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Communicating population projections

Extract of the recommendations on communicating population projections

Note by the Task Force on Population Projections

Summary

The document presents a shortened version of the *Recommendations on Communicating Population Projections,* prepared by the Task Force on Population Projections.

The objective of the document is to provide a series of good practices and recommendations on how to effectively communicate the results of population projections. Here communication encompasses not only the means by which projections should be disseminated to users but also what should be communicated. The document starts with a section describing the methods used for data collection, and defining some terms. A series of broad recommendations on good practices is then presented in four chapters tackling distinct aspects of population projections. The shortened version is prepared for translation purposes and does not include boxes, appendices, references and most of the footnotes of the original full document.

The full text of the Recommendations has been sent to all members of the Conference of European Statisticians for electronic consultation. Subject to a positive outcome of the consultation, the Recommendations will be submitted to the 2017 plenary session of the Conference of European Statisticians for endorsement.

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Contents

Page

I. Introduction

1. The present Recommendations have been prepared by the Task Force on Population Projections, which included experts from Canada (chair of the Task Force), Italy, Mexico, Portugal, Sweden, Switzerland, Turkey, United Kingdom, Eurostat, United Nations Population Division, and United Nation Economic Commission for Europe (UNECE).

2. The objective of this document is to provide a series of good practices and recommendations how to effectively communicate the results of population projections, in line with the Task Force's terms of reference. Here communication encompasses not only the means by which projections should be disseminated to users but also what should be communicated. Consequently, a substantial portion of this document aims to improve the coherence between what is produced by National Statistical Offices (NSOs) and what is needed by users, planners and decision-makers. The document does not address questions of methodology except on rare occasions where methods are discussed as ways to produce desired outputs.

3. The good practices and recommendations come from various sources, such as practices of NSOs, the preferences of users, consultations among members of the Task Force and developments by academics and researchers in the field of population projections. While the opinions on practices were not always in consensus, efforts were made to represent all viewpoints and to clearly identify where agreement may be lacking.

4. The document does not specifically address issues or challenges related to subnational projections made for planners at local and sectoral levels, although it promotes an ongoing dialogue with users of population projections which is critical for ensuring that the projections respond adequately to the specific needs of these users.

5. Lastly, while it is not expected that NSOs and projection-makers in general will adopt all good practices and recommendations from this document, it is hoped that they will value them as general guidance and lines of reflection for possible improvements. Users of population projections may also find it instructive, as it details various ways that projection data can help decision-making.

6. The document starts with a methodology section describing the methods used for data collection, and defining some terms. A series of good practices is then presented in four chapters, formulated as broad recommendations, and each tackling a distinct aspect of population projections: Provide pertinent results (chapter 1), Cultivate transparency in population projections (chapter 2), Address uncertainty explicitly (chapter 3), and Foster relationships with users (chapter 4). The document concludes by identifying areas for future development.

II. Research framework and methodology

7. The research framework developed to guide the production of this document aims to integrate several points of view: those of the experts working to produce population projections (NSOs), those of projections users, as well as the viewpoints of scientists or academic experts. This approach is also consistent with the United Nations Fundamental Principles of Official Statistics which recommends maintaining regular dialogue with users and consulting the scientific community to ensure the relevance of statistical programmes. Various tools were designed and implemented to collect data about these three viewpoints. These tools are described below.

User survey

8. The Task Force developed a user survey to investigate how projections are used in order to propose improvements in the presentation. It consisted of approximately 20 questions, covering topics including: the user's associated organization, the reason for using population projections, the importance and evaluation of various elements of dissemination materials, whether users had contacted the NSO in the past for information and their associated level of satisfaction with that interaction, and what aspects of the communication of projections produced by their NSO could be improved upon, in their view. The user survey was sent to a sample of users of national and, in some cases, international population projections in June 2015. Data was collected during the summer of 2015. In total there were 151 respondents to the user survey.

9. Results of the user survey were very useful, but require careful interpretation due to limitations in the sampling methods used. In short, because only a limited number of NSOs were involved in the identification of projection users (essentially those represented in the Task Force), and because the sample nearly exclusively consisted of users who had previously contacted these NSOs for information (as most NSOs had no other ways to identify users), it is not possible to determine how representative the sample of users is.

NSO survey

10. An additional survey was developed and sent to NSOs from UNECE member countries (covering Europe, North America and Central Asia). The survey, consisting of approximately 30 questions, asked the producers of national population projections some basic questions about their projections, the information that is disseminated 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 the month of June 2015. In total there were 32 respondents to the NSO survey.

