



Population and Household Estimates for Northern Ireland

Methodology Overview

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1 Introduction

- 1.1 The Census of Population is the largest single statistical exercise undertaken by government, and remains the most important source of information on the size and nature of the population. Every effort is made to include everyone, and that is why the Census is so important. It is the only survey which provides a detailed picture of the entire population, and is unique because it covers everyone at the same time and asks the same questions of everyone. Subsequently, the information from the Census is used widely and underpins national and local policy making.
- 1.2 However, no Census is perfect – some people are inevitably missed and some people do not provide information for every question. NISRA uses complex statistical techniques to make allowance for any missing people or information. NISRA's aim is to ensure that Census statistics reflect the whole population of Northern Ireland, such that government, health and education authorities, and many other organisations can target resources more effectively and plan services.
- 1.3 The most recent Census was held on 27 March 2011. The purpose of this document is to provide background information on the process that underpins Census outputs. Through detailing these processes, users will gain an understanding of the underlying quality of the Census outputs. This paper provides a high-level overview of the Census process. In many instances, links are provided to papers that describe aspects of the process in greater detail; these papers themselves will be expanded and developed as further output is published.

1.4 Census Office had four high-level strategic aims for the 2011 Census, one of which was to provide high quality, value for money statistics that are fit for purpose and meet the needs of users. Among other things, this document considers the 'quality' of the initial Census outputs. The Office for National Statistics (ONS) has published guidelines for measuring statistical quality, based on the European Statistical System's six quality dimensions. The guidelines recommend assessing quality in terms of accessibility, accuracy, assessment of users' needs, clarity, coherence, comparability, punctuality, relevance and timeliness. Using these dimensions of quality as a framework, this document concludes (section 6) by linking the processes used in conducting the Northern Ireland Census 2011 to the quality framework, in order to convey information about the quality of the statistical outputs.

2 The Census Process

General planning

2.1 Planning for the 2011 Census started in December 2004 with the publication of a consultation paper 'The future provision of demographic statistics in Northern Ireland (Towards the 2011 Census)'.¹ This formal consultation was followed by a series of consultation events that will continue as outputs are released. The details of this consultation process, and the feedback² received, can be seen on the NISRA website. At the time of writing, the most recent

¹ 'The future provision of demographic statistics in Northern Ireland (Towards the 2011 Census)' is available from:

<http://www.nisra.gov.uk/archive/census/2011/information-paper-december-2004.pdf>

² 'The future provision of demographic statistics in Northern Ireland (Towards the 2011 Census), Consultation – Summary of Responses' is available from:

<http://www.nisra.gov.uk/archive/census/2011/consultation-summary-report-september-2005.pdf>

consultation events³ were three public meetings in Belfast, Derry and Enniskillen in January and February 2012 at which NISRA outlined plans for the content and dissemination of Census outputs. In addition to events such as these public meetings, NISRA has consulted regularly with key advisory groups such as the Northern Ireland Census Advisory Group (CAG)⁴, the Northern Ireland Statistics Advisory Committee (SAC)⁵ and the inter-departmental Statistics Co-ordinating Group (SCG).

2.2 The Census is governed by legislation. A Regulation of the European Parliament and Council on Population and Housing Censuses (Regulation no. 763/2008⁶) requires the generation of Census-type data. The conduct of the 2011 Census in Northern Ireland required a Census Order⁷ and Census Regulations⁸ to be passed by the Northern Ireland Assembly. In preparation for this, NISRA published a Proposals Document⁹ that described the planned Census process from end-to-end. In addition, a Privacy Impact Assessment¹⁰

³ Further information on recent consultation events is available from:

<http://www.nisra.gov.uk/archive/census/2011/previous-events-and-consultation.pdf>

⁴ Further information on the Northern Ireland Census Advisory Group is available from:

<http://www.nisra.gov.uk/census/2011/background/census-advisory-group.html>

⁵ Further information on the Northern Ireland Statistics Advisory Committee is available from:

<http://www.nisra.gov.uk/aboutus/default.asp.htm>

⁶ 'Regulation (EC) No 763/2008 of the European Parliament and of the Council' is available from:

