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Recommendations on Communicating Population Projections

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Recommendations on Communicating Population Projections

Prepared by
the Task Force on Population Projections

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Note

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Preface

The main purpose of this publication is to provide the producers of national and international population projections with a series of good practices and recommendations on effectively communicating the results of the projections. The publication primarily targets national statistical offices and is expected to be valuable also for users of population projections. The aim is to improve the coherence between what is produced by national statistical offices and what is needed by users, planners and decision makers.

The publication was prepared by a task force established by the Conference of European Statisticians (CES), composed by national experts from national statistical offices, and coordinated by the United Nations Economic Commission for Europe. The good practices and recommendations presented reflect practices in national statistical offices, preferences of users, and developments by academics and researchers in the field of population projections. The publication was endorsed by the Conference of European Statisticians at its 65th plenary session in June 2017.

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In addition to the members of the task force, the following people have been involved in preparing the recommendations: Stacey Hallman (Statistics Canada); Enver Tasti, Sebnem Bese Canpolat and Metin Aytaç (TurkStat, Turkey); and everyone who completed the user survey and the national statistical office (NSO) survey produced for the purpose of this publication. The task force wishes to acknowledge their contribution with much appreciation.

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Contents

Introduction

1. This publication contains a series of good practices and recommendations on effectively communicating the results of population projections, in line with the task force's terms of reference. Here, "communication" encompasses not only how projections should be disseminated to users, but also what should be communicated. The aim is to improve the coherence between what is produced by national statistical offices (NSOs) and what is needed by users, planners and decision makers. The publication does not address questions of methodology, except on rare occasions where methods are discussed as ways to produce desired outputs.[1] The publication primarily targets national statistical offices and is expected to be valuable also for users of population projections.

2. The good practices and recommendations presented reflect practices of NSOs, preferences of users, consultations among members of the task force, and developments by academics and researchers in the field of population projections. While consensus on the opinions and practices was not always reached, efforts were made to represent all points of view and to identify clearly where agreement may be lacking.

3. When possible, examples of various NSOs' practices are provided. These examples relate mainly to population projections by age and sex using the cohort-component method (by far the most commonly used). However, the good practices are broad enough that they encompass all kinds of projections (such as projections of households or projections of the population with certain characteristics) and methods (such as simple extrapolations, the cohort-component method, cohort-progression methods and microsimulation). Similarly, this publication does not specifically address issues or challenges related to subnational projections made for planners at local and sectoral levels. However, it promotes an ongoing dialogue with users of population projections, which is critical for ensuring that projections respond adequately to the specific needs of these users.

4. The publication begins with a methodology section (Chapter 1), in which the methods used for data collection are described and some terms are defined. A series of good practices is then presented in four chapters, formulated as broad recommendations. Each chapter tackles a distinct aspect of population projections: providing pertinent and accessible results (Chapter 2), cultivating transparency (Chapter 3), addressing uncertainty explicitly (Chapter 4), and fostering relationships with users (Chapter 5). The publication concludes by identifying areas for future development.

[1] Methodological aspects of population projections were partially covered in a report provided by a panel of experts convened in 1998 by the National Research Council's Committee on Population (see National Research Council 2000). The panel was asked to examine the scientific foundation of the methodology and assumptions of recent population projections and to review their accuracy. While the exercise was focused mainly on world population projections, the report provides several recommendations that apply in large part to national and subnational population projections.

List of recommendations and good practices

Recommendation 1: Provide pertinent and accessible results

Good practices:

1.1 Communicate results in clear and simple language
1.2 Introduce information in a progressive manner
1.3 Provide results that are consistent for a wide range of projection horizons
1.4 Disseminate projection results by single age and year whenever possible
1.5 Update the projections on a regular and predetermined basis or when important demographic changes affect the pertinence of the assumptions
1.6 Make electronic dissemination materials accessible and easy to navigate
1.7 Offer customizable or interactive projection data to users in tabular or graphical formats

Recommendation 2: Cultivate transparency

Good practices:

2.1 Provide descriptions of the data, methods and assumptions
2.2 Acknowledge any relevant stakeholders and describe the process and outcomes of all consultations
2.3 Clearly define key terms used in dissemination products
2.4 Describe how the new projections differ from previous editions
2.5 Assess the performance of previous projections

Recommendation 3: Address uncertainty explicitly

Good practices:

3.1 Develop an explicit strategy for characterizing and communicating the uncertainty of population projections
3.2 Identify and acknowledge the major sources of uncertainty
3.3 Clearly state the uncertain nature of the projection results in high-level dissemination materials
3.4 Dedicate space within dissemination materials to promote a better understanding of uncertainty and its interpretations
3.5 Pay close attention to verbal expressions of uncertainty
3.6 Solicit and publish expert opinions
3.7 Provide uncertainty analysis
3.8 Provide sensitivity analysis
3.9 Provide a range of plausible assumptions

Recommendation 4: Foster relationships with users

Good practices:

4.1 Provide a clearly identifiable means for users to obtain answers from projection makers
4.2 Consider developing and offering “outreach activities” to engage directly with users in a substantive manner
4.3 Provide notices of forthcoming projection releases to the media and frequent projection users
4.4 Embrace traditional and new media
4.5 Investigate and document the needs of users

Chapter 1 - Research framework and terminology

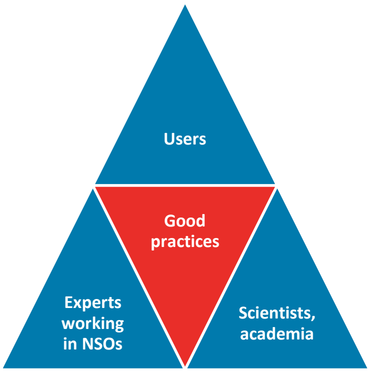
Research framework

5. While population projection results appear simple on the surface—future population figures broken down by characteristics (mainly age, sex and geography)—their speculative nature and the complex process to build them require that they be supplemented with assessments of their uncertainty and thorough documentation. Important challenges are associated with these tasks, including an often poor understanding of user needs or perceptions and the general challenge of disseminating complex scientific ideas. In fact, the general concepts of forecasts or projections, and what can be expected from such exercises, are often themselves misunderstood.

6. These difficulties are not unique to demographers—they are faced by scientists in general. In recent years, crafting adequate communication of complex science-related topics such as climate change or pharmaceutical research to non-expert audiences has proven especially difficult, with the acute danger of developing mistrust in science when unsuccessful. In fact, the difficulties in communicating science to the public have long been recognized, and this constitutes a field of study in itself, most often referred to simply as science communication.

7. Inspired in part by work in the field of science communication (e.g., Bruine de Bruin and Bostrom 2013; Fischhoff 2013), the research framework developed to guide the production of this publication aims to integrate several points of view. These perspectives are those of the experts working to produce population projections (NSOs), those of projection users, and those of scientists and academic experts (Figure 1). This approach is also consistent with the United Nations Fundamental Principles of Official Statistics, which recommend maintaining regular dialogue with users and consulting the scientific community to ensure the relevance of statistical programmes (United Nations 2015a).

Figure 1
Research framework



8. This publication compares the three viewpoints—users, experts and NSOs—to identify possible sources of conflict. In particular, an attempt was made to better understand the information that users need, their pre-existing interpretations and their decision-making processes. Indeed, as Fischhoff and Davis (2014, p. 13668) explained, "Science communication is driven by what audiences need to know, not by what scientists want to say."

9. Various tools were designed and used to collect data about these three viewpoints. These tools—a survey of users of national population projections, a survey of NSOs that produce national population projections, a consultation with academic and other non-NSO experts in the areas of population projections and science communication, and a literature review—are described below.

Data collection tools

User survey

10. One of the recommendations of the National Research Council's panel of experts convened to examine the methodology and assumptions of population projections is to investigate how projections are used in order to propose improvements in their presentation (National Research Council 2000). In line with this recommendation, the task force developed a user survey. It consisted of approximately 20 questions covering topics including the following:

- the user's associated organization
- his or her reason for using population projections
- the importance and evaluation of various elements of dissemination materials
- whether the user had contacted the NSO in the past for information, and his or her level of satisfaction with that interaction
- the aspects of the communication of projections produced by the NSO that could be improved upon, in the view of the user.

11. The user survey was sent to a sample of users of national and, in some cases, international population projections in June 2015. Data were collected during the summer of 2015. In total, there were 151 respondents to the user survey. The content of the user survey questionnaire is presented in Appendix A.

12. Results of the user survey were very useful, but require careful interpretation because of limitations in the sampling methods used. In short, it is not possible to determine how representative the sample of users is. Only a limited number of NSOs were involved in identifying projection users (essentially those represented in the task force), and the sample consisted nearly exclusively of users who had contacted these NSOs for information (as most NSOs had no other way to identify users). Responses indicate, for example, that the majority of user respondents considered themselves to have "high" or "intermediate" familiarity with population projections, as opposed to "low" familiarity. In part to compensate for this likely bias towards more experienced users, but also because most users of population projections are not demographers, careful consideration was given to the necessity of communicating results and methods effectively to a lay audience. Various strategies are proposed to this effect, such as using clear and non-technical language, introducing information progressively, providing a glossary of key terms and offering clearly identifiable means for users to ask questions (good practices 1.1, 1.2, 2.3 and 4.1, respectively).

National statistical office survey

13. Building upon a previous endeavour by Eurostat (Lanzieri and Giannakouris 2006), an additional survey was developed and sent to NSOs of UNECE member countries (covering Europe, North America and Central Asia). The survey consisted of approximately 30 basic questions. It asked the producers of national population projections about their projections, the information they disseminate in their publications, their approach to communicating uncertainty, their level of interaction with users and what they see as the main challenges in communicating projections to users. The survey was sent to respondents in June 2015. The content of the questionnaire sent to NSOs is presented in Appendix B. While individual NSOs may have at times inquired about the needs of their own users in various ways, the task force

is not aware of large initiatives in this regard. Indeed, it became clear in the NSO survey responses that most NSOs have a very limited idea of who their users are.

14. The responses to this survey provided a means of discovering more about the practices of NSOs, as well as their perceptions, capacities and limitations. They were also informative about the types of information NSOs feel they must communicate to users. In total, there were 32 respondents to the NSO survey.

Expert consultation

15. A third tool consisted of external evaluations of the good practices and recommendations proposed in this publication by several experts working in the field of population projections. The aim was to incorporate more formally the point of view of scientific experts, as a complement to the analysis by the task force of existing literature relevant to the topic.

16. Various steps were taken to achieve this objective. In April 2016, a preliminary version of this publication was presented at the Eurostat/UNECE Work Session on Demographic Projections. The audience was composed mainly of representatives from NSOs of UNECE member countries (with some exceptions), representatives from international organizations and researchers in the field of population projections. The work session was a good forum for thorough discussions on the contents of the publication. Updated versions were then reviewed by external experts. First, the publication was reviewed in September 2016 by a group of demographers from the United Nations Population Division composed of Lina Bassarsky, Patrick Gerland, Danan Gu and Mark Wheldon. Later, in November 2016, it was reviewed by a number of experts selected by the task force for their contribution to the field of population projections, namely Jakub Bijak, Dalkhat Ediev, Nico Keilman, Ronald D. Lee and Frans Willekens.

17. Overall, the consultation process was extremely helpful in identifying good practices for communicating population projections; evaluating the consensus around them; and equally representing the viewpoints of users, projection makers and experts. The consulted experts generally found the final version of the publication to be balanced, comprehensive, and a valuable resource for projection makers and users. However, the views expressed in this publication are those of the task force and do not necessarily reflect those of the people consulted during its production.

Literature review

18. Finally, a literature review supplemented the analysis, further highlighting the contrasting perspectives of users, NSOs and experts. It covered scientific articles in several fields, such as psychology, communications and demography, as well as publications released by NSOs. The literature review also provided key insights about effective ways to communicate complex scientific results.

Terminology

19. Before the recommendations and good practices are presented, it is necessary to establish clear definitions for a number of key terms related to population projections. The goal

here is not to propose a universal glossary, although a more uniform use of these terms by agencies around the world could facilitate clearer, more precise communication.

20. Population estimates published for future reference dates are most often referred to as population **projections** or population **forecasts**. Results from the NSO survey show that most NSOs (25 out of 32) use only the term projection, but 6 NSOs also use the term forecast. Those that provided reasons for using the term projection indicated a desire to convey less certainty than the term forecast does. It also appears that the term projection is used to encompass the plurality of approaches taken to envisage the future development of a population in the literature (as is done in this publication).

21. As Romaniuk (1976, 1994) noted, the distinction between the two terms has much to do with the epistemological posture adopted regarding our knowledge of the future. To generalize, projection makers want to accentuate the fact that projections are not predictions, whereas forecast makers seem to assume more boldly, within some limits, a capacity to predict.[2] This distinction poses some difficulty, since, as noted by Keyfitz (1972), the assumptions that constitute a projection are usually conceived with a concern for realism, without which the projection would have no real value. Hence, the notion of "predicting the future" can rarely be removed from any projection exercise. In accordance with Keyfitz, Hoem (1973, p. 13) noted: "It seems that most of the advance calculations actually made, can be placed somewhere in the area bordered by real projections on the one hand and pure forecasts on the other hand." In an effort to clarify some ambiguities, and in broad accordance with the most current contemporary practices and usage in the literature (although interpretations of the terms often differ), the following definitions are proposed:[3]

- In general terms, a **projection** refers to the calculation of some estimates at a future date.[4] As in Demopaedia (2016), a population projection is defined as "calculations which show the future development of a population when certain assumptions are made about the future course of population change, usually with respect to fertility, mortality and migration."
- A projection can be **deterministic** or **probabilistic**. A deterministic projection can be summarized in a single value, obtained from a series of projection assumptions. Deterministic projections typically do not incorporate measures of uncertainty. In contrast, a probabilistic projection is summarized by a set of values, or a probability distribution. The rationale is that since all variables used in a projection are random variables (variables that cannot be predicted with certainty), and since not all assumptions are equally likely, a probability distribution of plausible values is required. The variance of the distribution also yields an appropriate measure of uncertainty.

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[2] Both viewpoints have dominated at different points from the 18th century to the present, from the use of predictive laws of population growth to a more sober approach that emphasizes the complexity of the forces governing population growth (Romaniuc 1976; Le Bras 2008).

[3] It is recognized that some terms do not have exact equivalents in some languages.

[4] However, there can also be projections towards the past, usually labelled as "retro-projections" or "backward projections."

- When a projection is to be interpreted as the most probable development of a future population, it should be labelled a **forecast**.[5,6] The expression "most probable" implies that a projection is considered the most likely outcome among a set of possibilities, but since the set of possibilities is technically infinite, any single trajectory has a probability measure of 0 (or close to it). Accordingly, in a probabilistic framework, a forecast does not coincide with any single simulated trajectory, but rather reflects the whole probability distribution (e.g., the median outcome among all outcomes). The term forecast, in this context, refers to the expected value of a model outcome.[7,8] Note that the term forecast is also used sometimes in the context of deterministic projections. However, given that no likelihood is provided, a most probable outcome does not technically exist, and it may be preferable to speak of a "most indicative" outcome. The likelihood, in this case, most often reflects a judgment made by the projection makers, perhaps guided by statistical methods. In many cases, projection makers will not label any outcome as a forecast, but that does not prevent users from treating it as one. For example, users might interpret the result of a middle variant as being the most likely when more than one projection scenario is provided (Keyfitz 1981).
- A **prediction interval** is an interval associated with a random variable yet to be observed, with a specified probability of the random variable being within the interval. While similar in construction to a confidence interval, the latter term is used mainly in a frequentist approach to convey uncertainty related to the fact that an unobserved parameter was estimated from a sample.

[5] The term forecast has different definitions depending on the field. It has a stricter definition in time-series forecasting, for example, where it represents the prediction of future values on the basis of values observed in the past.

[6] Forecasts have variable projection horizons. However, because the uncertainty of a forecast increases considerably over time, short-term horizons are usually preferred (Demopaedia 2016).

[7] Compare, for instance, the expected value when a fair die is thrown (3.5); this value will never be observed.

[8] At the same time, the distinction between probabilistic projections and forecasts is somewhat blurred, since using probabilistic methods implies making a statement on the likelihood or relative likelihood of different trajectories.

Chapter 2 - Provide pertinent and accessible results

Introduction

22. As the Internet has become firmly entrenched in society, user expectations for highly detailed, flexible and easily accessible information have grown higher. Such demands are likely to continue growing in the future. Regularly evaluating dissemination procedures to improve the interpretability, accessibility and relevance of projection results becomes essential in this context.

23. The results of the user survey were mixed regarding the level of detail desired by users of population projections. While close to three-quarters (73 per cent) of the respondents think that the projection data are adequately detailed, about two-thirds (66 per cent) think that projections of characteristics other than age, sex or region are important or very important. However, when asked about aspects that could be improved, only four respondents mentioned more disaggregated results (two for spatial breakdowns, one for ethnicity and one for education). In contrast, respondents to the NSO survey did not appear to view more detailed projection data as an area of user concern. It could be that while users could benefit from more detailed variables, most are generally satisfied with the projections offered by NSOs. However, it is also possible that NSOs underestimate or are unaware of the desire of many users for more detailed information on all aspects of the projections.

24. In terms of data accessibility, 71 per cent of the respondents answered that the projection data were easily accessible. However, access to the dissemination materials was mentioned as an area for improvement by 10 per cent of all respondents. In 60 per cent of these cases, answers were elaborate enough to pinpoint difficulties in finding the desired information on the NSOs' websites. As for NSOs, 14 per cent of the respondents had received requests for help in accessing data.

25. The following good practices and recommendations provide some guidance on how to communicate effectively the results of a population projection.

Good practices

Practice 1.1: Communicate results in clear and simple language

26. Projection users are a diverse group differing in their level of familiarity with statistical and demographic concepts and techniques. They also have varying motivations for consulting projections. Users were asked whether they considered the language used in the projection dissemination to be "too simplistic," "appropriate" or "too technical." It is noteworthy that while the large majority of user respondents felt that the language was appropriate (83 per cent), more users found the language too technical (8 per cent) than too simplistic (1 per cent).

27. The following are suggested strategies for reaching the widest possible audience:

- Use plain, simple language to ease interpretation for different types of projection users. Choose words with a single definition or connotation and be consistent with word use.
- Include a glossary with clear definitions to further explain important terms (particularly those that are more technical in nature).
- Include in the dissemination an introductory text box or chapter that sets proper expectations for using the projections and explains at a high level their key caveats and limitations.
- Pretest draft dissemination materials on a small group of non-expert users to ensure that terms have been clearly defined and will be interpreted as intended (Centers for Disease Control and Prevention 1999).
- Offer short courses for non-professional users such as journalists or state employees who are not involved in the projections.

Practice 1.2: Introduce information in a progressive manner

28. An efficient strategy for communicating information of different technical levels to a variety of users is to release it in layers of increasing complexity. This approach, often referred to as the **progressive disclosure of information**,[9] helps create an efficient instructional design by minimizing the load on the working memory and segmenting complex explanations into intelligible portions (Kalyuga 2011). The progressive disclosure of information also allows uncertainty to be communicated gradually and repeatedly by integrating it as part of the message in the various layers of the communication (Kloprogge et al. 2007; Wardekker et al. 2008). As noted by Kloprogge et al. (2007), users differ in the forms of presentation they prefer; repeating messages in different forms (verbal, numeric and graphical) may help users better understand and may increase the chance that they will notice and correctly interpret the information.

29. Many NSOs tend to follow more or less consciously the approach of progressively disclosing information by releasing their projection results in several distinct layers, aiming for broad coverage of a variety of audiences. For instance, an NSO might publish a detailed report with press releases (shorter communications intended for the media) or shorter articles summarizing the results. These shorter communications are often those with the greatest exposure and are often the only medium by which the public will be informed about a given topic.

