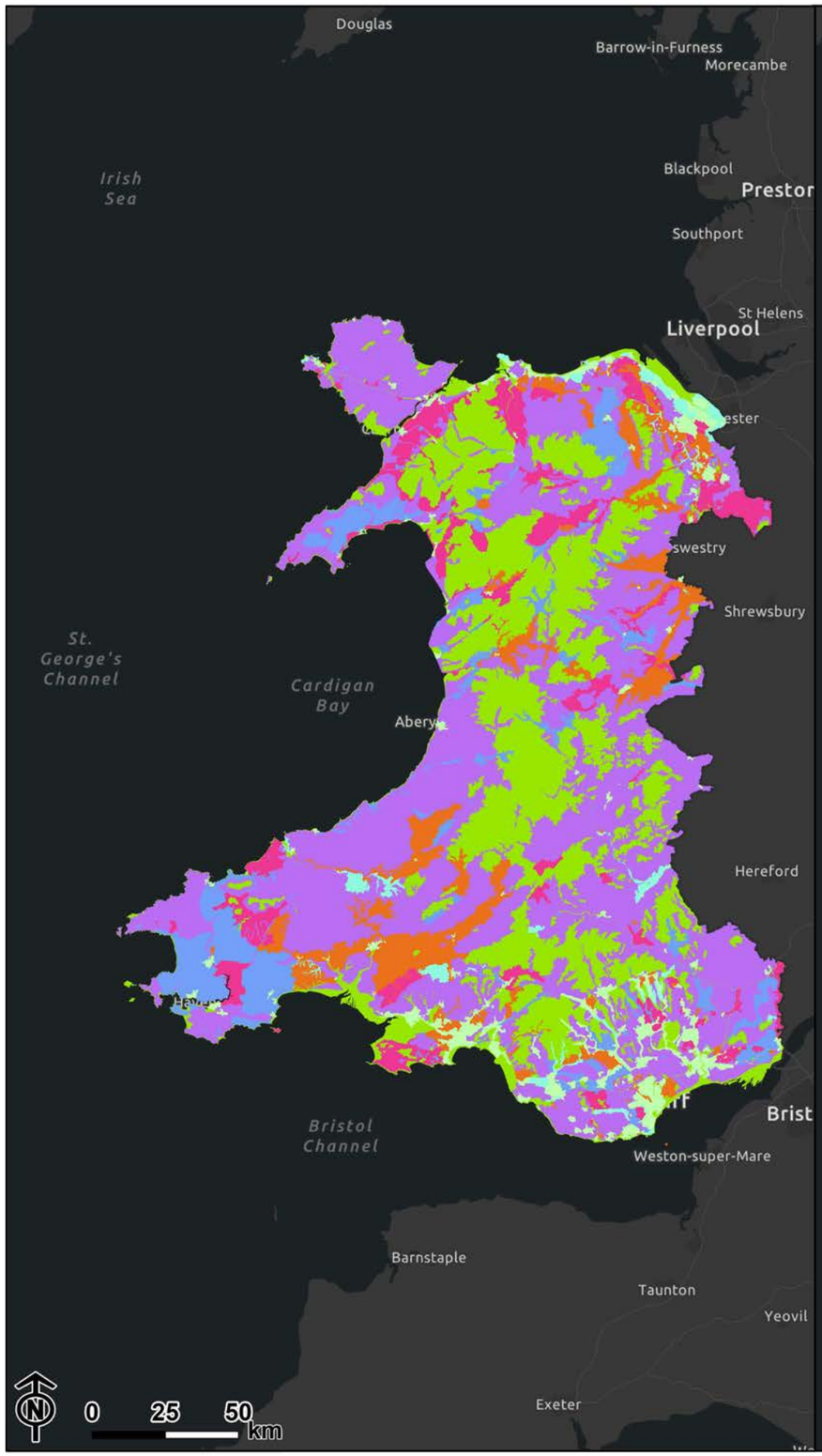
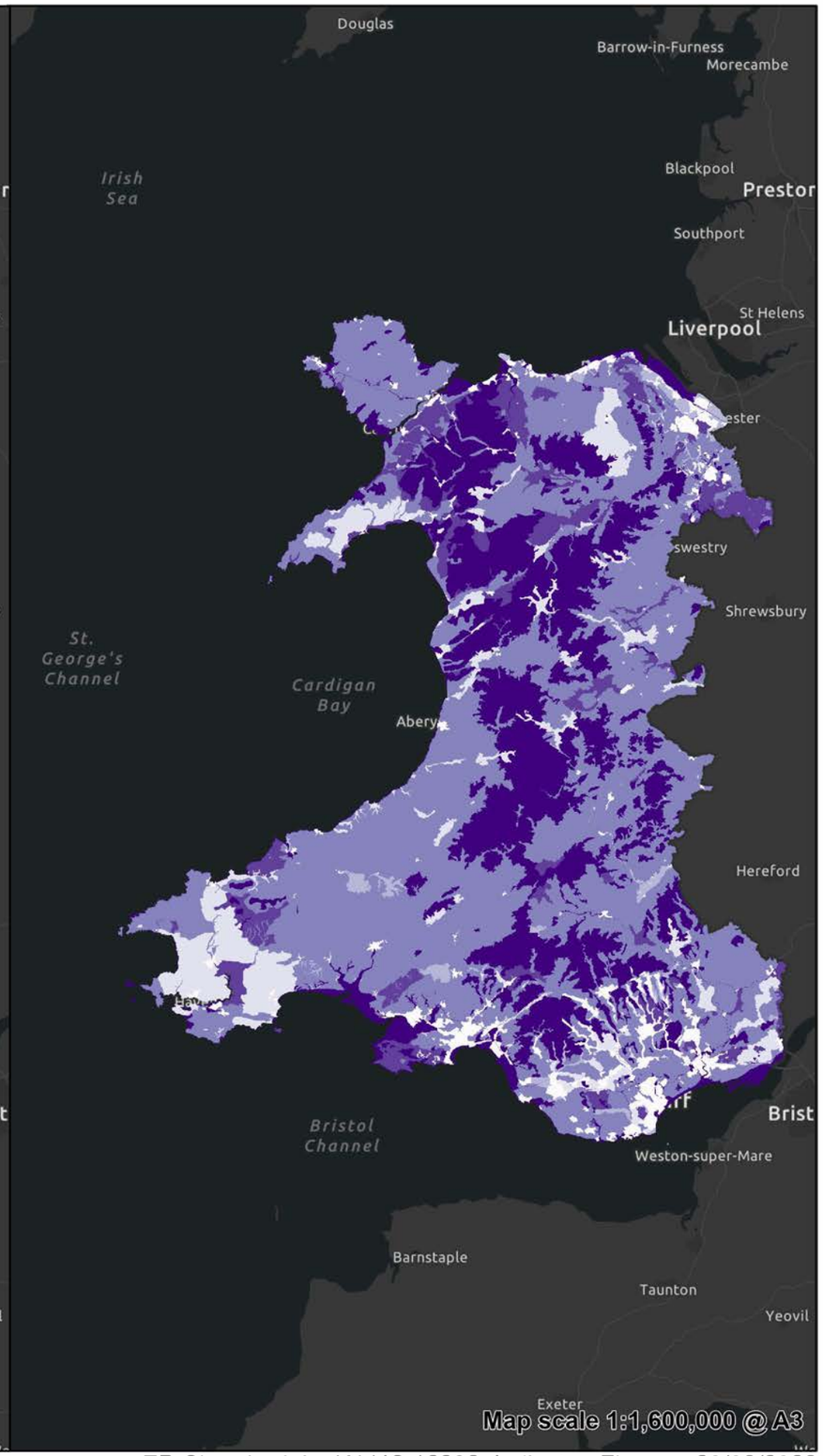
Figure 14 - T4-05 - Hearing lots of people rural data and map of results

Data

Result





Data
LANDMAP classification
- Urban
- Linear
- Village
- Scattered Rural/Farm
- Clustered
- Mixture
- No settlements

Result
Score
- 0 - lowest tranquillity
- 2
- 4
- 6
- 8
- 10 - highest tranquillity

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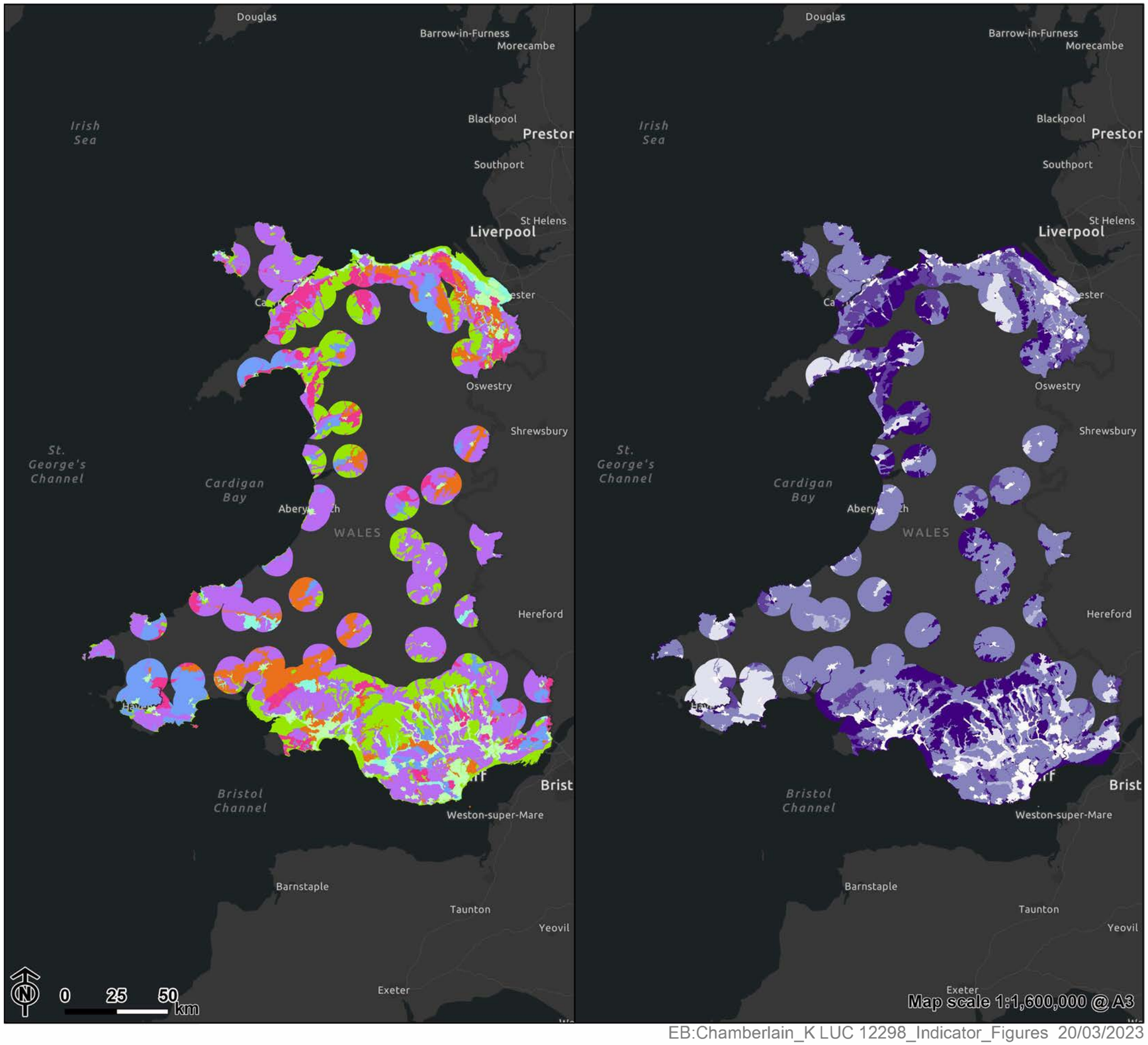
Figure 15 - T4-05 - Hearing lots of people urban data and map of results

Data

Result



Data
LANDMAP classification
- Urban
- Linear
- Village
- Scattered Rural/Farm
- Clustered
- Mixture
- No settlements

Result
Score
- 0 - lowest tranquillity
- 2
- 4
- 6
- 8
- 10 - highest tranquillity

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Indicator T4-06 – Hearing non-natural sounds

This indicator is considered to detract from tranquillity. The louder the sound the more it is expected to detract from tranquillity, therefore higher scores are more tranquil and lower scores are less tranquil.

This indicator has used data where it was available, keeping in mind that it is solely focussed on static non-natural sound. Suggestions were made in the stakeholder workshop for other contributing factors for this, for example hearing farming machinery, but given the lack of data around where these sounds are likely to be heard or how loud they are likely to be, they could not be included at this stage. These are covered in the Limitations and future enhancements section.

Datasets

Rural – Ports, ferry terminals, marinas, active quarry/mine data (BGS), BEIS Renewables Energy Planning Database, industrial sites.

Urban – Ports, ferry terminals, marinas, active quarry/mine data (BGS), BEIS Renewables Energy Planning Database, industrial sites.

Method

Rural – Sound measurements for the above datasets were quite different and so the analysis was separated into two parts, then combined. It is important to note that this is focussing on sounds associated with in-situ, static machinery etc.

For turbines the scores were applied to each pixel as below, based on a sound measurement of 45 dB at 300m. This sound measurement was provided by LUC's renewable energy experts, as the maximum acceptable level that wind turbines will produce at this distance.

All pixels more than 1700 metres from a turbine are awarded a score of 10, the scoring below only applies to pixels within 1700 metres from a turbine.

Distance	**300m**	**600m**	**1200m**	**1700m**	**>1700m**
Sound level (dB)	>45	45-39	39-33	33-30	<30
Score	2	4	6	8	10

For the other sounds, the scores were based on sound measurements of 80 dB at source. Scores were applied as below.

Distance	**30m**	**60m**	**120m**	**250m**	**320m**	**>320m**
Sound level (dB)	80-50	50-44	44-38	38-32	32-30	<30
Score	0	2	4	6	8	10

Scores were combined with the highest score taking precedence for each pixel.

Urban – Analysis was completed using the same method as above, but using the scores and distances as below.

