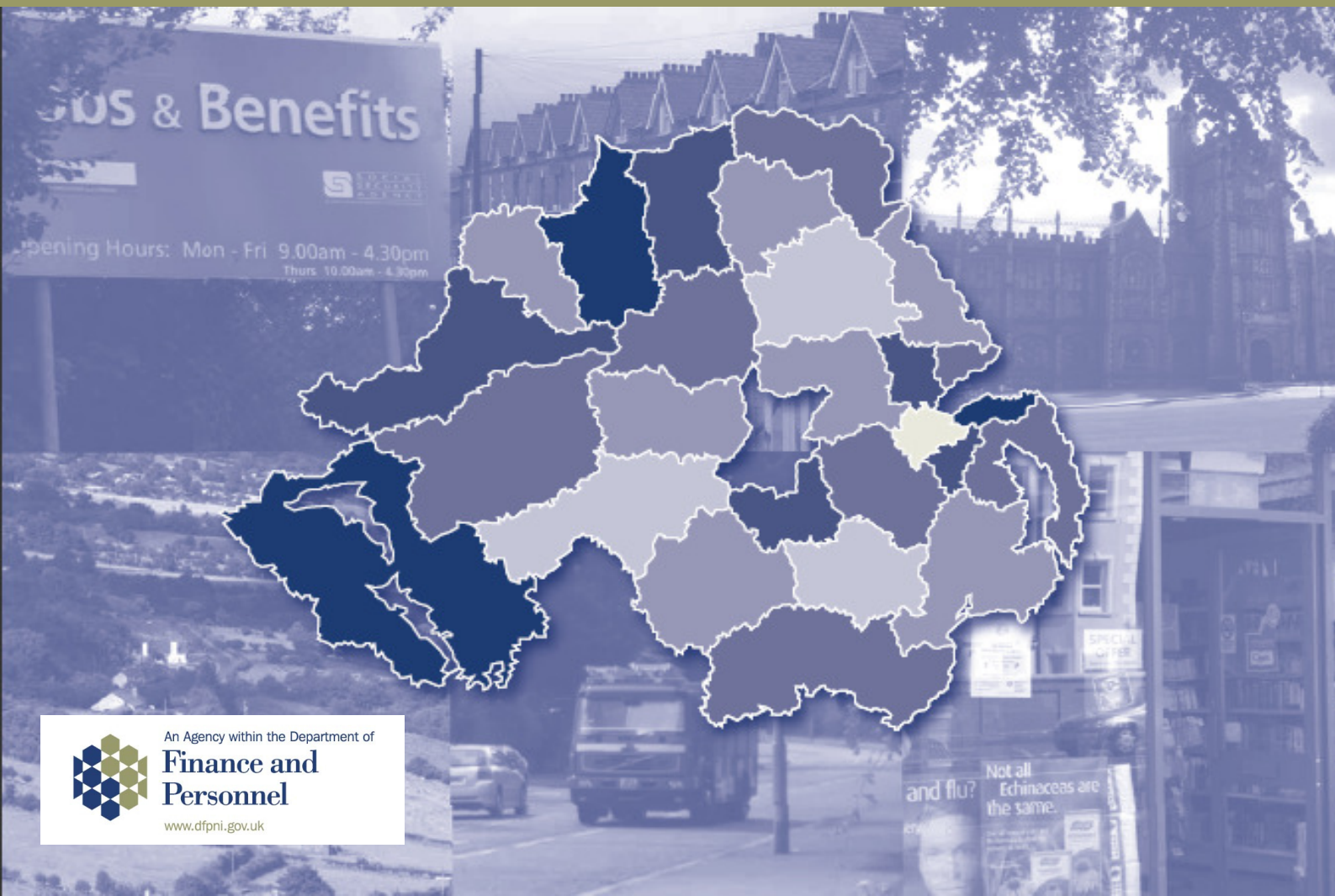




Northern Ireland  
**Statistics &  
Research**  
Agency

# Northern Ireland Multiple Deprivation Measure 2010: Domain Weight Analysis



An Agency within the Department of  
**Finance and  
Personnel**  
[www.dfpni.gov.uk](http://www.dfpni.gov.uk)



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## 1. Introduction

The purpose of this document is to consider the domain weights used in the construction of the Northern Ireland Multiple Deprivation Measure (NIMDM). It considers the domain weights used in the previous NIMDMs, alternative methods of choosing domain weights and an analysis of alternatives to the published NIMDM 2010 domain weights.

