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Demography and climate change

EU in the global context

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Contents

Abstract

Demography is intimately related to both climate change adaptation and mitigation. The report focuses on demography and climate mitigation through analyses of trajectories for emissions and population at global and EU levels. At the global level, the report highlights the role of population momentum. While population growth implies almost by definition higher emissions, at least in the short term, the intrinsic inertia in demographic processes implies that solutions to reduce emissions need to come from reducing inequalities, the greening of the economy and a change in consumption rather than from interventions on fertility. At the EU level, the report finds that although in absolute terms older people emit less, they have higher per capita emissions, a greater share of their emissions is concentrated in carbon-intensive consumption items and they are less likely to change their attitudes or behaviour towards more environmentally friendly patterns. Considering the trends for the ageing of the EU population, these intergenerational differences in consumption and attitudes add a new policy challenge to the already pressing need to reduce the differences in responsibilities for emissions linked to income.

Foreword

Our Europe is constantly evolving. Today, two of the most significant megatrends are population growth and climate change. They are trends that cannot be seen day-to-day, or even year-to-year. In a world where only fast-moving trends catch the eye, they tend to pass unnoticed. It often falls to scientists to explain their implications, and to point to the fundamental transformations that they will eventually bring.

The report that follows, written by the Joint Research Centre at the European Commission, takes a close look at both trends, and of the manner in which they interact. It examines how changes in the structure and size of populations will impact our efforts to reduce greenhouse gas emissions, mitigate climate change, and promote environmental sustainability, by looking at trends such as age, gender, education and the composition of the working population.

It shows that despite the slow rate of change, these demographic factors must be included in our efforts to reach carbon neutrality by the year 2050. Levels of education, geographical distribution, and inter-generational change are shown to be especially important, as they exert significant influence on attitudes to climate change. The report clearly demonstrates how younger generations, people who are highly educated and residents of large towns are more aware of the problem of climate change, and more open to changing their behaviour, with education being the single strongest factor.

Climate Change and Demography reminds us that even under optimistic scenarios, where the Paris target of limiting global average temperature increases to 1.5 degrees is met, considerable challenges will remain. There will be temperature and precipitation extremes, more tropical storms, and a significant rise in sea levels. And demographic factors will play a major role in our efforts to adapt to climate change.

Not everybody will be affected in the same manner, with some societies and some sectors of society significantly more vulnerable than others. Wealthy populations with high education levels tend to have more efficient institutions and better public health systems, and effective early warning systems. As the dangers of climate change grow over time, these demographic effects will become increasing noticeable. This underlines the importance of looking beyond mitigation, and of factoring demographic trends into long-term adaptive capacity.

For policymakers, there are many important implications in the knowledge that follows. When combined with reports with a broader environmental scope [1]), they serve as an urgent reminder of the need for policies that are not only green and transformational, but inclusive as well. Our green future will need to be built – by citizens and for citizens, leaving no one behind. Unforeseen training needs will need to be met, and fiscal policies will need to be adapted to avoid growing disparities.

Designing effective policies requires a clear understanding of the target audience. This report points to a picture that is shifting, and we will study its lessons with care. It will help improve our understanding of the interplay between populations, climate, biodiversity and environmental change, and of the need for well-designed policies that help Europe adapt to the complex changes ahead.

Europe is evolving – and with good policymaking, we can steer it to a sustainable, inclusive future.

Dubravka Šuica
Vice-President
Democracy and Demography

Virginijus Sinkevičius
Commissioner
Environment, Oceans and Fisheries

[1] The EU Environmental Foresight System (FORENV) – Final report of 2021-22 annual cycle – Emerging environmental issues due to demographic changes in the EU, Publications Office of the European Union, Luxembourg, 2023 ISBN 978-92-76-60198-2,

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Executive summary

The defining role of population in climate change re-emerged in November 2022 when the world population reached of the symbolic milestone of 8 billion. Besides affluence and technology, population is the third factor in the equation determining global emissions.

The relationship between demography and climate change can be seen from two directions. On one side, population size and demographic characteristics influence emissions and mitigation efforts. On the other side, populations are impacted by climate change, and demographic characteristics are among the fundamental aspects that need to be considered when assessing the exposure and vulnerability, as well as climate change adaptation options.

This report focuses on the mitigation side of the relationship and provides analyses of trajectories of emissions and population at the global and EU levels.

While the alarmist views of exponential population growth, which characterised the debate in the 1970s, are by now mostly superseded, the discussions about the role of population growth on emissions continue to shift between different viewpoints. One indicates that each person on an already crowded planet will almost by definition increase overall emissions, a second one emphasises the need to address income inequalities within and across regions, and a third one believes in the role of disruptive innovations in overcoming the sustainability challenges posed by economic and population growth.

The slowdown of population growth, the prevailing role assigned to income and techno-optimism should not come at the expense of a more encompassing consideration of demographic factors in climate change mitigation efforts. Some demographers have lamented that the population is often considered as an accessory only or just as an exogenous input in the energy and economic models of climate change. Actually, demography is barely mentioned, or not adequately considered, in the toolbox of climate mitigation and adaptation policies.

In an effort to raise awareness of the role of demography in climate change, this report, with a mix of empirical analyses, literature review, policy mapping and foresight, addresses a series of key questions relating to the impacts that demographic change in the EU and at the global level have on emissions.

What is the role of per capita greenhouse gas emissions across main world regions as compared to trends in population, technologies and economic growth? How are these trends decoupled from emissions?

The growth of the world population over the medium term is driven by the youthful age structure of some world populations, which stems from past high fertility. The so-called demographic momentum implies that some of the further growth of the total population in the coming decades is already pre-programmed in the age structure of the population, even if fertility is at a replacement level. Therefore, immediate solutions to reduce emissions until 2050 must come primarily from the greening of the world economy and a change in per capita consumption.

This does not mean that changes in the global population size are irrelevant. In the longer term, population size will matter greatly in terms of vulnerability and population's capacity to adapt to the already unavoidable climate change. Considering future emissions, the population size of the current low-emission countries will make a big difference as their economies grow and consumption levels rise. Both of these issues require more careful studies in terms of their implications for sustainability.

Within the general trend of global population growth, it is key to take into account regional differences in the demographic structure and the relations between population dynamics and urbanisation, green transition and development. Future population growth will be concentrated in the regions of the world which have currently the lowest of per capita emissions and limited responsibility for past emissions (Figure 1). Although starting from this low level, these regions are expected to have the slowest progress in terms of decarbonisation, improvement in energy efficiency and decoupling of economic growth from emissions.

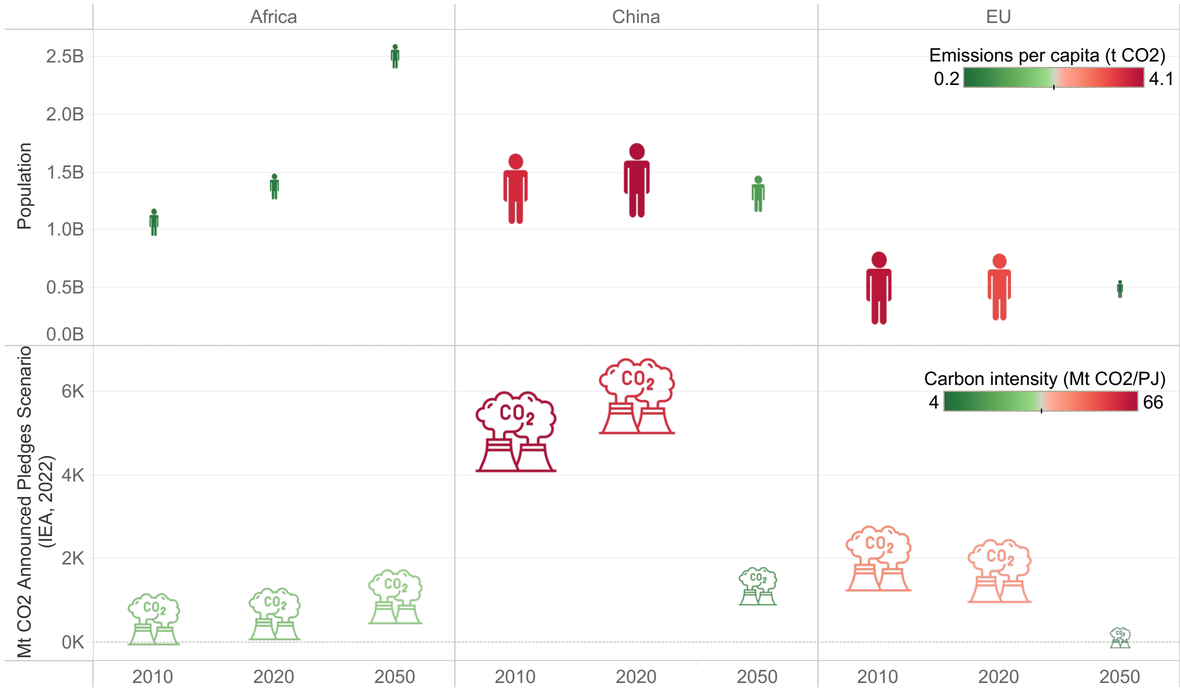

Figure 1 Population, emissions and carbon intensity

Source: own elaboration of energy and emission projections from IEA (2022) and population projections from UNDESA. See Chapter 1 for details. Notes: the size and the colour of the symbols reflect the emissions per capita and the carbon intensity (i.e., the ratio between emissions and energy).

The EU needs to continue its diplomatic efforts at the global level on climate action to guard its position as a role model for the international community. It lies with the EU and other affluent regions that have accounted for a large share of historic emissions to lead the coordination efforts to reduce energy intensity, develop green technology to decouple economic activity from burning fossil fuels and adopt more sustainable consumption patterns.

Policies supporting sustainable development through improvement in health, and education, as well as inequality and poverty reduction may slow population growth when carefully designed, but the international consensus on a common population and development agenda is waning. The EU could further intensify its support for strategies to reduce child and maternal mortality, provision of universal access to education, particularly of girls, gender equality, ending of child marriage, and provision of universal access to sexual and reproductive health and reproductive rights.

What will be the effect of ageing, shrinking household size, better education and urbanisation on emissions in the EU?

Despite having a marginal role in global population growth, the demographic dynamics in the EU are expected to play a role in the level of emissions through their impacts on consumption.

Overall, emissions follow closely the income and total expenditure age profiles. However, when neutralising the effect of income and when considering emissions in per capita terms, it is possible to observe that older people tend to emit on average more than younger generations (Figure 2).

In cities, emissions are lower thanks to so-called urban economies of scale (e.g., from the sharing of public transport). On the other hand, these efficiencies are contrasted by the higher income of urban residents, which normally translates in more consumption and emissions. In addition, when considering emissions in per capita terms, people in cities are penalised by the fact that households in cities tend to be smaller with respect to rural areas and therefore emissions are divided by a smaller number of family members.

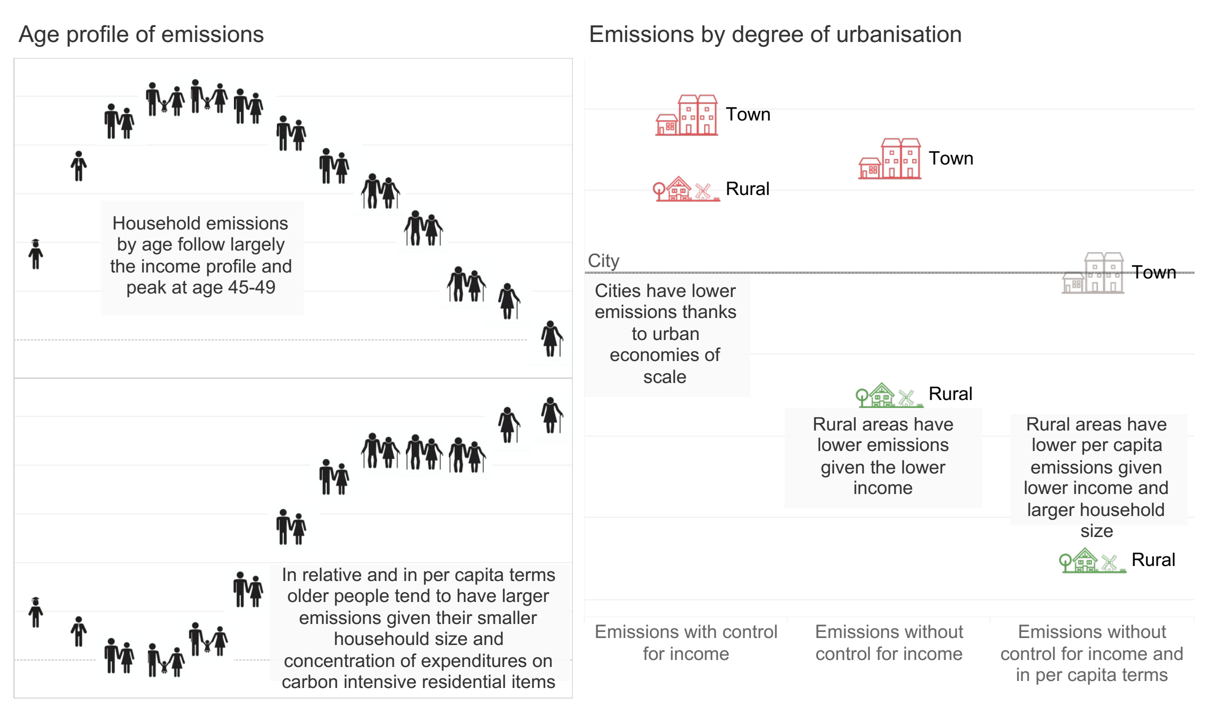

Figure 2 Effect on emissions in the EU from age and degree of urbanisation

Source: regressions based on Eurostat Household Budget Survey data (2015) and Exiobase multipliers. See Chapter 2 for details

In the next decades, despite the differences in consumption patterns across age profiles, the projected changes in the age structure of the EU population are not expected to lead to dramatic increases in emissions. The shift in the responsibility for emissions towards older generations is more relevant.

The fact that more and more emissions will be produced by older people who have fewer possibilities and predisposition to change their patterns of consumption poses the need to target mitigation policies particularly towards older generations.

How can sociodemographic differences in attitudes towards climate change impact the green transition through behavioural changes and political support?

In the EU, younger generations, highly educated persons, and residents of large towns and cities are more likely to believe that climate change is the most serious or very serious problem (Figure 3).

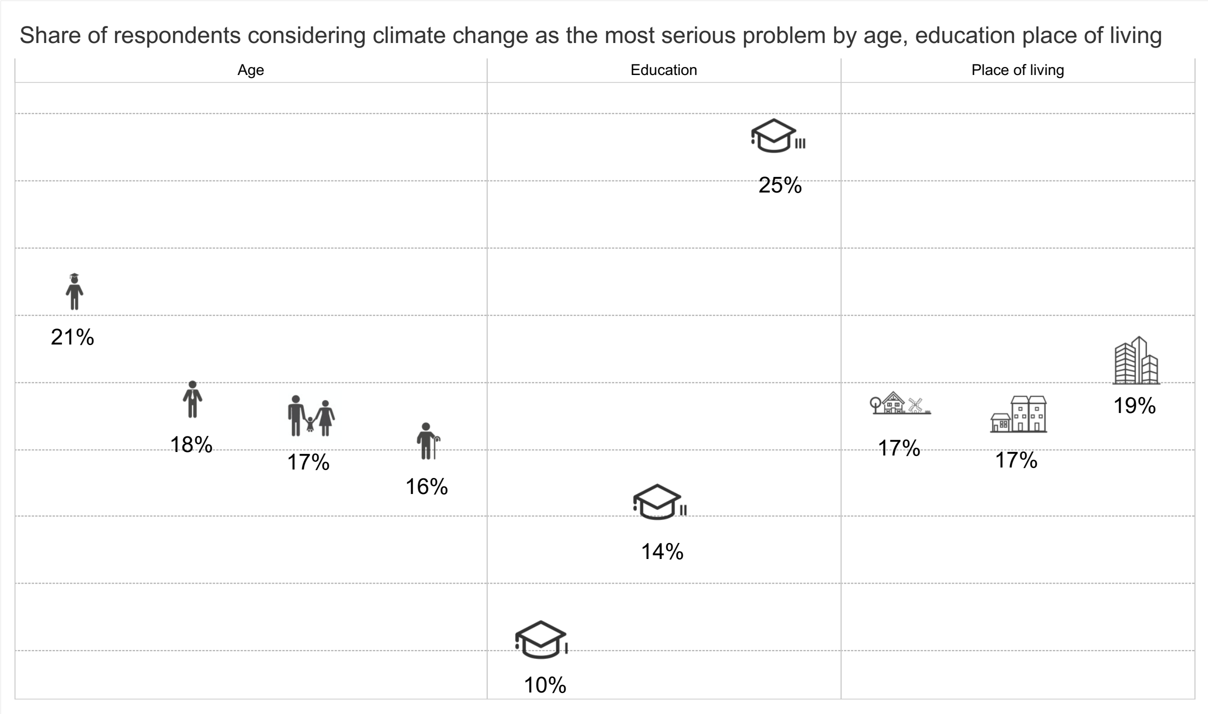

Figure 3 Concerns about climate change by age, education and place of living

Source: own elaboration of Eurobarometer data. See Chapter 3 for details

These sociodemographic differences in the concerns about climate change also translate into differences in reported personal behaviours.

In terms of trends analysed over the past decade, the perceived seriousness of climate change increased among EU citizens. The level of awareness of the severity of climate change varies less across age groups, than over time. This might indicate that individual perceptions of climate change are more determined by the ideas and beliefs that characterise particular periods in time, rather than the characteristics of specific generations.

Education is not only shaping the perception of climate change, but can also determine individual actions and the support for governmental climate strategies. Policy design on climate action should consider the changing age and education structures as well as the regional distribution of students. It should also include a strong focus to improve the overall level of environmental education.

How will uncertainties on the relationship between demography and climate change unfold considering foresight scenarios for the EU in a global context?

Demographic developments have an important role in relation to climate change, but at the same time, they are long-term trends that are difficult to influence.

Low-carbon innovation will be a central lever to reduce emissions and compensate for demographic trends. It will be of crucial importance to accelerate the transfer of green technologies to countries that have not yet created fossil fuel path dependencies.

Education, urbanisation and social cohesion have a fundamental role to play in the societal push for environmental action and sustainability. It is very important to understand and focus on how lifestyles can become more sustainable, as the green transition can be influenced largely by changes in lifestyles and individual behaviours.

Globally coordinated efforts are key for the global climate transition. Governments in regions that have the financial and technological capacities to be pioneers should capitalise on these and demonstrate that the climate transition is possible.

Overall conclusion

The findings of this report highlight the need to recognise that world regions are now at very different stages of their demographic transitions, with different implications for climate change.

In the EU, the focus is on the impact of ageing on changing consumption patterns and the differences in attitudes in relation to climate change across age groups. While these trends are not expected to cause a large increase in emissions, they highlight the need for policies aimed at addressing intergenerational inequalities.

The fact that throughout Europe the younger generations are better educated than the older ones - and more education comes with more environmental awareness and flexibility in changing consumer behaviour - is likely to be a demographic force accelerating the green transition in the EU.

At the global level, the EU could proactively support the advancement of the international agenda on population and development. In that context, it could further intensify the support for strategies to provide universal access to sexual and reproductive health and reproductive rights and to education, especially for girls.

Introduction

Background and policy context

On 15 November 2022, the world population reached the symbolic milestone of 8 billion. This occasion was marked by debates on the impact of population growth on environmental sustainability, the carrying capacity of the planet and climate change[2]. With population growth decreasing and with the population peak in sight, the trajectory of the global population is now more resembling the "S" shape of a logistic function rather than the exponential indefinite growth formulated by neo-Malthusians in the 1970s (see Figure 4).

Shifting from a concept of exponential growth to logistic growth does not mean that population is less relevant for climate change. Growth rates are applied to a much larger population than in the past and a growth rate of 1% for the population of 2022 means adding ten new cities, almost the size of New York, in one year. It is difficult to imagine how this expansion, which will continue at least until 2060, could not pose consequences to global efforts for climate mitigation and adaptation. On the other hand, the recognition that we are approaching a new era characterised by the stabilisation of population growth and, in the long run, by population decline brings new elements to the debate around the role of demography in climate change. This role is re-dimensioned especially when considering population against the backdrop of trajectories of energy consumption and economic growth still governed by expectations of exponential growth. At the same time, it becomes more important to consider the differences in trends across world regions and the specificities of demographic characteristics, besides just total population size and growth.

Variations in the stages of demographic transition across world regions pose different challenges to climate change mitigation

Within the general trend of growth of the global population, regions and countries in the world are positioned at different stages in a historical process of demographic transition. This process follows a well-defined path the alongside urbanisation development and industrialisation. Despite differences in the start and time and sometimes in the speed of transition, most countries are experiencing a characteristic shift from a level of high mortality and high fertility to a level of low mortality and low fertility. Many developing countries and a great part of Africa are still in the early stage of demographic transition and exhibit rapid population expansion with a marked young age structure. On the contrary, most industrialised countries and all EU Member States have completed the demographic transition and are now facing the challenges of ageing and of population decline.

The different growth rates and age structures of populations have implications for climate change mitigation efforts. By just looking at the limited population growth in advanced economies and the EU, demographic factors seem to play just a minor role in the debate about future global emissions. If anything, the demographic decline becomes an issue of concern for its macroeconomic impacts and possible consequences of stagnation. These concerns are for example reflected in the Communication "A Green Deal Industrial Plan for the Net-Zero Age" recently launched by the European Commission (2023c), where demographic change is mentioned alongside high inflation, labour shortages, and post-COVID supply chains disruptions, as one of the headwinds challenging the resilience of the EU industry.

A completely different perspective emerges when considering the projections for the expansion of the global population, which will be mostly concentrated in the African continent. The question here is how population growth can be reconciled with economic growth and a foreseeable increase in consumption towards the levels now enjoyed only by advanced economies.

From alarmist views to the downplaying of demography from global warming policies

While the alarmist views of exponential population growth are by now discarded by most analysts, also, the more moderate concerns about the impact of a still expanding world population are often minimised with the argument that ultimately emissions are more influenced by income rather than by population size itself. The shift of attention towards income is generally accompanied by trust in human ingenuity and in the role that technology can play in the efforts to decarbonise our economies. Some see in more people on the planet opportunities arising for the enrichment in human capital and diversity which will ultimately allow addressing the challenges faced by humanity (Goldin, 2014). Techno-optimists put trust in the force of innovation and tend to ignore the basic dependence of global economies on energy and in particular on the material needs of fossil

[2] See for example https://populationmatters.org/8-billion-people-and-counting/ and https://www.un.org/en/dayof8billion

fuels (Smil, 2022). At the extreme, futurists like Harari (2017) or Kurzweil (2001) invoke upcoming singularities such as digital transformation, artificial intelligence or the advent of fusion energy which will allow for the human species to continue along its path of exponential economic expansion, independently from population size and planetary boundaries.

The possible consequence of too-optimistic views dismissing population from the equation governing future emissions is that population policies get also ignored from the toolbox of instruments to address climate mitigation and adaptation. As provocatively stated in the title of an article by leading demographers, population risks being "left out in the cold" from global warming policy (Bongaarts & O'Neill, 2018). The arguments raised by these demographers are that population growth is not over, that population change is not destiny and that also small reductions in fertility through family planning policies could have tangible effects on emissions.

Part of the reason why population policies are left aside from the debates on environmental sustainability dates to the hostility towards coercive population control policies which developed in the period between 1974 and 1994 leading to the Cairo population conference (Coole, 2021). The consensus reached in Cairo and re-affirmed in the subsequent Framework of Actions for the follow-up to the Programme of Action of the International Conference on Population and Development (United Nations, 2014), represented a paradigm shift where the concerns of over-population and sustainability have been replaced by a strong focus on the centrality of individual human rights and dignity, universal access to sexual and reproductive health for sustainable development.

A key question raised by some authors nowadays is if these human rights principles cannot be also reconciled with efforts to stabilise the planet's human population for environmental reasons (Coole, 2021). According to these authors avoiding family planning policy for its controversial nature could mean renouncing to an important climate policy lever in the efforts to reach zero-net emissions; a goal, that given the urgency and the risks of environmental and human civilisation catastrophes, should be pursued with all possible instruments at our disposal.

A two-sided relation between demography and climate change in EU policies

EU policies contain several references about the relationship between demography and climate change considering both directions of the causal pathways moving from and to population (see Box 1 and

Box 2 and more details on the mapping exercise of EU policies in the Appendix to the Introduction). On the one side, climate adaptation policies and demography policies highlight the impacts of climate change and environmental degradation on the EU population in terms of exposure and vulnerability, and, on the other side, climate mitigation policies cater for the implications of the EU green transition for the different population groups with the main idea that no person and no place is left behind. Rather than on population size and growth, most of the demographic references in EU climate mitigation and adaptation policies are related to the need to cater for the vulnerability of an ageing population, low-income status and rural place of living.

Box 1 Role of demography in EU climate adaptation and demography policies

Climate change and demographic change are two global trends that impact one another. The European population is ageing rapidly. Eurostat projects that there will be close to half a million centenarians in the EU-27 by 2050 (Eurostat, 2023a). This shift in the age structure of the European population is happening in parallel with changes in climate. Increasingly frequent heatwaves, droughts and extreme weather events affect overall mortality rates, human well-being and people's livelihoods. In the context of an ageing population, older adults will become vulnerable and face challenges related to their health, housing, mobility as well as their capacity to deal with extreme weather. These interlinkages between climate change and demographic change represent both challenges and opportunities for the EU. Tackling them will require forward-looking policies, which protect vulnerable groups – in particular older persons.

The **EU Adaptation Strategy** (European Commission, 2013) stresses the unequal exposure of the EU population to the impacts of heatwaves, flooding, water scarcity, forest fires and sea-level rise. The strategy indicates that in regions with low GDP, a high proportion of people with low socio-economic status and a high percentage of older people live areas affected by high temperatures. The strategy identifies the ageing population as particularly vulnerable to climate change impacts. Flooding in cities and water scarcity are more frequently experienced in southern Europe, where more than half of the population lives in permanent water scarcity conditions.

Climate change is mentioned as a factor influencing human livelihoods and well-being in the EU initiatives, which aim to tackle the consequences of demographic change. The policy instruments highlight how the pressures created by the demographic change are exacerbated by climate change and environmental degradation. The **Commission Demography Reports 2020 and 2023** (European Commission, 2020b, 2023a) warned that global warming and environmental deterioration could have a major impact on demographic change, contributing to decreased life expectancy, increased mortality, chronic illnesses and people displacement.

The **Green Paper on Ageing** (European Commission, 2021d) emphasises that in the context of demographic change, there will be more older adults suffering from chronic diseases, while the effects of climate change, natural disasters and environmental degradation put disproportionate pressure on older people and their health. This will increase the need for healthcare services that are adapted for older adults and that are able to cope with the consequences of the changing climate. The **European Care Strategy** (European Commission, 2022) aims to respond to this challenge. It emphasises the need to adapt care settings so that they protect older people from climatic conditions such as heat waves.

Older people are not the only demographic group that is disproportionally affected by climate impacts. The **Strategy on the Rights of the Child** (European Commission, 2021c) underlines that climate change also exacerbates pre-existing forms of discrimination against children and makes them more exposed to vulnerable situations. The rights for children presented in the strategy include the right to live in a clean and healthy planet and the right to enjoy the natural environment. The strategy also highlights the opportunity for today's children, who are at the forefront of raising awareness of the climate crisis, to be leaders of tomorrow. The Education for Climate Coalition aims to help children become agents of change in the implementation of the **European Climate Pact** and the **EU Green Deal**.

The least industrialised regions are particularly vulnerable to the effects of climate change. The changing climatic conditions increase the vulnerability of farmers and rural communities, who face specific challenges related to climate change, including increasing heatwaves and droughts. The **Long-term Vision for Rural Areas** (European Commission, 2021b) indicates that rural areas will potentially bear greater costs linked to the climate transition. However, it also underlines that the natural resources of rural areas are key defining assets for building a sustainable future, and that rural areas play a key role in making the EU the first climate-neutral continent by 2050. In this context, supporting farmers, foresters and rural entrepreneurs who are the enablers of the transition towards a greener society is essential.

The **EU Rural Action Plan** identifies concrete areas for action to make rural areas more resilient to climate change. These include actions to increase the preservation of natural resources and the greening of farming activities and supply chains. The Commission's Communication on **Harnessing Talent in Europe's Regions** (European Commission, 2023b) recognises that the labour shortages that the EU as a whole has been confronted with could increase in the context of the transition towards climate neutrality, unless skills are aligned with the changing needs of the market. Disadvantaged regions, which already face the problem of intense departure of their young and skilled workforce, are likely to be more acutely impacted. The Communication proposes tools and strategies to address the loss of talent and skills in the most disadvantaged regions and outlines targeted measures to transform rural communities affected by population loss, ageing and a lack of economic opportunities into dynamic talent-driven locations.

Box 2 Role of demography in climate mitigation policies

Human populations are at the centre of the climate debate. Population growth and human activities contribute to increased greenhouse gas emissions. Demographic change and population ageing will lead to diverse consumption and emissions patterns. Climate change impacts different demographic groups and geographic areas differently. Older people, children living in poverty as well as populations in areas that are sensitive to climate impacts such as sea-level rise, are particularly vulnerable to climate change and environmental degradation. Embedding demographic considerations in climate policies, and understanding the diverse impact of climate change on different demographic and socioeconomic groups, is important for the design of climate mitigation policies that take into account the needs of the changing population.

The **European Green Deal** aims to transform the EU into a modern, resource-efficient and competitive economy. Its main objective is to ensure that there will be no net emissions of greenhouse gases by 2050, that economic growth is decoupled from resource use, and that no person and no place is left behind. This means that all Europeans should be able to benefit from the transition as fairly as possible.

Overall, the green transition is expected to bring positive impacts in terms of the economy and jobs, but the impacts will be felt differently by different socio-economic groups, economic sectors and countries. The European Commission has proposed a **Social Climate Fund**, which will provide funding to the EU Member States to support vulnerable European citizens. The Social Climate Fund is part of the EU's **Fit for 55 in 2030** package, i.e. the EU's plan to reduce greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, in line with the **European Climate Law**. It will benefit vulnerable households and transport users that are particularly affected by energy and transport poverty. Other policy measures also contain elements to increase the inclusiveness and social consciousness of EU climate policies. The **Energy Taxation Directive** offers possibilities to exempt vulnerable households from higher energy taxes, the **Energy Efficiency Directive** and **Renewable Energy Directive** aim to stimulate energy savings to alleviate energy poverty and the **Alternative Fuels Infrastructure Regulation** aims to ensure that charging and refuelling infrastructure for zero-emission vehicles will reach all parts of Europe.