Turbines:

Distance	**300m**	**530m**	**>530m**
Sound level (dB)	>45	45-40	<40
Score	6	8	10

Other static sounds:

Distance	**15m**	**30m**	**60m**	**100m**	**>100m**
Sound level (dB)	80-56	56-50	50-44	44-40	<40
Score	0	4	6	8	10

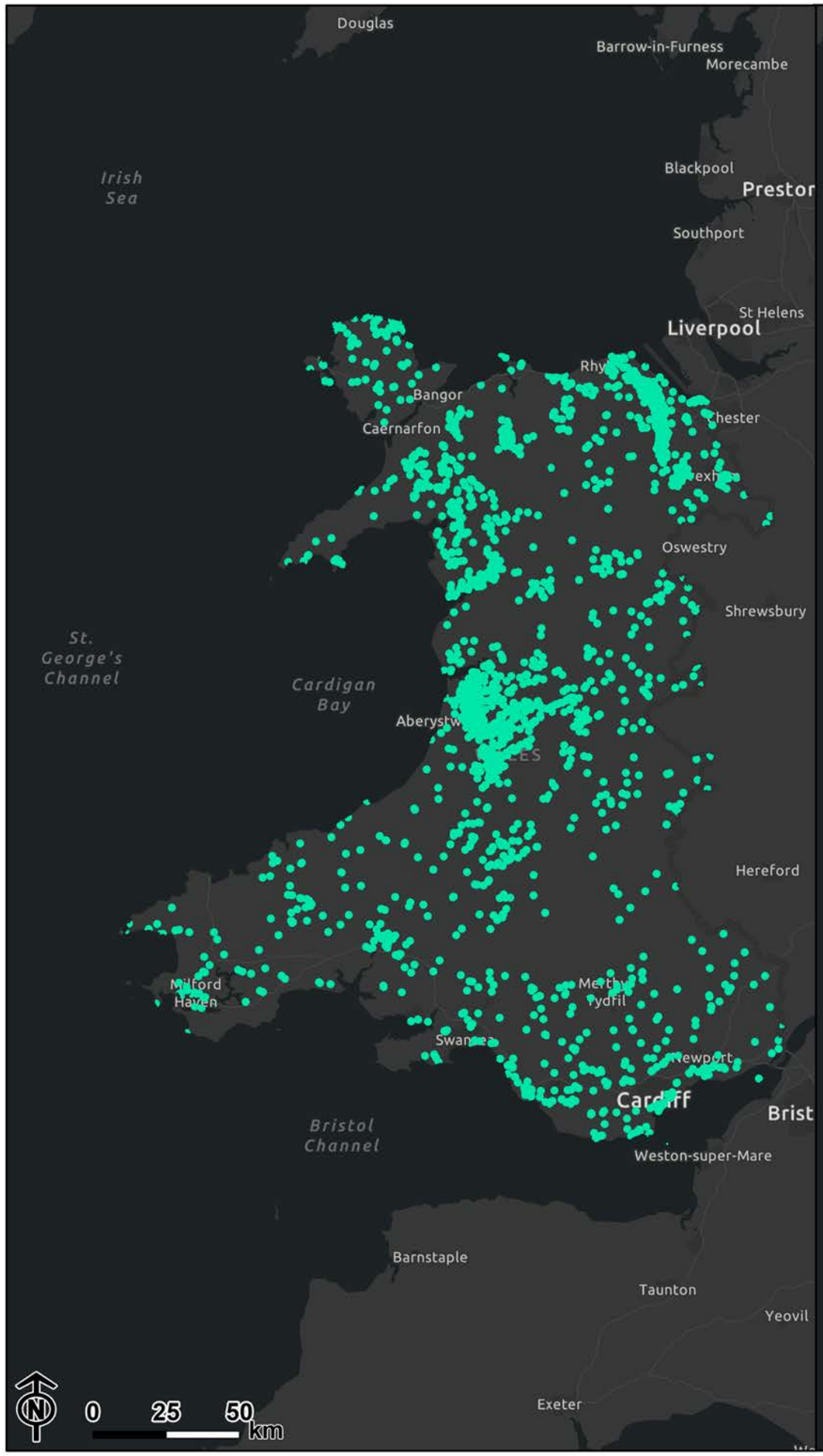
Result

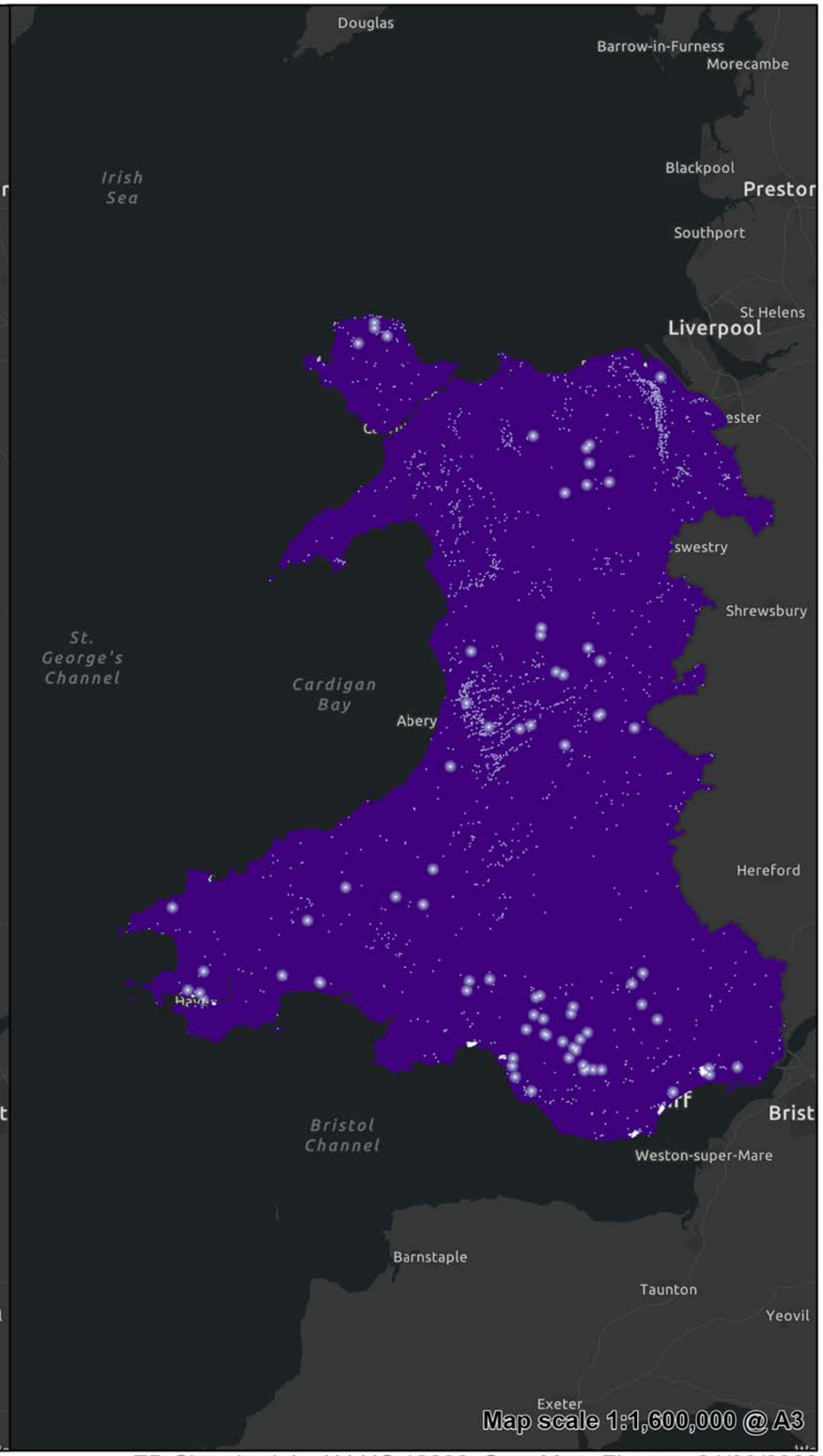
The results of this analysis are shown in Figure 16 and Figure 17 below. The louder the sound the more it detracts from tranquillity, therefore higher scores are less tranquil and lower scores are more tranquil.

Figure 16 - T4-06 - Hearing non-natural sounds rural data and map of results

Data

Result





Data

- Port, ferry terminal and marina
- Active quarry, metal mine, industrial site and turbine

Result

Score

- 0 - lowest tranquillity
- 2
- 4
- 6
- 8
- 10 - highest tranquillity

EB:Chamberlain_K LUC 12298_StoryMap_Figures 24/03/2023

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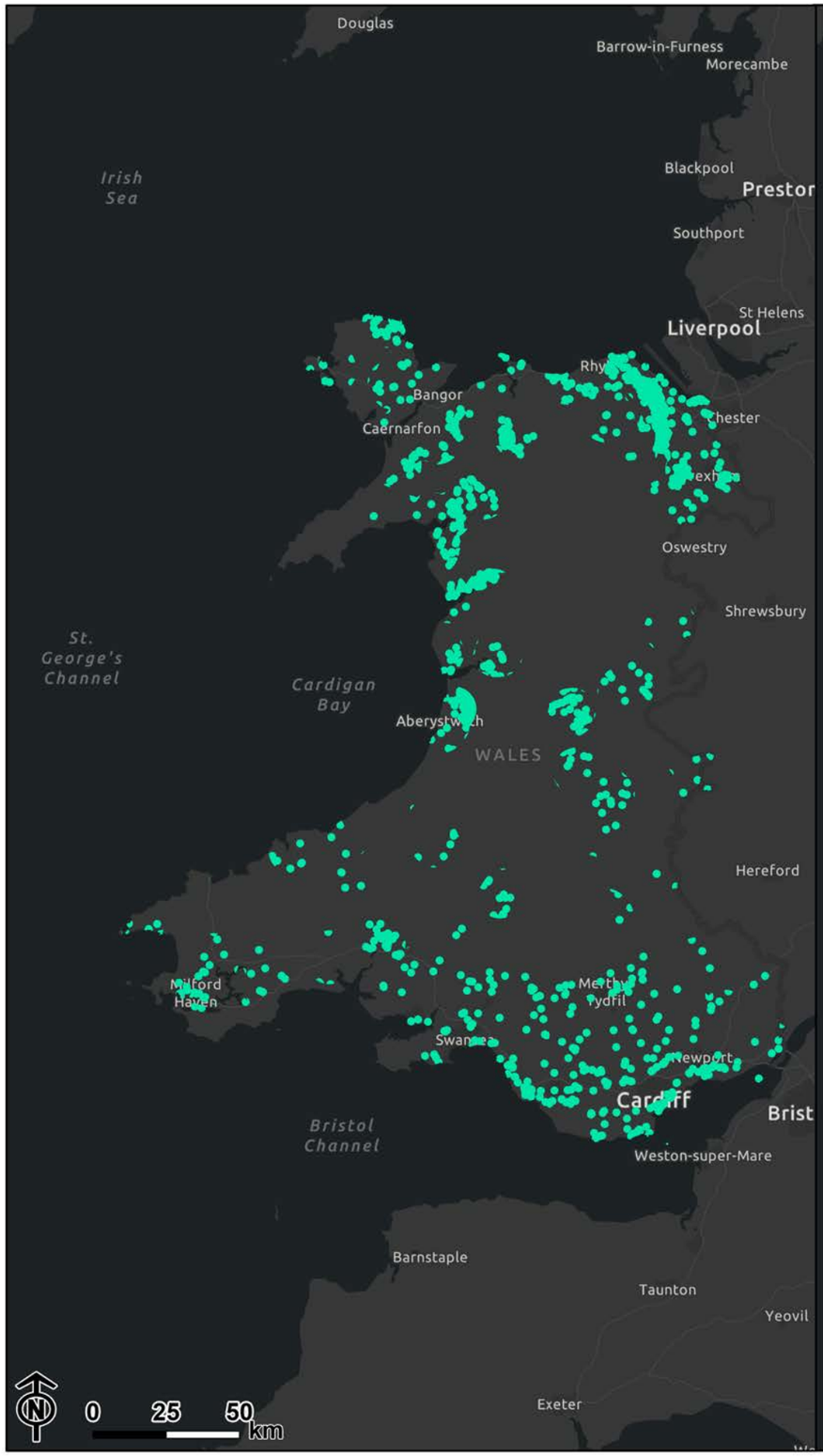
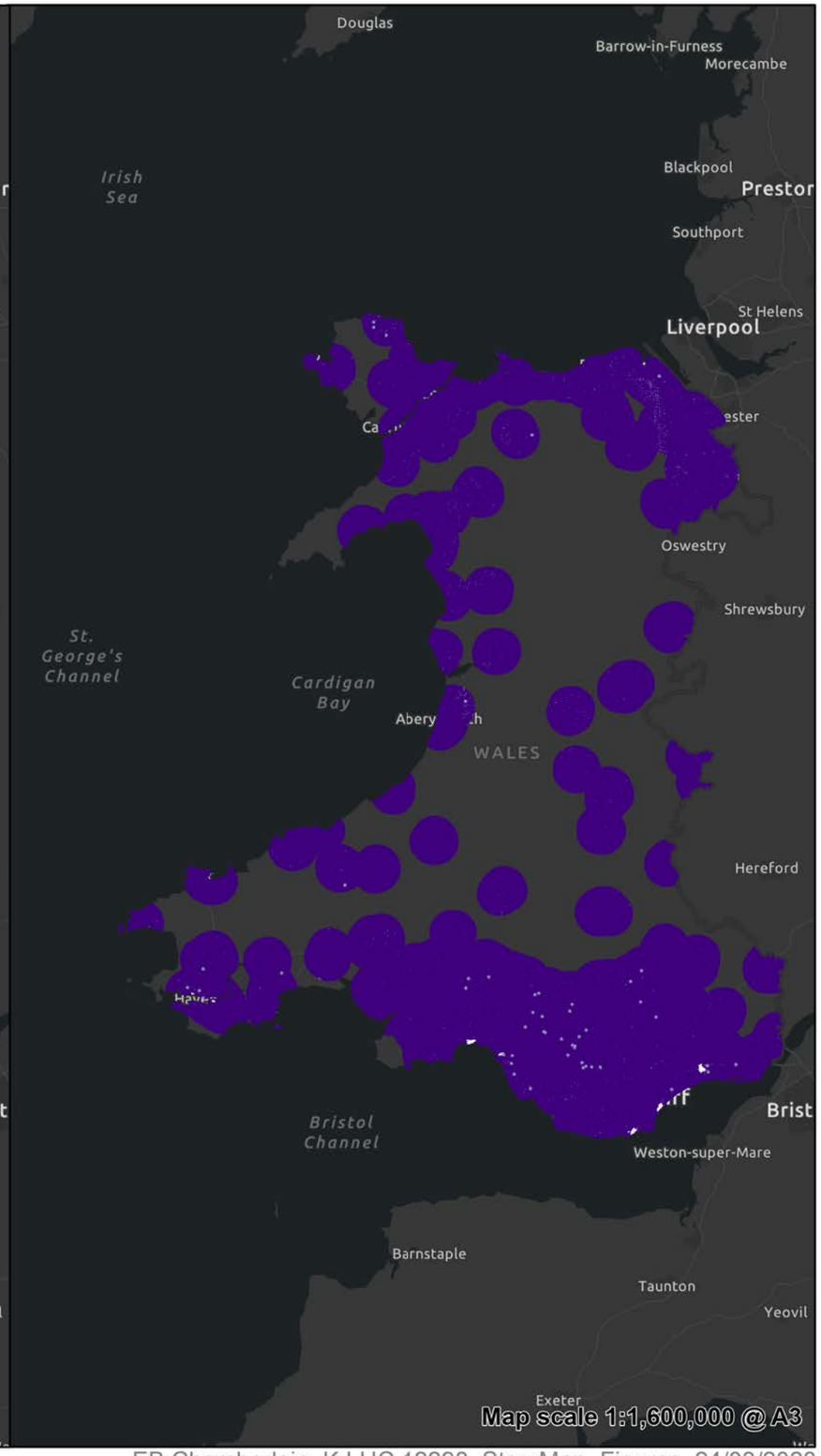
Figure 17 - T4-06 - Hearing non-natural sounds urban data and map of results

Data

Result





Data

- Port, ferry terminal and marina
- Active quarry, metal mine, industrial site and turbine

Result

Score

- 0 - lowest tranquillity
- 4
- 6
- 8
- 10 - highest tranquillity

Cyfoeth Naturiol Cymru
Natural Resources Wales

Combined theme 4 part 1 dataset

Once all the analysis had been run for both the rural/all Wales and urban datasets, the indicators for each were combined to give an overall score for this theme. For this theme, a higher score means the pixel is expected to be more tranquil. The rural map is shown in Figure 18, and the urban map in Figure 19.

Refer to the Combination of indicators section of the Methodology for a full explanation of this process.

This resulting dataset was then normalised to have a maximum theoretical range of between 0 and 1, as set out in the methodology section.