## 2. NIMDM 2001, 2005 and 2010 Weights

Three recent measures of small area deprivation in Northern Ireland (NIMDM 2001, NIMDM 2005 and NIMDM 2010) have been based on a 'domain' methodology where information is combined on separate forms or 'domains' of deprivation to construct an overall measure of multiple deprivation. An explicit weight is given to each of the domains when combining to form the overall multiple deprivation measure based on a number of considerations.

There are at least five options for selecting the weights.<sup>1</sup> These are:

1. Driven by theoretical considerations
2. Empirically driven
3. Determined by policy relevance
4. Determined by consensus
5. Other grounds

### *Weights driven by theoretical considerations*

In the theoretical approach, account is taken of the available research evidence which informs the theoretical model of multiple deprivation and weights are selected which reflect this theory.

### *Empirical approaches to weighting*

There are two sorts of approaches that might be applicable here. First a commissioned survey or re-analysis of an existing survey could generate weights. Here one might generate a proxy for multiple deprivation or exclusion - perhaps in terms of 'socially perceived necessities' and use multivariate

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<sup>1</sup> [http://www.nisra.gov.uk/deprivation/archive/dep\\_consult.pdf](http://www.nisra.gov.uk/deprivation/archive/dep_consult.pdf), section 7.

predictive modelling to derive weights. Then one might apply a technique such as Factor Analysis to extract some latent 'factor' called 'multiple deprivation' assuming, that is, that the analysis permitted a single factor solution.

*Weights determined by policy relevance*

It might be that only the individual domain scores could be released and weighted for combination in accordance and (proportion) to the focus of particular policy initiatives or weighted in accordance with public expenditure on particular areas of policy.

*Weights determined by consensus*

Policy makers and other 'customers' or experts could simply be trawled for their views and the results examined for consensus.

*Weights chosen on other grounds*

Simply choosing weights without reference to the above or deciding to use equal weights in the absence of empirical evidence would come into this category.

## **2.1. NIMDM 2001<sup>2</sup>**

In the NIMDM 2001 theoretical considerations prevailed. Reviews of the relevant literature indicated that low income and dislocation from the labour market are key drivers of other deprivations such as poor health outcomes (see for example Mitchell et al, 2000; Gallie et al, 1994), and poor educational attainment (see for example Halsey, Heath and Ridge, 1980; Smith and Noble, 1997; DWP, 2002; Sparkes, 1999) and should therefore be up-weighted in any measures of multiple deprivation.

In addition in the NIMDM 2001 this overriding criterion was modified such that domains supported by the most robust data were weighted more than those where the data were less robust but still sufficiently robust for inclusion. The Income Deprivation and Employment Deprivation domains were regarded as the most important contributors to the concept of multiple deprivation and the indicators comprising the domains were very robust. It was therefore decided that they should carry more weight than the other domains. As such weights of 25%, 25%, 15%, 15%, 10%, 5% and 5% were assigned to the Income deprivation, Employment deprivation, Health deprivation and disability, Education, skills and training deprivation, Geographical access to services, Social environment, and Housing stress domains respectively. The resulting weightings of the domains were supported by the research team's work and the consultation process.

