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QuantMig: The use of migration scenarios in future characterisations: A systematic review and typology

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1. Summary

1.1 Background

Migration plays an increasingly important role in shaping the demographic profiles of developed countries and receives ample attention in society at large as well as among policymakers. To understand how migration flows might evolve in the future, the QuantMig project set the goal of producing migration scenarios to support European migration policy. To do so, we need to make clear with what purpose scenarios are developed, how they are developed, and on which flows they focus. Other questions concern whether they are designed to describe the most likely future or a possible future, whether they are extrapolating trends observed in the past (assuming no fundamental changes in policies), or whether they are designed to describe desirable futures (migration as a panacea for ageing societies) or undesirable futures (massive inflow of immigration from developing countries). To produce the best possible migration scenarios, it is essential to get an overview of the literature. Migration scenarios have been used in a variety of future characterisations including forecasts, projections, and foresights. However, the term migration scenario is rarely well-defined or used consistently. Before developing a set of own scenarios, this document takes the necessary step of providing an overview of the existing literature and provide a definition and typology of migration scenarios. Based on this work, alternative ways of exploring the future of migration (for example in a vignette survey) will be discussed that lay out the bases for the extension of the work in the next deliverables of the work package.

1.2 Methods

This document looks at how migration scenarios are used in the literature presenting characterisations of societies' futures. Relevant documents are systematically retrieved and assigned to one of six categories part of a pre-established typology. The typology rests on the focus (either migration or another aspect of societies influenced by migration) and purpose (either to predict the future, explore the future, or establish how a specific target can be reached) of each future characterisation. Subsequently, the techniques used for generating migration scenarios are described in terms of the approach taken (quantitative or qualitative) and how data is generated and transformed into meaningful output. Finally, the specific geographical context and characteristics of migration and migrants included in the scenarios are explored.

1.3 Results

A total of 107 documents were analysed. More than half presented migration scenarios that were developed to answer questions not about migration itself, but about its influence on a population's future growth, age composition, or economic performance, among others. Future characterisations had most often prediction as purpose, being for example population forecasts, while many others had exploration as purpose, where the sensitivity of a given phenomenon to different migration assumptions is assessed. Most scenarios rest on a quantitative approach rather than on a narrative, but the latter has clearly expanded in the last years. Migration scenarios that follow a quantitative approach often rest on past migration trends to characterise the future, but seldom provide likelihoods that a given scenario will realise. Migration scenarios that follow a qualitative approach, on the other hand, often rest on experts and stakeholders' views for input, or rely on previously developed storylines. Finally, quantitative scenarios often concentrate on net migration figures inside of a single, usually economically developed country, while qualitative scenarios are more likely to consider bidirectional flows between two (world) regions.

1.4 Conclusions

There was an increase over time in the use of qualitative scenarios to characterise the future of migration. However, these scenarios were seldom used to translate storylines into quantitative outputs that specifically aim at predicting future migration flows. Ways to achieve this are discussed, including more advanced data collection techniques among experts and stakeholders, and the consideration of multiple types of migration.

2 Introduction

Migration is a key driver in population change in economically developed countries that are otherwise characterised by sub-replacement fertility and ageing populations. Migration, however, is also challenging increasingly diverse societies, its social cohesion and public acceptance. As a result, it is increasingly becoming important for stakeholders to understand how migration may evolve in the future and how flows can be better managed. In this context, the QuantMig project aims at producing migration scenarios to support European migration policy. One key departure point is the recognition that migration is notoriously difficult to predict, especially in the long term. By taking a scenario approach, QuantMig explicitly acknowledges this uncertainty, and aims at improving knowledge of the future of migration by offering not one single view of a future, but different views on different possible futures.

To support the elaboration of scenarios, it is essential to get an overview of the expanding literature on the future of migration. Different strands of literature are covering and using migration scenarios. However, the term scenario is rarely well-defined or used consistently in the literature about future characterisations. This does not only apply to future characterisations of migration (Sohst et al. 2020), but also to all types of future characterisations. In fact, previous authors noted that there does not exist “a comprehensive or even consistent theoretical and methodical substantiation for scenario methods” (Gaßner and Kosow 2008; 6). Hence, before developing a set of own migration scenarios, this literature review takes the necessary step of defining better what scenarios are in the context of future characterisations of migration.

This study starts by looking at how the term “migration scenario” is used in the literature presenting future characterisations. Future characterisations are any description of what a society could look like in the future as a result of a more or less intricate process or series of events. Often, future characterisations are called forecasts, predictions, or projections. As defined in work package 1.1 of this project (Bijak & Czaika 2020), forecasts and predictions are “unconditional statements about the future” (p. 4). The purpose of forecasts and predictions is usually to predict the future. Hence, future characterisations that are presented as forecasts or predictions will be said to be predictive. Forecasts and predictions can be contrasted with projections, which contain statements about the future that “are conditional upon their assumptions and underlying narratives” (idem). This group of future characterisations often contains sensitivity analyses and is said to be explorative. Alternatively, if future characterisations aim at establishing how a certain target can be reached, they are said to be normative. It should be noted that usually, future characterisations are made of two or more scenarios that may focus on migration but also on more general aspects of population change in societies (e.g. their demographic composition) of which migration is part.

Here, we are not starting from any strict definition of “migration scenario” since our aim is to get a comprehensive overview of how this expression is used in the literature. We do note, however, two distinct usage in the literature. First, the word “scenario” is often found as a stand-alone expression in future characterisations with a focus on migration to refer to any foresight exercise about migration. These usually have a short time horizon and do not attempt to predict the future

but provide narratives that describe possible migration futures. Second, and alternatively, the compound expression “migration scenarios” is used in either forecasts or projections to refer to migration developments under different constraints or assumptions, or to different variants of the migration component of a forecast or a projection. In the first case, “scenario” can be interpreted as an expression equivalent to migration future while in the second case, “migration scenarios” are just one part of a more general migration future. In the remainder of this document, the expressions “scenario” or “migration scenarios” are used to refer to any particular instantiation of the use of those expressions in future characterisations. The expression “future characterisation”, on the other hand, will be used to refer to any attempt at predicting or describing possible or desirable futures that either focus on migration or contain some migration component. In principle, each reviewed document contains one future characterisation and each future characterisation contains one or multiple migration scenarios.

In the subsequent parts of this document, we define the context in which migration scenarios are used by first systematically retrieving from the academic and grey literature those documents that present future characterisations with migration scenarios. Here, the goal is not to retrieve all the documents that correspond to a set of predefined criteria. Instead, it is to cover, to the extent possible, all *types* of future characterisations in which migration scenarios were used. By doing this, we aim to cover also the different methods that were used to develop such scenarios, as well as to describe most of the different applications of those scenarios. For example, statistical agencies in different countries regularly publish population forecasts that usually present future characterisations containing migration scenarios. However, the methods they use do not necessarily vary. Therefore, future characterisations of certain types will not be exhaustively covered if they show little diversity. Instead, only the more recent future characterisations of those types, or those that include insightful innovations, will be included. For example, we include only the most recent version of the United Nations’ World Population Prospects. Likewise, from the series of population forecasts based on the Shared Socioeconomic Pathways (Lutz et al. 2019; Lutz et al. 2018), we include only those that proposed new methods or approaches, or those that were used to solve different problems, for example by focusing on different parts of the world.

From the studies found during an extensive database search, a selection is thus made based on the relevance of their content for the purpose of this work. Then, to understand better the context in which migration scenarios are used, documents were assigned to one of six categories that are part of a typology defined by the research team and inspired by previous work in the field of futures research (Börjeson et al. 2006). The typology builds on two dimensions: focus and purpose. Focus refers to whether future characterisations specifically focus on migration as an outcome of interest, or whether they focus on other aspects of societies that are influenced by migration, for example a population’s size or composition by age. Purpose, on the other hand, refers to whether future characterisations were elaborated to predict or explore the future, or to evaluate how a specific target can be reached.

After providing an overview of the different kinds of future characterisations there are, this study then describes the techniques that are used for building migration scenarios in the context of future characterisations. This is done by describing each migration scenario in terms of the approach

taken and the techniques used for input generation and integration. We distinguish between quantitative and qualitative migration scenarios and study techniques for input generation and integration, differentiating between those that are generated through the course of some participatory exercise or builds on previously established scenarios. Finally, we explore to which extent scenarios rely on time series for producing output and whether different likelihoods are assigned to different variants or scenarios. We also provide more detail on some aspects of the techniques used in migration scenario building for example, when it comes to the recurrent narratives and participatory techniques upon which scenarios are built. Finally, we also analyse the specific types of migration flows the migration scenarios are applied to. This context thus includes the flow being considered (i.e. whether migration is considered from and to a specific country, between two countries, or between multiple countries) and the place of interest (a country, a group of countries, or a larger geographical area for example). In the conclusion section, we summarize the most important findings and reflect on their use and implications.

3 Methods

3.1 Document search

Methods for retrieving documents that presented future characterisations containing migration scenarios are reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Protocols (PRISMA-P) guideline for systematic reviews (Moher et al., 2009). Document retrieval proceeded in two steps: first, a search strategy was established that allowed to generate a pool of documents that made use of scenarios in the context of future characterisations of migration; second, eligibility criteria were identified that allowed to distinguish between those documents that are relevant for our purposes from those that are not.