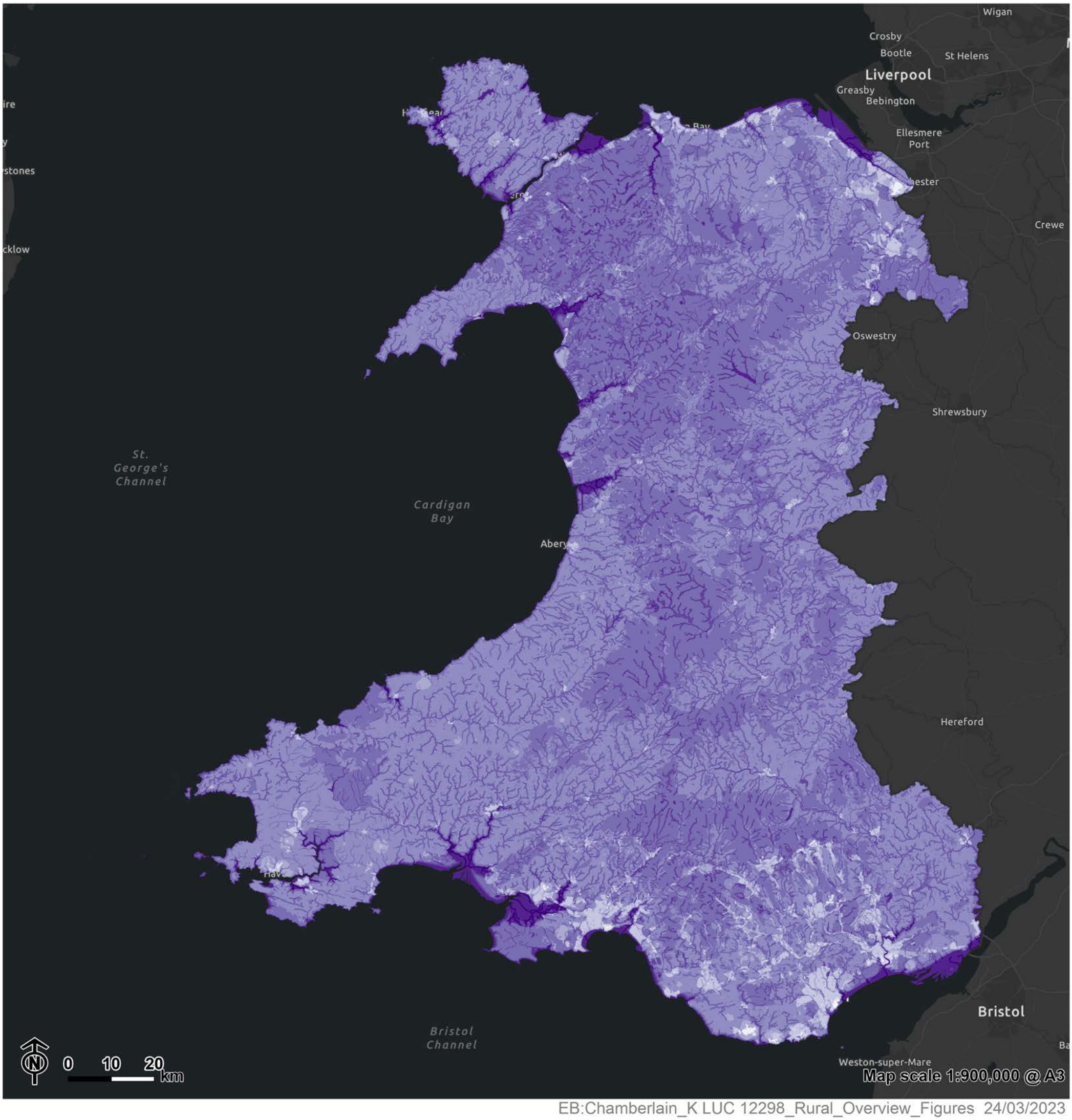


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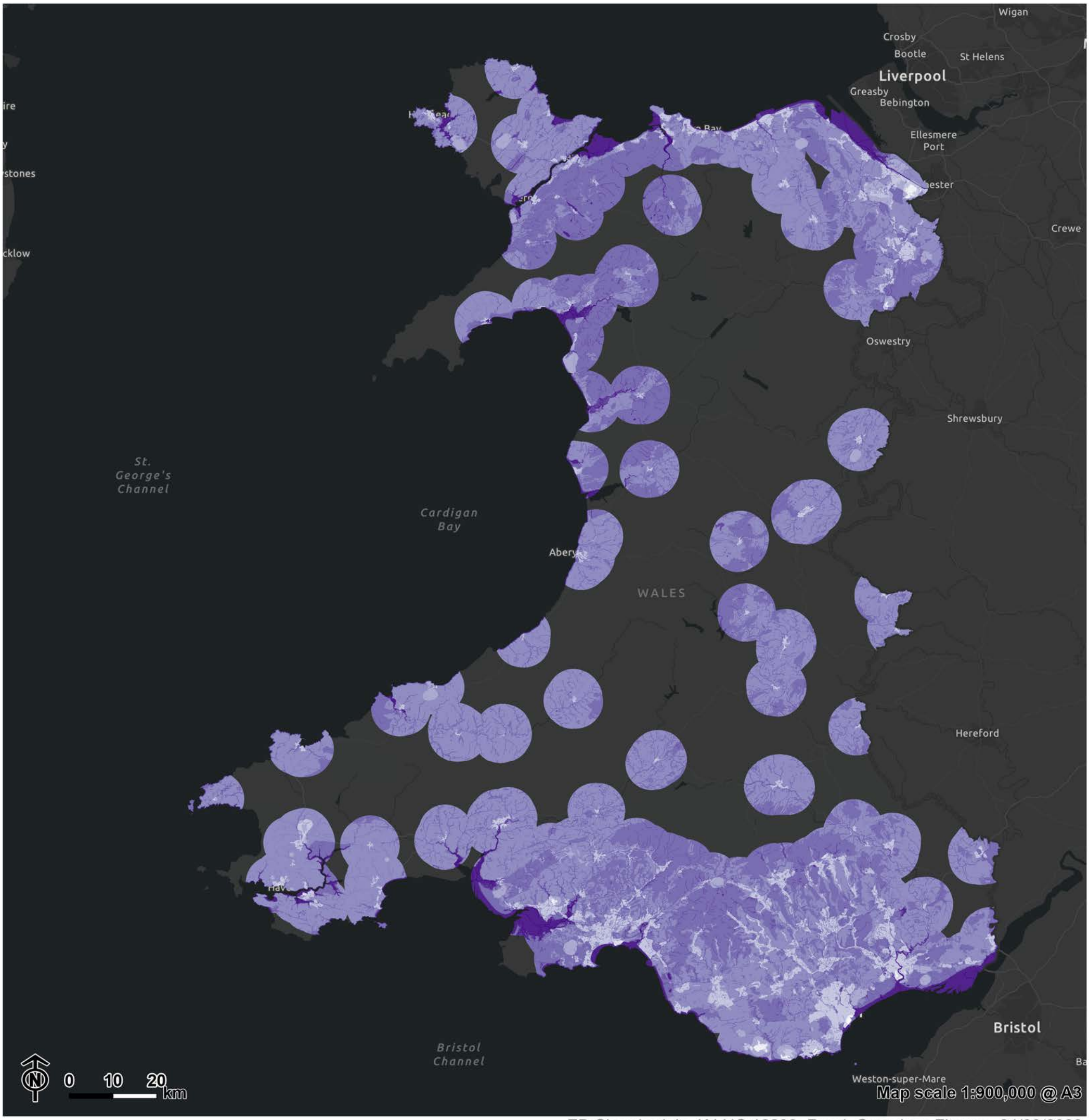
Figure 18: Combined map of theme 4 part 1 indicators (rural)

Category
- 1 (least tranquil)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (most tranquil)



EB:Chamberlain_K LUC 12298_Rural_Overview_Figures 24/03/2023

Figure 19: Combined map of theme 4 part 1 indicators (urban)

Category
- 1 (least tranquil)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (most tranquil)

Headline figures and statistics

Using GIS (ESRI's Spatial Analyst extension), quantitative analysis has been undertaken to explore the theme 4 part 1 data in more detail. This section presents the findings of the national and regional analysis. The analysis has been based on the rural tranquillity dataset.

The following geographic boundaries have been analysed:

- All Wales
- NRW operational areas, these also relate to Area Statements
- Designated landscapes (National Parks and Areas of Outstanding Natural Beauty (AONB)
- National Landscape Character Areas
- Local authorities
- The 4 regions of Future Wales
- LANDMAP Visual and Sensory aspect areas - due to the large number of aspect areas across Wales, the findings are not presented in this report. This data is presented visually on the interactive StoryMap, which is discussed later in this report, and in the accompanying spreadsheet to this report.

Interpreting the findings

As noted in the Aims and objectives section, this study covers just part 1 of theme 4. As such, all the results presented here should be understood to be only part of the information required to more fully report on Tranquillity & Place Sound Environment.

At first glance it may appear that only a very small part of Wales falls into the three most tranquil categories (0.2%), however, to fall into these categories, the pixel must score well against all six indicators. When compared to the visual themes, the spatial range of sound indicators is far more limited. Many features of the landscape can be seen from much further than they can be heard; even a truly turbulent river will not be audible for a great distance. As such, it is much less likely that a pixel will be influenced by multiple indicators when compared to the visual analysis.

There are, for example, many tranquil areas within Wales that are relatively far from both the sea and a river, limiting their scoring potential. The limited number of indicators assessed within this study means that the impact of scoring poorly against one of them is increased, when compared to the visual themes which included more indicators.

The remedy for this will be to integrate the part 2 mapping results. Once this is done, the areas with a more tranquil sound environment will be much more apparent. Those could be areas that part 1 identifies as places where natural sounds may be more prominent than noise, but just as likely is that they will be areas with moderate part 1 scores, and high part 2 scores. These will be areas with a number of sounds that contribute to tranquillity, but more importantly, no road or rail noise to detract from those sounds.

Because of this, the headline figures and statistics in this section are presented with limited commentary, and should be interpreted as interim results that will need to be integrated with the part 2 results before they can more fully report on the tranquillity and place sound environment of Wales.

National findings

For ease of analysis, understanding and presentation, the theme 4 part 1 map has been broken down into 10 equal categories, based on the theoretical minimum and maximum values of 0 – 1. 10 represents the most tranquil places and 1 the least tranquil places.

Table 6 Value ranges used to categorise the sound environment part 1 tranquillity map

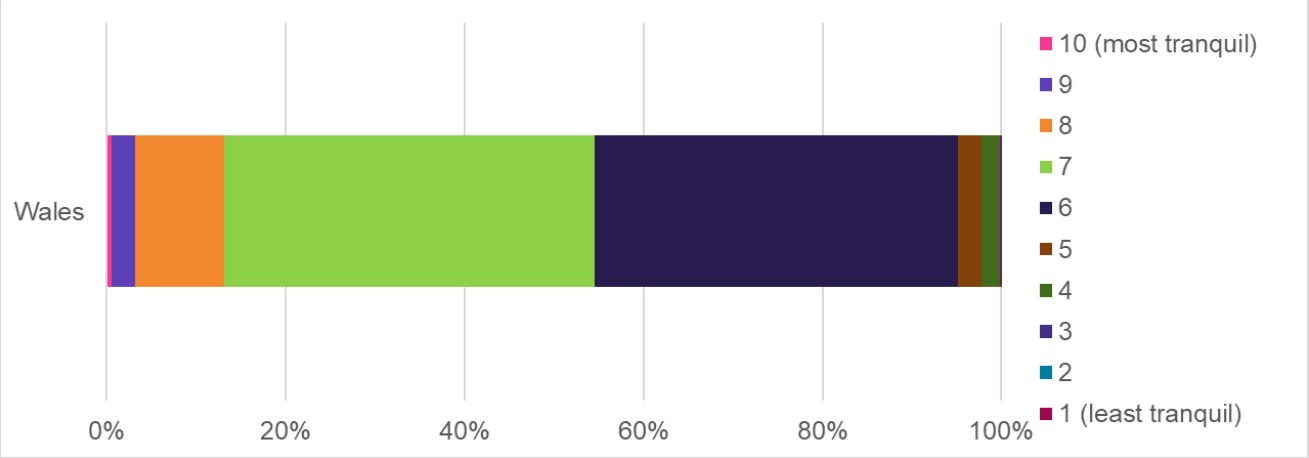
Category	**Values**
1	0.0 – 0.1
2	0.1 – 0.2
3	0.2 – 0.3
4	0.3 – 0.4
5	0.4 – 0.5
6	0.5 – 0.6
7	0.6 – 0.7
8	0.7 – 0.8
9	0.8 – 0.9
10	0.9 – 1.0

Table 7 and Figure 20 show the breakdown of land coverage across Wales into these ten categories. These statistics are based on the land areas of Wales, as defined by Ordnance Survey.

Table 7 Percentage and area of Wales falling into each tranquillity category for theme 4 part 1 (rural)

Category	% of total area	Area (km^2)
1 (least tranquil)	0.0	0.6
2	0.1	13.0
3	0.1	21.8
4	2.1	446.1
5	2.6	542.3
6	40.6	8,627.8
7	41.4	8,779.1
8	10.0	2,122.8
9	2.6	553.7
10 (most tranquil)	0.6	118.5

Figure 20 Percentage of Wales falling into each tranquillity category for theme 4 part 1



For the urban tranquillity dataset, the assessed areas are broken down as per Table 8.

Table 8 Percentage and area of urban area falling into each tranquillity category for theme 4 part 1

Category	**% of total for all urban areas**	**Urban Area with highest percentage in this category**
1	0.1	Cardiff (1%)
2	1.5	Broughton (85%)
3	0.6	Mostyn (12%)
4	63.6	Bettws (96%)
5	14.4	Tycroes Capel Hendre Saron (94%)
6	13.9	Port Talbot Margam Aberafon Sandfields Baglan (38%)
7	5.2	Llay (27%)
8	0.7	Glyncorrwg (7%)
9	0.1	Tredegar (2%)
10	0.0	Conwy (0.3%)

NRW operational areas

Figure 21 shows the breakdown between the categories by NRW operational areas. These areas are shown against the data in Figure 22.

Figure 21 Percentage of each NRW operational area falling into each sound environment tranquillity category for theme 4 part 1 (rural)

Appendix 2 contains a full breakdown of the proportion of each area in each category, both as a percentage and in km^2.