Expert consultation

11. A third tool consisted of external evaluations of the good practices and recommendations proposed in this document 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.

12. Various steps were undertaken to achieve this objective. Firstly, in April 2016, a preliminary version of this document was presented at the Eurostat/UNECE Work Session on Population Projections, to an audience composed mainly of representatives from NSOs of UNECE member countries, from international organizations as well as researchers in the field of population projections. The Work Session offered a good forum for thorough discussions on the content of the document. Updated versions were then reviewed by external experts: first, 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, and later, in November 2016, 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.

Literature review

13. 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, communication, and demography, as well as the publications

released by NSOs. The literature review also provided key insights about effective ways to communicate complex scientific results.

A. Terminology

14. Before entering the core of this document, 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 utilization of these terms by agencies globally could facilitate clearer, more precise communications.

Projections and forecasts

15. Estimates published for future reference dates are most often referred to as *projections* or *forecasts*. The distinction between the two terms has much to do with the epistemological posture adopted in regard to our knowledge of the future. To generalize, projection-makers want to accentuate the fact the projections are not predictions, whereas forecast-makers seem to assume more boldly, within some limits, a capacity to predict. This distinction poses some difficulty since assumptions constituting 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 an effort to clarify some ambiguities, and in broad accordance with the most current contemporary practices and usages in the literature (although interpretations of the terms often differ), the following definitions are proposed:

- The term *population projections* 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." It refers to the calculation of some estimates at a future date. Thus the term "projection" is a general term that encompasses different types of approaches to estimation at future dates. Note however that there can also be projections towards the past, usually labelled as 'retro-projections' or 'backward projections'.
- A projection can be *deterministic*, or *probabilistic*. A deterministic projection can be summarized in a single value, obtained from a series of projection assumptions. No measures of uncertainty are usually associated with a deterministic projection result. In contrast, a probabilistic projection is summarized in 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 that not all assumptions are equally likely, a probability distribution of plausible values is required. The distribution is the basis for the estimation of the distribution of demographic indicators such as total fertility rate (TFR), life expectancy and future population size. The variance of the distribution also yields an appropriate measure of uncertainty about which of the plausible values are (most) likely.
- When a projection is to be interpreted as the most probable development of a future population, it should be labelled a *forecast*.[1,2] The expression "most probable" implies that a projection is considered the most probable outcome among a set of

[1] Note that the term forecast has different definitions depending on the field. It has a more strict definition in time series forecasting for example, where it represents the prediction of future values on the basis of values observed in the past.

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

possibilities, but since the set of possibilities is technically infinite, any single trajectory has a probability measure of zero (or close to it). Accordingly, in a probabilistic framework, a forecast does not coincide with any 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.[3,4] 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 a user from doing so. For example, users will interpret the result of a middle variant as being the most likely when more than one projection scenario is provided.

III. Chapter 1 - Provide pertinent and accessible results

A. Introduction

16. As the Internet Era has become firmly entrenched in society, user expectations for highly detailed, flexible and easily accessible information have grown stronger and such demands are likely to continue to grow in the future. Regular evaluation of dissemination procedures, with a view to improving the interpretability, accessibility and relevance of projection results, becomes essential in this context.

17. The results of the user survey were mixed with regard to 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 (spatial breakdowns 2, ethnicity 1 and education 1). In contrast, respondents to the NSO survey did not appear to view more detailed projection data as an area of user concern.

18. In terms of accessibility of the data, 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 of 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' web sites. As for NSOs, help in accessing the data was a request received by 14 per cent of respondents.

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

[3] Compare, for instance, the expected value when you throw a fair die: 3.5, but you will never observe this value.

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

B. Good practices

1. Communicate results in clear and simple language

20. Projection users are a diverse group, differing in their level of familiarity with statistical and demographic concepts and techniques, as well as having varying motivations for consulting projection disseminations. 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 the language was "appropriate" (83%), there were more instances of users finding the language "too technical" (8%) than "too simplistic" (1%).

21. Suggested strategies for reaching the widest possible audience are:

- Use plain, simple language in order 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 in order to further clarify important terms (particularly those that are more technical in nature);
- Include in the dissemination an introductory text box or chapter for users which sets proper expectations for the use of the projections and explains in a high-level manner their key caveats and limitations;
- Pre-test 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;
- Offer short courses for non-professional users such as journalists or state employees who are not involved in the projections.

