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Llywodraeth Cymru Welsh Government

Welsh Index of Multiple Deprivation 2014 (WIMD 2014)

Technical Report

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1. Introduction

The Welsh Index of Multiple Deprivation (WIMD) is the Welsh Government's official measure of relative deprivation for small areas in Wales. It is designed to identify those small areas where there are the highest concentrations of several different types of deprivation in Wales, so that funding, policy and programmes can be effectively focussed on the most disadvantaged communities.

This Technical Report describes how WIMD 2014 was constructed and contains a full list of indicators and information about the indicators.

WIMD is a measure of multiple deprivation that is both an area-based measure and a measure of relative deprivation. These key terms are defined more fully below.

WIMD is currently made up of eight separate domains (or types) of deprivation. Each domain (listed below) is compiled from a range of different indicators.

- Income
- Employment
- Health
- Education
- Access to Services
- Community Safety
- Physical Environment
- Housing

Deprivation is the lack of access to opportunities and resources which we might expect in our society. The domains listed above relate to both material and social aspects of deprivation. Material deprivation is having insufficient physical resources – food, shelter, and clothing – necessary to sustain a certain standard of life. Social deprivation refers to the ability of an individual to participate in the normal social life of the community.

Multiple Deprivation refers to more than one type of deprivation. An area is multiply deprived if, for more than one of these domains, the area has a concentration of people experiencing that type of deprivation. Generally speaking, the greater the number of domains for which there are high concentrations of deprivation then the greater the overall deprivation in an area. This does not necessarily mean that the *same* people suffer multiple types of deprivation in the area, although we would expect there to be significant overlap.

Area-based measure*:* WIMD is calculated for all Lower layer Super Output Areas (LSOAs) in Wales. Following the 2011 Census, 1,909 LSOAs were defined in Wales and they have an average population of 1,600 people. Further information on LSOAs is provided in Section 3, including information on their revision following the 2011 Census. WIMD is based on indicators that consider the aggregate characteristics of the people living in the area as well as, in some cases, the characteristics of the area itself (e.g. the Physical Environment domain).

Relative measure**:** The Index provides a way of identifying areas in the order of least to most deprived. It does not provide a measure of the level of deprivation in an area, but rather whether an area is more or less deprived relative to all other areas in Wales. We can identify which areas are more (or less) deprived than others, but not by how much. The reason for taking such an approach is that this allows the different domains to be combined together.

Index**:** An index is a group of separate measurements which are combined into a single number. It is designed to show changes in a complicated variable, such as industrial output, prices or, as in this case, deprivation. An index then allows comparisons between different values – in the case of WIMD, the comparison is between LSOAs.

2. How the Index is Constructed

The Index has three main components:

- The Index itself, which is a set of ranks;
- The ranks of the eight types of deprivation, or domains, from which the Overall Index is constructed; and
- The underlying indicators, which are directly measurable, and which are combined to create the domain ranks. Many, but not all, of the indicators are produced as rates. The units depend on what is being measured.

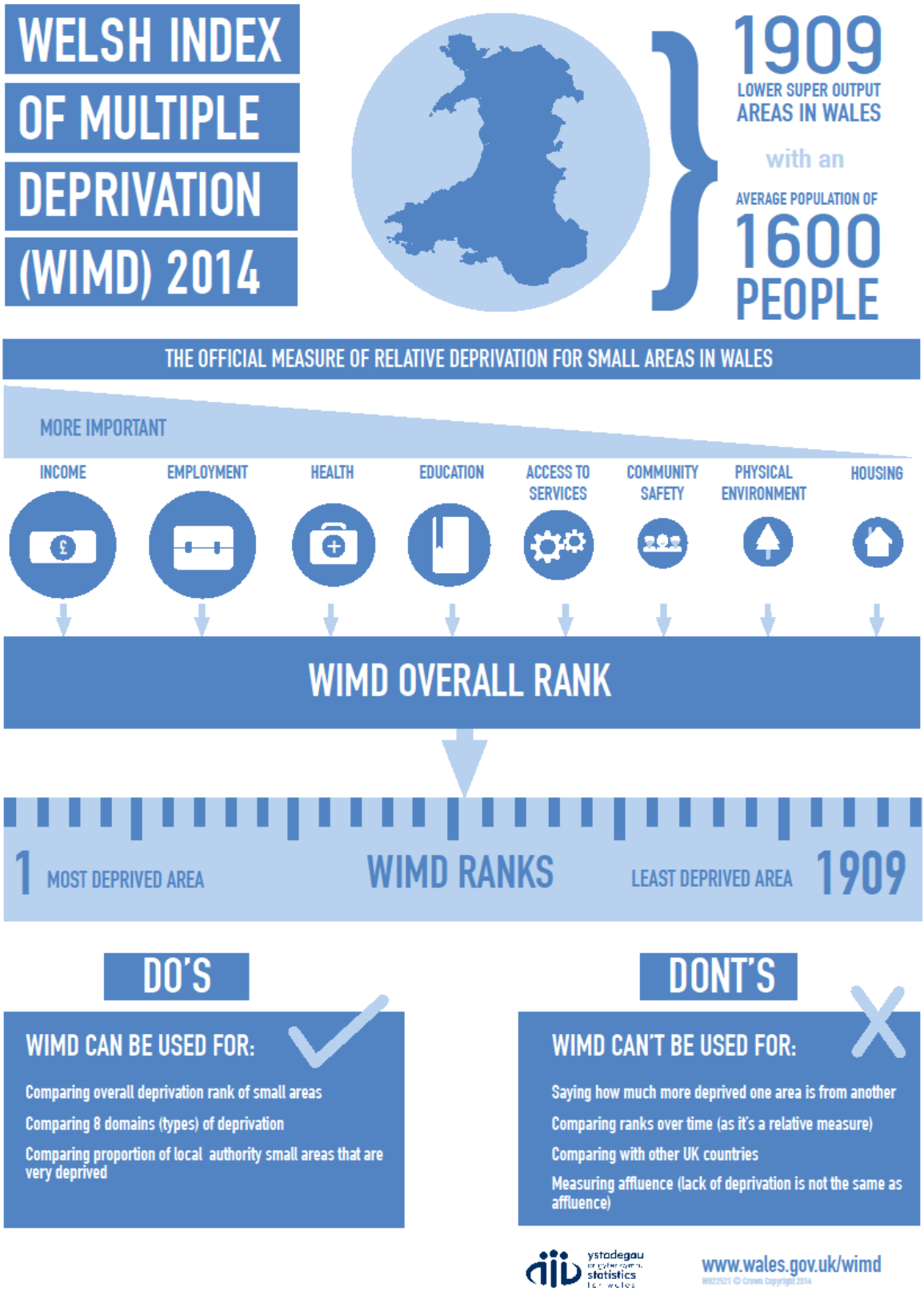
All of these components are calculated for each of the LSOAs in Wales. The overall 2014 WIMD ranks and the ranks of the eight domains of deprivation are published on the StatsWales website (www.statswales.wales.gov.uk). Where available, the underlying indicator data is now published annually on StatsWales.

The Index is constructed from a weighted sum of the deprivation score for each domain. The weights reflect the importance of the domain as an aspect of deprivation, and the quality of the indicators available for that domain. The domain weights for WIMD 2014 are:

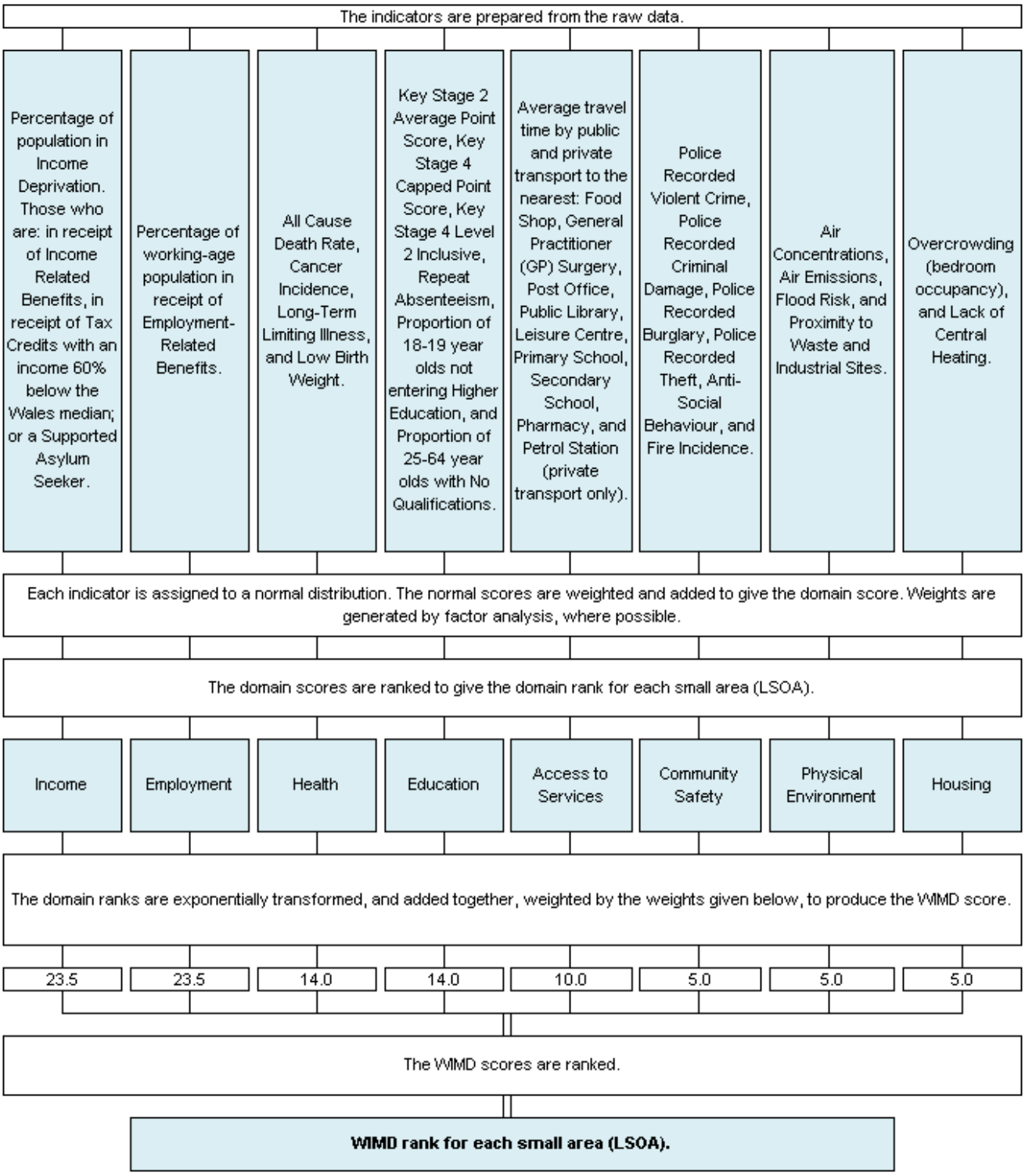
Income	23.5%
Employment	23.5%
Health	14.0%
Education	14.0%
Access to Services	10.0%
Community Safety	5.0%
Physical Environment	5.0%
Housing	5.0%

The overall methodology used within WIMD 2014 is the same as used for WIMD 2011. The domains have also stayed the same. There have been a small number of changes to individual indicators (or the inclusion of new indicators) within the Income, Education, Access to Services, Community Safety, Physical Environment and Housing domains, as well as some technical changes to some of the individual domains.

The following infographic provides a non-technical overview of how WIMD is calculated.



An overview of the construction of the Index is given in the diagram below.



The domains are built up from sets of indicators; these are measurable quantities which capture the concept of deprivation for each domain (e.g. the percentage of working age people in receipt of employment-related benefits for the employment domain; Key Stage scores in the education domain; all cause death rate in the health domain, etc). Indicators must be robust at the small area level and consistent across Wales. Not all indicators are measured in the same units. In practice, this means that the Index is based largely on administrative data, with a limited number of Census variables where appropriate administrative data are not available.

Weightings for indicators within domains are derived by using factor analysis where appropriate (for the Education, Health, Access to Services and Community Safety domains). A detailed explanation of the factor analysis process is given in Annex A.

As part of the process for calculating the WIMD overall and domain ranks, scores (domain and overall) are produced. The WIMD scores are a stage in the construction of the Index and not a product. The scores do not represent a level of multiple deprivation (e.g. if area A has twice the score of area B, this does not necessarily mean that area A is twice as deprived as area B). This means that scores do not contain any more information on levels of multiple deprivation than the ranks do. To assess levels of deprivation, underlying indicator data must be used.

The WIMD scores are published for two reasons only:

- for transparency (so that users have access to all stages of construction); and
- so that users can experiment with different weighting systems for the Index, if required.

The domain scores are published at Annex B.

Deprivation Groups

WIMD rankings are often grouped into deciles, quintiles and deprivation groups for analysis and mapping purposes. The decile (and quintile) groupings split the LSOAs into 10 (and 5) roughly equal groups. The deprivation groups are used within the main WIMD publication and maps.

As there are 1,909 LSOAs in Wales, these groups do not have exactly equal numbers of LSOAs within them.