30. Another frequently used strategy is to provide a separate technical report to present the methods and assumptions. However, several studies have shown that people tend to spend limited time reading such detailed reports (Kloprogge et al. 2007). It is therefore essential that general statements about the limitations of projections be found throughout the primary layers of the communication of population projection results, not only in a detailed technical report. Good practice 3.3 further discusses the importance of including statements about the uncertainty of population projections in high-level dissemination materials.

[9] The concept of progressive disclosure of information has its origins in computer application engineering, where it is used for improving interactions between humans and computers. It is also used in journalism.

Practice 1.3: Provide results that are consistent for a wide range of projection horizons

31. The needs of users regarding projection horizons are varied. Results from the user survey show a wide range of needs, from as short as 1 year to as long as 150 years in the future (Table 1). Notably, respondents to the user survey most frequently expressed a need for a projection horizon of 10 years, considerably lower than the modal horizon of 50 years disseminated by respondents to the NSO survey. The results also show that about one-quarter of all respondents stated that they use projections for a horizon of 10 years or less.

Table 1

Projection horizons disseminated (NSO survey) and needed (user survey)

	Projection horizon				NSOs or users for given ranges of projection horizons	
	Mean	**Mode**	**Min**	**Max**	**≤10**	**> 50**
		years			*number*	
NSO (disseminated) (N=32)	54	50	25	100	0	12
User (needed) (N=140)	31	10	1	150	34	14

32. How long should projection horizons be? The panel of experts convened by the National Research Council's Committee on Population to review different aspects of population projections suggested that beyond a period of 50 years, projections involve so much uncertainty that they should not be produced (National Research Council 2000). High uncertainty associated with certain demographic components can be a motivating factor for not extending the projection horizon too far. For example, fertility assumptions become increasingly perilous beyond 25 to 30 years, the mean length of a generation, after which the uncertainty with the numbers of potential mothers in the population compounds the uncertainty of associated birth rates (Lutz et al. 1994; Leridon 2015). Likewise, Bijak and Wiśniowski (2010) found that after a 5- to 10-year horizon, prediction intervals for international migration become too large to be very helpful to decision makers.[10]

33. Nonetheless, some users do require longer-term projection horizons for planning. For example, studies of the long-term viability of pension plans typically require horizons of 75 years or more. More globally, long-term projection horizons are also used by earth scientists in the context of climate change modelling (e.g., IPCC 2013). Recognizing the disparity between the reluctance of projection makers to go beyond a certain time horizon and the expectations of some users, Lutz et al. (1994) recommended clearly distinguishing between projections made for short- or mid-term horizons and those made for longer horizons (typically more than 30 years). However, providing a long-term projection should not be a problem, as long as it is accompanied by an appropriate relevant estimate of its uncertainty. As Lee (1998) pointed out, the increasing uncertainty over time will inform users about the risks of using projection results for long horizons (see Chapter 4).[11]

[10] There are, of course, other sources of increasing uncertainty over time in projections; Lutz et al. (1994) summarized the impacts of possible other sources of uncertainty in relation to the projection horizon.

[11] In some cases, users may require "infinite horizon" projections, that is, projections over a very long horizon produced to calculate some measures of imbalance in pension systems and evaluate the long-term sustainability

34. For users interested in the short term, such as 5 or 10 years after the launch of the projection, the question of projection horizon may seem irrelevant, since all surveyed NSOs project for much longer periods (at least 25 years). However, the adequacy of a projection for use in the short term cannot be evaluated on the basis of horizon length alone. Of considerable importance is the extent to which the projection maker has considered short-term eventualities in making the projection assumptions. Because the year-to-year fluctuations of the components of population growth are generally difficult to anticipate, demographers often prefer to hypothesize about long-term future developments and use simple interpolations for the interval years. However, deviations from an anticipated trend may have a substantial impact on the accuracy of a projection shortly after its launch (whereas these deviations may be cancelled out over time to some extent). In particular, abrupt variations in international migration flows in response to conflicts, famines or environmental crises may be a recurring cause of projection errors. The impact of these variations is probably made worse by the fact that users of short-term projections are often looking for changes at a finer level of granularity than users interested in long-term outcomes.

35. In general, the chance that a projection adequately captures recent variations and trends diminishes with the time since its publication. Frequent updates can contribute markedly to improving the fitness of a projection for users with a short-term focus in mind (see good practice 1.5). Frequent updates allow projection makers to renew the assumptions on the basis of recent trends and to correct inaccuracies in the base population, often a predominant source of projection error in the early years of a projection (Keilman 2001).[12]

36. Finally, several methods used to express the uncertainty of population projections tend to underestimate it in the short term (these methods are discussed in Chapter 4). For example, in the scenario approach, the alternative scenarios commonly depart very slowly from the "central" or most likely scenario. In probabilistic projections, the multiple simulations also tend to diverge slowly from each other when the random scenario approach is used (see Appendix H). Because they tend to assume perfect (or close to perfect) serial correlations and correlations between components, these settings produce an unrealistic view of the propagation of uncertainty over time (Lee 1998; Tuljapurkar et al. 2004).[13]

37. The fact that uncertainty tends to increase over time (because of compounding projection errors over time), combined with a possibly too-optimistic representation of uncertainty, may encourage users to be overly confident in the accuracy of projection outputs immediately following the base year. With this in mind, projection makers would be well

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of some fiscal regimes (e.g., Lee and Anderson 2005). Such projections are often called "routine" or "business as usual" projections, since they tend to exclude shocks to the system likely to occur in a very long period (ibid.). Very long projection horizons are sometimes used to obtain a stable population, at which point the population structure depends only on demographic rates and is independent of the initial conditions prevailing at the start of the projection. Stable states are useful for revealing the long-term demographic equilibrium of a series of demographic parameters subject to analysis, especially in comparative studies (Blanchet 1998). For such requests, projection makers may consider advising users on how to extend their projections if they are so inclined (e.g., by holding constant their end-of-projection vital rates).

[12] Results from the user survey show that the proportion of respondents who found frequent updates to be very important was slightly higher among users of projections over a horizon of five years or less (38 per cent) than among all respondents (31 per cent).

[13] This is because each scenario or simulation is essentially the result of interpolations from a baseline level towards a chosen target (for each component of the growth), and the interval years are simply interpolated. This procedure tends to yield straight lines that diverge very gradually from each other over the course of the projection.

advised to inform users about the limitations inherent to using short- and longer-term projection outputs.

Practice 1.4: Disseminate projection results by single age and year whenever possible

38. Population projections are typically produced by single year of age and one-year steps (1x1), or by five-year age group and five-year steps (5x5). Other configurations are possible when interpolation techniques are used. For example, a projection maker can publish projections by five-year age group and one-year steps (5x1), where the years between the five-year steps are interpolated. Interpolation can also be used to break down five-year age groups into single years of age.

39. The vast majority (87 per cent) of respondents to the NSO survey reported that they disseminated their projections by single year of age, and 81 per cent by single projection year. Responses to the user survey suggest that this is a good practice. Indeed, 84 per cent of respondents to the survey felt that it was important or very important for them to obtain projection results by single year and year of age. Providing projections by single year also offers users more flexibility in terms of projection horizon. This is especially important with very short-term projections, which some users need, as highlighted in good practice 1.3 above.

40. Finally, interpolation of coarser-grained projections can offer a good alternative to projections by single year of age and year built from the ground up. However, the results may not always be satisfactory, especially when performed over both the age dimension and the time dimension.[14] Therefore, it is advisable for projection makers to test their single-year projections for smoothness of outcomes (e.g., absence of undesirable features such as sawtooth patterns and irregularities). It is also desirable to inform users when an interpolation method is used and about its possible limitations.

Practice 1.5: Update the projections on a regular and predetermined basis or when important demographic changes affect the pertinence of the assumptions

41. Most NSOs update their projections on a regular basis, often when new or revised data become available. This is a good practice, as inaccuracies in the baseline data can be a non-negligible source of projection errors—sometimes the most important one in countries with generally low-quality data, especially with short- or mid-term horizons (Keilman 2001). New projections can also be produced on an ad hoc basis to reflect important demographic changes. Among NSOs, projections were most frequently updated every 5 years, ranging from a minimum of 1 year to maximum of 10 years (Table 2).

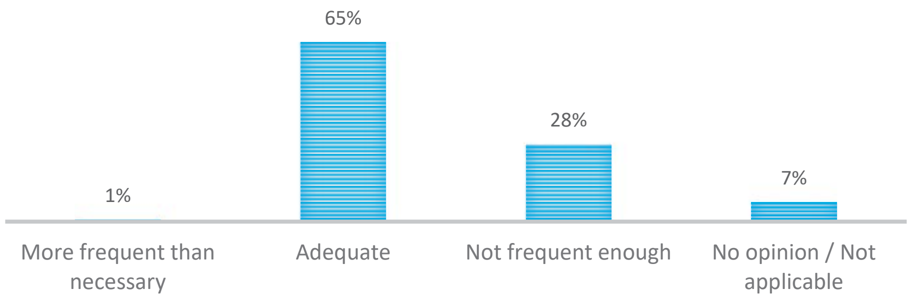
[14] Bermúdez and Blanquero (2016) discussed the difficulties associated with disaggregating population data grouped in age ranges into individual years of age while processing several consecutive years. They used optimization models to obtain results that are coherent both longitudinally and transversally (that is, between populations of consecutive ages in consecutive years).

Table 2
NSO SURVEY: Update frequency of projections among NSO respondents, in years (N=31)

Mean	Mode	Min	Max
3.8	5	1	10

42. Results from the user survey show that most users (65 per cent) found the update schedules of population projections to be adequate, although a sizeable proportion (28 per cent) felt they were not frequent enough (Figure 2).[15]

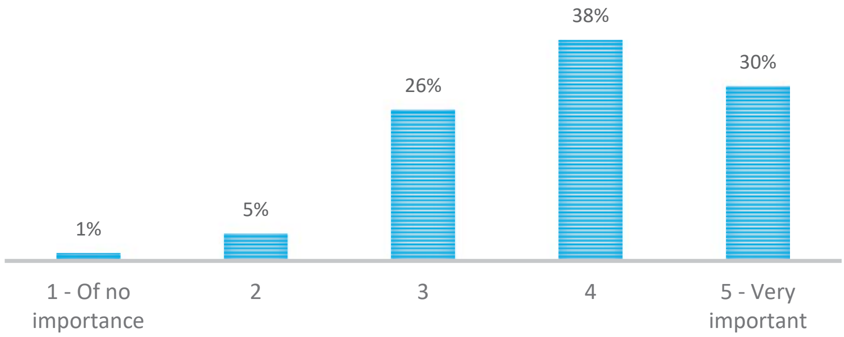
Figure 2
USER SURVEY: Users' opinion on the frequency of projection updates (N=144)



43. Other results from the survey show that the majority of users (68 per cent) found frequent updates to be important or very important (on a scale from 1 to 5, where 1 is "of no importance" and 5 is "very important") (Figure 3). Only 6 per cent of respondents found that regular updates were not important at all or not very important.

[15] Naturally, the frequency at which new projections are made available is likely to influence users' satisfaction with them (e.g., more frequent updates should generate higher satisfaction). This information is not available from the user survey, but can be found from the NSO survey if respondents are assumed to have used the most recent projections produced by the statistical agency of their country. This is an acceptable assumption since the respondents were identified as users by these same agencies. As expected, the results show that the proportion of satisfied users tends to increase as the interval between two updates shortens. For example, 9 in 10 users of projections found the schedule adequate when projections are updated at a frequency of two years or less, compared with one-third when the frequency is of three years or more. These results must be used with caution because of the small number of countries represented in the sample of the user survey and the way this sample was built (see the Research framework and methodology section).

Figure 3
USER SURVEY: Users' opinion on the importance of frequent updates (N=150)



44. It is difficult to propose an ideal update schedule, as the demographic context changes at a varying pace over time and geographically. Romaniuc (1994) provided a more sensible suggestion: "While respecting certain periodicity, as a matter of policy, the revision of the existing projections or development of new ones should be based on analytical considerations, when, for example, the demographic situation has changed to justify a new round of projections." Akin to this proposition, a revision policy based not only on the frequency of updates but also on the level of correspondence between projected and observed data would mitigate large discrepancies between projected data and observed trends, at least in the short term.

45. Still, Romaniuc's "analytical considerations" can appear somewhat vague without some guidance to determine how large a discrepancy can be tolerated. To assess with some level of confidence whether a projection differs from observed trends because of random fluctuations or because of systematic deviations requires the use of a statistical model. Another option is to use predetermined rules for deciding when a projection should be updated. For example, the Turkish Statistical Institute's revision policy states that an update must be produced if the correspondence between projection data and administrative data falls below 99 per cent in the total population or in the total population aged 15 to 64. An update is also required if the correspondence falls below 95 per cent in the total population of any NUTS (Nomenclature of Territorial Units for Statistics) 2 region (see Turkish Statistical Institute 2016a).

46. Finally, because the same future period can be covered by several consecutive editions, projections are uniquely subject to confusion regarding which edition is the most current. To ensure the relevance of the results, it is preferable that only the most recent edition of the projections be used by the media and other prominent users (unless in exceptional cases). Good strategies in this context include the following:

- Ensure that the search capabilities of the website lead to the most recent results.
- Clearly label and categorize as "ARCHIVED" (or an equivalent term) material related to past editions within the NSO website, with a hyperlink to the current edition on the same page.
- Advertise the dissemination of new population projections through the media (see Chapter 5).

Practice 1.6: Make electronic dissemination materials accessible and easy to navigate

47. Most users access dissemination materials through the NSOs' websites. It is therefore crucial to ensure that these materials are easy to access. A good practice in this context is to regularly evaluate the ease with which the data and all dissemination materials can be used, and their accessibility. NSOs should look for ways to improve the user experience on the population projection web pages, including search capabilities within the broader NSO website, data retrieval capabilities and navigational ease for users. Typically, such improvements would involve the whole NSO, and not only the people responsible for producing population projections, since most NSO websites have common look and feel guidelines or other restrictions in terms of the format of web content.

Practice 1.7: Offer customizable or interactive projection data to users in tabular or graphical formats

48. Interactive tools have the potential to make users' experiences more motivating and educational than the traditional, passive modes of communication (Morgan and Henrion 1990). A number of international and national statistical agencies supply users with such tools, allowing them to build their own tables or graphs (Box 1 provides some examples of customizable projection data). This should be seen as a good practice since these tools seem to be appreciated by users, as data from the user survey demonstrate. More than three-quarters (77 per cent) of respondents felt that it is important or very important to have access to customizable data tables.

49. However, a small number of respondents to the user survey (three) suggested that NSOs provide more flexible interactive tools that enable users not only to extract and possibly graph projection results, but also to generate their own projections based on a desired custom combination of assumptions. Such a tool has the potential to respond more extensively to different users' needs, but it is not without risks. One risk is that questionable results are attributed to the NSO that provided the interactive tool, even if they are engendered by implausible assumptions (possibly because of a user's deficient knowledge of demography) or by a user's intention to produce results fit for some personal purpose. Similarly, the reputation of the NSO could be used to lend authority and apparent neutrality to a custom-made projection. In the review process for these recommendations, several NSOs expressed serious concerns with this proposition, especially with regard to risks of possible misuse. In view of these concerns, a preferable alternative for NSOs to acknowledge the desire of users to obtain custom projections is to "run" the projections themselves (possibly at a cost). In this case, NSOs should ask users to identify the assumptions as theirs and to state clearly the role of the NSO (as merely providing the capacity to run the custom projections).

Box 1: Examples of customizable projection results

Statistics Norway

Statistics Norway offers a tool to create custom tables and graphs. It is possible to select different variables (e.g., population, various components of growth, and life expectancy) and values for these variables (e.g., specific ages). It is also possible to select various scenarios for comparisons. The outputs can be saved in a large number of formats.

Reference: Statistics Norway (2016).

Departamento Administrativo Nacional de Estadística (Colombia)

The population projection website of the Departamento Administrativo Nacional de Estadística offers an interactive visualization that includes a minute-to-minute population update, the population on a specific date and yearly population comparisons. Users can filter data by region or state to compare between different years and select age-specific participation.

Reference: Departamento Administrativo Nacional de Estadística (2017).

Eurostat

Eurostat's database offers rich possibilities for creating customized tables. Users can select various kinds of outputs and demographic indicators for different variants. It is also possible to view assumptions (e.g., age-specific mortality rates).

Reference: Eurostat (2016).

United Nations

The website for the 2015 revision of the United Nations' *World Population Prospects* offers multiple possibilities for viewing results, including maps, data tables, graphical representations of various outputs and key demographic indicators. Users can choose results for selected countries.

Reference: United Nations (2015b).

Chapter 3 - Cultivate transparency

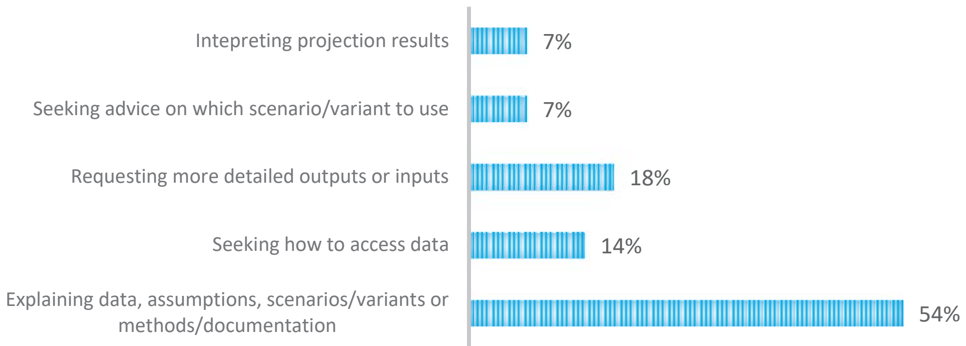
Introduction

50. Transparency is a principle of good scientific practice. Providing detailed and clear information about how a projection was produced allows users to interpret the results more accurately, and to understand more fully their limitations and the context in which they were made. The importance of transparency is recognized in the United Nations Fundamental Principles of Official Statistics: "Transparency on the sources, methods and procedures used to produce official statistics as well as data quality assessments readily available to users will enable them to judge the fitness of use of the data. Transparency therefore contributes greatly to increase the confidence and trust of users in statistics and thereby increasing use of statistics as evidence in decisions" (United Nations 2015a). A report prepared by the Panel on Population Projections of the National Research Council's Committee on Population concluded that "users would benefit from clearer presentation of the underlying methodology and assumptions" (National Research Council 2000, p. 12).

51. Users appear to place a high value on this "background" information. A large majority of respondents to the user survey indicated that receiving information about such elements was important or very important to them. This includes information about the current demographic context (90 per cent of users agreed), assumptions (86 per cent), methodology (78 per cent) and quality of underlying data sources (76 per cent). These percentages are higher even than the proportion of users who considered detailed analysis of results to be important (70 per cent). However, a sizeable percentage of respondents to the user survey felt that the information was not detailed enough about the current demographic context/trends (21 per cent), projection assumptions (29 per cent), methodology (24 per cent) or underlying data sources (22 per cent).

Figure 4

NSO SURVEY: What are the most common requests for technical assistance that you received? (N=28)



52. For their part, NSOs also seem to consider information about how the projections were produced to be a key element of their disseminations. Respondents to the NSO survey dedicated on average over one-quarter of their total disseminations to describing projection assumptions, the highest share of any projection element. Yet, among the various dissemination elements, respondents to the user survey were most dissatisfied with the level of detail disseminated by their NSO for population assumptions. Moreover, as shown in Figure 4, the most common

requests for technical assistance received by NSOs have to do with explaining data, assumptions and the methodology in general.

53. Thus, while NSOs appear to be dedicating a substantial portion of their disseminations to discussing projection assumptions, they could potentially improve the focus and content of these discussions to make them better suited to user needs for both qualitative contextual information and detailed quantitative data. The following good practices provide general recommendations and advice on how to communicate population projections in a transparent manner.