2. Introduce information in a progressive manner

22. An efficient strategy for communicating information of different technical levels to a variety of users is to release it in different layers of increasing complexity. This approach, often referred to as *progressive disclosure of information*, helps create an efficient instructional design by minimizing the load on the working memory and segmenting complex explanations into intelligible portions. Users differ in their preferences for specific forms of presentations; repeating messages using different forms (verbal, numeric and graphical) may result in better understanding and increase the chance that the user will notice and correctly interpret the information.

23. Another frequently-used strategy is to provide a separate technical report to present the methods and assumptions. However, several studies show that readers tend to spend limited time reading such detailed reports. It is therefore essential that general statements about the limitations of projections permeate the primary layers of the communication of population projection results, and are not only found in a detailed technical report.

3. Provide results for both short-term and long-term horizons, making clear that the uncertainty of projection results increases with the length of the projection horizon

24. The needs of users regarding projection horizons are varied. As seen in Table 1, while 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, horizon needs among user ranged from as short as one year to as long as 150 years in the future.

Table 1
Projection horizon disseminated (NSO survey) and used (user survey)

	Projection horizon in years				
	Mean	**Mode**	**Min**	**Max**	**> 50**
NSO (disseminated) (N=32)	*54*	*50*	*25*	*100*	*12*
User (needed) (N=140)	*31*	*10*	*1*	*150*	*14*

25. These results suggest that consideration of both short- and mid-term intervals within that horizon will benefit a large array of users. For instance, if it is thought that immigration will decrease in the long term, variations in the short term should also be taken into account and discussed in disseminations, as this will respond to the needs of users interested in short-term projections.

26. High uncertainty associated with certain demographic components can be a motivating factor for not extending the projection horizon too far. However, the provision of a long-term projection should not be a problem as long as it is accompanied by an appropriate relevant estimate of its uncertainty. The increasingly wide uncertainty over time will inform users about the risks of using projection results for long horizons (see chapter 3). Recognizing the disparity between a reluctance of projection-makers to go beyond a certain time horizon and the expectations of some users, it has been recommended making clear distinctions between projections made for short- or mid- term horizons and those made for longer horizons (typically for more than 30 years).

4. Disseminate projection results by single age and year whenever possible

27. The vast majority (87 per cent) of respondents to the NSO survey reported that they disseminated their projections by single years 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 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, as highlighted in good practice 1.2 above, are needed by some users.

28. Finally, interpolation of coarser-grained projections can offer a good alternative to projections by single age and year built from the ground up, but the results may not always be satisfactory, especially when performed over both the age and time dimensions. 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 saw-toothed patterns, irregularities, etc.). It is also desirable to inform users when an interpolation method is used and about its possible limitations.

5. Update the projections on a regular and predetermined basis or when important demographic changes affect the pertinence of the assumptions

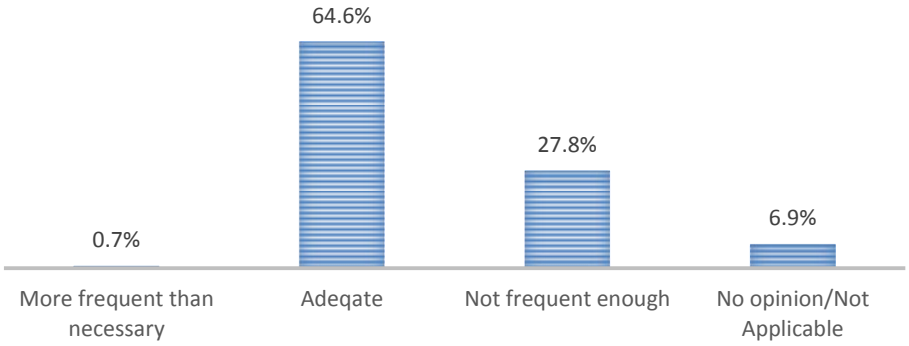
29. Most NSOs update their projections on a regular basis, often when new or revised data become available. This is a good practice as inaccuracies in the baseline data can be a non-negligible source of projection errors, sometimes the most important one in countries with generally low quality data,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