Ranks		Decile Group	Quintile Group	Deprivation group
1 - 191		1 (10% most deprived)	1 (20% most deprived)	1 (10% most deprived)
192 - 382		2 (10-20% most deprived)	1 (20% most deprived)	2 (10-20% most deprived)
383 - 573		3 (20-30% most deprived)	2 (20-40% most deprived)	3 (20-30% most deprived)
574 - 764		4 (30-40% most deprived)	2 (20-40% most deprived)	4 (30-50% most deprived)
765 - 955		5 (40-50% most deprived)	3 (40-60% most deprived)	4 (30-50% most deprived)
956 - 1146		6 (50-60% most deprived)	3 (40-60% most deprived)	5 (50% least deprived)
1147 - 1337		7 (60-70% most deprived)	4 (60-80% most deprived)	5 (50% least deprived)
1338 - 1528		8 (70-80% most deprived)	4 (60-80% most deprived)	5 (50% least deprived)
1529 - 1719		9 (80-90% most deprived)	5 (20% least deprived)	5 (50% least deprived)
1720 - 1909		10 (10% least deprived)	5 (20% least deprived)	5 (50% least deprived)

3. Geography: Lower layer Super Output Areas

Geographic unit

The geographic areas used in the calculation of WIMD 2014 are the 1,909 Lower layer Super Output Areas (LSOAs). LSOAs were used as the geographic unit in WIMD 2005, 2008 and 2011, and were designed for the reporting of small area statistics.

LSOAs are still a relatively new geography and, as such, data are generally not allocated to an LSOA as part of the collection process as it was the case for the education domain and community safety domain. Therefore, for WIMD 2014, a method of allocating other geographical level data to LSOAs had to be devised. A detailed explanation of how data were allocated to LSOAs is provided in Annex C.

Super Output Areas

Following the 2001 Census of Population, the Office for National Statistics developed a geographic hierarchy called Super Output Areas (SOAs). They were designed to improve the reporting of small area statistics in England and Wales. Where possible, official statistics are published at the SOA geography.

There are three layers of SOA: Lower layer, Middle layer, and Upper layer. This is because disclosure requirements mean that some sets of data can be released for much smaller areas than others. To support a range of potential data requirements, it was decided to create these three SOA layers.

- A Lower layer SOA must have a minimum population of 1,000. The mean size of all the Lower layer SOAs must be close to 1,600. They are built from groups of Census Output Areas (usually between four and six).
- A Middle layer SOA must have a minimum population of 5,000. The mean size of all the Middle layer SOAs must be close to 7,200.

Changes between 2001 Census and 2011 Census

SOA boundaries are revised following each Census, to account for changes in the population. WIMD 2014 will be the first Welsh Index of Multiple Deprivation to use the revised boundaries, following the 2011 Census. In the 2001 Census, there were 1,896 LSOAs; 49 of these have been discontinued and 61 new LSOAs have been created.

There have been changes to LSOA boundaries where populations have:

- become too big, so the LSOA has been split into two or more areas;
- become too small, so the LSOA/MSOA has been merged with an adjacent one; or
- changed in a complex way, so there has been a combination of the two cases above.

In some cases there have also been changes following the Output Geography Consultation, run by the Office for National Statistics in 2010. Where LSOAs have changed, the old code has been deleted and a new code has been assigned. To ensure ease of use, English and Welsh names have been allocated to each of the LSOA codes. Each LSOA name has been determined by the local authority to which the LSOA belongs.

In WIMD 2014, there are 1847 LSOAs with unchanged boundaries since WIMD 2011, 61 LSOAs with boundaries resulting from a merge with or split from an adjacent LSOA, and 12 LSOAs with boundaries resulting from more complex changes (combinations of merges and splits). A summary of LSOA boundary changes is provided in the Annex D.

4. Income Domain

The purpose of this domain is to capture the extent of deprivation relating to income. It focuses on the proportion of people with an income below a defined level.

The income domain has a weighting of 23.5 per cent in WIMD 2014.

Domain construction

The income domain is made up of one indicator, containing three elements:

- Income-Related Benefit claimants
- Tax Credit recipients
- Supported Asylum Seekers

This indicator is expressed as a percentage of the residential population for each LSOA.

Methodological changes

There were no methodological changes in the income domain between WIMD 2011 and WIMD 2014. However, recent changes to the welfare system mean that eligibility thresholds and criteria for some benefits have changed.

Indicator

Publication	WIMD 2014
Indicator Name	The income domain consists of a single composite indicator calculated from the following three elements. a) Income-Related Benefit claimants b) Tax Credit recipients c) Supported Asylum Seekers
Domain	Income domain
Source	a) The Department for Work and Pensions (DWP), Work and Pensions Longitudinal Study (WPLS) b) Her Majesty's Revenue and Customs c) Home Office
Type of Indicator	Percentage
Denominator	LSOA population (Mid-2012 Small Area Population Estimates, ONS)
Time period for WIMD 2014	a) Average of the individuals who were in receipt of these benefits during November 2012, February 2013, May 2013, and August 2013; b) Those in receipt of tax credits at 31st August 2012; c) Those who were supported under Section 95, at 1st September 2014.
Additional Notes	a) Income related benefit claimants, and their dependents. This includes Income Support claimants, Jobseekers Allowance claimants, Pension Credit claimants, and income-related Employment and Support Allowance claimants. b) The number of children and adults within families that are in receipt of Working Tax Credits and Child Tax Credits with an income which is less than 60 per cent of the median income for Wales (Before Housing Costs). c) Supported Asylum Seekers under Section 95, as defined in this document: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/285360/allocating-section95.pdf The above are counts of unique individuals (i.e. those who claim multiple benefits are only counted once). The three elements are summed and expressed as a percentage of the total population for the LSOA.
Comparability with WIMD 2011	Recent changes to the welfare system mean that eligibility thresholds and criteria for some benefits have already, or are about to, change. This means that the indicator data will not be strictly comparable with earlier years.

5. Employment Domain

The purpose of this domain is to capture lack of employment. This covers involuntary exclusion of the working-age population from work, including those who cannot work due to ill-health or who are unemployed, but actively seeking work.

The employment domain has a weighting of 23.5 per cent in WIMD 2014.

Domain construction

The Employment domain contains a single indicator; percentage of working age population in receipt of Employment-Related benefits. This is calculated from a count of individuals (i.e. those who claim multiple benefits are only counted once) entitled to:

- Incapacity Benefit (replaced Severe Disablement Allowance);
- Job Seekers Allowance (JSA);
- Employment and Support Allowance (ESA).

This indicator is expressed as a percentage of the working age population for each LSOA.

Methodological changes

New Deal participants are no longer included in this domain. This programme was replaced by the Work Programme, which requires a participant to be claiming either Job Seekers Allowance or Employment and Support Allowance. Both of these benefits are already included in the indicator. In addition to this, changes to the welfare system mean that eligibility thresholds and criteria for some benefits have changed.

Indicator

Publication	WIMD 2014
Indicator Name	Percentage of working age population in receipt of Employment-Related benefits
Domain	Employment domain
Source	The Department for Work and Pensions (DWP)
Type of Indicator	Percentage
Denominator	Working age population (Mid-2012 Small Area Population Estimates, ONS)
Time period for WIMD 2014	Average of the individuals who were in receipt of these benefits during November 2012, February 2013, May 2013, and August 2013.
Additional Notes	This is calculated from a count of individuals (i.e. those who claim multiple benefits are only counted once) entitled to: - Incapacity benefit (replaced Severe Disablement Allowance); - Job Seekers Allowance (JSA); - Employment and Support Allowance (ESA). This indicator is expressed as a percentage of the working age population for the LSOA.
Comparability with WIMD 2011	Recent changes to the welfare system mean that eligibility thresholds and criteria for some benefits have already, or are about to, change. This means that the indicator data will not be strictly comparable with earlier years.

6. Health Domain

The purpose of this domain is to capture deprivation relating to the lack of good health.

The health domain has a weighting of 14.0 per cent in WIMD 2014.

Domain construction

There are four indicators in the health domain, weighted as follows. Factor analysis was used to calculate the indicator weights.

- 44 per cent Indirectly age-sex standardised rate of people with limiting long-term illness
- 32 per cent Indirectly age-sex standardised death rate
- 13 per cent Indirectly age-sex standardised rate of cancer incidence
- 11 per cent Percentage of live single births less than 2.5 Kg

The indicators were counts of unique individuals (i.e. duplicates were removed), so that indicators could simply be summed and expressed as a percentage of the total population of the LSOA.

An indirect age-sex standardisation process was applied to three of the indicators, in order to adjust for different age and sex distributions amongst LSOA populations. For example, one might expect to observe a higher rate of deaths in an aging population than in one consisting predominantly of young families. Standardisation attempts to adjust for these differences in population (see Annex E).

For every indicator, each LSOA was ranked in order, with the most deprived LSOA ranked 1 and the lowest deprived LSOA ranked 1,909. These ranks were assigned to a normal distribution, with low ranks receiving a low normalised value. As with all domains, the final domain ranks were exponentially transformed, to form domain scores (see Annex F). These domain scores were used in the calculation of the overall WIMD 2014.

Methodological changes

There were no methodological changes in the health domain between WIMD 2011 and WIMD 2014.

Indicators

Publication	WIMD 2014
Indicator Name	Indirectly age-sex standardised rate of people with Limiting Long-Term Illness
Domain	Health domain
Source	2011 Census, Office for National Statistics
Type of Indicator	Standardised rate
Denominator	LSOA population, 2011 Census
Time period for WIMD 2014	2011
Additional Notes	This indicator covers any long-term illness, health problem or disability that limits daily activities or work, and includes all usual residents.
Comparability with WIMD 2011	Not comparable. The technique of indirect standardisation involves using different population structures to calculate each figure. It is not legitimate to make comparisons over time.

Publication	WIMD 2014
Indicator Name	Indirectly age-sex standardised Death Rate
Domain	Health domain
Source	Death registrations, Office for National Statistics
Type of Indicator	Standardised rate
Denominator	LSOA population (Mid-2012 Small Area Population Estimates, ONS)
Time period for WIMD 2014	2004-2013 average
Additional Notes	Poor health can manifest itself in lower life expectancy, which can be captured through age and sex standardised death rates.
Comparability with WIMD 2011	Not comparable. The technique of indirect standardisation involves using different population structures to calculate each figure. It is not legitimate to make comparisons over time.

Publication	WIMD 2014
Indicator Name	Indirectly age-sex standardised rate of Cancer Incidence
Domain	Health domain
Source	Velindre NHS Trust data
Type of Indicator	Standardised rate
Denominator	LSOA population (Mid-2012 Small Area Population Estimates, ONS)
Time period for WIMD 2014	2003-2012 average
Additional Notes	Count of all cases of cancer includes all malignancies, excluding non-melanoma skin cancer.
Comparability with WIMD 2011	Not comparable. The technique of indirect standardisation involves using different population structures to calculate each figure. It is not legitimate to make comparisons over time.

Publication	WIMD 2014
Indicator Name	Percentage of singleton live births less than 2.5 Kg
Domain	Health domain
Source	Birth registrations, Office for National Statistics
Type of Indicator	Percentage
Denominator	Number of singleton live births
Time period for WIMD 2014	2004-2013 average
Additional Notes	A birth weight less than 2.5 Kg is classified as a low birth weight. This can be linked to the mother's lifestyle and health as well as cause problems for the child in later life.
Comparability with WIMD 2011	Comparable

7. Education Domain

The purpose of this domain is to capture the extent of deprivation relating to education, training and skills. It is designed to reflect educational disadvantage within an area in terms of lack of qualifications and skills.

The education domain has a weighting of 14.0 per cent in WIMD 2014.

Domain construction

There are six indicators in the education domain, weighted as follows. Factor analysis was used to calculate the indicator weights.

- 25 per cent Key Stage 4 Level 2 Inclusive
- 21 per cent Key Stage 4 Capped Point Score
- 7 per cent Key Stage 2 Average Point Score
- 17 per cent Proportion of people aged 18-19 not entering Higher Education
- 16 per cent Number of Adults aged 25-64 with No Qualifications
- 15 per cent Repeat Absenteeism

For every indicator, each LSOA was ranked in order, with the most deprived LSOA ranked 1 and the lowest deprived LSOA ranked 1,909. These ranks were assigned to a normal distribution, with low ranks receiving a low normalised value. As with all domains, the final domain ranks were exponentially transformed, to form domain scores (see Annex F). These domain scores were used in the calculation of the overall WIMD 2014.

Methodological changes

There have been several methodological changes to the indicators since WIMD 2011. A full list of the changes is outlined below.

Three of the six indicators in the WIMD 2014 education domain were present in WIMD 2011:

- Key Stage 2 Average Point Score
- Proportion of people aged 18-19 not entering Higher Education
- Number of Adults aged 25-64 with No Qualifications

Of these, the age specification of the adults with no qualifications indicator has changed slightly, since the retirement age for women has been increased from 59 to 64 years old. The other two indicators remained unchanged.

The Key Stage 3 indicator included WIMD 2011 has been removed. The Key Stage 4 Average Wider Point Score indicator has been replaced by the two Key Stage 4 indicators included in WIMD 2014.

The two absenteeism indicators included in WIMD 2011 have been replaced with a single indicator on Repeat Absenteeism that covers both primary and secondary absenteeism. This indicator has been constructed using a new methodology and is, therefore, not comparable with the previous indicators used in WIMD 2011.