3.1.1 Search strategy

Searches were performed in the databases of Scopus and the Web of Science for scientific articles, and in Google for grey literature. Two word strings were used for searching each database: the first one specified that the words “population” (or demography) and “scenario” should appear within three words of each other either in the title, abstract or keyword list (concerning Scopus and Web of Science), or anywhere in the document (concerning Google), along with the word migration in the title, abstract, or keyword list (Scopus and Web of Science) or anywhere in the document (Google); the second words string specified that the words migration and scenario should appear within one word of each other anywhere in the title, abstract or keyword list (Scopus and Web of Science), or anywhere in the document (Google). Searches in Google were limited to documents in PDF format to help limiting the amount of irrelevant references. All documents found in Google were included in the pool of potentially relevant documents, except for those that were omitted by Google because they were judged as “very similar” to the ones already shown. Thus, searches in Google were in each case limited to the first 130 to 150 hits. Additionally, to better focus the searches, each word string further specified a number of words that should not appear in the title, abstract or keyword list (Scopus and Web of Science), or

anywhere in the document (Google). These words were selected because they are often associated with migration scenarios without representing what we are interested in, for example: data migration or any type of software migration; migration among other living species, for example among birds or fish; migration scenarios with application to the study of gene flows, especially among animals; or planetary migration. Truncation was used to allow different words with similar roots to be included in the searches. Table A1 in the appendix contains the complete word strings specific to each search.

3.1.2 Eligibility criteria

Documents found during the search phase had to satisfy the following criteria to be included in the analyses. First, documents must have concentrated on population dynamics among humans, thus not among animals or other entities (e.g. not planetary migration). Second, documents must have included a description of a future characterization including (but not necessarily limited to) one or more migration scenarios. Third, documents must have presented original migration scenarios, meaning that methodological documents or review articles were excluded. Fourth, documents part of a series of publications (for example population forecasts updates) were only included if they were the most recent of the series, or if they contained methodological innovations that were not found in subsequent similar publications, or if they presented an application of similar methods to a new problem (for example by concentrating on migration in an area that was not considered before). Among the population forecasts produced by statistical offices, only those with a broader scope or with broader diffusion were considered for inclusion, while those concentrating on a single country were excluded. As such, the population forecasts by Eurostat (European Union), the Population Reference Bureau (United States) or the United Nations (World), among others, were considered for inclusion, but not those from the Office for National Statistics (United Kingdom) or the Federal Statistical Office (Germany), for example. Population forecasts presented in scientific articles and future characterisations other than population forecasts were more likely to be included as these were less likely to be part of a series of similar publications.

Other criteria for inclusion were related to content in the sense that documents must have included sufficiently detailed information about the focus of the study, its purpose, and the techniques used in building different migration scenarios (more detail is presented below about what this entailed exactly). Documents could be research articles (peer reviewed or not), book chapters, (PhD or MA) theses, or reports from statistical agencies or supra- or intergovernmental organizations, but must have been written in English. No limitation was imposed in terms of publication year or research field.

3.2 Typology of future characterisations

Our typology contains two dimensions: purpose and focus. Concerning purpose, we follow the work of Börjeson et al., who presented in 2006 a typology of future characterisations that was also intended as a guide for analysts interested in developing such characterisations. This work provides a good starting point for our typology as it is authoritative and general enough to accommodate scenarios of different kinds, including migration scenarios. Börjeson and colleagues'

starting point is that future characterisations diverge in the first place in their purpose, i.e. whether they aim at describing possible, probable or preferable futures. They qualify future characterisations that aim at determining what *could* happen in the future as **explorative**. These include scenarios with unlikely premises, but that are nevertheless useful for understanding the impact of certain developments on a phenomenon of interest. For example, a characterisation of a country's future population size might include an unlikely scenario with zero migration, but this scenario, combined with a scenario with "normal" migration, can be useful to quantify the impact that migration might have on a country's future population size. Characterisations that aim at determining what *might* happen in the future are defined as **predictive**. Such characterisations include forecasts and predictions, or any other exercise that aims at determining what the producer considers as the most likely future. Finally, future characterisations may be used to ask how a specific target can be reached, in which case they are called **normative**. The United Nations' (2000) replacement migration scenarios are a good example of normative scenarios, where the authors ask what immigration targets should selected countries reach to maintain their population's size or age structure over time.

Producers of population forecasts often maintain that they do not make predictions about the future, but that they make projections that are conditional upon a given set of assumptions. In this sense, they make population projections, which are by definition explorative. However, following others (Keilman 2008), we consider here population projections as predictive rather than explorative. This is because assumptions for population projections usually reflect what the producer believes to be the most likely future developments. The way that population projections are prepared thus reflects a predictive approach. Population projections, or other similar exercises, will however be considered as explorative if the producer clearly indicates that they do not believe their assumptions to be realistic. This is often the case when assumptions are made to provide a benchmark against which other projections can be evaluated. As stated above, this can be the case in characterisations assuming zero migration, for example.

With regard to the second dimension, focus, we distinguish between future characterisations that specifically focus on migration as an outcome, and future characterisations that focus on other socioeconomic outcomes on which migration might have an important impact. The decision of considering this dimension is based on preliminary analyses of selected future characterisations which, in many cases, do not rely on migration scenarios to determine the future of migration itself, but to determine the sensitivity of given socioeconomic phenomena to different assumptions about migration. For example, studies have developed migration scenarios and studied their implications for future population size or age structure, or their implications for the economic performance of a country. Taking this consideration into account in our typology of future characterisations appeared important as this aspect might represent an important source of heterogeneity with respect to the techniques that are employed for developing migration scenarios. Table 1 presents our typology, which includes six categories resulting from the intersection between the two dimensions: purpose and focus.

Table 1 A typology of migration scenarios, defined with respect to purpose and focus

		Purpose		
		Predict the future	Explore the future	Evaluate how a specific target can be reached
Focus	Migration	Category 1: Predictive, focus on migration	Category 2: Explorative, focus on migration	Category 3: Normative, focus on migration
	Other aspects of societies	Category 4: Predictive, focus on other aspects	Category 5: Explorative, focus on other aspects	Category 6: Normative, focus on other aspects of societies

3.3 Assessment of methods and techniques

Techniques used in migration scenarios are assessed in two distinct steps. The first step consists in determining whether a quantitative or a qualitative approach was taken to scenario generation, or both, in which case a scenario is said to take a mixed approach. This dichotomy between quantitative and qualitative approaches is often encountered in different areas of social sciences, and has also been used in the scenario building approach presented by Popper (2008), for example.

The second step consists in identifying techniques that according to Börjeson et al. (2006) fall under the terms *generation of ideas* and *integration*. Generation of ideas concerns how input is generated for subsequent use in scenarios, while integration refers to how the information is transformed into interpretable output. Concerning generation of ideas, we distinguish between future characterisations that use output from a participatory activity (workshops, surveys, etc.) that was organized for the specific characterisation at hand, from future characterisations that use output from a previously organized participatory activity. An example of this practice concerns the Shared Socioeconomic Pathways (SSP) (O'Neill et al. 2017). These are a set of scenarios that were developed by scientists interested in the future impact of global warming on different aspects of societies and have been used multiple times in subsequent studies. Concerning integration, we consider two non-exclusive practices, i.e. the use of time series analysis to generate output and the assignment of a likelihood to each specific scenario. This last practice can consist in estimating the level of confidence that a given scenario will materialise, or the expression of a preference for a given scenario as being more likely than other scenarios of the same future characterisation. Each scenario can be built by referring to one or many of the approaches and techniques. For example, a scenario can present a narrative to which quantifiable variants are assigned. It has then a mixed approach (qualitative and quantitative). Scenarios that are qualitative can be based on previous narratives, while scenarios that are quantitative can rely on time series analysis. Scenarios that rely on either the qualitative or quantitative approaches can further be based on participatory work or

assign likelihoods to different variants. Figure 1 shows how scenarios of migration are characterised in terms of the approach they take to scenario building and in terms of the techniques they rely on for input generation and integration.

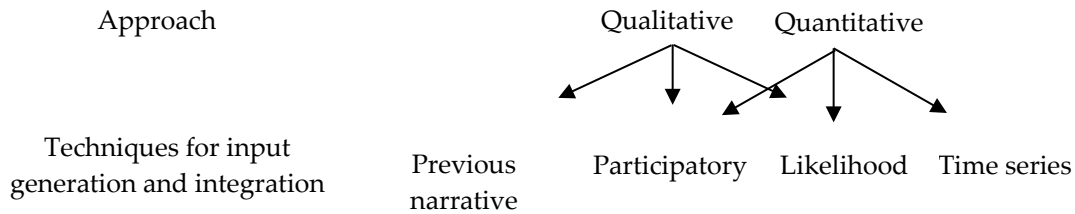


Figure 1 Diagram showing the characterisation of migration scenarios in terms of the approach they take and of the techniques they rely on for input generation and integration

3.4 Implementation of migration scenarios

To give a more precise idea of the concrete problems that migration scenarios are used to answer, information is extracted from each future characterisation first on the migration flows, then on the kind of migration considered. Migration flows are characterised in terms of whether they include immigration and emigration separately, or whether they include net migration only (i.e. the difference between the number of immigrants and emigrants). Migration flows are further characterised in terms of the geographical areas that they connect, i.e. whether they connect one specific area with the rest of the world (as often is the case when only net migration is considered), whether they connect two areas with bilateral flows, or whether they connect multiple areas in a matrix of flows. In each case, information is further extracted about the country, region, continent or other part of the world covered, and whether analyses are performed at the national level (between countries), subnational level (between states or provinces of a single country), or supranational level (between regions, groups of countries or continents).

Finally, information is extracted concerning whether scenarios focus on all kinds of migrations, or whether they concentrate on one or few specific kinds of migration. For example, scenarios may focus on migration due to global environmental change or on work-related migration.