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:218:0014:0020:EN:PDF>

⁷ 'The Census Order (Northern Ireland) 2010' is available from:

<http://www.legislation.gov.uk/nisr/2010/195/contents/made>

⁸ 'The Census Regulations (Northern Ireland) 2010' is available from:

<http://www.legislation.gov.uk/nisr/2010/218/contents/made>

⁹ 'The 2011 Census of Population in Northern Ireland' – proposals paper is available from:

<http://www.nisra.gov.uk/archive/census/2011/proposals.pdf>

¹⁰ 'Report of a Privacy Impact Assessment, Conducted by the Northern Ireland Statistics and Research Agency in relation to the 2011 Census Northern Ireland' is available from

<http://www.nisra.gov.uk/archive/census/2011/privacy-impact-assessment.pdf>

was published that focussed on the identified requirement for each question and how NISRA would ensure that Census data would be kept secure.

Developing the Census processes and infrastructure

- 2.3 The conduct of the 2011 Census came about after lengthy planning and development of many individual component parts of the Census.
- 2.4 The content of the Census questionnaire was developed continuously from the first consultation in 2004, in which respondents were asked about the value of the questions asked in the 2001 Census and further asked for ideas for additional questions and redundant current questions. Between 2004 and 2010 (the questionnaires were finalised and printed in 2010), the question set was subjected to numerous testing procedures, including both qualitative and quantitative techniques. The content of the questionnaire was formally finalised by the Assembly, with the topics to be covered being listed in a Schedule to the Census Order, and a copy of final questionnaire being included as a Schedule to the Census Regulations. In developing the Northern Ireland Census questionnaires, there was a high degree of collaborative work undertaken with the other Census Offices in the UK. As a result, the vast majority of questions were fully harmonised across the UK. The Northern Ireland questionnaires¹¹ are available on the NISRA website.
- 2.5 The high-level Census methodology was also developed in the period before the Census. For the 2001 Census, a paper Census questionnaire was delivered to every household by a Census enumerator and the respondent

¹¹ The Northern Ireland Household questionnaire is available from: <http://www.nisra.gov.uk/archive/census/2011/forms/household.pdf> and the Northern Ireland Individual questionnaire is available from: <http://www.nisra.gov.uk/archive/census/2011/forms/individual.pdf>

was asked to return the completed form by post. The return envelope in 2001 was addressed to a local Census office, and each of these offices managed the follow-up of non-returned forms locally. A Census Test was conducted in 2007. This tested, among other elements, use of the postal service to issue Census forms, use of a central receipting system for returned forms and the inclusion of potential new questions. The 2007 Test was viewed as demonstrating, in particular, that the use of post-out was feasible. A Census rehearsal in 2009 developed the methodology further and included the first test of an internet response option.

- 2.6 This led to a basic Census design of a paper questionnaire being issued by post to every known domestic address. The public were given the option to complete the paper form and return it by post, or to use an identification code provided on the paper questionnaire to make a Census return online. NISRA staff arranged to visit the managers of communal establishments, who assisted by distributing and (where necessary) collecting completed paper questionnaires. The use of a post-out method was critically dependent on the development of an authoritative address register. NISRA worked closely with the Land and Property Services Agency (LPS) to develop and test an address register of domestic properties, based on the Pointer address database.
- 2.7 In this development phase, NISRA procured (jointly with the Office for National Statistics) a lead service provider to cover the printing of Census questionnaires, the development and implementation of a questionnaire receipting and tracking system, the data capture from returned paper questionnaires, an internet response channel, and a telephone/online help facility.