Indicators

Publication	WIMD 2014
Indicator Name	Key Stage 4 Level 2 Inclusive
Domain	Education domain
Source	Pupil Level Annual School Census (PLASC) and Welsh Examinations Database (WED)
Type of Indicator	Percentage
Denominator	Total number of KS4 students
Time period for WIMD 2014	Three year average for Academic Years 2010/11 - 2012/13
Additional Notes	This is a new indicator and is intended to complement the Key Stage 4 Capped Points Score indicator. It measures the proportion of 15 year olds achieving the equivalent of 5 A*-C grades at GCSE (including Mathematics and English/Welsh). This indicator is included as a measure of pupils completing compulsory school education with adequate numeracy and literacy skills, and only includes maintained schools. The Level 2 Inclusive and Capped Point Score indicators replaced the Key Stage 4 Wider Point Score (used for WIMD 2011), as they measure complementary aspects of educational deprivation at the end of compulsory education.
Comparability with WIMD 2011	Not comparable – new indicator.

Publication	WIMD 2014
Indicator Name	Key Stage 4 Capped Point Score
Domain	Education domain
Source	Pupil Level Annual School Census (PLASC) and Welsh Examinations Database (WED)
Type of Indicator	Capped Point Score
Denominator	Total number of KS4 students
Time period for WIMD 2014	Three year average for Academic Years 2010/11 - 2012/13
Additional Notes	This is a slight change to the WIMD 2011 indicator, which was Key Stage 4 Average Wider Point Score. The Capped Point Score is the average points per 15 year old for all qualifications at all grades achieved, up to the equivalent of 8 GCSEs (i.e. the 'best 8 GCSEs or equivalent'). All GCSEs and vocational qualifications approved pre-16 are included. This indicator captures attainment across all abilities, and only includes maintained schools. A Capped Point Score is used as this minimises the impact of school policy on the number of qualification entries. The Level 2 Inclusive and Capped Point Score indicators have replaced the Key Stage 4 Wider Points Score as they measure complementary aspects of educational deprivation at the end of compulsory education. More information on the KS4 point scoring system can be found at: http://wales.gov.uk/statistics-and-research/examination-results/?lang=en#/statistics-and-research/examination-results/?tab=previous&lang=en.
Comparability with WIMD 2011	Not comparable – new indicator.

Publication	WIMD 2014
Indicator Name	Key Stage 2 Average Point Score
Domain	Education domain
Source	National Pupil Database (NPD), Pupil Level Annual School Census (PLASC) and National Data Collection (NDC)
Type of Indicator	Points score
Denominator	Total number of KS2 students
Time period for WIMD 2014	Three year average for Academic Years: 2010/11 - 2012/13
Additional Notes	Average point scores for pupils are assessed by teachers in Year 6 (final year of primary school). Postcode data from PLASC is matched to LSOAs, using a postcode to LSOA look-up. A 3-year average is used to reduce the impact of having small numbers of pupils at LSOA level. Because not all children are assessed in Welsh as a first language at Key Stages 2 and 3, the highest score in English and Welsh was taken along with the score in Mathematics and Science, to provide comparability across Wales. The indicator only includes maintained schools. The number of points received for each award is in the following table.
Comparability with WIMD 2011	Comparable

KS2 test outcome (Level)	Points: all subjects
Disapplied[1]	0
Absent[2]	0
Level 'N' (no information available)	0
Working towards level 1	3
1	9
2	15
3	21
4	27
5	33
6	39
7	45
8	51
Exceptional Performance	57

Notes on the points scoring table.

1. Children can be disapplied from following the National Curriculum, mainly as a result of them having a statement of special educational needs prepared by their LEA. Children can also be temporarily disapplied if they have recently arrived from a different educational system, had spells in hospital, been educated from school or been excluded. Children can be disapplied from any or all subjects.
2. Using Key Stage Teacher Assessments eliminates the issue of children who were absent from exams, as every pupil receives and assessment score based on their overall year performance. Pupils can only be awarded an Absent mark if, in the opinion of the school, they have missed a sufficient proportion of the year that it would be inappropriate to award a level.

Publication	WIMD 2014
Indicator Name	Proportion of people aged 18-19 not entering Higher Education
Domain	Education domain
Source	Higher Education Funding Council for England (HEFCE)
Type of Indicator	Percentage
Denominator	Number of all 18 to 19 years old resident in Wales
Time period for WIMD 2014	Academic Years 2005/06 - 2010/11
Additional Notes	The source for this indicator is Young Participant Rates data from Higher Education Funding Council for England (HEFCE), measuring those entering during Academic Years 2005-06 to 2010-11.
Comparability with WIMD 2011	Comparable

Publication	WIMD 2014
Indicator Name	Number of adults aged 25-64 with No Qualifications
Domain	Education domain
Source	2011 Census, Office for National Statistics (ONS)
Type of Indicator	Percentage
Denominator	Total population aged 25-64
Time period for WIMD 2014	2011
Additional Notes	This indicator was included in WIMD 2011 and is the only measure of educational deprivation amongst the adult population. Due to recent changes to the state pension age, this indicator looks at those aged 25-64.
Comparability with WIMD 2011	Comparable

Publication	WIMD 2014
Indicator Name	Repeat Absenteeism
Domain	Education domain
Source	Pupil Level Annual School Census (PLASC)
Type of Indicator	Percentage
Denominator	Number of primary and secondary school students
Time period for WIMD 2014	Academic Years 2010/11 - 2012/13
Additional Notes	This is a change to the WIMD 2011 indicators (overall absenteeism for primary and secondary pupils, separately). An indicator on the percentage of pupils missing 15 per cent or more of school sessions is used as a proxy for persistent absenteeism. Data are based on all pupils of statutory school age attending a maintained school. The indicator only includes maintained schools.
Comparability with WIMD 2011	Not comparable

8. Access to Services Domain

The purpose of this domain is to capture deprivation as a result of a household's inability to access a range of services considered necessary for day-to-day living. This covers both material deprivation (e.g. not being able to get food) and social aspects of deprivation (e.g. not being able to attend afterschool activities). Poor access to services is a factor that compounds other types of deprivation that exist within an area.

The access to services domain has a weighting of 10.0 per cent in WIMD 2014.

Domain construction

The access to services domain measures travel times to 8 services using public transport and 9 services using private transport. Public transport includes travel by: public bus, public train, foot and national coach. Private transport is considered to be transport by private car. The inclusion of private transport in the indicators is new for WIMD 2014.

The travel time indicators are a weighted average of the private and public transport times to each service. The weights are calculated for each LSOA using data from the 2011 Census on car ownership and the number of adults aged 17 and over. More information can be found under the Background Section of the WIMD webpages.

Each indicator is an average of the travel time by public and private transport (with the exception of petrol stations), with weightings as follows. Factor analysis was used to calculate the indicator weights.

Weight (per cent)	Indicators
29.0	Pharmacy
14.0	Food shop
14.0	General Practitioner (GP)
10.0	Public library
9.5	Post office
8.0	Primary school
6.0	Leisure centre
5.0	Petrol station (private transport only)
4.5	Secondary school

For every indicator, each LSOA was ranked in order, with the most deprived LSOA ranked 1 and the lowest deprived LSOA ranked 1,909. These ranks were assigned to a normal distribution, with low ranks receiving a low normalised value. As with all domains, the final domain ranks were exponentially transformed, to form domain scores (see Annex F). These domain scores were used in the calculation of the overall WIMD 2014.

Methodological changes

The access to services domain methodology has changed significantly between WIMD 2011 and WIMD 2014. The changes for WIMD 2014 are as follows:

- inclusion of private transport;
- inclusion of pharmacies and petrol stations;
- exclusion of NHS dentists and public transport stops; and
- travel times are measured to the nearest service point, rather than the nearest 10 service points, for each indicator.

Indicators

Public transport travel times (walking and using a public bus, public train or national coach) to the nearest access point for a given service were calculated using Mapumental API.

Private transport travel times to the nearest access point for a given service were calculated using RouteFinder 4.02 for MapInfo. The car network was captured using the Integrated Transport Network (Department for Transport), with car speeds based on Trafficmaster applied to each link.

For detailed information of the parameters used to calculate the access to services domain, see Annex G.

Publication	WIMD 2014
Indicator Name	Service types
Domain	Access to Services domain
Source	Welsh Government
Type of Indicator	Travel time (minutes), by public and private transport, to a given service
Denominator	N/A
Time period for WIMD 2014	2013/14
Additional Notes	• Pharmacy - a store where medicinal drugs are dispensed and sold, this includes pharmacies within a larger complex or supermarket. • Food shop - a store where you can purchase bread and milk. This includes premises from the local corner shop up to large supermarkets. • General Practitioner (GP) surgery - facilities where NHS GPs are registered to practice. • Public library - libraries that are open to the public. Mobile libraries are not included, due to a lack of geographical data. • Post office - includes all static post offices. • Primary school - schools that deliver education to 5-11 year olds. Travel times included in the calculation were limited to those where a child within the postcode was enrolled at a primary school. School enrolment data were sourced from PLASC. • Leisure centre - a non-commercial (i.e. pay-for-play) site containing two or more of the following: bowling green, swimming pool, tennis court, squash court, fitness centre and sports hall. • Petrol station - only included in the private transport element of the indicator. • Secondary school - schools that deliver education to 11-16 year olds. Travel times included in the calculation were limited to those where a child within the postcode was enrolled at a secondary school. School enrolment data were sourced from PLASC.
Comparability with WIMD 2011	Not comparable

9. Community Safety Domain

This domain is intended to consider deprivation relating to living in a safe community. It covers actual experience of crime and fire, as well as perceptions of safety whilst out and about in the local area.

The community safety domain has a weighting of 5.0 per cent in WIMD 2014.

Domain construction

There are six indicators in the community safety domain, with weightings as follows. Factor analysis was used to calculate the indicator weights

- 38 per cent Police Recorded Criminal Damage
- 32 per cent Police Recorded Violent Crime
- 17 per cent Police Recorded Anti-Social Behaviour
- 5 per cent Police Recorded Theft
- 4 per cent Police Recorded Burglary
- 4 per cent Fire Incidents

For every indicator, each LSOA was ranked in order, with the most deprived LSOA ranked 1 and the lowest deprived LSOA ranked 1,909. These ranks were assigned to a normal distribution, with low ranks receiving a low normalised value. As with all domains, the final domain ranks were exponentially transformed, to form domain scores (see Annex F). These domain scores were used in the calculation of the overall WIMD 2014.

Methodological changes

The Anti-Social Behaviour Incidences indicator included in WIMD 2014 has replaced the Percentage of Youth Offenders and Percentage of Adult Offenders indicators from WIMD 2011.

The denominator for the Police Recorded Theft, Violent Crime and Criminal Damage indicators has changed for WIMD 2014, compared with WIMD 2011, with the removal of the non-resident working population. More information can be found under the Background Section of the WIMD webpages.

Indicators

Publication	WIMD 2014
Indicator Name	Police Recorded Burglary
Domain	Community Safety domain
Source	Welsh Police Forces
Type of Indicator	Rate (per 100)
Denominator	The average of 2012 and 2013: Number of dwellings and business addresses
Time period for WIMD 2014	2012/13 - 2013/14
Additional Notes	The number of recorded burglaries, expressed as a percentage of the number of dwellings and business addresses were recorded by the police forces in Wales (North Wales, Dyfed Powys, South Wales and Gwent) and located to the point at which they occurred and allocated to the appropriate LSOA. Burglaries were of selected types which affect individuals or businesses. The criteria for selecting incidents by crime code is similar to that used in England, but a small number of additional codes were included. The additional codes produced only a small number of additional incidents. The crime codes (as defined by the Home Office Counting Rules) included were: • 28 A,B,C & D Burglary in a Dwelling • 29 Aggravated Burglary in a Dwelling • 30 A &B Burglary in a Building other than a Dwelling and • 31 Aggravated Burglary in a Building other than a Dwelling. More information on the Home Office Counting Rules can be found at: https://www.gov.uk/government/publications/counting-rules-for-recorded-crime
Comparability with WIMD 2011	Comparable

Publication	WIMD 2014
Indicator Name	Police Recorded Theft
Domain	Community Safety domain
Source	Welsh Police Forces
Type of Indicator	Rate (per 100)
Denominator	Total resident population (2012 Small Area Population Estimates), excluding total 2012 prison population
Time period for WIMD 2014	2012/13 - 2013/14
Additional Notes	The incidents (crimes) were recorded by the police forces in Wales (North Wales, Dyfed Powys, South Wales and Gwentand located to the point at which they occurred and allocated to the appropriate LSOA. Thefts were of selected types which affect individuals or businesses. The criteria for selecting incidents by crime code is similar to that used in England, but a small number of additional codes were included. The additional codes produced only a small number of additional incidents. The crime codes (as defined by the Home Office Counting Rules) included were: • 37/2 Aggravated Vehicle Taking • 39 Theft from the Person • 45 Theft from a Vehicle • 48 Theft or Unauthorised Taking of a Motor Vehicle and • 126 Vehicle Interference and Tampering. More information on the Home Office Counting Rules can be found at: https://www.gov.uk/government/publications/counting-rules-for-recorded-crime
Comparability with WIMD 2011	Comparable