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

Mean	Mode	Min	Max
3.8	*5*	*1*	*10*

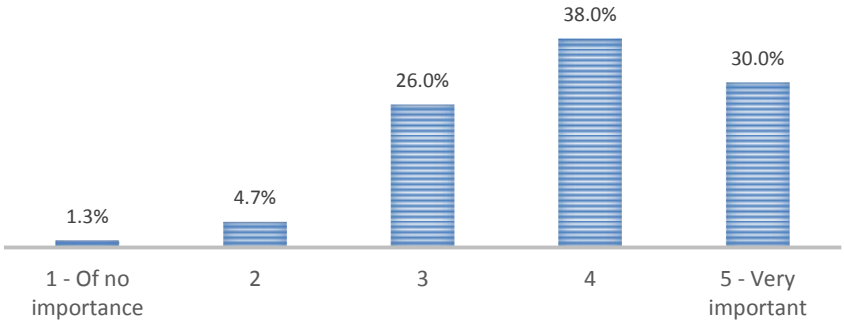
30. Results from the user survey show that most users (65 per cent) found the update schedules of population projections to be adequate, although a sizeable proportion (28 per cent) felt they were not frequent enough (Figure 1).

FIGURE 1
USER SURVEY - User's opinion on the frequency of projection updates (N=144)



31. 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 2). Only 6 per cent of respondents found that regular updates were not important at all or not very important.

FIGURE 2
USER SURVEY - User's opinon on the importance of frequent updates (N=150)



32. It is difficult to propose an ideal update schedule, as the pace at which the demographic context changes varies over time and geographically. 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.

33. To assess whether the projection differs from observed trends because of random fluctuations or because of or systematic deviations, within some level of confidence,

requires the utilization 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 follows a revision policy stating that an update must be produced if the correspondence between projection data and administrative data falls below 99 per cent in total population, below 99 per cent in total 15-64 aged population, or below 95% in any of the total population of NUTS 2 regions of Turkey.

34. Finally, because the same period in the future 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 media and other prominent users (unless in exceptional cases). Good strategies in this context include:

- Ensuring that search capabilities of the website will lead to the most recent results;
- Clearly labelling and categorizing 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;
- Advertising the dissemination of new population projections through media (see chapter 4).

6. Make electronic dissemination materials accessible and easy to navigate

35. Most users will access disseminated materials through the NSOs' websites. It is therefore crucial to ensure that the materials are easy to access. A good practice in this context is to regularly evaluate the ease of use and accessibility of the data and all dissemination materials. NSOs should look for means of improving the user experience of 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 persons 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.

7. Offer customizable/interactive projection data to users in tabular or graphical formats

36. If users can be actively involved in the selection and design of graphics to suit their special interests and skills, their experience is likely to be more motivating and educational than in the traditional, passive modes of communication. Data from the user survey shows that more than three-quarters (77 per cent) of respondents felt that it is important or very important to have access to customizable data tables.

37. Undoubtedly, the construction of an interactive application and its continuing updates are resource-intensive for NSOs. The desire of users to access different data or tables than what is available should nevertheless be acknowledged, and an alternative for NSOs is to be easily accessible and to offer to produce the requested information themselves (see chapter 4 for good practices about fostering relationships with users).

IV. Chapter 2 - Cultivate transparency

A. Introduction

38. Transparency is a basic principle of good scientific practice. Providing detailed and clear information about how the projection was produced allows users to develop a more

accurate interpretation of the results, and to understand more fully their limitations and the context in which they were built. 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."

39. Users appear to place high value on this 'background' information, with a large majority of respondents to the user survey clearly indicating that receiving information about such elements was important or very important to them, including 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 that considered detailed analysis of results to be important (70 per cent). However, a sizeable percentage of respondents to the user survey felt that there was not enough detail in the information about the current demographic context/trends (21 per cent), the projection assumptions (29 per cent), the methodology (24 per cent) or the underlying data sources (22 per cent).

B. Good practices

1. Provide descriptions of the data, methods and assumptions

40. As described in the introduction to this chapter, users value highly the background information accompanying projection results. In general terms, scientific research reports should provide descriptions of their procedures and assumptions to a level of detail sufficient for others to undertake a replication of the results. Although this can be difficult to do in practice, the documentation should be prepared with the ideal of reproducibility in mind.