## **2.2. NIMDM 2005<sup>3</sup>**

Two sets of weights were proposed by the research team in the consultation exercise<sup>4</sup> associated with the creation of the NIMDM 2005. One suggested set was identical to the weighting structure used in NIMDM 2001. The second suggested set gave a 25% weight each to the Income and Employment domains and 10% weight each to the remaining five domains. (The Social Environment domain and the Housing Stress domain were also replaced by

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<sup>2</sup>See [http://www.nisra.gov.uk/deprivation/archive/Measures%20of%20Deprivation%20for%20Northern%20Ireland%20\(28th%20June\).pdf](http://www.nisra.gov.uk/deprivation/archive/Measures%20of%20Deprivation%20for%20Northern%20Ireland%20(28th%20June).pdf) for NIMDM 2001 report

<sup>3</sup> See <http://www.nisra.gov.uk/deprivation/archive/NIMDM2005FullReport.pdf> for NIMDM 2005 report

<sup>4</sup> See [http://www.nisra.gov.uk/deprivation/archive/dep\\_consult.pdf](http://www.nisra.gov.uk/deprivation/archive/dep_consult.pdf) for Consultation Document

the Crime and Disorder domain and the Living Environment domain respectively.)

The consultation responses, research team's work and available wider academic literature supported a continued use of the weights employed in 2001; 25%, 25%, 15%, 15%, 10%, 5% and 5% assigned to the Income deprivation, Employment deprivation, Health Deprivation and Disability, Education, Skills and Training deprivation, Proximity to Services, Crime and Disorder and Living Environment domains respectively.

### **2.3. NIMDM 2010<sup>5</sup>**

The NIMDM 2010 was intended as an update to the NIMDM 2005. The scope of the update was broadly limited to a temporal update of the indicators and domains as used in the NIMDM 2005. Indicators were revised only where explicitly recommended in the 2005 research, where indicators were no longer available or where data sources had been significantly enhanced. As such a revision of the domain weights was outside the remit of the update, and the domain weights remained as per the NIMDM 2005.

### **2.4. Future Measures of Deprivation**

It is likely that measures of small area deprivation will be created after publication of the small area results of the 2011 Census. A fuller methodological review, including an examination of domain weights, will take place at this point.

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<sup>5</sup> See [http://www.nisra.gov.uk/deprivation/archive/Updateof2005Measures/NIMDM\\_2010\\_Report.pdf](http://www.nisra.gov.uk/deprivation/archive/Updateof2005Measures/NIMDM_2010_Report.pdf) for a copy of the full NIMDM 2010 report.

### 3. Sensitivity Analysis of Alternative Domain Weights

This section provides an analysis of the extent to which a change in the weights assigned to domains impacts on the final Northern Ireland Multiple Deprivation Measure 2010 ranks.

#### 3.1. Published and Alternative Domain Weights

The published domain weights used in the creation of the Northern Ireland Multiple Deprivation Measure 2010 are shown in Table 1 below. Two alternative sets of domain weights are also shown and considered.

Firstly the NIMDM 2010 was recalculated assuming that each domain receives equal weight. This set of weights has been labelled 'equal weights' (or 'equal'/'eql'). Secondly an additional set of weights was created by inverting the published domain weights. These have been labelled 'inverted weights' (or 'inverted'/'inv'). These weights were calculated by taking the reciprocal of each individual weight and rescaling all seven weights so that they sum to 100.

Table 1: Published and alternative NIMDM 2010 domain weights

<b>Domain of deprivation</b>	<b>Published weights (%)</b>	<b>Equal weights (% , 1dp)</b>	<b>Inverted weights (% , 1dp)</b>
Income	25	14.3	5.6
Employment	25	14.3	5.6
Health deprivation & disability	15	14.3	9.3
Education, skills and training	15	14.3	9.3
Proximity to Services	10	14.3	14.0
Living Environment	5	14.3	28.0
Crime and Disorder	5	14.3	28.0

The NIMDM 2010 was recalculated using each alternative set of weights. The resulting ranks are compared in Section 3.2.



### 3.2. Comparing Ranks from Alternative Domain Weight Models

The NIMDM 2010 domains were combined into an overall multiple deprivation measure using each of the three sets of weights shown in Table 1. These calculations were made at the Super Output Area (SOA) level as this is the primary output geography of the NIMDM 2010. A number of comparisons between the measures have been made below.