Publication	WIMD 2014
Indicator Name	Police Recorded Criminal Damage
Domain	Community Safety domain
Source	Welsh Police Forces
Type of Indicator	Rate (per 100)
Denominator	Total resident population (2012 Small Area Population Estimates), excluding total 2012 prison population
Time period for WIMD 2014	2012/13 - 2013/14
Additional Notes	The incidents (crimes) were recorded by the police forces in Wales (North Wales, Dyfed Powys, South Wales and Gwent) and located to the point at which they occurred and allocated to the appropriate LSOA. Criminal damages were of selected types which affect individuals or businesses. The criteria for selecting incidents by crime code is similar to that used in England, but a small number of additional codes were included. The additional codes produced only a small number of additional incidents. The crime codes (as defined by the Home Office Counting Rules) included were: • 56 A & B Arson • 58A Criminal Damage to a Dwelling • 58B Criminal Damage to a Building other than a Dwelling • 58C Criminal Damage to a Vehicle • 58D Other Criminal Damage • 58E Racially or Religiously Aggravated Criminal Damage to a Dwelling • 58F Racially or Religiously Aggravated Criminal Damage to a Building other than a Dwelling More information on the Home Office Counting Rules can be found at: https://www.gov.uk/government/publications/counting-rules-for-recorded-crime
Comparability with WIMD 2011	Comparable

Publication	WIMD 2014
Indicator Name	Police Recorded Violent Crime
Domain	Community Safety domain
Source	Welsh Police Forces
Type of Indicator	Rate (per 100)
Denominator	Total resident population (2012 Small Area Population Estimates), excluding total 2012 prison population
Time period for WIMD 2014	2012/13 - 2013/14
Additional Notes	The incidents (crimes) were recorded by the police forces in Wales (North Wales, Dyfed Powys, South Wales and Gwent) and located to the point at which they occurred and allocated to the appropriate LSOA. Violent crimes were of selected types which affect individuals or businesses. The criteria for selecting incidents by crime code is similar to that used in England, but a small number of additional codes were included. The additional codes produced only a small number of additional incidents. The crime codes (as defined by the Home Office Counting Rules) to be included were: • 1 Murder • 2 Attempted Murder • 3 A, B & C Threat or Conspiracy to Murder • 4/1 Manslaughter • 4/2 Infanticide • 5 A B & C, Wounding or Other Act Endangering Life • 5D Assault with Intent to Cause Serious Harm • 5E Endangering Life • 6 Endangering a Railway Passenger • 7 Endangering Life at Sea • 8F, G & K, Other Wounding • 8L, 9A Harassment • 8H & J Racially or Religiously Aggravated Other Wounding • 8M Racially or Religiously Aggravated Harassment • 8N Assault with Injury • 8P Racially or Religiously Aggravated Assault with injury • 9B Racially or Religiously Aggravated Public Fear, Alarm or Distress • 11 Cruelty to and Neglect of Children • 12 Abandoning Child Under Two Years • 34A Robbery of Business Property • 34B Robbery of Personal Property • 37/1 Causing Death by Aggravated Vehicle Taking • 81 Firearms Act 1968 and other Firearms Act • 105A Common Assault • 105B Racially or Religiously Aggravated Common Assault More information on the Home Office Counting Rules can be found at: https://www.gov.uk/government/publications/counting-rules-for-recorded-crime
Comparability with WIMD 2011	Comparable

Publication	WIMD 2014
Indicator Name	Anti Social Behaviour
Domain	Community Safety domain
Source	Welsh Police Forces
Type of Indicator	Rate (per 100)
Denominator	Total resident population (2012 Small Area Population Estimates), excluding total 2012 prison population
Time period for WIMD 2014	July 2012 - June 2014
Additional Notes	The incidents (anti-social behaviour) were recorded by the police forces in Wales (North Wales, Dyfed Powys, South Wales and Gwent). The incidents were located to the point at which they occurred and allocated to the appropriate lower super output area (LSOA). Anti Social Behaviour incidents indicator has replaced the youth and adult offender indicators (since the latter have previously been included as a proxy for anti-social behaviour in the community).
Comparability with WIMD 2011	Not comparable

Publication	WIMD 2014
Indicator Name	Fire Incidences
Domain	Community Safety domain
Source	Welsh Government
Type of Indicator	Rate (per 100)
Denominator	Total resident population (2012 Small Area Population Estimates)
Time period for WIMD 2014	2012/13 - 2013/14
Additional Notes	This indicator captures actual experiences of fire. In WIMD 2014, incidents of primary fires, with the addition of “derelict vehicle” fires were collected as counts by LSOA. Secondary "derelict vehicle" fires were only included if available at the LSOA level. Incidents requiring call out of fire and rescue services are related to deprivation and more likely within disadvantaged groups. Primary fires include “all fires in buildings, vehicles and outdoor structures or any fire involving casualties, rescues, or fires attended by five or more appliances”. Secondary fires are “the majority of outdoor fires including grassland and refuse fires unless they involve casualties or rescues, property loss or five or more appliances attend”.
Comparability with WIMD 2011	Comparable

10. Physical Environment Domain

The purpose of this domain is to measure factors in the local area that may impact on the wellbeing or quality of life of those living in an area.

Environmental deprivation is generally not correlated with social or economic deprivation in Wales (ref: Walker et al., 2003). This domain does not capture aspects of deprivation such as health inequalities (this is an objective of the health domain). Indicators were chosen that were judged to indicate an increased potential for reduced quality of life, and that were readily available.

The physical environment domain has a weighting of 5.0 per cent in WIMD 2014.

Natural Resources Wales (NRW) provided the data (and associated technical expertise) for all indicators within this domain.

Domain construction

The domain contains three sub-domains. Each sub-domain is given an equal (33.3 per cent) weighting.

- Air Quality (two indicators)
- Proximity to Waste Disposal and Industrial Sites (one indicator)
- Flood Risk (one indicator)

The Air Quality sub-domain contains two indicators (Air concentrations and Air Emissions) which are equally weighted within the sub-domain.

For the Air Quality sub-domain, both indicators were assigned to a normal distribution, and then combined (using equal weighting) to form sub-domain values and ranks.

For the other two sub-domains, each LSOA was ranked in order, with the most deprived LSOA ranked 1 and the least deprived ranked 1,909. The sets of ranks were assigned to a normal distribution.

Each sub-domain was exponentially transformed, combined (using equal weighting for the three sub-domains) and then ranked. As with all domains, the final domain ranks were exponentially transformed, to form domain scores (see Annex F). These domain scores were used in the calculation of the overall WIMD 2014.

Methodological changes

The methodology used to create the indicators for the physical environment domain is the same for WIMD 2014 as it was for WIMD 2011. However, there have been some technical improvements/changes to the Air Quality and Flood Risk indicators (Flood Risk categories and weights). These are outlined in the appropriate sections below.

Sub-domain Air Quality

The Air Quality sub-domain includes two separate indicators on Air Concentrations and Air Emissions. These were also included in WIMD 2011. They are created using measurements of pollutants that could have negative effects on human health and/or the environment, based on the best medical and scientific understanding, and are proposed as a proxy measure of the quality of the surrounding environment. Poor air quality suggests proximity to certain activities such as traffic, domestic combustion and industrial sites – activities that could have a negative impact on quality of life, the local environment and health.

The Air Concentrations Indicator is calculated using a combination of concentration data (modelled on air emission data) and Air Quality Management Areas.

Air Emissions data provides a set of complimentary data covering pollutants not included in the Air Concentrations indicator.

Air Quality indicators

Publication	WIMD 2014
Indicator Name	Air Concentration
Domain	Physical Environment domain
Source	Natural Resources Wales
Type of Indicator	Score (between 0 and 100)
Denominator	N/A
Time period for WIMD 2014	2012
Additional Notes	A 1 km x 1 km vector (polygon) grid was generated to cover Wales, corresponding to concentration GRIDs supplied by Netcen (2012 data). Concentration values were then extracted for each LSOA for the following pollutants and statistics: • Benzene annual mean • Ozone maximum daily 8 hour mean • Nitrogen oxides annual mean • Nitrogen dioxide annual mean • Particulates < 10 um annual mean • Particulates < 2.5 um annual mean • Sulphur dioxide annual mean • Sulphur dioxide 99.73 percentile of 1 hour mean Additionally, population averages for each LSOA containing an Air Quality Management Area (Particulates) and Air Quality Management Area (nitrogen dioxide) were calculated. For land-based cells without data, concentration values were inferred using a simple average of surrounding cells. Figures for LSOAs were calculated by examining the overlap of the 1 km grid data with each LSOA and averaging the results of each grid intersecting the LSOA, weighted by the number of residential address points in the intersection. The number of residential address points was derived from AddressBase data (downloaded from Ordnance Survey on 30/06/2014). The result is a household average for each LSOA.

	Each pollutant value was then adjusted (via transformation) using a factor based on the objective, standard or risk factor for that pollutant and statistic. This method was developed to take into account air quality standards for each substance, which are based on the best medical and scientific understanding of their effects on health and/or the environment. The method also ensures that areas which have high prevalence of certain pollutants, but not others, are ranked as highly deprived; low levels of one pollutant will not cancel out the effect of a high level of another pollutant.
Comparability with WIMD 2011	Broadly comparable, though some technical differences (see methodological changes).

Publication	WIMD 2014
Indicator Name	Air Emissions
Domain	Physical Environment domain
Source	Natural Resources Wales
Type of Indicator	Score (between 0 and 100)
Denominator	N/A
Time period for WIMD 2014	2012
Additional Notes	A 1 km x 1 km vector (polygon) grid was generated to cover Wales, corresponding to emission GRIDs supplied by Netcen (2011 data). Annual emission values were extracted for each grid cell for the following pollutants: • Arsenic • Benzo (a) pyrene • Butadiene • Cadmium • Chromium • Dloxins • Mercury • Ammonia • Nickel • Lead • Vanadium • Volatile organic chlorides Figures for LSOAs were calculated by examining the overlap of the 1 km grid data with each LSOA and averaging the results of each grid intersecting the LSOA, weighted by the number of residential address points in the intersection. The number of residential was derived from AddressBase data (downloaded from Ordnance Survey on 30/06/2014). The result is a household average for each LSOA. Each pollutant value was then adjusted (via transformation) using a factor based on the objective, standard or risk factor for that pollutant and statistic. This method was developed to take into account air quality standards for each substance, which are based on the best medical and scientific understanding of their effects on health and/or

	the environment. The method also ensures that areas which have high prevalence of certain pollutants, but not others, are ranked as highly deprived; low levels of one pollutant will not cancel out the effect of a high level of another pollutant.
Comparability with WIMD 2011	Broadly comparable, though some technical differences (see methodological changes).

Air Quality – Comparability

As a result of changes to air quality regulations and methodological changes within Defra a number of changes have been made to the Air Concentrations and Air Emissions indicators:

(a) Nitrogen oxides – Previously in the Air Emissions indicator. There is now a concentration grid as well as an emissions grid. Concentration grids are preferable as they can be directly related to the Objective. Nitrogen oxides moved to the Air Concentration indicator and uses the same 30 ug/m^3 standard from the Air Quality strategy (Wales) Regulations 2010.

(b) Carbon monoxide – previously in the Air Concentration indicator. There is no longer any CO modelling undertaken for the UK – the compliance assessment that this modelling is used for is now based on an objective estimation technique because the concentrations were so low. This has been removed from the indicator.

(c) Sulphur dioxide – previously there were two Air Quality objectives used in the Air Concentrations indicator. An annual mean of 20 ug/m^3 and a maximum of 266 ug/m^3 averaged over 15 mins with no more than 35 exceedences in any year. This second objective is not in the Air Quality Strategy (Wales) regulations 2010. The second objective has been changed to match the new Air Quality Strategy objective of 350 ug/m^3 averaged over 1 hour, with no more than 24 exceedences in any year.

(d) Particulate matter – the Air Concentrations indicator previously included a grid for PM10. The method used an annual mean objective of 20 ug/m^3. The current Air Quality Strategy limit value is 40 ug/m^3. The objective has been changed to match the target. In addition, there is now a limit value in the AQS (Wales) regulations 2010 for PM2.5 PM2.5 has been added to the Air Concentrations indicator, using the limit value of 20 ug/m^3.

<table>
<tr><td>Publication</td><td>WIMD 2014</td></tr>
<tr><td>Indicator Name</td><td>Proximity to Waste Disposal and Industrial Sites</td></tr>
<tr><td>Domain</td><td>Physical Environment domain</td></tr>
<tr><td>Source</td><td>Natural Resources Wales</td></tr>
<tr><td>Type of Indicator</td><td>Score (between 0 and 100)</td></tr>
<tr><td>Denominator</td><td>N/A</td></tr>
<tr><td>Time period for WIMD 2014</td><td>2014</td></tr>
<tr><td>Additional Notes</td><td>Each waste disposal and industrial site is assigned a band score which relates to the potential and the actual deprivation the site could cause to the environment and the people living within its vicinity. Operational Risk Appraisal (OPRA) scores were used to inform scores for sites which have them. OPRA is a risk-screening tool that Natural Resources Wales use to regulate operators under the Environmental Permitting (England and Wales) Regulations 2010 (EPR) Sites which do not have OPRA scores were assigned scores by Natural Resources Wales. All mobile sites were excluded as their location may vary from day to day.

The following table shows how OPRA scores relate to site band scores:

<table>
<tr><th>OPRA Score</th><th>Site Band Score</th></tr>
<tr><td>>=500</td><td>5</td></tr>
<tr><td>200-499</td><td>4</td></tr>
<tr><td>100-199</td><td>3</td></tr>
<tr><td>75-99</td><td>2</td></tr>
<tr><td>50-74</td><td>1</td></tr>
<tr><td><50</td><td>0</td></tr>
</table>

The matrix below was used to create LSOA proximity scores:

<table>
<tr><td rowspan="2">Size of proximity band around site site (km)</td><td colspan="6">Band score created from OPRA score (industrial and waste management sites)</td></tr>
<tr><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td><=0.5</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>>0.5 to 1</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>>1 to 1.5</td><td>3</td><td>2</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>>1.5 to 2</td><td>2</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>>2 to 3</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>

There are instances where the proximity bands overlap with each other. In these instances the proximity scores are added together. This means that the more sites with high scores that properties within an LSOA are close to, the more deprivation the residents could suffer.