The **Energy System Integration Strategy** stresses that the tools created in the context of the integration strategy should reflect the reality of demographic change and in particular the increasing numbers of older consumers who need to be specifically supported in the digital transition. Also, the Commission's communication on the **Renovation Wave for Europe** tackles energy efficiency together with accessibility, aiming to make buildings more usable and sustainable in the context of an ageing population.

The **Sustainability Smart Mobility Strategy** (European Commission, 2020a) represents a best practice in terms of integrating demographic considerations into EU policies. The staff working document contains a chapter on demographic trends and their impact on mobility, using population projections based on Eurostat data. The document highlights that besides the relative growth of the share of the population living in urban areas, ageing societies in Europe represent a demographic trend that is likely to shape mobility patterns in the future. The strategy recognises that a new approach to the design of network and business models is needed, which should also take into consideration the impact of climate change on the current and future infrastructure as well as the demographic change impacting the mobility patterns of the future.

The **New European Bauhaus** (European Commission, 2021a) is another good example of integrating demographic insights into EU policies. The Commission's communication and its annexes make ample references to the needs of different segments of society and socio-economic groups. The New European Bauhaus is guided by three values – sustainability, aesthetics and inclusion. In this context, the strategy considers the needs of the ageing population, as well as the needs of the most vulnerable groups – the elderly, young people and migrants

Not just population size

Population is a key element in Integrated Economic Assessment models (IAMs) used to evaluate the interaction between population, technology, energy, economic growth as well as carbon cycles and climate. The Nobel laureate Nordhaus who pioneered the development of IEA models underlines that there are three ways to reduce emissions: "lower population growth, lower growth in living standards, and lower CO_2 intensity (decarbonization)" (Nordhaus, 2013).

The role of the population is explicitly acknowledged in IPCC reports. The latest AR6 Synthesis Report for example states that "Globally, gross domestic product (GDP) per capita and population growth remained the strongest drivers of CO_2 emissions from fossil fuel combustion in the last decade (high confidence)" (IPCC, 2023a). In the IPCC reports population is more often mentioned when considering the opposite direction of the relation describing the impact of climate change on the population. The focus is in this case on the adaptation gaps and the impact of climate change in terms of exposure and higher vulnerability, considering the different demographic, socioeconomic characteristics and geographical context of populations.

The IEA 2022 Energy Outlook report (IEA, 2022) provides detailed modelling of energy supply and demand according to different energy and emissions mitigation scenarios. In these models, population is an external input with limited considerations of the possible interactions and feedback loops between GDP, energy and the demographic components of fertility, mortality and migration.

Furthermore, both IAM and energy models mostly refer on total population and tend to ignore the influences on emissions from more specific demographic dimensions such as age, education, rural-urban place of residence and household size and composition.

Examples of questions which arise when considering more explicitly the role of these demographic characteristics on climate change and environmental impacts are contained in a recent foresight exercise conducted by DG ENV under the EU foresight system for the systematic identification of emerging environmental issues (FORENV) (European Commission et al., 2023). The final report of this exercise identifies emerging environmental issues linked to demographic changes in the EU using expert knowledge and desk-based research into existing relevant literature. In particular, the following three issues refer to demographic dynamics in the EU which could represent important drivers for environmental impacts.

- How might Europe's ageing population influence political preferences for the green transition?
- What will be the environmental impact of changes in the demographic makeup of urban areas?
- As Europe's population ages, will consumption patterns change and what will this mean for the environment?

Aim and structure of this report

The main aim of this report is to argue in favour of a more encompassing consideration of demographic elements in climate change mitigation policies and modelling.

The report builds on the FORENV exercise and tackles the three questions above through findings from the literature and original empirical analyses. It expands the FORENV exercise by looking at the relation between demography and emissions not only in the EU but also in the global context.

The report is structured into four main chapters.

Chapter 1 sets the scene by describing the relationship between population and environment; why it matters; how it is addressed internationally and what are possible consequences of (in) action. The chapter introduces the concerns about the size of the global population, the environment and sustainable development that started in the middle of the 20th century and how it shifted from concerns mainly about food production and subsistence to concerns about emissions and climate change. It then discusses the contribution of the population to emissions highlighting the importance of demographic momentum and the decoupling of emissions from population and GDP growth.

Chapter 2 focuses on the EU and examines how age, household size and rural-urban place of living can determine emissions along the consumption channel. The analyses are based on the merging of microdata from the EU Household Budget Survey and CO_2 multipliers from macro multiregional input and output tables representing the specificities of sustainability of production systems in national economies and trade dependencies.

Chapter 3 turns to the individual perspective. It analyses people's attitudes towards climate change. In particular, it illustrates how individuals perceive climate change, how they evaluate the importance of personal actions and the responsibility of state authorities for tackling climate change, and how they assess public policies and the goals of the European Green Deal.

Chapter 4 complements the other chapters with a qualitative and forward-looking perspective. It makes use of *Reference foresight scenarios on the global standing of the EU in 2040* to explore the implications and possible future trajectories focusing on the points left unanswered in the empirical literature and in the quantitative analyses in the other chapters.

Chapter 1 The role of population growth for greenhouse gas emissions at the global level

Key messages

- A major challenge to achieving a sustainable future of human activity will be to meet international commitment and significantly speed up the lowering of greenhouse gas emissions in advanced economies as well as to support the prospect of economic growth, urbanisation and development in emerging economies with a reduction in energy and emission intensity.
- Debates about the limits to population growth have resurfaced in the context of climate change and will likely remain salient with the world population projected to continue growing by at least another billion until mid-century.
- Demographic research has been slow in contributing to the study of climate change despite the human population being at the centre of global warming.
- Population is a lesser contributor to global emissions than economic growth, and it is concentrated in the regions with the lowest emissions.
- There is a large gap between the emissions produced by a person in poorer countries, where population growth rates are often high, and the emissions produced by a person in higher-income countries where population growth rates are often low or already negative.
- Besides population growth, other demographic factors such as urbanisation, ageing, or internal and international migration processes, influence global emissions.
- While population adds to economic demand, global fertility levels are already falling and the world population is projected to stop growing in the second half of the 21st century.
- The growth of the world population over the medium term is highly certain as it is to a large extent driven by the current youthful age structure that stems from past growth.
- Long-term projections of the world population have a high degree of uncertainty and whether the global population levels off at 9, 10 or 11 billion in the second half of this century will have a strong effect on emissions as the world is far off the track from becoming carbon neutral by 2050.
- Sustainable development is recursively linked to lower birth rates which, in turn, also contributes to lower total emissions, but action to accelerate progress towards international development goals would need to be taken now to make a difference long-term as there is a significant lag for policy effects due to demographic inertia.
- The EU is committed to an internationally agreed population and development agenda, including support for current goals to reduce child and maternal mortality; provide universal access to education; achieve gender equality; end child marriage; and provide universal access to sexual and reproductive health and reproductive rights that are also related to a faster transition to lower levels of fertility.
- International consensus on an individual-rights-based approach to population policies is waning which impedes progress towards the goals of a common population and development agenda.

Introduction

After quadrupling in size in the last century, the number of people in the world is now above 8 billion and will plausibly reach between 9 and 12 billion before levelling off during the course of the 21st century (United Nations Department of Economic and Social Affairs, Population Division, 2022). Global temperatures have increased by 1.1 degrees Celsius in that time and the future population will face the challenge of an additional 1.5 to 3 degrees Celsius (IPCC, 2023a). The increase in the size of the world population and the warming of the climate have been labelled 'megatrends' or 'grand transitions' defining our times and future (EEA, 2015; Lutz, 2017; Smil, 2021). A third of 50 surveyed Nobel laureates cited 'population growth and global warming' as the biggest threat to humanity making it the top answer before nuclear war, infectious diseases, AI or inequality [3]. The important point is the presumed link in the posed question that population growth and climate change were presented as combined and not individual threats.

A simplistic narrative of population growth causing climate change evokes concerns about the re-emergence of coercive policies to control fertility, the United Nations Population Fund stresses in its latest report on the state of the World Population (UNFPA, 2023). There is also a stark mismatch in population growth rates and levels of emissions across countries. The main emitters, historic and current, the US, China, and the EU, are regions where the population has stopped growing or is growing at a low pace. The regions where populations are growing strongest are those that only contribute a fraction to global warming. Nevertheless, given that human activity is the main cause of global warming, a growing global population entails increasing greenhouse gas emissions in the absence of change in how humanity consumes and how it produces energy (O'Neill et al., 2010).

This chapter seeks to illustrate the complex relationship between population growth and climate change from the perspective of the EU in a global context. It first summarises the findings of the United Nation's International Panel on Climate Change (IPCC), the major international body that brings together experts and scientists to assess the current scientific knowledge on climate change, which has stressed the need to address climate change and the role of population growth for greenhouse gas emissions. This is followed by a discussion of the history of debate about the limits of population growth and its current understanding in the context of climate change. The chapter then turns to demographic studies of the role of population growth in climate change and looks at pledged and stated policies by the EU in comparison to other regions to decouple economic activity from global warming. The potential of reducing emissions by slowing the pace of population growth through policy interventions is discussed before the main points are summarised in the conclusion.

Beyond the effect of population growth on climate change, other demographic processes such as ageing from changes in the age composition of a population, changes in family size and house composition, or urbanisation and changes in population density have been shown to impact the emissions of greenhouse gas. This chapter will focus mostly on the factor of population growth for climate emissions as it is the central theme of the debate about limits to human populations and policy strategies to reduce the pace of population growth. Furthermore, a detailed overview of the demographic composition and structure of emissions is presented in Chapter 2 which analyses the European context.

The role of population growth in global emissions in IPCC reports

The importance of addressing climate change

Climate change is one of the defining global challenges facing humanity today. The warming of the planet is already being felt in the form of extreme weather events such as floods and droughts, rising sea levels, and loss of biodiversity. Continuous rise in temperatures will intensify these consequences of climate change with likely serious implications for human health, food security, and economic stability.

The IPCC AR6 Synthesis report states that "It is unequivocal that human influence has warmed the atmosphere, ocean and land since pre-industrial times" (IPCC, 2023a). Industrialisation, deforestation, and large-scale agriculture have dramatically increased the emission of greenhouse gases for almost two centuries leading to the warming of the atmosphere, ocean and land; and global emissions are continuing to reach record levels.

In 2015, the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was signed by almost all countries around the world. It showed global commitment to the formulated aim to

[3] Grove, J (2017) Do great minds think alike? The THE/Lindau Nobel Laureates Survey. The Times Higher Education, News, 31.08.2017. Retrieved April 21 2023. URL: https://www.timeshighereducation.com/features/do-great-minds-think-alike-the-the-lindau-nobel-laureates-survey

strengthen the global response to climate change and limit global warming to less than 2 degrees Celsius above pre-industrial levels and to pursue efforts to even keep the increase in temperature below 1.5 degrees Celsius[4].

However, countries are not taking sufficient action to reach pledged emission reduction targets and the Secretary General of the United Nations urged countries at the latest conference of the parties to the UNFCCC that "the world still needs a giant leap on climate ambition"[5]. The Intergovernmental Panel on Climate Change (IPCC) reported in its latest findings that the world is off-track from keeping global warming below the target of 1.5 degrees Celsius. It would need rapid, far-reaching and unprecedented changes in all aspects of society to reach net-zero emissions by 2050.

The EU has recognized the need to address climate change and introduced a comprehensive plan focused on the greening of its economy to reach a carbon-neutral economy by 2050[6]. The introduced policy instruments target investment in renewable energy, support for energy efficiency of buildings, protection of the environment, the greening of the agricultural sector, and transition to sustainable carbon-neutral mobility and transportation (see Box 1). However, also the EU climate action has been considered insufficient in its current form[7] and the European Commission has stated the need for urgent additional action[8].

With human activity, the primary cause for increasing concentration of greenhouse gas emissions, population growth is tightly linked to climate change. The IPCC Synthesis Report of the Fifth Assessment Round (AR5) in 2014 stated that "Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever." This statement somewhat masked the dependency of greenhouse gas emissions on not only population and income but also on consumption patterns and the efficiency of technologies for production in the summary report for policymakers.

The recently published IPCC Sixth Assessment Report (AR6) highlights the complex relationship between population and climate. It analyses the impact of population growth on climate change which is discussed in the Report on the Mitigation of Climate Change (WGIII) of the AR6 with a focus on the decoupling of growing population size and increase in emissions based on linkages between future climate change scenarios with a set of different population projection scenarios (IPCC, 2023b). The Synthesis Report's summary for policymakers now emphasises the interlinkages of demographic pressures from population growth, changes in population composition, and urbanisation with other drivers. The IPCC also stresses that population growth is not the main factor for global warming and that increases in emissions can also be observed independently from the increase in population size: "global greenhouse gas emissions have continued to increase, with unequal historical and ongoing contributions arising from unsustainable energy use, land use and land-use change, lifestyles and patterns of consumption and production across regions, between and within countries, and among individuals " (IPCC, 2023a).

The relationship between population growth and climate change

Debates about limits to population growth have resurfaced today in the context of climate change

Concerns about the size of the global population and climate are not new. Population-environment interactions have been examined since the global population began growing rapidly more than 200 years ago during the onset of the industrial revolution (Hunter et al., 2022). From the last 18th century onwards, the demands on resources have steadily increased while negative ecological consequences emerged such as worsening air and water quality, the decline in water and land resources, or with time climate change (Livi Bacci, 2017b; Véron, 2013).

The idea of population growth bound by limits of subsistence originates from the work of Thomas Malthus published in 1798 in his Essay on the principle of population (Malthus, 1798). It postulates that food production was not able to keep up with the pace of population growth, an idea that has been coined 'Malthusian trap'.

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[4] United Nations (2023) Climate Action – The Paris Agreement. Retrieved: 20.04.2023, URL: https://www.un.org/en/climatechange/paris-agreement

[5] United Nations (2023) COP27 - The 27th Conference of the Parties to the United Nations Framework Convention on Climate Change. Retrieved: 20.04.2023, URL: https://www.un.org/en/climatechange/cop27

[6] See recent speech by President von der Leyen at the Beyond Growth Conference in the European Parliament https://ec.europa.eu/commission/presscorner/detail/en/speech_23_2761

[7] Climate Action Tracker (2022) EU – 5 Nov 2022 Update. Retrieved April 21 2023. URL: https://climateactiontracker.org/countries/eu/

[8] European Parliament (2023) Statement of the European Commission on the debate on: IPCC report on Climate Change: a call for urgent additional action. Retrieved 28.04.2023, URL: https://www.europarl.europa.eu/doceo/document/CRE-9-2023-04-20-ITM-003_EN.html

Malthus suggested that people delay marriage or remain single to lower fertility and slow population growth. He also argued that increased mortality, especially among the poor, was necessary to prevent overpopulation so that population keeps within the limits of available resources.

Malthus's arguments received much prominence in updated form in the 1960s and 1970s when the pace of population growth was at its peak. Thomas Ehrlich published the book 'The Population Bomb' arguing that unchecked population growth would lead to environmental degradation. The Club of Rome published 'The Limits to Growth' warning about the collapse of society in the case of continued population growth, resource depletion and pollution basing its results on a first computerised population-environment model that predicted the world passing its carrying capacity within 100 years. These ideas are labelled neo-Malthusian as the based premise remains overpopulation and resource scarcity while the influence of consumption and technology is acknowledged.

Neo-Malthusian thinking was prevalent in international organisations and national governments. Population control was seen as necessary to achieve economic development and prevent resource scarcity (McDonald, 2016). This is reflected in the population policies introduced at that time in the two most populous countries: the one-child policy in China and India's population control program that entailed sterilisation campaigns with funding from the World Bank, the Swedish International Development Authority, and the United Nations Population Fund (Follet, Chelsea, 2020).

There has been strong opposition to the idea that population growth is limited by resource scarcity. Opponents argued that throughout history, population growth has driven technological advances that have allowed humanity to keep pace with increasing demands on natural resources and food production (Kremer, 1993). Population growth would lead to innovation and adaptation, and thus to economic progress and increased agricultural output without depleting resources (Boserup, 1965).

The tipping point where resources become limited and their depletion causes disastrous consequences leading to social collapse has not materialised. At the time of Malthus, the world population stood at about 1.5 billion. When the Club of Rome published about the limits of growth the world population was about to reach 4 billion. Since then, the world population has continued to grow, albeit at a continuously slower pace since the 1960s (Figure 4). Rather than an effect of limits of growth, this is explained by more and more countries completing the demographic transition from a largely rural agrarian society with high birth rates and high deaths rates to a predominantly urban industrial society with low birth rates and low deaths rate, which has happened in the course of economic development and modernisation (Lee, Ronald & Mason, Andrew, 2006; Livi Bacci, 2017a).

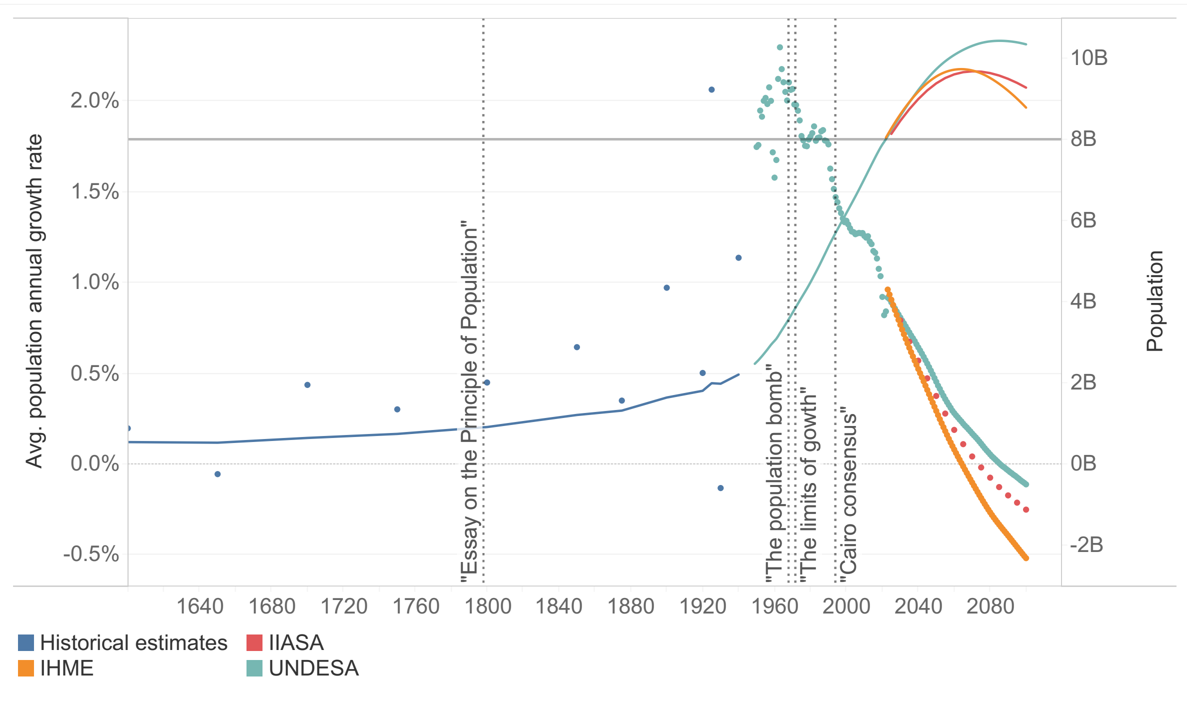

Figure 4 Global population size and annual growth rate: estimates, 1950-2022 and projections 2022-2100.

Notes: annual growth rate: dots and left axis; total population: line and right axis. Source: before 1950, Cohen (2003); 1950-2021, UNDESA; 2022-2100, IHME, IIASA, UNDESA.

The different theories are not necessarily mutually exclusive and offer partial views on the impact of population growth (Jolly, 1994). The retrospective observation that warnings about adverse consequences of population growth at times when the world population was much smaller and then continued to grow does not prove that future growth will not have negative effects on the environment (Weber & Sciubba, 2019). Trewavas (2002), for example, points to repeated 'Malthusian watersheds' in agriculture that humanity has overcome by applying scientific knowledge to increase crop yields. Rather than disproving Malthusian theory, it emphasises the need for continued innovation to meet the demands of a growing population. While concerns about sustainability have replaced concerns about subsistence, the different perspectives continue to provide the basis for debate (Hunter et al., 2022). Today, in a time when the world reached 8 billion people, the focus of the population-environment relationship has shifted to debates about climate change and loss of biodiversity. The question of whether the world's population should be reduced is now linked to limiting global warming (Mills & Rahal, 2021). However, after the fierce debate about the finite population growth and the links to the introduction of coercive population control policies, demographic research has only slowly started to contribute to the study of climate change despite the human population being at the centre of global warming.

This debate about the contribution of population growth to climate change will likely remain salient given the high certainty of continued population growth by at least another billion by mid-century. The further out the higher the uncertainty in the projection, but the global population is unlikely to start declining before well into the second half of the century. The United Nations project that the size of the global population will likely be between 8.5 billion and 8.6 billion in 2030, between 9.4 billion and 10 billion by 2050 and between 8.8 billion and 12.4 billion by 2100. There are alternative projections of the global population which include a faster decline in fertility rates (Lutz et al., 2014; Vollset et al., 2020). However, the differences over the medium term until 2050, where much climate action will have to have happened, are small. Population size by the end of the century is below the medium projection of the UN and the timing of the turning from population growth to decline is projected to happen earlier.

The population-emission mismatch: wealth inequalities across and within countries reflect disparate levels of emissions

Future population growth is unevenly distributed across world regions. Currently, the world is still growing at a pace of 80 million people annually. This is about the size of the most populous EU Member State, Germany, a country that would experience population decline if it was not for immigration. In fact, many countries and regions have already stopped growing or are projected to do so in the next decades while others are projected to continue to grow throughout the 21st century. It is the countries in those regions with no or slow population growth where emissions are highest.

Sub-Saharan Africa is projected to increase its population from 1.1 billion people today to 3.8 billion (3.0-4.8 billion, 95% prediction interval) in 2100, becoming the most populous world region and accounting for around 80% of future global population growth. Other regions with projected sustained growth are Oceania, Northern Africa and Western Asia. All other regions in Asia, Europe and Northern America and Latin America and the Caribbean will likely start declining in population size before the middle of the century.

Deceleration of population growth and development have tended to progress in parallel and may be mutually reinforcing (Dyson, 2010). Regions with currently high population growth are also the poorest with low levels of consumption which, in turn, explains the very low contribution to greenhouse gas emissions. However, because it is also these regions that are particularly affected by the consequences of global warming, a simplistic causal link between population growth and climate change has sometimes been drawn.

The mismatch of population and emission related to consumption patterns is best seen when grouping countries by their level of income (Figure 5). Today's high-income countries in the world achieved their wealth for the most part through highly resource-intensive patterns of production. Historically, these countries have accounted for most emissions, with upper-middle-income countries also contributing significantly. Upper-middle income countries have become the highest absolute emitter in the 21st century. Together, high-income and upper-middle-income countries account for about 85% of global emissions while only being home to 50% of the global population.

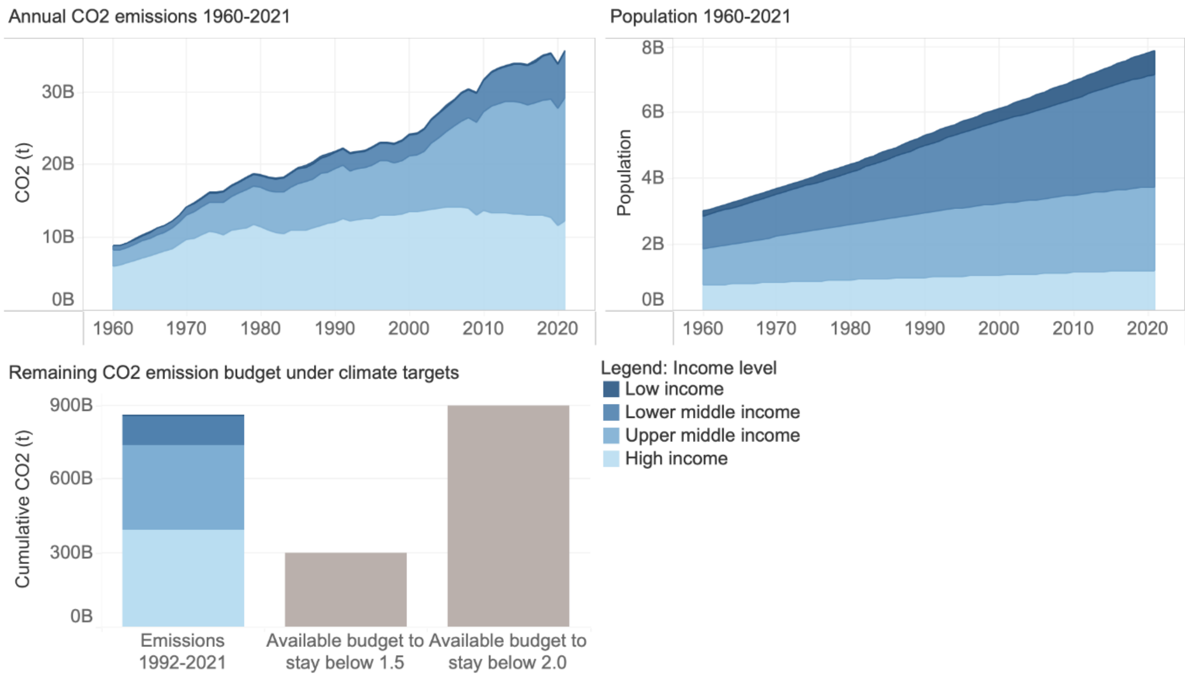

Figure 5 Trend in greenhouse gas emissions and global population, 1961-2021, by income group; and climate goals.

Source: Own calculation based on data from Global Carbon Project (Friedlingstein et al., 2019) , and United Nations Department of Economic and Social Affairs Population Division (2022)

For the other half of the world population, which lives in lower and lower-middle-income countries and is only responsible for 15% of global emissions, a similar path to economic development is no longer sustainable nor replicable (United Nations Environmental Programme, 2016). Human economic activity has overly relied on the burning of fossil fuels and has already caused a level of global warming that threatens the basis for sustainable development in the future (IPCC, 2014). To make progress towards global development goals such as the alleviation of poverty without overshooting climate targets, high-emitting countries have to substantially reduce their emissions (Bruckner et al., 2022).

The large gap between the emissions produced by a person in poorer countries, which tend to have higher population growth, and the emissions produced by a person in higher-income countries illustrates the difficult path to sustainable development. Most low-income and lower-middle-income countries in Africa, Asia and Oceania continue to experience high population growth, above 2% in the former and 1% in the latter (Figure 6). In most upper-middle- and high-income countries population growth is below 1% or is negative. Average emissions per inhabitant increases from less than 0.1 metric tons of CO_2 emissions per capita in the country with the lowest value, the Democratic Republic of Congo, to 32.2 metric tons CO_2 emissions per capita in the country with the highest value, Qatar (a more 300-fold higher value of emissions).

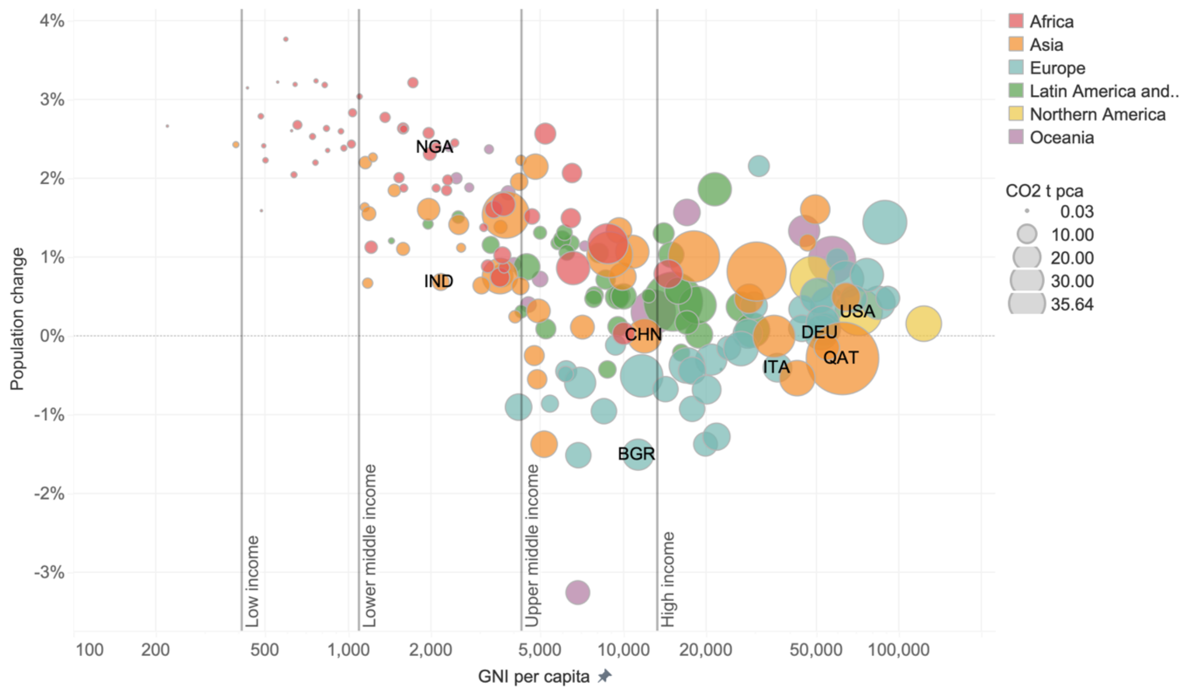

Figure 6 Population change (2020-2021) compared to per capita Gross National Income (2021) and per capita greenhouse gas emissions (2021).

Source: own calculations based on data from United Nations Department of Economic and Social Affairs Population Division (2022), World Bank and the Global Carbon Project (Friedlingstein et al., 2019). Notes: each circle represents a country; the size of symbols is proportional to per capita emissions; colours represent world regions.

Responsibility for emissions by wealth level differs not only between countries but also within countries according to estimates from Chancel (Chancel, 2022). The lifestyles of the wealthiest people are much more energy-intensive than those of other members of society, as they have a much higher share of the main sectors contributing to emissions: industry, agriculture, energy production, transport and buildings. The richest 10% of the world's population are responsible for 48% of greenhouse gas emissions, while the bottom 50% in terms of wealth emit only 12%.

The difference is even starker over time. In the last 30 years, the wealthiest 1% of the global population has caused 24% of emissions according to estimates. This accounts for 7% more greenhouse gas emissions than the bottom half of the population, and the gap has been increasing. The highly skewed concentration of individual greenhouse gas emissions within countries has become the main driver of inequalities in emissions in the 21st century. In 1990, 62% of global carbon inequality was due to between-country inequality. This changed in the early 2000s. In 2019, 64% of global carbon inequality was due to within-country inequality.