Note that as in the construction of the NIMDM 2010 the seven domain ranks are exponentially transformed before they are combined. For further information regarding the exponential transformation including how and why it is used, see page 66 of the NIMDM 2010 report.<sup>6</sup>

#### 3.2.1. Correlation Coefficients

The published NIMDM 2010 was compared with measures recalculated using equal weights and inverted weights. Correlation coefficients range from perfect negative correlation -1, to perfect positive correlation +1. The correlation coefficients calculated from NIMDM 2010 ranks using published and alternative weights were:

- Published weights & equal weights:  $r = 0.98$  (2 decimal places)
- Published weights & inverted weights:  $r = 0.89$  (2 decimal places)

Both alternative sets of weights correlate strongly and positively with the published NIMDM 2010 results. The 'equal weights' recalculation correlates particularly strongly. The mean absolute difference in ranks<sup>7</sup> between SOAs using published and equal weights is 37 ranks. The mean absolute difference in ranks between SOAs using published and inverted weights is larger, at 89 ranks.

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<sup>6</sup> NI Multiple Deprivation Measure 2010 report, May 2010

[http://www.nisra.gov.uk/deprivation/archive/Updateof2005Measures/NIMDM\\_2010\\_Report.pdf](http://www.nisra.gov.uk/deprivation/archive/Updateof2005Measures/NIMDM_2010_Report.pdf)

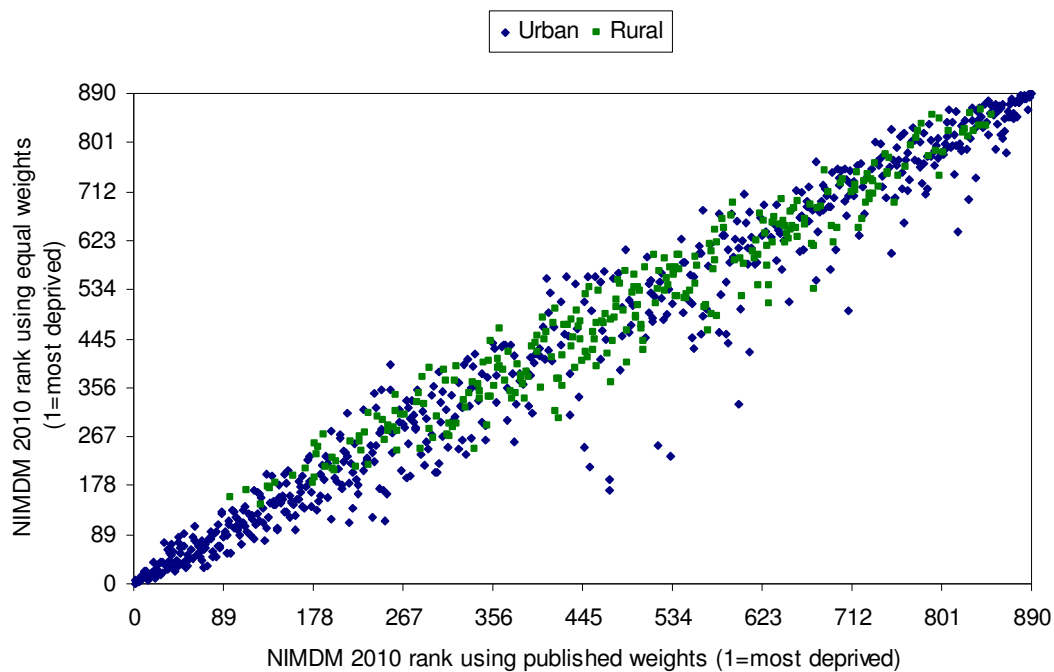
<sup>7</sup> Calculated at the SOA level by first the difference between each published and recalculated rank and then taking the absolute value of this difference. The figure quoted above is the mean value across all 890 SOAs.

### 3.2.2. Scatter Plots

#### A. Comparing Published Ranks and Ranks from Equal Weights

Figure 1 below plots the published NIMDM 2010 ranks against the NIMDM 2010 ranks recalculated with equal domain weights. Blue points represent urban SOAs and green points represent rural SOAs.