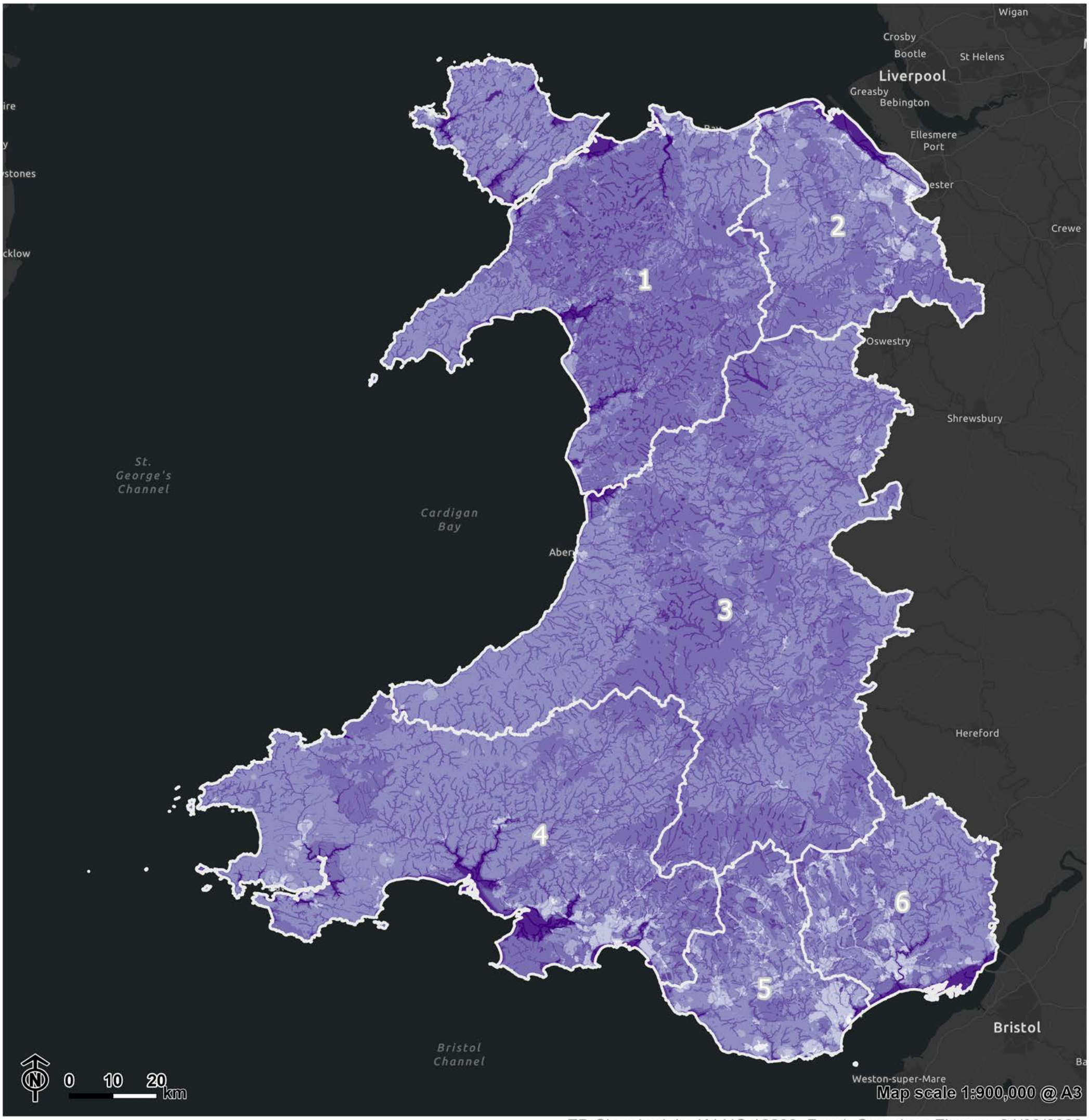


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Figure 22: Tranquillity and NRW operational areas

NRW operational area
1. North West Wales - Gogledd Orllewin Cymru
2. North East Wales - Gogledd Dwyran Cymru
3. Mid Wales - Canolbarth Cymru
4. South West Wales - De Orllewin Cymru
5. South Wales Central - De Cymru Canolog
6. South East Wales - De Ddwyrain Cymru

Category
1 (least tranquil)
2
3
4
5
6
7
8
9
10 (most tranquil)

Designated landscapes

The results for the 3 National Parks (Figure 23) and 5 AONBs (Figure 24) in Wales are presented below.

Figure 23 Percentage of each National Park falling into each tranquillity category for theme 4 part 1 (rural)

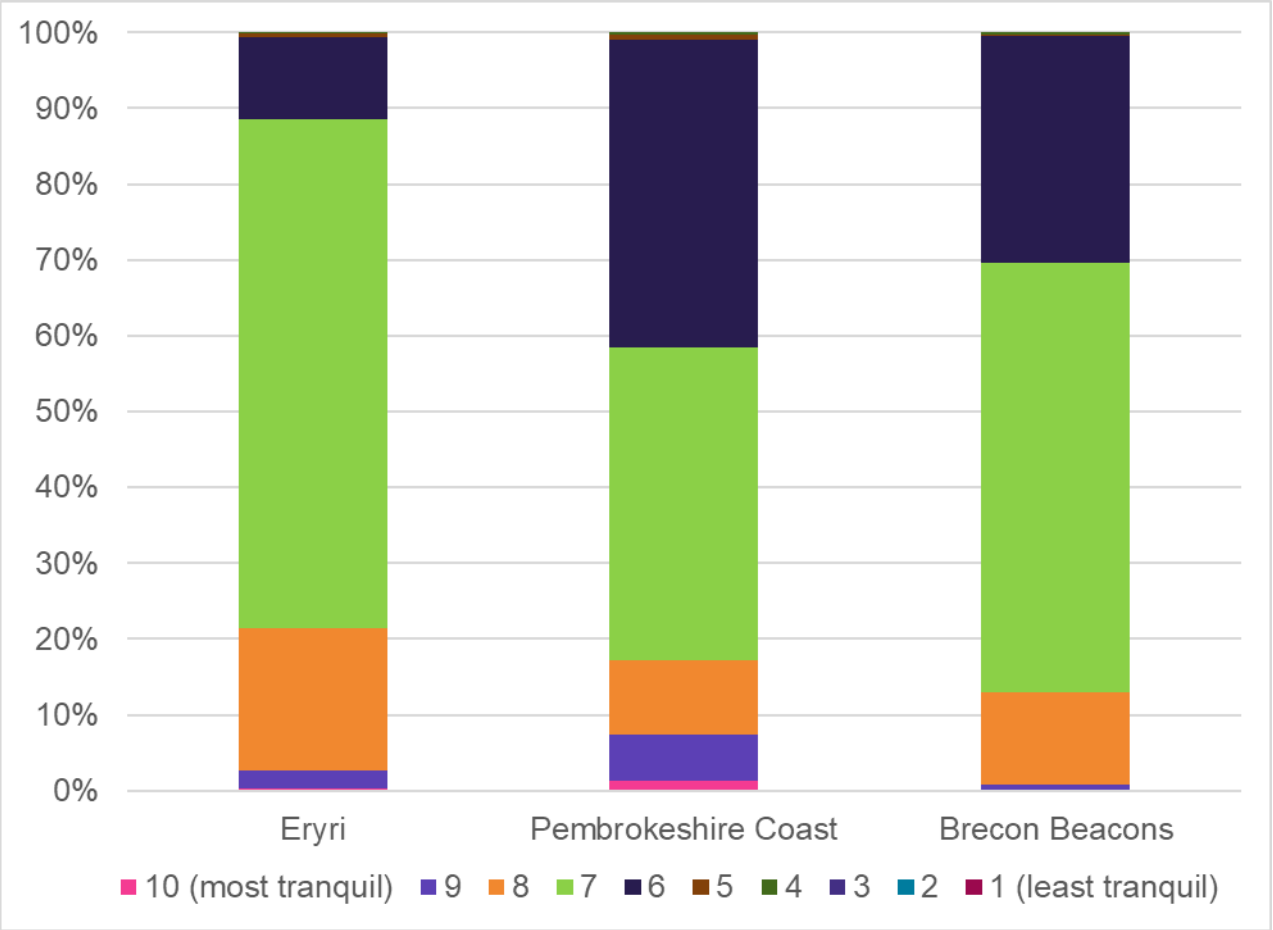
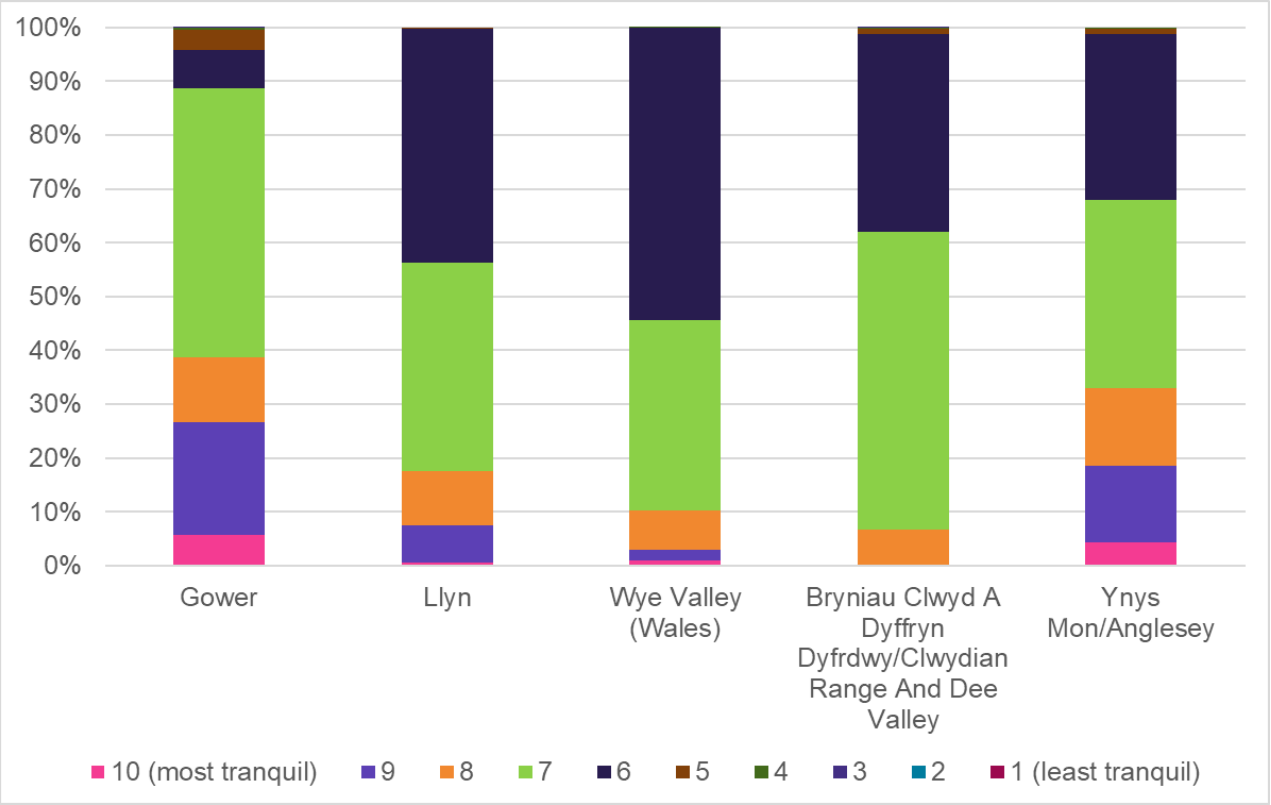
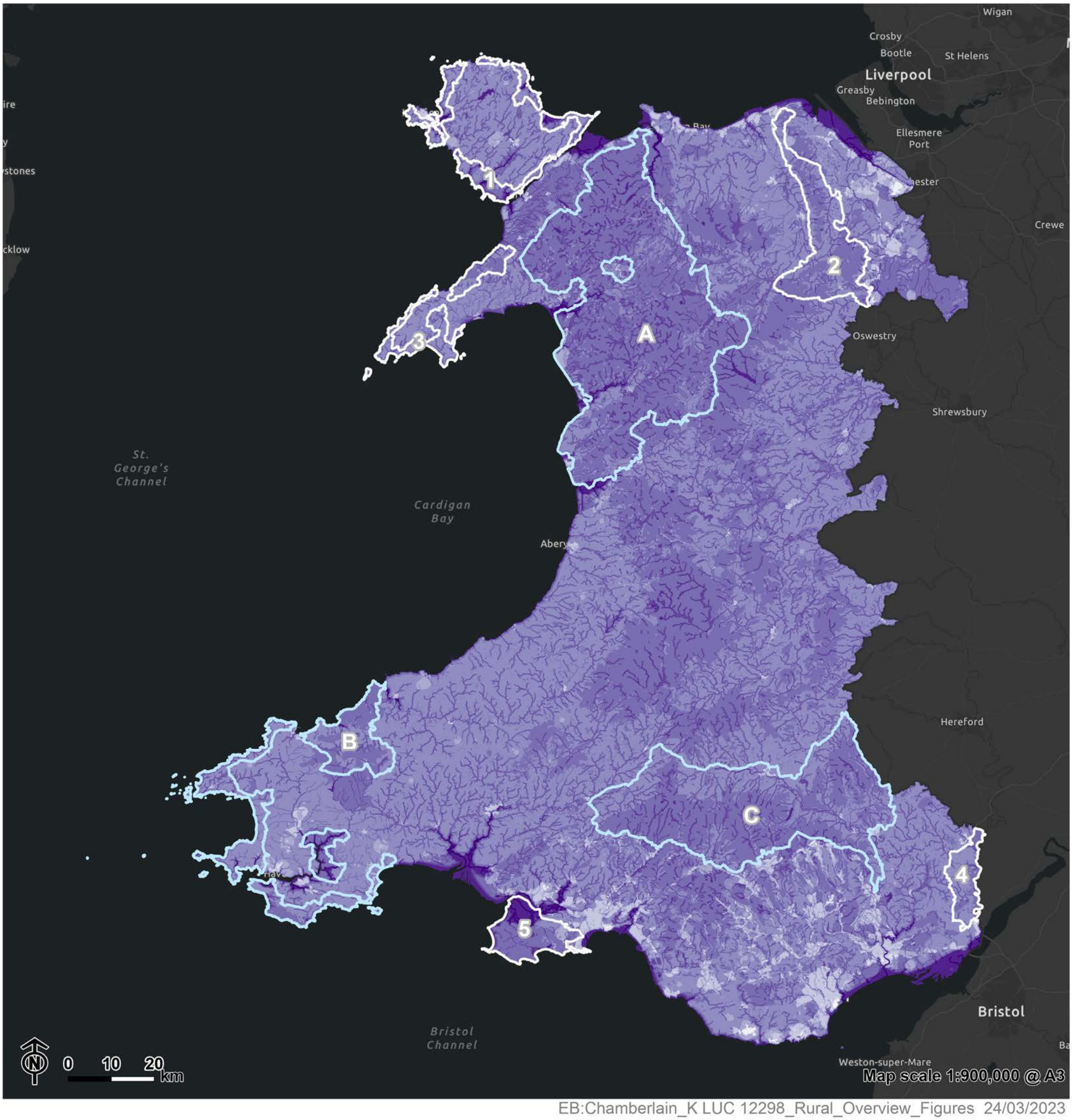


Figure 24 Percentage of each AONB falling into each tranquillity category for theme 4 part 1 (rural)



Appendix 3 contains a full breakdown of the proportion of each area in each category, both as a percentage and in km2.



EB:Chamberlain_K LUC 12298_Rural_Overview_Figures 24/03/2023

Figure 25: Tranquillity and designated landscapes

AONB
1. Ynys Môn - Anglesey
2. Bryniau Clwyd A Dyffryn Dyfrdwy - Clwydian Range And Dee Valley
3. Llŷn
4. Dyffryn Gŵy - Wye Valley
5. Gŵyr - Gower

National Park
A. Eryri
B. Arfordir Sir Benfro - Pembrokeshire Coast
C. Bannau Brycheiniog - Brecon Beacons

Category
1 (least tranquil)
2
3
4
5
6
7
8
9
10 (most tranquil)

National Landscape Character Areas

The theme 4 part 1 data is shown against the National Landscape Character Areas (also known as NLCAs) in Figure 26. An index for the reference numbers shown on the map is provided in Table 9.