A continued rise in temperature will severe the disproportional consequences of climate change for the poorest. Population growth in conjunction with urbanisation processes will increase the exposure of populations especially in lower-middle- and low-income countries to adverse effects of global warming while also exacerbating pressures on resources and ecosystems. It will likely also further concentrate vulnerability to climate change where the capacities of local, municipal and national governments, communities and the private sector are already least able to provide infrastructures and basic services (IPCC, 2023a). At the same time, to contribute to climate change mitigation, the poorest countries also face the task to progress with their development without substantially increasing greenhouse gas emissions.

Population as a factor in future emissions

Empirical studies of the role of population

A recent review of demographic perspectives on global environmental change by Muttarak (2021) showed that demography has made a significant contribution to research on climate change by providing scientific insights into how the size, distribution and composition of current and future populations contribute to greenhouse gas emissions. Among demographers and other social scientists, there has been a widespread agreement of population as a mediating variable, meaning the theory that population dynamics affect the environment through variables such as the level of consumption and technology, but also institutions and culture. Much research has focused on the role of population growth and approached the investigation of its role for global warming through the famous IPAT equation proposed by Ehrlich and Holden (Ehrlich & Holdren, 1971) and extended versions of it.

Applied to global greenhouse gas emissions, the IPAT equation proposes that the impact on climate change (I) is determined by the interaction of population size (P), affluence or in other words consumption (A) and technology (T). The technology component is further separated into the element of energy consumed per unit of income (energy intensity) and the emissions per unit of energy (emission intensity) to achieve the so-called 'Kaya-Identity' (B. O'Neill et al., 2000) that relates to greenhouse gas emissions to its main drivers (Kaya, Yoichi, 1990). There are further modifications of the IPAT formula such as the STIRPAT formula from Dietz and Rosa (Dietz & Rosa, 1994) (to add nuance by allowing for differential impacts by each of the components of the equation.

The IPAT identity approach provides an understanding of the interaction between its components. While it does not account for factors (e.g. culture or institutions) (Sherbinin et al., 2007), it gives insight into the relative contribution of changes in population compared to increase in consumption, advances in technology towards higher energy efficiency and lower carbon intensity. Most empirical studies following the IPAT approach find that population growth is positively associated with an increase in greenhouse gas emissions, while the increase in consumption plays the strongest role (Dietz & Rosa, 1997; Hamilton & Turton, 2002; MacKellar et al., 1995; O'Neill et al., 2012a; Weber & Sciubba, 2019). For example, a study looking at OECD countries attributed 12% of increase in CO2 emissions between 1982 and 1997 to population growth compared to 36% attributed to an increase in the GDP per capita (Hamilton & Turton, 2002). A recent study on subnational regions in Europe finds that population growth will make it more difficult to achieve ambitious climate goals due to regions in Western Europe that are growing in population from internal and international migration (Weber & Sciubba, 2019). The authors also point out that current Member State policies were more directed towards increasing fertility and that the benefit of a stable or declining population was rarely discussed in EU policy documents.

It is important to note that population growth is not the only demographic factor influencing emissions. As the study on the regions of the EU shows processes such as internal and international migration also play a role. O'Neill showed that urbanisation and ageing through their impact on population distribution and age structure are associated with emissions and their effects will be important in the future in particular world regions (O'Neill et al., 2012b). In China, changes in population structure together with changes in consumption level are highly correlated with increases in emissions over the last decade while population growth did not play a significant role (Zhu & Peng, 2012). Demographic processes and changes including in population structure and distribution, ageing, urbanisation, and house size changes are important when thinking about the impact of population on climate change (see also Chapter 2).

In the latest sixth assessment report, the IPCC developed five Shared Socioeconomic Pathways (SSPs) that integrate different scenarios of future demographic change. The SSPs were designed to represent plausible future trajectories for global development based on varying assumptions about economic, social, and technological trends. Each of the five SSPs represents a different combination of demographic, economic, and social factors, which link to projections of greenhouse gas emissions and land use and explain different future outcomes of climate change (Kc & Lutz, 2017; Riahi et al., 2017).

For each SSP, a single set of baseline projections was chosen for population, education, urbanisation, and GDP. They are coupled with baseline projections of scenario-specific changes in emissions and land in the absence of climate policies to allow for the evaluation of mitigation strategies. Riahi et al (2017) found that low emission targets might be out reach in SSPs featuring high challenges. The IPCC reports (2023), for example, high mitigation challenges for SSP3 which represents a future of 'Regional Rivalry' where the world is politically and economically fragmented with countries perusing their interests. The limits to mitigation strategies under this SSP result from the assumptions of slow technological change, high levels of global population growth, and lack of multilateralism. However, across all SSPs, assumptions about energy intensity and economic growth are found as the most relevant determinants of future missions, both with and without climate policy (Marangoni et al., 2017).

The use of a single population projection in each of the SSPs does not allow for possible uncertainty in future population trajectories within each scenario. While this approach does provide a suitable base to analyse climate change policies (Rozell, 2017), it is important to note that in four out of the five SSPs, the future growth of the global population is projected to be slower than in the United Nations medium projection. The difference in projections is mainly due to a generally assumed faster decline in fertility rates in countries where fertility rates are still high. If this assumption does not materialise, the eventual size of the world's population could be larger than projected in the SSPs and the efforts needed to decouple economic growth from global warming would need to be even greater than anticipated (United Nations Department of Economic and Social Affairs, Population Division, 2021a).

Decoupling population growth from increases in emissions is a major challenge for achieving sustainable development in poorer countries where per-capita emissions are still low

A simple way to appreciate the sustainability of the pathways of population and economic growth is to consider how the respective trends for these two components in the IPAT equation are decoupled with respect to the trend for emissions. Ideally, we should observe a trend where economic growth and population growth are respectively completely - or on their way to being partially – decoupled from emissions. In other words, growth of population and GDP should happen with a less-than-proportional increase or, even better, a decline in emissions. This principle is recognised in the 2030 Agenda and for Sustainable Development adopted by all UN Member States in 2015. Specifically, SDG 8 on 'Decent Work and Economic Growth' emphasises the need to decouple economic growth from environmental degradation to allow sustained, inclusive, and sustainable economic growth without resource depletion, climate change, or water and air pollution.

We calculate a decoupling index for the trends of population and emissions over the decades from 1990 and 2020. We sum the national emissions falling in the following four categories of decoupling: population decline, emissions growing but less than population, and emissions growing more than population. The figure shows both the absolute level of emissions and relative shares for each category.

Figure 7 Population growth and emissions growth over the last three decades.

Source: own calculations based on data from United Nations Department of Economic and Social Affairs Population Division (2022) and the Global Carbon Project (Friedlingstein et al., 2019).

Notes: each category of population decoupling consider the sum of emissions across all countries which recorded a certain value of the decoupling indicator. Countries and their emissions may change the category from one period to the other. The lower panel of the figure gives the relative share of total emissions according to their decoupling from population growth.

The comparison of emissions to changes in population size over time shows that the majority of emissions have been concentrated in countries where they were growing at a faster rate than population and that the total amount of emissions has also increased (Figure 7). A simplistic interpretation of this could be that population growth is problematic with countries failing to decouple increase in population from emissions. To be on a decoupling path, emissions should grow less or decrease despite population growth. In theory, population growth should not influence emissions differently across countries and when all relevant causal linkages are accounted for in a statistical model it should only act as a scale factor with an elasticity of one. Regression estimates of the stochastic version of the IPAT equation show both elasticities above and below one and this is a sign that there are more complex interaction and unobserved factors besides the simple multiplicative effect of the three main drivers of technology, population and affluence (O'Neill et al., 2012b).

When looking at specific areas and adding changes in GDP to the comparison of increasing emissions and population growth, high-income areas such as the EU and the United States, where emissions are already high, appear as the regions that are reducing emissions while managing to grow their GDP and experiencing population growth (Figure 8). In China, India, and Russia emissions are growing at a faster pace than population, but at a slower pace than their GDP is increasing. It is in Africa and also in Brazil where emissions are growing faster than both GDP and population. This is again a simplistic comparison. The contribution to emissions is much smaller as their level of energy use is much lower. However, it indicates a difficult pathway to sustainable development.

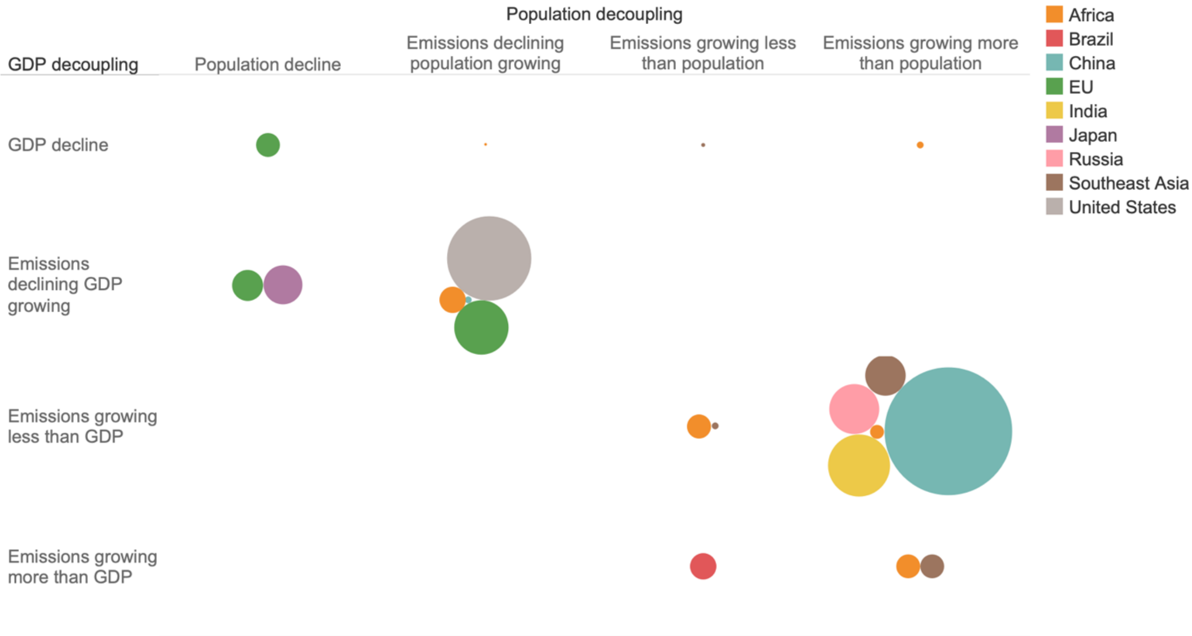

Figure 8 Change in emissions compared to the change in GDP per capita and population growth across selected regions.

Source: own calculations based on data from United Nations Department of Economic and Social Affairs Population Division (2022) and the Global Carbon Project (Friedlingstein et al., 2019).

Future emissions until 2050 have been projected by the International Energy Agency (IEA) for different scenarios (IEA, 2022). The results from the Announced Pledges Scenario (APS) are ex-post examined to look at the pathways for decarbonisation according to the announced ambitions and targets by governments. The Announced Pledges Scenario represents the most recently announced ambitions and targets, as of September 2022, to reduce greenhouse gas emissions and to transition to a low-carbon economy until 2050. The starting position in terms of carbon intensity in 2020 varies significantly, with the Chinese economy the most carbon-intense and the combined economies of Africa the least carbon-intense (Figure 9). Africa's trajectory stands out. While projected to experience strong population growth from 1.4 billion to 2.5 billion, carbon intensity is projected to remain at current levels and the total amount of emissions increasing. The economy of India is projected to decrease carbon intensity only after 2030 and is accompanied by moderate relative population growth. China, the EU, and the United States are projected to significantly decarbonise their economies and lower the total amount of emissions. The total amount of emissions in Russia is projected to decrease slightly with a small decrease in population and small advances towards lower carbon intensity.

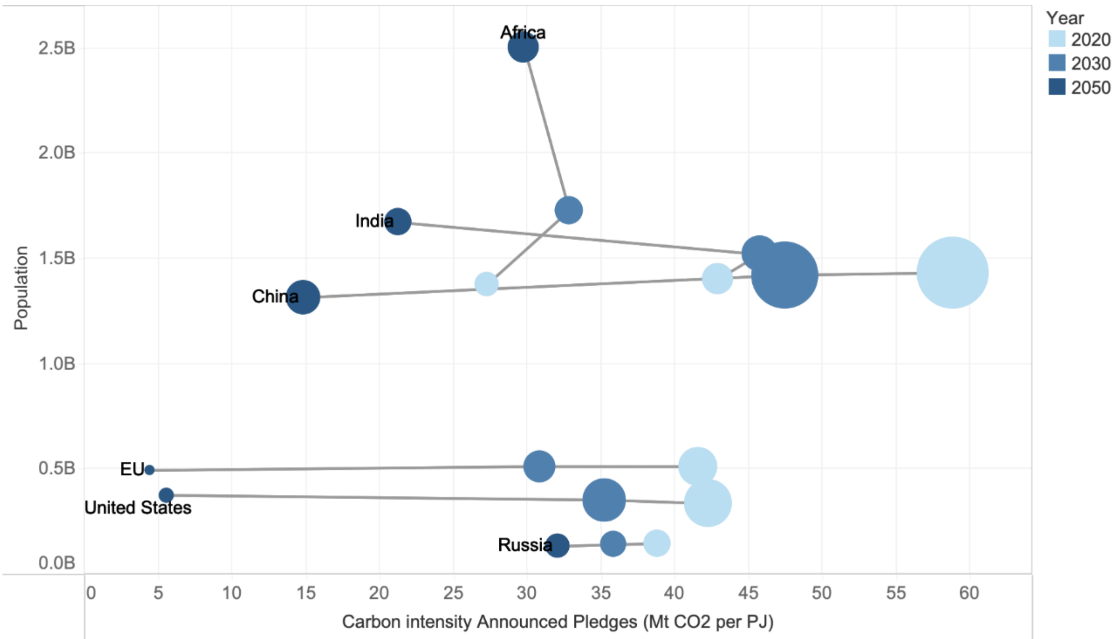

Figure 9 Future carbon intensities compared to population projections and pledged emissions targets across selected regions.

Source: own calculations based on emission projections from IEA (2022) and population projections from United Nations Department of Economic and Social Affairs Population Division (2022)

The projections of the IEA of future emissions under currently pledged policy ambitions and targets underline the difficult pathway to sustainable development (IEA, 2022). The challenge for mitigating climate change will be to compensate for the economic growth in less developed countries, with reductions in energy intensity and emission intensity starting from developed economies (O'Neill et al., 2012b). With the likely continued population growth until well into the 21st century, and GDP as the main driver of emissions, it lies with the affluent regions of the world to intensify their efforts in greening their economies and adopting sustainable consumption patterns. Decoupling the current over-reliance on fossil fuels from economic activity will require intensified political action and investments by governments in cooperation with the private sector and civil society in all regions and with strong support from the international community.

Political action in the context of population, sustainable development and climate change

Demographic foresight on the future trajectory of the world population: continued growth is highly certain and driven by population momentum

The possible contribution of slowing global population growth for climate mitigation can be frequently found as a recommendation to policymakers (O'Neill et al., 2012b). The IPCC reports that recognize population growth in combination with economic growth as a key driving force for climate change, identify demographic pressures as a highly certain future driver for greenhouse gas emissions (IPCC, 2023a). At the same time, the future trajectory of the global population in the 21st century is suggested as an uncertain outcome that will be among the most important in 'determining our future' (Smil, 2022). The prospects and possible magnitude of slowing population growth to reduce the population factor in the equation of climate change emissions remains a highly debated topic.

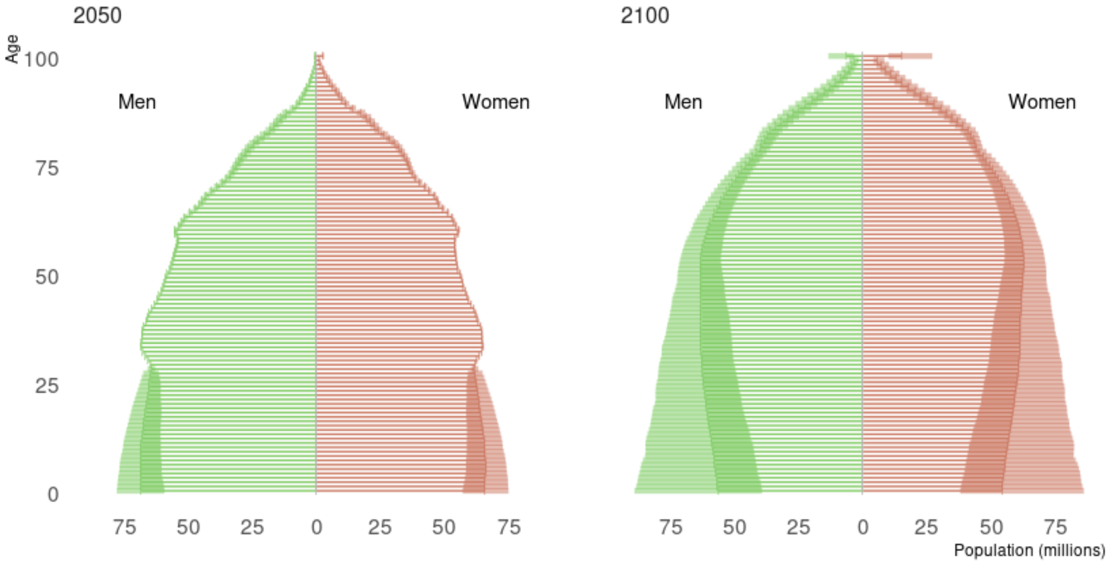

Figure 10 Projected future age-sex composition of the global population in 2050 and 2100. United Nations medium projections with 95% uncertainty intervals by age and sex.

Source: own elaboration of data from United Nations Department of Economic and Social Affairs Population Division (2022),

As was discussed earlier, the pace of population growth has been slowing and global population will likely level off before the end of the 21st century. The role of population growth can therefore be assumed to become less of a driver of climate change over the coming decades. However, projections of the size of the global population are much more certain over the medium term than over the long term. That is because many of the people who will be alive over the next decades are already born. We use data from the 2022 Revision of the United Nations World Population Prospects (United Nations Department of Economic and Social Affairs, Population Division, 2022) to assess the pace of future population growth.

The projected age and sex composition for 2050 and 2100 with the 95% upper and lower confidence intervals for each single-year age group (the 95% prediction interval describes a range of values where a future observation is expected to fall with 95% confidence) is shown in Figure 10. For 2050, the uncertainty about the size of the population below the age of 29 is much higher than for the rest of the population given that these are people who are yet to be born (the baseline year of the projections is 2022). The uncertainty also increases the lower the age given that future trajectories fertility levels become less certain the further out in time. In 2100, everyone below the age of 79 is yet to be born and uncertainty about people who will be born towards the end of 21st century is very low.

The continued and highly certain growth of the world population projected until 2050 is mainly a result of strong population growth in the past and the relatively youthful age composition of the current world population. The consequence is population momentum, which describes the phenomenon whereby a population continues to grow even after the fertility rate, or the average number of children per woman, drops to replacement level because a large proportion of the population is in their reproductive years. It explains why the world's population is likely to add over a billion people in the coming decades although many countries already experience low fertility rates and despite a global average number of births per woman that has dropped from 5.3 in 1963 to 2.3 today and is projected to continue to decline to 2.1 (1.9 to 2.4 95% prediction interval[9]) in 2050 and 1.8 (1.5-2.4 95% prediction interval) in 2100. How much the number of births per woman in all countries of the world has shifted towards lower levels from 1950 to today and the projected continuation of this trend can be seen in Figure 11. The majority of countries already experience fertility levels below the replacement level of

[9] The 95% prediction interval describes a range of values where we expect a future observation to fall with 95% confidence

2.1[10]. If fertility froze at the current levels in 2022 and remained constant in every country, the world population would increase to 10.2 billion by 2050, half a billion more than the projected 9.7 million.

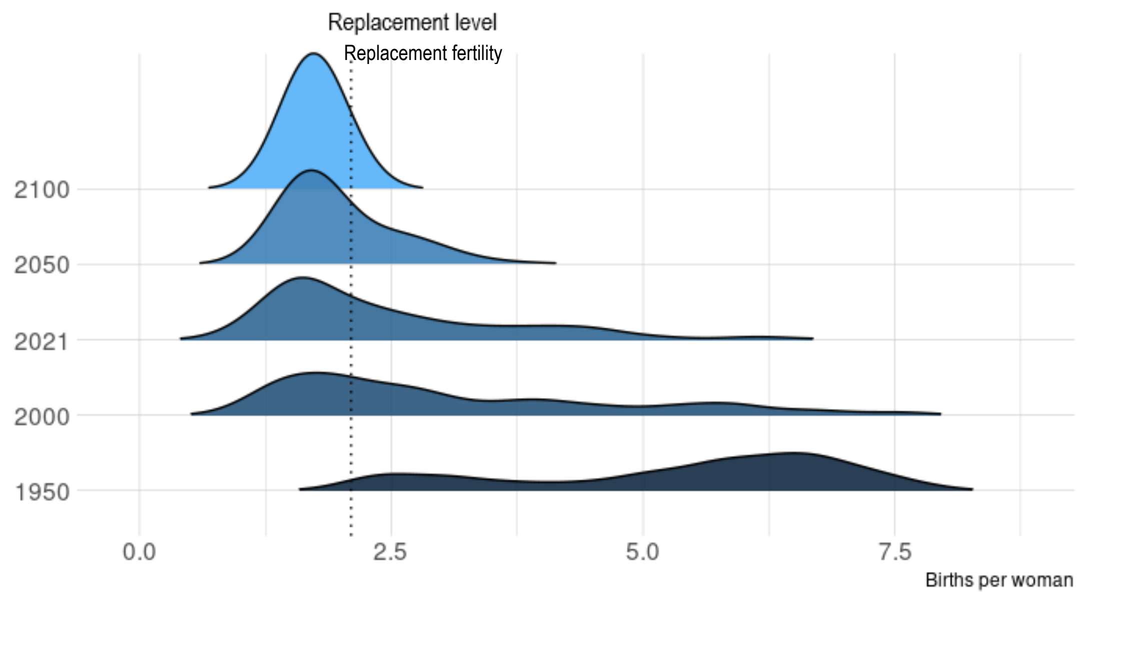

Figure 11 Estimates and projections of the number of births per woman in all countries and area of the world, 1950 to 2100.

Source: own calculations based on data from United Nations Department of Economic and Social Affairs Population Division (2022)

To quantify the contribution of momentum to future population change, we decompose the increase in growth in the global population and in major regions that is projected until 2050 and until 2100 (Andreev, Kirill et al., 2013). Beside the effect of momentum (or population age structure), the effects of other demographic components of fertility, mortality and migration are estimated. It shows that the current age structure of the world population accounts for an increase of 15% in the global population (Figure 12). That is about 1.2 billion of the 1.7 billion of the projected total increase of 23% from 8 billion in 2022 to 9.7 billion people in 2050. The remaining increase of half a billion is mostly attributed to mortality which accounts for an increase of 6% in global population and fertility which accounts for an increase of 2% of the global population. Looking at the growth until the end of 21st century, the increase in population to 10.3 billion is driven to a large part by the extension in life expectancy (mortality) and to a smaller part still the effect of the current youthful age structure. Fertility is projected to account for a decrease in global population. In other words, without the youthful age structure of the current population and in the absence of improvement to human life expectancy over the coming decades, the global population would be 3% smaller in 2100 than it is today.

The small contribution of the fertility component to global population growth until 2050 and its negative contribution until 2100 are explained by the increasing number of countries experiencing below replacement fertility. Figure 12 shows that low fertility accounts for the negative change in population size already in 2050 in all world regions except for sub-Saharan Africa, the regions of Melanesia, Micronesia, and Polynesia in Oceania, Northern Africa and Western Asia. Fertility is the major driver of population growth in sub-Saharan Africa where, by itself, it is projected to lead to a growth of the population by 45% by 2050 to by 133% by 2100. That it does not translate to a significant contribution to fertility on the global level is explained by the compounded offsetting effect of low fertility across most other regions. Furthermore, the larger the population in regions the stronger the effect for the global total. In Europe (and when looking only at the EU-27), the impact of age structure is already negative over the next decades. That means that the momentum effect has swung the other way. Even if fertility would go back to replacement level in Europe, in the absence of increases in life-

[10] The 2.1 replacement threshold is a general assumption. The level can be up to half a point higher in countries with skewed sex ratios from son preference and sex selective abortions or where child and young adult mortality is high

expectancy or contributions from migration, the population would continue to decline due to age structure marked by ageing.

The strong influence of population momentum demonstrates the inertia in the trend of world population size over the next 30 years. It can be anticipated that the world population will continue to grow by at least another billion by 2050. This underlines the urgency for policies to reduce greenhouse gas emissions from consumption and invest in technology to lower energy intensity. Lowering birth rates would not halt strong population growth in the medium term and translate into lowering emissions which is pivotal in light of the time pressure and expected cumulative effects of climate change (Bradshaw & Brook, 2014). Policy makers, when carving out pathways to a more sustainable future, should recognise the demographic foresight on the future trajectory of the continued growth of the world population over the medium-term. The latest IPCC report has highlighted the need to take drastic action now as there is insufficient global action to stay below even the 2° C goal.

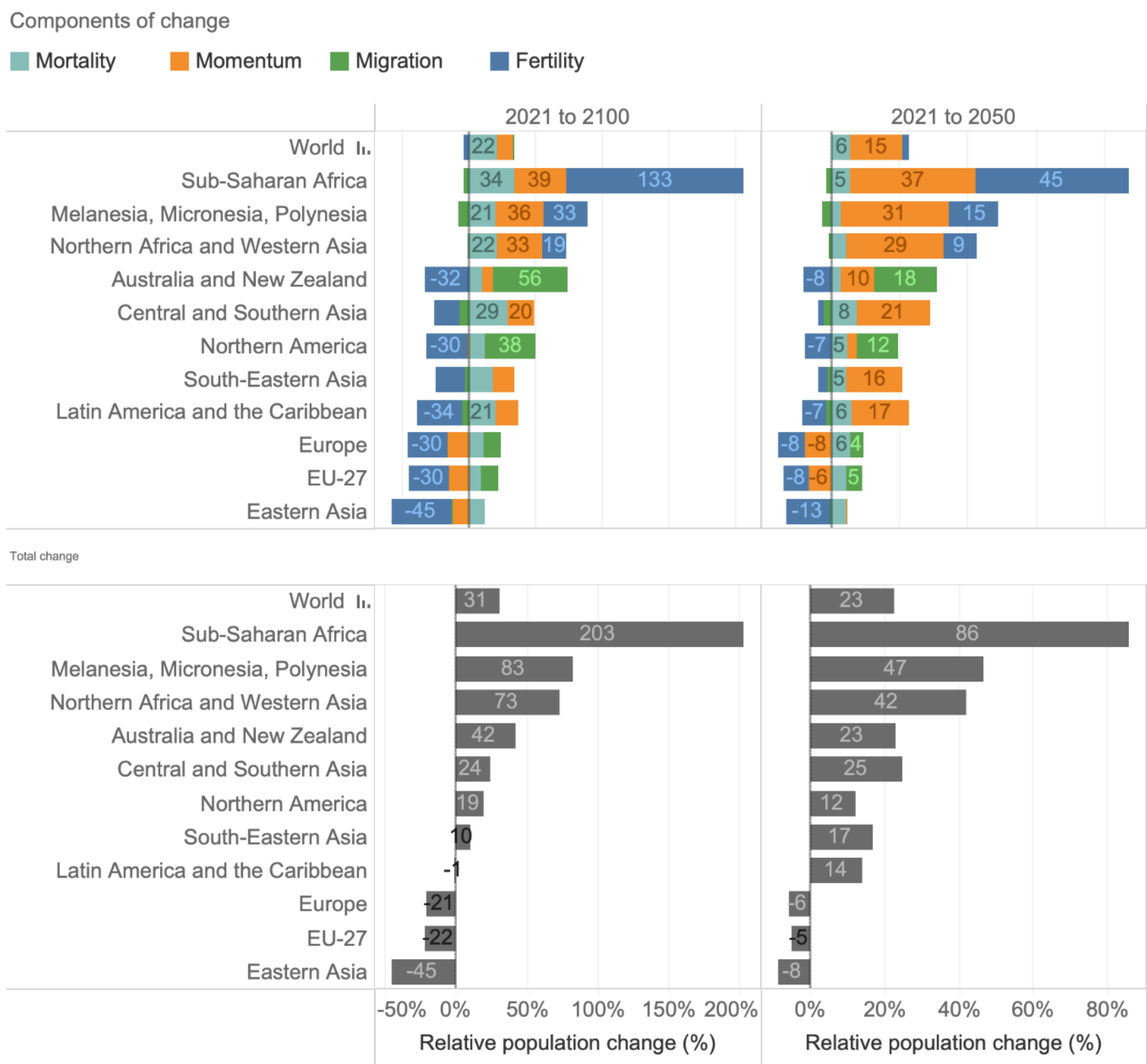

Figure 12 Relative contribution of components of future population growth (age structure, fertility, mortality and migration) from 2022 to 2050 and from 2022 to 2100, for the world and major regions.

Source: own calculations based on population projection scenarios from United Nations Department of Economic and Social Affairs Population Division (2022). Notes: Regions grouped to reflect common demographic trends across regions; EU-27 represents a subset of Europe.

That is not to say that population policies cannot make a contribution. On the contrary; there are proven and effective policies that support development and strengthen human rights while also leading to lower fertility rates (Bongaarts & O'Neill, 2018). However, the significant inertia in demographic trends needs long-term vision. Accelerated decline in global fertility rates will show predominantly in lower greenhouse gas emissions from population size in the second half of this century (Casey & Galor, 2016). Policy action would need to happen now to see the potential contribution that demography can make to mitigate climate change. As several decades tend to pass between a human's birth and death, there is a significant time lag for policies to take effect due to demographic inertia (Jolly, 1994) (Bongaarts, 1992).

Policies supporting sustainable development in health, education, inequality and poverty may slow population growth when carefully designed, but international consensus on a common population and development agenda is waning

There is general agreement on the reciprocal relationship of fertility and development and that rapid population growth in many low-income and lower-middle-income countries is both a symptom and cause of slow progress in development. In fact, population policies have evolved with levels of fertility (United Nations Department of Economic and Social Affairs, Population Division, 2021b). While countries that adopted lower family policies are now concerned with ageing and population, most of the countries of sub-Saharan Africa and in Pacific Island States, which continue to experience higher levels of fertility, have population policies to lower fertility.

There is also general agreement that high levels of fertility are linked to a lack of autonomy and opportunity among young women and girls and on key sustainable development strategies such as the reduction of child and maternal mortality, the provision of universal access to quality education, gender equality, the empowerment of women and girls, the provision universal access to sexual and reproductive health services, including family planning, as well as access to sexual and reproductive rights (United Nations Department of Economic and Social Affairs, Population Division, 2021a). They are formulated in the Programme of Action of the 1994 UN Conference on Population and Development (ICPD), held 1994 in Cairo, that reached a global consensus on a rights-based approach to population and development that shifted away from setting demographic targets. The Programme of Action recognises sexual and reproductive health and reproductive rights, as well as the empowerment of women and girls and gender equality as main pillars of population and development programmes.