Good practices

Practice 2.1: Provide descriptions of the data, methods and assumptions

54. As described in the introduction to this chapter, users value highly the background information accompanying projection results, for several reasons. As de Beer (2011, p. 215) noted, adequate descriptions of the methods and assumptions "[…] make it possible for the user to determine how to interpret the outcomes of the calculations." Also, a clear description of the assumptions and methods allows users to make their own decisions about whether a projection is adequate for their needs (Armstrong 2001). Morgan and Henrion (1990) noted that scientific research reports should provide descriptions of their procedures and assumptions to a level of detail sufficient for others to replicate the results. Although this can be difficult to do in practice, the documentation should be prepared with the ideal of reproducibility in mind.

55. Therefore, providing detailed descriptions of the model, the data and the methods used is a good practice. The following are some possible strategies to help projection makers achieve this goal:

- Clearly identify the data sources used and comment on any major quality issues and their associated impact on the quality of the projections. Also, provide information on the evaluation procedures and any adjustments of the initial data for the projection.
- Make clear the logical links between descriptions of the current demographic context and projection assumptions. As de Beer (2011) explained, the arguments underlying the choices of assumptions and methods and their consequences should be provided. In the case of data extrapolation methods, for example, the impact of the choice of a reference period should be described, especially when it is sensitive or particularly consequential.
- If necessary, briefly describe the procedure followed to obtain the base population. In several countries, this population is essentially derived from the last population census or from the population register. However, adjustments (for coverage and other factors) are almost always made and should be noted in disseminations. The same could be done with other data used for the projections, such as those used to build the assumptions (e.g., immigration figures and vital statistics data).
- Describe the methods that were used to compute the parameters of the projections. An efficient strategy is to publish a separate technical report, distinct from the results (e.g., Aase et al. 2014; Bohnert et al. 2015; United Nations 2015b). Alternatively, projection makers can produce a series of technical papers addressing particular topics of the projections following the release of the results. This option gives more time for NSOs

to produce the report, but it has the disadvantage of offering the technical information in a less punctual manner.

- Provide a general description of the projection model, along with its strengths and limitations. It may often not be necessary to dedicate a large part of the dissemination material to this purpose if some pre-existing documentation can be referenced (e.g., George et al. 2004; Preston et al. 2000).
- Disseminate projection inputs (e.g., age-specific fertility rates) in the same level of detail as was used to build the projection.[16] However, this may not always be possible given the amount and level of detail of the inputs to be published. A good strategy in this context is to be willing to engage in direct communication with users regarding data and methods and to provide input data upon request.[17]

56. Finally, a good practice would be to dedicate a portion of dissemination materials to the publication of key information about the projections. Many NSOs have a section of their website dedicated to providing information about their various statistical programmes. However, the formats used are often not very relevant for population projections that differ from most other statistical programmes, such as surveys or administrative data collection. Adopting a standard format adapted to the specific nature of population projections would improve the accessibility of key information about the projections. This would be particularly true if NSOs used a similar, standard way of reporting this information. Appendix C provides a template to help NSOs achieve this goal. For NSOs, a large portion of the information contained in this template should also be reported in the (forthcoming) UNECE database on population projection metadata once new population projections are published.

Practice 2.2: Acknowledge any relevant stakeholders and describe the process and outcomes of all consultations

57. Population projections, like official statistics in general, are intended to serve the information systems of democracies for better decision making. Independence and impartiality of population projections are preconditions for fulfilling this demanding role (United Nations 2015a). Users of population projections expect results that are independent and impartial, and these principles are generally followed by NSOs. A transparent approach can certainly help preserve and even promote these principles. A good strategy in this context is to provide in the dissemination materials a description of any major stakeholders, particularly those who may have had an influence in producing the projections, whether because they provided funding or for other reasons. When possible, the impact of stakeholders on the production of the projections (e.g., changes in assumptions) should be specified.

58. Whether or not stakeholders are involved, most NSOs appear to engage in some form of consultation in the process of creating their projections. Data from the NSO survey show that two-thirds of NSOs had noted some or all of their consultations in the products they disseminated (Table 3).

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[16] Examples of NSOs providing detailed projection inputs can be found from Eurostat (2016), Statistics Norway (2016), Statistics Portugal (2016) and Statistics Sweden (2016).

[17] Data from the NSO survey show that NSOs tend to comply with requests for input data from their users. Indeed, 83 per cent of NSOs in the survey answered that they would distribute detailed parameter/input data to allow users to reproduce the projections, or similar projections, upon request.

Table 3
NSO SURVEY: If you consulted any bodies during production of the projections, were these consultations noted in disseminated products? (N=31)

All of the consultations were noted	11
Some of the consultations were noted	8
No, the consultations were not noted	10
Not applicable (there were no consultations)	2

59. Documenting consultations may help contextualize why some decisions were taken in producing the projections. Such descriptions can also reveal the areas where there is consensus and those where it may be lacking, or where there may be greater uncertainty. Good examples of the thorough documentation of the expert consultation process can be found in Appendix D.

Practice 2.3: Clearly define key terms used in dissemination products

60. To be properly understood, communications must use clear and well-defined terms. Accordingly, key concepts should be defined as they are introduced in the dissemination materials. One recommended way to do this is to include a glossary of key terms in the dissemination materials. In particular, key terms associated with projections, such as "projection," "forecast," "scenario" and "variant," should be defined; it should not be presumed that users share the same understanding of these terms as the projection maker.

Practice 2.4: Describe how the new projections differ from previous editions

61. NSOs frequently update projections, most often according to a predetermined schedule, usually after the base population is updated (e.g., when new census data become available), or because some important demographic changes may have occurred or are at risk of occurring. Each update requires users to become familiar with a new set of assumptions, results and methods. A good practice in this context is to communicate any key changes in approach from previous editions.[18] For regular users who are familiar with projections, such information can greatly facilitate the learning process. Finally, users would benefit from being aware of the frequency of new releases and from being notified in a timely manner about any upcoming reviews outside the pre-established frequency. The key factors that may lead to such ad hoc updates or revisions also constitute relevant information.

Practice 2.5: Assess the performance of previous projections

62. Many NSOs have adopted the practice of analyzing the performance of their past projections, sometimes supplementing the publication of new projections with an in-depth analysis of the performance of past projections. Repeated comparison of projected values with historical estimates reveals the limitations of population projections and informs users about what can reasonably be expected from them. Engaging in this exercise is also a means for NSOs to reflect on the sources of past inaccuracies, serving as a basis for improving future projection assumptions and methodologies (Wilson and Rees 2005). Measurements of past errors have

[18] Vandresse (2017) provided an example of the documentation of changes from previous editions. The paper highlights how the projections depend on hypotheses, which themselves reflect changes in the demographic trends in the country and internationally. Major changes in methodology are also described.

also been used to produce prediction intervals for new forecasts when producing probabilistic projections (e.g., Keyfitz 1981; Stoto 1983) and are essential for calibrating probabilistic forecasts.

63. Such exercises should nevertheless be undertaken with some caution. The fact that population projections are not perfectly accurate does not render them totally useless. Indeed, the future is not only something to be discovered—it can also be seen as something to be created (Romaniuc 1994; Romaniuk 2010). He adds that projections can be instrumental as planning tools when peers and users recognize their analytical credibility. Besides, an inevitable limitation of such analysis is the fact that projections are used as means to influence the future, and thus can trigger outcomes that will prove them wrong—the problem of self-defeating prophecy. Another caution is that a projection is never perfectly comparable with previous ones, as there can be changes in the methods and in the demographic context. These caveats should be kept in mind and communicated to users in any relevant dissemination materials.

64. While an in-depth analysis of previous projection performance is ideal, NSOs may not necessarily need to undertake such an exercise with each new edition produced. A single assessment of the most recent projection is not very useful, since it implies that projection errors are computed only for short durations, and because random fluctuations in important parameters may have caused substantial gaps between projected and observed data. A better practice is to evaluate a series of historical projections. At a minimum, it is recommended that disseminations make some reference to the performance of previous editions, linking the discussion logically to a larger acknowledgement of the uncertainty of projections.[19]

[19] Some examples of communicating the past performance of projections are from the National Research Council (2000), Shaw (2007), Statistics New Zealand (2008), Dion and Galbraith (2015), the Office for National Statistics (2015a), Majérus (2015), and Statistics Sweden (2012).

Chapter 4 - Address uncertainty explicitly

Introduction

65. The urgency and the significance of issues that scientists are currently being asked to tackle have begun to move the question of uncertainty[20] from the periphery to the core of scientific methodology (Funtowicz and Ravetz 1993). For population projections, this means that in addition to the most likely sizes and structures of future populations, the uncertainty of their projected future values is also of interest for planning.

66. Organizations engage in risk management exercises to measure and manage the possible consequences of internal or external factors on the realization of their objectives. Typically, risk management provides an evaluation of risks, defined as the effect of uncertainty on an organization (ISO/IEC 2009) and measured in terms of the impact of uncertain outcomes on the organization's objectives, taking into account their probability of occurrence. For example, the International Organization for Standardization (ISO) provides a formal framework for risk assessment to determine whether the magnitude of risks is acceptable or tolerable (ISO 2009).

67. Another reason for communicating uncertainty is that responses to uncertain events often differ from responses to more certain events. In some cases, uncertainty may lead to postponing action or to developing precautionary measures or policies that can be adapted as the future unfolds (National Research Council 2000). For example, the **precautionary principle** suggests the use of mitigation or preventative measures when it is impossible to assess—scientifically and with sufficient certainty—the risk of an action.[21] This guiding principle has been adopted internationally in several fields, including the environment (Kriebel et al. 2001); health (World Health Organization 2004); and, more generally, economics and politics (Commission of the European Communities 2000).

68. In addition to being critical in decision making, communicating uncertainty promotes users' confidence, helps users manage expectations and truthfully reflects the state of the science (World Meteorological Organization 2008).

69. Results from the user survey highlight the importance of conveying measures of uncertainty when disseminating population projections. Although very few agencies quantify uncertainty,[22] the majority of user respondents (69 per cent) felt that quantifying the uncertainty

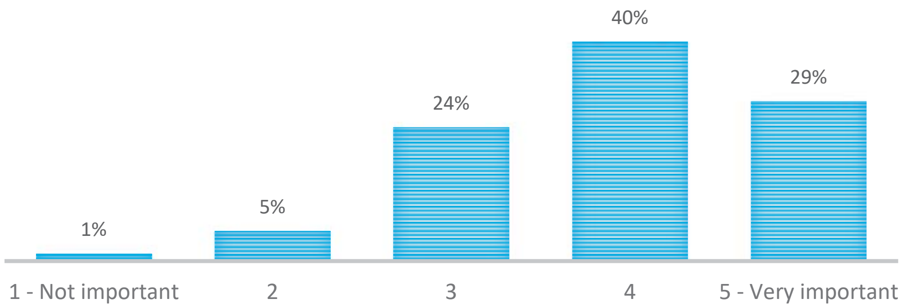
[20] In this chapter, following Knight's (1921) distinction, uncertainty can be aleatory—that is, when it comes from randomness—or epistemic, when its source is our lack of knowledge. In the case of population projections, the question of whether uncertainty comes from the fact that the future is not completely specified by the past (inherent randomness) or whether it comes from epistemic limitations (including imprecision in the data) is a metaphysical one, as the result is the same: our knowledge of future population growth is uncertain (de Beer 2000). In the end, as Morgan and Henrion (1990, p. 63) related, "you see a quantity as random if you do not know of any pattern or model that can account for its variation."

[21] UNESCO (2005) has written a working definition of the precautionary principle: "When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm."

[22] Most agencies publish a series of scenarios that are supposed to represent a plausible range of outcomes, as shown in Figure 7 later in this report.

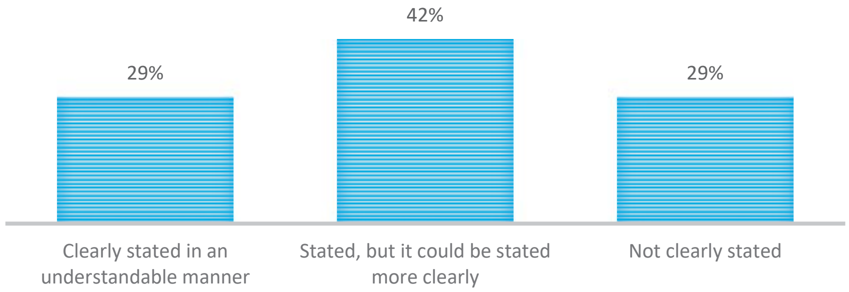
of projections was either important or very important. Very few (1 per cent) felt that it was not important at all (Figure 5).

Figure 5
USER SURVEY: Please rate the importance of the quantification of the uncertainty of the projections in regards to your use of population projections (N=148)



70. Results from the user survey also show that a majority of users thought that the communication of uncertainty could be improved (Figure 6). Asked about the information presented in the most recent edition of the population projections used, 29 per cent of respondents felt that the uncertainty was stated clearly and in an understandable manner.[23] The same proportion said that it was not clearly stated, and about two-fifths said that it could be stated more clearly. The fact that the majority of user respondents were interested in understanding the uncertainty of population projections illustrates the demand for such information. This could motivate NSOs to invest resources in improving the communication of uncertainty.

Figure 6
USER SURVEY: In your opinion, the uncertainty of the projection is: (N=119)



71. There is a general sentiment among demographers that the treatment of uncertainty in population projections is an area of work that remains underdeveloped.[24] O'Neill et al. (2001)

[23] All respondents were from countries whose national population projections contained more than one scenario.

[24] The adequate measurement of uncertainty in population projections has been identified as an area severely requiring improvement in several studies in recent decades, including by Keilman et al. (2002), Keilman (2008), the National Research Council (2000), de Beer (2000), Lee (1998), Keyfitz (1981) and Stoto (1983). This is also a conclusion of the report prepared by the Panel on Population Projections of the National Research Council's Committee on Population, which stated that "official projections have neglected the important issue of the uncertainty surrounding forecasts" (National Research Council 2000, p. 12).

noted that accurately characterizing the associated uncertainty is critical to ensuring that a population projection is used appropriately, yet there is no generally accepted approach for characterizing such uncertainty. The speculative nature of population projections makes it difficult to assess uncertainty, especially in quantifiable terms. Indeed, the future is not an experiment from which we can collect data. Nevertheless, as noted by Keyfitz (1981, p. 579), “the user of a population forecast has no less need to know its error than the user of a yield estimate or of an estimate of unemployment.”

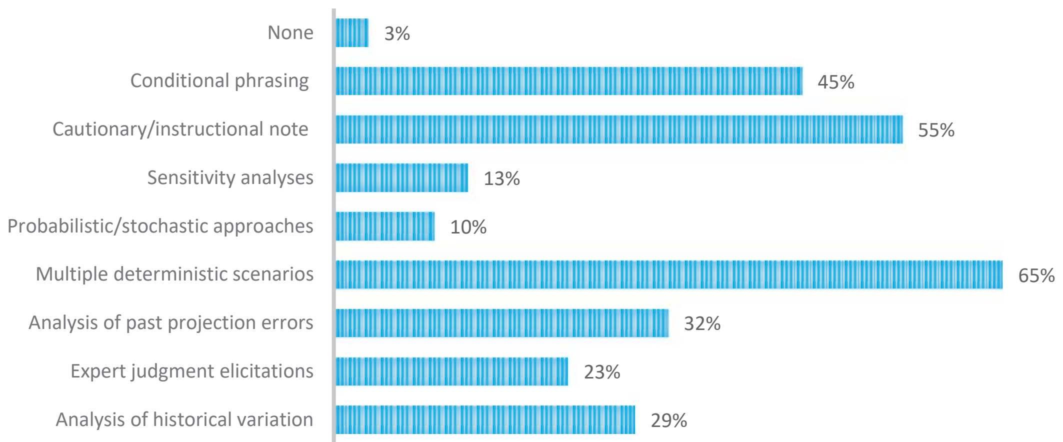
72. Many techniques for estimating the uncertainty of forecasts have been developed, including a vast literature on probabilistic models for time series. Demographic problems have also driven the development of forecasting methods, such as the Lee–Carter model for mortality (see Lee and Carter 1992). Smith (1997) and O’Neill et al. (2001) observed that efforts made to consider how best to express uncertainty and convey this information to users should be a priority for research, as this is key to improving the quality and usefulness of population projections. This point is important, since, as Jenkins (1982) pointed out, forecasts or projections may fail to achieve their objective not because of poor quality, but because insufficient attention was paid to the relationship between forecasting and decision making. Campbell (2011, p. 4892) provided a good description of the quandary scientists face with regard to uncertainty, noting that “the values of openness and transparency in communication to stakeholders and publics, not to mention a modicum of due humility, necessitate an explicit acknowledgement of scientific uncertainties. But this obligation flies in the face of a strong concern that expressed uncertainties can themselves undermine public trust. Resolution of this contradiction depends on the context and on how you tell it.”

Current practices

73. An examination of current practices reveals an unevenness in the commitment of statistical agencies to communicating the uncertainty of population projections and in the approaches used. As an example, Figure 7 shows the proportion of NSOs that used various methods to communicate uncertainty in their disseminations. While the majority used multiple deterministic scenarios and cautionary or instructional notes, fewer than half used conditional phrasing, a simple and effective means of indicating the uncertain nature of the results.

Figure 7

NSO SURVEY: In your disseminations, did you use any of the following methods to communicate the uncertainty of projections to users? Indicate all that apply (N=31)

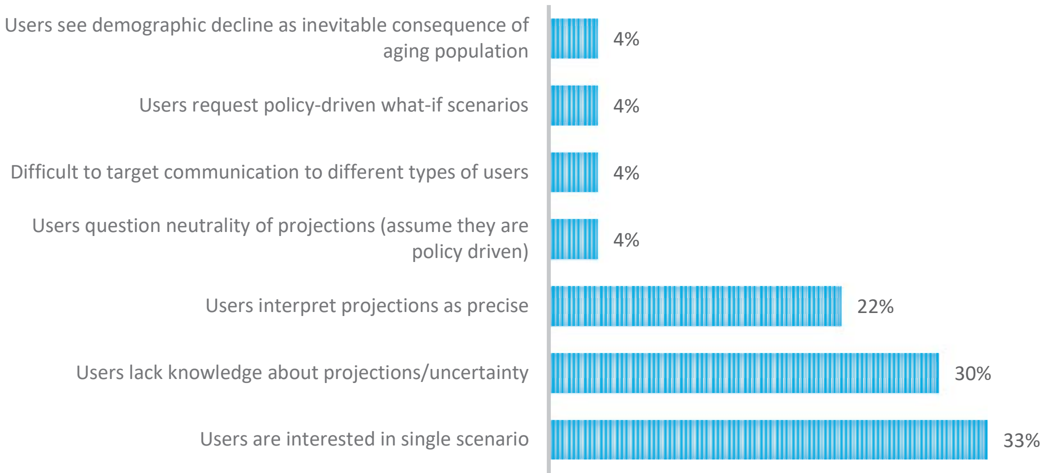


74. Survey findings also revealed variations in the number of scenarios produced and in the information and language used to characterize them. For example, some NSOs disseminate a "most likely" scenario or only a single scenario, while others provide multiple scenarios without assessing their likelihood of occurrence. Even the use and definition of basic terminology, such as the difference between a forecast and a projection, vary considerably across NSOs. This disparity of practices has increased with the publication in recent years of probabilistic projections providing specific prediction intervals.

75. The reluctance to express uncertainty is not confined to producers of population projections, but touches scientific communication in general. Fischhoff (2012) identified some causes of this reluctance on the part of experts: uncertainty is seen as giving misplaced or exaggerated imprecision; uncertainty may not be understood as intended; experts can be disparaged for communicating uncertainty; and, perhaps most fundamentally, experts in many cases do not know how to express or accurately measure uncertainty. Results from the NSO survey confirm some of these challenges. Approximately one-third of NSO respondents indicated that they felt users were interested in a single scenario or lacked knowledge about projections or uncertainty in general, making it challenging to communicate information about projection uncertainty to them (Figure 8).