To create the overall indicator score, an LSOA ranked percentile is produced. This is calculated by multiplying the number of address points within each site zone (regardless of LSOA boundary) by the sum of the proximity scores for these zones. All of these values are</td></tr>
</table>

	then summed to LSOA boundaries and divided by the number of address points within the LSOA to create the Proximity to Waste Disposal and Industrial Sites indicator score for each LSOA. A percentile is then produced. The number of households was calculated from the AddressBase data (downloaded from Ordnance Survey on 30/06/2014).
Comparability with WIMD 2011	This indicator is broadly comparable with WIMD 2011. The proximity indicator uses regulated site data collated from a number of databases within Natural Resources Wales, along with some information from the Local Authorities. The information is combined with digitised site boundary data where this is available. For the 2011 indicator boundary data for landfills and some of the industrial sites was used. For those sites with no boundary data, a radius of 500 m was assumed for the boundary, which in most cases is greater than the actual boundary. Since the calculation of the Environment domain in 2011, Natural Resources Wales has digitised a large number of site boundaries used in the Proximity to Waste Disposal and Industrial Sites indicator. The majority of boundaries for the industrial sites are now available digitally. This will have changed the number of properties counted within the proximity bands around each site, in most cases making the area potentially affected by sites smaller, in all cases making the data more accurate.

Publication	WIMD 2014
Indicator Name	Flood Risk
Domain	Physical Environment domain
Source	National Flood Risk Assessment data, via Natural Resources Wales
Type of Indicator	Score (between 0 and 100)
Denominator	N/A
Time period for WIMD 2014	2014
Additional Notes	The Flood Risk indicator considers the proportion of households at risk of flooding from rivers and the sea (but not surface water flooding). The risk is based on predicted frequency, rather than the level of damage caused by flooding. • Very Low - Less than 1 in 1000 (0.1%) chance in any given year • Low - Less than 1 in 100 (1%) but greater than or equal to 1 in 1000 (0.1%) chance in any given year • Medium - Less than 1 in 30 (3.3%) but greater than or equal to 1 in 100 (1%) chance in any given year • High - greater than or equal to 1 in 30 (3.3%) chance of flooding in any given year To ensure the areas at risk of more severe flooding rank as more deprived than areas at risk of less severe flooding, the following weighting was given: The number of households in an area at high risk was multiplied by 24; The number of households in an area at medium risk was multiplied by 4; and the number of households in an area at low or very low risk was

	multiplied by 1. More information on the methodology for deriving the above weights is available at Annex H. Each of these numbers is calculated for each LSOA and then added together to give total normalised number of households at a risk of flooding per LSOA. This number is then divided by the total number of households in the LSOA to give the proportion of households at risk of flooding. The number of households was calculated from AddressBase data (downloaded from Ordnance Survey on 30/06/2014).
Comparability with WIMD 2011	The flooding categories have changed since WIMD 2011 (when there were three risk categories). See Annex H for further details.

11. Housing Domain

Conceptually, the purpose of this domain is to capture deprivation through lack of adequate housing, in terms of housing physical condition, living conditions and availability. However, the lack of appropriate data means that it is not possible to fully measure housing deprivation according to this definition.

The housing domain has a weighting of 5.0 per cent in WIMD 2014.

Domain construction

There are only two indicators in the housing domain, with weightings as follows:

- 66.6 per cent Proportion of people living in overcrowded households (bedrooms measure)
- 33.3 per cent Proportion of people living in households with no central heating

For every indicator, each LSOA was ranked in order, with the most deprived LSOA ranked 1 and the lowest deprived LSOA ranked 1,909. These ranks were assigned to a normal distribution, with low ranks receiving a low normalised value. As with all domains, the final domain ranks were exponentially transformed, to form domain scores (see Annex F). These domain scores were used in the calculation of the overall WIMD 2014.

Methodological changes

In recognition of the fact that lack of central heating is becoming an increasingly poor indicator of housing quality over time, its weight within the domain has been lowered to 1/3. Correspondingly, the overcrowding indicator is now given a weight of 2/3.

The occupancy rating used to calculate the overcrowding indicator has changed from a measure of occupancy of rooms to a measure of occupancy of bedrooms.

Indicators

Publication	WIMD 2014
Indicator Name	Percentage of people living in overcrowded households (bedrooms measure)
Domain	Housing domain
Source	2011 Census, Office for National Statistics
Type of Indicator	Percentage
Denominator	Number of people living in households
Time period for WIMD 2014	2011
Additional Notes	This indicator provides a measure of whether a household's accommodation is overcrowded (based on the number of bedrooms). The ages of the household members and their relationships to each other are used to derive the number of bedrooms they require, based on a standard formula. The number of bedrooms required is subtracted from the number of bedrooms in the household's accommodation to obtain the occupancy rating. An occupancy rating of -1 implies that a household has one fewer bedroom than required. A bedroom is defined as any room that was intended to be used as a bedroom when the property was built, or any room that has been permanently converted for use as a bedroom. It also includes all rooms intended for use as a bedroom even if not being used as a bedroom at the time of the census. Bedsits and studio flats are counted as having one bedroom. Further information on Census methodology can be found at: http://www.ons.gov.uk/ons/guide-method/census/2011/census-data/2011-census-user-guide/quality-and-methods/quality/quality-notes-and-clarifications/index.html
Comparability with WIMD 2011	Not comparable. In WIMD 2011, an indicator based on overcrowded households (rooms measure) was used. This excluded all student households.

Publication	WIMD 2014
Indicator Name	Percentage of population living in households with no central heating.
Domain	Housing domain
Source	2011 Census, Office of National Statistics
Type of Indicator	Percentage
Denominator	Number of people living in households
Time period for WIMD 2014	2011
Additional Notes	A household's accommodation is classified as having central heating if it is present in some or all rooms (whether used or not). Central heating is classified by type, for example one or more of the types - gas, electric (including storage heaters), oil, solid fuel (e.g. wood or coal) or other types (including solar, Liquefied Petroleum Gas (LPG) or other bottled gas).
Comparability with WIMD 2011	Comparable, though the wording of the Census question changed between 2001 and 2011.

Annex A: The Factor Analysis Technique

Factor analysis overview

Factor analysis is a method for assessing the extent to which a set of indicators may be measuring the same underlying construct or factor. The premise behind a one-common-factor model is that the underlying factor is imperfectly measured by each of the indicators in the dataset but that indicators that are most highly correlated with the underlying factor will also be highly correlated with each other. By analysing the correlation between indicators it is therefore possible to make inferences about the common factor and as a result estimate a 'factor score' for each LSOA. This score is derived from a set of weights for each of the indicators in the data set that is generated by the process of factor analysis. This factor score can then be used as the domain index.

Factor analysis has only been applied to four domains: Health, Education, Access to Services and Community Safety. Factor analysis is used in these domains because they contain indicators that measure a number of forms of that deprivation, on potentially different metrics and with different levels of accuracy, and therefore cannot otherwise easily be combined. The main reasons why factor analysis has been used are:

- because the indicators are on different metrics and have different levels of accuracy, and so cannot simply be summed;
- to ascertain the factor that underlies the indicators within the domain; and
- to help take into account the problem of 'double counting' within a domain.

In the Employment and Income domains, we can identify individuals who are or are not deprived in terms of the domain definition. The number of deprived people can then simply be summed and divided by a suitable denominator to create an area rate. This is not possible in the other six domains, where forms of deprivation tend to present themselves in different ways at different times. For example, an individual is 'health deprived' if they die prematurely or are long-term sick. While the long-term sick may be more likely to die prematurely than others, these events do not occur to the same people at the same time. Typically, such domains include data on people at different ages and stages. For example, in the Education domain, lack of qualifications in the adult population as well as poor results at school level were assessed. We hypothesise that there is an underlying factor at the local area level (e.g. health deprivation) that makes these different states likely to exist together in the same area. This underlying factor cannot be measured directly but can be identified through its effects on specific individual measures (e.g. premature death, long-term illness, low birth-weight children etc.). We have, therefore, collected a number of indicators that measure, with different levels of accuracy, the effects of this underlying factor. By looking at the relationship between all these indicators the underlying factor can be identified and quantified.

Factor analysis also takes some account of the problem of 'double-counting' within domains. The Health, Education, Access to Services and Community Safety domains potentially contain indicators that overlap with each other. For example, in the Health domain, it is possible for an individual to have had cancer and also potentially to be included in the limiting long-term illness indicator. Combining data using other methods such as 'z scores' more directly double-weights these cases by taking them all into account. Factor analysis, however, takes some account of this overlap in that an indicator may have a lower weight if the contribution it makes has already been taken into account.

The choice of maximum likelihood estimation method

WIMD 2014 follows the WIMD 2011 and WIMD 2008 methodology and that applied by Oxford University for WIMD 2000, as well as the Indexes for the other three UK countries.

In Principal Components Analysis, all variance in an indicator is analysed, including measurement error (*error variance*) and the indicators' imperfect measurement of the underlying construct or constructs (*specific variance*). This is because it does not attempt to separate *common variance* (i.e. variance shared between three or more indicators) from *unique variance* (i.e. specific variance and error variance). It assumes that an indicator is perfectly reliable and measured without error. It was, therefore, not appropriate to use the Principal Components method. The appropriate technique, where it is suspected that indicators are not perfectly reliable or measured without error, is *common factor analysis* of which Maximum Likelihood Factor (ML) analysis is a type.

Principal Factoring (PF) has, in the past, been the favoured method of common factor analysis, but this was probably because of its relative computational simplicity. With the advent of high-powered computers, more sophisticated methods, such as ML factor analysis, are now easily accomplished. PF has a number of disadvantages in comparison to ML factor analysis. The PF solution depends on the scale of measurement of the input indicators (i.e. depends on whether or not they have been standardised), which means that there is not one, but an infinity of PF solutions among which the choice is arbitrary. The factor model itself is intrinsically scale free, and thus any procedures for its estimation should be scale invariant. ML is scale invariant. ML also treats the correlation matrix as a sample correlation matrix and attempts to explain variance in the *population* correlation matrix. This treatment of the data as a sampled dataset is consistent with the proposal, made throughout this project, that even 'census' indicators should be seen as a sample from a super-population.

Communality

This is the proportion of a variable's variance explained by a factor structure. A variable's commonality must be estimated prior to performing a factor analysis. A communality does not have to be estimated prior to performing a principal component analysis. Communality estimates are estimates of the proportion of common variance in a variable. *Prior communality* estimates are those which are estimated prior to the factor analysis. Common methods of prior communality estimation are to use: (1) an independent reliability estimate; (2) the squared multiple correlation between each variable and the other variables; (3) the highest off-diagonal correlation for each variable; or (4) iterate by performing a sequence of factor analyses using the final communality estimates from one analysis as prior communality estimates for the next analysis. *Final communality estimates* are the sum of squared loadings for a variable in an orthogonal factor matrix.

The default setting for communality prior estimates, Square Multiple Correlation, was used for WIMD 2014 calculations.

Calculation process

The indicators were first transformed to the standard normal distribution. The transformed indicators were then entered into a 'one common factor Maximum Likelihood factor analysis'. Fuller's regression method was used to derive factor scores from the resulting solution. The process was undertaken in SAS and the following details the settings used:

- the normally transformed values for each of the domain indicators were entered as the analysis variables;
- maximum likelihood factor analysis was chosen as the factoring method, for the reasons described above;
- the smallest eigenvalue was set to 1 because this is a commonly used indicator showing that sufficient factors have been extracted to reasonably explain the 'common variance' between the indicators.
- for prior communality estimates the method chosen was Squared Multiple Correlation with all other columns, as described above; and
- for the rotation method, no rotation was selected as we are only looking for a single factor solution and rotation only applies if there two or more factors.

Annex B: WIMD Domain Scores

As part of the process for calculating the WIMD overall and domain ranks, scores (domain and overall) are produced. The WIMD scores are a stage in the construction of the Index and not a product. The scores do not represent a level of multiple deprivation (e.g. if area A has twice the score of area B, this does not necessarily mean that area A is twice as deprived as area B). This means that scores do not contain any more information on levels of multiple deprivation than the ranks do. To assess levels of deprivation, underlying indicator data must be used.

The WIMD scores are published for two reasons only:

- for transparency (so that users have access to all stages of construction); and
- so that users can experiment with different weighting systems for the Index, if required.

The WIMD domain scores are published in the Technical information section of the WIMD webpages.

Annex C: Allocation of Data to Lower layer Super Output Areas

Background

LSOAs are still a relatively new geography and as such data are generally not allocated to an LSOA as part of the collection process. Therefore for WIMD 2014, a method of allocating other geographical level data to LSOAs had to be devised.

Different data sets vary in their level of geographic coding and so different approaches are required. Data sets fall into one of the following categories, shown in order of preference in terms of data quality:

1. data are geocoded and can be allocated to LSOAs exactly using a Graphic Information System (GIS);
2. data contain the full postal address and can be allocated exactly to LSOAs using ONS lookup tables; or
3. data are coded with some other small area geography and these can be allocated to LSOAs in some way, although the matching will not be exact.