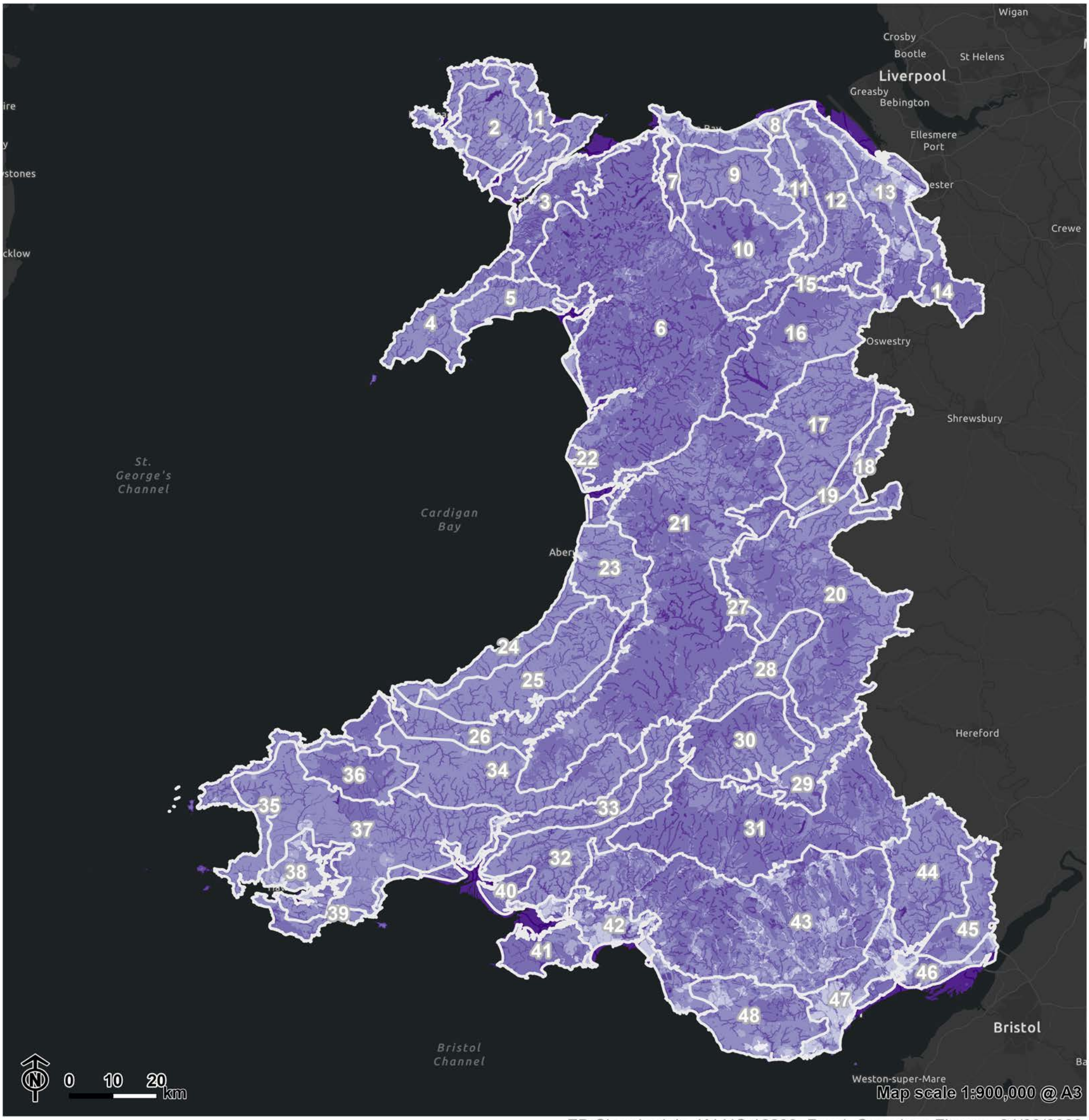
Appendix 4 contains a full breakdown of the proportion of each area in each category, both as a percentage and in km^2.

Table 9 National landscape character area reference table

Reference Code	Name
1	Arfordir Môn - Anglesey Coast
2	Canolbarth Men - Central Anglesey
3	Arfon - Arfon
4	Llŷn - Llŷn
5	Bae Tremadog - Tremadoc Bay
6	Eryri
7	Dyffryn Conwy - Conway Valley
8	Arfordir Colwyn ayr Gogledd - Colwyn and Northern Coastline
9	Bryniau Rhos - Rhos Hills
10	Mynydd Hiraethog - Denbigh Moors
11	Dyffryn Clwyd - Vale of Clwyd
12	Bryniau Clwyd - Clwydian Range
13	Glannau Dyfrdwy a Wrecsam - Deeside and Wrexham
14	Maelor Saesneg - Maelor
15	Dyffryn Dyfrdwy a Llangollen - Llangollen and the Vale of Dee

Reference Code	Name
16	Y Berwyn - Berwyn
17	Bryniau a Dyffrynnoedd Trefaldwyn - Montgomeryshire Hills and Vales
18	Bryniau Sir Amwythig (rhan) - Shropshire Hills (part)
19	Dyffryn Hafren - Severn Valley
20	Bryniau Maesyfed - Radnorshire Hills
21	Uwchdiroedd Cymru - Cambrian Mountains
22	Glannau Aberdyfi - Aberdovey Coast
23	Dyffrynnoedd a Bryniau Rheidol ac Ystwyth - Rheidol and Ystwyth Hills and Valleys
24	Arfordir Ceredigion - Ceredigion Coast
25	Ceredigion - Ceredigion
26	Dyffryn Tefi - Teifi Valley
27	Pen Uchaf Dyffryn Gwy - Upper Wye Valley
28	Ffynhonnau Durol Canolbarth Cymru - The Spas and Wells of Central Wales
29	Dyffrynnoedd Gwy a Gwysg - Wye and Usk Vales
30	Lwyfandir a Dyffrynnoedd Epynt - Epynt Plateau and Valleys
31	Bannau Brycheiniog ayr Mynyddoedd Du - Brecon Beacons and the Black Mountains
32	Dyffrynnoedd Gwendraeth - Gwendraeth Vales
33	Dyffryn Tywi - Tywi Valley

Reference Code	Name
34	Troedfryniau Penfro a Chaerfyrddin - Pembroke and Carmarthen Foothills
35	Arfordir Gorllewin a Gogledd Sir Benfro - West and North Pembrokeshire Coast
36	Bryniau Preseli - Preseli Hills
37	Dyffrynnoedd Taf ayr Cleddau - Taf and Cleddau Vales
38	Hafan Milffwrdd - Milford Haven
39	Arfordir De Sir Benfro - South Pembrokeshire Coast
40	Aber Afonydd Taf, Tywi a Gwendraeth - Taf, Tywi and Gwendraeth Estuaries
41	Gŵyr - Gower
42	Bae Abertawe - Swansea Bay
43	Dyffrynnoedd y De - South Wales Valleys
44	Canolbarth Mynwy - Central Monmouthshire
45	Dyffryn Gŵy a Choed Gwent - Wye Valley and Wentwood
46	Gwastadeddau Gwent - Gwent Levels
47	Casnewydd, Caerdydd ayr Barri - Newport, Cardiff and Barry
48	Bro Morgannwg - Vale of Glamorgan



EB:Chamberlain_K LUC 12298_Rural_Overview_Figures 24/03/2023

Figure 26: Tranquillity and National Landscape Character Areas

National Landscape Character Area (see table 9 for national character area names)

Category

- 1 (least tranquil)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (most tranquil)

Local authorities

The theme 4 part 1 data is shown against the local authority boundaries in Figure 27. An index for the reference numbers shown on the map is provided in Table 10.

Appendix 5 contains a full breakdown of the proportion of each area in each colour category, both as a percentage and in km^2.

Table 10 Local authority area reference table

Reference Code	Name
1	Sir Ynys Môn - Isle of Anglesey
2	Gwynedd - Gwynedd
3	Conwy - Conwy
4	Sir Ddinbych - Denbighshire
5	Sir y Fflint - Flintshire
6	Wrecsam - Wrexham
7	Powys - Powys
8	Sir Ceredigion - Ceredigion
9	Sir Benfro - Pembrokeshire
10	Sir Gaerfyrddin - Carmarthenshire
11	Abertawe - Swansea
12	Castell-nedd Port Talbot - Neath Port Talbot
13	Pen-y-bont ar Ogwr - Bridgend
14	Rhondda Cynon Taf - Rhondda Cynon Taf
15	Merthyr Tudful - Merthyr Tydfil
16	Caerffili - Caerphilly

Reference Code	Name
17	Blaenau Gwent - Blaenau Gwent
18	Tor-faen - Torfaen
19	Sir Fynwy - Monmouthshire
20	Casnewydd - Newport
21	Caerdydd - Cardiff
22	Bro Morgannwg - the Vale of Glamorgan

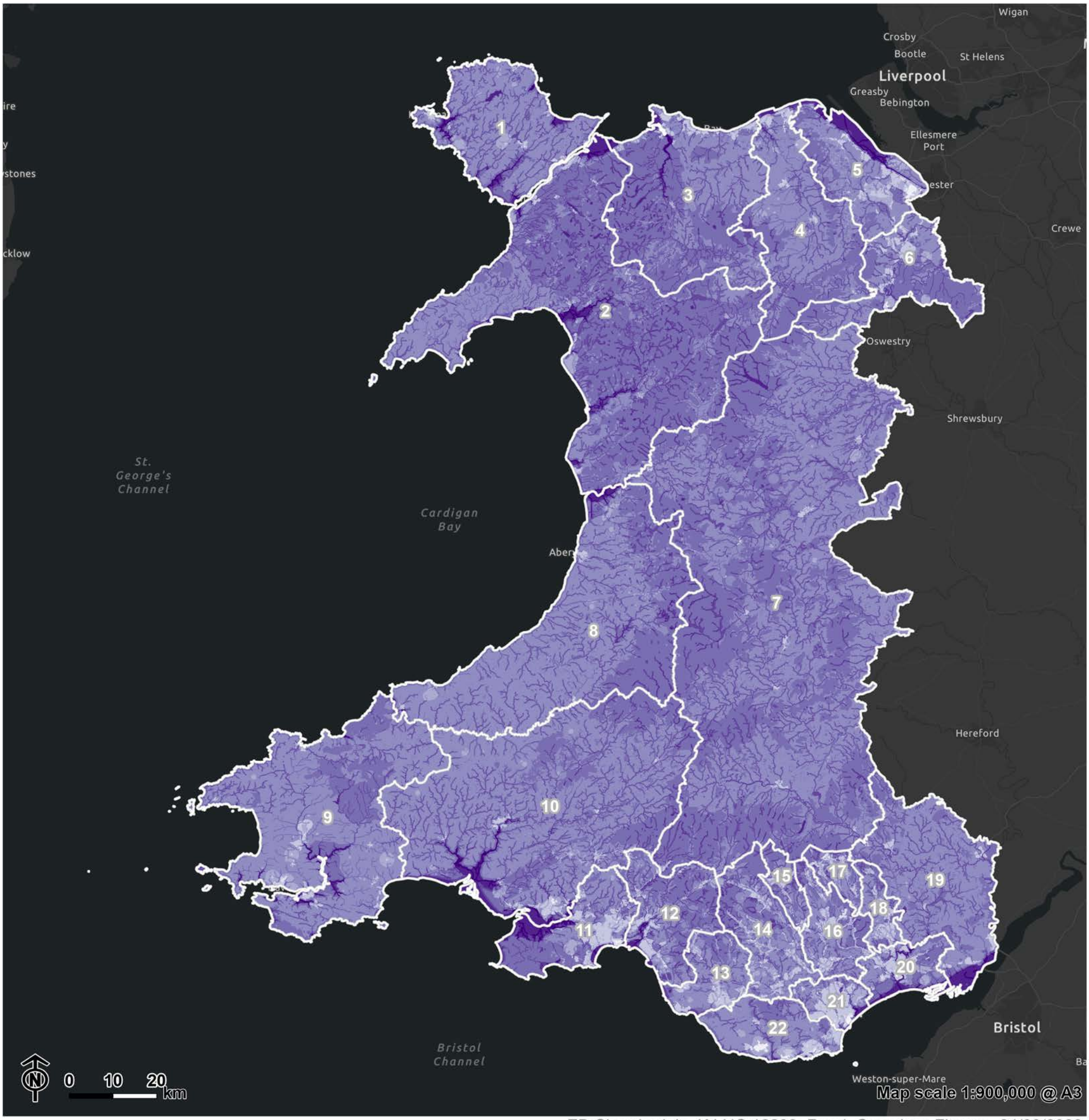


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Figure 27: Tranquillity and local authorities

Local authority area (see table 10 for local authority names)

Category

- 1 (least tranquil)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (most tranquil)

4 regions of Future Wales

The theme 4 part 1 data is shown against the 4 regions of Future Wales in Figure 28.

Appendix 6 contains a full breakdown of the proportion of each area in each colour category, both as a percentage and in km^2.

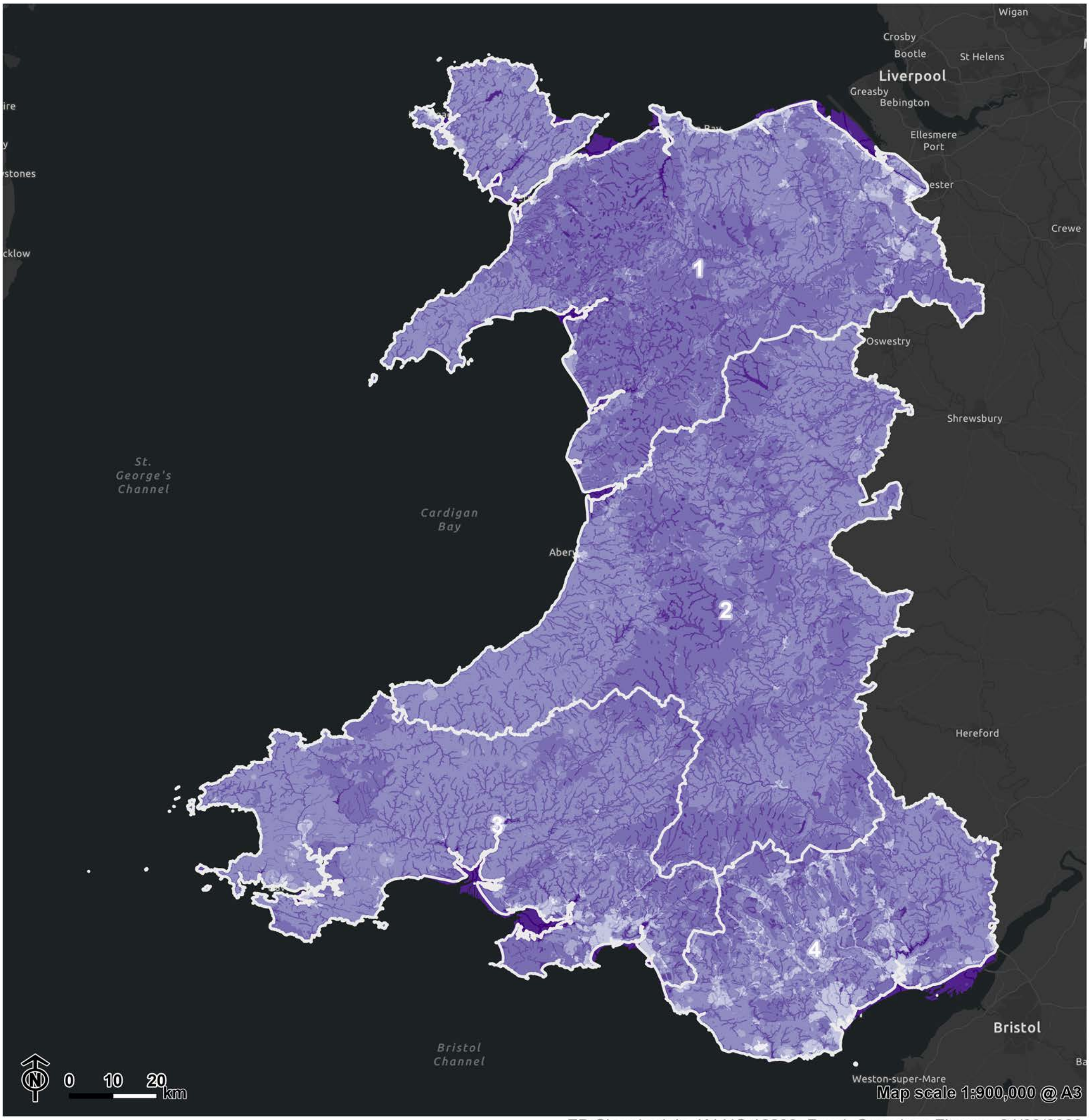

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Figure 28: Tranquillity and the 4 regions of Future Wales

Future Wales region
1. North
2. Mid Wales
3. South West
4. South East

Category
1 (least tranquil)
2
3
4
5
6
7
8
9
10 (most tranquil)

Limitations and future enhancements

Next steps

Part 2 of this study will build upon part 1 to incorporate the new roads and railways noise maps for Wales.