Figure 8

NSO SURVEY: In your opinion, what challenges do you encounter in communicating the uncertainty of population projections to users (for instance, do projection users have any common misconceptions about the projections)? (N=27)



76. The different strategies used by projection makers to communicate uncertainty can be grouped into two main approaches: the production of deterministic scenarios and the production of probabilistic projections (O'Neill et al. 2001; Lutz and Samir 2010). These two approaches are summarized below.

The deterministic (scenario) approach

77. Users of population projections will often be interested in a single most likely outcome (Lutz et al. 1994) and will tend to interpret the result of a middle variant as being the most likely when more than one projection scenario is provided (Keyfitz 1981). Despite these

tendencies, most NSOs have attempted to acknowledge the uncertainty of population projections through various means. By far the most common practice among NSOs is to provide a series of alternative deterministic variants in which the demographic components are combined in such a way as to maximize the range of results in terms of population sizes alone. For example, a low-growth scenario can be constructed by combining assumptions of low fertility, high mortality, low immigration and high emigration. The method is simple and fairly transparent to users.

78. The scenario approach, as Willekens (1990) explained, "[…] is a method for dealing with uncertainty. Its goal is not to predict the future, but to provide the user with alternative, internally consistent futures against which decisions can be tested and actions planned." This approach allows users to make comparisons and to understand the sensitivity of the projected results to variations in assumptions about vital rates (some assumptions being more or less plausible, and others being implausible but still instructive as hypothetical cases in policy-driven discussions). Such comparisons provide a form of sensitivity analysis and may be useful to guide potential interventions or policy development. Indeed, as Sanderson et al. (2003) noted, policy makers are used to thinking in terms of alternative scenarios—to evaluate, for instance, what the outcomes of different policies could be. The plurality of scenarios highlights the uncertain nature of population projections by making it clear that there is not just one possible outcome for the future, but, rather, multiple possibilities.

79. Romaniuc (1994) and Romaniuk (2010) described the usefulness of the scenario approach in terms of **prospective analysis** as a way of exploring and managing the future. Prospective analysis stands between **predictions** and their opposites, **simulations**. Predictions aim to predict the future, while simulations aim either to show the consequences of given conditions (process-oriented) or to find the conditions leading to a given outcome (goal-oriented), without any concern for the analytical credibility of the assumptions.

80. In addition, several projection makers reject the idea of producing forecasts or publishing measures of probability (as in the probabilistic approach, summarized in the next section), because such practices may convey a misleading sense of precision and may not be justifiable in view of the past performance of projections (Lutz et al. 2004).

81. However, the scenario approach has often been viewed as an unsatisfactory way to assess and communicate the uncertainty of population projections (e.g., Lee 1998; de Beer 2000; National Research Council 2000; Keilman et al. 2002; Bijak et al. 2015). Some of the noted limitations of the scenario approach are the following:

- The scenario approach does not adequately reflect the uncertain nature of population projections (National Research Council 2000; Bijak et al. 2015).
- In its most common application, namely the high-growth versus low-growth configuration, the scenario approach is designed to provide plausible variations only in terms of population size. Nothing ensures that the variations projected for other demographic indicators are either plausible or probabilistically consistent—that is, that the variations in these indicators are of the same size and order as those of population size. For example, the high-growth versus low-growth configuration tends to yield very narrow variations for the old-age dependency ratio, in contrast to variations of population size (Lee 1998; Lee and Edwards 2002; Keilman et al. 2002). Comparisons with probabilistic projection results suggest that these intervals are too narrow (Lee 1998; Lee and Edwards 2002; Keilman et al. 2002). For the scenario approach to provide plausible results, it must be tailored to the outcome for which uncertainty is to

be assessed (Lee ibid.). For example, an analysis centred on the old-age dependency ratio could compare two scenarios, one proposing high mortality and high fertility, and the other combining low mortality and low fertility. The issue gets more complicated when variations are needed for more than one outcome, as there will be no consistency in all scenarios.

- Levels of fertility, mortality and migration can be combined in several ways that yield similar ranges of population sizes. By comparing only a small number of scenarios, the scenario approach is unable to capture the infinite ways in which the various components of growth can combine (Lee 1998).
- Because no probabilities are associated with the different parameters of the inputs, it is not possible to provide a probabilistic interpretation of the results of deterministic scenarios. It is also not possible, without revising the specification of the scenarios, to modify the width of the high–low interval for some specific purposes. These characteristics may limit the usefulness of deterministic variants for planning purposes.
- To avoid providing statements about the likelihood of their projections, some NSOs publish several projection variants without giving the likelihood or probability of each variant. However, this contradicts the way in which population projections are usually produced. Indeed, as Keyfitz (1972) noted, most projection makers build their assumptions based on what they think the most likely outcomes are, since, without such an assessment, any possible variant would be as good as any other and there would be no special value to any scenario. Besides, the fact that a projection maker does not want to consider the projection as a forecast does not prevent users from doing so themselves. Deprived of any "most probable" outcome, planners often have no other choice. However, in practice, many decision makers may be willing to accept any kind of information about how reliable the projection will likely be, even a subjective but informed opinion. For de Beer (2000, p. 26), "to let users make their own choice does not seem an optimal use of expertise." Similarly, Keyfitz (1981) observed that, in practice, users depend on demographers for assessing the likelihood of different outcomes and that if this cannot be done by those specializing in the subject, then no one can do it.
- The scenarios themselves may also be difficult to interpret. Indeed, the scenario approach implies several kinds of high or perfect correlations that do not represent highly plausible outcomes (de Beer 2000; Keilman et al. 2002). For example, in a single variant, perfect correlation is assumed over time for a given component and between components (e.g., constant high mortality and low fertility). High correlations can also be found between scenarios, especially when designed specifically to provide a range of outcomes for a variable (e.g., population size).

The probabilistic approach

82. In recent years, an increasing number of researchers have advocated for a paradigm shift in population projections to solve the inconsistencies and address the caveats associated with the scenario approach described above. For these researchers, uncertainty should be characterized using the language of probability, and measures of uncertainty should be provided through the use of probabilistic methods.

83. Fundamentally, probabilistic projections result from the borrowing of methodologies developed for **uncertainty analysis** in other science fields and their application to population

projections.[25] Uncertainty analysis consists of quantifying the uncertainty in the results of a model (Saltelli et al. 2008). A general procedure for uncertainty analysis contains the following steps: (1) define the measurement process, (2) develop the error model, (3) identify the error sources and distributions, (4) estimate the uncertainties, (5) combine the uncertainties, and (6) report the results of the analysis. Methods used for uncertainty analysis can also be used for **sensitivity analysis**, which can be defined as "the study of how the uncertainty in the output of a model (numerical or otherwise) can be apportioned to uncertainty in the different inputs to the model" (Saltelli et al. 2004, p. 45).[26,27]

84. In a probabilistic projection, the parameters do not have single values but rather take on a range of possible values in accordance with a probability distribution. Such projections have been built using time-series extrapolations, expert elicitation, analysis of past forecast errors or a combination of these methods. Parameter values from the associated probability distributions for the various components of population change can be sampled to produce an infinite number of trajectories.[28] This approach allows the uncertainty associated with each component of population change to be integrated in a consistent manner (even though the components may be summarized by non-comparable indicators, such as the total fertility rate or life expectancy at birth). As a result, for any outcome variable (e.g., population size, the size of individual age groups and indicators of age structure), users can identify a single forecast, usually set equal to the median result from a large number of simulated trials (or trajectories), surrounded by a prediction interval corresponding to a selected probability (usually 80 per cent or 95 per cent). Furthermore, when outcomes have associated probabilities, it becomes obvious that some outcomes are more likely than others. Indeed, the vocabulary used to describe probabilistic projections suggests a predictive goal, reflected in the use of terms such as "forecast error."

85. Like deterministic projections, probabilistic projections are based on assumptions and are therefore unavoidably uncertain. As Alho and Spencer (2005, p. 244) noted, "In general, a forecaster must be prepared to describe a stochastic or probabilistic forecast as representing his or her subjective views of the likelihood of future developments."[29] However, probabilistic projections are seen as providing more authoritative assessments of uncertainty than the traditional deterministic projections because they allow more information about uncertainty to be incorporated and because they better mimic the propagation of uncertainty over time.

86. Of course, probabilistic projections, like deterministic ones, have several drawbacks. These are described at length in the literature and are summarized in Appendix E, which

[25] However, simplified alternatives have been developed to bring some of the benefits of probabilistic projections into the scenario approach framework (e.g., Bertino et al. 2012; Goldstein 2004).

[26] This is the definition retained for this report. However, as Saltelli et al. (2004) noted, the term "sensitivity analysis" may be interpreted differently depending on the setting or the technical community.

[27] This is often done without the machinery of probabilistic projections. For example, two scenarios could be run with the low and high values of an 80 per cent prediction interval for fertility to obtain a range of outputs associated strictly with variations in fertility. The results would reflect the differences given an 80 per cent prediction interval in assumptions. However, an 80 per cent prediction interval obtained from a probabilistic projection with varying levels of fertility could show different results in the presence of non-linear interactions between fertility and the other components of growth (if the projection model allows for them).

[28] More exactly, values should be sampled from one big multivariate distribution that includes correlations between components of change (possibly assumed to be 0), between men and women (for mortality and migration), between ages (all components), and across time (all components).

[29] This subjective approach to probabilities is natural in a Bayesian framework, embraced by several probabilistic projection makers (see Appendix G for more details).

provides a description of the benefits and limitations associated with the probabilistic approach (they are therefore not repeated here). Appendix F shows how uncertainty analysis and sensitivity analysis have analogues in the domain of population projections. Finally, Appendix G shows an application of decision making using results from probabilistic projections.

Good practices

Practice 3.1: Develop an explicit strategy for characterizing and communicating the uncertainty of population projections

87. NSOs should think of the quantification of uncertainty as a valuable result in itself. This would naturally lead to the development of a comprehensive and explicit strategy for communicating uncertainty. Moreover, a clear exposition of such a strategy would allow users to understand its strengths and limitations, as well as the multiple sources of uncertainty inherent in population projections.

88. An explicit strategy should entail selecting some specific key outcomes (e.g., population size, components of change and indicators of the age structure) for which it seems particularly important to communicate information about the uncertainty of the projections. For example, in industrialized countries, indicators of population ageing will likely be sought. Other indicators that decision makers could look for might include estimates of the size of future cohorts of students at various ages or the number of people entering the labour force. This approach would be preferable to the most current strategy used by NSOs, a rather mechanistic application of the high-growth versus low-growth configuration in the scenario approach. As mentioned earlier, this method has some flaws, especially when used for outputs other than population size.

89. A comprehensive strategy could also include the use of different methods to assess uncertainty in population projections. An exhaustive approach, for example, could include reporting the expected main sources of uncertainty in the projections, providing qualitative assessments of the assumptions by independent experts, estimating the model uncertainty through a comparison of various models, producing different scenarios for sensitivity analysis for some results deemed sensitive or important, and producing prediction intervals via probabilistic methods. This example may look somewhat extreme; it mainly serves to illustrate the variety of methods that NSOs can use to communicate uncertainty. That said, such comprehensive strategies have been used in other areas, such as studies of future climate change (e.g., IPCC 2013). The subsequent good practices in this chapter discuss some of these methods in more detail.

Practice 3.2: Identify and acknowledge the major sources of uncertainty

90. There are obviously innumerable sources of uncertainty in population projections. It is a good practice to identify the major sources of uncertainty in population projections, recognizing that some sources are not known even to the projection makers. The most important sources could be subject to more in-depth analysis when possible, following an explicit strategy as suggested above. In probabilistic projections, the uncertainty that is unquantifiable but potentially relevant can be identified and evaluated with regard to overall

importance. Such practices would reinforce the observation that population projections are not predictions while also enhancing the transparency of the resulting projections. The various sources of uncertainty in population projections have been described in several papers and books (e.g., Hoem 1973, p. 14; Lee 1998, p. 157; de Beer 2000, p. 2; Alho and Spencer 2005, p. 238) and are summarized in Box 2.

91. Finally, although population projections usually perform well within limited time horizons thanks to demographic momentum and in situations with little variation in vital rates,[30] their accuracy is adversely affected by unpredictable events such as wars, economic crises and natural catastrophes. For example, the sudden surge in the number of births (the baby boom) and its abrupt end two decades later (the baby bust) were largely unforeseen (Keyfitz 1981; Reher 2015). One might argue that such events are unlikely to be missed today because the techniques of population projection have greatly improved over time. However, there is no clear evidence that this is indeed the case or that the accuracy of forecasts will substantially improve in the future (Keilman 2008). It seems foolhardy to believe that demographers will not be surprised by other unforeseen demographic events in the future.[31] Noting the disastrous records of forecasters in other domains, such as finance, Taleb (2012, p. 9) warned against "the (unscientific) overestimation of the reach of scientific knowledge." He observed that, because of structural limitations and an inevitable blindness with respect to randomness, there are areas where the possibility of rare but very consequential events simply cannot be assessed (Taleb 2010). These limitations should be made explicit to the users of population projections.[32]

[30] For example, projections of population ageing in most industrialized countries can be considered robust in the short and mid-term, given their current age structures.

[31] For example, some Mediterranean countries experienced decreases in fertility in the second half of the 1980s and the first half of the 1990s that were similar in proportion to the post-war baby boom and baby bust. Those changes had not been anticipated either (Alho and Spencer 2005, p. 232).

[32] Demographers are mostly aware of this, as illustrated by the current common practice among NSOs of publishing a warning or cautionary note that projections are the result of plausible assumptions but do not account for unpredictable events or circumstances such as economic crises, wars or natural catastrophes (see Appendix H). Also, as noted by the National Research Centre (2000), some of these events would change the world so significantly that the original planning the projections were intended to inform would largely lose its relevance.

Box 2: Main sources of uncertainty in population projections

- **Uncertainty related to data:** This uncertainty includes imprecision in the data used to construct the projection, such as the baseline population and the observed vital rates used to choose the assumptions. Reviewing world projections published by the United Nations since 1950, Keilman (2001) noted that projection errors related to inaccuracies in baseline data tend to decline over time. This may nevertheless remain the main source of projection errors for as long as 10 years after the projection in countries with particularly poor-quality data. Keilman also found that poor quality of birth and death data contributes to errors in the projection of total fertility or life expectancy (ibid.). Lutz et al. (2007) provided an example where uncertainty in the current demographic conditions can be found in probabilistic projections of China.
- **Uncertainty of the future:** This is uncertainty about whether the assumptions used in making the projections will accurately reflect future demographic trends. This type of uncertainty increases with time. It includes uncertainty about whether events will occur, such as the implementation of policies affecting demographic levels and trends. Because precise information about the future does not exist, these questions must be framed in terms of probability and plausibility.
- **Structural uncertainty:** This refers to uncertainty related to limitations in our understanding of population dynamics and in our capacity to model them. Experts tend to underestimate the magnitude of the structural uncertainty that is inherent to complex systems and processes (Morgan and Henrion 1990). Typically, parts of the population projection methodology are immune to structural uncertainty. For example, in a cohort-component model, the demographic equation consists of exact relationships between population growth and the components of growth (births, deaths and migration). However, structural uncertainty comes into play when modelling these components and projecting them into the future.

  The following are possible sources of structural uncertainty:

  - lack of scientific knowledge
  - limitations or boundaries of the modelling processes
  - events with low probability that are not considered in the modelling process
  - limitations of indicators used in the modelling process.

Practice 3.3: Clearly state the uncertain nature of the projection results in high-level dissemination materials

92. The uncertain nature of population projections can be described in a simple, clear and candid manner as part of any high-level or summary dissemination materials (Wardekker et al. 2008). Projection users cannot be expected to understand the nature of their uncertainty if it is not explained and summarized for them in a convenient manner (Campbell 2011; Fischhoff 2013). Discussing the concept of uncertainty and how it affects the interpretation of the results can be especially useful for a lay audience. Including a statement about uncertainty in high-level dissemination materials increases the chances that journalists pick up on the topic. A statement on the uncertainty of the projections does not require a specific quantity or measure. On the contrary, the message should be short and accessible to help inform the public of the speculative nature of projections. Box 3 provides some examples of simple statements

on uncertainty that can be included in a press release or in other high-level dissemination materials.

93. In addition, a short introductory section of this nature could explain how uncertainty affects the results and how it is dealt with in the context of a given projection, guiding readers through the various sections where uncertainty information is disclosed. Such a section could also include an assessment of what is known and what is highly uncertain, as well as a summary of the main sources of uncertainty. This could be discussed in greater detail elsewhere in the dissemination materials, employing the technique of progressive disclosure of information, as discussed in Chapter 2 (good practice 1.2).

94. A review of the most recent disseminations by NSOs indicated that many have already embraced, to varying degrees, the practice of producing high-level summary information on the uncertainty of projections. Appendix H lists several good examples from NSOs of tactics for communicating the uncertainty of population projections. The following are some of the most useful approaches:

- Note that projections are not intended to be predictions about what will happen in the future, nor do they describe an inevitable outcome.
- In cases where multiple deterministic projection scenarios are published, encourage users to consider a range of projection results rather than a single result, by comparing multiple scenarios.
- In cases where probabilistic projections are produced, publish prediction intervals, possibly at different levels (e.g., 80 per cent and 95 per cent). Also, showing one or a few trajectories (iterations) is helpful to illustrate how the uncertainty may propagate over time in the projections and to help users understand the approach (e.g., United Nations 2015b).
- Note that the accuracy of a projection depends on a number of factors that are difficult or impossible to anticipate, such as economic crises, wars and natural catastrophes.
- Note that projections are uncertain and become increasingly so with the length of the projection horizon (e.g., projection uncertainty is much greater for the characteristics of cohorts who have not yet been born, as these require assumptions about future fertility patterns).
- Offer answers to common questions from users (e.g., “which series should I use?”) that provide an opportunity to explain that using several scenarios yields a more realistic picture of possible future trends.
- Note the key differences between population estimates and projections.
- Observe that certain components of a projection contain more uncertainty than others and explain why (e.g., assumptions about future net migration are highly uncertain, since immigration levels can be volatile as a result of economic and policy changes, while knowledge of emigration levels may be very poor because of data quality issues).

Box 3: Examples of good practices in communicating uncertainty in high-level dissemination materials

Federal Statistical Office of Germany (Destatis)

Press release

In this example, a portion of a press release was dedicated to stating the uncertain nature of population projections. The release mentioned that many variants were published and mentioned how they were produced. This practice can certainly increase the likelihood of receiving more accurate press coverage.

“WIESBADEN – […] As the President of the Federal Statistical Office (Destatis), Roderich Egeler, stated at a press conference to present the results of the 13th coordinated population projection, the country’s 2013 population of 80.8 million was expected to increase, depending on the assumed extent of net immigration, over a period of five to seven years and to decline afterwards. He continued that the population figure would be below 2013 levels not before 2023. In 2060, the population size would be 67.6 million according to a lower and 73.1 million according to a higher immigration variant.

However, long-term population projections are not forecasts. They provide ‘if-then statements’ and show how the population and its structure would change based on certain assumptions. The results shown here were obtained by two of the total of eight variants included in the 13th coordinated population projection. These variants describe the development until 2060 based on the assumptions that the average annual birth rate will be 1.4 children per woman, with the average age at birth rising; life expectancy will increase by seven years (men) and six years (women); and migration will develop according to two different assumptions […]”

Reference: Federal Statistical Office of Germany (Destatis) (2016).

World population stabilization unlikely this century

Article in *Science*

This example shows how, in probabilistic projections, it is possible to demonstrate the uncertain nature of population projection results very simply by using the language of probability.

“The United Nations (UN) recently released population projections based on data until 2012 and a Bayesian probabilistic methodology. Analysis of these data reveals that, contrary to previous literature, the world population is unlikely to stop growing this century. There is an 80% probability that world population, now 7.2 billion people, will increase to between 9.6 billion and 12.3 billion in 2100. This uncertainty is much smaller than the range from the traditional UN high and low variants. Much of the increase is expected to happen in Africa, in part due to higher fertility rates and a recent slowdown in the pace of fertility decline. Also, the ratio of working-age people to older people is likely to decline substantially in all countries, even those that currently have young populations.”