The Census goes ‘live’, advertising and the field process

- 2.8 The decision to use a post-out/post-back or online return design meant that, unlike previous Censuses, most households would have very limited or indeed no direct interaction with Census Office staff. An advertising campaign was developed to raise awareness among the public about the Census. While the Census is a devolved responsibility in Northern Ireland, many advertising media – such as some satellite television channels – operate at the UK level. Accordingly NISRA worked closely with colleagues in the Office for National Statistics and adapted – as required for Northern Ireland – the advertising and publicity campaign for the Census in England and Wales. Thus, the outdoor poster campaign included photographs that were shot locally but on similar themes to those in England and Wales, while the television advertisements had similar visuals but local voice-overs.
- 2.9 The Census operation went fully ‘live’ on 14 March 2011 when some three-quarters of a million pre-addressed questionnaires were sent out through Royal Mail. On the same day, the internet online response channel went live.
- 2.10 In the run-up to the Census, Census Office recruited a temporary field force of approaching 2,000 staff. Over the two week period prior to Census Day, field staff checked the location of every address to which forms had been sent, and identified potential new addresses. In addition, the helpline organised for forms to be issued to households who, for whatever reason, required new or replacement forms. By Census Day, Census Office was confident that every household had received a form.
- 2.11 Although Census returns were not required until Census Day, returns were made from 14 March onwards. Census Office monitored the return of

completed forms and, 10 days after Census Day, provided the field staff with lists of addresses from which a completed form had not yet been received. Over a six-week follow-up period, the field staff repeatedly visited addresses from which a completed census form had yet to be received. Census returns were accepted, no matter how late they were returned.

Data capture/Information Assurance

- 2.12 Census returns were made either on paper or online. It is estimated that 15 per cent of household returns were made online. The paper version of the Census questionnaire had been designed to ease completion by respondents, but also to assist in the electronic capture of the data. Thus, most questions were based on 'tick boxes', with a relatively small number of questions involving 'write-ins'. For the latter, the design of the form encouraged the use of one letter per box. The information on the completed paper forms was captured using 'scanning and imaging' technology, with pre-defined quality levels. Thus, for example, for a question with a tick box return, the specification might have been that a sample of returns were re-examined to ensure that the correct tick box had been captured on x per cent of occasions, where x would usually have been in the high nineties. Similar specifications were set for capture and identification of each letter in a 'write-in' response.
- 2.13 Where write-in responses were used, the responses were put into classifications through auto-coding software that allowed 'fuzzy matches' where, for example, the respondent may have mis-spelt the relevant word.
- 2.14 Census Office is content that the service provider captured and coded the information from the questionnaires in accordance with the agreed requirements and service levels.

2.15 Census returns contain personal information provided by respondents. Census Office places a high priority on respecting the confidentiality of respondents, and the Census form states that it will be kept confidential. Census Office has taken a number of initiatives to ensure that the information provided by respondents is kept secure. The UK Census Offices jointly commissioned an independent review of information assurance. The review team concluded that “the public can be assured that the information they have provided has been well protected”. The report of the review team can be is available on the NISRA website.¹²

Analysis and Quality Assurance of the Census returns

2.16 The patterns in the captured data where observed repeatedly from initial capture of the raw data, through a number of processes, described below, to ensure that the statistical outputs from the Census are of high quality and fit for purpose. The quality assurance processes are described in more detail in the Census Quality Assurance Strategy paper.¹³

2.17 It was anticipated that some Census respondents would not answer every question on the form. As indicated in the Census Proposals Document, missing responses to questions within a form were imputed using standard statistical procedures. In line with arrangements across the UK, this was based on the Canadian Census Edit and Imputation System or CANCEIS programme (a statistical programme developed by Statistics Canada for edit and imputation in survey responses). It is noted that this item non-response adjustment was not applied to the religion question (Q17 on the form).

¹² ‘2011 Census Security: Final Report to the Census Offices’ is available from:
<http://www.nisra.gov.uk/archive/census/2011/iar-june-2012.pdf>

¹³ ‘Census Quality Assurance Strategy’ is available from:
<http://www.nisra.gov.uk/archive/census/2011/quality-assurance-strategy.pdf>

2.18 Although every effort was made to obtain a Census return from every household, it is acknowledged that a small proportion of the population will not be covered on Census returns. NISRA conducted a Census Coverage Survey (CCS) in June 2011, based on a stratified random sample of about 14,000 households across Northern Ireland. This survey was conducted using trained social survey interviewers, and tried to establish the usual residents at each of the sampled addresses on Census Day. The information from the Census Coverage Survey was merged with that from the Census, and statistical models developed that estimated the coverage of the Census and enabled adjustments to be made for any under-enumeration. In addition, NISRA worked with colleagues in the Business Services Organisation (BSO) to analyse activity-based statistics from the Medical Card system to establish the likely basic demographic structure (age by sex) of residents in households that had not responded to the Census. The purpose of these analyses – both with BSO and through matching with the CCS – was to try to ensure that statistical outputs from the Census represented the complete usually resident population of Northern Ireland. Further details on the methodology to adjust for Census under-enumeration can be found on the Office for National Statistics website.¹⁴