Incorporating this data will likely dramatically change the overall outcome of the sound environment across Wales and, in doing so, will provide a more complete picture.

Once this final dataset of Tranquillity & Place Sound Environment has been created (the combined theme 4), it can be incorporated with the rest of the themes to build theme 6 – the final overview of Tranquillity & Place across Wales.

Data

The project has benefited from a very engaged contract manager and group of stakeholders who contributed time and ideas during the method development phase. A number of data layers were suggested during the stakeholder event that the project team were either unable to secure access to within the project timeframe, or a nationally consistent layer does not yet exist.

It was considered vitally important to use robust, nationally consistent datasets that have a high probability of being maintained and updated in the future.

Whilst some areas have very valuable information that could contribute to our understanding of local tranquillity associated with sound, if datasets that are not nationally consistent are introduced, the results will be positively biased towards those areas (or conversely negatively biased depending on the data).

Due to the fairly short timescales of this project, there were some datasets that were requested, but that were not available before the project came to an end. Where relevant, these are expanded upon in the Future enhancements section.

Future enhancements

Due to the complexity of approximating the propagation of sound, this project has made a number of assumptions around how loud sounds are, and what produces them. With the benefit of more time to perform in-depth research and ground truthing, and access to other, or more complete datasets, the accuracy and breadth of this study could be increased.

The following factors or datasets were considered and dismissed, but could be reconsidered in future iterations of this project, should the situation change:

- High flying aircraft – This was dismissed due to the difficulty in finding accurate GIS data for flight paths, plane frequency and noise levels. Feedback from the consultation workshop also indicated that this was not considered a significant detractor from tranquillity.

- Using airport action plans to accurately map noise contours for low flying aircraft – only Cardiff Airport is large enough to have an action plan. Consideration was given to using the Cardiff plan to approximate similar noise contours for other airports, but the different runway configurations made this impossible. In the end the Cardiff Airport action plan was used to estimate the distance that sound should be considered from an airport boundary. It is recognised that this will likely misrepresent the impact that the low flying aeroplanes will have around these smaller airports, however in the absence of more accurate data, this was considered a good starting point.
- MOD land – the noise associated with military activities was considered an important consideration for indicator T4-06, however this data was unavailable to use for this purpose.
- MOD flying routes – This data was considered for use, specifically the noise generated around RAF Valley, and flight paths such as the Mach Loop where there is a great deal of low flying aircraft noise. However, it proved difficult to find reliable data to represent the noise this would generate. Noise complaints are common in this area, however it was decided that there is a significant gulf between when sound affects tranquillity and when it is loud enough to generate noise complaints, so this was left as a potential future enhancement.
- Farming noise – this was raised in the consultation workshop as a possible factor affecting tranquillity – in both a contributing and detracting way. Machinery was generally highlighted as a detracting factor, and (non-intensive) animal farming was considered a potential contributing factor. Due to the difficulty that would be involved in mapping and measuring this, it was discounted.
- Unexpected noise – this was another factor suggested as a possible detracting factor in the consultation workshop. However, unexpected events are, by their nature, challenging to map, and so it was discounted because of this.
- Wind noise – either in isolation or as a modifier to other factors. In isolation the sound of wind would be very challenging to map, even if it was just prevailing wind. As a modifier to other factors (for example having sound propagate further with the direction of the prevailing wind), the introduction of this factor would complicate the analysis, without necessarily adding any more accuracy.
- Topography and barriers – The effect of topography and barriers on sound is a highly complex process, requiring detailed modelling and simulations to achieve any significant degree of accuracy. As such, it was decided that straight-line buffers, whilst simple, offer a more consistent and robust approach given the limitations of time and budget available for this project.
- Urban quiet areas – quiet areas were considered as a modifying factor to other factors within the study. However, research into these areas suggests that they are areas within which noise is managed through the planning process, and not areas that will inherently be quieter than other close by comparable areas. As such, their inclusion was discounted from the analysis. This study (alongside part 2) could be used to see if those areas are indeed quieter than surrounding areas that are not in quiet areas.
- The temporal nature of factors – many noise sources vary significantly across time. As with the visual themes, where visual contributors and detractors from tranquillity would not be visible at night (and the inverse for the dark skies theme), this was not considered. The consideration of the temporal nature of the factors would not allow for the creation of a single map of the sound environment.
- Local or perceptual factors – for example, the appropriateness of a sound to a specific location, especially if it wouldn't be considered appropriate in others. For example, the

sound of different types of birds, like seagulls on the beach, which may be considered a negative by some or a positive by others.

Using the information

The results of this study are intended to be used in a number of ways, including:

- Providing evidence and information that may be beneficial to and align with the Welsh Government Noise and Soundscape Action Plan, an updated TAN 11 Air quality, noise and soundscape (consultation ended January 2023) and a potential national soundscapes strategy.

  An Environment (Air Quality and Soundscapes) (Wales) Bill was introduced to the Senedd on Monday 20 March. Climate Change Minister Julie James said *'By introducing this Bill, our ambition is to further improve air quality and soundscapes by bringing forward new measures to reduce the impacts of air and noise pollution on human health, biodiversity and the natural environment'.*

- Providing evidence that can be incorporated into plans, assessments and evidence reports such as the State of Natural Resources Reporting (SoNaRR), Green Infrastructure Assessments, Area Statements, designated landscapes state of reports and management plans, local landscape character assessments and Well-being Assessments.

- Identifying contributing and detracting sound environments that can help to inform policy, strategy and development management applications. Including the potential to consider tranquillity and its conservation and enhancement linked to design, placemaking and the Placemaking Charter.

- Providing new landscape evidence for the LANDMAP Visual & Sensory dataset and landscape monitoring programme.

- Highlighting the contribution and effect of the sound environment to landscapes. identifying places and areas of tranquillity close to where people live, connecting this to placemaking, nature and health, well-being, spiritual benefit and quality of life.

- Over time, if this study were to be repeated, changes in tranquillity could be measured and monitored to see if increased awareness of the importance of tranquillity is making a positive difference.

StoryMap and interactive web app

In the previous phase of this study, an interactive web application (web app) of Tranquillity & Place - Mapping tranquil places was created to present a summary of the results of this study. Visit the Tranquillity & Place - Mapping tranquil places StoryMap for further information

The embedded web app allows an individual to interrogate the data themselves in order to get a better understanding of the levels of visual tranquillity in their area of interest. This is presented in a non-technical way, and is intended to allow anyone with an interest in this information to access it in an intuitive way.

As this web app uses several different geography levels to present context to the visual tranquillity data, it will also serve as a useful planning tool to allow decision makers to determine the sensitivity of the visual tranquillity of an area to developments and consider opportunities for conserving and enhancing existing tranquillity.

This web app has been updated to include reference to the theme 4 part 1 data and results.

Figure 29 Screenshot of the interactive StoryMap

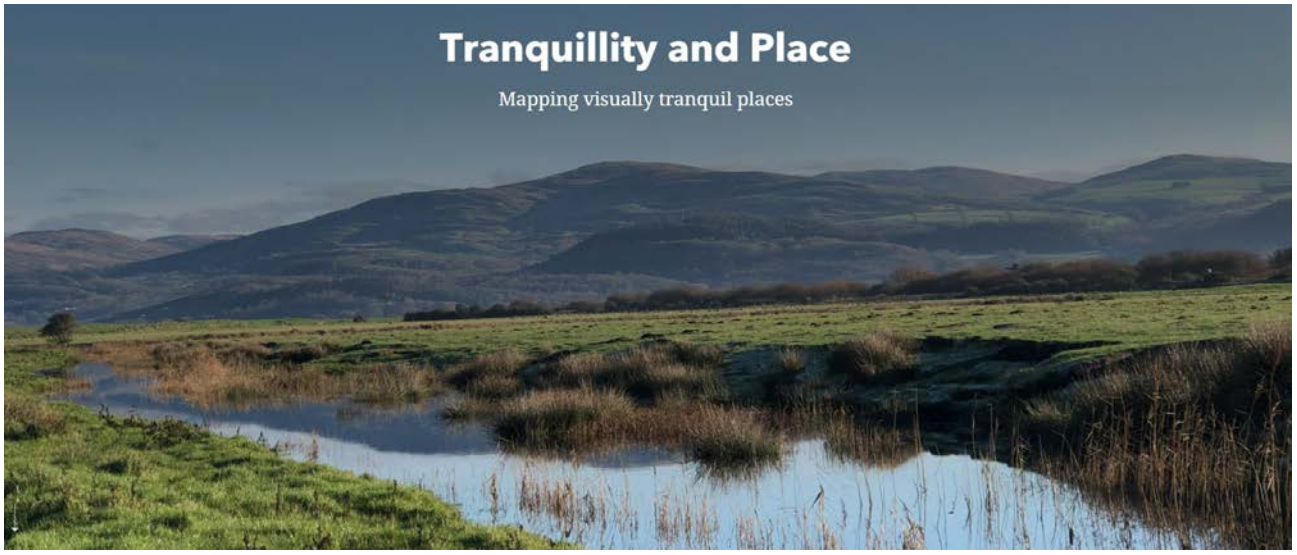

Figure 30 Screenshot of the new sound environment section of the StoryMap

References

Cardiff Airport Area Navigation Consultation Document (2014) https://www.cardiff-airport.com/uploads/Cardiff%20Airport%20RNAV%20Consultation%20document%20-%20Final%20Draft.pdf [Accessed 13 March 2023]

Collman, R., (2015) Distance Attenuation https://www.acoustical.co.uk/distance-attenuation/how-sound-reduces-with-distance-from-a-point-source/ [Accessed 13 March 2023]

Green C, Manson D, Chamberlain K 2022. Tranquillity and Place. NRW Report No: 569, 185 pp, NRW.

King et al (2012). King, G., Roland-Mieszkowski, M., Jason, T., & Rainham, D. G. (2012). Noise levels associated with urban land use. Journal of urban health: bulletin of the New York Academy of Medicine. https://doi.org/10.1007/s11524-012-9721-7 [Accessed 13 March 2023].

Mehta et al (1999). Mehta, M., Johnson, J., and Rocafort, J. Architectural Acoustics: Principle and Design. Merrill Prentice Hall. Upper Saddle River, NJ.

Appendices

Appendix 1 Extracts from February 2023 stakeholder workshop breakout discussions

Small breakout groups were prompted to discuss the following aspects in two separate sessions:

Session 1 – Hearing tranquillity

Participants were asked to think about:

- What makes a tranquil sound environment for you?
- What detracts from a tranquil sound environment for you?
- Do you agree with the indicators we have presented?
- What other datasets could we use?

Considerations:

- Do you agree with the indicators we have presented?
- What other datasets could we use?

The following list highlights the range of responses to the question ‘what makes a tranquil sound environment for you’?

- Ground noise/terrain noise
- Ability to have conversations
- Lack of modern sounds – machine age (cars/vehicles)
- Bird song
- Water – can be tranquil or not. Depends on rate of flow. Sometimes raging torrent can be tranquil/exhilarating. Especially when in flood.
- Sea – can have quiet sea or stormy seas/crashing against the cliffs.
- Human activity on a lake – more impact on tranquillity than something similar at sea – which would be more fleeting
- Access to nature gives you well-being benefit – doesn’t need to be quiet.
- Sound of the wind – particularly in vegetation
- Absence of sound – low background noise

The following list highlights the range of responses to the question ‘what detracts from tranquillity’?

- Farming noises
- Human made noise
- No noise can be threatening
- Unexpected noises
- Lots of traffic
- Lack of understanding about what the noise is

- Recycling plants
- Motorboats/canoeing/paddling – human powered
- Military training
- Level of an intrusive sound compared to background noise considered most important.

Session 2 – Relative importance of factors

Participants were asked to think about:
- Are there factors that are more important than others
- How does distance factor in (buffer distances)

They were also asked to consider rural urban differences, for example:
- What factors are different between rural and urban
- Are there any additional factors at play in one or the other
- Could we use the same data but just change the distances to which they are relevant
- Different datasets in rural/urban

Indicator T4-01 – Hearing moving water

- Sound attenuation drops off quickly – suggest some ground truthing
- Likely overestimating the sound of this, particularly over distance, drops off very fast
- Still in urban context – especially canals – energy behind the river influenced by climate change
- Think about steepness of slopes as modifiers.

Indicator T4-02 – Hearing the sea

- Tidal patterns/storms will impact this – difficult to capture
- Lots of energy in waves – sound carries a long way as a constant roar rather than individual waves
- Moving inland will potentially buffer individual waves, constant roar can sometimes be confused with wind/road noise
- Water in urban area – gives a break from urban environment. Fountains.
- Water underestimated – but can be some resistance to water due to danger.

Indicator T4-03 – Hearing nature

- Look at habitat network modelling. Condition will change sounds.
- Green infrastructure mapping
- Urban quiet area – TAN work
- Links to work on soundscape – TAN 11
- SuDS created ponds – attract birds
- Farming animals – some animal noises are considered tranquil but farming machinery noise is not (agricultural sounds are difficult to classify into detracting and contributing factors).

- Positive factors: sounds of woodland (trees creaking), feeling of ground underfoot – relates to landform and soils – sound of livestock
- Local differences, e.g. waterfall would be more important locally due to volume
- Different types of bird sound in urban/rural, e.g. seagulls

Indicator T4-04 – Hearing low flying aircraft

- Helicopters not that frequent – mostly Western side of Brecon Beacons National Park
- Some like to watch planes - personal perception
- RAF Valley – flying over schools – sound insulation in roofs required. Struggle to achieve acceptable standards in schools
- Helicopter training, frequent in mid Wales and Borders – more so than low flying aircraft. Refer back to difference between ambient sound

Removed indicator - Hearing high altitude aircraft

- Don't tend to hear them. Can be heard on Anglesey – background noise levels. Not as intrusive – spark curiosity/jealousy!
- Some across Brecon Beacons National Park– can't really hear them
- Aircraft over 7000 ft doesn't affect tranquillity – CAA guidance CAP1616, p.172
- High-flying aircraft – can be heard in very quiet context – urban/rural difference?