Many of the studies on the effect of population growth and other population processes on climate change state the need to slow population growth to mitigate global warming and argue for greater support of rights-based population policies. Casey and Galor (2016), for example, found lower fertility to have the simultaneous effect of increasing income and lower emissions and stressed that population policies should be considered as part of the global policy response to climate change. Dasgupta (2021) argues that the 2030 Agenda on Sustainable Development and the Paris Agreement were reticent about population and disregarded the role population plays in our demands on nature and calls for greater international investment into family planning programmes. Bongaarts and O'Neill (2018) identify a misperception that population policy was too controversial to succeed and advocate for the consideration of population policies by the IPCC. Stronger voices see inexcusable neglect of ethical measures to reduce fertility (Bradshaw & Brook, 2014) or argue tentatively that discourse about how to think ethically about population change and its implications for sustainable development was overdue (UNFPA, 2023).

The 2023 report on the Status of the World Population of the United Nations Population Fund (UNFPA) assesses resurfacing debates about 'overpopulation'. It is critical about the contribution of studies that deem slowing population growth as essential for the mitigation of climate change or other development targets, especially in the context of sexual and reproductive autonomy. While acknowledging the economic and development benefits, the report emphasises that these should not be secondary goals to the essential goal of empowering women and girls. This could have a detrimental effect as it raises suspicion about family planning programmes as a backchannel of population control (Sasser, 2014). However, family planning combined with other human welfare such as increased equality and the expansion of education and employment, as well as improvement of the status of women and girls would support demographic transitions that offer opportunities for economic and developmental gain (Lee, Ronald & Mason, Andrew, 2006). In that way, the Programme of Action of the International Conference closely links to the 2030 Agenda for Sustainable Development.

The European Union's development approach aligns with the UN's 2030 Agenda and offers strong support for health, education, and climate and energy as two of the five priorities of the Global Gateway strategy, but also specifically for gender equality, women empowerment, and reproductive health and rights. This is formulated in the 2017 European Consensus on Development, in the EU's 2021 Action Plan on Gender Equality and Women's Empowerment, and in the 2022 Youth Action Plan. Commissioner for International Partnerships Jutta Urpilainen stated that "The EU is committed to the right of every individual to decide freely and responsibly on matters related to their sexuality and their sexual and reproductive health – this is a core part of our global health policy[11]." The EU was also the ninth largest donor to UNFPA with 59 million[12] US Dollars and spends 2% of its overseas development aid budget on matters of sexual and reproductive health and rights[13]. The EU supports multiple UN initiatives such as the UNFPA supplies partnership, the EU-UN Spotlight Initiative to end violence against women, or the UNICEF-UNFPA Global Programme to End Child Marriage. Six EU Member States are also among the top ten donors to UNFPA.

In contrast to the EU's commitment to the goals of UNFPA, the consensus in the international community on matters related to sexuality and reproduction is waning. Debates about matters of sexual and reproductive health and rights and comprehensive sexuality education, abortion and access to contraception are now new, but opposition in international forums has increased. Based on a qualitative policy analysis of developments at two UN Commissions between 2014 and 2019, the Commission on the Status of Women and the Commission on Population and Development, Gilby et al. (2021) finds a retreat from previously agreed on language in UN negotiations and conferences that would present a challenge for the realisation of development goals related to sexual and reproductive health and reproductive rights.

The lack of international consensus on matters related to sexuality and reproduction is argued to impede the advancement on other points of the population and development agenda (Coole, 2021) (see Chapter 4 for a foresight exercise on possible consequences of a fragmented world for population and development). Indeed, the annual Commission on Population and Development, which is tasked with monitoring and reviewing the implementation of the ICPD's Programme of Action, did not adopt resolutions in five of the past ten years although each annual meeting sets the focus on a different population and development theme. No consensus resolution could be agreed to in the most recent annual meeting of the Commission on Population and Development in April 2023 on the theme of 'population, education and sustainable development'[14]. Against the backdrop of worsening environmental prognoses, Coole (2021) analysed UN conferences and negotiations and sees a 'toxification of the population discourse'. She questions whether the goal of universal access to sexual and reproductive health and reproductive rights and the goal of reducing fertility and slowing population growth to contribute to the mitigation of environmental degradation were not compatible and advocate for a reconsideration of demographic targets as a legitimate interest of sustainable development. However, Gilby et al. (2021) see a need to defend the commitment to sexual reproductive health and reproductive rights in international agenda-setting.

Conclusion

How the global population addresses climate change is one of the defining questions of the 21st century. The latest assessment report of the International Panel on Climate Change (IPCC) clearly stated the responsibility of human activity for global warming and the interlinkages of demographic pressures from population growth, changes in population composition, and urbanisation channelled through unsustainable energy use, land use, lifestyles and consumption. The objective of this chapter was to illustrate the role that population processes and especially population growth play in global emissions of greenhouse gases, to help anticipate future trajectories of emissions and populations across world regions, and to discuss policies concerning population and sustainable development and the waning international consensus on an individual rights-based approach.

Despite the human population, the very subject of demography, being at the centre of global warming, demographic research only slowly started to contribute to the study of climate change after debates about the finite of population growth due to resource scarcity and links to the introduction of coercive population control policies in the 1960s and 1970s. Recent advances in methodology, data collection and availability, and the integration of population and climate change scenarios have allowed demography to make important contributions to the field by demonstrating the sizeable effect that population processes such as population growth, ageing, or urbanisation have had on the number of global emissions.

However, there is a dramatic population-emission mismatch defined by wealth inequalities. Population, a lesser contributor to global emissions than economic growth, is concentrated in the regions with the lowest emissions while emissions are highest in regions where population growth is low or where populations have started to

[11] European Commission, Directorate for International Partnership, News Announcement, 24 Sept 2022, Sexual and reproductive health and rights: EU announces additional €45 million for UNFPA Supplies Partnership. URL: https://international-partnerships.ec.europa.eu/news-and-events/news/sexual-and-reproductive-health-and-rights-eu-announces-additional-eu45-million-unfpa-supplies-2022-09-24_en

[12] UNFPA, Donor contributions. URL: https://www.unfpa.org/data/donor-contributions

[13] Countdown 2030 Europe. European Support – Country Profiles. https://www.countdown2030europe.org/analysis

[14] United Nations Department of Economic and Social Affairs (2023) Commission on Population and Development, fifty-sixth session (2023). URL: https://www.un.org/development/desa/pd/events/CPD56

decline. The population-emission mismatch also translates to wealth inequalities within countries. The lifestyles of the wealthiest people are much more energy-intensive than those of other members of society. The richest 10% of the world's population are currently responsible for 48% of greenhouse gas emissions, while the bottom 50% in terms of wealth emit only 12%; and the historic gap of cumulative contributions to emissions is even starker.

For half of the world population that lives in lower and lower-middle-income countries and is only responsible for 15% of global emissions today, a path to economic development dependent on resource-intensive patterns of consumption and production is no longer sustainable nor replicable. Therefore, a major challenge to achieve a sustainable future of human activity will be to realise international commitments to significantly lower the emission of greenhouse gases in advanced economies that have largely been responsible for anthropogenic global warming and to support the prospect of economic growth, urbanisation and development in emerging economies with a reduction in energy and emission intensity.

Empirical analysis of projected future emissions and the contribution of projected population growth, economic growth, emission intensity, and energy intensity demonstrates the difficult path ahead to realise the decoupling of achieving economic and developmental goals while becoming carbon neutral, especially in countries with strong population growth. The EU needs to keep pushing ahead with its green and digital transition agenda to guard its position as a role model for the international community. It lies with the EU and other affluent regions who have accounted for the large share of historic emissions to lead the way in intensifying efforts to reduce energy intensity, develop green technology to decouple economic activity from burning fossil fuels and adopt sustainable consumption patterns.

Analysis of the global demographic trends shows that continued growth is highly certain despite the global fertility level having continuously fallen to 2.3 births per woman and the majority of countries experiencing below replacement level fertility. Medium-term growth until 2050 is driven to a large extent by population momentum and the global population will likely grow by at least another billion over the next three decades. Population momentum describes the effect of the current youthful age structure of the global population that leads to continued population growth even after fertility rates decline due to the large number of people of reproductive age and younger ages arriving in the reproductive age range over the coming decades. Population growth would continue even if fertility levels were to fall immediately to below replacement levels in all countries. Therefore, needed the drastic solutions called for by the IPCC to reduce emission until 2050 change must come from the greening of the world economy and a change in consumption.

Uncertainty in population projections increases significantly over the longer term until 2100 and whether the global population levels off at 9, 10 or 11 billion in the second half of this century will have a strong effect on emissions as the world is far off the track from becoming carbon neutral by 2050. Action to accelerate progress towards sustainable development goals, which is presumed to be a faster transition to lower birth rates, needs to be taken now to make a difference long-term. As several decades tend to pass between a human's birth and death, there is a significant time lag for policy effects to realise due to demographic inertia.

Policies supporting sustainable development in health, education, inequality and poverty may slow population growth when carefully designed, but international consensus on a common population and development agenda is waning. The EU is a strong supporter of the international agenda on population and development and its broader development strategy is aligned with international goals on education, health and climate. The findings of this chapter highlight the role that the EU could play with its external policies instruments that support sustainable development, which is recursively linked to lower births rates which, in turn, also contributes to lower total emissions. The EU could further intensify the already existing strong support for strategies to reduce child and maternal mortality; provide universal access to education; achieve gender equality; end child marriage; and provide universal access to sexual and reproductive health and reproductive rights.

International consensus on an individual-rights-based approach to population policies is waning in relevant United Nations' forums which impedes progress towards the whole population and development agenda. Two contrary ways how to address this roadblock are being proposed: intensify efforts to defend individual rights on sexuality and reproduction or open the paradigm for re-evaluation in favour of the advancement of other sustainable development issues.




Chapter 2 Demographic characteristics and emissions in the EU

Key messages

- In addition to the general relation with income, individual emissions are shaped by the interaction between age and total expenditures, the composition of the expenditure basket, the rural-urban place of living and the household size.
- When taking these interactions into account, it is possible to observe an increase in per capita emissions with age. Given the overall lower level of expenditures of older people, this increase is in relative terms and is explained by the concentration of their consumption of carbon-intensive items for housing and by their smaller household size.
- Households living in cities have lower emissions thanks to urban economies of scale, more efficient forms of mobility and smaller houses. However, such advantages are contrasted by higher income and by smaller household sizes.
- By taking into account the effects of age on emissions in demographic projections for the EU, we estimate an increase of emissions of 6% by 2039. After this peak, emissions are expected to decrease by 4% by the end of the century.
- Overall, the effect of ageing is present but not striking. What is more relevant, is that demographic trends will also imply a shift in the responsibility for emissions towards older generations. By 2060, 39% of total emissions will be produced by people above 65.
- This trend bears implications if we consider that the consumption pattern of older people traps them in high emissions consumption patterns with limited possibilities for change.
- The findings of this chapter highlight the importance of targeting policy measures for energy efficiency and green transitions for older and low-income individuals.

Introduction

Chapter 1 describes how the effect of population on emissions can be represented through a simple multiplicative equation between total population, affluence, energy efficiency and carbon intensity (IPAT). In this equation population size is a factor of scale where population increases proportionally translate into increases in the emissions (O'Neill et al., 2012a).

Focusing only on population size represents an oversimplification of the pathways leading to emissions. Several studies analysing energy consumption in the US (Estiri & Zagheni, 2019; O'Neill & Chen, 2002) or directly CO_2 emissions in various European and OECD countries (Ivanova & Wood, 2020; Ottelin, 2022; Zheng et al., 2022) have shown that besides total population, age, education, rural-urban place of living and household size, can determine the level of emissions, either directly or indirectly through interactions with the other three components of the IPAT equation.

These additional demographic effects take place through the two main channels of consumption and production.

In the consumption channel, age is correlated with the overall level of spending and savings and can therefore increase emissions as more income is destined for consumption. Moreover, with changes over the life course, spending preferences can shift towards more or less carbon-intensive products or services.

When considering the production channel, the age structure of the population affects labour productivity and at the macro level, it can boost economic growth through a demographic dividend or cause stagnation due to the shrinking and ageing of the labour force (Bloom et al., 2015). These macroeconomic effects have in turn repercussions on emissions which, as seen in Chapter 1, are closely linked to GDP per capita and income distribution across and within countries. Furthermore, the age composition and education level of the labour force can determine the availability of specific skills which will be required for the industrial transformation towards a green economy.

This chapter complements Chapter 1 by examining how age, household size and rural-urban place of living can determine emissions in the EU [15].

[15] The analysis covers E27 with the exception of Austria and is referring to 2015 which represents the latest year available for the Household Budget Survey microdata.

The chapter focuses on the consumption channel. As stressed by several authors (Davis & Caldeira, 2010; Throne-Holst et al., 2007) and by the SGD 12 ("Unsustainable patterns of consumption and production are root causes of the triple planetary crises of climate change, biodiversity loss and pollution") to reach climate mitigation targets it is not sufficient to pursue improvements in energy efficiency and the decarbonisation on the production side but we need to look more closely on the less appealing idea of acting on the consumption side of emissions.

The analyses in this chapter are based on microdata from the Eurostat Household Budget Survey (HBS). HBS provides information about household final consumption of goods and services, with information on income and other demographic and socio-economic characteristics of households and their members.

The expenditure data from HBS, expressed in Euro, have been transformed into greenhouse gases and CO_2 equivalents using multipliers from Multi-Regional Supply and Input-Output Tables (Tukker et al., 2014). These tables connect production to final consumption giving a detailed representation of the interindustry monetary flows in national economies and international trade. With a set of environmental extensions, they also provide a translation of monetary flows into environmental impacts and material needs.

By considering the mix of a macro and micro approach we can avail on one side of a detailed breakdown of consumption by individual and household socio-demographic characteristics and, on the other side, reflect the specific characteristics and the environmental sustainability of national economies. In addition, the connection between national accounts through trade in the multiregional input-output tables allows accounting for the responsibility of emissions linked to the consumption of imported goods produced in other countries.

As a word of caution, it must be stressed that the emissions derived from the HBS do not allow to capture emissions related to government spending and public investments nor they can represent items of consumption related to one-time purchases such as a house or a new car.

In addition, the merging between the macro and microdata is not always straightforward since the two sources use different classification schemes, respectively the PRODCOM items of production in the multiregional input and output tables and the COICOP items of consumption in HBS. Our approach entails therefore a series of methodological adjustments and limitations which are described more in detail in the Appendix to Chapter 2.

The first four sections in this chapter describe the emissions patterns about income, the composition of the expenditure basket, the role of household size and of the rural-urban place of residence. Section five combines these different perspectives and examines the role of age on emissions after controlling for the other demographic characteristics, through a series of regression models. The final section provides a simple simulation of the evolution of emissions in the EU based on Eurostat demographic projections.

Findings

Emissions peak at middle age alongside the increase in income and expenditures

As indicated in Chapter 1 the strongest driver for emissions is income. Income is translating into consumption and, despite differences in the carbon intensity of different forms of consumption, the future of trajectories of emissions can be considered largely depending on economic growth.

A correlation between income and age is well established in the literature. Studies based on the system of National Transfer Accounts (R. Lee & Mason, 2014) show clear differences in the distribution of income, expenditure and public and private transfers across generations. This macro perspective is confirmed in our analyses of microdata from the HBS.

In Figure 13 we show the profiles of income, expenditure and emissions as a function of age. For most of the analyses included in this chapter where we refer to individual attributes and in particular to age, we allocate the HBS expenditure from the household to one reference person in household[16]. This solution is not just a technical step but relates more fundamentally to the issue of allocation of responsibility for emissions linked to decisions for consumption among the members of households. In our approach, we assume that the responsibility for emissions of children lies entirely with one of their parents. In other words, older persons

[16] The person aged 16 or more who most contributes to the household income, however some countries use subjective criteria (e.g. the person who is designated as such by the other members).

inherit the responsibility for the emissions linked to the age-specific patterns of consumption of the younger generations, as long as they live in the same household.

As shown in the upper panel of Figure 13 the profile of both income and expenditure as a function of age shows a typical inverted U shape. Both income and total expenditure increase until age 50-54 and then start to decline.

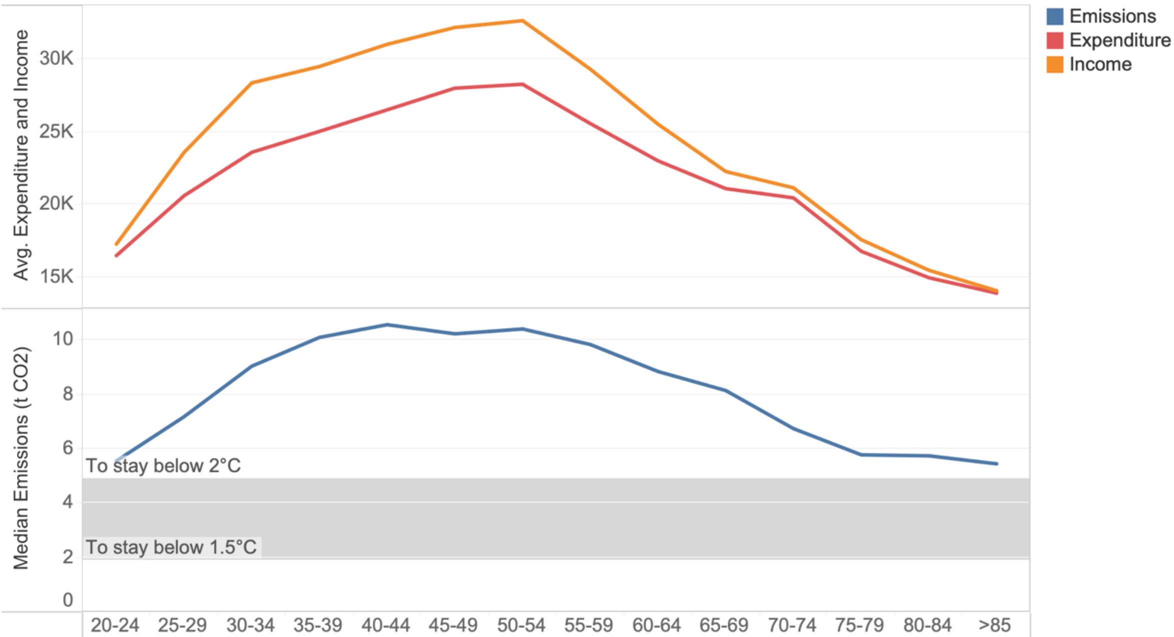

Figure 13 Average income and expenditure and median emissions by age in the EU (2015)

Source: own elaboration of Eurostat HBS microdata and CO_2 multipliers from Exiobase. Notes: the grey band shows the level of individual annual emissions in a world where the available carbon budget compatible with the targets of 1.5°C and 2°C would be equally distributed across the world population

The gap between the two lines, of expenditure and income, is following a similar inverted U shape and becomes larger in middle age. A lower gap in the case of the younger and older generations reflects the fact that they tend to consume a higher portion of their income. From this, they have lower room for savings and investments and possibly a need to compensate for deficiencies in income through intergenerational private or public transfers. The younger generation is mostly supported through private transfer by the parents while the older generation is supported by governments through the pension system.

In our data, we cannot observe expenditures linked to goods and services produced by governments such as education and health care. By imputing also these values to expenditures, like normally done in National Transfer Accounts, we would not just see a shrinking gap between consumption and income but actually that the older generation has a balance of consumption well over their income.

The unbalance between income and consumption across ages highlights the consequences of increasing dependency rates and the impact of demographic trends of ageing on the sustainability of the government's budget (R. Lee & Mason, 2014). What is more interesting for our purposes is that the profiles for income and expenditure after the conversion of Euro into CO_2 directly translate into a similar profile for emissions across age groups.

The lower panel in Figure 13 shows that the median emissions peak at age 40-44 and start to decline after age 50-54. The difference across age groups is substantial and corresponds to almost 5 t of CO_2 more for people aged 40-44 with respect to people aged 20-24 and over 75.

To put these numbers in perspective, the allowed emissions which at a global level would be compatible with 1.5°C and 2°C targets have been estimated in the range between 1.9 t and 4.9 t of CO_2, respectively (Chancel, 2022). The median of emissions across EU MS for all age groups is generally above these targets and in the case of ages 40-44, it is almost double what is allowed to reach the 2°C target.

Besides age differences, the close relationship between income, expenditure and emissions points to another form of inequality in the distribution of emissions in the population.

Chapter 1 already briefly described how the responsibility for emissions is unequally distributed across world countries depending on the level of GDP per capita. These global inequalities in the distribution of emissions about income are evident also in our household perspective and when considering the income distribution within EU countries.

Figure 14 provides an estimate of the median emissions across quantiles of the income distribution within the EU. The quantiles are ordered from low-income levels on the left to high-income levels on the right. They are calculated on each national distribution and therefore neutralise differences in income across EU MS.

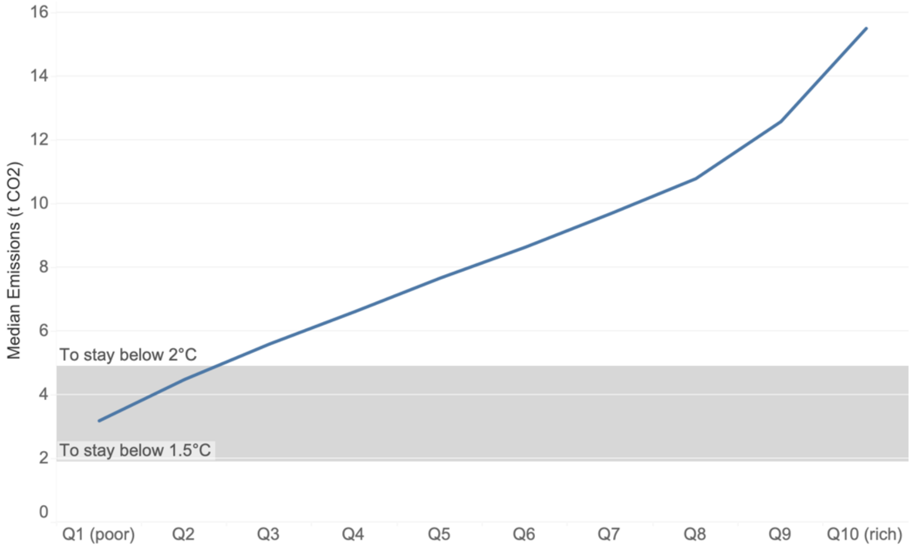

Figure 14 Median emissions in the EU by income quantile

Source: own elaboration of Eurostat HBS microdata and CO_2 multipliers from Exiobase

Also, in this case, the level of emissions is put in context with the level which would be required to limit global warming to 1.5-2°C. Median emissions increase with the level of income, starting from around 3 t CO_2 in the lowest income quantile to reaching around 16 t CO_2 in the highest income quantile.

The median level of emissions of the poorer households in the EU is within the range of the global individual emissions target of 2°C while the richest households in the EU have emissions which are seven times higher than what would be allowed to meet the 1.5°C target.

Taken together the two analyses above indicate that there are two interlinked forms of inequalities in the distribution of the responsibility for emissions in the EU. The first is inter-generational and the second is related to the unequal distribution of income within and across countries. Given the strong association between income and age, we can expect that ageing in the EU will impact emissions through both intergenerational economic transfer and income inequalities.

Emissions by younger generations are mostly caused by transport while older people have emissions concentrated on residential items such as heating and electricity

Despite the overall association between income and emissions, small differences between the two age profiles in Figure 13 can be explained by a different composition of the basket of consumption and the carbon intensity of the specific expenditure items during the life course.

Figure 15 shows for each age group the shares and the median absolute levels of emissions related to four main categories of expenditures: health, residential items, transports, food and a remaining other category grouping items such as education, clothing, communication, durable and non-durable goods.

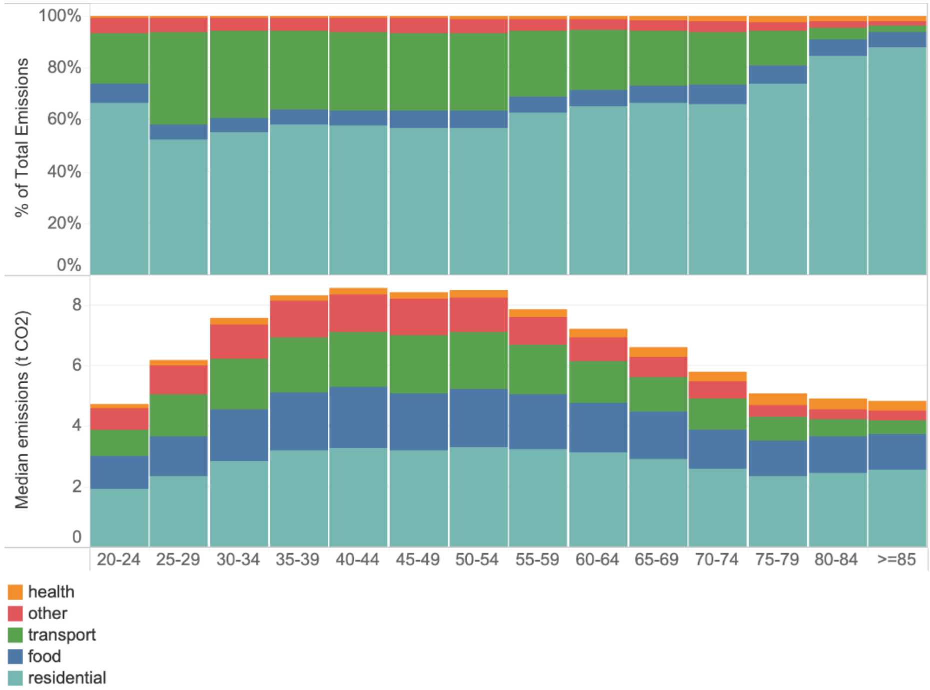

Figure 15 Relative and median absolute emissions in the EU by main consumption categories and by age (2015)

Source: own elaboration of Eurostat HBS microdata and CO_2 multipliers from Exiobase

Residential emissions have the most important role in total emissions for all age groups except ages 25-29. Their relevance is increasing with age, reaching more than 80% for people above 85. The residential category comprises items such as rents, which have a high weight in terms of expenditures but low impacts in terms of emissions, but also items such as energy for heating, gas and electricity, which have the highest multipliers for the conversion from Euro into emissions of CO_2 equivalents, among all expenditure items.

The second most impacting category is represented by transport. This category includes, among its most impacting items, sea transport, flights and gasoline and petrol for private cars. The relative importance of the emissions generated by transport is of almost 50% in the case of those aged 25-29. Transports emissions decrease with age and have therefore an opposite trend with respect to residential emissions. By age of retirement, the relative importance of total emissions linked to transport is halved to 25% and for ages above 85 it drops to less than 2.5% reflecting the almost total reduction of the mobility of very old people.

In the case of old people, it is also possible to observe the increase in emissions linked to health and a reduction of expenditure for the category other. These two categories have a very low relevance in terms of their contribution to total emissions.

In synthesis, a great part of the patterns of emissions is explained by a shift of importance for the two categories of residential and transport between younger and older generations. Transports play a major role in the case of younger ages while residential emissions play a major in older ages.

The items in the consumption basket react differently to changes in income within each age group, based on the discretionary versus non-discretionary nature of spending. This bears important implications for the possibilities of modifying the behaviours towards less impacting consumption patterns.

To highlight such constraints, Figure 16 presents the distribution of the total expenditures across the categories of consumption for each income and age group of the population. In this case, we consider a more detailed breakdown into electricity, gas and other fuels, food and non-alcoholic beverages, restaurants and hotels and transport. The figure tells for example that people of age above 60 in the poorest income quantile (Q1) have on average 12% of their spending destined to electricity, gas and other fuels.

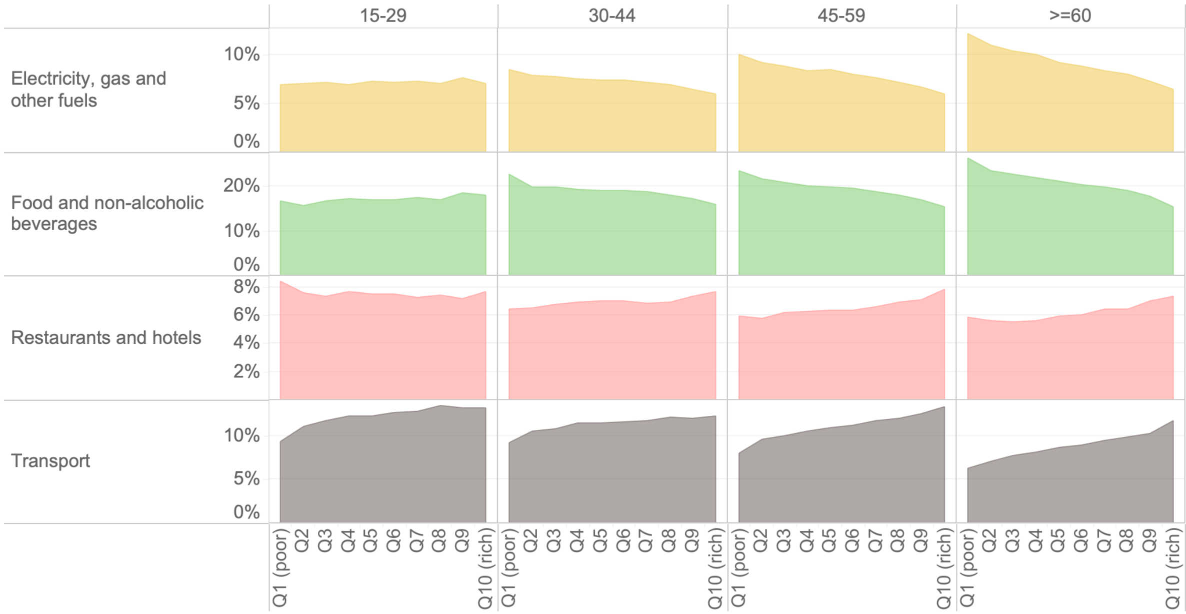

Figure 16 Median shares of specific items of consumption in the total expenditures of each age and income quantile group

Source: own elaboration of Eurostat HBS microdata

As already seen when considering the age patterns for emissions, independently from their income, people of age above 60 have a higher share of expenditures destined for residential energy while younger people towards transport. Figure 16 also highlights that within the age group over 60, the share of residential energy is particularly pronounced for the lower income quantiles and tends to decrease with income.

This pattern is in the opposite direction when considering the discretionary spending for restaurants and hotels and transport. In these cases, the old people in the richest income quantiles have higher relative spending than the poorest people.