2.19 The statistical adjustments for incomplete Census returns and Census under-enumeration were designed to ensure that the Census represented the characteristics of the full population of Northern Ireland. The statistical estimates were subjected to quality assurance procedures to ensure that, as far as possible, they were viewed as high quality and representative of the

¹⁴ 'Summary of coverage assessment and adjustment methodology' is available from: <http://www.ons.gov.uk/ons/guide-method/census/2011/the-2011-census/processing-the-information/statistical-methodology/index.html>

Northern Ireland population. The quality assurance processes are described in the Census Quality Assurance Strategy paper¹³ (published in advance of the Census) and the resulting quality assurance of the population estimates is described in the 'Population and Household Estimates for Northern Ireland – Quality Assurance Report'.¹⁵

3 Accuracy/coherence of the Census estimates

3.1 The Census is subject to a number of potential sources of statistical error, despite the fact that it was designed to be a full enumeration of the whole population and thus, in theory, free from sampling error which is usually the main source of error in sample surveys. The Census is actually subject to sampling error through the use of the CCS (above) to adjust for Census under-enumeration. The effect of this sampling error on the Census Day population estimate has been calculated as equivalent to a 95 per cent confidence interval about the population estimate (1,810,900) of +/- 11,000, or roughly 0.6 per cent of the estimated population. Confidence intervals for other Census estimates are provided in the Quality Assurance Report. One of the key design objectives of the CCS was to minimise the resulting confidence intervals about the population estimate.

¹⁵ 'Population and Household Estimates for Northern Ireland – Quality Assurance Report' is available from:
<http://www.nisra.gov.uk/archive/census/2011/results/population-estimates/quality-assurance-report-16-07-2012.pdf>

3.2 The Census is also potentially subject to a number of other sources of non-sampling error. These are briefly outlined below:

- **Coverage error**

This refers to the Census not being able to identify the target population – the usually resident population of Northern Ireland. The CCS was designed to address this issue, but it cannot deal with, for example, errors made by householders who include dependents (and repeat the error in the CCS) who actually are usually resident elsewhere, and not usual residents of Northern Ireland.

- **Non-response error**

This can occur at the item level (a respondent does not respond to a specific question) or at a person or household level (a person or household does not respond). The CANCEIS software (described above) was used to address item non-response. The adjustment for under-enumeration outlined above, based on the CCS, was used to address person and household level non-response.

- **Measurement error**

This can occur when the Census fails to collect the correct information from respondents. This might occur through a poorly designed questionnaire. This was addressed in a number of ways, of which the main two methods were as follows. Firstly, all questions on the 2011 Census were the subject of intensive testing over a number of years. Most were included in the 2007 Test, the 2009 Rehearsal and a number of sample surveys. Piloting of the questions was also conducted

through the Omnibus Survey (a regular household sample survey conducted by NISRA) and focus groups to gauge how well the questions were understood. The questions that were harmonised across the UK were also independently tested by the other UK Census Offices.

In addition, NISRA conducted a Census Quality Survey (CQS) in late June/early July 2011. Approximately 2,000 households (selected at random across Northern Ireland) were visited by trained social survey interviewers who asked a subset of key questions from the 2011 Census questionnaires in a face-to-face environment. The responses given in the CQS will be compared to the Census returns for these households to quantify the reproducibility of Census responses. This is one element of the quality of Census responses. The analysis of the CQS will be reported in 2013.

- **Processing error**

This source of error describes the potential effect of various processes to which the data are subjected prior to publication. These include the processes involved in capturing the data (see data capture above) and processes such as coding.

3.3 It is impossible to quantify the net aggregate effect of all these potential sources of error. Rather, it is noted that steps have been taken to minimise their effect throughout the Census process with – for example – carefully designed and tested questions, the use of tick boxes where possible, a carefully designed CCS, the use of a Census Quality Survey and so forth.