3.5 Data extraction

The above information was extracted systematically from the selected documents following a set of pre-established questions which are listed in the appendix (Supplementary material A2). In total 72 documents were retrieved and coded in the first stage. Based on the references in these 72 documents in combination with expert knowledge in the team, an additional 35 documents were added for analyses as they fulfilled the criteria for inclusion as specified above. Three reviewers participated in the data extraction and coding phase of these 107 documents. Two of them went

through each document and provided answers to each of these question based on its content. In cases where answers differed between the two reviewers, the third one was called upon to adjudicate and make a final decision. Answers to each question were collated into a database to allow for a quantitative treatment. Results are presented in the next section.

4 Results

The analyses that we conducted can be summarized in four parts along which results will be presented. First, an overview of the document selection process is provided. Second, a breakdown of the selected documents according to the categories of the typology is presented. Third, we examine how methods used for scenario building vary according to the different categories of the typology and discuss more specific points relating to these techniques. Fourth, a description is provided of the concrete implementations of future characterisations with respect to the populations they covered.

4.1 Documents selection

Figure 2 shows how the document selection proceeded. Searches in the three databases (Scopus, Web of Science and Google) allowed to find a total of 647 documents. Duplicates were removed, providing a list of 506 records that were screened based on their title and abstract for suitability. This first screening allowed to remove 377 documents, mostly because they did not present an original future characterisation containing migration scenarios. The remaining 129 documents were screened again based on their full text, which allowed to remove an additional 57 records. The remaining 72 documents were selected for analyses, to which an additional 35 records were added based on the reference lists of the previously 72 selected documents, or based on expert knowledge. This procedure resulted in a total of 107 documents to be analysed.

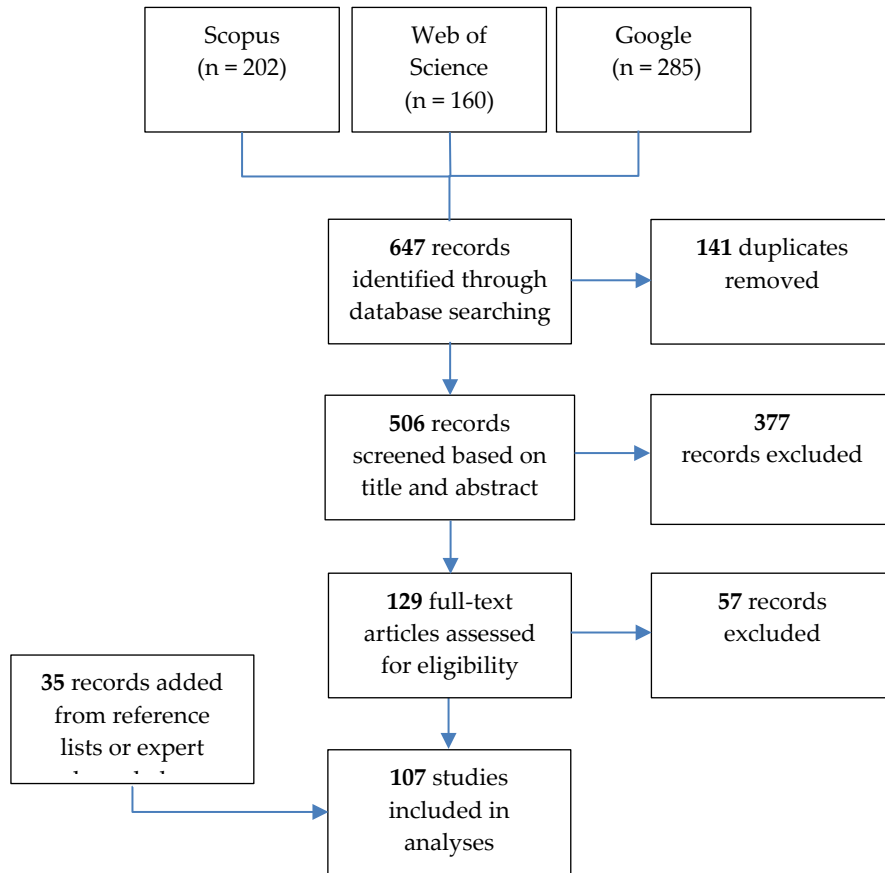


Figure 2 Document selection flow chart

4.2 Typology

Table 2 presents how each selected document was assigned to one of the six categories of the typology specified above (see section 2.2 Table 1). Approximately two-thirds (73 of 107) of all selected documents focus on topics other than migration. The nature of these topics will be discussed in more detail in subsection 3.4. Among these, more than half are predictive (n=38) while about one-third are explorative (n=29). A minority of documents with focus on other topics are normative (n=6). Meanwhile, approximately one-third of the selected future characterisations focus on migration. The majority of these are explorative (n=26), while only eight of them are predictive. None of the future characterisations with migration as focus is normative.

Table 2 Study breakdown with respect to the focus and the purpose of the future characterisations they present (the cells in the last line of the table correspond to the six categories of the typology)

Focus	Migration			Other topic		
Number of studies	34			73		
Purpose	Predictive	Explorative	Normative	Predictive	Explorative	Normative
Number of studies	8	26	0	38	29	6

4.3 Methods used for scenario building

4.3.1 Approach

Table 3 breaks down the selected documents according to the six typology categories and three approaches at building migration scenario, i.e. quantitative, qualitative and mixed. It can be noticed that some categories of the typology tend to privilege certain approaches over others. More concretely, future characterisations of the Category 2 (Explorative, focus on migration; see Table 1 for categories) usually take a qualitative approach at scenario building, while future characterisations in the Category 4 (Predictive, focus on other aspects) usually take an approach that is either quantitative or mixed. Future characterisations in the Category 6 (Normative, focus on other aspects) almost exclusively take a quantitative approach. In contrast, future characterisations in categories 1 and 5 do not particularly favour the use of one approach over the others.

Table 3 Study breakdown with respect to the approach taken at building migration scenarios (quantitative, qualitative, mixed), according to the six typology categories

	Quantitative	Qualitative	Mixed	Total
Category 1: Predictive, focus on migration	2	2	4	8
Category 2: Explorative, focus on migration	2	20*	4	26
Category 3: Normative, focus on migration	0	0	0	0
Category 4: Predictive, focus on other aspects	22*	1	15*	38
Category 5: Explorative, focus on other aspects	13	6	10	29
Category 6: Normative, focus on other aspects of societies	5	1	0	6
Total	44	30	33	107

* Indicate quantities that are significantly higher than an equal distribution would have suggested.

4.3.2 Techniques for input generation and integration

Table 4 breaks down the selected documents according to the six typology categories and four techniques for scenario building. The most common technique consists in relying on a time series analysis for scenario building (Total=40). This technique is mostly encountered in future characterisations that are part of Category 4 (Predictive, focus on other aspects). Scenarios are

otherwise often built relying on previous narratives (Total=21). Such common narratives are those part of the Shared Socioeconomic Pathways, as we shall see below in section 3.4 (O'Neill et al. 2017). These are not necessarily found in one typology category more than in others. Scenarios were also often built relying on an own participatory work. This is especially the case concerning future characterisations that are part of Category 2 (explorative, focus on migration). These studies including a participatory element often consisted of workshops where specialists and stakeholders are brought together to elaborate narratives of migration futures.

Table 4 Study breakdown with respect to the four scenario building techniques (previous narrative, participatory, likelihood, time series), according to the six typology categories

	Previous narrative	Participatory	Likelihood	Time series
Category 1: Predictive, focus on migration**	2	3	4	4
Category 2: Explorative, focus on migration**	5	10*	1	2
Category 3: Normative, focus on migration**	0	0	0	0
Category 4: Predictive, focus on other aspects**	8	1	2	27*
Category 5: Explorative, focus on other aspects**	5	1	1	7
Category 6: Normative, focus on other aspects of societies**	1	0	0	0
Total	21	15	8	40

* Indicate quantities that are significantly higher than an equal distribution would have suggested.

** Studies may employ anywhere between zero and all four of the four techniques listed in the column headers. As a result, row totals may exceed or fall below the totals for each typology category.

4.3.3 Integration of typology categories and approaches at modelling migration scenarios and trends over time

Tables 3 and 4 highlighted certain regularities in the intersection between the six typology categories and the approach and techniques used in scenario building. These regularities can be linked to some recurrent types of studies in the literature. First, predictive future characterisations with focus on migration can be considered as migration forecasts, projections or scenarios. There is no specific approach or techniques that is privileged in these studies. As such, they can equally be quantitative, qualitative or mixed, and they can equally rely on previous narratives or participatory work, and assign likelihoods or rely on a time series analysis. Second, explorative future characterisations with a focus on migration are overwhelmingly qualitative and mainly rely on participatory work for providing the content-wise input. In the literature, these are often foresight or scenario studies in the sense that they present narratives of possible migration futures. Third, predictive future characterisations with a focus on other aspects take mostly a quantitative or mixed approach, and are more likely to rely on time series analysis. In the literature, these are often referred to as population projections or forecasts. They usually concentrate mostly on the future development of fertility and mortality and put little emphasis on migration, for which simple (e.g. high, medium, low) scenarios are assumed. Fourth, explorative future characterisations with focus on other aspects do not heavily rely on a specific approach or technique. These are often studies that aim at determining the impact of migration on for example the economic output of a country. Migration scenarios are often to be interpreted as “what-if” scenarios and are not necessarily likely to materialise. Fifth, only a few normative characterisations could be found and they all focus on other aspects of societies. The goal of these studies is usually to determine how much migration would be needed to reach a certain target, for example in terms of population size or age structure, or in terms of labour force size. As such the migration scenarios that these studies present are also not likely to materialise.