41. Provision of detailed descriptions of the model, the data and the methods used is therefore a good practice. Some possible strategies to help projection-makers achieve this goal are:

- Clearly identify the data sources used and comment on any major quality issues and their associated impact on the quality of the projections. Information on the evaluation procedures and any adjustments of the initial data for the projection should also be provided;
- Make clear the logical links between descriptions of the current demographic context and projection assumptions;
- If necessary, provide a brief description of the procedure followed to obtain the base population. 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, vital statistics data, etc.);
- Provide a description of 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. 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;

- Disseminate projection inputs (for example, age-specific fertility rates) in the same level of detail as was utilized in the building of the projection;
- Finally, a good practice would be to dedicate a portion of dissemination materials to the publication of key information about the projections.

2. Acknowledge any relevant stakeholders and describe the process and outcomes of all consultations

42. Population projections, like official statistics in general, intend to serve the information systems of democracies for better decision-making. Independence and impartiality of population projections are preconditions for fulfilling this demanding role. Users of population projections expect results that are independent and impartial, and these principles are generally followed by NSOs. However, a transparent approach in this domain can certainly help to 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 influential role in the production of the projections, whether because they provided some degree of funding or for other reasons. When possible, the impact of stakeholders on the production of the projections (for example, changes in assumptions) should be specified.

43. Whether or not stakeholders have been 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 their disseminated products.

44. Documentation of consultations may help contextualize why some decisions were taken in the production of the projections. Such descriptions can also reveal the areas where there is general consensus and those where it may be lacking, or where there may be greater uncertainty.

3. Clearly define key terms used in dissemination products

45. 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 material. One recommended way to achieve this practice is to include a glossary of key terms in the dissemination materials. In particular, key terms associated with projections such as projection, forecast, scenario or variant, should be defined and it should not be presumed that users share the same understanding of these terms as the projection-maker.

4. Describe how the new projections differ from previous editions

46. NSOs produce frequent updates of projections, most often following a predetermined schedule, usually after the updating of the base population (e.g., when new census data becomes available), or due to some important demographic changes that 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. 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 periodicity of new releases and to be notified in a timely manner about any upcoming reviews outside of the pre-established periodicity. The key factors that may lead to such ad hoc updates or revisions also constitute relevant information.

5. Assess the performance of previous projections

47. 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.

48. 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, 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 to the 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.

V. Chapter 3 - Address uncertainty explicitly

A. Introduction

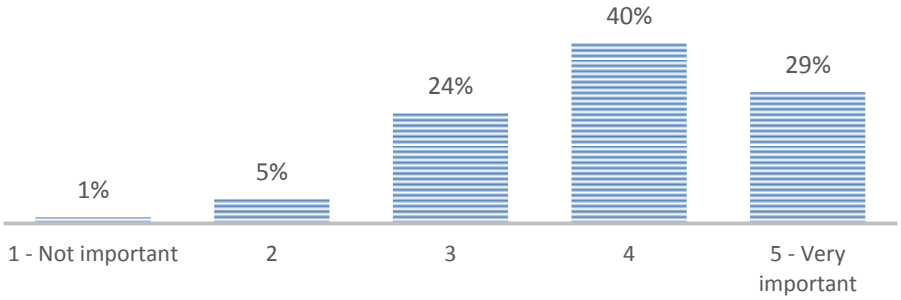
49. The urgency and the significance of issues that scientists are currently being asked to tackle have begun to move the question of uncertainty from the periphery to the core of scientific methodology. For population projections, this means that not only are the most likely sizes and structures of future populations of interest for planning, but so is the uncertainty of their projected future values.

50. Organizations engage in risk management exercises in order to measure and manage the consequences that internal or external factors could have on the realization of their objectives. Typically, risk management provides an evaluation of risks, defined as the effect of uncertainty on an organization and measured in terms of the impact of uncertain outcomes on the organization’s objectives taking into account their probabilities of occurrence.

51. 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 postponement of action, or to precautionary measures or policies that can be adapted as the future unfolds. 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. This guiding principle has been adopted in several domains internationally, including the environment, health, and more generally in economics and politics.

52. In addition to being a critical tool to assist decision-making, the communication of uncertainty promotes users’ confidence, helps users to manage expectations and truthfully reflects the state of the science.

FIGURE 3
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)



53. Results from the user survey highlight the importance of conveying measures of uncertainty when disseminating population projections. Although very few agencies provide quantification of uncertainty, the majority of user respondents (69 per cent) felt that quantification of the uncertainty of projections was either important or very important, while very few (1 per cent) felt that it was not important at all (Figure 3).

54. However, when asked about the information present in the most recent edition of the population projections used, a third of respondents (29 per cent) felt that the uncertainty was not clearly stated, and about two-fifths said that it could be stated more clearly.