4 Dissemination

- 4.1 NISRA is committed to disseminate a wide range of outputs from the 2011 Census, free at the point of delivery through the internet. An Outputs Prospectus is available on the NISRA website, which details the broad schedule to which NISRA intends to adhere. The Prospectus details all the statistics which NISRA intends to publish; the content of these statistics has been determined through the consultation exercises detailed above. The Prospectus goes on to detail how users can request, upon demand, any further specified output or analysis, and noting that these may be subject to charging.
- 4.2 All Census outputs will be subject to Statistical Disclosure Control (SDC) techniques. The purpose of these techniques is to allow robust statistics to be published for small geographic areas while ensuring that the confidentiality of individual respondents is respected. The technique is based upon the idea of adding a small amount of 'noise' to Census returns, so that statistical outputs cannot be used to infer information about a person with confidence, but retaining the main messages in the statistical outputs. 'Targeted record swapping' has been the main SDC tool used in the 2011 Census. This 'pre-tabular' technique will help to ensure that published tables from the 2011 Census are both additive and have consistent cell-counts across tables, which meets one of the key requirements identified by users. More detail can be found on the ONS website.¹⁶

¹⁶ Further information on statistical disclosure control methods is available from:
<http://www.ons.gov.uk/ons/guide-method/census/2011/census-data/2011-census-prospectus/new-developments-for-2011-census-results/statistical-disclosure-control/index.html>

4.3 Census outputs will be produced for a range of geographic units across Northern Ireland down to Census Output Area (COA). Digital versions of the boundaries for output geographies used for Census outputs will be made available prior the publication of the relevant outputs.

4.4 The dissemination of Census outputs will be complemented by documents (such as this paper) that will provide background information on the Census. These additional documents will cover such areas as:

- Definitions and Output Classifications¹⁷
- Frequently Asked Questions¹⁸
- Quality Assurance

4.5 These supporting documents will be developed further over time.

5 Further information

UK liaison and harmonisation/Use of standard classifications

5.1 The three UK Census Offices have worked closely throughout the 2011 Census. This close working is articulated through a formal agreement on harmonisation and joint working that is available on the NISRA website.¹⁹ Census outputs use international standard classifications.

¹⁷ '2011 Census Definitions and Output Classifications' is available from:

<http://www.nisra.gov.uk/archive/census/2011/definitions-and-output-classifications.pdf>

¹⁸ '2011 Census Frequently Asked Questions' is available from:

<http://www.nisra.gov.uk/archive/census/2011/frequently-asked-questions.pdf>

¹⁹ Further information on UK Harmonisation is available from:

<http://www.nisra.gov.uk/census/2011/background/uk-harmonisation.html>

The link to mid-year estimates (MYEs) of population

5.2 One of the main purposes of the Census is to benchmark the mid-year estimates (MYEs) of population. NISRA will publish new 2011 mid-year estimates of population in late 2012. Further detail on the timing of these publications can be found on the NISAR website.²⁰

6 Linking the Census processes with quality

6.1 A summary of how the 2011 Census processes contribute to the ONS Quality Framework is outlined below. This will be developed as further outputs are released.

Accessibility

6.2 Accessibility refers to the ease with which users are able to access the data, and also reflects the formats in which data are made available and the availability of supporting information. For example:

- Outputs from the 2011 Census have been developed after consultation with users, and as such reflect user requirements.
- Outputs have been pre-announced through the Outputs Prospectus²¹, which has provided specifications of outputs and an outputs timetable.
- All pre-specified outputs, developed through user consultation, are being made available free at the point of delivery.

²⁰ Further information on Mid-Year Population Estimates is available from:
<http://www.nisra.gov.uk/demography/default.asp17.htm>

²¹ Northern Ireland Census 2011 Output Prospectus is available from:
<http://www.nisra.gov.uk/census/2011CensusProposedOutputs.html>

- Outputs are being supported by metadata including Definition of terms, Frequently Asked Questions, and Quality Assurance reports
- All outputs are being disseminated through NISRA's Neighbourhood Information Service (NINIS) that will present Census outputs in the context of other official statistical data.