Given the change in attention on migration scenarios in society and among policymakers one may expect the developments over time in how migration scenarios are specified and on what they focus. Figure 5 shows how the number of future characterisations evolved over time with respect to each of the six categories of the typology. Bars are color-coded to represent the use of the different approaches (quantitative, qualitative, mixed) in each future characterisation. We see that characterisations that are part of Category 4 (Predictive, focus on other aspects) were published at regular intervals throughout time, but especially in the last five years. We remind that this category contains mostly population forecasts. Hence, the high prevalence of such characterisations in the last five years could be due to our selection criteria that privileged more recent population forecasts over older ones. We otherwise observe the steady increase in the use of explorative future characterisations that have migration as focus during the last 20 years. It is furthermore clear that they mainly take a qualitative research approach but more recently seem to become also mixed methods studies. No clear time trend can be noticed concerning the use of other types of future characterisations.

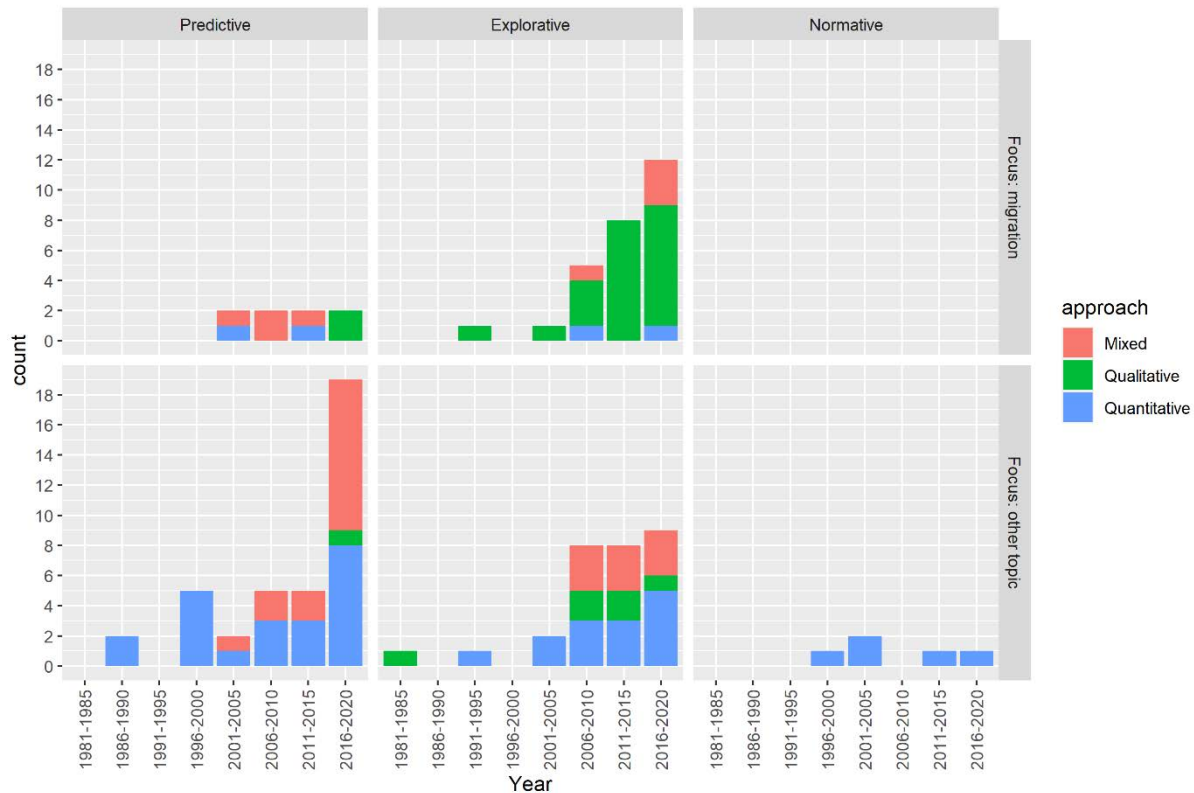


Figure 3 Variation over time (5-year classes) in the number of future characterisations according to their purpose (columns), focus (rows) and approach (colour coded, see legend)

4.3.4 Additional information on the studies' focus

The typology presented above rests on the distinction between future characterisations with migration or other topics as main focus. One question that arises is what those other topics are. Table 5 breaks down those future characterisations with other topics as focus according to seven foci. Most characterisations ($n=36$) that did not focus on migration specifically aimed at projecting the size of different populations in the future. Here, scenarios are used to determine the sensitivity of population size to different assumptions about migration. Twenty-seven studies otherwise assessed the sensitivity of the composition by age of populations to different assumptions about migration. Lower numbers of studies assessed the sensitivity of the size of the labour force ($n=12$), economic output ($n=10$), public finances ($n=6$) and employment ($n=5$). Other studies relied on migration scenarios while assessing change in the spatial distribution of populations ($n=4$), their ethnic composition ($n=3$), or their exposure to environmental hazards such as droughts or floods ($n=3$).

Table 5 Future characterisations (counts) according to their focus (provided it is not migration)^a

Focus	Count
Population size	36
Age structure	27
Labour force size	12
Economic output	10
Public finances	6
Employment	5
Spatial distribution	4
Ethnic composition	3
Exposure to environmental hazard	3

^a Studies may have more than one focus

^b Topics that were the focus of less than three studies are not shown

4.3.5 Additional information on participatory work

Above, it was noted that a total of seven future characterisations relied on the input of experts or stakeholders to either identify different migration scenarios or assign probabilities that different migration scenarios will realise. Since there exist different approaches to collecting such input, Table 6 details which study used which type of approach. Most studies that relied on the input of experts or stakeholders did so in the framework of a workshop, where experts and stakeholders are brought together to develop scenarios. Otherwise, studies used interviews or questionnaires, the Delphi method, or a combination of workshops and interviews/questionnaires.

Table 6 Approaches used in studies that relied on input from experts and stakeholders

Type of approach	Number of studies
Workshop	10
Interviews/questionnaires	3
Delphi method	1
Combination of workshop and interviews/questionnaires	1

A total of fifteen future characterisations were built using previously published storylines. As shown in Table 7, these previously published storylines belong for the most part to work that is the fruit of vast consultations that are widely known both inside and outside of the academic world. For example, seven future characterisations used the storylines that are part of the Shared Socio-economic Pathways (SSP), while one characterisation relied on the Representative Concentration Pathways (RCP) (which also serves as input in the SSP) and two rested on the Special Report on Emission Scenarios (SRES), which can be seen as a predecessor of the RCP. Three studies otherwise used the United Nations World Population prospects as input for their future characterisation, and one used the narratives from the Sustainable Development Goals. Other studies relied on work which impact is limited to the academic world such as the Global Migration Futures (Vezzoli et al. 2017) project (categorized as ‘Other projects’).

Table 7 Previously published storylines appearing in the selected literature

Previous work	References
Shared Socio-economic Pathways	8
United Nations World Population prospects	3
Special Report on Emission Scenarios	2
Representative Concentration Pathways	1
Sustainable Development Goals	1
Other projects	4

4.4 Implementation of migration scenarios

This last part of the results section concentrates on the concrete problems that migration scenarios helped answering. This is first done by providing an account of the way that migration flows were modelled, the different parts of the world that were covered, as well as how this was done. Table 8 shows that most studies modelled migration as the difference between immigration and emigration (net migration) either inside of a single country or while considering multiple countries. These studies disregard where migrants may come from and were mostly found among characterisations focusing on topics other than migration and with exploration as purpose. Some studies considered migration between two regions, for example between eastern and western Europe, or between south and north Mediterranean countries. These studies were more likely to focus on migration and have exploration as purpose. A relatively large number of studies considered migration inside a system of different origins and destinations (multiple flows), either by considering different regions or countries covering the whole world, or by considering a reduced number of countries inside of a given region, or a number of subdivisions (e.g. states, provinces) inside of a given country. Only very few studies (n=3) considered in the same characterisation both net migration and multiple flows. This approach was taken for example to model migration both from outside a given political unit (e.g. net migration in the European Union) and inside of it (e.g. migration flows between the different countries of the European union) in the 3 studies that apply this approach.

Table 8 Migration flows and their geography

Net migration/ separate flows	Geography	Number of studies
Net migration	Single country	29*
Net migration	Multiple countries	40*
Bidirectional flows	Two regions or countries	12†
Multiple flows	Different regions or countries of the world	15
Multiple flows	Different countries of a region/ Different subdivisions of a country	18
Net migration + Multiple flows	Single region or country, different subdivisions	3

*Approach more common in characterisations focusing on topics other than migration and with exploration as purpose

† Approach more common in characterisations focusing on migration and with exploration as purpose

Table 9 provides studies counts according to the part of the world that they covered. Europe is the

part of the world that received the most interest, while fewer studies focused on less or other more economically developed countries. Thirty-one studies considered the whole world.

Before concluding this section, a word on the type of migrant that studies focused on. In general, studies did not distinguish between different types of migrants, e.g. reason for migration, type of residence, other individual characteristics. Studies that relied on net migration overall make less distinctions than those who look at separate flows, which as we saw corresponded to about half of all selected studies. Studies that included a storyline (mostly those focusing on migration and with exploration as purpose) tended to discuss more thoroughly the potential impact of different types of migration, often discussing the implication of forced migration, either because of political reasons or climate change. The implications of economic migration were also discussed. However, these studies did not necessarily establish boundaries or scenarios for different types of migrants and migration. We do note four studies which strictly considered the impact of climate change on migration (without considering other influences) (Brown, 2008; Cameron, 2018; Marchiori et al., 2012; United Kingdom’s Government Office for Science, 2011), one that strictly considered labour migrants (Groenewold & de Valk, 2016), and one that distinguished between different origins (European vs. not European) (Armstrong & Van de Ven, 2016).