The following sections explain the approach taken for WIMD 2014 in each case.

1 Geocoded data

Geocoding is still relatively rare, particularly for national-level data sets. In the case of WIMD 2014, the only geocoded information available was the service point location information (e.g. schools, post offices etc.) used in the Access to Services domain.

2 Address Matching

This is the most accurate method for allocating data that has not been geocoded. The ONS have created a lookup to allocate each individual address to a LSOA which forms part of the toolkit for data providers of Neighbourhood Statistics (a package called MatchCode).

There are two main issues with this approach. The first is to do with address quality; addresses are often incomplete or partially incorrect (e.g. missing house number or incorrect postcode). There may then be a residual of records for which another approach is required (e.g. allocate on the basis of postcode). The second problem has to do with data confidentiality and legal restrictions, which prevent the supply of full address information. The solution to the second problem is for the data provider to address match data and provide LSOA level counts; this was the case with benefits data that had already been coded for use in Neighbourhood Statistics.

3 Allocating small area data to LSOAs

The most common small area identifier is the postcode, and this was the building block used for many indicators in WIMD 2014.

Postcode level data

LSOA boundaries do not fit exactly with postcode boundaries. However, it was initially assumed that the fit would be good, that the occurrence of postcodes being split by LSOA boundaries would be minimal and that splits would generally result in the majority of a postcode clearly within a single LSOA. A detailed investigation found that there was a high proportion of split postcodes and that the occurrence of postcodes effectively split down the middle was not negligible, particularly in urban areas where LSOA boundaries can go down the middle of streets.

The standard approach with postcode level data is to allocate data on a best fit basis using the Postcode Address File (PAF), where postcodes are allocated to the area in which most of the population lies. As noted above, the match of postcodes to LSOAs in Wales is not a close fit and this causes concern with something like WIMD as rates are calculated using denominators from a different source and areas are then ranked. An alternative method of apportioning postcode data to each of the LSOAs that lie within the area was developed.

Apportionment of split postcodes

The only information generally available with postcode level data is the count (e.g. the number of deaths) and the rate that is derived from this. The basic principle used was that the rate for the given indicator should apply equally across the whole postcode and that this should be preserved under any allocation methodology. This can be done by weighting the postcode rates according to the proportion of the postcode population sitting within the LSOAs, as shown below:

$$LSOA\,rate = \frac{\sum \left(PC_{in}\,popn \times PC\,rate \right)}{LSOA\,popn}$$

Where: PC_{in} popn = population of the postcode within the LSOA
PC rate = postcode rate
LSOA rate = LSOA rate
LSOA popn = LSOA population

When postcodes are not split this essentially gives the rate a weighting of 1 as the postcode population figures cancel:

$$LSOA\,rate = \frac{\sum (PC\,popn \times PC\,num / PC\,popn)}{LSOA\,popn}$$
$$= \frac{\sum PC\,num}{LSOA\,popn}$$
$$= \frac{LSOA\,num}{LSOA\,popn}$$

Where: PC popn = total population of the postcode
PC num = number of individuals in the postcode
LSOA num = the total number of individuals in the LSOA

When postcodes are split, it has been assumed that:

$$\frac{PC_{in}\,popn}{PC\,popn} = \frac{AddressPoints_{in}\,num}{AddressPoints_{tot}\,num} = Percentage PC in LSOA$$

Where: $AddressPoints_{in}$ num = number of postal address points in the postcode that are within the LSOA
$AddressPoints_{tot}$ num = total number of postal address points in the postcode
$Percentage PC_{in}$ LSOA = estimated percentage of the postcode population within the LSOA

This says that the proportion of address points is equivalent to the proportion of the population, and hence assumes that population is distributed in the same way within each sub-area within the postcode. While it will not always be the case that the number of persons per household is the same in all parts of a postcode, it will not generally be dramatically different.

Under this assumption, the LSOA rate is calculated as follows:

$$LSOA\,rate = \frac{\sum (PC_{in}\,popn \times PC\,rate)}{LSOA\,popn}$$
$$= \frac{\sum \left(\frac{PC_{in}\,popn \times PC\,num}{PC\,popn} \right)}{LSOA\,popn}$$
$$= \frac{\sum (Percentage PC in LSOA \times PC\,num)}{LSOA\,popn}$$

Which is equivalent to:

$$LSOA\,num = \sum (Percentage PC in LSOA \times PC\,num)$$

Hence, approximate counts for indicators can be constructed at LSOA level by taking the relevant percentage of the counts for each postcode that falls within it. While this is the most straightforward way to estimate an LSOA figure, the above analysis shows that it is actually equivalent to giving every individual in split postcodes the rate for that postcode.

Implementation of this approach

To facilitate this approach, the Welsh Government Geography and Technology Unit produced postcode look up tables for years up to and including 2013, where it was possible to calculate apportionment rates based on number of dwellings as above for each postcode. This lookup was initially used to match as much postcode data to LSOAs as possible.

However, not all postcodes in the data were covered by the above lookup. For those that didn't match, the team used a second lookup, obtained from ONS, which assigned an LSOA based on the nearest geographical centre of an LSOA to the postcode. This lookup did not include weights by dwellings, so a weight of 1 was assigned by default to all postcodes matched in this way.

Any data still unmatched at this point was unable to be included in the calculations.

Best fit to postcode boundaries

While the apportionment method has been used for most WIMD postcode level data, there were a small number of instances where out-of-date postcodes were contained in data records and the only option was to use the best fit method. A best fit method could be used as the ONS All Fields Postcode Directory (AFPD) holds historical postcodes.

Annex D: Changes to SOA Boundaries between 2001 Census and 2011 Census

In WIMD 2014, there are 1847 LSOAs with unchanged boundaries since WIMD 2011, 61 LSOAs with boundaries resulting from a merge with or split from an adjacent LSOA, and 12 LSOAs with boundaries resulting from more complex changes. A summary of LSOA boundary changes is provided in the table overleaf.

Table of LSOA changes between the 2001 Census and 2011 Census

LSOA 2001	Local Authority	LSOA 2001 Name	LSOA 2011	LSOA 2011 Name	Change
W01000045	Gwynedd	Aberdaron	W01001932	Aberdaron / Botwnnog & Tudweiliog	M
W01000046	Gwynedd	Aberdovey	W01001933	Aberdovey / Bryn-crug / Llanfihangel	M
W01000055	Gwynedd	Botwnnog & Tudweiliog	W01001932	Aberdaron / Botwnnog & Tudweiliog	M
W01000058	Gwynedd	Bryn-crug/Llanfihangel	W01001933	Aberdovey / Bryn-crug / Llanfihangel	M
W01000120	Conwy	Abergele Pensarn	W01001927	Abergele Pensarn 1	S
W01000120	Conwy	Abergele Pensarn	W01001928	Abergele Pensarn 2	S
W01000160	Conwy	Llansanffraid 1	W01001926	Llansanffraid	M
W01000161	Conwy	Llansanffraid 2	W01001926	Llansanffraid	M
W01000357	Wrexham	Dyffryn Ceiriog/Ceiriog Valley 1	W01001930	Ceiriog Valley 3	M
W01000358	Wrexham	Dyffryn Ceiriog/Ceiriog Valley 2	W01001930	Ceiriog Valley 3	M
W01000421	Wrexham	Smithfield	W01001929	Smithfield 2	S
W01000421	Wrexham	Smithfield	W01001931	Smithfield 3	S
W01000435	Powys	Crickhowell 1	W01001903	Crickhowell	X
W01000436	Powys	Crickhowell 2	W01001904	Llangattock and Glangrwyney	X
W01000437	Powys	Cwm-twrch	W01001899	Cwm-twrch	X
W01000462	Powys	Llangattock	W01001904	Llangattock and Glangrwyney	X
W01000463	Powys	Llangors & Bwlch	W01001905	Llangors, Bwlch & Grwyney	X
W01000468	Powys	Llanrhaeadr-ym-Mochnant	W01001906	Llanrhaeadr-ym-Mochnant	X
W01000469	Powys	Llanrhaeadr-ym-Mochnant/Llansilin	W01001907	Llansilin	X
W01000490	Powys	St. John 1	W01001901	St. John 1	X
W01000491	Powys	St. John 2	W01001902	St. John 2	X
W01000495	Powys	Talybont-on-Usk	W01001897	Talybont-on-Usk	X
W01000514	Ceredigion	Aberystwyth Gogledd/North	W01001934	Penglais	M
W01000520	Ceredigion	Borth 1	W01001937	Borth	M
W01000521	Ceredigion	Borth 2	W01001937	Borth	M
W01000526	Ceredigion	Faenor 2	W01001934	Penglais	M
W01000530	Ceredigion	Llanbadarn Fawr - Padarn & Llanbadarn Fawr - Sulien	W01001935	Llanbadarn Fawr South	S
W01000530	Ceredigion	Llanbadarn Fawr - Padarn & Llanbadarn Fawr - Sulien	W01001936	Llanbadarn Fawr North	S

Table of LSOA changes between the 2001 Census and 2011 Census continued

LSOA 2001	Local Authority	LSOA 2001 Name	LSOA 2011	LSOA 2011 Name	Change
W01000661	Carmarthenshire	Glanymor 3	W01001923	Glanymor 3	S
W01000661	Carmarthenshire	Glanymor 3	W01001924	Glanymor 4	S
W01000668	Carmarthenshire	Hengoed (Carmarthenshire) 2	W01001925	Hengoed 2	M
W01000669	Carmarthenshire	Hengoed (Carmarthenshire) 3	W01001925	Hengoed 2	M
W01000743	Swansea	Castle 2	W01001955	Castle 2 North	S
W01000743	Swansea	Castle 2	W01001958	Castle 2 South	S
W01000748	Swansea	Castle 7	W01001938	Castle 7 East	S
W01000748	Swansea	Castle 7	W01001957	Castle 7 West	S
W01000780	Swansea	Killay North 1	W01001956	Killay 3	M
W01000783	Swansea	Killay South 2	W01001956	Killay 3	M
W01000972	Neath Port Talbot	Ystalyfera 1	W01001900	Ystalyfera 1	X
W01000988	Bridgend	Bryntirion, Laleston and Merthyr Mawr 1	W01001918	Bryntirion Laleston and Merthyr Mawr 1	S
W01000988	Bridgend	Bryntirion, Laleston and Merthyr Mawr 1	W01001919	Bryntirion Laleston and Merthyr Mawr 4	S
W01000988	Bridgend	Bryntirion, Laleston and Merthyr Mawr 1	W01001920	Bryntirion Laleston and Merthyr Mawr 5	S
W01000988	Bridgend	Bryntirion, Laleston and Merthyr Mawr 1	W01001921	Bryntirion Laleston and Merthyr Mawr 6	S
W01001074	The Vale of Glamorgan	Castleland 2	W01001910	Castleland 2G	S
W01001074	The Vale of Glamorgan	Castleland 2	W01001911	Castleland 2H	S
W01001163	Rhondda Cynon Taf	Church Village 2	W01001915	Church Village 2	S
W01001163	Rhondda Cynon Taf	Church Village 2	W01001916	Church Village 3	S
W01001254	Rhondda Cynon Taf	Tonyrefail West 2	W01001914	Tonyrefail West 2	S
W01001254	Rhondda Cynon Taf	Tonyrefail West 2	W01001917	Tonyrefail West 4	S
W01001323	Merthyr Tydfil	Vaynor 1	W01001898	Vaynor 1	X
W01001544	Monmouthshire	Caldicot Castle 2	W01001908	Dewstow	M
W01001547	Monmouthshire	Croesonen	W01001909	Croesonen	M
W01001550	Monmouthshire	Dewstow & Green Lane 1	W01001908	Dewstow	M
W01001570	Monmouthshire	Mardy 1	W01001909	Croesonen	M
W01001656	Newport	Marshfield 1	W01001912	Marshfield 4	S
W01001656	Newport	Marshfield 1	W01001913	Marshfield 5	S

Table of LSOA changes between the 2001 Census and 2011 Census continued

LSOA 2001	Local Authority	LSOA 2001 Name	LSOA 2011	LSOA 2011 Name	Change
W01001700	Cardiff	Butetown 2	W01001942	Butetown 3	S
W01001700	Cardiff	Butetown 2	W01001950	Butetown 6	S
W01001700	Cardiff	Butetown 2	W01001952	Butetown 8	S
W01001701	Cardiff	Butetown 3	W01001940	Butetown 2	S
W01001701	Cardiff	Butetown 3	W01001943	Butetown 4	S
W01001701	Cardiff	Butetown 3	W01001944	Butetown 5	S
W01001701	Cardiff	Butetown 3	W01001951	Butetown 7	S
W01001723	Cardiff	Cathays 6	W01001922	Cathays 9	S
W01001723	Cardiff	Cathays 6	W01001939	Cathays 10	S
W01001723	Cardiff	Cathays 6	W01001941	Cathays 11	S
W01001763	Cardiff	Grangetown 5	W01001945	Grangetown 10	S
W01001763	Cardiff	Grangetown 5	W01001947	Grangetown 12	S
W01001763	Cardiff	Grangetown 5	W01001946	Grangetown 11	S
W01001801	Cardiff	Llanishen 11	W01001949	Llanishen 11	S
W01001801	Cardiff	Llanishen 11	W01001953	Llanishen 12	S
W01001845	Cardiff	Radyr 1	W01001948	Radyr & Morganstown 3	S
W01001845	Cardiff	Radyr 1	W01001954	Radyr & Morganstown 4	S

M = merge, S = split, X = complex change

Further information on geographical boundary changes between the 2001 and 2011 Census can be found on the Office for National Statistics website.