In more technical terms we can recognise in these shares of consumption across ages and income levels variations in elasticities to income about discretionary versus non-discretionary spending.

The consumption of old people and poor people is concentrated on residential energy which not only has high carbon intensity but is also representing a high share of total expenditure due to its non-discretionary nature. This implies that for this type of consumption, they also have limited leverage to modify their behaviour.

In other words, the old and poor despite their low level of emissions in absolute terms are "trapped" in a pattern of high emissions in relative terms with limited scope to shift towards more sustainable lifestyles.

Given their smaller household size, older people have higher emissions when considering them in per capita terms

As indicated above when considering the spending patterns by age, so far, we have attributed household expenditures entirely to the reference person in the household. However, since the household size is also correlated with age, it is also relevant to explore how individual emissions vary when accounting for changes in household size over the life course.

For this purpose, we divide the total household expenditures and emissions by the number of members of each household [17] to obtain emissions in per capita terms.

[17] In line with analyses of income and other variables requiring to switch from a household to individual perspective we rely on the OECD-modified equivalence scale which assigns a value of 1 to the household head, of 0.5 to each additional adult member and of 0.3 to each child.

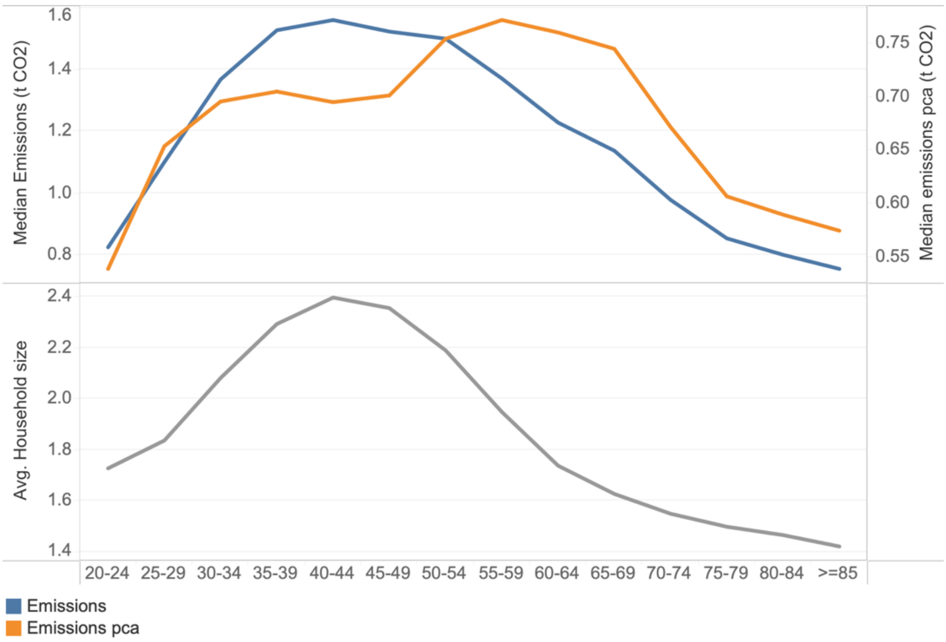

Figure 17 Median household and per capita emissions (upper panel) and average household size (lower panel) by age in the EU (2015)

Source: own elaboration of Eurostat HBS microdata and CO_2 multipliers from Exiobase

The size of the household is closely linked to the various stages of the life course and family formation. From the lower panel in Figure 17, we can observe that the average household size tends to increase with age and reaches its maximum value of 2.4 for reference persons aged 40-44. After this peak, the household size starts to decrease as a result of children leaving their families and, at older ages, the passing away of a partner.

These variations in household size have clear effects when switching from total emissions to per capita emissions. In particular, we can observe that due to smaller household size, emissions in per capita terms peak at 55-59 rather than at age 40-44. With ageing, per capita emissions continue to be high despite the decline in expenditures and income.

According to Eurostat data, the average household size in the EU was on average 2.2 members and the number of single-person households without children in the EU increased by 28.5 % between 2009 and 2021 (Eurostat, 2023b). As seen from the analysis in this section this demographic process of shrinking household size which is closely linked to low fertility could bring an increase in emissions at the aggregate level due to a reduction of so-called family economies (e.g., the energy consumption of houses designed for larger families will be shared by a smaller number of residents).

City residents can benefit from energy savings and urban economies of scale but they tend to emit more with respect to rural residents due to their higher income and their smaller household size

Besides age and household size, the third demographic characteristic which is expected to generate impacts on consumption and emissions is represented by the rural-urban place of living.

The findings from the literature on the impacts of urbanisation on emissions and environmental sustainability are mixed. Papers based on data at the national level, city level and micro analyses of household budget data find both negative and positive effects (Ala-Mantila et al., 2014; Fremstad et al., 2018; Koslowski et al., 2020; Moran et al., 2018). These mixed results may be linked to differences in the granularity of analysis, which especially in macro studies may constrain the possibility of properly controlling for income and other factors influencing emissions, in the geographical context, in the development level of countries and the stage of urbanisation. We may expect for example very different effects on emissions if we compare urbanisation in slums and megacities in developing countries with the densification of old cities in Europe, urban sprawling in the US or rapidly emerging new cities in China.

The latest IPCC AR6 synthesis report recognises with high confidence that urbanisation and urban form are among the three key drivers of emissions, besides population size and income (IPCC, 2023a). The report also highlights, on one side, the opportunities for decarbonisation through urban planning and, on the other side, the challenges posed by urbanisation and the positive correlation between urbanisation and income.

Cities allow for urban efficiencies and economies of scale, for example through the sharing of public spaces and transport, but they also entail an accelerated pace of life and changes in lifestyle with potential adverse consequences on emissions. These two contrasting factors emerge clearly when looking at how the growth of material infrastructure and innovation and economic activity scale differently to city population size.

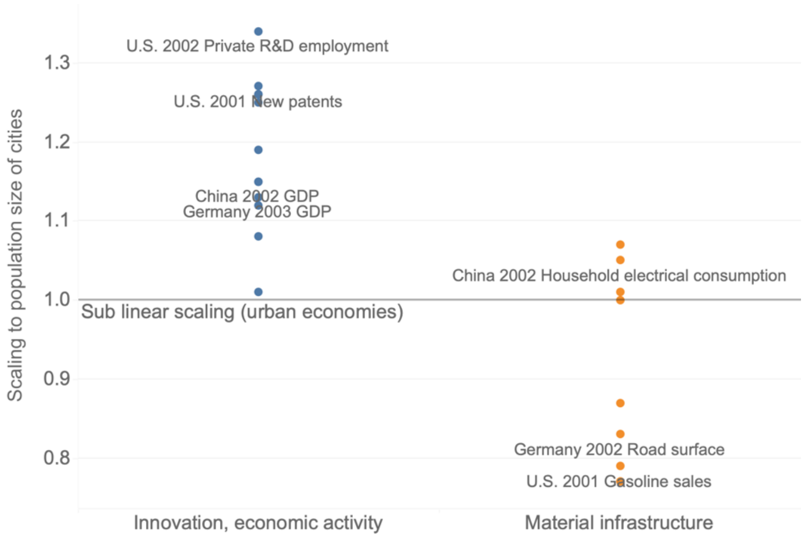

Figure 18 Examples of scaling of innovation, economic activity and material infrastructure with respect to population size.

Source: reproduction of estimates published in Bettencourt (2020).

In Figure 18 a scaling factor above one in the case of innovation and economic activity like new patents, employment and GDP means that cities create the conditions for economic growth over their population, while a scaling factor lower than one for material infrastructure like road surface and gasoline sales, points to higher efficiencies and so-called urban economies of scale. As succinctly stated by West in his attempt to establish a new "science for cities" the very essence of cities and their "job" is to facilitate human interaction, innovation and exchange of information by providing adequate and more efficient infrastructure (West, 2017).

The potential adverse consequences of emissions entailed in this role lie in the correlation between higher income and consumption. A key question which needs to be still addressed is if the process of urbanisation is still very strong in developing countries, urban efficiencies will prevail on the emissions generated by higher income and lifestyle changes. In the case of the EU, where urbanisation is almost complete and on the contrary, there are signs of counter-urbanisation and suburbanisation, the questions are: first if these processes are going to be substantial and second if they will imply losing some of the advantages of cities in terms of economies of scale, while not fundamentally altering the high levels of consumption.

In line with the other analyses of this chapter, we approach these questions by using data from the HBS survey. In this case, we consider how emissions vary in function of the variable of the degree of urbanisation which describes if the household is residing in a city, town or rural area.

Also, by looking at simple median emissions across these three classes of the degree of urbanisation (Figure 19) we can recognise that the place of residence of households has indeed considerable impacts on both the relative composition of emissions across categories of consumption and their absolute level.

In the three rural-urban typologies residential emissions play the major role ranging from 60% in cities, 55% in towns and above 70% in rural areas. In rural areas, residential emissions have the highest share in total emissions (73%) but a low absolute level (2.5 t CO_2) in comparison to cities (3 t CO_2) and towns (3.2 t CO_2).

Emissions linked to transport play a relatively smaller role in rural areas while they register, in absolute terms, a similar value to the emissions in cities.

Towns appear to be penalised both with respect to cities and rural areas, given the higher transport emissions in relative and absolute terms and high residential emissions in absolute terms.

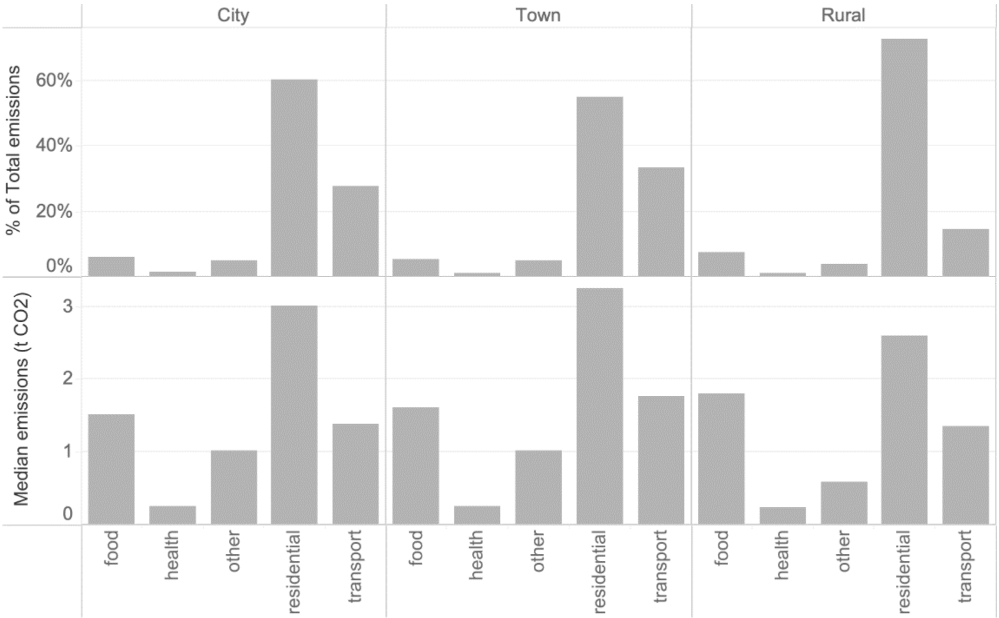

Figure 19 Relative and absolute (median) emissions by category of consumption and degree of urbanisation

Source: own elaboration of Eurostat HBS microdata and CO_2 multipliers from Exiobase

To further explore the effects of the rural-urban typologies we use a series of regression models which allow capturing simultaneously effects linked to age structure, income and household size.

Figure 20 presents the results of three models showing for simplicity only the coefficients for the degree of urbanisation (for full model results see table in Appendix to Chapter 2).

Figure 20 Effect of the degree of urbanization on emissions in three separate regression models

Source: statistical models based on Eurostat HBS microdata and CO_2 multipliers from Exiobase. See Appendix to Chapter 2 for models' specifications and results

The first model on the left includes controls for income and age. In this model households living in towns and rural areas have higher emissions than those living in cities (considered as baseline). This model is neutralising the effect of a younger population and more importantly the higher income in cities. The levelling of income allows for urban economies to emerge and highlights the beneficial effects on emissions linked to savings from shorter commuting time, more efficient and sustainable transport and smaller houses.

In the second model, after excluding the control for income, the lower consumption in rural areas prevails and we obtain a lower emission for rural residents in comparison to people living in cities.

The last model by considering as a dependent variable the emissions in per capita terms further reduces the effect on emissions for rural residents in comparison to those living in cities. The results of this model are explained by the fact that people in rural areas can share emissions with more family members and benefit from so-called family economies.

As already seen with the descriptive analyses in Figure 19, households in towns are at an intermediate position having higher emissions due to the higher income in comparison to those living in rural areas and higher emissions in comparison to those living in cities mainly due to the high incidence linked to transports [18].

In essence, there are three components which can determine differences in emissions across rural-urban typologies. In cities, the advantages linked to urban economies of scale are contrasted by higher consumption and by a lower family economy and can only emerge when controlling for these two last components.

When controlling for income, household size and place of residence, emissions tend to increase with age

The patterns of income and expenditure and households' size in function of age, described in previous sections, can be finally combined in a series of regression models to explore the role of age on emissions.

[18] To explore what is driving differences in total emissions we used a series of models fitted independently for the main categories of consumption. For detailed model results see Appendix to Chapter 2.

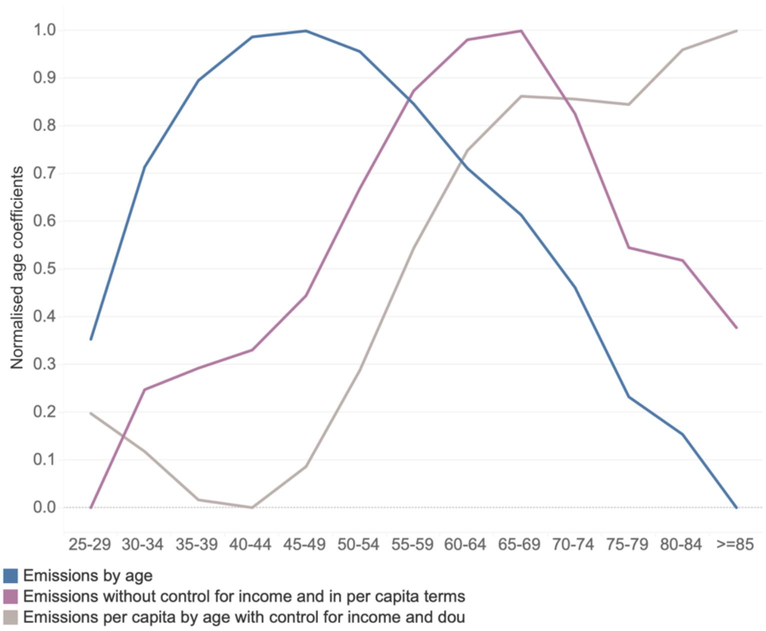

Figure 21 Effects of age on emissions, emissions per capita and emissions per capita after controlling for income, education and degree of urbanization

Source: statistical models based on Eurostat HBS microdata and CO_2 multipliers from Exiobase. See Appendix to Chapter 2 for full models' specifications and results. Notes: regression coefficients for age are normalised using min-max normalisation

Figure 21 shows these effects in the form of normalised coefficients for age estimated in three regression models.

The first model has as a dependent variable the total emissions of the household and as the only independent variable the age of the reference person of the household. The second model considers emissions per capita as the dependent variable. The last model expands the second model with the addition of the level of income of the household and the place of residence of the reference person, as control variables.

The inverted U-shape age profile emerging from the first model for total emissions mirrors closely resembles the expenditures and income profiles by age already seen in Figure 13. The largest effect on emissions is recorded for ages 40-44 and 45-49 and decreases progressively with age, suggesting that emissions may be related to the financial resources of households at different ages.

The accounting of the different household sizes in the second model has a critical effect on the age profile of emissions. The emissions per capita remain low at younger ages corresponding to childbearing and family formation. After age 45-49 when the children leave their families, the emissions increase more rapidly, and after age 60-64 they start to decrease.

In the third model, after controlling for the effect of income, the per capita emissions for ages 25-29 become more evident. The effect on emissions decreases to the lowest level at age 40-44 and afterwards starts again to increase with age.

This last model is in line with the results in other studies (Ottelin, 2022; Zheng et al., 2022) showing the increase in the level of per capita emissions associated with ageing societies. However, when confronting with the other two models, it is also possible to recognise that the higher levels of emissions of older people are generated by the reduction of the household size and emerge only after controlling for their decreasing income.

In other words, older people can be accountable for higher emissions only in relative terms within a lower overall level of expenditures and mostly because they cannot benefit from the economies of scale of living in large families.

Demographic decline and ageing in the EU could bring a decrease in emissions in the long run and to a concentration of the responsibility for emissions in older age groups

Previous sections have shown that the emissions are depending on age, household size and degree of urbanisation. These are static patterns referring to 2015. Future emissions scenarios will be shaped by how the decarbonisation and energy efficiency gains in the green transition will interact with economic growth and with changes in demographic characteristics, that, as we have seen, can influence the level and type of consumption in a more complex way than just the total population.

A proper model to project the evolution of all these components goes beyond the scope of this report. However, to have an idea of the consequences of ageing in terms of emissions we revert to a stylised projection where we simulate the effect of age keeping all the other elements static. In this model, we apply the coefficients estimated from the model on emissions per capita by age to the Eurostat projections of the EU population until 2100.

Through this approach, we take a series of simplifying assumptions. First, we consider the same carbon intensity coefficients of consumption embedded in the CO_2 multipliers of 2015. Secondly, we let all the dimensions play their role only through age, possibly neglecting changes in the relations between age and household size and urbanisation. Finally, we assume that the relation between age and emissions remains constant over time and therefore we do not account for the possibility that future generations will adopt different behaviours in comparison to their parents at the same age.

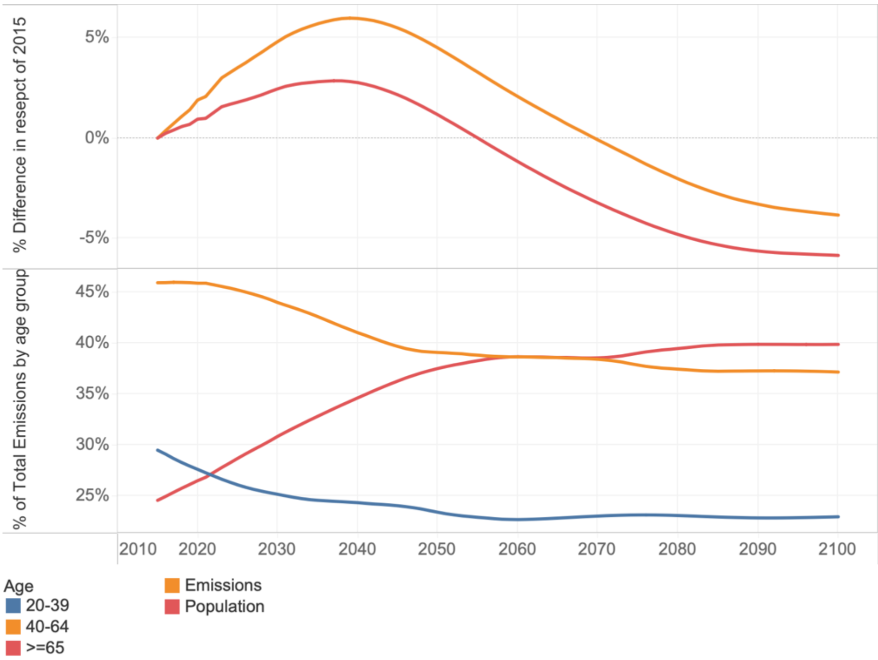

Figure 22 Projected percentage change of emissions in the EU (upper panel) and share of projected emissions by age groups (lower panel)

Source: the projected emissions are calculated by applying the age-specific emission coefficients (see Figure 21) to the Eurostat EUROPOP19 projections

The results of the projection are presented in the upper panel of Figure 22 in terms of the percentage change of emissions with respect to the level of emissions of the year 2015. To compare this outlook for emissions with the trend for population, the same graph includes the percentage change for the total population.

The projections indicate that emissions would increase with respect to the baseline reaching an excess of almost 6% by 2039. After this peak, they are expected to decrease by 4% by the end of the century.

Emissions increase more than just population. In particular, they are expected to exceed population growth by 3% in 2039. In the long run emissions in the EU will decline following population trends but this decline will be less rapid due to the impacts of ageing on consumption.

Overall, the effect of ageing is present but not striking. What is probably more relevant to note in the lower panel of Figure 22 is that demographic trends will also imply a change in the relative responsibility for emissions across age groups with a shift in the responsibility for emissions towards older generations. By 2060, 39% of total emissions will be produced by people above 65 and this will group will overtake the other two younger age groups in terms of responsibility for emissions. On the contrary, the responsibility for emissions of the age group 20-39 is expected to constantly decrease from 30% in 2015 to around 23% from 2060 until 2100.

Conclusion

This chapter considered how demographic characteristics and in particular age, household size and rural-urban residence could influence emissions through a series of effects on consumption. Especially in the EU where population growth is not expected to play a big role in future emissions, it is important to look at the role of these demographic characteristics rather than total population size.

The increase in the share of emissions produced by older people bears policy implications for the targeting of climate mitigation policies. Older people despite the lower consumption in absolute terms have higher concentrations of emissions on high carbon intensity products and produce more emissions in per capita terms. They are also more represented in rural areas than cities and cannot avail of urban economies. Finally, they have fewer possibilities to change patterns of consumption having a concentration of spending on high carbon intensity items which also have low elasticities to income.

All these factors taken together and from a future perspective highlight a priority of targeting mitigation policies, particularly for older generations.

The shift in the responsibility for emissions between generations brings new elements to the debates around social justice in climate change besides the normal consideration of income inequalities. On one side, climate change is impacting younger generations, on the other side, the responsibility for emissions will increasingly lie in older age people, who do not necessarily have the means to modify consumption towards more sustainable lifestyles.

The next chapter shows how these intergenerational differences in the responsibility for emissions linked to consumption patterns also relate to differences in attitudes and concerns about climate change and elaborates on how attitudes may or may not translate into behaviours and actions.

Chapter 3 Sociodemographic differences in the attitudes towards climate change

Key messages

- According to the Climate Change Special Eurobarometer survey, citizens of EU countries think that climate change has become the single most serious problem facing the world as a whole. Around four in five EU citizens perceive climate change as a very serious problem.
- The perception of the severity of climate change differs across groups with disparate sociodemographic characteristics. Younger generations, highly educated individuals, and residents of large towns within the EU are more likely to believe that climate change is the most serious and a very serious problem.
- A large majority of EU citizens say that governmental entities are responsible for tackling climate change and around two-thirds report that they recently took personal action to fight climate change. More educated individuals are more likely to identify at least one responsible governmental body and to claim to have taken personal action.
- Reported personal behaviours differ by the degree of individual concern about climate change. EU citizens that perceive climate change as a bigger problem and that see an individual level of responsibility for action also more often claim to have taken personal steps to tackle climate change.
- Almost all EU citizens support the key target of the EU strategy on Adaptation to Climate Change of making the EU economy climate-neutral by 2050. About four out of five EU citizens believe that the damages caused by climate change outweigh the costs of a green transition.
- Over the past decade, the perceived seriousness of climate change increased among EU citizens. The awareness of the severity of climate change varies less across age groups than over time. This might indicate that individual perceptions of climate change are more determined by the zeitgeist than elements that are characteristic of specific generations.
- The findings on the attitudes towards climate change recorded in the EU are broadly in line with the general trends at a global level. According to the Afrobarometer survey, around three out of five citizens of selected African countries heard about climate change but the awareness is decreasing with age, the educational level, and is less prevalent among rural area residents.
- A large majority of those African citizens that heard about climate change say that climate change is making life worse. Similar to EU citizens, African citizens that perceive climate change as a bigger problem also more often believe in the effectiveness of personal actions to fight it.

Introduction

The increasing visibility of the adverse effects of climate change through the expanding intensity and frequency of extreme weather events generated growing public attention for the topic of climate change. As described at length in Chapter 1 of this report, important international debates about the urgency of climate action have led to an increasingly conducive environment for the adoption of climate mitigation policies. In 2015, the United Nations General Assembly established the Sustainable Development Goals including a specific goal on climate action. In the same year, the Paris Agreement has been negotiated by 195 signatories, which sets the target of limiting the rise in global temperature levels to well below two degrees Celsius. As discussed in more detail in the box in the introduction of this report, the European Green Deal has been adopted in 2019 as an essential adaptation strategy. It contains key targets for tackling climate change and challenges related to environmental factors. Finally, in recent years, the Fridays for Future movement gained momentum and mobilized millions of participants in climate strikes worldwide.

In light of the growing level of public attention and important debates about climate change topics, this chapter provides an overview of people's perceptions and attitudes towards climate change. To this end, the chapter turns to the individual perspective. It complements the previous chapters by analysing how individuals perceive climate change, how they evaluate the importance of personal actions and the responsibility of state authorities for tackling climate change, and how they assess public policies and the goals of the EU strategy on Adaptation to Climate Change. In line with the general topic of the report, the chapter specifically focuses on the links between sociodemographic dimensions and attitudes towards climate change. Since individual consumption habits are affected by the personal level of concern about climate change (Saari et al., 2021), the analysis aims to address whether differences in attitudes and behaviours are potentially a contributing factor behind the relationship between age and emissions outlined in the previous chapter. In addition, the chapter analyses which other sociodemographic factors take on a pivotal role in potentially shaping climate actions.

The current analysis builds predominantly on survey data from the Climate Change Special Eurobarometer waves biennially collected since 2009. This survey collects information on individual perceptions and attitudes towards climate change in all European Union Member States and consists of nationally representative samples of around 1,000 respondents per country. The major focus of the chapter lies on the attitudes of European citizens towards climate change and on how these attitudes vary across groups with specific sociodemographic characteristics. The chapter describes the results of a multivariate regression analysis that allows estimating the effect of various sociodemographic variables on individual attitudes towards climate change. In this way, the chapter mirrors the analysis of the previous chapters. More specifically, chapter 2 demonstrated the relevance of age and other sociodemographic factors in shaping emission levels. Building on this finding, this chapter studies whether similar patterns are also reflected in individual attitudes and behaviours to further enrich the analysis of the interactions between demographic change and green transition. Furthermore, the current chapter addresses how some of the attitudes evolved over the most recent decade to investigate whether attitudes are ultimately formed by the particular mindset of a certain generation or rather strongly affected by factors that are contemporary at certain points in time.

The threats associated with climate change are not limited to the European context. It is therefore essential to broaden the geographical scope of the chapter and to include a global dimension in the analysis of this report. In recent years, a massively increasing number of international surveys studied individual attitudes towards climate change in various world regions (for a limited selection of the latest surveys see (Dabla-Norris et al., 2023; Dechezleprêtre et al., 2022; IPSOS, 2022; Pew Research, 2022; Seah et al., 2022; UNDP & Univeristy Oxford, 2021). Overall, several common findings of these surveys indicate that people are globally getting more concerned about climate change, younger individuals are more worried about climate change, and education is an important sociodemographic factor shaping attitudes towards climate change (Arıkan & Günay, 2021; Kvaløy et al., 2012; T. Lee et al., 2015; Levi, 2021). The final section of this chapter adds further details to these general common findings by providing information on attitudes towards climate change in 34 African countries. The analysis relies on nationally representative survey data from the 2016-2018 wave of the Afrobarometer. This allows placing the specific findings on the attitudes of EU citizens into a broader global perspective.

Findings

EU citizens think climate change is the single most serious problem

According to the most recent wave of the Climate Change Special Eurobarometer, around 18 per cent of individuals in the EU identified climate change in 2021 as the single most serious problem facing the world as a whole. When asked to select the most serious issue among a list of eleven items, respondents to the Eurobarometer most frequently named climate change.[19] This means that the share of respondents who see climate change as the most pressing concern is larger than the share of respondents who identify issues such as poverty, hunger and lack of drinking water (17 per cent of respondents), the spread of infectious diseases (17 per cent) or the economic situation (15 per cent) as most severe. For the first time since respondents were asked to identify the single most serious problem facing the world as a whole, climate change tops the list of selected problems.[20]

In terms of the perceived seriousness of climate change, a vast majority of EU citizens say that climate change is a very serious problem. Respondents to the Eurobarometer were asked to rank the seriousness of climate change on a scale from one to ten. More than 78 per cent of EU citizens assign a number of seven or higher to the seriousness of climate change, which is interpreted as the threshold for seeing climate change as a very serious problem.

Younger generations in the EU more often perceive climate change as a serious problem

As described in detail in Chapter 2, the level of emissions is essentially affected by sociodemographic characteristics. Age is a particularly important factor shaping emissions. This chapter analyses whether a similar relationship is also reflected in individual attitudes towards climate change. The Eurobarometer indeed indicates

[19] The precise question texts and answer options are provided in the Appendix to Chapter 3.

[20] In the 2021 Special Eurobarometer questionnaire, three new items were added to the list of single most serious problems, which implies that the question cannot be used directly to compare results between different waves of the survey. Nevertheless, over the years the list of items has been expanded which might have even reduced the likelihood that climate change tops the list of most serious problems.

that the shares of individuals that regard climate change as the single most serious problem and as a very serious problem vary across groups with different sociodemographic characteristics. Except for the oldest age group, climate change is selected more often than any other item as the single most serious problem facing the world as a whole across all age groups. Only among respondents older than 60 years of age, the share of respondents that identify the spread of infectious diseases as the most pressing issue (20 per cent) is larger than the share of respondents selecting climate change (16 per cent).

Younger people are more likely to see climate change as the single most serious problem and as a very serious problem than older generations. Figure 23 illustrates that the shares of respondents seeing climate change as the most or as a very serious problem are decreasing across four age groups. While around 21 per cent of EU citizens of 15-29 years of age perceive climate change as the single most serious problem, this share decreases to 18, 17, and 16 per cent, for EU citizens 30-44, 45-59, and above 60 years of age, respectively. Similarly, around 83 per cent of EU citizens of 15-29 years of age think that climate change is a very serious problem, whereas this share amounts to approximately 78 per cent for the other three age groups.