Table 9 Regions of focus in migration scenarios^{a,b}

Region of focus	Count
Europe	49
Other more economically developed countries	20
Less economically developed countries	19
World	31

^a Europe refers to its geographic denomination (not political) and may include the United Kingdom and the European part of Russia

^b Other more economically developed countries refer to the United States, Canada, Australia, New Zealand South Korea and Japan. Less economically developed countries are any country that is not within Europe or other more economically developed countries.

5 Discussion

In this study we reviewed the existing literature on migration scenario’s and aimed to understand how they can be characterized as well as what is covered. We did so by an open exploration of the available literature taking differences in methods and scope into account. Two strands of future characterisations appear to dominate the literature on migration scenarios. One strand focuses primarily on topics other than migration but includes migration as one of the aspects and is mostly

quantitative; the other strand focuses specifically on the future of migration flows and is mostly qualitative. Both aim to explore what could happen in the future, rather than trying to predict what will happen or establish how a given target could be reached. The first strand of characterisations includes studies that aimed at determining the effect of different migration scenarios on a future population with respect to its size, composition by age, workforce or economic output. These studies often start from a baseline migration scenario which either rests on past migration trends or suppose constant migration with respect to a baseline year. They then develop two or more alternate scenarios that correspond to an arbitrarily chosen ratio of the baseline scenario (e.g. low and high variants). These scenarios usually consider net migration and concentrate on a single (often economically more developed) destination country. This approach can be seen as a sensitivity analysis where researchers test the sensitivity of a given phenomenon (like populations size or composition) to different assumptions about migration. Though useful in its own right, this class of scenarios provide little insight into how migration might actually evolve in the future, or into how to build better scenarios that would provide such insights.

The second group of future characterisations – with a focus on migration and with the purpose to explore what could happen in the future – consisted mostly of qualitative studies along storylines of different plausible futures. When building these scenarios authors often relied on insights from experts and stakeholders to generate input. These scenarios often concentrate on migration flows between two regions including different countries (for example between northern Africa and European countries) or discuss the general state of migration in the world by discussing the potential role of larger regions, often continents. Overall, there seems to be an emphasize on north/western Europe as destination countries even though this has been contested in recent studies where it has been shown that almost all countries are both destination and origin countries. These scenarios potentially offer better insights into how migration might evolve in the future for they thoroughly discuss the key factors influencing migration and take into account the multiple forces at play. They often discuss the role of different migratory pressures, for example climate change and political instability, and take a more global take on migration than those characterisations part of the first class described above.

Having said that, both strands of literature still tend to (exclusively) focus on immigration and do not take emigration into account. The migration move is still seen as a one-in-a-lifetime event with an origin and destination where this has been shown to be inaccurate in the current connected world we live in. This static view ignores the fact that migration is a dynamic process, where moves may happen at different times in the life course of a person and includes immigration, emigration as well as potentially different types of onward moves (see De Jong & de Valk 2020). Additionally, still most studies aim to understand how many people are arriving (or leaving) rather than covering also who is arriving (or leaving). Getting more insight into the characteristics of those included in the migration flow is essential to understand the impact and challenges that can be related to it. Despite attempts at covering and estimating flows in terms of demographic characteristics, especially in the more qualitative approaches, more detail on who is moving would be an asset to refine views and scenarios of future migration flows. In this sense further connection between the two methodological approaches would also be useful to be better able to understand who is potentially moving (at the population level) and potential story lines on what migration

flows could look like from a more qualitative perspective. On a similar note, methods of the qualitative and quantitative studies could be linked further to potentially lend migration scenarios significantly more power in addressing future migration flows. In most of the studies that collected an own input (thus that did not rely on previous work), this was done in a workshop with experts and stakeholders. The resulting output is a set of narratives based on the participants' discussions. These narratives however do not lend themselves well to a quantitative treatment of the data. Only two studies relied on questionnaires to collect information among experts and stakeholders, while one study relied on the Delphi method (see CrossMigration project and related report Acostamadiedo et al. 2020). Interestingly enough, studies also find that overall, experts hold very different views on the future of migration and even in a Delphi setting are not more likely to adjust their view (e.g. Acostamadiedo et al. 2020). This implies that most may have formed their insights based on their specific experiences. A route that has not been explored yet is the use of for example vignette. In these types of studies people have to make a trade-off between different aspects that are randomly assigned to respondents. As such it could be an interesting and fruitful option for future characterisations. It is also a method that can be applied to both smaller and larger groups of respondents and in a factorial survey design that could also take characteristics of the respondents into account. In the second deliverable of the WP (7.2.) this route will be further explored.

Finally, in the reviewed documents by and large no distinction is made between different migration flows or between different types of migrants. Those few studies that did discuss different migration flows or movements among different types of migrants are usually qualitative, and it is unclear how the different types of migration that they discuss could be operationalized into quantifiable scenarios. Though this situation depends largely on the data that is available on migration, the increasing availability of new sources could be tapped into to offer a richer view of future migration flows (Willekens et al. 2016). In the same vein, moves within Europe may need to be better understood and included in migration scenarios than they are to date. Moves of EU nationals may have substantial demographic and economic impacts (on origin and destination regions) and moving of third country nationals within the EU is a potential source of changing populations and migration. These flows are despite their relevance and impacts largely ignored so far. Drivers of these migration moves need to be better understood also to capture them in more meaningful ways in scenarios.

This work provided a comprehensive overview of the use of migration scenarios in future characterisations with emphasis on what such scenarios are, how they are built, and which problems they were applied to. This work has been developed in a time where the COVID 19 pandemic was affecting lives in societies all around the world. It also clearly impacted mobility and migration due to restrictions and efforts to stop spreading of the virus. This new reality we are facing is unknown to our times and many aspects in life are uncertain. It is unclear what the long-term effects will be on migration to, from and within Europe. Uncertainty has become part of our daily lives in societies where it was thought everything including migration could be managed. One thing that is becoming even more clear in the current context is the usefulness of different scenarios. Different views on what may happen when it comes to amongst others migration, can help also responding accurately by policy makers as the different implications can be thought

through beforehand along the scenarios that are sketched. This report provided an overview of what we know and need to know and made suggestions for further improvement. It is clear that scenarios may become even more relevant and important to manage the uncertainties in the world today.

References

- Abel, G. J. (2018). Non-zero trajectories for long-run net migration assumptions in global population projection models. *Demographic Research*, 38, 1635–1662.
- Abel, G. J., Barakat, B., Samir, K. C., & Lutz, W. (2016). Meeting the Sustainable Development Goals leads to lower world population growth. *Proceedings of the National Academy of Sciences*, 113(50), 14294–14299.
- Acostamadiedo E, Tjaden J, Sohst R, de Valk H and Groenewold G (2020) Future European Migration Scenarios until 2030: Plausible, Probable and Relevant? CrossMigration project report. Berlin: IOM GMDAC.
- Ahlburg, D. A., & Vaupel, J. W. (1990). Alternative projections of the US population. *Demography*, 27(4), 639–652.
- Alvarez-Plata, P., Brücker, H., & Siliverstovs, B. (2003). *Potential migration from Central and Eastern Europe into the EU-15: An update*. European Commission, Directorate-General for Employment and Social Affairs. Berlin, DIW.
- Anderson, B., & Sheppard, J. (2010). Fiscal futures, institutional budget reforms, and their effects: What can be learned?. *OECD Journal on Budgeting*, 9(3), 7–117.
- Andreev, E., Scherbov, S., & Willekens, F. (1998). Population of Russia: What can we expect in the future?. *World Development*, 26(11), 1939–1955.
- Aral, M. M. (2020). Knowledge based analysis of continental population and migration dynamics. *Technological Forecasting and Social Change*, 151, 119848.
- Armstrong, A., & Van de Ven, J. (2016). The impact of possible migration scenarios after ‘Brexit’ on the state pension system. *Economies*, 4(4), 1–13.
- Ayadi, R., & Sessa, C. (2011). What Scenarios for the Euro-Mediterranean in 2030 in the Wake of the Post-Arab spring?. *MEDPRO Policy Papers*, (2), 1–5.
- Benton, M., & Patuzi, L. (2018). *Jobs in 2028: How Will Changing Labour Markets Affect Immigrant Integration in Europe?*. Brussels, Migration Policy Institute Europe.
- Berthou, A., Haincourt, S., de la Serve, M. E., Estrada, Á., Roth, M. A., & Kadow, A. (2019). *Assessing the macroeconomic impact of Brexit through trade and migration channels*. Occasional Paper 1911. Madrid, Banco de España.
- Bijak, J. & Czaika (2020). Assessing Uncertain Migration Futures: A Typology of the Unknown QuantMig Deliverable D1.1.
- Bijak, J., & Wiśniowski, A. (2010). Bayesian forecasting of immigration to selected European countries by using expert knowledge. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 173(4), 775–796.
- Bijak, J., Kicing, A., & Kupiszewski, M. (2013). International migration scenarios for 27 European countries, 2002–2052. In Bijak, J., Kicing, A., & Kupiszewski, M. (Eds.) *International migration and the future of populations and labour in Europe* (pp. 75–92). Dordrecht, Springer.
- Bijak, J., Kicing, A., & Kupiszewski, M. (2013). Population ageing, population decline and replacement migration in Europe. In Bijak, J., Kicing, A., & Kupiszewski, M. (Eds.) *International migration and the future of populations and labour in Europe* (pp. 75–92). Dordrecht, Springer.
- Bijak, J., Kupiszewska, D., Kupiszewski, M., Saczuk, K., & Kicing, A. (2007). Population and