Figure 1 – Scatter plot of NIMDM 2010 ranks (published weights against equal weights) for all 890 urban and rural Super Output Areas



Note the strong, positive correlation between the two sets of ranks. SOAs tend to have similar ranks towards both ends of the distribution i.e. the most and least deprived SOAs in Northern Ireland. The greatest differences occur in urban SOAs towards the centre of the distribution. Such SOAs tend to be located below the diagonal i.e. they are considered relatively more deprived when equal weights are used than when the published weights are used.

#### *SOAs experiencing large changes in rank*

On closer inspection these areas constitute a cluster of SOAs in South Belfast that appears to be more sensitive to this change in domain weights than other

SOAs. There are ten SOAs whose ranks differ by more than 156 ranks.<sup>8</sup> For example Botanic 1 SOA is ranked at 532 in the published NIMDM 2010 and 230 using equal weights. Similarly Stranmillis 3 SOA is ranked at 817 in the published NIMDM 2010 and 639 using equal weights. In each case the SOA is considered relatively more deprived when equal weights are used rather than published weights. These SOAs include parts of Botanic (four SOAs), Windsor (three SOAs), Stranmillis, Ravenhill and Ballynafeigh (one SOA each). One characteristic that most of these SOAs have in common is relatively large student populations.<sup>9</sup> The use of equal weights lessens the importance of the income and employment domains, which count those in receipt of income or employment related benefits. Lowering the weight of the income and employment domains may result in SOAs with large proportions of students being ranked as relatively more deprived if such areas were considered deprived on other domains.

### *Rural Areas*

Using the 'Statistical Classification and Delineation of Settlements' report produced by the Inter-Departmental Urban-Rural Definition Group in February 2005. The 890 SOAs in Northern Ireland were defined as either urban or rural. Approximately one third of SOAs (286) were classed as rural and two-thirds (604) were classed as urban. Figure 1 shows that few of the SOAs within rural areas were ranked in the most deprived deciles in Northern Ireland while a large proportion of rural SOAs featured in the middle deciles. See also pages 38-39 of the NIMDM 2010 report.<sup>6</sup> Considering only rural SOAs reveals a similar relationship between the published NIMDM 2010 ranks and the recalculated 'equal weight' ranks. The correlation coefficient between rural SOAs using published and equal weights,  $r=0.97$ , and the mean absolute difference in ranks<sup>7</sup> is 36 ranks.

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<sup>8</sup> 156 is three times the interquartile range of the absolute difference in ranks between the published measure and 'equal-weights' measure. This is an often used rule of thumb for identifying 'extreme outliers'.

<sup>9</sup> Of the ten SOAs identified, eight had more than 10% of their population classed as full-time students at the time of the 2001 Census compared to NI average of 2.4%.