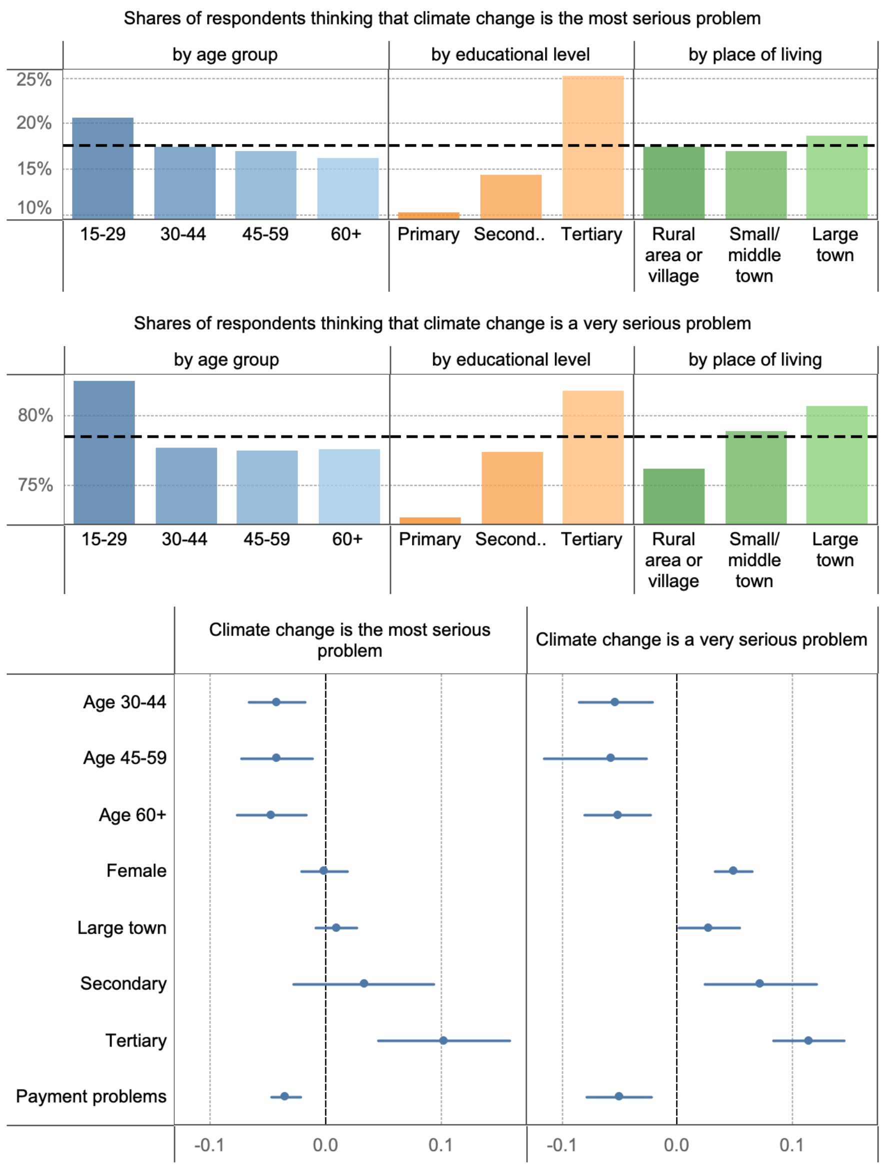

Figure 23 Perceived seriousness of climate change in 2021 in Europe

Source: own elaboration and regression analyses based on Eurobarometer, 2021

These patterns are confirmed by the results of a multivariate regression analysis. More specifically, a logit model is used as a strong analytical tool that provides further insights and adds precision to the estimated relationship between sociodemographic characteristics and attitudes towards climate change.[21] The specifications include dummy variables for the age groups analysed above and multiple additional sociodemographic variables. The lowest panel of Figure 23 contains the visualisation of the regression results. The figure depicts the estimates expressed as average marginal effects and the corresponding confidence intervals. The estimation coefficients for the age group dummies show that older age groups are less likely to perceive climate change as the single most serious problem or as a very serious problem. The coefficients for the three older age groups are negative and the results are highly statistically significant. For example, the probability that individuals between 30 and 44 years of age name climate change as the single most serious problem is 27 per cent lower than for the reference age group of individuals of 15-29 years of age. Similarly, individuals aged 30 to 44 are 28 per cent less likely to see climate change as a very serious problem than those aged 15 to 29.

Highly educated EU citizens are more concerned about climate change

In addition, Figure 23 illustrates how the perceived seriousness of climate change varies by groups with different educational levels. Compared to the group with a primary level of education, the share of individuals selecting climate change as the single most serious problem facing the world as a whole is around 2.5 times larger for the group with a tertiary level of education. Likewise, only 73 per cent of EU citizens with primary education see climate change as a very serious problem. This share rises to 77 and 82 per cent for EU citizens with a secondary and tertiary level of education, respectively.

The multivariate regression analysis also includes dummy variables for different educational levels. The statistically significant results confirm that highly educated individuals have a higher probability of thinking that climate change is a very serious issue. Compared to the primary educated, those holding a tertiary degree of education are around twice as likely to see climate change as the most serious problem and as a very serious problem.

Residents of large towns within the EU more often perceive climate change as a very serious problem

Climate change is more frequently regarded as a very serious or as the most serious problem in large towns than in middle towns or rural areas.[22] Around 19 per cent of respondents in large towns across the EU see climate change as the most serious problem, and 81 per cent of residents of large towns think that climate change is a very serious problem. These shares are much smaller for individuals in rural areas or middle towns, amounting to 17 per cent and between 76 and 79 per cent, respectively.

The coefficient for the dummy variable capturing whether an individual lives in a large town is positive and statistically significant for the question about the perceived seriousness of climate change. Inhabitants of large towns are 18 per cent more likely to believe that climate change is a very serious problem compared to residents in middle towns and rural areas.

Finally, it is important to note that the individual economic situation affects the perception of the seriousness of climate change (Baiardi & Morana, 2021). Those respondents that report difficulties paying their bills at the end of the month are 23 per cent less likely to see climate change as the single most serious problem and 27 per cent less likely to see climate change as a very serious problem compared to the group of citizens without such payment problems.

Governments are seen as key actors responsible for tackling climate change in the EU

In addition to public awareness about the risks associated with climate change, broad public support is essential in order to enable governmental entities to design effective policies for climate change mitigation. This requires comprehensive public acceptance of governmental authority for taking climate action, which may not be automatically granted by citizens (Fairbrother, 2022). For example, Dechezleprêtre et al., (2022) and Drews & Bergh, (2016) show that public support for climate policies is determined by a variety of factors and is context-specific. Respondents to the Special Eurobarometer were asked to select from a list of six items the entities they perceive as being in charge of addressing the effects of climate change. Multiple selections were allowed.

[21] Details on the model specification and the corresponding regression tables are provided in the Appendix to Chapter 3.

[22] The classification across the rural-urban typology follows the self-reported categories included in the Special Eurobarometer questionnaire. The precise question texts and answer options are provided in the Appendix to Chapter 3. The three categories analysed here might be interpreted as cities, towns, and rural areas as defined in the new degree of urbanisation (Dijkstra & Poelman, 2014).

A total of 85 per cent of respondents think that at least one governmental entity is responsible, consisting of 63 per cent of respondents mentioning national governments, 57 per cent selecting the EU, and 43 per cent choosing regional and local authorities. At the same time, around 58 per cent of EU citizens see the responsibility with businesses and the industry, 41 per cent report a personal level of responsibility, and 30 per cent mention environmental groups.

Figure 24 provides the shares of EU citizens identifying at least one governmental entity as being responsible for tackling climate change disaggregated by groups with specific sociodemographic characteristics. The shares are increasing only slightly across most of the age groups and the rural-urban typologies. They deviate from the total average share by a maximum of around one percentage point. By contrast, 82 per cent of EU citizens with a primary level of education name at least one governmental entity as responsible for tackling climate change, compared to as many as 89 per cent of highly educated EU citizens.

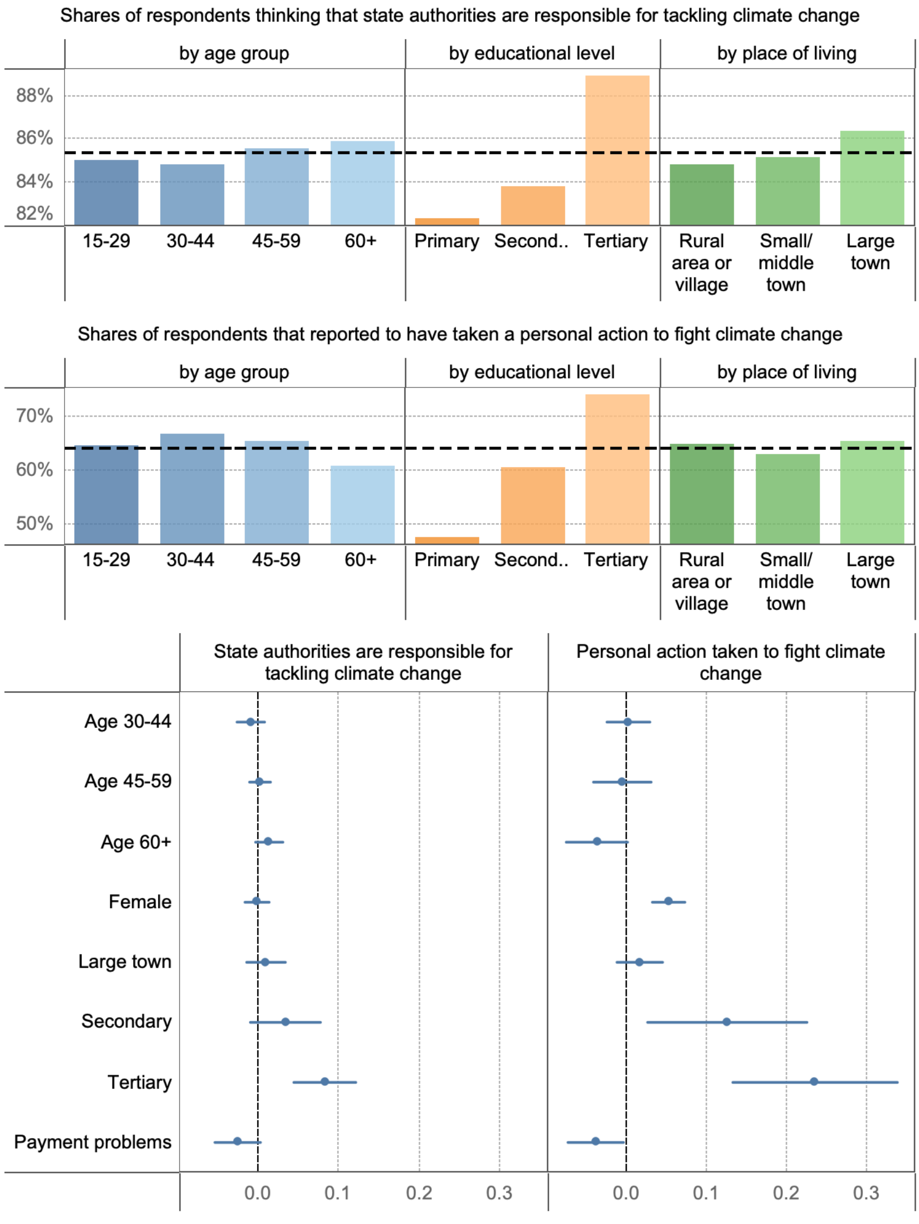

Figure 24 State responsibility and personal action for fighting climate change in 2021 in Europe

Source: own elaboration of regression analyses based on Eurobarometer, 2021

Almost two in three EU citizens report that they have personally taken action to tackle climate change

In addition to general public support for climate actions of governmental actors, efforts at the individual level are essential for addressing the complex challenges associated with climate change. According to the Eurobarometer, 64 per cent of EU citizens claim to have taken action to fight climate change over the past six months. While this fraction does not differ considerably across age groups and among urban and rural area residents, the share of EU citizens that report having taken action is 26 percentage points larger for those with the highest level of education than for the primary educated.

These findings are confirmed by the results of a multivariate regression analysis. The lower panel of Figure 24 shows that the average marginal effects are very close to zero for the dummy variables reflecting the age and place of residence. Moreover, almost none of the estimated coefficients for those variables are statistically significant. Meanwhile, EU citizens with a tertiary level of education are almost twice as likely to place responsibility for climate action on at least one governmental entity and are about three times more likely to say they have taken personal action than EU citizens with primary education. As opposed to the effects for most of the other variables, these results are highly statistically significant.

Finally, compared to the group of individuals without payment problems, those with such financial issues have a 19 per cent and 17 per cent lower probability to assign responsibility to governmental entities and to say they have taken personal action to address climate change, respectively.

Climate change awareness and the reported individual actions to tackle the issue are interlinked in the EU

While the previous sections highlighted an increasing level of public awareness about the problem and a common belief of sharing a personal level of responsibility for addressing climate change issues, it is less clear whether these higher levels of awareness also lead to changes in individual behaviours. For example, a recent study in Germany identifies a gap between behaviours and attitudes providing no strong evidence for adjustments in consumption habits (Venghaus et al., 2022). In light of this evidence, this section analyses whether personal actions and climate change awareness are potentially interlinked.

Figure 25 shows the differences in reported behaviours for those Europeans that are relatively more or less concerned about the severity of climate change. Among the 78 per cent of respondents to the Eurobarometer that perceive climate change as a very serious problem, 69 per cent also report having taken personal steps to tackle climate change. By contrast, among the respondents that do not see climate change as a very serious issue, only 47 per cent claim to have taken action (left panel of Figure 25). Similarly, 78 per cent of those that believe to be personally responsible also say they took some personal action to tackle climate change in the past six months (right panel of Figure 25). This share is 24 percentage points smaller for those Europeans that do not see a personal level of responsibility. In line with the findings of other studies, this shows that the individual perception of personal responsibility is an essential determinant of attitudes towards climate change (Syropoulos & Markowitz, 2022).

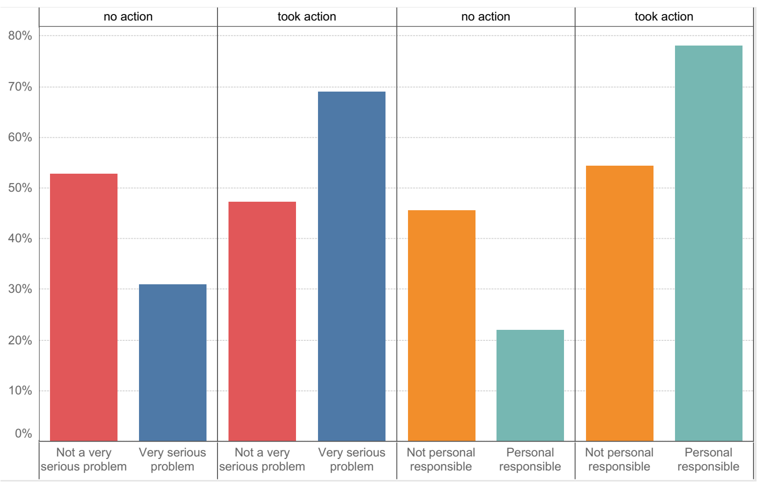

Figure 25 Perception of climate change and personal action in 2021 in Europe

Source: own elaboration based on Eurobarometer, 2021

While Figure 25 indicates that potentially a strong link between climate change awareness and behaviours exists, it is important to recognise that the current analysis is not able to overcome the potential biases resulting from a gap between reported and actual individual behaviour. In this regard, some of the recent literature report a change in individual voting behaviour and increasing public pressure for placing climate action high on political agendas (Hoffmann et al., 2020; Venghaus et al., 2022). The next section, therefore, turns to the analysis of individual support for public policies related to climate action within the EU.

A large majority of EU citizens support the key goals of the European Climate Law

Multilateral settings are seen as particularly effective and suitable for designing policies in climate action (Bechtel et al., 2022). In that sense, the adoption of the European Green Deal in 2019 has been a milestone for the EU on the path to addressing the risks of climate change and achieving climate neutrality.[23] The key element that characterises European Climate Law is the goal of making the EU climate-neutral by 2050 through a reduction in greenhouse gas emissions to a minimum while counteracting the remaining emissions. In 2021, the EU reaffirmed its goal of achieving climate neutrality by reducing emissions within the EU by at least 55 per cent by 2030. According to the Eurobarometer, more than 92 per cent of EU citizens declare agreement with the key target of achieving climate neutrality by 2050.[24] Figure 26 illustrates that for none of the groups with different sociodemographic characteristics described in this chapter, the approval rate deviates more than one percentage point from the total average approval rate. This indicates that different sociodemographic factors do not markedly affect individual support for the key target of the European Climate Law of achieving climate neutrality.

[23] See the box on population and demography in EU Green Deal Policies in the introduction of this report for a detailed discussion of the development of the EU Adaptation to Climate Change policy frameworks.

[24] In order to ensure consistency with respect to the questions analysed above, the respondents that report to not knowing an answer to the question are excluded for the computation of approval rates.

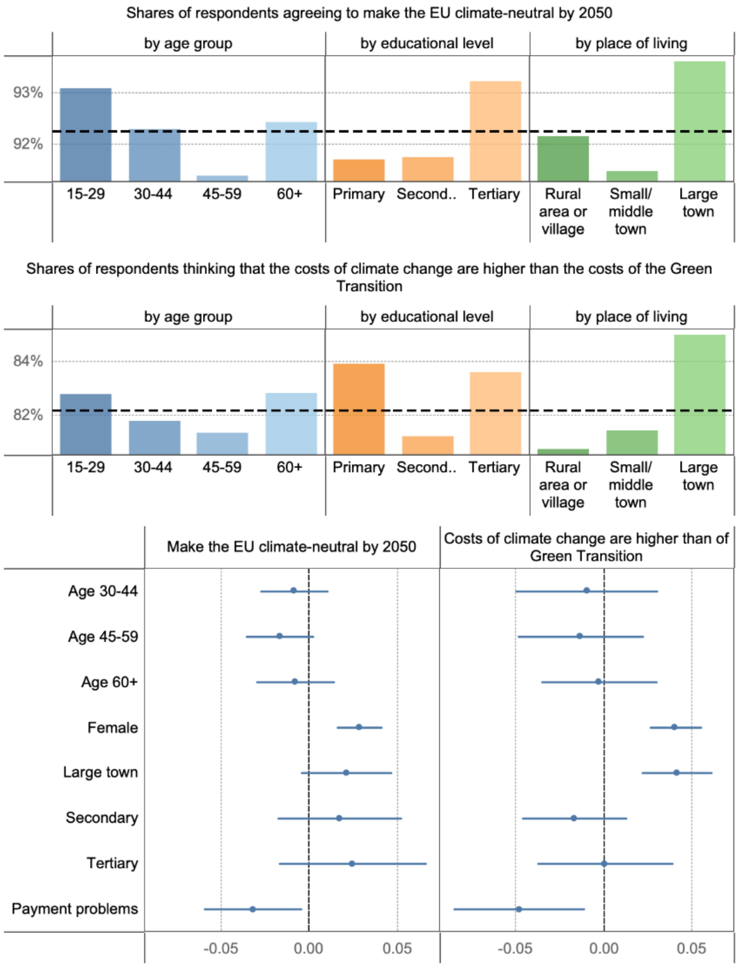

Figure 26 Attitude towards green transition in 2021 in Europe

Source: own elaboration of regression analyses based on Eurobarometer, 2021

In addition, around 82 per cent of EU citizens think that the costs of the damages caused by climate change are substantially higher than the costs associated with investments required for a green transition.[25] Only for the group of inhabitants of large towns, the agreement rate differs by more than two percentage points from the average rate and peaks at almost 85 per cent.

Similar to figures 1 and 2, the lower panel of Figure 26 illustrates the results of a multivariate regression analysis addressing the alignment of EU citizens with the specific climate mitigation measures outlined above. Unsurprisingly, the depicted absolute sizes of the average marginal effects are much smaller than the effect sizes for the multivariate regression analyses reported in Figure 23 and Figure 24. This provides additional suggestive evidence that individual agreement with the central elements of European Climate Law is less affected by sociodemographic characteristics than the level of concern and perception of responsibility for tackling climate change.

In the EU, the attitudes towards climate change vary stronger over time than across age groups

While the findings described above point to an inverse relationship between the level of climate change concern and age, there is a large strand of literature studying whether this relationship simply reflects characteristics specific to certain generations (Ballew et al., 2019; Skeirytė et al., 2022). Hence, the distinction between age-specific and cohort-specific effects merits attention (Geys, 2006; Gray, 2014; Milfont et al., 2021). To a limited

[25] In order to ensure consistency with respect to the questions analysed above, the respondents that report to not knowing an answer to the question are excluded for the computation of approval rates.

degree, the Eurobarometer allows focussing on this distinction since it collected information about the individual perceptions of climate change for more than a decade.[26] Figure 27 illustrates how the attitudes towards climate change evolved over time and varied by different age groups. The share of respondents thinking climate change is a very serious problem increased by about ten percentage points from 69 per cent in 2011 to 79 per cent in 2021. At the same time, for none of the six periods analysed in this report, the age-group-specific shares of people perceiving climate change as a very serious problem deviated by more than five percentage points from the total average shares. This suggests that climate change awareness is more influenced by time-specific factors than characteristics that distinguish different generations.

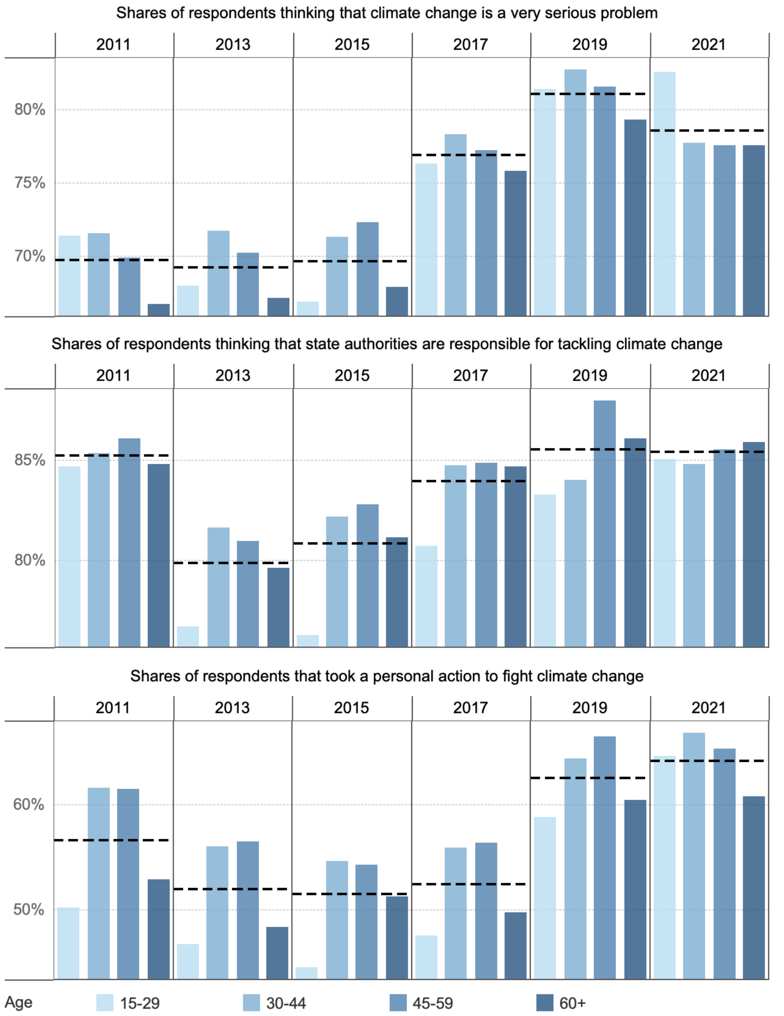

Figure 27 Opinions and attitudes towards climate change by age groups over time in Europe

Source: own elaboration of Eurobarometer (2011-2021). Notes: Due to changes in EU memberships, the composition of the country sample changed over time. The samples include Croatia since 2013 and exclude the United Kingdom since 2017.

In addition, Figure 27 shows how the shares of respondents to the Eurobarometer claiming that governmental entities are responsible and personal actions have been taken to tackle climate change developed over time. Compared to the perception of the severity of climate change, the opinions on these latter points were somewhat more nuanced across different age groups and over time. Nevertheless, the trend lines depicted in Figure 27 indicate that over the past ten years, the shares of EU citizens thinking that governmental entities

[26] In the context of studying the behaviour of certain generations, a decade might be a short period of time. However, academic literature has focussed on time intervals of similar length to study generational effects (see Milfont et al., 2021). In addition, it is important to note that the Eurobarometer does not repeatedly interview the same individuals over time, which may potentially create biases. Nevertheless, the Eurobarometer consists of nationally representative samples for different points in time, which substantially mitigates this risk.

are responsible for taking action to tackle climate change increased by five percentage points from around 80 per cent in 2013 to 85 per cent in 2021. Over the same period, the share of EU citizens saying that they have taken personal actions to fight climate change grew by even twelve percentage points from less than 52 per cent in 2013 to more than 64 per cent in 2021.

More than half of the citizens in 34 African countries have heard about climate change but awareness differs across groups with diverse sociodemographic characteristics

Some of the key results for EU citizens outlined in detail above are broadly in line with the findings of a number of other large surveys conducted in different world regions. The most recent studies include the survey of UNDP and the University of Oxford collecting information from around 1.2 million individuals in 2021 in 50 countries worldwide, Dechezleprêtre et al., (2022) surveying around 40,000 individuals in 20 countries, Dabla-Norris et al., (2023) gathering data on around 30,000 people in 28 countries, Ipsos interviewing approximately 23,500 people in 34 countries in 2022, the Pew Research Center analysing the opinions of almost 20,100 individuals in 19 highly developed countries in 2022, and Seah et al., (2022) focussing on around 1,400 respondents in ten Southeast Asian countries. The general common findings of these surveys indicate that the level of concern about climate change is rising but is essentially higher among younger and more educated individuals.

The final part of this chapter further contextualises these results at a broader global level by providing additional details based on survey data collected in Africa. This allows placing the findings on the attitudes towards climate change of EU citizens into a wider global context. More specifically, this section complements the above analysis by describing data collected in the seventh wave of the Afrobarometer public opinion survey. Similar to the Special Eurobarometer, the questionnaire of the 2016-2018 wave of the Afrobarometer includes a number of questions on the individual perception and attitudes towards climate change. The survey collects data for 34 African countries and contains nationally representative samples of around 1,200 observations for each country.

Compared to EU citizens, survey respondents in Africa usually face sharply different socioeconomic challenges. In light of evidence demonstrating that individual levels of concern about climate change grow with national and personal income levels (Baiardi & Morana, 2021; Franzen & Vogl, 2013; Lou et al., 2022), it might not be surprising that the perception of the most serious problems may strongly differ between societies in both world regions.[27] It is crucially important to be aware of the strong disparities in socioeconomic conditions when analysing and interpreting the results on the attitudes towards climate change of respondents to the Afrobarometer. The results discussed in this section should therefore be interpreted with caution.

As a first step, it is important to describe the shares of respondents that have heard about climate change. Figure 28 shows that between 2016 and 2018 a total of 59 per cent of individuals in the 34 African countries have heard about climate change.[28] This share varies considerably by age, educational level, and place of residence. While 61 per cent of respondents 15-29 years of age heard about climate change, only 55 per cent of those above 60 years of age are aware of it. The share of people that heard about climate change in urban areas is nine percentage points larger than the respective share of residents in rural areas. The results further indicate that education is a particularly strong determinant of the awareness of climate change in Africa. More than 81 per cent of respondents to the Afrobarometer holding a tertiary degree say they heard about climate change, whereas this share is as low as 47 per cent for the respondents with a primary level of education.

[27] For example, when respondents to the Afrobarometer were asked about the most important reason for emigrating, only a tiny fraction mentioned natural disasters as a reason. The majority of reasons for emigration were associated with economic opportunities.

[28] The precise question texts and answer options are provided in the Appendix to Chapter 3.

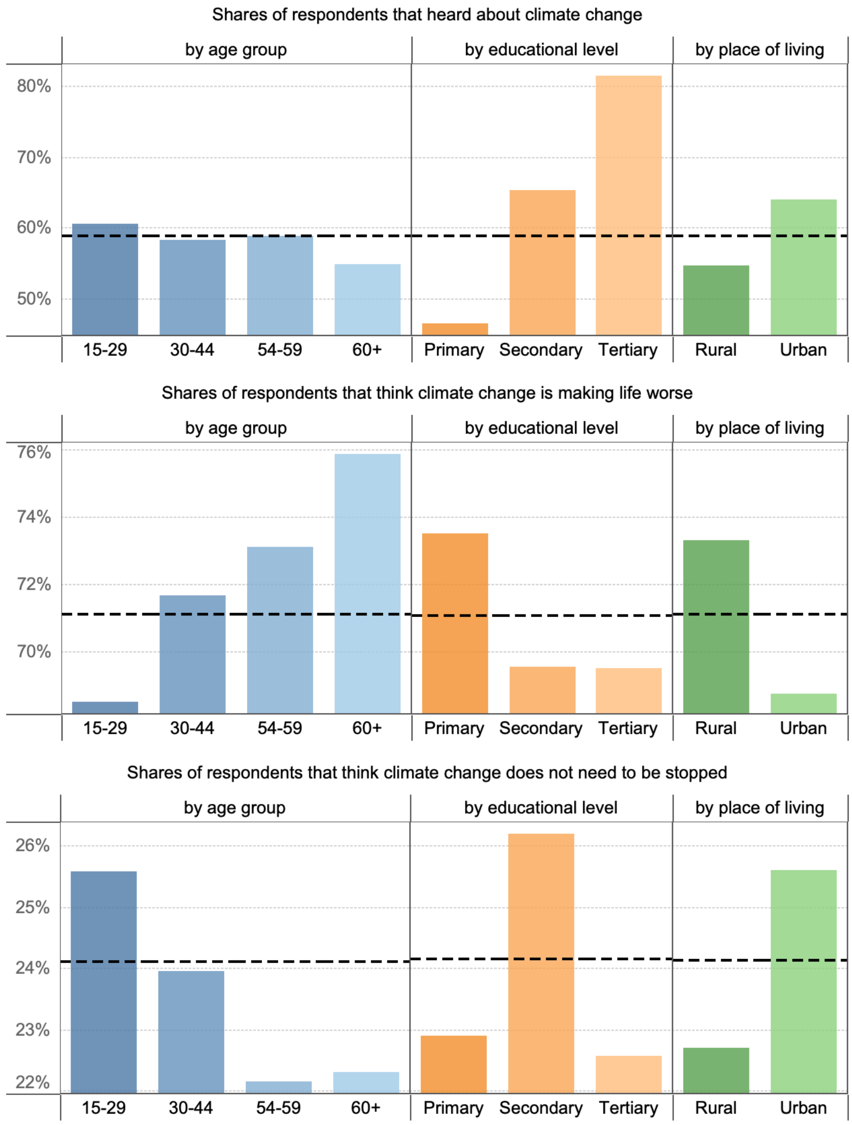

Figure 28 Opinions and attitudes towards climate change by age groups in 2016-2018 in Africa

Source: own elaboration of Afrobarometer (2019).