Indicator T4-05 – Hearing lots of people

- Motorsport – circuit – cars and bikes
- Population can swell due to tourism
- Jacuzzi's in the middle of night – result in noise complaints – people come to party! E.g. on Anglesey
- Bank holidays – huge influx
- Rural events – sound can travel and have a greater impact than it would in an urban area

Indicator T4-06 – Hearing non-natural sounds

- Military testing in Pembrokeshire Coast National Park – can even be heard on the beach. Locals get used to it. Could be personal perception – if you're going to have an army, need to train, but did spoil tranquillity
- Turbines – probably need to be close (within 1km?). Institute of Acoustics planning guidance. Probably more detracting if you can see them
- Solar – no noise
- Foreground wind obscures sounds, once sheltered the noise is there
- Topography and its relationship with sound to be considered
- Continuous sounds are much more intrusive than infrequent

- Car sirens/police station/fire station/ambulance – have gotten louder over time.
- Holyhead – port
- Drones - tends to be honeypot sites – nice beaches. Need a licence if over a certain height
- Could include heat pumps and generators that power some wind farms
- Manmade noise may contribute to tranquillity where characteristic, e.g. chugging of canal boat engine
- Agriculture, negative noise of intensive units/industrial farming
- Can hear emergency vehicles more at night and in rural areas
- Factory farming – they are being fed all night long. A lot of animals in a dense space. Not tranquil.
- Non-natural sounds – wind turbines listed but no other infrastructure e.g. substations, battery storage, 'hum'
- Other industry / warehouses can be included too – depends on mapping
- Negative influence of farmsteads, e.g. generator noise – military training areas and game shoots (seasonal)
- Sound of off-road motorbikes using rural routes, sound travels a long way – police database for this type of activity

General notes from both sessions

- Noise is acceptable when appropriate to place; however it can be quite subjective. What one finds annoying, another may not take any notice of it. Seagulls was given as an example.
- No noise was not preferable.
- Acceptability of noise relates to personal interests.
- Suggested factor to consider is whether the noise is constant or unexpected noise.
- Could green barriers be mapped? (natural ones i.e. mountain, rivers).
- Many indicators deemed as being fine although there are many nuances and subtle sounds that ought to be factored in but there is probably not the data available to capture them in the model.
- Interesting one for tranquillity is the rise of wind turbines. Visually intrusive?
- Wind noise as an indicator of tranquillity – use datasets relating to wind? Prevailing wind
- Amount of sound – louder sounds less tranquil – storms, weather, waterfalls – may be exhilarating
- Landform influence on sound – exposure, quarries – data on elevation / landform – also relationship with landscape character
- Quietness recognised as background noise of 20db
- Topography creates areas of silence, or may exacerbate noise. How to recognise this?
- Positive factors: clouds passing by, gliders, birds gliding – conflict with vehicles, off-roading – 28 days rule allows off-roading without planning consent – camping quiet vs. caravan parks more noisy
- Wind direction influences noise. You don't need much wind speed to shift the balance of how you hear things. Particularly in rural/coastal areas. Prevailing wind is less temporal.
- Temporal and meteorological factors are being mentioned frequently.
- Peri-urban and semi-rural (there is no sharp divide). Conflicts are greatest here.

- 6db for doubling from point source
- 3db from linear source – drop off
- Perception and expectation in urban vs rural
- The effects of vegetation on the perception of traffic noise Greg Watts, Linda Chinn, Nigel Godfrey Applied Acoustics 56 (1999) 39-56
- The lack of other sounds can make sounds more disruptive
- Low pitch / high pitch
- Prominence of sound, what frequencies are most prominent.
- Surface temperature affects distance sound travels
- Climate change could result in more tranquil areas as a result of loss of species – may need to update in future
- Different context in urban/rural, relative importance of sounds

Appendix 2 Full Results of NRW Operational Areas Analysis

Percentage of NRW Operational Area in each category

Name	1	2	3	4	5	6	7	8	9	10
Mid Wales	0.00	0.00	0.00	0.23	0.72	43.37	44.98	9.68	0.93	0.10
North East Wales	0.00	0.27	0.20	3.74	4.49	40.68	39.89	7.00	3.12	0.60
North West Wales	0.00	0.00	0.01	0.69	1.45	27.62	51.04	14.67	3.67	0.85
South East Wales	0.00	0.02	0.41	5.48	5.11	43.49	33.08	7.67	4.10	0.65
South Wales Central	0.05	0.52	0.45	10.26	10.27	37.98	30.75	7.72	1.85	0.16
South West Wales	0.00	0.02	0.11	2.22	2.62	48.48	33.46	8.66	3.44	0.99

Area (km^2) of NRW Operational Area in each category

Name	1	2	3	4	5	6	7	8	9	10
Mid Wales	0.00	0.00	0.06	15.82	50.43	3,036.48	3,148.84	677.66	64.89	6.92
North East Wales	0.05	5.01	3.71	68.74	82.58	747.99	733.34	128.75	57.30	11.08
North West Wales	0.00	0.00	0.37	31.42	65.40	1,249.51	2,308.75	663.78	165.87	38.33
South East Wales	0.00	0.32	6.56	88.55	82.51	702.77	534.56	123.96	66.20	10.44
South Wales Central	0.60	6.64	5.70	131.31	131.50	486.11	393.66	98.77	23.67	2.07
South West Wales	0.00	1.07	5.40	110.28	129.86	2,404.96	1,659.81	429.71	170.45	49.17

Appendix 3 Full Results of Designated Landscapes Analysis

Percentage of National Parks in each category

Name	1	2	3	4	5	6	7	8	9	10
Arfordir Sir Benfro - Pembrokeshire Coast	0.00	0.00	0.00	0.28	0.66	40.68	41.13	9.83	6.18	1.24
Bannau Brycheiniog - Brecon Beacons	0.00	0.00	0.00	0.22	0.25	29.90	56.60	12.22	0.81	0.00
Eryri	0.00	0.00	0.00	0.05	0.53	10.84	67.15	18.77	2.36	0.30

Area (km^2) of National Parks in each category

Name	1	2	3	4	5	6	7	8	9	10
Arfordir Sir Benfro - Pembrokeshire Coast	0.00	0.00	0.00	1.73	4.03	248.10	250.84	59.93	37.72	7.56
Bannau Brycheiniog - Brecon Beacons	0.00	0.00	0.00	2.99	3.37	403.73	764.24	165.03	10.89	0.00
Eryri	0.00	0.00	0.00	1.06	11.44	231.98	1,436.55	401.49	50.45	6.36

Percentage of AONBs in each category

Name	1	2	3	4	5	6	7	8	9	10
Bryniau Clwyd A Dyffryn Dyfrdwy - Clwydian Range And Dee Valley	0.00	0.00	0.01	0.19	1.01	36.81	55.32	6.41	0.23	0.00
Dyffryn Gŵy - Wye Valley	0.00	0.00	0.00	0.01	0.06	54.35	35.28	7.39	1.91	1.00
Gŵyr - Gower	0.00	0.00	0.00	0.37	3.86	7.11	49.91	12.13	20.85	5.77
Llŷn	0.00	0.00	0.00	0.00	0.29	43.45	38.75	10.06	6.98	0.47
Ynys Môn - Anglesey	0.00	0.00	0.00	0.17	1.05	30.81	35.10	14.35	14.32	4.21

Area (km^2) of AONBs in each category

Name	1	2	3	4	5	6	7	8	9	10
Bryniau Clwyd A Dyffryn Dyfrdwy - Clwydian Range And Dee Valley	0.00	0.00	0.05	0.76	3.95	143.32	215.38	24.95	0.91	0.00
Dyffryn Gŵy - Wye Valley	0.00	0.00	0.00	0.02	0.07	63.71	41.36	8.66	2.24	1.18
Gŵyr - Gower	0.00	0.00	0.01	0.69	7.19	13.26	93.02	22.60	38.86	10.75
Llŷn	0.00	0.00	0.00	0.00	0.46	69.41	61.90	16.07	11.16	0.75
Ynys Môn - Anglesey	0.00	0.00	0.00	0.38	2.30	67.62	77.02	31.50	31.42	9.24

Appendix 4 Full Results of National Landscape Character Areas Analysis

Percentage of National Landscape Character Areas in each category

Name	1	2	3	4	5	6	7	8	9	10
Aber Afonydd Taf, Tywi a Gwendraeth - Taf, Tywi and Gwendraeth Estuaries	0.00	0.00	0.01	0.34	3.06	23.61	44.77	20.78	5.83	1.60
Arfon	0.00	0.00	0.00	2.25	4.27	14.15	57.10	20.24	1.70	0.30
Arfordir Ceredigion - Ceredigion Coast	0.00	0.00	0.00	0.03	2.39	66.09	22.96	5.60	2.72	0.20
Arfordir Colwyn a'r Gogledd - Colwyn and Northern Coastline	0.00	0.00	0.21	13.23	10.15	43.77	23.12	7.19	2.26	0.07
Arfordir De Sir Benfro - South Pembrokeshire Coast	0.00	0.00	0.00	1.05	1.12	54.63	32.13	7.93	2.92	0.22
Arfordir Gorllewin a Gogledd Sir Benfro - West and North Pembrokeshire Coast	0.00	0.00	0.00	0.55	0.43	46.82	39.69	8.59	3.63	0.27
Arfordir Môn - Anglesey Coast	0.00	0.00	0.01	1.32	2.95	46.18	33.05	12.27	3.47	0.75
Bae Abertawe - Swansea Bay	0.00	0.34	1.23	25.61	13.70	28.20	17.91	9.46	2.58	0.95

Name	1	2	3	4	5	6	7	8	9	10
Bae Tremadog - Tremadoc Bay	0.00	0.00	0.00	0.67	4.36	48.62	29.89	12.65	3.23	0.58
Bannau Brycheiniog a'r Mynyddoedd Du - Brecon Beacons and the Black Mountains	0.00	0.00	0.00	0.07	0.11	23.17	62.88	12.86	0.91	0.00
Bro Morgannwg - Vale of Glamorgan	0.01	1.30	0.27	6.21	9.18	51.40	24.62	6.46	0.46	0.09
Bryniau a Dyffrynnoedd Trefaldwyn - Montgomeryshire Hills and Vales	0.00	0.00	0.00	0.00	0.43	61.82	29.38	8.35	0.02	0.00
Bryniau Clwyd - Clwydian Range	0.00	0.00	0.10	0.67	3.12	46.03	44.97	4.99	0.14	0.00
Bryniau Maesyfed - Radnorshire Hills	0.00	0.00	0.00	0.08	0.33	46.72	45.05	7.64	0.18	0.00
Bryniau Preseli - Preseli Hills	0.00	0.00	0.00	0.00	0.06	39.22	52.58	8.00	0.14	0.00
Bryniau Rhos - Rhos Hills	0.00	0.00	0.00	0.17	0.86	69.48	23.80	5.68	0.00	0.00
Bryniau Sir Amwythig (rhan) - Shropshire Hills (part)	0.00	0.00	0.00	0.01	0.58	61.55	32.51	5.22	0.12	0.00
Canolbarth Môn - Central Anglesey	0.00	0.00	0.05	0.54	3.25	66.75	20.93	7.44	1.05	0.00
Canolbarth Mynwy - Central Monmouthshire	0.00	0.00	0.00	0.68	0.59	61.58	27.88	8.27	0.83	0.18

Name	1	2	3	4	5	6	7	8	9	10
Casnewydd, Caerdydd a'r Barri - Newport, Cardiff and Barry	0.22	0.50	1.29	36.23	17.74	22.16	15.81	5.01	0.75	0.29
Ceredigion	0.00	0.00	0.00	0.00	1.11	75.65	18.00	5.24	0.00	0.00
Dyffryn Clwyd - Vale of Clwyd	0.00	0.00	0.07	2.35	1.76	64.65	24.14	7.02	0.01	0.00
Dyffryn Conwy - Conway Valley	0.00	0.00	0.00	1.08	2.25	7.56	64.09	18.46	4.53	2.04
Dyffryn Dyfrdwy a Llangollen - Llangollen and the Vale of Dee	0.00	0.00	0.00	0.31	0.75	33.33	52.30	13.24	0.07	0.00
Dyffryn Gŵy a Choed Gwent - Wye Valley and Wentwood	0.00	0.00	0.00	1.15	0.92	53.88	36.70	5.78	1.05	0.51
Dyffryn Hafren - Severn Valley	0.00	0.00	0.02	1.85	4.02	41.57	38.63	13.91	0.00	0.00
Dyffryn Tefi - Teifi Valley	0.00	0.00	0.01	0.46	0.83	62.22	26.38	9.23	0.72	0.14
Dyffryn Tywi - Tywi Valley	0.00	0.00	0.12	1.78	1.32	54.59	30.75	10.76	0.45	0.23
Dyffrynnoedd a Bryniau Rheidol ac Ystwyth - Rheidol and Ystwyth Hills and Valleys	0.00	0.00	0.00	0.98	2.52	66.23	23.71	6.03	0.47	0.06
Dyffrynnoedd Gwendraeth - Gwendraeth Vales	0.00	0.00	0.00	0.20	1.88	59.85	28.64	9.02	0.41	0.00
Dyffrynnoedd Gwy a Gwysg -	0.00	0.00	0.00	0.87	0.86	60.30	29.13	8.10	0.75	0.00

Name	1	2	3	4	5	6	7	8	9	10
Wye and Usk Vales										
Dyffrynnoedd Taf a'r Cleddau - Taf and Cleddau Vales	0.00	0.00	0.00	0.78	1.74	70.31	21.80	5.18	0.19	0.00
Dyffrynnoedd y De - South Wales Valleys	0.00	0.00	0.31	5.29	7.85	35.26	41.36	9.41	0.53	0.00
Eryri	0.00	0.00	0.00	0.05	0.27	10.87	68.54	18.44	1.78	0.06
Ffynhonnau Durol Canolbarth Cymru - The Spas and Wells of Central Wales	0.00	0.00	0.00	0.83	0.80	59.97	28.97	9.30	0.13	0.00
Glannau Aberdyfi - Aberdovey Coast	0.00	0.00	0.00	1.65	4.05	33.00	35.68	16.35	7.08	2.19
Glannau Dyfrdwy a Wrecsam - Deeside and Wrexham	0.01	1.20	0.71	12.65	12.20	36.85	27.62	7.14	1.21	0.40
Gwastadeddau Gwent - Gwent Levels	0.00	0.21	1.83	8.93	10.68	28.15	34.43	10.78	3.43	1.54
Gŵyr - Gower	0.00	0.00	0.00	1.28	5.16	13.27	56.37	13.99	7.24	2.69
Hafan Milffwrdd - Milford Haven	0.00	0.02	0.68	5.41	10.77	47.49	24.91	7.16	2.74	0.82
Llŷn	0.00	0.00	0.00	0.00	0.28	56.77	32.22	7.91	2.59	0.22
Lwyfandir a Dyffrynnoedd Epynt - Epynt Plateau and Valleys	0.00	0.00	0.00	0.00	0.01	37.44	51.19	11.13	0.24	0.00

Name	1	2	3	4	5	6	7	8	9	10
Maelor Saesneg - Maelor	0.00	0.00	0.00	0.52	2.41	24.76	62.18	9.52	0.61	0.00
Mynydd Hiraethog - Denbigh Moors	0.00	0.00	0.00	0.00	0.53	32.77	54.62	11.47	0.61	0.00
Pen Uchaf Dyffryn Gwy - Upper Wye Valley	0.00	0.00	0.00	0.71	1.04	38.85	49.08	9.90	0.41	0.00
Troedfryniau Penfro a Chaerfyrddin - Pembroke and Carmarthen Foothills	0.00	0.00	0.00	0.00	0.77	70.10	22.77	6.32	0.04	0.00
Uwchdiroedd Cymru - Cambrian Mountains	0.00	0.00	0.00	0.00	0.35	26.32	60.90	11.37	1.06	0.00
Y Berwyn - Berwyn	0.00	0.00	0.00	0.00	0.14	29.66	60.38	7.91	1.90	0.00

Area (km^2) of National Landscape Character Areas in each category

Name	1	2	3	4	5	6	7	8	9	10
Aber Afonydd Taf, Tywi a Gwendraeth - Taf, Tywi and Gwendraeth Estuaries	0.00	0.00	0.02	0.45	4.11	31.74	60.19	27.94	7.84	2.15
Arfon	0.00	0.00	0.00	5.55	10.53	34.89	140.80	49.91	4.19	0.75
Arfordir Ceredigion - Ceredigion Coast	0.00	0.00	0.01	0.07	4.90	135.36	47.03	11.47	5.57	0.41