Accuracy

- 6.3 Accuracy is the degree of closeness between an estimate and the true value. There is no single overall measure of the accuracy of a census; however there are several indicators of its quality. The main threats to accuracy are sampling errors and non-sampling errors.
- 6.4 One of the key objectives of the Census design was outputs that reflect the complete usually resident population of Northern Ireland, taking account of Census under-enumeration.
- 6.5 A Quality Assurance strategy was published in advance detailing how the outputs would be quality assured. A Quality Assurance document will accompany each publication, reporting on the outcomes of the quality assurance analyses.
- 6.6 This document, and the quality assurance report for the first release (July 2012), has quantified the sampling error around the key statistical estimates and described potential sources of non-sampling error.

Assessment of user needs

- 6.7 The assessment of user needs will reflect the extent to which users were consulted throughout the development and implementation of the census process. Regarding the Census, respecting the confidentiality of the

information provided by respondents – and Information Assurance more generally – is considered as part of user need.

6.8 NISRA has conducted continuous consultation through the Census process, from the first consultation paper published in 2004 through to (to date) to public awareness meetings in early 2012. This will continue as outputs are produced.

6.9 NISRA published a formal Proposals paper (March 2010), a Privacy Impact Assessment (May 2010), and two reports from an Independent Information Assurance Review (February 2011²² and June 2012).

Clarity

6.10 Clarity refers to the quality and sufficiency of the release details, illustrations and accompanying guidance.

6.11 All Census outputs will be accompanied by interpretive commentary, appropriate charts and diagrams, glossaries, Frequently Asked Questions and other supporting materials. A dedicated Customer Services team will be in place to provide further assistance and information.

Coherence

6.12 Coherence is the degree to which data that are derived from different sources or methods, but refer to the same topic, are similar.

6.13 In developing the Census questionnaire, Census Office has worked with other producers of official statistics to ensure, as far as possible, that Census

²² '2011 Census Security: Report of the Independent Review Team' is available from: <http://www.nisra.gov.uk/archive/census/2011/iar-february-2011.pdf>

outputs use the same definitions as other sources. Census Office uses internationally agreed, harmonised classifications. In addition, the Census meets Northern Ireland's obligation to contribute the UK meeting its requirements detailed in EU Regulation 763/2008 (referred to in section 2.2).

Comparability

- 6.14 Comparability is the degree to which data can be compared over time and domain, the latter can refer to a topic (such as labour market status) or geographic location.
- 6.15 Census Office acknowledges that the Census will not obtain full responses from all respondents. Further, some individuals and households will be missed by the Census. The design and analysis of the Census aims to include adjustments for incomplete responses, and missing individuals and households, to ensure that Census outputs reflect the complete usually resident population. As such, outputs from the 2011 Census should be comparable with other official statistics that similarly reflect the full population.
- 6.16 Regarding geographic units, NISRA has published a paper on this – 'Policy for main geographic outputs from the 2011 Census'.²³

²³ 'Policy for main geographic outputs from the 2011 Census' is available from:
<http://www.nisra.gov.uk/archive/census/2011/methodology/geographic-outputs.pdf>

Punctuality

- 6.17 Punctuality refers to the gap between planned and actual publication dates.
- 6.18 NISRA has published an Outputs Prospectus that details planned publication dates for all outputs. As releases are published, the planned and actual publication dates will be reported.

Relevance

- 6.19 Relevance is the degree to which statistical outputs meet users' needs.
- 6.20 This is covered by the section on user needs above. As stated above, NISRA has conducted continuous consultation through the Census process, from the first consultation paper published in 2004 through to (to date) to public awareness meetings in early 2012. This will continue as outputs are produced.
- 6.21 NISRA published a formal Proposals paper (March 2010), a Privacy Impact Assessment (May 2010), and two reports from an Independent Information Assurance Review (February 2011 and June 2012).

Timeliness

- 6.22 Timeliness refers to the lapse of time between publication and the period to which the data refer.
- 6.23 Throughout the planning of the 2011 Census, NISRA has stated that Census outputs would follow a publication schedule that broadly matched that for the 2001 Census. The first 2001 outputs (population estimates) were published in September 2002, Key Statistics in late 2002/early 2003 and cross-tabulations in early/mid 2003.