In 34 African countries, a large majority thinks climate change is making life worse but a sizable minority does not see need for action

Only those respondents that report to have heard about climate change were subsequently asked about its impact and options for taking action to address it.[29] A large majority of 71 per cent of citizens of the 34 surveyed African countries believe that climate change is making life worse, while a sizable minority of around 24 per cent think that climate change does not need to be stopped. Somewhat surprisingly, the share of individuals agreeing that climate change is making life worse is larger for older age groups, less educated individuals, and residents of rural areas. Similarly, younger individuals and residents of urban areas relatively more often think that climate change does not need to be stopped.

Finally, similar to the analysis for EU citizens above, it is possible to study the relationship between the individual perception of climate change and personal actions to tackle climate change. Among the respondents to the Afrobarometer that think climate change is making life worse, a large majority of 62 per cent say ordinary

[29] It is important to note that this conditionality in the question design might generate sizeable biases. This may further impede the direct comparability of the results of the Eurobarometer and Afrobarometer survey.

citizens can do something to tackle climate change.[30] Meanwhile 64 per cent of those respondents that say climate change is not making life worse also do not believe in the effectiveness of the actions of ordinary citizens. Interestingly, these results are very similar to the results reported in the left panel of figure 4 that investigates the relationship between the individual perception and personal action to tackle climate change in the EU. This suggests that for those respondents to the Afrobarometer that heard about climate change similar links between the perceived severity and the possibility of taking personal steps to fight climate change exist.

Conclusion

The analysis of this chapter complemented the previous chapters by providing additional insights into the individual perspective. The chapter primarily built on survey data collected through the Eurobarometer and the Afrobarometer surveys. In particular, the analysis focussed on the attitudes of EU citizens towards climate change and provided a detailed perspective of the sociodemographic drivers behind these attitudes.

The findings indicate that the level of concern about climate change increased among EU citizens in the past decade. Age, educational attainment, and the place of residence have a strong effect on the individual perception of the severity of climate change. By contrast, the perception of public and individual levels of responsibility for tackling climate change and the support for public policies for climate action, such as the European Climate Law and EU's Strategy on Adaptation to Climate Change, differ generally much less between diverse age groups. In addition, the findings suggest that while attitudes towards climate change may be determined to some degree by age, effects that are specific to certain moments of time can have a strong impact on how climate change is publicly perceived.

In line with evidence provided by an overwhelming number of studies, the findings point to the important role of education as a factor that not only shapes the perception of climate change but also individual steps and the support of governmental climate actions. Furthermore, the personal level of concern about climate change frames the individual willingness to take actions. On a broader scale, these findings appear to be generalisable for world regions beyond Europe. Survey data collected in Africa, a world region where climate change knowledge is far from universally existing, show that education is a particularly strong determinant of how climate change is perceived. In a world in which the adverse consequences of climate change become increasingly visible and individual climate change vulnerability is growing, these findings are a strong indication that sociodemographic factors play an important role for shaping the individual attitudes towards climate change. This suggests that besides accounting for the effect of age, policies designed to address climate change would benefit from including a strong focus on general levels of education and environmental education in particular.

[30] This category includes respondents to the Afrobarometer that answer "ordinary [citizens] can do a little bit" or "ordinary [citizens] can do a lot" when asked to assess how much ordinary citizens can do to stop climate change.

Chapter 4 A foresight perspective on demographic developments

Key messages

- The Foresight approach used in this chapter helps to identify emerging issues and uncertainties that, given the long-term horizon of climate change, are difficult to capture purely through modelling efforts.
- Demographic developments have a substantial influence on climate change and can pose a challenge for the climate transition but they are long-term developments that are difficult to influence.
- Low-carbon innovation will be a central lever to reduce emissions and compensate for demographic trends. It will be of crucial importance to transfer green technologies to countries that have not yet created fossil fuel path dependencies.
- Not only is it important to understand the urgency of the climate transition but also to understand how lifestyles can be more sustainable. Education, urbanisation and social cohesion have a fundamental role to play in the societal push for environmental action and sustainability.
- The global climate transition requires globally coordinated efforts. Governments in regions that have the financial and technological capacity to be first movers should capitalise on it and demonstrate that the climate transition is possible.

Introduction

Foresight scenarios provide a framework to investigate some of the quantitative assumptions raised in previous chapters of this report. Climate change has a long-term horizon, which creates many uncertainties that are difficult to capture purely through modelling efforts. Foresight is an approach that helps to identify emerging issues and uncertainties, and flag them to decision makers to manage them efficiently (European Commission et al., 2023). Foresight scenarios have already been widely used in the field of climate action (e.g. Shared Socioeconomic Pathways (SSPs) (O'Neill et al., 2017) and IPCC Special Report on Emission Scenarios (Nakićenović & IPCC, 2000)).

They offer a possibility to explore the robustness of forecasts (quantitative assumptions about the future), by posing 'what if'-questions and offering a range of plausible future conditions.

In this study, we use the Joint Research Centre's reference foresight scenarios (Vesnic-Alujevic et al., 2023) to assess common assumptions on the interrelation of demographic developments and climate change. The reference scenarios are broad in nature, and look at uncertainties of future development in five areas: i) social values; ii) source of geopolitical power; iii) reaction to environmental degradation; iv) food, water, health, and energy nexus; and v) technological developments. Using broad scenarios enables a holistic assessment of demographic change and how these different areas are related to it. Figure 29 gives an overview of the reference scenarios and their main characteristics in relation to the five areas of future development. The Appendix to Chapter 4 provides more detailed information on the use of strategic foresight for decision-making and the reference scenarios.

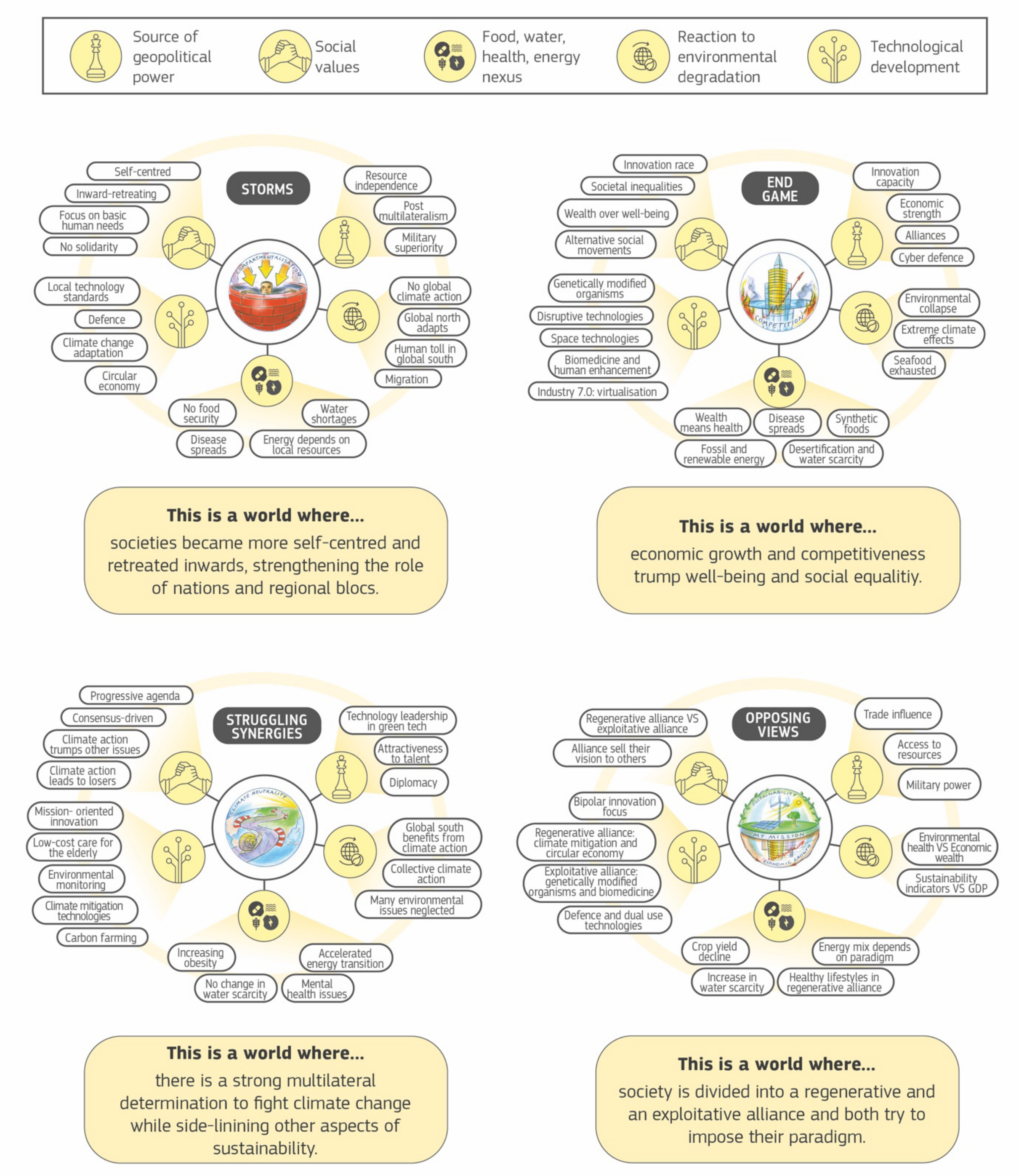

Figure 29 Overview of reference scenarios

Five demographic and two cross-cutting assumptions were selected for stress testing. They were selected based on the research explained in previous chapters, focusing on elements of uncertainty when considering future developments. Two participatory workshops were organised to discuss these assumptions. The aim of the workshops was to stress-test the assumptions within scenarios, by exploring how pertinent these assumptions are within each of the four reference foresight scenarios, and to discuss their implications.

This chapter summarises the insights gained during these workshops and an analysis of the four reference scenarios. For each assumption, a summary is provided to wrap up the understanding of the assumption in the literature and how it affects climate change. This summary is followed by a discussion of how plausible each assumption would be in each of the foresight scenarios. The chapter also presents takeaways to guide decisions on how to deal with future demographic developments in the context of the climate transition.

This chapter looks at five demographic and two cross-cutting drivers of the future. First, assumptions regarding the five demographic drivers of the future i) household size, ii) income levels, iii) lifestyle changes, iv) urbanisation, and v) population size are discussed. However, our analysis suggests that two crosscutting non-demographic drivers will also be crucial to consider. Hence, this chapter also discusses the role of vi) technological innovation and vii) geopolitics.

Findings

Household size

A decrease in household sizes could lead to higher per capita emissions. Recent trends in most industrialised countries show a constant decrease in household sizes, which can be explained by a combination of low fertility and changes in social norms about family formation and structure. The decrease in average global household size is substantial (Ivanova & Büchs, 2022). As shown in Chapter 3, this development can be problematic from a climate mitigation perspective, as smaller households tend to have higher per capita emissions than larger households (Lévay et al., 2021). The reason for this correlation is that larger households can realise economies of scale (Ivanova & Büchs, 2022). For example, sharing space or appliances can lead to substantial savings when it comes to energy-intensive services, such as heating or cooling (Underwood & Zahran, 2015), but also resource consumption.

Smaller household sizes in the future are plausible but the resulting impact depends on regional differences. The trend towards smaller household sizes is plausible in all four scenarios, as ageing, low fertility, and household size reduction in the process of demographic transition go hand in hand. Furthermore, regional developments play a fundamental role. A stronger negative impact is plausible in the case of strong economic growth in current developing countries (*Struggling synergies*, *Opposing views*), as an increase in wealth would lead to a more accelerated demographic transition with substantial shifts to low fertility and thus smaller households. This development has already taken place in more affluent regions (*Storms*).

Low-carbon innovation could mitigate the negative impact of decreasing household sizes but not fully negate it. Low innovation rates or lack of green innovation focus point to a particularly negative impact of decreasing household sizes (*Storms*, *End game*). Only step-changes in decarbonising electricity, heating, and cooling sectors can mitigate this effect (*Struggling synergies*). However, it will be difficult to offset completely the negative impact of smaller households, as even in a climate-neutral economy, smaller household sizes would lead to higher resource consumption due to the lack of economies of scale.

Social values are another important factor in mitigating the impact of decreasing household sizes. Smaller household sizes are more plausible if there is a lack of social glue (*Storms*, *End game*). A lack of social cohesion, a strong focus on individualism, and more self-centred societies could lead to an increase in isolated individuals that live by themselves (*Storms*, *End game*). In contrast, a positive impact could be a change in attitudes, in particular a re-thinking of the success of an economy (*Struggling synergies*, *Opposing views*). For example, replacing gross domestic product as the performance indicator with other alternatives, such as indicators of happiness or sustainability could have a positive impact on social cohesion and change the priorities of individuals, leading to less importance of status symbols.

Income levels

An increase in income is believed to have a negative impact on greenhouse gas emissions. Chapter 1 describes extensively the fundamental role of economic growth in determining the level of emissions besides total population size, carbon intensity, and energy intensity. The relation between economic growth and emissions can be examined through the production and macro channel of GDP and income inequality in national economies, as described in Chapter 1, or through the micro channel of individual and household consumption patterns, as described in Chapter 2. This relationship is not necessarily linear at macro level: the Environmental Kuznets Curve suggests that environmental pressure increases at early stages of economic growth whereas it decreases in later stages. However, research suggests that the effect holds true for only less than half of high-income countries (Narayan et al., 2016). The rationale for considering the consumption channel is because households with higher incomes tend to have more carbon-intensive lifestyles (Lévay et al., 2021).

The assumption of increasing income is not plausible across all scenarios. Wealth increases are plausible if there is non-restrained capitalism and a strong preference for wealth (*End game*), or if a region prefers economic growth to sustainability (*Opposing views*). De-globalisation and high inflation (*Storms*), a costly climate transition (*Struggling synergies*), or the preference for sustainability over economic growth (*Opposing views*) make substantial wealth increases less plausible.

Higher incomes can lead to increased emissions but this is not a necessity. On the other hand, higher income does not necessarily lead to increased consumption, for example, if the cost of climate action requires higher investments leading to lower discretionary income (*Struggling synergies*), or if there is a general tendency towards more sustainable consumption (*Struggling synergies*, *Opposing views*). Low-carbon production systems would be a way to reduce the impact of higher income levels. In scenarios with a strong focus on green innovation, it is plausible that the growth in wealth and emissions can be decoupled (*Struggling synergies*). However, such a decoupling would require very high low-carbon innovation rates that outpace economic growth (for more details on decoupling see Chapter 1).

An important factor is where wealth increases will be realised and by whom. Negative impacts of wealth increases are particularly plausible in regions with low per capita income (*Opposing views*) as an increase in wealth would not lead to higher savings but to higher levels of consumption. Climate diplomacy and international relations will also play an important role to avoid emission reductions in one region being outweighed by emission increases in another one (*Opposing views*). It also becomes apparent that global emission reductions can be plausible despite wealth increases, if a region becomes a role model for the climate transition, illustrating its positive impacts for citizens (*Struggling synergies*, *Opposing views*).

Lifestyle changes

Lifestyle changes related to transport, food, heating, and cooling are difficult to realise but can play an important role in the climate transition. As shown in Chapter 2, the composition of expenditure baskets of households towards more or less carbon-intensive items can influence the overall level of emissions of individuals and households. In this respect, lifestyles can have a substantial impact on the greenhouse gas emissions of households that even exceeds the impact of income growth (Grottera et al., 2020; Zhang et al., 2020). Relevant lifestyle changes regarding emissions include transport (e.g. reduction of motorized transport and shift to public transport), food (e.g. reducing the consumption of meat), and heating and cooling (e.g. reduce the energy needed for heating and cooling) (Grottera et al., 2020). The highest potential for emission reductions through lifestyle changes is among higher income groups (Grottera et al., 2020). However, changing lifestyles to a degree that would meaningfully support the climate transition is difficult (Capstick et al., 2014).

Radical changes in lifestyles are not plausible in all scenarios. One barrier to radical lifestyle changes is conservative social values that focus on the protection of wealth in an ageing society (*Storms*). Another barrier is focusing on adaptation to the adverse impacts of climate change instead of reducing greenhouse gas emissions (*End game*). However, strong support for the climate transition from one societal group can lead to society-wide changes in behaviours (*Struggling synergies*, *opposing views*).

Several conditions that are not primarily targeting the climate transition could have positive impacts on emissions. Scenarios point to developments that can complement lifestyle changes and thus increase their efficiency. A global economy with more distributed supply chains could lead to a shift to local consumption (*Storms*, *Opposing views*). Furthermore, scenarios that are characterised by scarcity could lead to a focus of consumption on goods that address basic needs (*Storms*). Lastly, innovation could lead to the replacement of carbon-intensive products with green alternatives, for example replacing animals with lab-grown proteins (*End game*).

A societal push for the climate transition can lead to lifestyle changes. Scenarios point to a divide between generations when it comes to the willingness and ability to change lifestyles. Those scenarios that see a strong influence of the youth in politics and society create a stronger push for green behavioural changes (*Struggling synergies*, *Opposing views*) whereas a focus on serving an ageing society seems to cement established behavioural patterns (*Storms*). It becomes also apparent that a strong societal push can create momentum for green policies, triggering technological developments and behavioural change (*Struggling synergies*). Important enablers for society-wide lifestyle changes are social cohesion and economies of scale to make sure that all societal groups have access to green lifestyles and not only a small elite (*End game*).

Urbanisation

Urbanisation can greatly influence greenhouse gas emissions but the relation can be both positive or negative, depending on the urban form and the geographical context. Insights from research point to the fact that carbon footprints in urban areas are higher than in rural areas, as there are higher income levels in cities, which lead to more carbon-intensive consumption patterns (Ottelin, 2022). However, assessments that control for income levels and household size conclude that the per capita greenhouse gas emissions in urban areas are lower than in rural areas (Ottelin, 2022). The positive impact of urbanisation on emissions depends on the type of urbanisation and is most pronounced in compact cities (Abdallh & Abugamos, 2017). Compact cities enable shorter intra-urban travelling distances, less automobile dependency, more district-wide and local energy solutions, and optimal land use (OECD, 2012).

Urbanisation is one of the Megatrends the world faces and it is plausible in all scenarios that this trend will continue. However, scenarios point to different impacts of urbanisation on climate change. Some scenarios imply that urbanisation would not be managed to aim at emission reductions (*Storms*, *End game*, *Opposing views*). However, urbanisation that is geared towards sustainability also seems plausible (*Struggling synergies*, *Opposing views*).

The impact of urbanisation is strongly interlinked with other demographic drivers. The development of these drivers partly determines if urbanisation will be beneficial or detrimental to sustainability. Strong economic growth lowers the chance of positive impacts of urbanisation on sustainability (*End game*) while slower economic growth might increase them (*Storms*). Furthermore, the positive impact of urban economies of scale on sustainable development is only plausible in scenarios with sufficient green innovation (*Struggling synergies*, *Opposing views*). Lastly, green lifestyles make a positive impact of urbanisation more plausible (*Struggling synergies*).

*Urban economies of scale are plausible in the scenarios***.** Nevertheless, the plausibility of emission reductions is higher in scenarios that assume changes in consumption behaviour, such as co-housing or car sharing (*Struggling synergies*, *Opposing views*). Cities can also create an ecosystem that fosters changing lifestyles through exchanges between residents, reinforcing sustainable development paths (*Struggling synergies*). However, both developments require planned urbanisation that is geared towards sustainable development (*Struggling synergies*, *Opposing views*).

Adverse environmental and societal impacts can endanger the realisation of urban economies of scale. Scenarios with high global warming trajectories indicate that buildings in urban centres will require the creation of more green spaces in cities to contrast heat island effects. At the same time air conditioning could increase urban heat and bring to higher energy demands (*End game*). Furthermore, a lack of social cohesion will make planned urbanisation more difficult, as poverty can increase the risk of slumification (*Storms*, *End game*, *Struggling synergies*). Such developments would make it difficult to benefit from urban economies.

Population size

Population growth can lead to higher greenhouse gas emissions and literature suggests it will continue in the near future. Population size and the growth in population is widely considered one of the drivers of environmental stress and greenhouse gas emissions (Muttarak, 2021; O'Neill et al., 2012a). However, its impact is considered less substantial than some of the other drivers in this chapter (Arto & Dietzenbacher, 2014; Muttarak, 2021). There is a strong link between population growth and other developments, as consumption patterns and developments in green technologies can offset parts of its negative impact (Arto & Dietzenbacher, 2014; Rosa & Dietz, 2012). Family planning can somewhat affect fertility trends (O'Neill et al., 2012a) but the momentum of population growth is expected to lead to a population size of at least 10 billion by the end of the century (Rosa & Dietz, 2012).

Continued population growth is plausible in all four scenarios and difficult to offset. However, different growth rates are plausible in the long term depending on the developments in the scenarios. For example, extreme direct and indirect impacts of climate change could cause a slowdown in population growth (*Storms*, *End game*). In addition, the evolution of affluence and fertility in developing countries (e.g. Sub-Saharan Africa) and the possible rebound of low fertility in post-transition countries could create some divergence in population growth in the long run (*End game*, *Struggling synergies*, *Opposing views*).

Education and economic developments are two factors that can lead to different long-term population developments in the different scenarios. Better education systems and family planning options can reduce fertility rates (*End game*). On the other hand, some technologies can help to sustain larger populations, for example, new food production technologies that require less land or are more resilient to extreme weather events (*End game*, *Struggling synergies*). Strong economic development, particularly in emerging economies with currently young populations can lead to a softening of the population growth curve (*End game*, *Struggling synergies*, *Opposing views*) a worsening global economy would make continued fast population growth plausible (*Storms*).

The impact of population growth on greenhouse gas emissions can differ, depending on technological developments and lifestyles. In the current situation with economies that are not climate neutral, each new person will increase humanity's carbon footprint. Only step changes in the development of green technologies will pave the way to climate neutrality (*Struggling synergies*). In addition, conscious changes in lifestyles, such as sustainable family planning, can lead to fertility levels that are not stressing the environmental boundaries of the earth (*Struggling synergies*, *Opposing views*).

Technological innovation

It is assumed that innovation and increased digitalisation can lead to emission reductions. Technological innovation is important because it increases economic growth but can also impact energy consumption (Acheampong et al., 2022). There is evidence that low-carbon innovation can help to cope with the challenges posed by demographic developments (Jordaan et al., 2017; Rosa & Dietz, 2012). Shifts of emissions between sectors should not be underestimated. For example, while innovation in the industrial sector can decrease the emissions, it can lead to increases in the construction sector (Erdoğan et al., 2020). The positive impact of innovation can also vary between different regions, and green technology innovations seem to contribute more to reducing emissions in higher income countries than lower income countries (Du et al., 2019).

Adequate innovation rates do not seem plausible in the majority of scenarios. Slow innovation rates are problematic because they lower the plausibility of meaningful alterations to existing carbon-intensive industries (*Storms*). Very high innovation rates would be needed with a focus on low-carbon innovation to become climate-neutral (*Struggling synergies*, *End game*). However, high low-carbon innovation rates in only one part of the world might not be sufficient, if major emitters remain in other parts of the world (*Opposing views*).

Innovation focus on low-carbon technologies is important but not sufficient. Besides increasing innovation rates, it is crucial that innovation focuses on climate neutrality to achieve adequate emission reductions (*Struggling synergies*). Otherwise, innovation could lead to more carbon-intensive consumption patterns (*End game*). Climate change adaptation is also an important area of innovation but has its limits and should not be considered as the single solution to dealing with climate change (*End game*). Reduced emissions realised by technological innovation need to be supported by lifestyle changes so that these benefits are not neutralised by an increase in consumption (*Storms*, *End game*).

Disruptive innovation with a common goal to reach climate neutrality is key. Marginal efficiency improvements would not be sufficient to become climate neutral in time, and disruptive innovation on a global scale will be crucial (*Struggling synergies*, *Storms*). Higher self-reliance could be a driver for more regional solutions although with limited effects (*Storms*). Mission-oriented innovation for decarbonising the economy radically would make it plausible to keep climate change at low levels (*Struggling synergies*). Such radical innovation would require global technology transfers (*Struggling synergies*), but these do not seem always plausible in future without functioning multilateralism (*Storms*, *Opposing views*).

Geopolitics

Geopolitical tensions could reduce the efficiency of climate action. There is evidence of a strong correlation between climate change and peace and security (Sharifi et al., 2021). The rise in geopolitical tensions that we have experienced in the recent past is problematic. Geopolitical tensions led to a changed global order, less incentives towards global cooperation, weaker alliances, and interruptions of global supply chains (KPMG, 2022). These developments are worrying, as a fragile global governance threatens to result in decreased efforts to fight climate change (Thorp, 2022).

Domestic or international political tensions are plausible across the majority of scenarios. Political tensions can occur between countries or regions (*Storms*, *Opposing views*), or within a country (*Struggling synergies*). Scenarios show that geopolitical tensions could make it difficult to implement global systems to govern the climate transition (*Storms*, *Opposing views*). Furthermore, increased geopolitical tensions could divert investments away from the climate transition towards defence and security (*Storms*). Lastly, migration due to climate change could lead to tensions between and within countries (*Storms*, *End game*).

A lack of global agreement can affect efforts towards climate neutrality. A lack of multilateralism, regions turning inwards, or trade disruptions could affect efforts for environmental action negatively (*Storms*). While global competition could stimulate innovation in general, it could also impede targeted innovation towards green technologies, if focused on other areas (*End game*, *Opposing views*). Having the world divided into blocks makes it difficult to reach a consensus on global climate action (*Opposing views*). In contrast, stable multilateralism for collective global action and science diplomacy could lead to a world that collectively engages in fighting climate change (*Struggling synergies*).

Conclusion

The foresight analysis points to fields of action that are crucial to managing demographic drivers in the context of the climate transition. It becomes clear that many demographic developments have a substantial influence on climate change. Furthermore, they pose a challenge for the climate transition, as they are long-term developments that are difficult to influence. However, our analysis showed several strategies to cope with demographic change to achieve the goals of the climate transition. An analysis of drivers across four foresight scenarios yielded an overview of options that can help to manage demographic developments in the context of the climate transition. Looking ahead, there are three relevant fields of action: future technologies, future societies, and future governments.

Future technologies: fundamental technological change is necessary to become climate neutral. This is why green innovation will be crucial to decarbonise the global economy. Low-carbon technologies are a central lever to reduce emissions despite household size decreases, growing population, and increasing affluence. Financial flows have to be steered towards innovation that lowers emissions from burning fossil fuels or production processes and reduces the resource footprint of economies. Mission-oriented, disruptive innovation aimed at environmental action could ensure high innovation rates. These are needed to achieve global climate neutrality fast enough to meet the goal of keeping global warming at 1.5°C. It will also be of crucial importance to transfer green technologies to countries that have not yet created fossil fuel path dependencies and can build up energy and industrial ecosystems using innovative low-carbon technologies.

Future societies: societal push towards sustainability will be crucial. To be able to reach climate neutrality, our societies have to re-think if economic development can continue to be the guiding principle for future development. There is already an ongoing discourse on using sustainability indicators or indicators of well-being instead of gross domestic product. Such a paradigm change would be beneficial to cope with globally increasing levels of population and wealth. It would also help to change consumption patterns and adapt lifestyles to be more environmentally friendly – despite increasing levels of affluence. Education will be a cornerstone for a sustainable future society. Not only is it important to understand the urgency of the climate transition but also to understand how lifestyles can be more sustainable. Another cornerstone will be a societal push for environmental action. Some demographic developments are advantageous to create such a sustained push. For example, urbanisation could create community dynamics that fuel a self-reinforcing societal push for more sustainable lifestyles. Social cohesion will play a crucial role in creating wide public acceptance of environmental action and should be at the core of any climate strategy.

Future governments: governments need to plan ahead and look for globally concerted solutions. Former smaller-scale examples, such as the transition of coal regions, have shown that forward-looking planning is crucial to turn the challenges of a transition into opportunities. The global climate transition requires efforts at a much bigger scale than the transition of one economic sector in a certain region. Convincing society of ambitious environmental action can be a challenge, as it would require following unchartered territories. Governments in regions that have the financial and technological capacity to be first movers should capitalise on it and demonstrate that the climate transition is possible. When it comes to managing demographic developments, planned approaches will be essential. For example, planned urbanisation can lead to an increase in climate resilience, if its negative impacts (e.g. the creation of heat islands) are softened while its positive impacts (e.g. urban economies of scale) are maximised. Lastly, climate change is a global problem that needs globally coordinated solutions. Climate diplomacy will be crucial to make sure the global community works together towards a common goal. Therefore, international collaboration is essential to work towards global climate neutrality.

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Appendix Introduction

Demography in EU Green Deal policies – a mapping exercise

The table below indicates some of the EU Green Deal policies which integrate demographic considerations in the policy design, consider climate and environmental impacts on specific socio-economic or demographic groups and aim to include different demographic groups in climate or environmental action, or give them an active role in the policy planning.

The assessment is based on a mapping of keywords (population, demography, demographic change, ageing, elderly, migration, migrant, fertility, mortality, equality, youth, young, child) in the main climate and environmental policy instruments. The mapping is not meant to be exhaustive and it does not include all Green Deal instruments. The mapping provides a positive indication for the instruments that make a specific reference to demographic aspects and/or inclusiveness in the main policy instruments (usually the Regulation, proposal for a Regulation or the Commission Communication laying the foundations of the policy instrument). The mapping aims to provide a starting point for a further discussion on the inclusion of demographic insights in EU policies, and to enable sharing of knowledge of best practices in this area, to promote a coherent policy approach that is inclusive and forward looking.

Most of the policy instruments analysed consider the impact of climate change and environmental degradation on populations to a certain extent. The shading of the green indicates the extent to which demographic aspects are considered in the policy instruments. The darker green indicates that the issue is well or quite well addressed, while lighter green indicates that there is a reference, without a lot of detail or deeper analysis. In general, further analysis could be useful on the impact of demographic change and population dynamics on climate and environmental targets, as well as on the impact of climate change and environmental degradation on the different demographic groups, in particular the most vulnerable groups (older persons and children), on the long term. Integrating foresight techniques to such analysis could help understand the effects on the most vulnerable groups on the long term (by 2050 and beyond), unless the climate targets are met. Furthermore, further efforts could be made to include older persons, young people and children in the debates and planning for climate policies.

Policy instrument	Considers the impact of climate change and/or environmental degradation on populations or the impact of population change on the climate	Considers the impact of climate change and/or environmental degradation on different demographic groups, in particular the most vulnerable groups (children, young people, migrants, older persons)	Integrates demographic insights or analysis of demographic trends (e.g., ageing) in policy design	Strives to include different demographic groups, in particular children, young people and older adults in climate/environmental action, or give them an active role/voice in the policy planning.
European Climate Law	✓	×	×	✓
European Climate Pact	✓	✓	×	×
The EU adaptation strategy	✓	✓	✓	×
The Energy system integration strategy	✓	×	✓	×
Renovation Wave for Europe	✓	✓	✓	×
Sustainability Smart Mobility Strategy	✓	✓	✓	×
New European Bauhaus	✓	✓	✓	✓
Zero pollution action plan	✓	✓	✓	×
Biodiversity strategy for 2030	✓	×	×	✓

Appendix Chapter 2

Merging HBS and I/O tables (EXIOBASE)

The analyses in Chapter 2 are based on microdata from HBS (wave 2015) and macro data from multiregional I/O tables from the Exiobase project (Tukker et al., 2014).