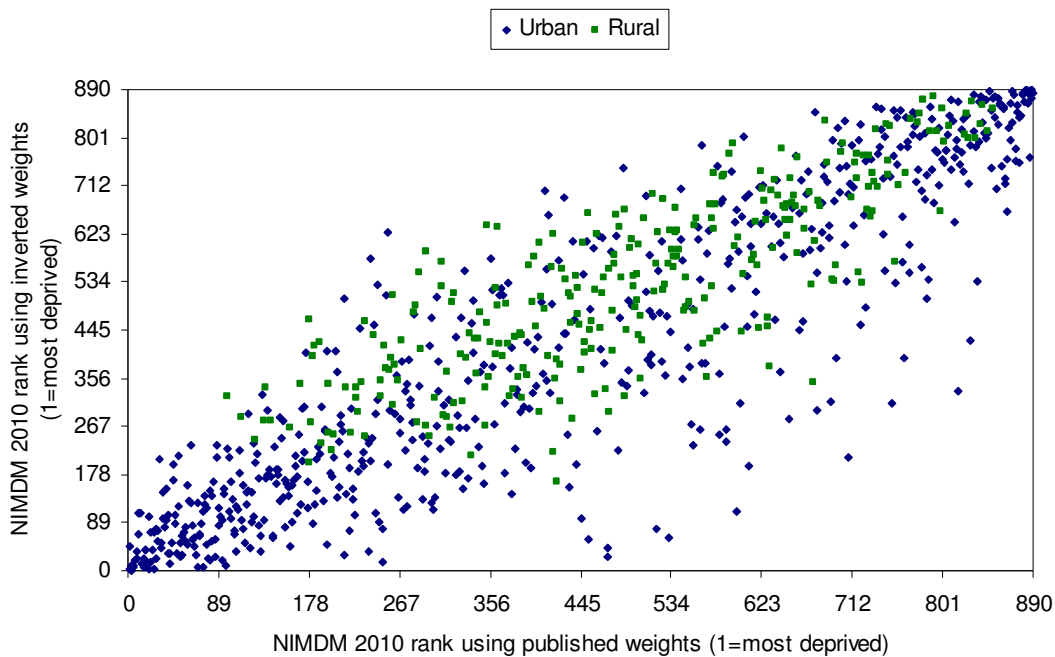
<http://www.ninis.nisra.gov.uk/mapxtreme/viewdata/Census/CensusKS09B.xls>

<http://www.ninis.nisra.gov.uk/mapxtreme/viewdata/Census/CensusKS09C.xls>

Males/females aged 16-74, economically active, full-time students

## B. Comparing published ranks and ranks from inverted weights

Figure 2 – Scatter plot of NIMDM 2010 ranks (published weights against inverted weights) for all 890 urban and rural Super Output Areas



Note the positive correlation between the published ranks and inverted ranks in Figure 2. As with the comparison of ranks calculated from published weights and equal weights, SOAs tend to have similar ranks towards both ends of the distribution i.e. the most and least deprived SOAs in NI. Once again the greatest differences in ranks occur in urban SOAs towards the centre of the distribution. Such SOAs are often located below the diagonal i.e. they are considered relatively more deprived when inverted weights are used than when the published weights are used.

### *SOAs experiencing large changes in rank*

Comparing the published NIMDM 2010 ranks with ranks calculated using the inverted domain weights (so that income and employment are the *least* important domains) has a larger effect on the previously identified cluster of SOAs with larger proportions of students. Of these ten SOAs, none lie within the most deprived 10% of SOAs in NI according to the published NIMDM 2010 ranks. Switching to equal weights makes all ten SOAs more deprived however none lie within the most deprived 10% in NI. Switching to inverted weights moves five of these ten SOAs into the most deprived 10% of SOAs in

NI. This group of SOAs seems to be more sensitive than most to changes in weights, particularly if income and employment no longer carry the largest weights.<sup>10</sup>

### *Rural Areas*

Considering only rural SOAs maintains the strong, positive correlation between the published NIMDM 2010 ranks and the recalculated 'inverted weight' ranks. The correlation coefficient between rural SOAs using published and inverted weights,  $r=0.82$ , and the mean absolute difference in ranks<sup>7</sup> is 89 ranks.

### **3.3. Correlations between NIMDM 2010 domains**

The observed stability of most of the NIMDM 2010 SOA ranks to changes in the underlying domain weights is due to the strong correlations between most of the domains. Table 2 shows the correlation coefficients between the seven different domains and the overall measure.

**Table 2:** Correlation coefficients between NIMDM 2010 and domains

	<b>Income</b>	<b>Employment</b>	<b>Health</b>	<b>Education</b>	<b>Proximity</b>	<b>Living Environment</b>	<b>Crime and Disorder</b>
<b>Income</b>	1.00	0.94	0.94	0.88	-0.32	0.61	0.55
<b>Employment</b>		1.00	0.93	0.84	-0.29	0.54	0.48
<b>Health</b>			1.00	0.85	-0.37	0.59	0.55
<b>Education</b>				1.00	-0.36	0.64	0.54
<b>Proximity</b>					1.00	-0.52	-0.66
<b>Living Environment</b>						1.00	0.63
<b>Crime and Disorder</b>							1.00
<b>NIMDM 2010</b>	<b>0.97</b>	<b>0.95</b>	<b>0.94</b>	<b>0.91</b>	<b>-0.27</b>	<b>0.65</b>	<b>0.53</b>