55. There is a general sentiment among demographers that the treatment of uncertainty in population projections is an area of work that remains underdeveloped. It has been 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.

56. 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. It has been observed that efforts made to consider how best to express uncertainty and convey this information to users should be a priority for research, as it is key to improving the quality and usefulness of population projections. This point is important, since 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.

1. Current practices

57. The different strategies used by projection-makers to communicate uncertainty can be grouped into two main approaches: the production of deterministic scenarios and probabilistic projections. These two approaches are summarized below.

A. The deterministic (scenario) approach

58. Users of population projections will often be interested in a single most likely outcome, and will tend to interpret the result of a middle variant as being the most likely when more than one projection scenario is provided. 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.

59. The scenario approach allows users to make comparisons and to understand the sensitivity of the projected results to variation in assumptions about vital rates (with 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.

60. However, the scenario approach has often been viewed as an unsatisfactory way to deal with the assessment and communication of the uncertainty of population projections. 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.
- 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 sizes. Nothing ensures that the variations projected for other demographic indicators are plausible nor probabilistically consistent, that is, that the variations in these indicators are of the same size and order as those of population size. For the scenario approach to provide plausible results, it must be tailored to the outcome for which one wants to assess uncertainty. For example, an analysis centred on the old-age dependency ratio could compare two scenarios, one proposing high mortality and high fertility and a second one combining low mortality and low fertility.
- There can be several ways of combining levels of fertility, mortality and migration 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.
- 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.
- To avoid providing statements about the likelihood of their projections, some NSOs provide a plurality of projection variants without providing the likelihood or probability of each variant. This is in contradiction, however, with the way in which population projections are usually produced. Indeed, most projection-makers build their assumptions based on what they think the most likely outcomes are, since without such 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.
- 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.

B. The probabilistic approach

61. In recent years, an increasing number of researchers have advocated for a paradigm shift in population projections in order 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.

62. Fundamentally, probabilistic projections result from the borrowing of methodologies developed for *uncertainty analysis* in other domains of science and their application to population projections. Uncertainty analysis consists of quantifying the uncertainty in the results of a model. 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 uncertainties, 5) combine uncertainties, and 6) report 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.

63. 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. By sampling parameter values from the associated probability distributions for the various components of population change, an infinite number of trajectories can be produced. This approach allows the integration of the uncertainty associated with each component of population change in a consistent manner (even though they may be summarized by non-comparable indicators, such as the total fertility rate, life expectancy at birth, etc.). As a result, for any outcome variable (population size, the size of individual age groups, indicators of age structure, etc.), 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 or 95 per cent).

64. 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”. 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. This subjective approach to probabilities is natural in a Bayesian framework, embraced by several probabilistic projection-makers.

65. Because it allows one to incorporate more information about uncertainty and to better mimic the uncertainty propagation over time than the traditional deterministic projections, probabilistic projections are seen as providing more authoritative assessments of uncertainty.

B. Good practices

1. Develop an explicit strategy for characterizing and communicating the uncertainty of population projections

66. 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 the communication of uncertainty. Moreover, a clear exposition of such a strategy would allow users to understand its strengths and limitations, and the multiple sources of the uncertainty inherent in population projections.

67. An explicit strategy should entail the selection of 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. This approach would be preferable to what is the most current strategy used by NSOs, a rather mechanistic application of the high-growth/low-growth configuration in the scenario approach.

68. 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, qualitative assessments by independent experts of the assumptions, estimation of model uncertainty through comparison of various models, production of different scenarios for sensitivity analysis for some results deemed sensitive or important and the production of prediction intervals via probabilistic methods. Such comprehensive strategies have been used in other domains such as the studies of future climate change. Subsequent good practices in this chapter discuss some of these methods in more details.

2. Identify and acknowledge the major sources of uncertainty

69. 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 the topic of a more in-depth analysis when possible, following an explicit strategy as suggested above. In probabilistic projections, the uncertainties that are 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.

70. Finally, although population projections usually perform well within limited time horizons thanks to demographic momentum and also in situations with little variation in vital rates, their accuracy is adversely affected by unpredictable events such as war, economic crises, or natural catastrophes. For example, a sudden surge in the number of births (the ‘baby boom’) and its abrupt termination two decades later (the ‘baby bust’) were largely unforeseen. One might argue that such events are unlikely to be missed today because the techniques of population projection have greatly improved over time. There is, however, no clear evidence that this is indeed the case nor that substantial improvements in the accuracy of forecasts will occur in the future. It seems foolhardy to believe that demographers will not be surprised by other unforeseen demographic events in the future.