The HBS microdata includes detailed household budgets for around 270,000 households in the EU (excluding Austria) with all the necessary information to analyse emissions according to individual and household socio-demographic characteristics. On the other hand, EXIOBASE provides greenhouses gases equivalents multipliers needed to translate Euros of consumption into emissions.

The merging of HBS and EXIOBASE relied on a bridging matrix from (Ivanova & Wood, 2020) which gives the possibility to link the 200 items of production according to the PRODCOM classification in Exiobase to the 63 items of consumption according to the COICOP classification followed in HBS.

In this matrix, PRODCOM items have a one-to-many relationship with COICOP as shown in the following example.

Table 1 Example of bridging table between COICOP and PRODCOM

COICOP	PRODCOM	
Electricity	Distribution and trade services of electri..	0.27
	Electricity by coal	0.06
	Electricity by gas	0.14
	Electricity by nuclear	0.40
	Electricity by wind	0.01
	Transmission services of electricity	0.10

These weights can be seen as the shares of the environmental impacts from production ingredients that need to be taken into account to calculate the total emissions of a consumption item. For example, to estimate emissions linked to the consumption of electricity we would need to account for the emissions associated with its different production forms (wind, solar, nuclear…).

The emissions themselves were obtained from the satellite accounts in the I/O tables and included the following main greenhouse gases. Values of output for each gas have been converted into CO_2 equivalents using standard conversion factors from the literature[31].

Table 2 Impact categories entered in the calculation of CO_2 emissions

CH4 - agriculture - air
CH4 - combustion - air
CH4 - non combustion - Extraction/production of (natural) gas - air
CH4 - non combustion - Extraction/production of crude oil - air
CH4 - non combustion - Mining of antracite - air
CH4 - non combustion - Mining of bituminous coal - air
CH4 - non combustion - Mining of coking coal - air
CH4 - non combustion - Mining of lignite (brown coal) - air
CH4 - non combustion - Mining of sub-bituminous coal - air
CH4 - non combustion - Oil refinery - air
CH4 - waste - air
CO2 - agriculture - peat decay - air
CO2 - combustion - air
CO2 - non combustion - Cement production - air
CO2 - non combustion - Lime production - air
CO2 - waste - biogenic - air
CO2 - waste - fossil - air
N2O - agriculture - air
N2O - combustion - air
SF6 - air

The CO_2 multipliers are specific to each production item and country and take into account the specificities of national industries. While still referring to 2015, they capture in some sense the progress toward decarbonisation and green transition in national economies. For imported products, the system of I/O allows to

[31] CO2 (1), CH4 (25), N2O (298), SF6 (22800) (from combustion and non-combustion) GWP100-Kyoto protocol https://en.wikipedia.org/wiki/Global_warming_potential

trace back the environmental impacts to the countries of origin. In this way, EU consumers would for example be accountable for the emissions of products produced abroad considering the specific sustainability of the countries of origin.

The multiplier for each COICOP was calculated as the weighted sum of the greenhouse gas multipliers across their respective production ingredients. After this multiplication, done at the lowest level of 63 COICOP items, we calculated total emissions and emissions at a higher level of classification for each household (e.g. residential, transports, food…) through simple sums.

To explore emissions by individual characteristics and in particular by age we allocated entirely the emissions of the household to the age of the reference person in the household. The reference persons are defined according to the HBS guidelines as "the person aged 16 or more who most contributes to the household income, however, some countries use subjective criteria (e.g. the person who is designated as such by the other members). for each household".

Some limitations which are not addressed entirely in our exercise are linked to underreporting of expenditures in the HBS data, differences between prices of production used in PRODCOM and consumption used in HBS, not inclusion of products with direct consumption and the lack of government expenditures.

Exiobase provides a very detailed representation of interindustry flows. All this detail has the advantage, as indicated above, of capturing specificities of the sustainability of national production systems however it also entails a great deal of noise and at times a high variation of country-PRODCOM multipliers which with considerable impact in a micro analysis perspective. To reduce the noise and avoid biasing the results from outliers we excluded from the analysis some country-PRODCOM multipliers with particularly high values. Furthermore, for the descriptive analyses in the chapter are 2 whenever possible we used median values instead of averages.

Regressions tables for total emissions and emissions per capita

Besides the simple descriptive analyses with cross-tabulations and medians, Chapter 2 is based on a series of regression models considering either the log total emissions or the log of per capita emissions as dependent variables. All these models include country-fixed effects. The following table provides detailed results of the estimations shown in the figures in Chapter 2.

Table 3 OLS regressions for emissions

	Emissions by age	Emissions per capita by age and dou	Emissions per capita by age with control for incom..	Emissions by age and dou	Emissions by age with control for income and dou
Variable	R2: 0.49 Nr obs: 264588	R2: 0.48 Nr obs: 264588	R2: 0.57 Nr obs: 264588	R2: 0.50 Nr obs: 264588	R2: 0.67 Nr obs: 264588
25-29	0.268 (0.014) ***	0.189 (0.014) ***	0.040 (0.012) **	0.268 (0.014) ***	0.050 (0.012) ***
30-34	0.461 (0.014) ***	0.256 (0.014) ***	0.008 (0.012) n.s.	0.459 (0.014) ***	0.096 (0.012) ***
35-39	0.558 (0.014) ***	0.268 (0.014) ***	-0.03 (0.012) *	0.557 (0.014) ***	0.116 (0.012) ***
40-44	0.606 (0.014) ***	0.279 (0.014) ***	-0.03 (0.012) **	0.606 (0.014) ***	0.141 (0.012) ***
45-49	0.613 (0.014) ***	0.309 (0.012) ***	-0.00 (0.012) n.s.	0.613 (0.014) ***	0.154 (0.010) ***
50-54	0.590 (0.014) ***	0.37 (0.012) ***	0.075 (0.012) ***	0.590 (0.014) ***	0.159 (0.010) ***
55-59	0.532 (0.014) ***	0.425 (0.012) ***	0.177 (0.012) ***	0.532 (0.014) ***	0.168 (0.010) ***
60-64	0.460 (0.014) ***	0.455 (0.012) ***	0.259 (0.012) ***	0.460 (0.014) ***	0.172 (0.010) ***
65-69	0.406 (0.014) ***	0.460 (0.012) ***	0.304 (0.012) ***	0.406 (0.014) ***	0.178 (0.010) ***
70-74	0.326 (0.014) ***	0.412 (0.014) ***	0.301 (0.012) ***	0.328 (0.014) ***	0.166 (0.012) ***
75-79	0.203 (0.014) ***	0.337 (0.014) ***	0.297 (0.012) ***	0.207 (0.014) ***	0.151 (0.012) ***
80-84	0.162 (0.016) ***	0.329 (0.014) ***	0.343 (0.014) ***	0.166 (0.016) ***	0.186 (0.012) ***
>=85	0.080 (0.017) ***	0.290 (0.017) ***	0.358 (0.016) ***	0.086 (0.017) ***	0.186 (0.014) ***
Town		0 (0.004) n.s.	0.017 (0.004) ***	0.070 (0.004) ***	0.096 (0.004) ***
Rural		-0.17 (0.004) ***	-0.08 (0.004) ***	-0.07 (0.005) ***	0.050 (0.004) ***
log(Income)			0.679 (0.003) ***		0.996 (0.003) ***

The independent variable income is also expressed in a log and proxied by total household expenditure to compensate that not all countries report values for income.

The descriptive analyses about the breakdown of emissions by main categories of expenditures have been checked and through a series of models fitted for residential, transport, food, health and other emissions.

Overall, the coefficients estimated from these models confirm the shift in emissions typologies across younger and older ages and the role of transport and residential emissions on the rural-urban differences.

Table 4 OLS Regressions for emissions by category of consumption

	Emissions by age and dou					Emissions by age, dou and income					Emissions pca by age and dou				
	food	health	other	residen..	transport	food	health	other	residen..	transport	food	health	other	resident..	transport
	R2:0.59	R2:0.21	R2:0.45	R2:0.46	R2:0.35	R2:0.72	R2:0.31	R2:0.68	R2:0.54	R2:0.51	R2:0.60	R2:0.24	R2:0.45	R2:0.44	R2:0.35
Variable	262699	209533	264084	264602	210953	262699	209533	264084	264602	210953	262699	209533	264084	264602	210953
25-29	0.174 0.012 ***	0.233 0.027 ***	0.275 0.019 ***	0.258 0.019 ***	0.480 0.030 ***	0.011 0.010 n.s.	0.037 0.025 n.s.	-0.026 0.014 .	0.082 0.018 ***	0.131 0.026 ***	0.095 0.011 ***	0.157 0.026 ***	0.196 0.018 ***	0.180 0.019 ***	0.398 0.029 ***
30-34	0.318 0.012 ***	0.410 0.025 ***	0.437 0.018 ***	0.458 0.018 ***	0.685 0.028 ***	0.047 0.010 ***	0.097 0.024 ***	-0.062 0.014 ***	0.164 0.017 ***	0.122 0.024 ***	0.116 0.011 ***	0.229 0.025 ***	0.234 0.017 ***	0.255 0.018 ***	0.480 0.027 ***
35-39	0.411 0.011 ***	0.469 0.025 ***	0.534 0.018 ***	0.568 0.018 ***	0.741 0.028 ***	0.083 0.010 ***	0.086 0.023 ***	-0.072 0.013 ***	0.211 0.016 ***	0.059 0.024 *	0.123 0.010 ***	0.199 0.024 ***	0.245 0.017 ***	0.280 0.017 ***	0.448 0.027 ***
40-44	0.479 0.011 ***	0.508 0.024 ***	0.541 0.017 ***	0.633 0.018 ***	0.722 0.027 ***	0.132 0.009 ***	0.099 0.023 ***	-0.098 0.013 ***	0.257 0.016 ***	-0.004 0.024 n.s.	0.152 0.010 ***	0.199 0.024 ***	0.213 0.017 ***	0.306 0.017 ***	0.385 0.026 ***
45-49	0.508 0.011 ***	0.536 0.024 ***	0.484 0.017 ***	0.655 0.017 ***	0.713 0.027 ***	0.165 0.009 ***	0.135 0.023 ***	-0.148 0.013 ***	0.283 0.016 ***	-0.023 0.023 n.s.	0.205 0.010 ***	0.253 0.024 ***	0.179 0.016 ***	0.351 0.017 ***	0.387 0.026 ***
50-54	0.492 0.011 ***	0.570 0.024 ***	0.381 0.017 ***	0.648 0.017 ***	0.688 0.027 ***	0.170 0.009 ***	0.195 0.023 ***	-0.213 0.013 ***	0.299 0.016 ***	-0.025 0.023 n.s.	0.273 0.010 ***	0.370 0.024 ***	0.160 0.016 ***	0.428 0.017 ***	0.439 0.026 ***
55-59	0.422 0.011 ***	0.645 0.024 ***	0.227 0.017 ***	0.626 0.017 ***	0.565 0.027 ***	0.152 0.009 ***	0.331 0.023 ***	-0.275 0.013 ***	0.331 0.016 ***	-0.068 0.023 **	0.317 0.010 ***	0.560 0.024 ***	0.120 0.016 ***	0.520 0.017 ***	0.425 0.026 ***
60-64	0.346 0.011 ***	0.707 0.024 ***	0.076 0.017 ***	0.590 0.017 ***	0.329 0.027 ***	0.133 0.009 ***	0.470 0.023 ***	-0.321 0.013 ***	0.358 0.016 ***	-0.198 0.024 ***	0.342 0.010 ***	0.732 0.024 ***	0.070 0.017 ***	0.585 0.017 ***	0.288 0.027 ***
65-69	0.292 0.011 ***	0.799 0.024 ***	-0.052 0.017 **	0.567 0.018 ***	0.117 0.028 ***	0.124 0.009 ***	0.629 0.023 ***	-0.366 0.013 ***	0.382 0.016 ***	-0.325 0.024 ***	0.346 0.010 ***	0.888 0.024 ***	0.001 0.017 n.s.	0.620 0.017 ***	0.127 0.027 ***
70-74	0.193 0.012 ***	0.871 0.025 ***	-0.202 0.018 ***	0.517 0.018 ***	-0.124 0.029 ***	0.075 0.010 ***	0.761 0.023 ***	-0.426 0.014 ***	0.386 0.017 ***	-0.493 0.025 ***	0.279 0.010 ***	0.991 0.025 ***	-0.117 0.017 ***	0.602 0.018 ***	-0.097 0.028 ***
75-79	0.076 0.012 ***	0.946 0.025 ***	-0.452 0.018 ***	0.449 0.018 ***	-0.473 0.030 ***	0.037 0.010 ***	0.934 0.023 ***	-0.533 0.014 ***	0.403 0.017 ***	-0.720 0.026 ***	0.206 0.011 ***	1.115 0.025 ***	-0.323 0.017 ***	0.578 0.018 ***	-0.428 0.029 ***
80-84	-0.014 0.013 n.s.	0.924 0.027 ***	-0.727 0.020 ***	0.406 0.020 ***	-0.637 0.035 ***	0.007 0.011 n.s.	0.981 0.025 ***	-0.703 0.015 ***	0.422 0.018 ***	-0.818 0.030 ***	0.151 0.012 ***	1.127 0.027 ***	-0.564 0.019 ***	0.569 0.020 ***	-0.585 0.034 ***
>85	-0.122 0.014 ***	0.929 0.030 ***	-0.934 0.022 ***	0.376 0.023 ***	-0.816 0.044 ***	-0.043 0.012 ***	1.051 0.028 ***	-0.809 0.017 ***	0.457 0.021 ***	-0.959 0.038 ***	0.083 0.013 ***	1.168 0.030 ***	-0.732 0.021 ***	0.581 0.022 ***	-0.762 0.043 ***
log(Income)						0.751 0.002 ***	0.881 0.005 ***	1.369 0.003 ***	0.807 0.004 ***	1.614 0.006 ***					
Rural	0.036 0.004 ***	-0.055 0.007 ***	-0.267 0.006 ***	-0.233 0.006 ***	0.302 0.009 ***	0.133 0.003 ***	0.045 0.007 ***	-0.097 0.004 ***	-0.131 0.005 ***	0.462 0.008 ***	-0.065 0.003 ***	-0.156 0.007 ***	-0.369 0.005 ***	-0.334 0.006 ***	0.193 0.009 ***
Town	0.037 0.004 ***	0.002 0.007 n.s.	-0.055 0.005 ***	0.007 0.005 n.s.	0.280 0.008 ***	0.056 0.003 ***	0.022 0.007 ***	-0.018 0.004 ***	0.028 0.005 ***	0.313 0.007 ***	-0.033 0.003 ***	-0.065 0.007 ***	-0.125 0.005 ***	-0.063 0.005 ***	0.210 0.008 ***

Appendix Chapter 3

Empirical analysis

The multivariate regression analysis is based on the following simple estimable equation:

- $A_{ic} = \beta_0 + SD_{ic}B + \alpha_c + \epsilon_{ic},$

where A describes the set of attitudes towards climate change, SD denotes a set of sociodemographic characteristics, α capture country-specific fixed effects, and ϵ is the error term. The subscripts i and c stand for the individual and country, respectively.

The dependent variable A takes a value equal to zero or one depending on the individual level of agreement to six questions on attitudes. More specifically, for the category "climate change is the most serious problem", the variable takes a value of one if the answer to QB1a of the Special Eurobarometer is equal to 1 and a value of zero if the answer is equal to 2-11 and 996.[32] For the category "climate change is a very serious problem", the variable takes a value of one if the answer to QB2 is equal to 7-10 and a value of zero if the answer is equal to 1-6. For the category "state authorities are responsible for tackling climate change", the variable takes a value of one if the answer to QB3 is equal to 1-3 and 997 and a value of zero if the answer is equal to 4-6, 996 and 998. For the category "personal action taken to fight climate change", the variable takes a value of one if the answer to QB5 is equal to 1 and a value of zero if the answer is equal to 2. For the category "make the EU climate-neutral by 2050", the variable takes a value of one if the answer to QB10 is equal to 1-2 and a value of zero if the answer is equal to 3-4. Finally, for the category "costs of climate change are higher than of green transition", the variable takes a value of one if the answer to QB4 is equal to 1-2 and a value of zero if the answer is equal to 3-4.

The set of sociodemographic characteristics SD includes dummy variables for the age groups of 30-44, 45-59, and above 60 years of age. In addition, it includes a dummy variable for gender, a dummy variable for respondents that say they live in large towns, and a dummy variable for those individuals that report a difficulty to pay the bills at the end of the month most of the times or from time to time. Finally, two dummy variables capture the individual level of education, for those respondents that obtained a secondary level of education and those that acquired a tertiary level of education. It is important to note that all these variables are derived from self-declared information.

The empirical models described by equation (1) are estimated using a logit model. Table 1 contains some key descriptive statistics and table 2 depicts the results of the multivariate regression analysis.

[32] The description of the Eurobarometer Questionnaire in this appendix provides the precise question texts and answer options.

Table 5 Attitudes and sociodemographic characteristics in Europe in 2021 – Descriptive statistics

	Observations	Mean	Std. Dev.	Min	Max
Climate change is the most serious problem	26,607	0.177	0.381	0	1
Climate change is a very serious problem	26,600	0.761	0.426	0	1
State authorities are responsible for tackling climate change	26,453	0.846	0.361	0	1
Personal action taken to fight climate change	26,513	0.623	0.485	0	1
Make the EU climate-neutral by 2050	26,328	0.915	0.278	0	1
Costs of climate change are higher than of green transition	24,870	0.819	0.385	0	1
Age	26,663	49.939	17.040	15	97
Female	26,669	0.524	0.499	0	1
Large town	26,667	0.325	0.468	0	1
Secondary	26,633	0.540	0.498	0	1
Tertiary	26,633	0.424	0.494	0	1
Payment problems	26,511	0.294	0.456	0	1

Source: Eurobarometer (2021).

Table 6 Attitudes and sociodemographic characteristics in Europe in 2021 – Multivariate regression analysis

Variables	Climate change is the most serious problem	Climate change is a very serious problem	State authorities are responsible for tackling climate change	Personal action taken to fight climate change	Make the EU climate-neutral by 2050	Costs of climate change are higher than of green transition
Age 30-44	-0.042*** (0.012)	-0.054*** (0.016)	-0.009 (0.008)	0.003 (0.013)	-0.009 (0.009)	-0.010 (0.019)
Age 45-59	-0.042*** (0.015)	-0.058*** (0.015)	0.002 (0.006)	-0.005 (0.017)	-0.017* (0.009)	-0.014 (0.017)
Age 60+	-0.047*** (0.015)	-0.052*** (0.014)	0.014 (0.008)	-0.036* (0.019)	-0.008 (0.011)	-0.003 (0.016)
Female	-0.001 (0.010)	0.049*** (0.008)	-0.001 (0.007)	0.053*** (0.010)	0.028*** (0.006)	0.040*** (0.007)
Large town	0.009 (0.009)	0.027** (0.013)	0.010 (0.012)	0.017 (0.014)	0.021 (0.012)	0.041*** (0.010)
Secondary	0.033 (0.030)	0.072*** (0.024)	0.034 (0.021)	0.126** (0.048)	0.017 (0.017)	-0.017 (0.014)
Tertiary	0.102*** (0.028)	0.114*** (0.015)	0.083*** (0.019)	0.235*** (0.050)	0.024 (0.020)	0.000 (0.019)
Payment problems	-0.035*** (0.006)	-0.051*** (0.014)	-0.025* (0.014)	-0.038** (0.017)	-0.032** (0.013)	-0.048** (0.018)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26,418	26,411	26,265	26,328	26,145	24,720

*Notes: Standard errors are clustered at country level and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Average marginal effects are reported. Source: Eurobarometer (2021).*

Questionnaire, EUROBAROMETER 95.1, 2021.

1. Climate change is the most serious problem:

Question:

QB1a - Which of the following do you consider to be the single most serious problem facing the world as a whole?

Answer options:

1 – Climate change; 2 – International terrorism; 3 – Poverty, hunger and lack of drinking water; 4 – Spread of infectious diseases; 5 – The economic situation; 6 – Health problems due to pollution; 7 – Proliferation of nuclear weapons; 8 – Armed conflicts; 9 – The increasing global population; 10 – Deterioration of nature; 11 – Deterioration of democracy and rule of law; 996 – Other; 998 – None; 999 – Don't know

2. Climate change is a very serious problem:

Question:

QB2 - And how serious a problem do you think climate change is at this moment? Please use a scale from 1 to 10, with '1' meaning it is "not at all a serious problem" and '10' meaning it is "an extremely serious problem".

Answer options:

1 – 1 Not at all a serious problem; 2 – 2; 3 – 3; 4 – 4; 5 – 5; 6 – 6; 7 – 7; 8 – 8; 9 – 9; 10 – 10 An extremely serious problem; 999 – Don't know

3. State authorities are responsible for tackling climate change:

Question:

QB3 - In your opinion, who within the EU is responsible for tackling climate change?

Answer options:

1 – National governments; 2 – The European Union; 3 – Regional and local authorities; 4 – Business and industry; 5 – You personally; 6 – Environmental groups; 996 – Other; 997 – All of them; 998 – None; 999 – Don't know

4. Personal action taken to fight climate change:

Question:

QB5 - Have you personally taken any action to fight climate change over the past six months?

Answer options:

1 – Yes; 2 – No; 999 – Don't know

5. Make the EU climate-neutral by 2050:

Question:

QB10 - To what extent do you agree or disagree with the following statement: We should reduce greenhouse gas emissions to a minimum while offsetting the remaining emissions, for instance by increasing forested areas, to make the EU economy climate-neutral by 2050.

Answer options:

1 – Totally agree; 2 – Tend to agree; 3 – Tend to disagree; 4 – Totally disagree; 999 – Don't know

6. Costs of climate change are higher than of green transition:

Question:

QB4 - To what extent do you agree or disagree with each of the following statements?

3 - The costs of the damages due to climate change are much higher than the costs of the investments needed for a green transition.

Answer options:

1 – Totally agree; 2 – Tend to agree; 3 – Tend to disagree; 4 – Totally disagree; 999 – Don't know

7. Sociodemographic characteristics:

a) Age

Question:

SD5 - How old are you?

Answer options:

Years

b) Gender

Question:

D11 - Gender

Answer options:

1 – Man; 2 – Woman; 3 – None of the above/ Non binary/ do not recognize yourself in above categories

c) Education

Question:

SD3b - What is the highest level of education you completed?

Answer options:

1 – Pre-primary education; 2 – Primary education; 3 – Lower secondary education; 4 – Upper secondary education; 5 – Post-secondary non tertiary; 6 – Short-cycle tertiary; 7 – Bachelor or equivalent; 8 – Master or equivalent; 9 – Doctoral or equivalent; 10 – Education up to ISCED 4 completed abroad; 11 – Education ISCED 5 and above completed abroad; 997 – Refusal; 999 – Don't know

d) Location

Question:

D25 - Would you say you live in a...?

Answer options:

1 – Rural area or village; 2 – Small or middle sized town; 3 – Large town; 999 – Don't know

e) Payment problems

Question:

D60 - During the last twelve months, would you say you had difficulties to pay your bills at the end of the month...?

Answer options:

1 – Most of the time; 2 – From time to time; 3 – Almost never/ Never; 997 – Refusal

Questionnaire, Round 7 Afrobarometer Survey, 2016-2018.

1. Heard about climate change:

Question:

Q73A - Have you heard about climate change or haven't you had the chance to hear about this yet?

Answer options:

0 – No, I haven't had the chance to hear about it; 1 – Yes; 9 – Don't know/Haven't heard enough to say; 8 – Refused to answer; -1 – Missing

2. Climate change is making life worse:

Question:

Q75 - Do you think climate change is making life in [ENTER COUNTRY] better or worse, or haven't you heard enough to say?

Answer options:

1 – Much better; 2 – Somewhat better; 3 – Neither/no change/about the same; 4 – Somewhat worse; 5 – Much worse; 7 – Not applicable [If response to Q73 was 0=No]; 9 – Don't know/Haven't heard enough to say; 8 – Refused to answer; 99 – Not asked in the country; -1 – Missing

3. Climate change does not need to be stopped:

Question:

Q76 - Do you think that climate change needs to be stopped? [If yes] How much do you think that ordinary [ENTER NATIONALITY] can do to stop climate change?

Answer options:

1 – Much better; 2 – Somewhat better; 3 – Neither/no change/about the same; 4 – Somewhat worse; 5 – Much worse; 7 – Not applicable [If response to Q73 was 0=No]; 9 – Don't know/Haven't heard enough to say; 8 – Refused to answer; 99 – Not asked in the country; -1 – Missing

0 – No, climate change doesn't need to be stopped; 1 – Yes, Ordinary [ENTER NATIONALITY] can do nothing at all; 2 – Yes, Ordinary [ENTER NATIONALITY] can do a little bit; 3 – Yes, Ordinary [ENTER NATIONALITY] can do a lot; 7 – Not applicable [If response to Q73 was 0=No]; 9 – Don't Know[DNR]; 8 – Refused to answer; 99 – Not asked in the country; -1 – Missing

4. Sociodemographic characteristics:

a) Age

Question:

Q1 – How old are you?

Answer options:

Years; 998 – Refused; 999 – Don't know; -1 – Missing

b) Education

Question:

Q97 – What is your highest level of education?

Answer options:

0 – No formal schooling; 1 – Informal schooling only (including Koranic schooling); 2 – Some primary schooling; 3 – Primary school completed; 4 – Intermediate school or Some secondary school / high school; 5 – Secondary school / high school completed; 6 – Post-secondary qualifications, other than university e.g. a diploma or degree from a polytechnic or college; 7 – Some university; 8 – University completed; 9 – Post-graduate; 99 – Don't know; 98 – Refused to answer; -1 – Missing

c) Location

Question:

URBRUR - Urban or Rural Primary Sampling Unit

Answer options:

1 – Urban; 2 – Rural; 3 – Semi-Urban; 460 – Peri-Urban

Appendix Chapter 4

Strategic foresight

Strategic foresight is the discipline of exploring, anticipating and shaping the future to help build and use collective intelligence in a structured, and systemic way to anticipate key future developments (European Commission, 2020c). It uses collective intelligence in a structured and systematic way to explore different possible futures, as well as anticipate emerging issues, challenges and opportunities and potential implications to better prepare for change and draw insights for policymaking. It can help policymakers act in the present to shape the future we want.

Scenario planning is one of the most established foresight methods. It has been used since the late 1940s (Horwath, 2006; van Notten et al., 2003). In the following couple of decades, their use expanded to support decision-making processes and policy analysis in both business and government realm (Amer et al., 2013; van Notten et al., 2003). Nowadays many governments around the world, as well as businesses, use strategic foresight and scenario planning as a specific method (e.g. Finland, Canada, Shell). This is especially important in times of VUCA (volatility – uncertainty – complexity – ambiguity), as under these circumstances, traditional predict and control approaches of linear planning cannot address and understand the implications of challenges and uncertainties we are facing (Chermack, 2022; Ramírez & Wilkinson, 2016).

Foresight scenarios are developed at the edge of plausibility, taking into consideration signals, trends and uncertainties that lie ahead and their interactions, in a coherent and systematic way (Amer et al., 2013). They challenge and question assumptions we have about the future. This is why they are provocative to enlarge decision-makers' perspectives (Schulte et al., 2021), reframe the understanding of issues faced today (Mukherjee et al., 2020) as well as help shape the future and adapt to it better (Scoblic & Tetlock, 2020). Therefore, they are neither predictions nor projections and they do not describe visions or desirable futures.

Building upon trends, uncertainties and weak signals, foresight scenarios are used as simulations of plausible futures and possible future conditions. As such, they can be used to stress-test the robustness of a strategy or a policy and point towards potential uncertainties. They can help understand the choices available today and their potential consequences for the future.

Reference foresight scenarios

In 2020, the European Commission Joint Research Centre was tasked to produce the set of reference foresight scenarios. (European Commission, 2020c) Online workshops with a dedicated working group were held in 2021. Results were later refined and validated with experts through a series of interviews conducted in 2022. The scenarios were recently published as a Joint Research Centre Science for Policy Report.

The scenarios were built using Oxford Scenario Planning Approach. In its core lies the idea that looking at different future scenarios allow us to reframe 'official future' and re-perceive our ideas and options. Through it, this approach allows us to learn about the present from the perspective of the future (and not the opposite) (Ramírez & Wilkinson, 2016). Therefore, scenario building is an important learning process. However, the use of scenarios after their creation is even more significant. There are several ways how scenarios could be used, for example to discuss implications for a specific policy area, to be used in strategic discussions or to stress-test or wind-tunnel different policy options and assumptions.

Reference foresight scenarios on the global standing of the EU in 2040 bring four plausible futures to point towards key uncertainties. These uncertainties include, for example, shifts in geopolitical power, environmental action, technological developments, and social values. The four scenarios are titled: Storms, Endgame, Struggling Synergies, Opposing Views. Here below we provide a snapshot of these four futures. Based on the analysis of the entire foresight scenario set, potential implications for a specific policy area can be discussed. A report dedicated to the development of the reference scenarios provides more details (reference to come).

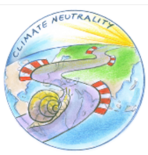
Table 7 Reference scenarios

Storms

Global co-operation has collapsed and the world is divided into blocks. Each geopolitical block is protecting its own way of life. Strategic autonomy is the credo. Scarcity is the new normal, leading to hostility between the blocks. The collapse of multilateralism made a globally co-ordinated approach to climate mitigation and environmental protection impossible. Social equality and the protection of minorities are not priorities.

Endgame

Economic growth trumps wellbeing. The international competition for companies and jobs increased the power of businesses over governments. Innovation is seen as the means to achieve competitive advantages mainly through higher efficiency and access to new types of resources. Authoritarian powers and the rise of populism lead to a lower protection of the environment and human rights.



Struggling synergies

While there is strong multilateral determination to fight climate change, other environmental, economic, and social aspects of sustainability are side-lined. Technology leadership in low- or zero-carbon technologies is a determinant of success. Social inequalities have increased. Citizens increasingly struggle to find a balance between global values and their personal desires, namely at the crux of consumption and sustainability.

Opposing views

A green enlightened and euro-centric elite leads the interests of future generations in a progressive global block, the 'regenerative alliance'. Social equality and environmental sustainability are the top priorities in the regenerative alliance. There is an 'exploitative alliance' centred around Brazil, Russia, India, and China and follows a different approach. Economics and efficiency are at the centre, without being steered by sustainability goals.

Science for policy

The Joint Research Centre (JRC) provides independent, evidence-based knowledge and science, supporting EU policies to positively impact society

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