<sup>10</sup> If the process used to identify the cluster of SOAs whose ranks differ the most is repeated for inverted weights, a cluster of eleven SOAs are identified. Nine of these are the same as before and two new SOAs are added to the cluster - another SOA in Windsor and one from Malone, both in South Belfast. The Ballynafeigh SOA drops out.

Six of the seven deprivation domain ranks at SOA level are positively correlated with each other indicating that an area experiencing one form of deprivation tends to also experience other forms of deprivation. Of particular note were the strong, positive correlations between the income, employment, health deprivation and disability and education, skills and training domains, with each pair-wise correlation at least +0.84. The Living Environment and Crime and Disorder domain ranks are also positively correlated with each other and with the four domains described above, but to a lesser extent, with all pair-wise correlations at least +0.48.

The Proximity to Services domain ranks exhibit negative correlations with the other six domains, suggesting that as Proximity to Services deprivation increases, deprivation in the other domains tends to decrease.

A change in the domain weight model such that the Proximity to Services domain has the most weight is likely to have the largest impact on the MDM ranks when compared to the published results due to the negative correlation between the Proximity to Services domain and the other six domains.

#### **4. How to Create and Compare Domain Weight Models**

The spreadsheet 'NIMDM\_2010\_user\_defined\_domain\_weights.xls'<sup>11</sup> allows the calculation of a multiple deprivation measure based on the existing domain ranks but specifying alternative domain weights. Firstly decide how many domains you would like to use and their weights, taking the alternative approaches to deciding domain weights into account. Open the 'NIMDM2010\_user\_defined\_domain\_weights.xls' spreadsheet and then follow the instructions below:

- 1) Click on the 'Choose Weights' tab to enter domain weights.
- 2) Type your chosen domain weights into the 'user-defined weights' cells.
- 3) Click 'Go to Results' or select the 'Results' tab.

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[http://www.nisra.gov.uk/deprivation/archive/Updateof2005Measures/NIMDM\\_2010\\_user\\_defined\\_domain\\_weights.xls](http://www.nisra.gov.uk/deprivation/archive/Updateof2005Measures/NIMDM_2010_user_defined_domain_weights.xls) Note: You may need to select 'enable macros' if prompted. If you cannot enable macros the 'Go to Results' button will not work but you can manually click on the 'Results' tab at the bottom of the screen instead.

The spreadsheet will display a list of all 890 Super Output Areas, the published NIMDM 2010 rank and the newly calculated rank based on your chosen weights. The spreadsheet will also show the rank correlation coefficient between, and a scatter plot of the two sets of ranks.

## **5. Summary**

- The Northern Ireland Multiple Deprivation Measures (NIMDM) 2001, 2005 and 2010 were based on the 'domain' methodology. Separate domains are combined with weights to form the overall measure. There are a number of options for selecting domain weights.
- The Northern Ireland Multiple Deprivation Measure 2001 chose weights based on theoretical considerations. Available research evidence was used to inform the theoretical model of multiple deprivation and weights were selected which reflected this theory.
- These weights were used in the NIMDM 2005 after being consulted on. As the NIMDM 2010 was limited in scope to an update of the 2005 measure the same weights were used.
- NIMDM 2010 ranks are relatively robust to changes in the domain weights. Two alternative sets of domain weights, 'equal weights' and 'inverted weights', provided ranks which correlated strongly and positively with the published NIMDM 2010 ranks.
- Six of the seven domains that make up the NIMDM 2010 are positively correlated. As the most deprived areas tend to be deprived on more than one domain, changes to the domain ranks do not have a large effect on the overall NIMDM 2010 ranks.
- It is possible for users to create a measure based on an alternative weighting model using the same methodology as the NIMDM.

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