Reference: Gerland et al. (2014).

Practice 3.4: Dedicate space within dissemination materials to promote a better understanding of uncertainty and its interpretations

95. The uncertain nature of population projections calls for at least a minimal understanding of related concepts such as assumptions, scenarios, plausibility and uncertainty itself, all of which are complex topics. The concept of a forecast or a projection, and what we can reasonably expect from such an exercise, is often misunderstood. Even among demographers, such topics continue to be the subject of lively debate. However, this is not surprising, since conceptualizing ideas such as chance and uncertainty has been challenging ever since Bernoulli's seminal thinking on the subject of probability in the early 18th century (Fischhoff 2013, p. 69).

96. While it is useful to include all concepts related to uncertainty in an accessible glossary within the dissemination materials, another good practice is to dedicate a section of these materials to educating people on how to understand uncertainty more accurately and in greater depth.[33] This section could also be the place to engage in a more direct and informal dialogue with users on the communication of uncertainty and other relevant topics. By showing not only expertise but also a desire to teach and a sense that they care about users, experts are likely to reduce the distance between themselves and the lay public and to increase the public's trust in them and in their information. Lastly, graphs can be very helpful for portraying uncertainty simply and effectively (e.g., Spiegelhalter et al. 2011). Box 4 provides examples of good practices in communicating concepts of uncertainty related to population projections.

[33] For example, Woloshin et al. (2007) found that when patients were given a booklet describing how to understand the risks of an intervention and its possible benefits or harms, data interpretation skills among patients improved considerably.

Box 4: Examples of good practices in communicating concepts of uncertainty related to population projections

United Kingdom

POSTnote number 438: Uncertainty in Population Projections

This note, published by the Parliamentary Office of Science and Technology in the United Kingdom, describes how population projections work, gives a short assessment of past projections, addresses the limitations of various projection models and provides guidance on how to manage uncertainty in a policy context.

Reference: Parliamentary Office of Science and Technology (2013).

Population Reference Bureau

Policy Brief, July 2014: Understanding Population Projections: Assumptions Behind the Numbers

In this brief, the authors encourage policy makers and planners to understand how projections rely on assumptions about the future and the implications of uncertainty for successful planning. They examine the population projections produced by the United Nations (*World Population Prospects: The 2012 Revision*) to describe how uncertainty comes from a variety of sources and how it increases over time. The authors also debunk some myths about projections (e.g., the growth of a country does not stop immediately once its fertility reaches replacement level).

Reference: Kaneda and Bremner (2014).

Practice 3.5: Pay close attention to verbal expressions of uncertainty

97. Words can effectively convey a general idea of uncertainty. In general, verbal expressions are more easily remembered than numerical expressions and are better adapted to lay audiences (Kloprogge et al. 2007). Qualitative assessments and evaluations can be appropriate when quantitative measurements are impossible to provide (IPCC 2010). They are especially relevant when communicating degrees of consensus among experts.[34] The following are some simple strategies for communicating uncertainty in words:

- Describe the results of multiple variants rather than a single estimate (in the case of deterministic projections) or a prediction interval (for probabilistic projections).
- Use conditional phrasing so as to integrate uncertainty within the message. This is particularly important for probabilistic projections, given that the language used may tend to exaggerate the predictive capabilities of the projection makers.
- Emphasize that the results are not predictions and that the report contains additional information regarding the uncertainty of the results.
- Draw attention to differences of opinion regarding the main assumptions and explain how such choices can influence the results.

[34] Projection makers can also find some inspiration for assessing their methods in protocols developed for integrating qualitative and quantitative dimensions of uncertainty and communicating them efficiently, such as the NUSAP (Numeral, Unit, Spread, Assessment and Pedigree) notational system (e.g., Funtowicz and Ravetz 1993).

- Demonstrate how a given result could change if there were a deviation from assumptions or an unexpected event (e.g., population ageing may be likely across a range of plausible scenarios, but its magnitude could be lessened by higher-than-expected levels of fertility or immigration).

98. Probabilistic projections can also benefit from verbal expressions in the form of fixed scales in which calibrated language is used to express probabilistic estimates. For example, the Intergovernmental Panel on Climate Change (IPCC 2010) used a likelihood scale in which the linguistic qualifiers "virtually certain" and "very likely" were associated with the ranges of probabilities "greater than 99 per cent" and "90 per cent to 99 per cent," respectively.

99. Fixed scales have some disadvantages: terms are imposed upon users and are not necessarily used in the way they would intuitively have used them, and, like numerical expressions, fixed scales are not well adapted to uncertainties that are difficult to quantify (Kloprogge et al. 2007). Verbal expressions may also be consistent with various interpretations, depending on the context (Morgan and Henrion 1990). However, as noted by Renooij and Witteman (1999), this also occurs in the case of numerical expressions.

Practice 3.6: Solicit and publish expert opinions

100. Asking experts for their best professional judgment is often the only viable option when a decision must be made in the absence of empirical data, or when the required data are limited, unreliable or prohibitively expensive (Allan et al. 2010; Runge et al. 2011). In the context of modelling uncertain events, expert elicitation can be used to translate professional judgment about uncertain events into something that can be usefully modelled (Gosling 2014).

101. Expert elicitation should not be viewed merely as a last resort, as it offers several benefits. An important feature of expert elicitation in a statistical framework is that the expert uncertainty is explicitly and formally included in the modelling process, reflecting the differences of opinion between experts (e.g., Bijak and Wiśniowski 2010). Indeed, when properly structured and documented, expert elicitation characterizes uncertainty in a transparent manner. It is also relatively quick and inexpensive to undertake, compared with intensive research or data collection (ibid.; Gosling 2014). Furthermore, in some cases, expert elicitation may be preferable to other methods, such as time-series extrapolation, if it takes into consideration additional information beyond what was previously observed. According to Lutz et al. (1998), this argument is especially pertinent in the case of population projections, as demographic trends are highly affected by social changes and policies that can be difficult to predict based only on historical trends.

102. However, there are limitations to expert elicitation. It can be difficult for experts to articulate their views (Gosling 2014), especially when they are asked to assign probabilities to specific events. Indeed, it has been found that humans, whether experts or not, are generally not good at estimating probabilities (Morgan and Henrion 1990; Garthwaite et al. 2005; Kynn 2008). Faced with such a task, individuals resort to heuristic devices that can lead to biased

outcomes.[35] Projection makers who use expert elicitation should be aware of such limitations. Various protocols have been created to facilitate the process of expert elicitation.[36]

Practice 3.7: Provide uncertainty analysis

103. As indicated in the introductory part of this chapter, uncertainty analysis is a standard practice in science. Its application to population projections, yielding probabilistic projections, provides a means of translating the uncertainty estimated for each component of the growth, and possibly the baseline data, into the uncertainty of the results (see Appendix F for an illustration). Equipped with probabilistic projections, users can acknowledge and integrate the uncertainty associated with projections of future population trends into an analysis that uses projections as inputs for research on various topics or for other types of forecasts.

104. Uncertainty analysis (and probabilistic projections more specifically) provides a means for projection makers to communicate the range of errors that can reasonably be expected in a particular demographic forecast. This is typically done by publishing results in the form of prediction intervals. A good practice is to avoid very large intervals, which are not very useful, and very narrow ones, which exaggerate the precision of the forecast. A reasonable choice for publication in this context, often selected by the providers of probabilistic projections, is 80 per cent. However, an application that allowed users to select their own prediction intervals would encourage them to think about risks associated with unexpected outcomes. Projection makers might also consider posting a database containing the full set of sample paths to allow users to calculate their own statistics (e.g., a prediction interval for the size of the labour force in the future).

105. Results from the user survey support the provision of probabilistic projections to a certain extent, suggesting that users want some quantification of the uncertainty of population projections. Indeed, as mentioned in the introduction to this chapter, more than two-thirds of respondents (69 per cent) felt that it was either important or very important to quantify the uncertainty of the projections. Very few (1 per cent) felt that this was not important at all.

106. On the other hand, not all projection makers believe in the added value of probabilistic projections.[37] One frequent concern is that providing statements about uncertainty may lead users to infer greater precision than is intended (Fischhoff and Davis 2014; Lutz and Goldstein 2004). Put differently, this may lead users to think that projection makers know more about how the future will unfold than they really do (Lutz and Goldstein ibid.). In reality, measures of uncertainty are appropriate only if the statistical model behind them is a very good approximation of the underlying processes it aims to simulate (and continues to apply in the future). However, this is very difficult to assess, especially for long-term projections. In particular, the impossibility of considering all sources of uncertainty in projections and the

[35] More details about these possible biases can be found in publications by Morgan and Henrion (1990), Hoffman et al. (1995), Kynn (2008), Lutz et al. (1998), and Martin et al. (2011).

[36] Examples or summaries of such protocols can be found in publications by Morgan and Henrion (1990), Hoffman et al. (1995), Collopy et al. (2001), van der Sluijs et al. (2004), Garthwaite et al. (2005), Scapolo and Miles (2006), Aspinall (2010), Knol et al. (2010), and Fischhoff and Davis (2014), among others.

[37] When reviewing the recommendations in this report, not all NSOs were convinced of the added value of probabilistic projections. The main concerns expressed are discussed here.

typical overconfidence found in experts' opinions (Morgan and Henrion 1990) are likely to induce an underestimation of uncertainty.[38]

107. These concerns are legitimate. However, as Stoto (1988) observed, the point is not one of estimation but of communication. In other words, prediction intervals may be wrong, but they serve to communicate more precisely the intentions of projection makers. Along the same lines, Lutz and Goldstein (2004, p. 3) suggested that probabilistic projection makers should "[…] clearly tell the users that the stated uncertainty ranges should not be seen as precise objective probabilities but rather as indicative ranges depending on the specific model and parameter assumptions made according to the best judgement of the producers." Users should therefore be made aware that probabilistic projections, like deterministic ones, require that certain assumptions be made by projection makers, and the probabilities attached to a forecast are also projections and have their own uncertainty. Projection makers should also explain clearly how the prediction intervals were computed and to what they refer (i.e., expert opinion, historical variations, past projection errors or a mix of sources).

108. Methods used to produce probabilistic projections should be tested with historical data and recalibrated if necessary. Calibration is indeed an important tool for projection makers in developing plausible estimates of the uncertainty associated with population projections. For example, observed values are expected to be contained in an 80 per cent prediction interval, on average 80 per cent of the time (Raftery 2014). Calibration can be achieved by using sequences of retrospective forecasts, where a past period is forecasted using data available at the beginning of the forecast.[39] By measuring how a forecast methodology performs in past contexts, retrospective forecasts also provide an indication of how it is likely to perform in the future (Kirtman et al. 2013). Results from cognitive research show that calibration tends to improve trust in forecasts (Raftery 2014).

109. It is clear, given the speculative nature of such an exercise, that evaluating the uncertainty of population projections is a difficult task. However, the machinery of probabilistic projections, when properly executed, can help projection makers provide an assessment of uncertainty that is deemed authoritative, at least compared with what can be obtained with other methods. Put differently, in the current state of knowledge, this assessment should constitute a valid standard for comparison against which other methods should be judged.

110. In light of the benefits and limitations of disseminating probabilistic projection results (summarized in Appendix E), a well-guided approach is for NSOs to evaluate carefully their capacity to implement such methods without compromising the overall quality of their projections (including the plausibility of the median trajectory in probabilistic projections).[40] In particular, explicit measures of uncertainty should be provided only when projection makers are confident in their capacity to build scientifically sound confidence intervals, relying on robust data and solid expertise. High-level principles guiding uncertainty analysis currently exist, but no consensus has been found in how they should be applied specifically to population

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[38] Although, as Dunstan and Ball (2016) noted, spuriously precise prediction intervals remain preferable to a spuriously precise deterministic projection.

[39] The backtesting of models, or retrospective forecasts, has been used extensively in the fields of meteorology and oceanography, where they are also termed "hindcasts."

[40] See Dunstan and Ball (2016) for a series of recommendations to projection makers considering developing probabilistic projections. These include engaging with users, collaborating with other organizations and adopting a gradual approach (e.g., publishing probabilistic national projections before subnational projections).

projections. For example, probabilistic projection makers have used various sources to estimate the uncertainty of future population growth (e.g., expert elicitation procedures, time-series techniques, measurement of past projection errors or a combination of these techniques). In this context, NSOs may understandably prefer to postpone the production of probabilistic projections and wait for further developments in the field, although it is unclear whether a perfect consensus on a standard approach will ever be reached.

Practice 3.8: Provide sensitivity analysis

111. Most NSOs have used the scenario approach to convey a sense of uncertainty about their projections, often describing it as a sensitivity analysis. However, it is useful to distinguish clearly between these two practices. As described earlier, the goal of sensitivity analysis is not to represent a range of possible assumptions, which is generally the goal of the scenario approach (discussed in the following good practice). Its goal is rather to help users understand how a particular input in the model can influence the results.

112. The relevance of sensitivity analysis is greatest when tackling societal concerns. It is particularly useful to recognize and understand the main drivers of an outcome such as population growth or population ageing, as this may help policy makers devise policies targeting the key factor or factors for a given objective. For example, in industrialized countries, numerous sensitivity analyses have shown that, contrary to conventional wisdom, immigration has limited potential as a means of moderating population ageing, especially when compared with the long-term impact of an increase in fertility (e.g., United Nations 2000). However, outcomes from sensitivity analysis (typically presented as “what-if” or “analytical” scenarios) can also help to understand the outputs from scenarios deemed more plausible.

113. Probabilistic population projections do not eliminate the need for sensitivity analysis, as they do not reveal the consequences of a specific change in an assumption for a given scenario (Lutz and Goldstein 2004). In fact, probabilistic approaches do not preclude the use of sensitivity analysis. For example, Statistics New Zealand (2014) published probabilistic projections in conjunction with deterministic “what-if” scenarios, an approach that Dunstan and Ball (2016) described as useful for users and pragmatic from the point of view of projection makers. Sanderson et al. (2003) showed how the various simulations from probabilistic projections can be combined in distinct groups based on projected levels of fertility and mortality to obtain probabilistic analogues of deterministic scenario analysis.

Practice 3.9: Provide a range of plausible assumptions

114. In contrast to a forecast that reflects only the most likely outcome, the scenario approach, when properly implemented, aims to retain all assumptions that seem plausible (Lachapelle 1977). When implemented in this way, the scenario approach provides valuable insights about the uncertainty of population projections. First, the publication of multiple deterministic scenarios underlines the fact that the future does not have just one path. Second, it provides a simple way to communicate the plausible range of future demographic trends given what is currently known (Romaniuc 1976). Romaniuk (2010) stated, about projections in general: “By properly exploring the future, we may have been able to narrow its blind spots.” Hence, even without likelihood assessments, the plurality of scenarios remains useful to stimulate reflection and guide actions leading towards a more desirable future (Romaniuc 1994, Romaniuk 2010; Isserman 1992).

115. However, to be effective, the scenario approach should follow a carefully thought-out and comprehensive strategy for communicating uncertainty (as described in good practice 3.1). Such a strategy comprises multiple facets of results, such as population sizes, geographical distribution and various indicators of age structure. It is difficult in practice to consider all possible aspects of the results. Therefore, the choice of outcome variables should be guided by specific policy preoccupations in the country at hand, such as population ageing, the renewal of the labour force or the magnitude of migration flows. Additionally, NSOs should communicate clearly which aspects were considered and which were left out of the analysis.

Chapter 5 - Foster relationships with users

Introduction

116. Good science communication must begin with aiming to understand audience needs and how to address them (National Academy of Sciences 2014; Bruine de Bruin and Bostrom 2013; Fischhoff 2013). Interactions with users provide an opportunity to determine whether or not the communication is well understood and can lead to improvements when it is not. Interactions can also help determine whether the communication approach responds well to the needs of users in general and can trigger important changes in this regard. Furthermore, scientists are increasingly being asked to help solve important policy issues with high stakes and highly uncertain information (e.g., climate change). Funtowicz and Ravetz (1993) called for an approach favouring a dialogue between all legitimate participants and the recognition of different perspectives, especially for environmental, societal and ethical aspects. For all these reasons, effective scientific communication is increasingly being recognized as a two-way process.

117. One way to approach the public is through the media. Media coverage involving both traditional media and new media can be helpful to communicate messages effectively and to reach new audiences. It is therefore critical to understand how the media in all forms work and to cultivate good relationships with journalists.

118. The attitudes and the actions of the experts working in NSOs have a large part to play in the communication process, as these experts are the ones entering into contact with the public (Davies 2008). The following good practices should help NSOs foster relationships with users, which should improve users' experiences with the products and make the projections more useful.

Good practices

Practice 4.1: Provide a clearly identifiable means for users to obtain answers from projection makers

119. Requests for technical assistance from users can shed light on areas for improvement in disseminations. Among the respondents to the user survey who had previously contacted their NSO for information, 90 per cent felt that their NSO adequately responded to their request. This suggests that, generally, interactions between NSOs and users are productive from the users' point of view and, therefore, should be encouraged by NSOs.

120. It is recommended that NSOs consider taking the following interrelated actions in relation to fielding requests from users:

- Provide on the NSO's website a clearly identifiable way for users to ask questions and provide feedback to projection producers, and respond to requests in a timely manner.

- Identify common themes in user queries and provide responses to frequently asked questions or items known to be less understood in the dissemination material.[41]

Practice 4.2: Consider developing and offering "outreach activities" to engage directly with users in a substantive manner

121. To improve users' understanding of projections, NSOs may wish to consider engaging in direct contact with users through outreach activities such as instructional workshops, training sessions or online chat sessions. Several respondents to the NSO survey mentioned that outreach activities such as these proved to be the most successful strategy for communicating with users. Communications that are more in-depth and interactive provide an opportunity to reveal misconceptions or misinterpretations that users may have about the projection results. This can identify more specifically and clearly areas where communication could be improved and highlight users' needs in terms of projection content. There is, in fact, some evidence from the literature that direct instruction by scientists generates positive reactions among members of the public (National Academy of Sciences 2014).

122. Outreach activities can also help boost the credibility of projection makers and NSOs in general. Indeed, activities such as discussing, teaching and simply sharing information indicate trustworthy intentions. This is paramount, since trust, along with expertise, is the main component of scientific credibility (Fiske and Dupree 2014).

Practice 4.3: Provide notices of forthcoming projection releases to the media and frequent projection users

123. A good practice for NSOs is to distribute notices to the media and frequent projection users informing them of forthcoming projection releases. The popular media in particular play a vital role in communicating science to the public; indeed, the majority of people gain knowledge about scientific findings through the media (SIRC undated).

Practice 4.4: Embrace traditional and new media

124. For scientists, communicating with the public is often negatively perceived as a difficult and perilous duty (Davies 2008). However, popular media should be seen as a major channel for scientists to fulfill their responsibility of communicating with the public (ECCR 2007). Indeed, the quality of press releases has been shown to have an impact on the quality of subsequent news reporting (Schwartz et al. 2012). A proactive approach in this area can help provide an accurate and balanced picture to the public and avoid possible pitfalls and misunderstandings, which could hinder the development of public trust.

125. In addition to traditional media such as print, radio and television, projection makers should direct efforts towards embracing newer, Internet-based media forms, including social media. As noted by Brossard and Scheufele (2013), the new norm is for the public to use the Internet to seek information about scientific issues, and new media science coverage may reach audiences not typically targeted by traditional media. Best practices in terms of online science communication are currently lacking (Brossard 2013). However, it should be a priority for

[41] An example is the question and answer fact sheet prepared by the Australian Bureau of Statistics (2017). The fact sheet also provides the telephone number of the National Information and Referral Service for users who would like more information.

projection makers to investigate using new media, such as social networking sites, blogs and online forums, for communicating dissemination materials. New media provide more opportunities for potential users to be exposed to the information (ibid.).