The table below lists the number of LSOAs in each local authority in Wales.

Local Authority	Number of Lower Layer SOAs
Isle of Anglesey	44
Gwynedd	73
Conwy	71
Denbighshire	58
Flintshire	92
Wrexham	85
Powys	79
Ceredigion	46
Pembrokeshire	71
Carmarthenshire	112
Swansea	148
Neath Port Talbot	91
Bridgend	88
Vale of Glamorgan	79
Rhondda Cynon Taf	154
Merthyr Tydfil	36
Caerphilly	110
Blaenau Gwent	47
Torfaen	60
Monmouthshire	56
Newport	95
Cardiff	214

Annex E: Health Domain – Indirect Age-Sex Standardisation

Indirect standardisation involves applying age-sex specific rates observed at national level to the population structure of each LSOA. The reason for using age-sex standardisation for the WIMD health indicators is to adjust the indicators to allow for different age and sex distributions amongst LSOA populations. For example, one might expect to observe a higher rate of deaths in an aging population than in one consisting predominantly of young families. Standardisation attempts to adjust for these differences in population.

The number of expected incidences (for WIMD these are limiting long-term illness, cancer and death) for each age-sex group in an LSOA is estimated by multiplying the number of people in the given age-sex group in the LSOA by the age-sex specific rate observed for Wales as a whole for that age-sex group. The total number of expected incidences for the LSOA is calculated by totalling the number of expected incidences for each age-sex group. The standardised ratio (e.g. of cancer incidence) for each LSOA is the number of observed incidences in the LSOA divided by the number of expected incidences.

$$\text{standardised ratio} = \frac{\text{observed incidences}}{\text{expected incidences}}$$

An indirectly age-sex standardised rate can be obtained by multiplying the standardised ratio for the LSOA by the crude rate for all of Wales. The Welsh crude rate is the number of incidences observed in Wales divided by the total Welsh population. The result is expressed as a rate per 100,000 people.

$$\text{indirectly standardised rate} = \text{standardised ratio} \times \text{Welsh crude rate} \times 100{,}000$$

Annex F: Exponential Transformation of the Domain Indexes

The precise transformation involved is as follows. For any LSOA, denote its rank on the domain, scaled to the range (0,1], by R (with R=1/1909 for the least deprived, R=1909/1909=1 for the most deprived).

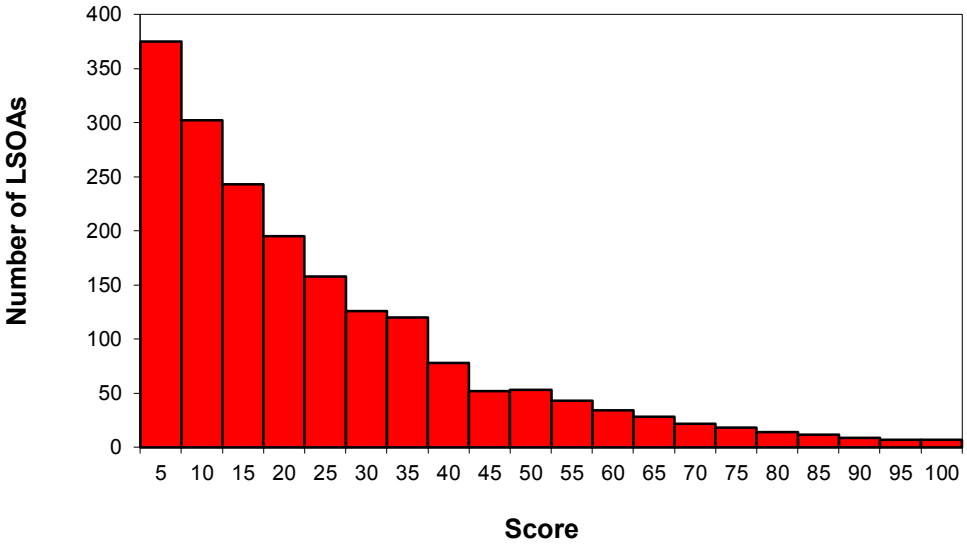
The transformed domain, (X) equals:

$-23 \times \log\{1 - R \times [1 - \exp(-100/23)]\}$,

where log denotes natural logarithm and exp the exponential or antilog transformation. This formula is straightforward to calculate and is in fact simpler than the commonly-used transformation to a normal curve, which requires the use of a look-up table. The resulting distribution is illustrated below in a histogram.

Each transformed domain has a range of 0 to 100, with a score of 100 for the most deprived LSOA. Ten percent of LSOAs have a score higher than 50. When transformed scores from different domains are combined by averaging them, the skewness of the distribution reduces the extent to which deprivation in one domain can be cancelled by lack of deprivation in another. For example, if the transformed scores on two domains are simply averaged, with equal weights, a (hypothetical) LSOA that scored 100 on one domain and 0 on the other would have a combined score of 50 and would thus be ranked at the 90th percentile (averaging the untransformed ranks, or after transformation to a normal distribution, would result in such a LSOA being ranked at the 50th percentile; the high deprivation in one domain would have been fully cancelled by the low deprivation in the other). Thus the extent to which deprivation in some domains can be cancelled by lack of deprivation in others is, by design, reduced.

Histogram of a transformed domain



Annex G: Parameters for Calculation of the Access to Services Domain

Introduction

A public consultation was held to agree proposals for WIMD 2014; this covered which services to include and the inclusion of indicators based on public and private travel times.

The indicators were agreed with the Access to Services domain group, the WIMD Advisory Group and the WIMD Steering Group.

Public transport

Public transport travel times will be calculated using Mapumental API[1]. The API will be used to generate Public Transport travel time grids for a given indicator.

Mapumental API calculates travel times using Dijkstra's algorithm and the National Public Transport Data Repository (NPTDR), dataset for real public transport journey times. The NPTDR covers the following public transport services:

- Public bus
- Public train
- National Coach

Mapumental API uses the following assumptions:

- a changeover time of 5 minutes at non-bus stops, 1 minute change at a bus stop;
- a walking speed between stops of 1.34m/s or 3 mph;
- a maximum walking time between two stops of 10 minutes[2]; and
- a maximum travel time of 4 and ¼ hours.

If the walking time between two stops exceeds ten minutes then, using the standard Dijkstra algorithm, we wait at the stop as long as necessary to continue the journey (i.e. until another service arrives).

Note also that walking speeds and times between stops are calculated irrespective of terrain (i.e. a passenger travels at a constant speed over all gradients) and obstacles (i.e. a passenger travels 'as the crow flies' between stops).

Walking is not permitted along motorways.

Trips where walking is the only mode of transport are permitted, if the single journey time is less than or equal to 20 minutes.

Public transport can be provided in England or Wales, where cross border travel is required.

Journey times (to the nearest minute), will be calculated by allocating a time value for each dwelling from the public transport travel time grid produced.

Private transport

Private transport travel times will be calculated using RouteFinder 4.02 for MapInfo[2].

[1] https://mapumental.com/api

Journey times will be calculated from every origin to the nearest service destination, calculated to the nearest minute.

The car network will be captured by using the Ordnance Survey Integrated Transport Network[3] supplied by Department for Transport in England (in a post-processed format that can integrate car speed data directly).

Car speeds will be applied to each link on the road network. This speed is based on Trafficmaster[4] (TM), data (data generated from the movements of GPS-equipped 'probe' vehicles which are mapped to a representation of the road network in order to estimate average vehicle journey times across England and Wales), taking into account actual delay on each road link. To provide sufficient coverage for TM observations across the road network, data observations will be set at the average speed of all observations on a road link for all weekdays, from November 2013 to April 2014 inclusive.

To ensure that TM gives a reasonable reflection of congestion along a road link, the minimum number of observations needed in order to apply the TM data to a road link is 5. Where the number of observations is less than 5, standard default speeds (less 10 per cent), will be used - the speeds for 'Alley' and 'Private Road - Publicly Accessible', were set to 10 mph.

Trafficmaster observations (Nov 2013 – April 2014 inclusive)

Table 1 Number of observations per ITN road link (Inter peak: 10:00 – 16:00).

DescTerm	Total links	Links with no observations	With at least 1 observation	>= 5 Obs	>=10 obs
Motorway	791	2	789	789	789
A Road	43,456	239	43,217	43,176	43,141
B Road	30,114	111	30,003	29,850	29,665
Minor Road	121,955	11,027	110,928	89,874	77,698
Local Street	251,114	117,029	134,085	104,610	86,643
Alley	18,469	14,494	3,975	724	376
Private Road - Publicly Accessible	3,195	1,873	1,322	1,042	875
Total	**469,094**	**144,775**	**324,319**	**270,065**	**239,187**

[2] http://www.routeware.dk/routefinder/routefinder.php

[3] http://www.ordnancesurvey.co.uk/business-and-government/products/itn-layer.html

[4] http://www.teletrac.co.uk/trafficmaster-traffic

Table 2 Number of observations per ITN road link (AM peak: 07:00 – 10:00)

DescTerm	Total links	Links with no observations	With at least 1 observation	>= 5 Obs	>=10 obs
Motorway	791	2	789	789	789
A Road	43,456	245	43,221	43,161	43,124
B Road	30,114	119	29,995	29,762	29,482
Minor Road	121,955	13,263	108,692	86,011	73,925
Local Street	251,114	120,090	131,024	99,980	81,330
Alley	18,469	14,902	3,567	658	341
Private Road - Publicly Accessible	3,195	1,905	1,290	991	828
Total	**469,094**	**150,526**	**318,568**	**261,352**	**229,819**

Table 3 Number of observations per ITN road link (PM peak: 16:00 – 19:00)

DescTerm	Total links	Links with no observations	With at least 1 observation	>= 5 Obs	>=10 obs
Motorway	791	2	789	789	789
A Road	43,456	239	43,217	43,169	43,143
B Road	30,114	113	30,001	29,816	29,656
Minor Road	121,955	10,736	111,219	90,606	78,756
Local Street	251,114	116,209	134,905	106,369	89,089
Alley	18,469	14,244	4,225	828	428
Private Road - Publicly Accessible	3,195	1,865	1,330	1,046	890
Total	**469,094**	**143,408**	**325,686**	**272,623**	**242,751**

The following modes of transportation will not be included in either category (this list is not exhaustive): bicycle, school buses, hail & ride services (due to a lack of data – not centrally collected), post buses, water taxis (timetable data not supplied by the NPTDR).

Origins

Origins will be captured by using the Residential dwellings from the AddressBase Premium[5] dataset (Epoch 22).

There are 1,350,664 residential dwellings in Wales in the origins dataset.

[5] http://www.ordnancesurvey.co.uk/business-and-government/products/addressbase-premium.html

Services

The services included are:

- Pharmacy (New to WIMD 2014)
- Food shop
- General Practitioner (GP)
- Public library
- Post office
- Primary school
- Leisure centre
- Petrol station (private transport time only)
- Secondary school

Travel times

Travel times are used for both public and private (rather than distance).

The journey to a service from a residential dwelling is defined as the **journey to the service.**

The journey to a residential dwelling from a service is defined as the **journey to the residential dwelling**.

The journey to the service is a defined as **single journey**, as is the journey to residential dwelling. The combination of these two elements is defined as the **return journey**.

Travel times will be calculated for a one way single journey at a specific time. The maximum specified travel time for a single journey will be 90 minutes (1.5 hours).

Any travel times over 90 minutes will be given the value of 90 minutes.

Travel times are defined as the time taken to travel from a residential dwelling to the services; the quickest travel times to the individual services will be used.

The private travel time and public travel times may refer to different services of the same type (i.e. an individual using public transport may go to a different GP than an individual using private transport).

Travel times to services located in England will be included.

Time periods

Public transport: three travel times were calculated for both the journey to the service and the journey to the residential dwelling. The average (mean), of the three journeys to the service times were added to the average of the three journeys to the residential dwelling times. Calculating the average of the three journeys in both directions reflects the service frequency for a particular journey.

Private transport: two journeys to the service time were calculated; the travel time of these two journeys were summed.
Note: This has the same effect as averaging the two values and then doubling to take into account the return journey. Doubling the single journey time as the journey to and from the

dwelling will show no/very little difference by private transport. This wouldn't be the case by public transport.

The times of travel by public transport journeys were:

Service	Day	Arrive/ Depart	Time		
Primary School	Tuesday	Arrive	8:30	8:45	9:00
Primary School	Tuesday	Depart	15:30	16:00	16:30
Secondary School	Tuesday	Arrive	8:30	8:45	9:00
Secondary School	Tuesday	Depart	15:30	16:00	16:30
Food shop	Tuesday	Arrive	9:00	10:00	11:00
Food shop	Tuesday	Depart	11:00	12:00	13:00
GP	Tuesday	Arrive	9:00	10:00	11:00
GP	Tuesday	Depart	11:00	12:00	13:00
Pharmacy	Tuesday	Arrive	9:00	10:00	11:00
Pharmacy	Tuesday	Depart	11:00	12:00	13:00
Public Library	Tuesday	Arrive	9:00	10:00	11:00
Public Library	Tuesday	Depart	11:00	12:00	13:00
Post Office	Tuesday	Arrive	9:00	10:00	11:00
Post Office	Tuesday	Depart	11:00	12:00	13:00
Leisure Centre	Tuesday	Arrive	16:00	17:00	18:00
Leisure Centre	Tuesday	Depart	18:00	19:00	20:00

The times of travel by private transport journeys were:

Service	Weekday travel time period
Primary School	AM peak (07:00 – 10:00)
Secondary School	AM peak (07:00 – 10:00)
Food Shop	Inter-peak (10:00 – 16:00)
GP	Inter-peak (10:00 – 16:00)
Pharmacy	Inter-peak (10:00 – 16:00)
Public Library	Inter-peak (10:00 – 16:00)
Post Office	Inter-peak (10:00 – 16:00)
Petrol Station	Inter-peak (10:00 – 16:00)
Leisure Centre	PM peak (16:00 – 19:00)

Note: Petrol stations are only included in the private transport journey travel times.