3. Clearly state the uncertain nature of the projection results in high-level dissemination materials

71. 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. 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 may pick up on the topic. A statement on the uncertainty of the projections should be short and accessible, helping to inform the public of the speculative nature of projections.

72. Concerning tactics for communicating the uncertainty of population projections, some of the most useful approaches include:

- Noting 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, encouraging users to consider a range of projection results rather than a single result, by comparing multiple scenarios;
- In cases where probabilistic projections are produced, publishing 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 over time in the projections and facilitate the understanding of the approach;
- Noting that the accuracy of a projection depends on a number of factors that are difficult or impossible to anticipate, such as economic crises, wars or natural catastrophes;
- Noting 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);
- Offering answers to common questions from users, e.g., "which series should I use?", which provides an opportunity to explain that using several scenarios yields a more realistic picture of possible future trends;
- Noting the key differences between population estimates and projections;
- Observing that certain components of a projection contain more uncertainty than others and explaining why this is true.

4. Dedicate space within disseminated materials to promote a better understanding of uncertainty and its interpretations

73. 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 a subject of lively debate.

74. While it is useful to have all concepts related to uncertainty included in an accessible glossary within the disseminated materials, another good practice is to dedicate a section of these materials to a discussion designed to educate people on how to understand uncertainty more accurately and in greater depth. Lastly, the use of graphs can be very helpful to portray uncertainty simply and effectively.

5. Pay close attention to verbal expressions of uncertainty

75. Words can be an effective way of conveying a general idea of uncertainty. In general, verbal expressions are more easily remembered than numerical expressions and are better adapted to lay audiences. Qualitative assessments and evaluations can be appropriate when quantitative measurements are impossible to provide. They are especially relevant when communicating degrees of consensus among experts. Some simple strategies for communicating uncertainty in words include:

- 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;
- 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;
- 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).

76. The benefits of verbal expressions can also be achieved in the case of probabilistic projections by using fixed scales in which calibrated language is used to express probabilistic estimates. For example, a likelihood scale can be used in which linguistic qualifiers like "virtually certain" and "very likely" are associated with ranges of probabilities such as greater than 99 per cent, and 90 to 99 per cent, respectively.

6. Solicit and publish expert opinion

77. 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. In the context of modelling uncertain events, elicitation of expert opinion can be used to translate professional judgment about uncertain events into something that can be usefully modelled.

78. Indeed, when properly structured and documented, expert elicitation characterizes uncertainties in a transparent manner. Furthermore, in some cases, expert elicitation may be preferable over other methods, such as time series extrapolation, if it takes into consideration additional information beyond what was previously observed. 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.

79. There are limitations to expert elicitation, however. One is that it can be difficult for experts to articulate their views, especially when they are asked to assign probabilities to specific events. Indeed, it has been found that humans in general, whether experts or not, are not good at estimating probabilities. Projection-makers who utilize expert elicitation should be aware of such limitations.

7. Provide uncertainty analysis

80. 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 purveyors 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 a user to calculate their own statistics (e.g., a prediction interval for the size of the labour force in the future).

81. Methods used to produce probabilistic projections should be tested with historical data and re-calibrated if necessary. It is expected, for instance, that observed values would be contained in an 80 per cent prediction interval, on average 80 per cent of the time. 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. Results from cognitive research show that calibration tends to improve trust in the forecasts.

82. In light of the benefits and limitations of disseminating probabilistic projection results, 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). In particular, explicit measures of uncertainty should be provided only when projection-makers are confident of their capacities to build scientifically sound confidence intervals, relying on robust data, solid expertise, and methods that are at least partially standardized, to the extent that a standard method has been agreed by consensus.

83. When probabilistic projections are produced, it is crucial to explain clearly how the prediction intervals were computed and to what they refer (i.e., which demographic components were allowed to vary in order to quantify the uncertainty in future population).

84. Finally, users should be made aware that the probabilities attached to a forecast are also projections and have their own uncertainty. A suggestion is to 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. At the current time, probabilistic projections remain relatively rare and recent initiatives. Hence, thorough evaluations of their performance are practically non-existent.