Practice 4.5: Investigate and document the needs of users

126. Several of the good practices above can serve not only to provide information to users but also to gather information about what users need and what could be improved. Thus, interactions with users should be seen as opportunities to document their unmet requirements; identify good practices to maintain; and, more generally, constantly gauge the pertinence of the projections.

127. One particular area where unmet needs often occur is projections at subnational levels or for some given regions. Most NSOs provide results not only at the national level but also for some lower geographic levels. However, they may be unaware of the specific needs of planners at more regional levels in terms of geographical disaggregation, time horizon and projected characteristics. NSOs can decide to produce custom projections for specific needs, possibly on a cost-recovery basis, or, alternatively, offer guidance in producing such projections.

128. Encouraging interactions with users can be challenging in practice. It is easier for users to contact projection makers than for projection makers to contact users. Indeed, for the most part, users download projection materials from the NSO’s website anonymously, and there is no way for NSOs to know who has accessed or viewed their materials unless users contact them with an inquiry. Often, the best information NSOs have about their users is the number of web hits and downloads.

129. Some practices can maximize the collection of information from users, including the following:

- Provide means for users to contact experts through the NSO’s website (see good practice 4.1 above).
- Engage in outreach activities such as conferences, seminars and workshops (see good practice 4.2 above).
- Establish a working group (with knowledgeable users) that can help inform methodological changes and keep users involved.
- Maintain relationships with known users.
- Conduct consultations (formal or informal).
- Invite feedback whenever possible (e.g., at events, in publications and in signatures at the end of emails).

Conclusion

130. This publication was prepared with the objective of providing a series of good practices and recommendations on communicating population projections. Four key recommendations were identified: to provide pertinent and accessible results, to cultivate transparency, to address uncertainty explicitly and to foster relationships with users. For each of these recommendations, a number of good practices were identified. These good practices should be useful for projection makers wishing to improve the pertinence of their projections, guiding them as to what should be published and how.

131. The aim of this publication was also to provide an accurate portrait of the current state of knowledge in population projections and to act as a bridge between users, researchers and NSOs. Particular attention was given to recent developments intended to improve the fitness of population projections for decision making, a trend also observed in other scientific areas such as climate change forecasting, mathematical modelling and engineering. However, the field of population projections is expected to continue evolving significantly in the near future. In this context, the key recommendations in this publication can serve as a framework to guide the implementation of new methodologies. For example, algorithmic modelling techniques (e.g., machine learning) appear particularly useful in the absence of theories or models to elucidate the relationships between explanatory variables, and when rich datasets are available (Breiman 2001). Some researchers are currently exploring the potential of these techniques for population projections (e.g., Bandyopadhyay and Chattopadhyay 2006). But it is unclear at this stage how such developments, focused exclusively on predictive accuracy, often at the cost of transparency, will contribute to better communicating population projections.

132. In preparing this publication, the task force strove to attain a balance between the views of users, NSOs and experts, perhaps with a positive bias towards responding to users' needs. Despite some shortcomings, the survey of users constituted a rare opportunity to explore what information they use and how they do so. However, the concept of "users' needs" remains complex and difficult to circumscribe. One problem is that in some cases, users may be looking for information that supports a particular ideology or policy option. Furthermore, and perhaps more importantly, users may be unaware of certain ways in which they could benefit from projections.

133. This latter issue indicates the importance of good communication between users and projection makers. For example, Lee and Edwards (2002) observed that users tend to conceive probabilistic projections merely as improved high and low prediction intervals, despite their potential for more detailed and sophisticated analysis. Consequently, it is doubtful that providing probabilistic projections will lead to markedly better decision making if there is no accompanying increase in knowledge about how to use such projections. Although classic examples involving **decision theory** (such as the one provided in Appendix G) are instructive, this question likely deserves a more thoughtful treatment. Therefore, the documentation and promotion of better practices for decision making clearly emerges as an area for future development. This is particularly true considering the urgency and significance of societal concerns in which expected population sizes and characteristics constitute key variables, such as climate change, viability of pension funds and sustainable development. The question would definitely merit a dedicated report or workshop. Resources could also be made publicly available to inform statistical data users of the fundamental principles applicable to decision making, perhaps similarly to what the Royal Statistical Society (2016) achieves with its

initiative on statistical literacy. Additionally, it could be imagined that in the not-so-distant future, most projection makers would be ready and disposed to advise decision makers on how to use this "new" kind of information efficiently. In any case, better decision-making practices can result only from good interactions between projection makers and users.

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Appendix A - Questionnaire of the user survey

Introduction

Dear Sir/Madame,

This survey is the result of an important initiative of a recently-appointed Task Force on Population Projections* within the United Nations Economic Commission for Europe**. Its purpose is to obtain information about how national population projections outputs are used and user's perspective about various aspects of the projections.

If you did consult population projections for your country prepared by the National Statistical Office in recent years, we ask you to support this initiative by completing the present survey. Your responses will be used in the formulation of a collection of good practices on communicating population projections and will help identifying areas for improvement in that regard. As a result, your elaboration in as much detail as possible in the comment sections of the survey is greatly appreciated and strongly encouraged.

If you feel that other persons in your organization might be in a better position to respond to the survey, or they could simply provide an additional perspective, please invite them to participate in the survey by forwarding the participation link.

You are kindly invited to complete the survey by 30 June 2015.

If you have any questions or concerns about the survey, please contact the representative of your National Statistical Office that invited you to participate in this survey, or send a message to social.stats@unece.org at your earliest convenience.

Thank you in advance for your assistance in this endeavour.

Paolo Valente
Statistical Division
United Nations Economic Commission for Europe

Classification questions

INFORMATION ON THE COMPILATION OF THE QUESTIONNAIRE

- In order to navigate through the questionnaire please use the PREVIOUS and NEXT buttons located at the bottom of each page, and not the buttons on your browser.
- The questionnaire can be filled in more than one session.
- Clicking on the PREVIOUS and NEXT buttons at the bottom of each page saves automatically the data entered. However, the information entered can be corrected later, if necessary.

1. Please provide the following identification information (optional):
   (To be used only for the purpose of this survey).
   Name (optional):
   Affiliation (optional):
   Country:
   Email address (optional):

2. How would you categorize yourself/your organization?
   - o Private sector
   - o Government (National)
   - o Government (Regional/municipal)
   - o Research group
   - o School/University
   - o Media
   - o Non-governmental organization
   - o Other (please specify below)

   Please specify or provide comments:

3. How would you rate your level of familiarity with population projections?
   - o High
   - o Intermediate
   - o Low

4. For what purpose do you use projections?
   Indicate all that apply.
   - o Planning
   - o Research
   - o Education
   - o Reference for building own population projections
   - o Reference for building own projections (of characteristics other than population)
   - o Other (please specify below)

   Please specify or provide comments:

Core questions

5. Using a scale from 1 to 5, where 1 is “of no importance” and 5 is “very important”, please rate the importance of the following elements in regards to your use of population projections:

	1 - Of no importance	2	3	4	5 - Very important
Information about the current demographic context/trends	O	O	O	O	O
Information about the assumptions	O	O	O	O	O
Information about the methodology	O	O	O	O	O
Information about the quality of the underlying data sources	O	O	O	O	O
Detailed analysis of the results	O	O	O	O	O
Visual description of results (graphs)	O	O	O	O	O
Customizable data table	O	O	O	O	O
Summary information about the results (e.g., highlights)	O	O	O	O	O
The provision of a set of several different scenarios/variants	O	O	O	O	O
The designation of a “best” or “most likely” scenario/variant	O	O	O	O	O
Detailed projection data (e.g., data tables by single year)	O	O	O	O	O
Frequent updates	O	O	O	O	O
Quantification of the uncertainty of the projections	O	O	O	O	O
Projection of characteristics other than age/sex/region	O	O	O	O	O

6. Which of the following statements best characterizes your use of population projection data?
   - O You primarily use data from the variant/ scenario that was labelled as most likely by the projection makers.
   - O While the projection makers did not identify specifically a variant/scenario as the most likely, you primarily use data from the medium variant/scenario.
   - O While the projection makers did not identify specifically a variant/scenario as the most likely, you primarily use data from a variant/scenario that you considered to be the most likely result, based on the specifications of that variant/scenario.
   - O You primarily use data from a variant/scenario that you specifically chose as being the most useful for your specific needs, based on the specifications of that variant/scenario.
   - O You use data from several variants/scenarios to obtain a range of possible future outcomes.

   Comments (optional):

7. What is the time horizon for which you usually need projected population estimates?
   in years.

Please respond with reference to the most recent edition of the population projections that you used.

8. In your opinion, the information about the current demographic context/trends is:
   - O Not detailed enough
   - O Adequate
   - O Too detailed
   - O No opinion/Not applicable

   Comments (optional):

9. In your opinion, the information about the projection assumptions is:
   - O Not detailed enough
   - O Adequate
   - O Too detailed
   - O No opinion/Not applicable

   Comments (optional):

10. In your opinion, the information about the projection methodology is:
    - O Not detailed enough
    - O Adequate
    - O Too detailed
    - O No opinion/Not applicable

    Comments (optional):

11. In your opinion, the information about the quality of the underlying data sources is:
    - O Not detailed enough
    - O Adequate
    - O Too detailed
    - O No opinion/Not applicable

    Comments (optional):

12. In your opinion, the analysis of the results is:
    - O Not detailed enough
    - O Adequate
    - O Too detailed
    - O No opinion/Not applicable

    Comments (optional):

13. In your opinion, the number of scenarios/variants provided is:
    - O Not detailed enough
    - O Adequate
    - O Too detailed
    - O No opinion/Not applicable

    Comments (optional):

14. In your opinion, the projection data are:
    - O Not easily accessible
    - O Easily accessible
    - O No opinion/Not applicable

    Comments (optional):

15. In your opinion, the projection data are:
   - ○ Not adequately detailed
   - ○ Adequately detailed
   - ○ Too detailed
   - ○ No opinion/Not applicable

   Comments (optional):

16. In your opinion, the uncertainty of the projections is:
   - ○ Not clearly stated
   - ○ Stated, but it could be stated more clearly
   - ○ Clearly stated in an understandable manner
   - ○ No opinion/Not applicable

   Comments (optional):

17. In your opinion, the frequency of projection updates is:
   - ○ Not frequent enough
   - ○ Adequate
   - ○ More frequent than necessary
   - ○ No opinion/Not applicable

   Comments (optional):

18. In your opinion, the language used in the projection dissemination is:
   - ○ Too simplistic
   - ○ Appropriate
   - ○ Too technical
   - ○ No opinion/Not applicable

   Comments (optional):

19. Have you ever contacted the national statistical organization for more information about the projections?
   - ○ No
   - ○ Yes

   Optional comments:

20. Do you feel the national statistical organization provided an adequate response to your request(s)?
   - ○ Yes
   - ○ No (please elaborate below)

21. In your opinion, could some aspects of the communication of the projections be improved?
   - ○ No
   - ○ Yes (please elaborate below)

End of the questionnaire

Thank you very much for your participation. If you want, you may provide below any comments on the survey, in particular if you found any problems in understanding the questions, or providing the answers, or if you would like to provide additional information on any of the questions.

Appendix B - Questionnaire of the NSO survey

Introduction

Dear Colleague,

You have been identified as the contact person for the population projections produced by your National Statistical Office.

We are contacting you on behalf of a recently-appointed Task Force on Population Projections* within the United Nations Economic Commission for Europe** (UNECE). The Task Force on Population Projections, which includes members from various countries along with representatives from Eurostat, UNECE and the United Nations Population Division (DESA), was created following the recommendations of an In-Depth Review of population projections commissioned by the Conference of European Statistician (CES) in 2014.

The main objectives of the Task Force are to (a) promote the sharing of good practices on communicating population projections and (b) create mechanisms for collecting and disseminating metadata on national and international population projections.

As part of the Task Force's information-gathering process, we have developed a survey to be completed by national population projection makers. The purpose of the survey is twofold:

- Firstly, to obtain basic information about your organization's national population projections. Your responses will be used to populate a database containing metadata about the national population projections of all UNECE member countries. This database, to be updated on a regular basis, will provide a central information access point for projection users.
- Secondly, to obtain information about your organization's approach to communicating population projection to users. Your responses will be used, in conjunction with a parallel survey of a sample of projection users and the ongoing work of the task force, to develop a report containing a collection of good practices for communicating population projections.

Your participation in this survey is essential to the achievement of the Task Force's main objectives. It is hoped that the forthcoming database and good practices report will provide useful information for all national statistical agencies involved in the production of population projections.

We ask that you kindly complete the present survey by 20 June 2015. If you feel that another person in your organization might be in a better position to respond to the survey, please forward to this person the participation link.

If you have any questions or concerns about the survey, please send a message to

social.stats@unece.org at your earliest convenience. Thank you in advance for your assistance in this endeavour.

Paolo Valente
Statistical Division
United Nations Economic Commission for Europe

*http://www.unece.org/statistics/about-us/statstos/task-force-on-population-projections.html
**http://www.unece.org/stats/stats_h.html

INFORMATION ON THE COMPILATION OF THE QUESTIONNAIRE

- In order to navigate through the questionnaire please use the PREVIOUS and NEXT buttons located at the bottom of each page, and not the buttons on your browser.
- The questionnaire can be filled in more than one session.
- Clicking on the PREVIOUS and NEXT buttons at the bottom of each page saves automatically the data entered. However, the information entered can be corrected later, if necessary.

Contact information

1. Please provide the following contact information for any follow-up communications in the future:

   Name:
   Title/position:
   National Statistical Organization:
   Email address (for follow up communications):

2. Email address for direct contact by projections users (optional):

   The United Nations Economic Commission is planning to create a publicly accessible database of metadata on population projections. Each NSO may indicate (on an optional basis) an email address at which users of this database would be able to send requests in case they need information or clarification about the national projections. Only this email address, if provided, will be included in the public database.

   Email address:

General information on population projections

The following questions pertain to the most recent edition of national population projections produced by your organization.

3. Please specify the month and year of the dissemination of the projections and/or related datasets (if multiple products were published over a period, please indicate the earliest date, including web dissemination):

4. Please provide electronic hyperlink(s), if available, to the dissemination products (publications and/or datasets):

5. Please specify the start and end year of the projections (if different year-ends are used for different products, please provide the farthest):

   Start Year:
   End Year:

6. Please indicate the source of the data for the base population, its reference date (month and year) and information on adjustments, if any:

   Source:
   Reference date (month and year):
   Adjustments (if any):

7. Please indicate what is the update frequency of your projections:

8. Which population characteristics, other than age and sex, were distinguished in your projections:
Indicate all that apply.

- ○ Sub-national geography
- ○ Marital status
- ○ Household type
- ○ Citizenship
- ○ Country of birth or origin
- ○ Ethnicity
- ○ Education
- ○ Language
- ○ None
- ○ Other (please specify below)

Please specify of provide comments:

9. Please indicate the number and type of scenarios/variants published:

- ○ One scenario only
- ○ One scenario with surrounding confidence interval based on probabilistic/stochastic methods
- ○ Several scenarios/variants based on deterministic methods (please specify below the number of scenarios/variants).

Please specify the number of scenarios/variants or provide comments:

10. Please specify what level of detail is disseminated for age:

- ○ Single years of age, until age:
- ○ Five-year age groups, until age group:

11. Please specify what level of detail is disseminated for year:

- ○ Single years
- ○ Every 5 years
- ○ Other (please specify below)

Please specify or provide comments:

12. In your disseminations, did you use the term(s):
Indicate all that apply.

- ○ Projection (please elaborate below why)
- ○ Forecast (please elaborate below why)
- ○ Other (please specify below and elaborate why)

Please elaborate on choice:

13. Referring to the term(s) selected in the previous question, do you define this term(s) in your disseminations?

- ○ Yes
- ○ No

14. In your disseminations, did you use the term(s):
    Indicate all that apply.

    - ○ Scenario (please elaborate below why)
    - ○ Variant (please elaborate below why)
    - ○ Other (please specify below and elaborate why)

    Please elaborate on choice:

Dissemination approach

15. Please indicate the approximate percentage devoted to the following elements in your disseminations:
    If other please comment in the next question

    Information about the current demographic context/trends:
    Information about the assumptions:
    Information about the methodology:
    Information about the quality of the underlying data sources:
    Analysis of the results:
    Other (please specify in next question)

16. Comments on other specification in the previous question:

17. What information was disseminated in regards to projection outputs or results?
    Indicate all that apply.

    - ○ Pre-defined data tables
    - ○ Customizable database
    - ○ Written summary/highlights of results
    - ○ Detailed written analysis of results
    - ○ Visual description of results (graphs)
    - ○ Other (please specify below)

    Please specify or provide comments:

18. As part of your dissemination process, did you present the results of your projections:
    Indicate all that apply.

    - ○ In press releases
    - ○ In press conferences
    - ○ In external professional meetings
    - ○ In scientific conferences
    - ○ Upon request
    - ○ Never
    - ○ Other (please specify below)

    Please specify or provide comments:

19. Upon request, would you distribute detailed parameter/input data to allow users to reproduce the projections, or similar projections:
    For example age specific fertility rates.
    - ○ Yes
    - ○ No
    - ○ Don't know

    Comments (optional):

Communication – consultation

20. Please indicate which of the following bodies you consulted during the production of the projections, if any, and for what purpose(s) did you consult them:
    Indicate all that apply.

	To develop assumptions and/or methodologies	To obtain feedback about assumptions (though you keep the final word on the assumptions)	To obtain feedback about assumptions (to which you must comply)	To inform them in advance of the official projection release with a primary focus on results	To inform them about the status of the production	NOT consulted
Senior management within the NSO	○	○	○	○	○	○
Other units within the NSO	○	○	○	○	○	○
National government agencies	○	○	○	○	○	○
Sub-national government agencies	○	○	○	○	○	○
International statistical agencies	○	○	○	○	○	○
International bodies (e.g., international experts group)	○	○	○	○	○	○
Expert advisory group/panel	○	○	○	○	○	○
Frequent projection users, private sector	○	○	○	○	○	○
Academic researchers other than formal expert panel	○	○	○	○	○	○
Other (please specify below)	○	○	○	○	○	○

Please specify or provide comments:

21. If you consulted any bodies during the production of the projections, were these consultations noted in disseminated products?
    - ○ All of the consultations were noted
    - ○ Some of the consultations were noted
    - ○ No, the consultations were not noted
    - ○ Not applicable (there were no consultations)

    Comments (optional):

Interaction with users

22. Do you have some measures of usage of the projections?
    Indicate all that apply.
    - ○ No
    - ○ Yes, electronic web hits/page views views/downloads
    - ○ Yes, other (please specify below)

    Please specify or provide comments:

23. Can you identify the major users of your projections?
    - ○ No
    - ○ Yes, all of them
    - ○ Yes, some of them

24. Please indicate the major users:
    Indicate all that apply.
    - ○ Government agencies
    - ○ General public
    - ○ Business/industry Media
    - ○ Academia
    - ○ Other (please specify below)

    Please specify or provide comments:

25. Can users receive technical assistance on projections matters?
    (For instance, technical explanation).
    - ○ Yes, they can directly contact the projection makers
    - ○ Yes, mediated by some user support service
    - ○ No

    Comments (optional):

26. Are users explicitly informed of the availability of this technical assistance in dissemination products?
    - ○ Yes, in all dissemination products
    - ○ Yes, but only in some dissemination products

27. What are the most common requests for technical assistance that you received? Please elaborate:
    For example, if most requests relate to methodological issues, what are the most common methodological issues requiring further explanation?

28. Can you provide approximately in which proportions these requests come from the following category of users?
    Leave blank if unknown.

    Government agencies:
    General public:
    Business/industry:
    Media:
    Academia:
    Other (please specify in following question):

29. Please elaborate on *other* if used in the previous question:

30. In your opinion, which initiatives or strategies for *communicating population projections* (including results and methods) to users have been most successful for your institution?

31. In your opinion, which aspects of your projection publications would your users like to see expanded or improved, if any?