Data sources

The following data sources were used for the locations of services.

Service	(Num. of) Locations	Data Source	Complied by	Currency
GPs	983	NHS Wales Directory	Welsh Government	January 2014
Primary Schools	1,522 (inc. 4 Middle Schools)	Welsh Government (Wal); Landmark InterestMap[6] (Eng)	Welsh Government	September 2013
Secondary Schools	258 (inc. 4 Middle Schools)	Welsh Government (Wal); Landmark InterestMap (Eng)	Welsh Government	September 2013
Sports Halls/Leisure Centres	319	Local Authorities	Sports Council for Wales	January 2014
Food Shops	2,656	Landmark InterestMap	Welsh Government	January 2014
Post offices	1,000	Landmark InterestMap	Welsh Government	January 2014
Public Library	297	Local Authorities	Welsh Government	January 2014
Pharmacies	819	NHS Wales Directory (Wal); Local Authorities (Eng)	Welsh Government	January 2014
Petrol stations	860	Landmark InterestMap	Welsh Government	January 2014

Provision to the WIMD team

Content and format

The data will be provided as a CSV file.

The data set provided to the WIMD team included a record for every residential dwelling (1,350,664 records) and values for each indicator, for the 6 public transport journeys and the private transport journey time.

[6] http://www.promap.co.uk/maps-and-data/points-of-interest/point-x

The variables in the table (with examples for Primary Schools and Libraries), were:

Variable code	Variable description
Residential dwelling code	A unique value for each residential household
Residential Dwelling Address	Full address of each residential households
Residential Dwelling LSOA	Lower Layer Super Output area which the dwelling resides within
Residential Dwelling LA Code	Local Authority in which the dwelling resides
Residential Dwelling LA Name	Name of Local Authority in which the dwelling resides
Primary School_PT_TUE_ARR_0830	*Journey to the nearest Primary School, on a Tuesday, to arrive at 0830.*
Primary School_PT_TUE_ARR_0845	*Journey to the nearest Primary School, on a Tuesday, to arrive at 0845.*
Primary School_PT_TUE_ARR_0900	*Journey to the nearest Primary School, on a Tuesday, to arrive at 0900.*
Primary School_PT_TUE_DEP_1530	*Journey to the nearest Primary School, on a Tuesday, to depart at 1530.*
Primary School_PT_TUE_DEP_1600	*Journey to the nearest Primary School, on a Tuesday, to depart at 1600.*
Primary School_PT_TUE_DEP_1630	*Journey to the nearest Primary School, on a Tuesday, to depart at 1630.*
Primary School_Car_AM_peak	*Journey to the nearest Primary School, travelling during AM peak times (0700-1000), by private transport.*
Library_PT_TUE_ARR_0900	*Journey to the nearest Library, on a Tuesday, to arrive at 0900.*
Library_PT_TUE_ARR_1000	*Journey to the nearest Library, on a Tuesday, to arrive at 1000.*
Library_PT_TUE_ARR_1100	*Journey to the nearest Library, on a Tuesday, to arrive at 1100.*
Library_PT_TUE_DEP_1100	*Journey to the nearest Library, on a Tuesday, to depart at 1100.*
Library_PT_TUE_DEP_1200	*Journey to the nearest Library, on a Tuesday, to depart at 1200.*
Library_PT_TUE_DEP_1300	*Journey to the nearest Library, on a Tuesday, to depart at 1300.*
Library_Car_Inter_peak	*Journey to the nearest Library, travelling during inter-peak peak times (1000-1600), by private transport.*

Data quality assurance and validation

Data were quality assured by the Geography & Technology department and then provided to the WIMD team.

Quality Assurance process:

Public Transport

- A comparison was done with results using desktop Public Transport accessibility software TRACC[7] for 1,000 dwellings in Wales (against all indicators)
- A visual 'sense check' for each set of results, in the form of a heat map, was also done

Private Transport

- A comparison with results using standard road speeds (-10 per cent), and a comparison against Google maps 'directions' for a sub-set of dwellings (against all indicators)
- A visual 'sense check' for each set of results, in the form of a heat map, was also done

[7] http://www.basemap.co.uk/software/tracc.aspx

Annex H: Flood Risk Category Weightings

The Flood Risk indicator considers the proportion of households at risk of flooding from rivers and the sea (but not surface water flooding). The risk is based on predicted frequency rather than the level of damage caused by flooding. The numbers of households at significant risk of flooding are given higher weighting than those at lower risk.

Due to a change in flooding categories, new weights were required for WIMD 2014. The method was developed in partnership with Natural Resources Wales.

WIMD 2011 – Flood Risk indicator

In WIMD 2011, the flood indicator was calculated using National Flood Risk Assessment (NaFRA) 2009 data. The level of flood risk (Significant, Moderate, Low) was taken into account in the calculation by applying a weighting factor to the number of properties within each LSOA at each risk category before being converted into a single index.

NaFRA Category	Definition (chance of flooding in any given year)	% of residential properties at risk of flooding	Weighting
Significant	Greater than or equal to 1 in 75	2.6%	0.04 (or 16)
Moderate	Less than 1 in 75 but greater than or equal to 1 in 200	2.3%	0.01 (or 4)
Low	Less than 1 in 200	2.8%	0.0025 (or 1)

WIMD 2014 – Flood Risk indicator

The way Flood Risk is communicated changed during 2013. Following consultation, it was agreed that WIMD 2014 would use the new externally published NaFRA risk categories. New weighting factors are required for the new risk categories.

NaFRA Category	Definition (chance of flooding in any given year)	% of residential properties at risk of flooding	Weighting
High	Greater than or equal to 1 in 30	0.6%	0.06 (or 24)
Medium	Less than 1 in 30 but greater than or equal to 1 in 100	1.3%	0.01 (or 4)
Low	Less than 1 in 100 but greater than or equal to 1 in 1000	5.6%	0.0025 (or 1)
Very Low	Less than 1 in 1000.	0.05%	0.0025 (or 1)

New method for determining weights

It is proposed that we use information on average flooding damages as produced by the Middlesex University Flood Hazard Research Centre in their Multi Colour Manual. It is assumed that implications on quality of life are increased as potential damage increases.

The damage values are assigned based on a sample of damages calculated to individual properties experiencing flooding from a range of modelled events for specific return-periods. No differentiation is made between the types of residential property.

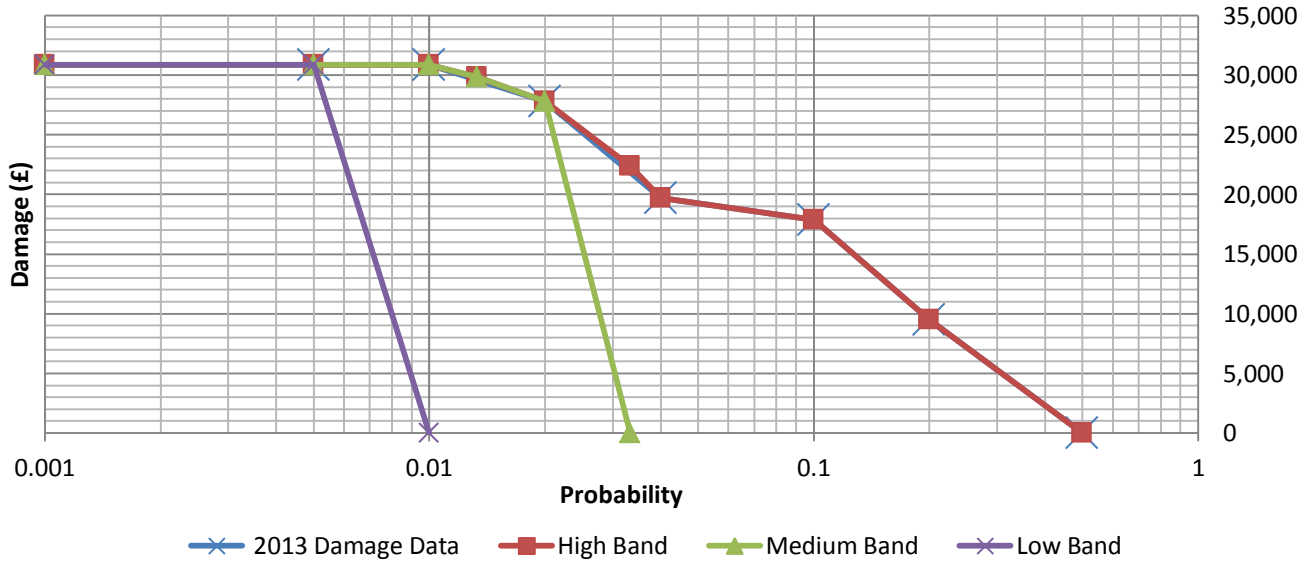
Flood Frequency	Damage (£)
5	9,500
10	17,847
25	19,716
50	27,776
100	30,877

Source: Economic Appraisal Manual, 2013

The weighted annual average flood damage (WAAD) is the area under the graph of flood damages plotted against exceedence probability (the reciprocal of the return period in years). This is the area under the curve in

.

Figure 1 Damage vs Probability



For properties in the high NaFRA band, the probability of onset of flooding is 0.5. For properties in the medium and lower risk bands, the probability of the onset of flooding is reduced. The WAAD for each band is approximated to the area under each curve.

Assumptions

(a) The weighted annual average damage calculation is based on properties within the extent of floodzone 2 of the NRW floodmap. This equates to properties with a greater than 0.1 per cent annual chance of flooding.

(b) For the UK in general, for increasingly extreme events the numbers of properties affected increases but average depths tend to be less than 1 m.

(c) The new very low flooding category is an artefact of combining NaFRA 50 m model squares with the extreme flood outline and affects a very small proportion of properties. Properties will be given the same low weighting.

Summary

Return Period	Exceedence Probability	WAAD Value	WAAD Ratio	WIMD Value	WIMD Ratio
30	0.0333	4976	23.5	0.0600	24
100	0.0100	767	3.6	0.0100	4
1000	0.0010	211	1	0.0025	1

Supporting data and calculations

Table 1 Source Table 4.32, "FCERM: Manual for Economic Appraisal 2013" FHRC

Return Period	Exceedence Probability	Damage (£)	Probability Interval	Mean Damage (£)	Annual Interval Damages (£)
2	0.500	0			
			0.300	4,750	1,425
5	0.200	9,500			
			0.100	13,674	1,367
10	0.100	17,847			
			0.060	18,782	1,127
25	0.040	19,716			
			0.020	23,746	475
50	0.020	27,776			
			0.010	29,327	293
100	0.010	30,877			
			0.005	30,877	154
200	0.005	30,877			
				WAAD	**4,842**

Table 2 High Band WAAD Calculation

Return Period	Exceedence Probability	Damage (£)	Probability Interval	Mean Damage (£)	Annual Interval Damages (£)
2	0.500	0			
			0.300	4,750	1,425
5	0.200	9,500			
			0.100	13,674	1,367
10	0.100	17,847			
			0.060	18,782	1,127
25	0.040	19,716			
			0.007	21,059	140
30	**0.033**	**22,403**			
			0.013	25,089	335
50	0.020	27,776			
			0.007	28,810	192
75	**0.013**	**29,843**			
			0.003	30,360	101
100	0.010	30,877			
			0.005	30,877	154
200	0.005	30,877			
			0.004	30,877	134
1,000	0.001	30,877			
				WAAD	**4,976**

Table 3 Medium Band WAAD Calculation

Return Period	Exceedence Probability	Damage (£)	Probability Interval	Mean Damage (£)	Annual Interval Damages (£)
2	0.500	0			
			0.300	0	0
5	0.200	0			
			0.100	0	0
10	0.100	0			
			0.060	0	0
25	0.040	0			
			0.007	0	0
30	**0.033**	**0**			
			0.013	13,888	185
50	0.020	27,776			
			0.007	28,810	192
75	**0.013**	**29,843**			
			0.003	30,360	101
100	0.010	30,877			
			0.005	30,877	154
200	0.005	30,877			
			0.004	30,877	134
1,000	0.001	30,877			
				WAAD	**767**

Table 4 Low Band WAAD Calculation

Return Period	Exceedence Probability	Damage (£)	Probability Interval	Mean Damage (£)	Annual Interval Damages (£)
2	0.500	0			
			0.300	0	0
5	0.200	0			
			0.100	0	0
10	0.100	0			
			0.060	0	0
25	0.040	0			
			0.007	0	0
30	**0.033**	**0**			
			0.013	0	0
50	0.020	0			
			0.007	0	0
75	**0.013**	**0**			
			0.003	0	0
100	0.010	0			
			0.005	15,439	77
200	0.005	30,877			
			0.004	30,877	134
1,000	0.001	30,877			
				WAAD	**211**