- labour force projections for 27 European countries, 2002-052: impact of international migration on population ageing. *European Journal of Population/Revue Européenne de Démographie*, 23(1), 1-31.
- Bleha, B., Földházi, E., Šprocha, B., & Vaňo, B. (2014). Population projections for Hungary and Slovakia at national, regional and local levels. *Population projections developed within the project 'SEEMIG Managing Migration and Its Effects—Transnational Actions Towards Evidence Based Strategies'*.
- Böckenförde, M., & Braune, E. (2018). *Prospective Migration Policy: Scenario Building on Relations Between West Africa and Europe*. Bilingual Edition: English-French (Global Dialogues 15). Duisburg, Käte Hamburger Kolleg/Centre for Global Cooperation Research.
- Bonin, H., Raffelhüschen, B., & Walliser, J. (2000). Can immigration alleviate the demographic burden?. *FinanzArchiv/Public Finance Analysis*, 57(1), 1-21.
- Borgy, V., & Chojnicki, X. (2009). Labor migration: macroeconomic and demographic outlook for Europe and neighborhood regions. *Économie internationale*, 359(3), 115-153.
- Borgy, V., Chojnicki, X., Le Garrec, G., & Schwellnus, C. (2010). Macroeconomic consequences of global endogenous migration: a general equilibrium analysis. *Annals of Economics and Statistics*, 97/98, 13-39.
- Börjeson, L., Höjer, M., Dreborg, K.H., Ekvall, T. and Finnveden, G., (2006). Scenario types and techniques: towards a user's guide. *Futures*, 38(7), 723-739.
- Brown, O. (2008). *Migration and climate change*. Geneva, International Organization for Migration.
- Bruni, M. (2009). Demographic forecasts, migration and transition theory: A labor market perspective. *Papeles de población*, 15(62), 9-73.
- Butz, W. P., McCarthy, K. F., Morrison, P. A., & Vaiana, M. E. (1982). *Demographic challenges in America's future*. Santa Monica, The Rand Corporation.
- Byrne, S., & O'Brien, M. D. (2017). Understanding Irish labour force participation. *The Economic and Social Review*, 48(1), 27-60.
- Cafaro, P., & Dérer, P. (2019). Policy-based population projections for the European Union: A complementary approach. *Comparative Population Studies*, 44, 171-199.
- Cameron, M. P. (2018). Climate change, internal migration, and the future spatial distribution of population: A case study of New Zealand. *Population and Environment*, 39(3), 239–260.
- Campos, R. G., & Timini, J. (2019). *An estimation of the effects of Brexit on trade and migration*. Occasional Paper 1912. Madrid: Banco de España.
- Carter, T.R., Jones, R.N., Lu, X., Bhadwal, S., Conde, C., Mearns, L.O., O'Neill, B.C., Rounsevell, M.D.A., Zurek, M.B. (2007). New assessment methods and the characterisation of future conditions. In: M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, C.E. Hanson (Eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 133–171). Cambridge: Cambridge University Press.
- Casarico, A., & Devillanova, C. (2003). Social security and migration with endogenous skill upgrading. *Journal of Public Economics*, 87(3-4), 773-797.
- Coleman, D. (2010). Projections of the ethnic minority populations of the United Kingdom 2006–2056. *Population and Development Review*, 36(3), 441-486.
- Curtis, K. J., & Schneider, A. (2011). Understanding the demographic implications of climate change: estimates of localized population predictions under future scenarios of sea-level

rise. *Population and Environment*, 33(1), 28-54.

Davoudi, S., Wishardt, M., & Strange, I. (2010). The ageing of Europe: Demographic scenarios of Europe's futures. *Futures*, 42(8), 794-803.

De Haas, H. (2005). *Morocco's migration transition: Trends, determinants and future scenarios*. Geneva, Global Commission on International Migration.

De Haas, H. (2011). Mediterranean migration futures: Patterns, drivers and scenarios. *Global Environmental Change*, 21, S59-S69.

Döös, B. R. (1994). Environmental degradation, global food production, and risk for large-scale migrations. *Ambio*, 23 (2), 124-130.

Duwicquet, V., Mouhoud, E. M., & Oudinet, J. (2014). International migration by 2030: impact of immigration policies scenarios on growth and employment. *Foresight-The journal of future studies, strategic thinking and policy*, 16(2), 142-164.

Emerson, M., Busse, M., Di Salvo, M., Gros, D., & Pelkmans, J. (2017). *An assessment of the economic impact of Brexit on the EU27: Study*. Brussels, European Parliament Policy Department A: Economic and Scientific Policy.

ESPON, NIDI, CEFMR/IOM (multiple authors). 2009, 2010. Demographic and migratory flows affecting European regions and cities. DEMIFER project reports.

European Commission Joint Research Centre (2018). *Many more to come? Migration from and within Africa*. Luxembourg, Publications Office of the European Union.

European Commission. (2012). *Global Europe 2050*. Luxembourg, Publications Office of the European Union

European Political Strategy Centre. (2018). *The Future of Migration and Integration*. Brussels, European Political Strategy Centre

Fonseca, M. L., de Abreu, D., & Esteves, A. (2017). Ageing and Migration: Some Reflexions on the Effects of the Economic and Financial Crisis on Demographic Trends in Portuguese Regions. In Fonseca, M., & Fratesi, U. (2017). *Regional Upgrading in Southern Europe* (pp. 265–298). Cham, Springer.

Friedrich-Ebert-Stiftung, Global Future and International Organization for Migration (2017). *Tomorrow's World of Migration*. Geneva, FES, Global Future, IOM.

Frontex. (2011). *Futures of Borders. A Forward Study of European Border Checks*. Warsaw, Frontex.

Frontex. (2016). *Risk Analysis for 2016*. Warsaw, Frontex.

Frühmann, J., & Jäger, J. (2010). Linking the earth's future to migration: Scenarios of environmental change and possible impacts on forced migration. In Afifi, T., & Jäger, J. (Eds.). *Environment, Forced Migration and Social Vulnerability* (pp. 247-262). Berlin: Springer.

Fuchs, J. (2001). Decomposing the effect of population ageing on labour supply. *Athens Journal of Social Sciences*, 2(2), 109-124.

Fuchs, J., Kubis, A., & Schneider, L. (2016). *Replacement migration from a labour market perspective: Germany's long-term potential labour force and immigration from non-EU member countries* (4). IAB-Discussion Paper. Nürnberg: Institut für Arbeitsmarkt- und Berufsforschung,

Gaßner, R., & Kosow, H. (2008). *Methoden der Zukunfts- und Szenarioanalyse*. Berlin, Institut für

Zukunftsstudien und Technologiebewertung.

Glazar, O., & Strielkowski, W. (2010). Turkey and the European union: possible incidence of the eu accession on migration flows. *Prague economic papers*, 3, 218 - 235.

Global Migration Futures. (2012). Using scenarios to explore future migration in the Horn of Africa & Yemen. Oxford, International Migration Institute

Global Migration Futures. (2013). Pacific Region: Drivers, Processes and Future Scenario of Migration. Oxford, International Migration Institute

Gonnot, J. P., Prinz, C., & Keilman, N. (1995). Adjustments of public pension schemes in twelve industrialized countries: possible answers to population ageing. *European Journal of Population*, 11(4), 371-398.

Groenewold, G., & De Beer, J. (2013). *Population Scenarios and Policy Implications for Southern Mediterranean Countries, 2010-2050*. MEDPRO Policy Paper No, 5.

Groenewold, G., de Beer, J., & Huisman, C. (2012). *Population Scenarios for South Mediterranean Countries 2010-2050*. MEDPRO Report No. 2.

Groenewold, W. G., & de Valk, H. H. (2016). Prospects of labour migration pressure in Algeria, Morocco, Tunisia and Turkey. *Genus*, 72(8), 1-20.

Gurrman, R., Petit, M. P., Duwicquet, V., Mouhoud, E. M., & Oudinet, J. (2014). International migration by 2030: Impact of immigration policies scenarios on growth and employment. *Foresight*, 16(2), 142-164.

Harrington, L. J., & Otto, F. E. (2018). Changing population dynamics and uneven temperature emergence combine to exacerbate regional exposure to heat extremes under 1.5 C and 2 C of warming. *Environmental Research Letters*, 13(3), 034011.

Heleniak, T., & Sanchez Gausson, N. (2016). *The impact of migration on projected population trends in Denmark, Finland, Iceland, Norway and Sweden: 2015–2080*. Stockholm: Nordregio

Johnson, S. (2020). *A Changing Nation: Population Projections Under Alternative Immigration Scenarios*. US Department of Commerce, US Census Bureau.

Keilman, N. (2008). European demographic forecasts have not become more accurate over the past 25 years. *Population and development review*, 34(1), 137-153.

Kippen, R., & McDonald, P. (1998). Achieving population targets for Australia: an analysis of the options. *People and Place*, 6(2), 11-23.

Kippen, R., & McDonald, P. (2004). Can increased immigration be a substitute for low fertility?. *People and Place*, 12(3), 18-28.

Kosow, H., & Gaßner, R. (2008). *Methods of future and scenario analysis: overview, assessment, and selection criteria* (Vol. 39, p. 133). DEU.

Kwok, C. L., Lloyd, C. J., & Yip, P. S. (2013). Aging population scenarios: an Australian experience. *Journal of Population Research*, 30(4), 335-345.

Lachmanová, L. and Drbohlav, D., 2004. The Probable Future Development of European East-West Migration (The Delphi Method Revived). *European Spatial Research and Policy*, 11(1), 135-156.

Lanzieri, G. (2013). *Long-term contribution of migration in ageing populations: Japan compared with Europe*. Luxembourg, Publications Office of the European Union.