Name	1	2	3	4	5	6	7	8	9	10
Arfordir Colwyn a'r Gogledd - Colwyn and Northern Coastline	0.00	0.00	0.35	22.13	16.99	73.25	38.69	12.03	3.78	0.11
Arfordir De Sir Benfro - South Pembrokeshire Coast	0.00	0.00	0.00	1.24	1.31	64.00	37.65	9.29	3.42	0.26
Arfordir Gorllewin a Gogledd Sir Benfro - West and North Pembrokeshire Coast	0.00	0.00	0.00	1.52	1.20	129.54	109.81	23.77	10.06	0.75
Arfordir Môn - Anglesey Coast	0.00	0.00	0.04	4.80	10.71	167.65	119.99	44.54	12.60	2.72
Bae Abertawe - Swansea Bay	0.00	1.02	3.70	76.86	41.11	84.63	53.76	28.40	7.76	2.86
Bae Tremadog - Tremadoc Bay	0.00	0.00	0.00	1.68	10.95	122.06	75.03	31.76	8.12	1.45
Bannau Brycheiniog a'r Mynyddoedd Du - Brecon Beacons and the Black Mountains	0.00	0.00	0.00	0.71	1.17	248.65	674.64	138.01	9.79	0.00
Bro Morgannwg - Vale of Glamorgan	0.02	5.23	1.10	24.90	36.81	206.13	98.72	25.92	1.83	0.35
Bryniau a Dyffrynnoedd Trefaldwyn - Montgomeryshire Hills and Vales	0.00	0.00	0.00	0.02	2.38	343.46	163.22	46.37	0.13	0.00

Name	1	2	3	4	5	6	7	8	9	10
Bryniau Clwyd - Clwydian Range	0.00	0.00	0.43	2.97	13.87	204.87	200.14	22.20	0.64	0.00
Bryniau Maesyfed - Radnorshire Hills	0.00	0.00	0.00	0.85	3.64	514.23	495.79	84.09	2.00	0.00
Bryniau Preseli - Preseli Hills	0.00	0.00	0.00	0.00	0.15	95.47	128.00	19.48	0.34	0.00
Bryniau Rhos - Rhos Hills	0.00	0.00	0.00	0.56	2.77	223.89	76.71	18.32	0.00	0.00
Bryniau Sir Amwythig (rhan) - Shropshire Hills (part)	0.00	0.00	0.00	0.01	0.64	67.03	35.40	5.69	0.13	0.00
Canolbarth Môn - Central Anglesey	0.00	0.00	0.17	1.88	11.34	232.88	73.03	25.95	3.66	0.00
Canolbarth Mynwy - Central Monmouthshire	0.00	0.00	0.00	3.24	2.84	294.66	133.37	39.57	3.95	0.84
Casnewydd, Caerdydd a'r Barri - Newport, Cardiff and Barry	0.58	1.34	3.45	96.73	47.37	59.17	42.20	13.38	2.00	0.78
Ceredigion	0.00	0.00	0.00	0.01	5.74	391.87	93.24	27.15	0.00	0.00
Dyffryn Clwyd - Vale of Clwyd	0.00	0.00	0.10	3.57	2.67	98.01	36.60	10.65	0.02	0.00
Dyffryn Conwy - Conway Valley	0.00	0.00	0.00	0.95	1.98	6.65	56.40	16.24	3.99	1.79
Dyffryn Dyfrdwy a Llangollen - Llangollen and the Vale of Dee	0.00	0.00	0.00	0.36	0.86	38.46	60.35	15.28	0.09	0.00

Name	1	2	3	4	5	6	7	8	9	10
Dyffryn Gŵy a Choed Gwent - Wye Valley and Wentwood	0.00	0.00	0.01	2.68	2.15	125.25	85.32	13.44	2.45	1.19
Dyffryn Hafren - Severn Valley	0.00	0.00	0.04	3.79	8.21	84.89	78.88	28.40	0.00	0.00
Dyffryn Tefi - Teifi Valley	0.00	0.00	0.05	1.71	3.09	231.18	98.02	34.30	2.67	0.52
Dyffryn Tywi - Tywi Valley	0.00	0.00	0.30	4.36	3.22	133.46	75.18	26.31	1.11	0.56
Dyffrynnoedd a Bryniau Rheidol ac Ystwyth - Rheidol and Ystwyth Hills and Valleys	0.00	0.00	0.00	2.54	6.51	171.02	61.22	15.57	1.21	0.15
Dyffrynnoedd Gwendraeth - Gwendraeth Vales	0.00	0.00	0.01	0.91	8.31	265.14	126.88	39.94	1.81	0.00
Dyffrynnoedd Gwy a Gwysg - Wye and Usk Vales	0.00	0.00	0.00	2.28	2.25	158.26	76.44	21.25	1.96	0.00
Dyffrynnoedd Taf a'r Cleddau - Taf and Cleddau Vales	0.00	0.00	0.01	7.25	16.17	654.03	202.78	48.17	1.75	0.00
Dyffrynnoedd y De - South Wales Valleys	0.00	0.02	4.95	83.30	123.63	555.49	651.62	148.22	8.35	0.00
Eryri	0.00	0.00	0.01	1.11	5.77	234.16	1,476.77	397.26	38.30	1.30
Ffynhonnau Durol Canolbarth Cymru - The	0.00	0.00	0.01	2.18	2.10	157.45	76.07	24.40	0.34	0.00

Name	1	2	3	4	5	6	7	8	9	10
Spas and Wells of Central Wales										
Glannau Aberdyfi - Aberdovey Coast	0.00	0.00	0.01	1.74	4.25	34.65	37.46	17.17	7.44	2.30
Glannau Dyfrdwy a Wrecsam - Deeside and Wrexham	0.05	5.01	2.97	52.74	50.86	153.59	115.12	29.76	5.04	1.66
Gwastadeddau Gwent - Gwent Levels	0.00	0.28	2.43	11.86	14.20	37.41	45.74	14.33	4.56	2.05
Gŵyr - Gower	0.00	0.00	0.01	2.26	9.08	23.34	99.15	24.60	12.74	4.73
Hafan Milffwrdd - Milford Haven	0.00	0.05	1.55	12.31	24.49	107.98	56.65	16.28	6.23	1.88
Llŷn	0.00	0.00	0.00	0.01	0.66	135.50	76.89	18.89	6.19	0.53
Lwyfandir a Dyffrynnoedd Epynt - Epynt Plateau and Valleys	0.00	0.00	0.00	0.00	0.05	151.51	207.16	45.03	0.97	0.00
Maelor Saesneg - Maelor	0.00	0.00	0.00	0.92	4.24	43.53	109.32	16.73	1.07	0.00
Mynydd Hiraethog - Denbigh Moors	0.00	0.00	0.00	0.00	2.32	143.34	238.92	50.18	2.69	0.00
Pen Uchaf Dyffryn Gwy - Upper Wye Valley	0.00	0.00	0.00	0.49	0.71	26.50	33.48	6.76	0.28	0.00
Troedfryniau Penfro a Chaerfyrddin - Pembroke and	0.00	0.00	0.00	0.01	4.86	441.86	143.51	39.82	0.27	0.00

Name	1	2	3	4	5	6	7	8	9	10
Carmarthen Foothills										
Uwchdiroedd Cymru - Cambrian Mountains	0.00	0.00	0.00	0.09	6.85	517.82	1,198.26	223.72	20.92	0.00
Y Berwyn - Berwyn	0.00	0.00	0.00	0.01	0.80	169.59	345.27	45.25	10.86	0.00

Appendix 5 Full Results of Local Authority Areas Analysis

Percentage of Local Authority Areas in each category

Name	1	2	3	4	5	6	7	8	9	10
Abertawe - Swansea	0.00	0.11	0.50	11.00	6.61	24.50	33.65	9.58	10.44	3.61
Blaenau Gwent - Blaenau Gwent	0.00	0.01	1.32	10.06	10.59	29.50	40.45	7.70	0.36	0.00
Bro Morgannwg - the Vale of Glamorgan	0.01	1.60	0.63	6.83	8.72	47.80	24.29	7.00	2.91	0.22
Caerdydd - Cardiff	0.38	0.79	0.97	33.28	15.31	22.29	16.97	5.46	3.84	0.70
Caerffili - Caerphilly	0.00	0.00	0.71	8.84	9.44	35.43	37.98	7.23	0.35	0.00
Casnewydd - Newport	0.00	0.14	1.29	12.12	9.45	22.52	31.87	8.26	12.46	1.90
Castell-nedd Port Talbot - Neath Port Talbot	0.00	0.00	0.15	4.99	4.99	26.33	46.69	13.03	3.31	0.51
Conwy - Conwy	0.00	0.00	0.01	1.40	1.48	28.45	52.40	12.99	2.68	0.60
Gwynedd - Gwynedd	0.00	0.00	0.00	0.33	1.00	19.85	57.58	16.73	3.74	0.77
Merthyr Tudful - Merthyr Tydfil	0.00	0.00	0.09	7.96	8.20	26.82	44.37	12.47	0.09	0.00
Pen-y-bont ar Ogwr - Bridgend	0.00	0.00	0.25	8.99	8.75	42.73	29.75	7.19	2.23	0.11
Powys - Powys	0.00	0.00	0.00	0.22	0.47	40.49	48.11	10.05	0.65	0.00

Name	1	2	3	4	5	6	7	8	9	10
Rhondda Cynon Taf - Rhondda Cynon Taf	0.00	0.00	0.32	6.26	11.20	35.69	37.77	8.14	0.63	0.00
Sir Benfro - Pembrokeshire	0.00	0.00	0.09	1.33	2.50	56.40	29.78	6.51	2.73	0.65
Sir Ceredigion - Ceredigion	0.00	0.00	0.00	0.23	1.43	51.66	35.96	8.60	1.74	0.38
Sir Ddinbych - Denbighshire	0.00	0.00	0.07	1.52	2.25	46.86	40.90	7.19	1.21	0.00
Sir Fynwy - Monmouthshire	0.00	0.00	0.02	1.44	0.82	54.19	31.18	7.40	4.26	0.71
Sir Gaerfyrddin - Carmarthenshire	0.00	0.02	0.04	0.80	1.56	51.32	33.44	9.15	2.80	0.86
Sir y Fflint - Flintshire	0.01	0.90	0.50	6.31	8.77	40.18	27.05	4.85	9.14	2.30
Sir Ynys Môn - Isle of Anglesey	0.00	0.00	0.03	0.89	2.96	53.48	25.92	10.04	5.18	1.50
Tor-faen - Torfaen	0.00	0.00	0.16	11.09	13.48	34.28	31.43	9.53	0.03	0.00
Wrecsam - Wrexham	0.00	0.12	0.13	4.96	4.10	30.71	50.59	8.78	0.60	0.00

Area (km^2) of Local Authority Areas in each category

Name	1	2	3	4	5	6	7	8	9	10
Abertawe - Swansea	0.00	0.45	2.10	46.28	27.83	103.08	141.58	40.31	43.94	15.20
Blaenau Gwent - Blaenau Gwent	0.00	0.01	1.44	10.94	11.52	32.07	43.97	8.37	0.39	0.00

Name	1	2	3	4	5	6	7	8	9	10
Bro Morgannwg - the Vale of Glamorgan	0.02	5.44	2.14	23.22	29.62	162.40	82.53	23.79	9.90	0.73
Caerdydd - Cardiff	0.58	1.18	1.45	49.73	22.88	33.32	25.37	8.17	5.74	1.05
Caerffili - Caerphilly	0.00	0.00	1.98	24.54	26.19	98.29	105.36	20.07	0.97	0.00
Casnewydd - Newport	0.00	0.31	2.80	26.36	20.55	48.98	69.30	17.97	27.10	4.12
Castell-nedd Port Talbot - Neath Port Talbot	0.00	0.00	0.66	22.53	22.56	118.99	210.96	58.88	14.98	2.32
Conwy - Conwy	0.00	0.00	0.14	16.17	17.05	328.08	604.32	149.84	30.86	6.88
Gwynedd - Gwynedd	0.00	0.00	0.02	8.55	26.18	520.68	1,510.35	438.74	98.09	20.32
Merthyr Tudful - Merthyr Tydfil	0.00	0.00	0.11	8.91	9.18	30.03	49.68	13.96	0.11	0.00
Pen-y-bont ar Ogwr - Bridgend	0.00	0.01	0.65	22.92	22.32	109.02	75.89	18.34	5.68	0.28
Powys - Powys	0.00	0.00	0.05	11.68	24.58	2,103.55	2,499.35	522.31	33.76	0.20
Rhondda Cynon Taf - Rhondda Cynon Taf	0.00	0.01	1.36	26.53	47.50	151.36	160.20	34.51	2.66	0.00
Sir Benfro - Pembrokeshire	0.00	0.05	1.55	21.90	41.32	931.25	491.80	107.48	45.15	10.70
Sir Ceredigion - Ceredigion	0.00	0.00	0.01	4.15	25.85	932.93	649.48	155.38	31.36	6.90

Name	1	2	3	4	5	6	7	8	9	10
Sir Ddinbych - Denbighshire	0.00	0.00	0.57	12.88	19.02	396.62	346.13	60.85	10.28	0.03
Sir Fynwy - Monmouthshire	0.00	0.00	0.14	12.72	7.22	480.16	276.25	65.53	37.72	6.32
Sir Gaerfyrddin - Carmarthenshire	0.00	0.58	1.09	19.57	38.15	1,251.64	815.50	223.06	68.38	20.89
Sir y Fflint - Flintshire	0.05	4.39	2.47	30.87	42.91	196.67	132.40	23.75	44.76	11.27
Sir Ynys Môn - Isle of Anglesey	0.00	0.00	0.21	6.70	22.18	400.77	194.24	75.26	38.82	11.25
Tor-faen - Torfaen	0.00	0.00	0.21	14.00	17.02	43.27	39.68	12.03	0.04	0.00
Wrecsam - Wrexham	0.00	0.61	0.67	24.99	20.65	154.71	254.82	44.24	3.03	0.00

Appendix 6 Full Results of the 4 regions of Future Wales Analysis

Percentage of the 4 regions of Future Wales in each category

Name	1	2	3	4	5	6	7	8	9	10
Mid Wales	0.00	0.00	0.00	0.23	0.72	43.47	45.08	9.70	0.77	0.03
North	0.00	0.08	0.07	1.62	2.40	32.34	49.19	12.68	1.46	0.16
South East	0.02	0.25	0.44	7.81	7.59	42.24	32.91	7.84	0.74	0.16
South West	0.00	0.02	0.11	2.29	2.69	49.97	34.47	8.85	1.33	0.26

Area (km^2) of the 4 regions of Future Wales in each category

Name	1	2	3	4	5	6	7	8	9	10
Mid Wales	0.00	0.00	0.06	15.82	50.43	3,036.44	3,148.62	677.38	53.53	2.20
North	0.05	5.01	4.08	100.15	147.94	1,997.30	3,037.71	782.90	90.24	10.07
South East	0.60	6.96	12.26	219.77	213.59	1,188.54	925.94	220.72	20.80	4.36
South West	0.00	1.07	5.40	110.27	129.67	2,404.79	1,658.89	425.98	64.07	12.46

Data Archive Appendix

Data outputs associated with this project are archived in NRW DMS (LANDMAP) for report, maps, images and GIS Services for GIS on server–based storage at Natural Resources Wales.

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] A full set of maps produced in JPEG and PDF format.

[C] A set of raster files in ESRI format.

[D] An Excel spreadsheet containing the zonal statistics analysis.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue https://libcat.naturalresources.wales (English Version) and https://catllyfr.cyfoethnaturiol.cymru (Welsh Version) by searching 'Dataset Titles'.

Further copies of this report are available from library@cyfoethnaturiolcymru.gov.uk