Communication of uncertainty

32. In your disseminations, did you use any of the following methods to communicate the uncertainty of projections to users:
    Indicate all that apply.

    - ○ Analysis of historical variation Expert judgment elicitations Analysis of past projection errors
    - ○ Creation of multiple deterministic scenarios
    - ○ Use of Bayesian reasoning
    - ○ Use of probabilistic/stochastic approaches
    - ○ Sensitivity analyses
    - ○ Cautionary/instructional note on the uncertainty of projection results
    - ○ Conditional phrasing (e.g., ‘would’ instead of ‘will’), please specify:
    - ○ None
    - ○ Other (please specify below)

    Please specify or provide comments:

33. In your opinion, which initiatives or strategies for *communicating the uncertainty of population projections* to users have been most successful for your institution?

34. In your opinion, what challenges do you encounter in *communicating the uncertainty of population projections* to users (for instance, do projection users have any common misconceptions about the projections)?

End of the questionnaire

Thank you very much for your participation. If you want, you may provide below any comments on the survey, in particular if you found any problems in understanding the questions, or providing the answers, or if you would like to provide additional information on any of the questions.

Appendix C - Suggested template for reporting metadata about population projections

The following template has been designed as a tool to facilitate the task of projection makers in reporting relevant information about their projections and to help users quickly find this information. Projection makers are invited to modify the template, if necessary, to provide any information they deem relevant in the way they believe will be the most useful for users. A good practice would be to dedicate a portion of dissemination materials related to the projections to publishing the information contained in this template. In addition, for National Statistical Offices, a large portion of the information contained in this template should also be reported in the UNECE database on population projections metadata once new population projections are published.

(*insert title of the projections*) **Descriptive summary sheet**		
Country/ies to which the projection refers:		
Title of the projection:		
Organization:		
Stakeholders involved in the production: *(list the stakeholders who have had an influential role in the production of the projections)*		
Links to disseminated products:		
Who to contact for more information:		
General information		
Year/month of dissemination (YYYY-MM): *(if multiple products were published over a period of time, this refers to the earliest date, including web dissemination)*		
Projection start date (YYYY-MM-DD):		
Projection end date (YYYY-MM-DD): *(if different end dates are used for different products, this refers to the latest):*		
Production frequency (in number of years):		
Population concept (de jure / de facto):		
Target population: *(population covered by the projections)*		
General model of projection: *(e.g. cohort-component model, microsimulation, extrapolation, etc.)*		
Type of projection:	Deterministic Number and type of scenarios/variants:	Probabilistic Levels of prediction intervals:

Disseminated details	
Sub-national geography – availability and consistency with national geography:	o Not available o Available, not consistent with national geography o Available, consistent with national geography (bottom-up) o Available, consistent with national geography (top-down)
Age (multiple answers possible)	o Single years of age (calculated) o Single years of age (interpolated) o Age groups, please define:
Maximum age or age group:	
Years	o Single years (calculated) o Single years (interpolated) o Every 5 years
Households and/or family projections available:	o Households o Families
Other variables projected:	o None o Household type o Citizenship o Country of birth o Other(s), please specify:
Data sources	
Base population:	
Other data sources used:	
Methodology for handling uncertainty of the projections	
Measures taken to communicate uncertainty of population projections: *(Short description of the strategy used to communicate uncertainty of population projections, e.g. dissemination of various scenarios, publication of prediction intervals, etc. If no measures were taken, indicate "no measures taken".)*	
Other relevant information or details about the population projections:	

Appendix D - Examples of documentation of consultations with experts

Central Statistics Office (Ireland)

In the assumption-building process for their 2011-based Population and Labour Force Projections, the Central Statistics Office of Ireland received input and advice from a large Expert Group. The associated report presents the projection assumptions including descriptions of the elements that the Expert Group considered most important, hence helping users to follow the thought process that led to the adoption of the final assumptions. The report (see Central Statistics Office of Ireland 2013) can be found on the Central Statistics Office's website: http://www.cso.ie/en/media/csoie/releasespublications/documents/population/2013/poplabfor2016_2046.pdf

Institut National de la Statistique et des Études Économiques (INSEE), France

In the assumption-building process for their 2007-based Population Projections, the INSEE received input and advice from a large Expert Group. The associated report presents the projection assumptions including descriptions of the elements that the Expert Group considered most important, hence helping users to follow the thought process that led to the adoption of the final assumptions. The report "Projections de population 2007-2060 pour la France métropolitaine : méthode et principaux résultats" (see Blanpain, N. and O. Chardon. 2009) can be found on the INSEE's website (in French):
http://www.insee.fr/fr/methodes/sources/pdf/proj_pop_2007_2060_F1008.pdf

Office for National Statistics (UK)

For their 2014-based National Population Projections, the Office for National Statistics (UK) published the complete minutes of their Expert Advisory panel meetings. This exhaustive rendering of the dialogue between experts and members from the ONS makes it possible to identify the topics that triggered greater discussion or for which there was less consensus. These minutes ("National Population Projections: 2014-based projections", Chapter 1, Annex A) can be found on the ONS website:
http://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/compendium/nationalpopulationprojections/2015-10-29/backgroundandmethodology#appendix-a-minutes-of-expert-panel

Statistics Canada

For their 2013-based National Population Projections, Statistics Canada surveyed the community of Canadian demographers in order to gather their opinions about future demographic trends. In the technical report on the methodology and assumptions that was released along with the report of the results, they describe the results of the survey, often using box-plots graphs that show mean responses as well as their spread. It is therefore easy to identify areas where consensus is lacking. The technical report (see Bohnert et al. 2015) can be found on Statistics Canada's website:
http://www.statcan.gc.ca/pub/91-620-x/2014001/chap02-eng.htm

Appendix E - Main advantages and limitations associated with probabilistic projections

The benefits of probabilistic projections have been described at length by many demographers, often showing the advantages they have over deterministic projections (e.g., Lee 1998; National Research Council 2000; de Beer 2000; Keilman et al. 2002; Lutz et al. 2004; Lutz and Samir 2010; Raftery 2014). Probabilistic projections also have limitations, although these tend to be less well documented. These limitations are not insurmountable, but NSOs should be aware of them when evaluating the option of producing probabilistic projections. The main benefits and limitations of probabilistic projections are summarized below.

Main benefits:

- Because probabilities do not exist in nature—rather, they are created as a means of expressing uncertainty because of our lack of knowledge—expressing projection results in terms of probabilities contributes to representing honestly the limits of our predictive abilities (Silver 2012). While the measures of uncertainty are themselves uncertain, they exist and highlight the uncertainty associated with projection figures. As Dunstan and Ball (2016, p. 951) explained, “It is only possible for users to think about uncertainty if that uncertainty is conveyed to them appropriately.” For Bijak et al. (2015), an explicit and transparent forecast of uncertainty promotes the values of honesty, humility and trust.
- The fact that a projection maker does not want to consider a projection as a forecast will not prevent a user from doing so. In the end, as it is impossible to observe the future, decision makers have no other option than to consider a projection as a prediction. In these circumstances, decision makers may be willing to accept any kind of information about how reliable the projection likely is, even a subjective but informed opinion. Probabilistic projections offer a way to provide this information.
- One of the main practical benefits of the probabilistic approach is that it provides the ability to produce consistent bounds of uncertainty for non-linear population indices (e.g., the old-age dependency ratio).
- Probabilistic projections are well suited to different types of users and needs. With probabilistic projections, users can tailor a prediction interval according to their sensitivity to uncertainty (Keyfitz 1972; Raftery 2014).
- Probabilistic projections improve the capacity of users to make decisions according to their sensitivity to risk. When users are able to quantify a loss (or utility) function, it can be combined with probabilistic projection results to determine the optimal course of action or to choose between a series of finite choices (see Appendix G for an illustration).[42] Experiments have shown that providing uncertainty in the form of probabilistic information contributes significantly to better decision making (World Meteorological Organization 2008).

[42] Although, as Raftery (2014) indicated, this contribution should not be exaggerated, as users will often not be aware of their loss functions or will refrain from using these methods because of the cognitive load they entail. Perhaps it cannot be expected that most users would be able to apply formal decision theory for decision making based on population projections. However, by providing the means to do so, NSOs would definitely encourage good practices. It is possible, though, that probabilistic projections will be used as they become more widely available (ibid.).

- Probabilistic projections offer a natural framework for evaluating the probabilities of policies achieving different goals and for maximizing these probabilities (Tuljapurkar 2006). For example, they have been shown to be very useful in settings that involve intergenerational transfers over long time horizons, such as fiscal or health expenditures planning (e.g., ibid.; Lee and Edwards 2002; Lee and Anderson 2005; Lassila and Valkonen 2008).
- Prediction intervals are a natural tool in the context of Bayesian statistics, which offer several methodologies for making decisions under uncertainty (Bijak 2010).
- In the scenario approach, deterministic projections require that the assumptions for all components of growth be set in advance. Hence, perfect correlations between these components are assumed, usually a highly implausible assumption. Perfect correlations are not necessary in probabilistic projections. Provided that appropriate assumptions are made about the temporal autocorrelations of demographic rates, probabilistic projections are well adapted for simulating how uncertainty is revealed over the course of the projection (Lee 1998).
- The prediction intervals can support the decision of projection makers in selecting the projection horizon to be published and can help users determine the usefulness of projection data in a given horizon (Dunstan and Ball 2016).

Main limitations:

- Population projections are typically made to inform or even assist active policy measures. This contrasts sharply with short-term weather forecasts where the response is more about adaptation than policy making. Despite the rich amount of information that they provide, probabilistic population projections do not eliminate the need for sensitivity analyses that can assist policy making (see good practice 3.8). However, most existing probabilistic population projections are not, in their current shape, addressing this aspect.
- Producing probabilistic projections tends to be data-intensive and requires research scientists' specialized knowledge to implement (Lutz and Goldstein 2004), two elements that may constitute impediments for NSOs often operating with limited resources. Clearly, the development of probabilistic projections may not fit well with the intensive pace of production of NSOs because of the constant demand for recurrent updates, specific customer requests and other obligations.
- Reflecting on the experience of Statistics New Zealand, Dunstan and Ball (2016) noted that there are non-trivial investment costs associated with developing a probabilistic approach. However, they also noted that statistical agencies can reduce development costs by adopting methodologies and software developed elsewhere; once the methodology is adopted, the ongoing costs of producing probabilistic or deterministic projections do not differ significantly (ibid.).
- The desire to produce probabilistic projections may lead projection makers to focus on the assessment of uncertainty at the expense of the "medium" or "most probable" scenario. This would be problematic, given that a large proportion of users will be interested only in values from that medium scenario. In particular, projection makers could be tempted to favour methodologies that provide some forms of uncertainty measurements (such as extrapolations of time series) at the expense of other methods that incorporate more substantive knowledge about the various components of growth and their determinants (Lutz and Goldstein 2004).
- The added complexity of probabilistic projections may also be detrimental for communicating assumptions, hindering the transparency of the projections. As Lutz and

Goldstein (2004) noted, NSOs must not only make projections that are scientifically sound, but must also produce descriptions of uncertainty that will be easily understood by a broad range of users. In many cases, users may not be equipped to understand complex models and, therefore, could have difficulty judging the merits of the assumptions.

- While uncertainties related to measurement are present (e.g., errors in the estimation of the baseline population and imperfections in the data used to determine the projection assumptions), an important source of uncertainty in the model outputs is of another nature. It is related to the necessity of making assumptions about the future, for which no data exist. Indeed, producing probabilistic projections presupposes the capacity to develop reliable estimates of the uncertainty associated with the projection assumptions. The ultimate test for a forecast is calibration.[43] For example, meteorological forecasts have been shown to be well calibrated, meaning, for example, that when a 40 per cent chance of rain is predicted, it will rain about 40 per cent of the time (Silver 2012). Contrary to demographers, meteorological forecasters benefit from large numbers of daily forecasts to help them check and calibrate their models. Producers of probabilistic projections can often use repeated cross-validations and out-of-sample prediction for short- or mid-term validation of the performance of the model. However, a probabilistic approach may not be appropriate when it is difficult or impossible to calibrate the model (International Actuarial Association 2010).
- In addition to situations when calibration is not possible, probabilistic modelling may not be the best approach when the added complexity prevents the models from being thoroughly reviewed and validated, or when it is difficult or impossible to determine appropriate probability distributions for some variables (International Actuarial Association 2010).
- The above-mentioned absence of consensus on a single methodology and the difficulty of estimating uncertainty in the inputs of population projections can lead demographers to use a variety of methods and data sources. These are often imaginative. However, the results are likely to vary depending on the choice of methods and other subjective factors in modelling.[44] While calibration may help counter these problems, it could be difficult to perform in some circumstances, such as when uncertainty data come from an expert elicitation process.
- Despite the numerous developments in recent years, more research is needed in some areas of probabilistic methods to make them more readily applicable for projection makers. For example, Wilson and Rees (2005) noted that migration is rarely forecasted probabilistically, and that this component deserves more research.[45]
- At the current time, probabilistic projections remain relatively rare and recent initiatives. Hence, thorough evaluations of their performance are practically non-existent.
- The interpretability of the probabilities associated with future outcomes is not straightforward.[46] As Romaniuc (1994) observed, the theoretical foundation for

[43] For an example of probabilistic projections where calibration was used, see Raftery et al. (2012).

[44] For example, as Lee (1998, p. 186) reported, “A comparison of the Alho (1997) and Lutz, Sanderson, and Scherbov (1996) probability distributions for essentially the same forecasts revealed huge differences.”

[45] However, there have been some interesting developments in recent years (e.g., Azose et al. 2016).

[46] Such difficulties have been well documented in the field of meteorological forecasts. For example, the results of several surveys in the United States have shown that the public has difficulty interpreting probabilities of precipitation, even though such probabilities have been published since the 1960s (Morss et al. 2008). In a survey conducted in 2008, less than one respondent in five was able to find the correct interpretation of the sentence

probabilistic projections is not clear, stemming in large part from the elusive nature of uncertainty in population projections. In general, probabilistic projection makers conceive probabilities as representative of a degree of belief that an event will occur. They use data such as divergences of opinion among experts, variability in past estimates and errors in past projections to compute them.[47]

- Findings from behavioural research indicate that people have difficulty interpreting intervals well enough to extract key information. There are, for instance, known biases in the perception and evaluation of uncertain outcomes (e.g., Kahneman and Tversky 1979).[48]

"There is a 60% chance of rain for tomorrow." The correct interpretation is "It will rain on 60% of the days like tomorrow" (ibid.).

[47] This is a Bayesian interpretation of probabilities. More on this can be found in Appendix G.

[48] On the other hand, there are also indications from cognitive research that probabilistic projections can generally be well understood by people and lead to better decision making (Raftery 2014).

Appendix F - Examples of uncertainty analysis and sensitivity analysis

The following example is taken from Saltelli et al. (2008), who aimed to provide a general framework for integrating the uncertainty from various components in any kind of model. Here, a general model of population growth replaces the original model to show how probabilistic projections are simply cases of uncertainty analysis applied to population projections.

Imagine a very simplistic model where the total growth of a single population at time t+1 depends on three parameters: the future number of deaths, the future number of births and the future net international migration. Thus, the model can be written simply as

$$growth_{t,t+1} = bth_{t,t+1} - dth_{t,t+1} + net_{t,t+1}$$

Now, the values of the inputs come from assumptions about the future and are uncertain. Consequently, some measurements of their uncertainty should be available. For example, the future number of births could be forecasted using time-series forecasting methods. The forecasted mean and variance could be used to obtain a predictive distribution for the number of births between t and t+1, assuming a normal distribution.

In uncertainty analysis, one wants to translate the uncertainty of the inputs into the uncertainty of the results. To do so, it is necessary to compute the propagation of error in the model and over time. When a model is linear or relatively simple, this can be done analytically through uncertainty propagation equations, through partial derivatives or by regression analysis. However, for more complex models, or as a way to integrate the various sources of uncertainty (often from different kinds of distributions), Monte Carlo simulations are often required (Booth 2006).[49] Monte Carlo simulations allow a large number of iterations to be run in which the parameters can be sampled from various types of probability distributions associated with the inputs.

With the Monte Carlo method, a number of iterations (e.g., 1,000) would be run each time using different values for the number of births and deaths and for the net migration, sampled from their respective probability distributions. All parameters could be seen to be contained in a matrix M, composed of 1,000 series of randomly drawn parameters:

$$\mathbf{M} = \begin{bmatrix} bth^1 & dth^1 & net^1 \\ bth^2 & dth^2 & net^2 \\ \vdots & \vdots & \vdots \\ bth^{1,000} & dth^{1,000} & net^{1,000} \end{bmatrix}$$

[49] This is almost always the case for population projection models in which the inputs are often correlated and where there is time autocorrelation (i.e., the projection at time t+2 is dependent on the projection at time t+1).

The result of the 1,000 projections is a vector of 1,000 values, which is the predictive probability distribution for the population growth between *t* and *t*+1:

$$\mathbf{G} = \begin{bmatrix} g^1 \\ g^2 \\ \vdots \\ g^{1,000} \end{bmatrix}$$

From this distribution, it is possible to compute a mean or a median scenario and measures of variance (e.g., standard error or prediction intervals). Thus, the resulting probability distribution of *g* integrates the uncertainty of all parameters.

In sensitivity analyses, one generally wants to know how the output (the population growth between *t* and *t*+1), will vary given a change in one of the inputs. For example, one could be interested in knowing how the growth will be affected by some variation in the number of births. Depending on the objective, these variations can be specified in different ways:

a) A general target could be used, possibly inspired by a given policy target (e.g., a given percentage increase).
b) One could follow some probability distributions that model the plausible fertility levels between *t* and *t*+1, in which case the variations would be defined specifically by choosing a prediction interval (e.g., 80 per cent).
c) Alternatively, one could use Monte Carlo simulations to measure the sensitivity of the growth to fertility. One could obtain, for example, the upper limit of an 80 per cent prediction interval of population growth (simply the 80th percentile of the distribution).[50] Note that this is not the same as the previous item, in which a single projection is run using the upper limit of an 80 per cent prediction interval of the probability distribution of the fertility parameters.
d) Caswell and Gassen (2015) used calculus and projection matrices to conduct **prospective sensitivity analysis**, which consists in measuring the sensitivity of the output with respect to specifications of the model. While the calculations do not provide information about the uncertainty of the outcome,[51] they “[…] formalize the intuitive notion that uncertainty in a parameter to which an outcome is very sensitive translates into a high degree of uncertainty in that outcome […]” (ibid., p. 827). The method allows for the measurement of the sensitivity of any outputs (e.g., growth rates and population ratios) to perturbations in any set of vital rates without having to build alternative scenarios or specify modifications to projection parameters. Hence, only the initial population vectors and the parameters of the various components of growth are needed to perform sensitivity analysis. Access to the projection makers’ proprietary computer software is unnecessary. For this reason, Caswell and Gassen urged agencies “to consider reporting the basis of their projections in the form of projection matrices” (ibid., p. 829).

[50] The method allows sensitivity analysis to be carried out to evaluate the relative influence of different parameters on the future population size. For example, it is possible to plot the distribution of each parameter against the distribution of the projected population and to compare the results (see Saltelli et al. [2008] for an illustration).

[51] This is in contrast to **retrospective sensitivity analysis**, which focuses on the uncertainty of the parameters (see Caswell [2000] for a description of both types of analysis).

Some general notes:

1. The relative simplicity of the Monte Carlo method paints a rather deceptive picture of the efforts necessary to produce probabilistic projections. In most cases, the challenge really lies in drawing the probability distribution for each parameter (Saltelli et al. 2008). This usually requires many assumptions and a great deal of modelling. Based on the data available, the uncertainty is estimated from time-series methods, analysis of past projection errors, expert elicitation techniques or a mix of these. Bayesian techniques are often used to work around a lack of data or to incorporate more sources of information (e.g., United Nations 2015b; Abel et al. 2013; Billari et al. 2012; Bijak et al. 2010; Girosi and King 2008).