Lisenkova, K., Mérette, M., & Sanchez-Martinez, M. (2014). The long-term economic impact of

reducing migration in the UK. *National Institute Economic Review*, 229(1), R22–R30.

Liu, W., Sun, F., Lim, W. H., Zhang, J., Wang, H., Shiogama, H., & Zhang, Y. (2018). Global drought and severe drought-affected populations in 1.5 and 2 C warmer worlds. *Earth System Dynamics*, 9(1), 267–283.

Lomax, N., Wohland, P., Rees, P., & Norman, P. (2020). The impacts of international migration on the UK's ethnic populations. *Journal of Ethnic and Migration Studies*, 46(1), 177–199.

Lutz, W., & Scherbov, S. (1998). An expert-based framework for probabilistic national population projections: The example of Austria. *European Journal of Population/Revue Européenne de Démographie*, 14(1), 1–17.

Lutz, W., Amran, G., Bélanger, A., Conte, A., Gailey, N., Ghio, D., Grapsa, E., Jensen, K., Loichinger, E., & Marois, G. (2019). *Demographic Scenarios for the EU: Migration, population and education*. Luxembourg, Publications Office of the European Union.

Lutz, W., Goujon, A., Kc, S., Stonawski, M., & Stilianakis, N. (2018). *Demographic and human capital scenarios for the 21st century: 2018 assessment for 201 countries*. Luxembourg, Publications Office of the European Union.

Lutz, W., Sanderson, W., & Scherbov, S. (1997). Doubling of world population unlikely. *Nature*, 387(6635), 803–805.

Marchiori, L., Maystadt, J.F., & Schumacher, I. (2012). The impact of weather anomalies on migration in sub-Saharan Africa. *Journal of Environmental Economics and Management*, 63(3), 355–374.

Marois, G., Bélanger, A., & Lutz, W. (2020). Population aging, migration, and productivity in Europe. *Proceedings of the National Academy of Sciences*, 117(14), 7690–7695.

Marois, G., Sabourin, P., & Bélanger, A. (2019). How reducing differentials in education and labor force participation could lessen workforce decline in the EU-28. *Demographic Research*, 41, 125–158.

McDonald, P. F., & Temple, J. (2010). *Immigration, Labour Supply and Per Capita Gross Domestic Product; Australia 2010–2050*. Canberra: Australian Demographic and Social Research Institute, Department of Immigration and Citizenship.

Merkens, J. L., Lincke, D., Hinkel, J., Brown, S., & Vafeidis, A. T. (2018). Regionalisation of population growth projections in coastal exposure analysis. *Climatic Change*, 151(3–4), 413–426.

Merkens, J.-L., Reimann, L., Hinkel, J., & Vafeidis, A. T. (2016). Gridded population projections for the coastal zone under the Shared Socioeconomic Pathways. *Global and Planetary Change*, 145, 57–66.

Mixed Migration Centre (2019). Mixed migration in West Africa in 2030: results from the mixed migration scenario building workshop.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Prisma Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS med*, 6(7), e1000097.

Morefield, P. E., Fann, N., Grambsch, A., Raich, W., & Weaver, C. P. (2018). Heat-related health impacts under scenarios of climate and population change. *International journal of environmental research and public health*, 15(11), 2438.

Morgenroth, E. (2018). *Prospects for Irish regions and counties: scenarios and implications*. Dublin, Economic and Social Research Institute.

- Mountford, A., & Rapoport, H. (2016). Migration policy, African population growth and global inequality. *The World Economy*, 39(4), 543–556.
- Neumann, B., Vafeidis, A. T., Zimmermann, J., & Nicholls, R. J. (2015). Future coastal population growth and exposure to sea-level rise and coastal flooding—a global assessment. *PloS One*, 10(3), e0118571.
- OECD. (2009). *The Future of International Migration to OECD Countries*. Paris: OECD Publishing.
- OECD. (2016). *Perspectives on Global Development 2017 International Migration in a Shifting World*. Paris: OECD Publishing.
- O'Neill, B. C., Kriegler, E., Ebi, K. L., Kemp-Benedict, E., Riahi, K., Rothman, D. S., ... & Levy, M. (2017). The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. *Global Environmental Change*, 42, 169–180.
- Pendall, R., Martin, S., Astone, N., Nichols, A., Hildner, K. F., Stolte, A., & Peters, H. E. (2015). *Scenarios for regional growth from 2010 to 2030*. Washington: The Urban Institute.
- Popper, R. 2008. Foresight Methodology. In Georghiou, L., Cassingena Harper, J., Keenan, M., Miles, I., Popper, R (Eds.) (2008). *The Handbook of Technology Foresight* (pp. 44–88). Cheltenham: Edward Elgar.
- Punch, A. (2005). Ireland's growing population – an emerging challenge. In Reynolds, B., & Healy, S. (Eds.). (2005). *Securing fairness and wellbeing in a land of plenty*. CORI Justice Commission.
- Reed, H., & Stark, G. (2018). *Forecasting Child Poverty in Scotland*. Edinburgh: Scottish Government
- Rees, P. (1987). How many old people will there be in the United Kingdom and where will they live?. *Espace Populations Sociétés*, 5(1), 57–72.
- Rees, P., van der Gaag, N., de Beer, J. and Heins, F., 2012. European regional populations: Current trends, future pathways, and policy options. *European Journal of Population*, 28(4), 385–416.
- Robson, W. B., & Mahboubi, P. (2018). *Inflated Expectations: More Immigrants Can't Solve Canada's Aging Problem on Their Own E-Brief*, 274. Toronto: CD Howe Institute.
- Samir, K. C., & Lutz, W. (2014). Demographic scenarios by age, sex and education corresponding to the SSP narratives. *Population and Environment*, 35(3), 243–260.
- Samir, K. C., & Lutz, W. (2017). The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100. *Global Environmental Change*, 42, 181–192.
- Sánchez-Montijano, E., Kaya, A., & Sökmen, M. J. (2018). *Highly Skilled Migration between the EU and Turkey: Drivers and Scenarios*. FEUTURE Online Paper, 21.
- Schwarzwälder, J., & Thode, E. (2014). *Harnessing European Labour Mobility: Scenario analysis and policy recommendations*. Berlin: Bertelsmann Stiftung.
- Shaw, C. (2001). United Kingdom population trends in the 21st century. *Population Trends*, 103, 37–46.
- Shaw, C., Crujisen, H., De Beer, J., & De Jong, A. (1997). Latest population projections for the European Union. *Population Trends*, 90.
- Shaw, C., Crujisen, H., De Beer, J., & De Jong, A. (1997). *Population Trends 90, Latest population projections for the European Union*. London: Office for National Statistics.
- Sohst, R.R., Dag Tjaden, J., de Valk, H. & Melde, S. (2020). CrossMigration Deliverable 9.1: A

systematic review of the literature on migration scenarios and forecasting. Work Package 9: Migration Scenarios.

Stiller, S. (2000). *Demographic change and consumption: A long-term simulation analysis*, HWWA Discussion Paper (No. 99). Hamburg, Institute of International Economics.

Szczepanikova, A., & Van Criekinge, T. (2018). *The future of migration in the European Union*. Luxembourg, Publications Office of the European Union

Thu Hien, D., Docquier, F., Maurel, M., & SCHAUS, P. (2018). *Global Migration in the 20th and 21st Centuries: The Unstoppable Force of Demography*. Lyon, Hyper Articles en Ligne

Turton, H., & Hamilton, C. (1999). *Population Growth and Greenhouse Gas Emissions*. Australia Institute.

Tyers, R., & Shi, Q. (2007). Demographic change and policy responses: Implications for the global economy. *World Economy*, 30(4), 537-566.

UK Economic Outlook. (2017). How might lower EU migration affect the UK economy after Brexit?. London, Price Waterhouse Coopers

United Kingdom's Government Office for Science. (2011). *Migration and Global Environmental Change: Future Challenges and Opportunities*. London, The Government Office for Science.

United Nations (2001). Replacement migration: Is It a Solution to Declining and Ageing Populations?. United Nations Publications

US Environmental Protection Agency. (2009). *Land-use scenarios: National-scale housing-density scenarios consistent with climate change storylines (Final Report)*. Washington, Office of Research and Development

US Environmental Protection Agency. (2017). *Updates to the demographic and spatial allocation models to produce integrated climate and land use scenarios (Iclus)(Version 2)*. Washington, Office of Research and Development

Vah Jevsnik, M., & Toplak, K. (2014). Foresight as a method in migration studies. *Dve domovini-two homelands*, 40, 139-146.

Van der Mensbrugge, D. (2006). The Potential Gains from International Migration. *Global Economic Prospects: Economic Implications of Remittances and Migration 2006*.

Vezzoli, S., Bonfiglio, A., & De Haas, H. (2017). Global migration futures: Exploring the future of international migration with a scenario methodology.

Vollset, S. E., Goren, E., Yuan, C. W., Cao, J., Smith, A. E., Hsiao, T., ... & Dolgert, A. J. (2020). Fertility, mortality, migration, and population scenarios for 195 countries and territories from 2017 to 2100: a forecasting analysis for the Global Burden of Disease Study. *The Lancet*, 396(10258), 1285-1306.

Walmsley, T., Aguiar, A., & Ahmed, S. A. (2011). Migration and Growth in East and South-East Asia [Paper presentation]. The 14th Annual Conference on Global Economic Analysis, Venice, Italy.

Willekens, F., Massey, D., Raymer, J., & Beauchemin, C. (2016). International migration under the microscope. *Science*, 352(6288), 897-899.

Wilson, T., & Rees, P. (2003). Why Scotland needs more than just a new migration policy. *Scottish Geographical Journal*, 119(3), 191-208.