8. Provide sensitivity analyses

85. Most NSOs have used the scenario approach to convey a sense of uncertainty about their projections, often describing it as a sensitivity analysis. It is useful, however, 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), but rather to understand how a particular input in the model can influence the results.

86. The relevance of sensitivity analysis will be 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 policymakers to devise policies targeting the key factor(s) for a given objective.

9. Provide a range of plausible assumptions

87. In contrast to providing a forecast that only reflects the most likely outcome, the scenario approach, when properly implemented, aims to retain all assumptions that seem plausible. When implemented as such, the scenario approach provides valuable insights about the uncertainty of population projections. First, the publication of multiple deterministic scenarios underlines the fact that there is not one single path for the future. Second, it provides a simple way to communicate the plausible range of future demographic trends given what is currently known. Even deprived of likelihood assessments, the plurality of scenarios remains useful to stimulate reflection and guide actions leading towards a more desirable future.

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

VI. Chapter 4 - Foster relationships with users

A. Introduction

89. Good science communication must begin with aiming to understand audience needs and how to address them. 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 to determine whether the communication approach responds well to the needs of users in general, and can trigger important changes in this regard.

90. The attitudes and the actions of the experts working in NSOs have a large part to play in the communication process, as they are the ones entering into contact with the public. The following good practices should help NSOs to foster their relationships with users, which should improve users' experience with the products and enhance the utility of the projections.

B. Good practices

1. Provide a clearly-identifiable means for users to obtain answers from projection-makers

91. Requests for technical assistance from users can shed light on areas for improvement in disseminations. It is therefore 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 means for users to ask questions and provide feedback to projection producers, and respond to requests in a timely manner;
- Identify common themes in customer queries and provide responses to frequently asked questions or items known to be less understood in the dissemination material.

2. Consider developing and offering 'outreach activities' to engage directly with users in a substantive manner

92. NSOs may wish to consider engaging in outreach activities involving direct contact with users such as instructional workshops, training sessions, or online chat sessions in order to improve user understanding of projections. In terms of successful strategies for communicating with users, several respondents to the NSO survey mentioned that the use of outreach activities such as these proved to be the most successful strategy for communicating with their users. There is in fact some evidence from the literature that direct instruction by scientists generates positive reactions among members of the public.

3. Provide notices of forthcoming projection releases to media and frequent projection users

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

4. Embrace traditional and new media

94. For scientists, communicating with the public is often negatively perceived as a difficult and perilous duty. However, popular media should be seen as a major channel for scientists to perform their responsibility of communicating with the public. A proactive approach in this domain can help provide an accurate and balanced picture to the public and avoid possible pitfalls and misunderstandings, which could hinder trust from the public.

95. In addition to traditional media such as print, radio and television, projection-makers should direct efforts towards embracing 'new', internet-based media forms including social media. 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.

5. Investigate and document the needs of users

96. Several of the previous good practices may 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 as a way to constantly gauge the pertinence of the projections.

97. There are some practices that can be used to maximize the collection of information from users. Here are a few:

- Provide means for users to contact experts through the NSO's website (see Good practice 1 above);
- Engage in outreach activities such as conferences, seminars, workshops (see Good practice 3 above) ;
- Establish a working group (with knowledgeable users) that can help inform methodological changes, and also keeps the users involved;
- Maintain relationships with known users;
- Conduct consultations (formal or informal);
- Invite feedback whenever possible (e.g. at events, in publications, in signatures at the end of emails).

VII. Conclusion

98. This document aimed to portray the current state of knowledge in population projections and to act as a bridge between users, researchers and NSOs. While it would be almost impossible for a projection-maker to implement all the good practices and recommendations contained in this document, it is hoped that projection-makers will find in it ideas that contribute to improving the usefulness of their projections and guidelines as to what should be published and how.

99. In the course of the preparation of this document, the Task Force strived to attain a balance between the views of the users, the NSOs and the experts, perhaps with a positive bias for responding to users' needs. The user survey constituted a rare occasion to explore what information users utilize and how they use it. However, despite this noble effort, the concept of 'users' needs' remains a complex one, 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. For example, users would find

no special value in probabilistic projections if they are unaware of how to use the extra information about uncertainty.

100. 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 or sustainable development. It could be imagined that in the not-so-distant future, most projection-makers would be apt and disposed to advise decision-makers on how to efficiently use this 'new' kind of information. In any case, better decision-making practices can only result from good interactions between projection-makers and users.