2. The uncertainty estimated from a model will be adequate only if the choice of the model is appropriate. Often, only after the fact can a glimpse of this uncertainty be measured through ex post errors (Keyfitz and Caswell 2005). However, for statistically driven approaches, out-of-sample predictions can be used to guide the choice of a model. Alho and Spencer (2005, p. 240) provided an approach for acknowledging variance attributable to the choice of model. Abel et al. (2013) computed parameters from a range of models to assess the uncertainty attributable to model choice.

3. Models have limitations in capturing uncertainty, especially in relation to rare events, which, by definition, are often non-existent in time-series data (Taleb 2010). Furthermore, extreme values (outliers) are sometimes removed in the modelling process. These limitations should be acknowledged.

4. In the example provided, the only output is total population size. Had population by age been projected instead, prediction intervals around some age structure indicators could also have been computed. Thus, the method allows for a comprehensive and consistent estimation of the uncertainty associated with all outputs.

5. The correct modelling of the propagation of errors requires sound specification of the various correlations that exist in the model. The difficult part is often to estimate adequate representations of the various sources of covariance. However, to understand how correlations may exist in population projections, it is necessary to expand the example as a projection for more than one year. Here are three examples[52] of possible correlations in population projections:

    a) Correlations can exist between the various inputs. For example, it could be preferable to assume that the future number of deaths in a given year is correlated with the number of births and the net migration forecasted in previous years, given that the population at risk will be higher. In most population projections, the input is not the number of births but birth rates applied to a population at risk, so the projected number of deaths would increase automatically with an increase in the number of births or in net migration. It would not be necessary to specify autocorrelations between the components of growth. But even when the parameters are specified in the form of rates, correlations between components can exist. For example, a rise in fertility could be expected to follow a rise in immigration levels because of higher fertility rates among immigrant women. Taking such correlations into account adds substantially to the complexity of the process. To date, independence between the various components of growth has been assumed in most applications of probabilistic projections.

[52] Lee (1998) provided a more complete listing of various types of correlations in population projections.

b) Time autocorrelation is also present when considering a single input of the model, because parameter values tend to move relatively slowly over time rather than exhibit radical movements from one year to the next. In this context, the parameter value at a given time $t+x$ is correlated with the values in previous periods. As Lee (1998) illustrated, how time autocorrelations are specified is consequential in the projected variance of inputs over time. For example, assuming no time autocorrelation, parameter values over time would simply fluctuate around the mean, with no large deviations in the long run. Conversely, perfect time autocorrelation would yield a straight path in a projection from the beginning to the end, with no fluctuations.[53]

c) In an increasingly globalized world, different regions or countries may tend to follow similar paths. For example, the spread of medical technologies, but also of threats to life, may cause interregional correlations with respect to the evolution of life expectancy (Lutz et al. 2004). Interregional correlations have important consequences for the estimation of uncertainty in the various regions (Lee 1998). Fosdick and Raftery (2014) modelled between-country correlations for regional probabilistic forecasts of fertility as functions of time-invariant characteristics (although the method can be used for forecasting other components). Alho and Spencer (2005, p. 292) discussed ways to deal with interregional correlations.

[53] Two distinct approaches are typically used to deal with time autocorrelation in population projections: the **random scenario forecast** method and the **stochastic forecast** method, as defined by Tuljapurkar et al. (2004) and Lee (1998). In the first method, the parameters represent a target in a given horizon and all intermediate years are interpolated from the launch year to the target year. In our example, this method would yield 1,000 straight lines from start to finish. In the random scenario approach, the parameters for all the various inputs in a single iteration are perfectly correlated over time. However, it is not necessary to sample values for each year of the projection and to compute time autocorrelations that should restrain the random sampling process. The random scenario approach is useful when probability distributions are available only for a given horizon, such as when expert elicitation methods are used (e.g., Billari et al. 2012). In contrast, the stochastic forecast method consists of randomly drawing a value for each year from the parameter distributions. As a result, the 1,000 trajectories are no longer straight lines and instead can cross over time. This method represents more realistically how uncertainty propagates over time.

Appendix G - Example of the use of probabilistic projections for optimal decision making

Imagine that some planners need to make a decision about the number and size of schools that have to be built in a given jurisdiction to accommodate population growth. Building schools and maintaining them is costly, so, ideally, the number of new places offered would fit the demand perfectly. Aware that future population growth cannot be predicted precisely, these planners would nevertheless appreciate having some approximate figures to support their decision-making process.

Fortunately, they can rely on available population projections. While population projection data are imperfect and uncertain, they constitute a neutral and objective source of information to support informed, open and democratic decision making, when they are built independently and impartially. The simplest way to use the projection data would be to base the number of new school places on the growth projected in the "most likely," or "medium," scenario. But would that be the optimal decision?

The size of a future cohort is a stochastic variable, and its forecast should ideally be accompanied by estimates of forecast error. So, imagine instead that the planners are equipped with probabilistic forecasts. The planners will have to settle on a single number, but they will have some information about the uncertainty associated with it. If the uncertainty is too high, some precautionary measures could be suggested, such as school designs that can be easily expanded if required. In this case, the probabilistic projection would give a plausible idea of what a necessary expansion could be.

However, using methods that arise from the development of the Bayesian theory of probability, the planners can go much further in their decision making by finding the optimal strategy that will minimize the potential losses caused by the inherent uncertainty of the future (Raiffa and Schlaifer 1961; Morgan and Henrion 1990; Alho and Spencer 2005; Bijak 2010).[54] Their first step is to evaluate the **loss** function—in this case, how much a gap between the future number of students and the number of places available in schools will cost.

Imagine now that the planners were able to estimate that each overestimated student will cost about $250 and each underestimated student will cost about twice that amount (i.e., the planners may have realized that measures for adapting to a surplus in the number of students are more costly than dealing with empty seats). In this case, the loss function can be described as **linear**, since the loss is a linear function of the error in the number of students, and **asymmetric**, because it would cost twice as much to underestimate the demand than to overestimate it. Such a loss function could be written as follows:

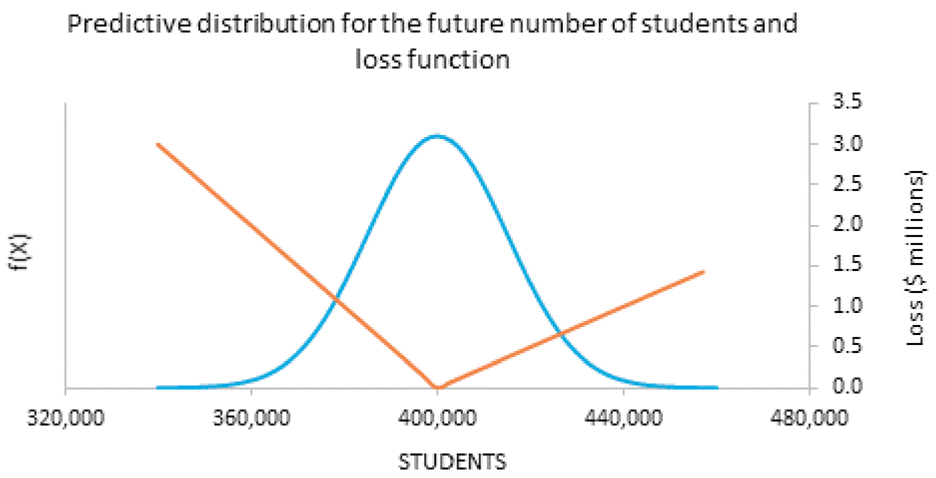
$$l(d,x) \propto \begin{cases} c(d-x) & if\ d > x \\ \lambda c(x-d) & if\ d \leq x \end{cases}$$

where d is a decision (that is, the target for the total number of seats to be available in the schools), x represents an estimate of the future number of students, c is a constant reflecting the cost of excess places and λ reflects by how much an underestimation is costlier than an overestimation (2, in this example). Assume further that the predictive distribution of the

[54] Much of this example has been built from information provided in these references. Bijak (2010) in particular provided multiple examples in the context of population projections.

number of students obtained from the probabilistic forecast, $f(x)$, can be approximated as normal with a mean of 400,000 and a standard deviation of 15,000: $X \sim N(400{,}000{,}225{,}000)$. The resulting probability density and loss functions are illustrated in Figure G1. Even though 400,000 seems a rational "guess," it is not necessarily an optimal choice because of the uncertainty surrounding it. In fact, the optimal choice should be located in the right tail of the distribution.

Figure G1



The optimal decision is the one for which the expected loss will be minimized. The expected loss for a given choice, d, can be computed as follows:

$$c\int_{-\infty}^{d}(d-x)f(x)dx + \lambda c\int_{d}^{\infty}(x-d)f(x)dx$$

The minimum expected loss occurs when d equals the quantile of rank $\lambda/(\lambda+1)$ of the cumulative distribution function of x. The optimal choice, d^o, is then the one for which the probability that $x \leq d^o$ equals $\lambda/(\lambda+1)$. In this example, the value that would minimize the given loss function is 406,491 students (to be more precise, the growth would be 406,491 minus the current number of students).

Some general notes:

1. The term "Bayesian" here does not refer explicitly to Bayes's theorem, but rather to an idea of probability that is strongly (but not exclusively) associated with the Bayesian approach and that relates to a "state of uncertainty and not (only) to the outcome of repeated experiments" (D'Agostini 2003, p. 29). Essentially, in a Bayesian framework, there is a desire to "conceptualize some kinds of ignorance by characterizing our degrees of uncertainty in terms of subjective probabilities" (Morgan and Henrion 1990, p. 307). Bayesian decision theory offers a framework for explicitly incorporating uncertainty information into decision making (Morgan and Henrion 1990; Bijak 2010; Bijak and Bryant 2016). In general, Bayesian methods tend to work better and more naturally for more complex or highly structured problems and provide the possibility of describing multiple sources of uncertainty in a coherent way (Bijak and Bryant 2016).
2. Given what precedes, the method described here does not eliminate subjectivity. Still, it provides a mechanism to formalize preferences and judgments, leading "[…] to

decisions which are not only less arbitrary but actually more objective" (Raiffa and Schlaifer 1961, p. vii). In fact, the Bayesian approach brings transparency and coherence for decision making but also for statistical demography in general (Bijak and Bryant 2016). Moreover, the subjective interpretation of probability in the Bayesian approach allows the subjective aspects of population projections to be emphasized. In other words, probabilities do not reflect some frequency of occurrence as in the frequentist approach, or some equality of likelihood as in the classical interpretation. Rather, they reflect the beliefs of the projection makers, given some data about the past and some views about the future.

3. In the Bayesian framework, the planning problem can be described this way: the planners must make a decision d in a space of possible decisions ($d \in \mathbf{D}$), based on the size of the future population of students. While there is no way to determine this quantity with certainty, the planners are willing to use the results of a probabilistic population forecast, from which they obtain a plausible value x from space $\mathbf{X}$ ($x \in \mathbf{X}$). The uncertainty about x is characterized by a probability distribution function $f(x)$. The loss function is then a function of the decision d and the state x: $L(d,x)$. Then, $E[L(d,x)] \equiv \int_{\mathbf{X}} L(d,x)f(x)dx$ is the expectation of the loss for the decision.

4. In forecasting, a loss function is often defined as the value to be minimized. The loss function is equivalent to the inverse of the utility. In this case, planners would want to maximize the utility.

5. In cases where the loss function is linear and symmetrical, the optimal strategy would be to use the median of the probability distribution, as $\lambda/(\lambda+1)$ would equal 0.5 (the median is also the mean, since a normal distribution was assumed in this specific case).

6. The expected value of including uncertainty (EVIU) is the expected difference in loss between a choice that would have been made without any estimates of uncertainty, d^{iu}, (here 400,000), and the optimal decision reached with this information, d^{o}:

$$EVIU \equiv \int_{\mathbf{X}} \left[L\left(d^{iu},x\right) - L(d^{o},x)\right] f(x)\,dx$$

$$= \mathrm{E}\left[L\left(d^{iu},x\right)\right] - \mathrm{E}[L(d^{o},x)]$$

Appendix H - Examples of high-level communication about uncertainty

Bureau fédéral du Plan (2016), Belgium
Demographic projections, 2015-2060, (page 3) (translated from French)

Perspectives and not forecasts

“An important objective of the demographic projection is to serve as decision support, based on a scenario of unchanged policy and ‘social organization’, and not to predict the demographic future. The assumption of unchanged "social organization" does not involve freezing the value of different key parameters but to assume the long-term continuation of the trends that mark the current societal context, excluding breaks and upheaval. In the short term, the scenario also incorporates specific events that occurred in the recent past and likely to influence demographic trends.”

Statistics Canada (2014)
Population Projections for Canada (2013 to 2063), Provinces and Territories (2013 to 2038), Cautionary note (page 5)

“The population projections produced by Statistics Canada's Demography Division are not intended to be interpreted as predictions about what will happen in the future. They should instead be understood as an exercise designed to investigate what the Canadian population might become in the years ahead according to various scenarios of possible future change. For this reason, Statistics Canada always publishes several scenarios and formulates several explicit assumptions regarding the main components of population growth. Accordingly, users are encouraged to consider several scenarios when they analyze the projection results.

It should also be kept in mind that the accuracy of the projections produced depends on a number of factors; various events - for example, economic crises, wars, natural catastrophes - that are difficult (or impossible) to anticipate can affect the growth and composition of the Canadian population. For this reason, Statistics Canada revises the population projections on a regular basis, so that the context in which they are developed is taken into account.”

Statistics Finland (2015)
Population projection 2015–2065 (page 2)

“Statistics Finland’s population projections are demographic trend calculations based on observations on past development in the birth rate, mortality and migration. The projections do not seek to estimate the effect of economic, socio-political regional policy and other such factors on population development.

The calculations mainly indicate the outcome from the present development under the assumption that it continues unchanged. Thus, they should not be interpreted as descriptions of the inevitable. The task of a population projection is to provide tools with which decision-makers can assess whether measures need to be taken to influence the development.”

Federal Statistical Office of Germany (Destatis) (2015)
Statistics from A to Z: Population Projections

> **"How accurate are population projections?**
>
> Population projections are based on hypotheses and therefore are subject to uncertainties. Their results depend, on the one hand, on the current number and structure of the population and, on the other, on the assumptions regarding fertility, life expectancy and migration. As the increasing distance from the base date makes it more and more difficult to predict the components' development, long-term population projections have a model character.
>
> Calculating several scenarios makes it possible to illustrate the scope of potential change resulting from alternative assumptions on the development of the determinant components. When unforeseeable events occur, such as epidemics, wars or natural disasters, when there are unexpected changes in the generative behaviour of the population, such as the sudden drop in birth rates started by the pill in the mid-1960s, or when migration changes drastically, not even the calculation of alternative variants can increase the accuracy of population projections.
>
> The ultimate purpose of population projections, however, is not to exactly predict future developments. They are rather intended to show how the population size and structure might change under specific conditions."

Statistics New Zealand (2014)
National Population Projections: 2014(base)–2068, "Important advice for using projections" (page 2)

> "National population projections give an indication of the future population usually living in New Zealand. They indicate probable outcomes based on different combinations of fertility, mortality, and migration assumptions. Users can make their own judgement as to which projections are most suitable for their purposes.
>
> These projections are not predictions. They should be used as an indication of the overall trend, rather than as exact forecasts. The projections are updated every 2–3 years to maintain their relevance and usefulness, by incorporating new information about demographic trends and developments in methods.
>
> At the time of release, the median projection (50th percentile) indicates an estimated 50 percent chance that the actual value will be lower, and a 50 percent chance that the actual value will be higher, than this percentile. Other percentiles indicate the distribution of values (such as projection results or assumptions). For example, the 25th percentile indicates an estimated 25 percent chance that the actual value will be lower, and a 75 percent chance that the actual value will be higher, than this percentile."

Tønnessen et al. (2016), Statistics Norway
Population projections 2016-2100: Main results – "Uncertainty in the figures" (page 10)

> "All projections of the future population, its composition and geographical distribution are uncertain. The uncertainty increases the further into the future we look, and the figures are even more uncertain in projections for small groups, such as the population of municipalities by sex and age in years. Future immigration is particularly subject to a large degree of uncertainty, but fertility, mortality, immigration and internal migration can also end up

rather different than expected. The assumptions used in projections determine the outcomes of the different alternatives, as evidenced by the variations between the different alternatives and the disparities between projections by other institutions."

Instituto Nacional de Estadistica, (2015), Spain
Population Projections in Spain 2014-2064, Introduction (page 3)

"**Methodology**

Demographic forecast shall express prospective trends based on the past and on highly likely scenarios for the future. This is very complex and subjective, since it depends on a much wider —and usually difficult to quantify — range of parameters (economic, social, etc.).

Demographic projections represent scenarios that would occur, should certain hypotheses take place, regardless of how plausible these hypotheses are. They can simply be useful to understand the consequences in the case that a certain hypothesis —even being improbable— is verified.

Thus, the Population Projections by the National Statistics Institute are not intended to be a 'divination' of the future, but a support tool for the decision- making based on a statistical simulation of the demographic course that the population resident in Spain would take in the next years, always under the hypothesis that the current demographic trends continued."

Swiss Federal Statistical Office (2015)
Scenarios of evolution of the Switzerland's population 2015 – 2045, (page 5) (translated from French)

"The new scenarios of evolution of the Switzerland's population describe plausible evolution regarding the permanent resident population of Switzerland during the coming decades. They are not forecasts, but possible evolutions that depend on the fulfillment of the proposed hypotheses."

Turkish Statistical Institute (2013)
National Population Projections, 2013-2075, (translated from Turkish)

"[…] Changes in the population of all the provinces between 2013 and 2023 were projected by analyzing the trends of the demographic events and population projections were produced for all provinces. On the other hand alternative population projections reflecting different fertility variants were also made. In Turkey, population projections are produced by using deterministic models, based on the so called "cohort component model" by using package program. The experience of other countries on fertility and mortality are utilized as well to formulate the assumptions."

Office for National Statistics (2015b), United Kingdom
2014-based National Population Projections, Frequently Asked Questions

"**How far ahead do the projections go?**

Projections are uncertain and become increasingly so the further they are carried forward in time. For this reason, analysis of the projection results mainly focuses upon the first 10 or 25 years of the projection period, which corresponds with the planning horizons of the majority of users of the projections, whilst recognising that uncertainty will be greater over a 25 year period.

However, some main users require projections over a longer period for modelling purposes, and the principal projection is also published for up to 100 years ahead. However, caution should be used when interpreting this longer-term projection as projections become increasingly uncertain the further into the future they go."

Colby and Ortman (2014), United States (Census Bureau)
Projections of the Size and Composition of the U.S. Population: 2014 to 2060 – "Understanding the assumptions used to make population projections" (page 2).

"Projections illustrate possible courses of population change based on assumptions about future births, deaths, and net international migration. The projected values presented throughout this report are one possible outcome for the future that would occur only if all the assumptions hold true. All assumptions about the components of change are based on historical trends. Factors that might influence the levels of population components, policy decisions for example, cannot be predicted with any degree of certainty. Therefore, no attempts are made to incorporate these into the assumptions that produce the projections. Both the size and the composition of the projected population reflect the assumptions included in these projections. The accuracy of the projections will depend on how closely actual trends in fertility, mortality, and migration are consistent with these assumptions."

Recommendations on Communicating Population Projections

This publication contains a series of good practices and recommendations on effectively communicating the results of population projections. Here, "communication" encompasses not only how projections should be disseminated to users, but also what should be communicated. The aim is to improve the coherence between what is produced by national statistical offices and what is needed by users, planners and decision makers.

The publication was prepared by a task force established by the Conference of European Statisticians, composed by national experts from national statistical offices, and coordinated by the United Nations Economic Commission for Europe. The good practices and recommendations presented reflect practices in national statistical offices, preferences of users, and developments by academics and researchers in the field of population projections.

The publication primarily targets national statistical offices and is expected to be valuable also for users of population projections.

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