World Bank. (2006). *Global economic prospects 2007: managing the next wave of globalization*. Washington, World Bank.

Yucesahin, M. M., & KC, S. (2015). Demographic and human capital heterogeneity in selected provinces of Turkey: A scenario analysis using multi-dimensional population projection model. *Economics and Sociology*, 8(3), 215–244.

Zinkina, Y. V., Shulgin, S. G., Aleshkovski, I. A., & Andreev, A. I. (2018). Some implications of the changes in the world population distribution: How globalized will the world remain?. *RUDN Journal of Sociology*, 18(2), 271-283.

Appendix

Table A1 Query terms used in each search

Search engine	Search no.	Query terms
Scopus	1	(TITLE-ABS-KEY (population* OR demograph*) w/3 scenario and *migration AND NOT *ware AND NOT *planet* AND NOT animal AND NOT gene* AND NOT species* AND NOT fish*)) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English"))
	2	(TITLE-ABS-KEY (migration w/1 scenario AND NOT *ware AND NOT *planet* AND NOT animal AND NOT gene* AND NOT species* AND NOT fish*) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English"))
Web of science	1	TS=((population* OR demograph*) NEAR/3 scenario AND migration NOT (*planet* OR animal OR gene* OR species OR fish* OR *ware*)) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article OR Book Chapter)
	2	TS=(migration NEAR/1 scenario NOT (*planet* OR animal OR gene* OR species OR fish* OR *ware*)) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article OR Book Chapter)
Google	1	("population scenario" migration) OR ("demograph* scenario" migration) -planet* -animal -gene* -species -fish* - software -hardware
	2	"migration scenario" -planet* -animal -gene* -species -fish* - software - hardware

* Indicates truncation

AND, NOT, OR and the minus sign (-) are Boolean operators that allow for different combinations of words in a single search.

NEAR/# and w/# indicate where different words should appear with respect to each other.

Apostrophes (" ") indicate that an expression must appear as such in the document.

Supplementary Material A2: List of questions used for data extraction

1. Is the focus on migration as outcome? (Choose one)
 - a. If yes: Type "1" under **1.1 Focus migration**
 - b. If no: Write down what the focus is under **1.2 Focus other**
2. What is the purpose of the future characterization? (Choose one)
 - a. If purpose is prediction: Type "1" under **2.1 Prediction**
 - b. If purpose is to evaluate how a target can be reached: Type "1" under **2.2 Target**
 - c. If purpose is neither prediction nor the evaluation of how a target can be reached: Type "1" under **2.3 Exploration**
3. Are the outcomes of the future characterization presented in terms of quantities?
 - a. If yes: Type "1" under **3. Quantitative**
4. Does a storyline underpin the different scenarios?
 - a. If yes: Type "1" under **4. Qualitative**
5. If 3. = yes: Are the outcomes determined by time series analysis?
 - a. If yes: Type "1" under **5. Time series**
6. Do the authors assign a likelihood to the realization of each scenario/express preference for the realization of one scenario over another?
 - a. If yes: Type "1" under **6. Likelihood**
7. Were the scenarios developed based on participatory work (i.e. input from experts/stakeholders)?
 - a. If yes: Type "1" under **7. Participatory**
8. Were the scenarios developed based on previous work?
 - a. If yes: Type "1" under **8.1 Previous work**
 - b. If yes: Type the name of the previous work under **8.2 Previous work name**

How is migration modelled? (Choose one)

- a. If net migration: go to 9.
 - b. If migration flows: go to 10.
9. What is the area of focus?
 - a. Type the name of the area of focus under **9. Area**
 10. Are flows between two areas or multiple (more than two) areas? (Choose one)
 - a. If two areas: type the name of the sending area under **10.1 Sending** and type the name of the receiving area under **10.2. Receiving**

-
- b. If multiple areas: type the geographic denomination that includes all the areas considered under **10.3 Multiple**
11. What is/are the geographical level(s) of analysis? (Choose one, two or three)
- a. Larger than countries: type "1" under **11.1 Supra**
 - b. Equal to countries: type "1" under **11.2 National**
 - c. Smaller than countries: type "1" under **11.3 Sub**
12. Are all kinds of migrants / all kinds of causes for migration considered?
- a. If no: type the specific kind(s) of migrants / specific kind(s) of causes for migration under **12. Kind**

Table A3 Complete overview of the selected studies with respect to their focus, purpose, approach and techniques

Category 1: migration as focus and prediction as purpose

Reference	past trends	likelihood	participatory	previous work
Approach: Mixed				
Lachmanova & Drbohlav 2004	-	+	+	-
Bijak & Wisniowski 2010	+	-	+	-
Glazar & Strielkowski 2010	+	+	-	-
Bijak et al. 1 2013	-	-	-	-
Approach: Quantitative				
Borgy et al. 2010	-	-	-	
Campos & Timini 2019	+	-	-	

Category 2: migration as focus and exploration as purpose

Approach: Qualitative				
Doos 1994		-	-	-
de Haas 2005		-	-	-
EACH-FOR 2009		-	-	-
OECD 2009		-	-	-
Fruhmann & Jager 2010		-	-	-
Ayadi & Sessa 2011		-	-	-
Haas 2011		-	-	+
United Kingdom's Government Office for Science 2011		-	+	-
Frontex 2011		+	-	-
Global Migration Futures 2012		-	-	-
Global Migration Futures 2013		-	+	-
Vah Jevsnik & Toplak 2014		-	+	+
Bertelsmann Stiftung 2014		-	-	-
Frontex 2016		-	+	-
OECD 2016		-	-	-
Friedrich-Ebert-Stiftung 2017		-	+	-
Bockenforde & Braune 2018		-	+	-
Szczepanikova & Van Criekinghe 2018		-	+	-
EPSC 2018		-	-	-
Mixed Migration Centre 2019		-	+	-
Joint Research Centre 2020		-	-	-

Category 4: other topics than migration as focus and prediction as purpose

Approach: Mixed				
Brown 2008	-	-	-	+
Fonseca et al. 2017	-	-	+	-
Thus Hien Dao et al. 2017	+	-	+	+
European Commission 2018	-	-	-	-
Approach: Quantitative				
Rees 1987	+	-	-	
Ahlburg & Vaupel 1990	+	-	-	
Lutz et al. 1997	-	+	+	
Shaw et al. 1997	+	-	-	
Andreev et al. 1998	-	-	-	
Hal & Clive 1999	+	-	-	
Stiller 2000	-	-	-	
Shaw 2001	-	-	-	
World Bank 2006	+	-	-	
Anderson & Sheppard 2009	-	-	-	
Coleman 2010	-	-	-	
Lanzieri 2013	+	-	-	
Bleha et al. 2014	-	-	-	
Yucesahin & K.C. 2015	-	-	-	
Abel 2018	+	-	-	
Morgenroth 2018	-	-	-	
Harrington et al. 2018	+	-	-	
Zinkina et al. 2018	+	-	-	
Aral 2020	+	-	-	
Johnson 2020	+	-	-	
Lomax et al 2020	+	-	-	
Vollset et al. 2020	+	-	-	
Approach: Qualitative				
Cafaro & Derer 2019		-	-	-

Category 5: other topics than migration as focus and exploration as purpose

Approach: Mixed				
Wilson & Rees 2003	+	-	-	-
U.S. EPA. 2009	-	-	-	-
ESPON 2010	+	-	-	-
Groenewold et al. 2012	+	-	-	-
Rees et al 2012	+	-	-	-
Abel et al. 2016	+	+	-	+
Mountford and Rapoport 2016	+	-	-	-
Sanchez Gassen & Heleniak 2016	+	-	-	-
U.S. EPA. 2017	-	-	-	+
Cameron 2018	+	-	-	+
Lutz et al 2018	+	-	-	-
Morefield et al. 2018	+	-	-	+
Wenbin et al. 2018	+	-	-	+
Lutz et al. 2019	+	-	-	-
Marois et al. 2019	+	-	-	-
Approach: Quantitative				
Gonnot et al. 1995	-	-	-	
Fuchs 2001	-	-	-	
Casarico & Devillanova 2003	-	-	-	
Van der Mensbrugge 2006	+	+	-	
Bijak et al. 2007	-	-	-	
McDonald & Temple 2010	-	-	-	
Walmsley et al. 2011	-	-	-	
Kwok et al. 2013	-	-	-	
Lisenkova et al. 2013	-	-	-	
Fuchs et al. 2016	-	-	-	
Byrne & O'Brien M 2017	+	-	-	
Reed & Stark 2018	-	-	-	
Berthou et al. 2019	-	-	-	
Marois et al. 2020	-	-	-	
Approach: Qualitative				
Butz 1982		-	-	-
Benton and Patuzzi 2009		-	-	-
Davoudi et al. 2010		-	-	-

European Commission 2012		-	+	-
Groenewold & de Beer 2013		-	-	-
Groenewold et al 2016		-	-	-

Category 6: other topics than migration as focus and establishing how a target can be reached as purpose

Approach: Mixed				
Tyers & Shi 2007	+	-	-	-
Borgy & Chojnicki 2009	-	-	-	+
Bruni 2009	+	-	-	+
Curtis & Schneider 2011	+	-	-	-
Duwicquet et al. 2014	-	-	-	-
Neumann et al. 2015	+	-	-	+
Armstrong & Van de Ven 2016	-	-	-	+
Merkens et al. 2016	-	-	-	+
UK Economic Outlook 2017	+	-	-	-
Approach: Quantitative				
Kippen & Mcdonald 1998	-	-	-	
United Nations 2001	-	-	-	
Kippen & Mcdonald 2002	-	-	-	
Bijak et al. 2 2013	-	-	-	
Robson & Mahboubi 2018	-	-	-	

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