WDA Discussion Paper

On Demographic Challenges

 # 03/2020

"The Power in Demography – Unlocking the Value of Health"

Clear Thinking and Careful Analysis with the Aid of *"Demographic Heat Maps"*

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Foreword: Nicholas N. Eberstadt, Thomas Zeltner

Executive Summary

Longevity is one of the greatest achievements in human history. Life expectancy started to rise significantly in the 19th century and has not stopped rising yet. **The reasons for ever longer life spans are multiple, with public health, healthcare and continuous improvements in medical treatments being key drivers for this success story in the past, present and future.** But it is not just about treatment provision – at least as important is broad access to preventive care and healthy living conditions across all parts of society in developed, emerging and developing countries.

The novel approach of **"Demographic Heat Maps"** provides a **new understanding of the human longevity evolution** over the past decades for the different age groups. For a given country, this methodology generates valuable insights about the contribution of different age groups to longevity and the potential for future gains in human life span. Therefore, this type of analysis is a novel strategic tool for clear thinking and careful planning. It helps policy makers, industries and businesses in their efforts to add value for a longer and better life – based on longevity-shaped population dynamics. By considering the development stage of a given country's healthcare and social security system, **"Demographic Heat Maps" also contribute to an understanding of what type of new products or services have to be prioritized.** Thus, they are also a powerful tool to be used to inform policy stakeholders.

In this WDA Discussion Paper, longevity dynamics of **selected countries on all five continents** were analyzed. **The 18 in-scope countries represent 57% of the world population and almost 70% of the global GDP in 2020.** In addition, "Demographic Heat Maps" are discussed in more detail for selected developed countries.

- Huge health improvements have been achieved in the past 100 years as part of **better health and survival of those under 50 years of age** – particularly in countries which have granted access to modern healthcare and disease prevention without exclusion.
- **The proportion of the world population aged 65+ will nearly double in the coming 30 years**, from 9% in 2020 to 16% in 2050. By 2100 the proportion aged over 65 will increase to 23%. The world will then have the same age structure already seen in Japan in 2012.
- In the past decades **life expectancy at birth (LE) has grown faster than healthy life expectancy at birth (HALE). Therefore, future innovations for a "new long life"** will have the most powerful impact if they target health, particularly improving that of the 60+/70+ and even 80+ age groups. Besides innovations from pharmaceutical research**, digital technology such as big data, artificial intelligence and machine learning represent huge potential**.
- The ultimate goal is for healthy life expectancy to grow at a higher rate than overall life expectancy. Therefore, the **focus of progress has to be on a further expansion of active lives by reducing the burden of disease**, including communicable and non-communicable morbidities.
- In **developed countries** the **main target for the health industry are the growing 60+ age groups**, who aim to live longer in good health and have the financial resources to spend more on personal health.
- In **developing countries, the health industry's focus should be on growing populations - particularly working-age populations**. Their human capital will drive economic growth only if these age groups improve their health further. This does not mean to ignore the special needs of other age groups.
- **Universal access** to healthcare is critical for further gains in life expectancy across the world – independent of a country's development stage.

As progress is being made towards longer and healthier lives, nations, societies and individuals need to start developing a vision of how to capitalize on longevity – socially, culturally and economically.

There is no doubt: **Mankind is facing an unprecedented transition which nobody has a track record of navigating. A thorough understanding of the dynamics of longevity becomes a critical need** for policy makers, business leaders and their strategic planners.

About the WDA Forum

As a think tank, the WDA Forum actively shapes the discussion on demographic topics. We work closely with the Institute of Insurance Economics at the University of St. Gallen as well as other educational and research institutions including the Harvard T.H. Chan School of Public Health in Boston, Stanford University in California, the American Enterprise Institute in Washington, D.C., the Population and Ageing Centre at the University of New South Wales in Sydney, Fudan University in Shanghai, and the swissnex network of science and technology.

The WDA Forum was founded in 2002 and is based in St. Gallen, Switzerland.

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Foreword

by Nicholas N. Eberstadt

There is no shortage of trouble to worry about in our world today — from immediate and pressing worries regarding the still unchecked global Coronavirus pandemic itself and the political polarization it engenders, to the longer term threats to humanity from climate change and weapons of mega-death. Yet if we only permit ourselves a moment of reflection, we should be able to see that our era has also been **a century of absolutely breathtaking developmental successes** — and on a truly global scale.

Between 1913 and 2016, to go by estimates from the Maddison project, per capita output for the world as a whole has roughly sextupled. Over roughly those same years, according to Our World In Data, the proportion of humanity living in absolute poverty (under roughly $2 per day) has plummeted from over 80 percent to under 10 percent. This **"Great Escape"**, as Nobel Economics Laureate Angus Deaton termed it, took place even as human numbers were exploding. **The world's population is over four times larger today than a century ago.** So, humanity has not only cheated Malthus—but done so on a scale and in a manner our forebears would scarcely have imagined.

The key element in this Great Escape has been a revolutionary transformation in the value of human time—from the standpoint of development, arguably the world's most important non-renewable resource. Improvements in the value of human time today are universal, continuing, and in important ways self-sustaining. **Continuing expansion of the frontiers of scientific knowledge are of the essence in this revolution — and the main engine of this revolution comes by its application to human resources.** Human potential is augmented through enhancing "human capital" — the advances in nutrition, health, knowledge and skills that extend human capabilities, including economic capabilities. An auspicious "business climate" — institutions and policies of propitious quality — make it easier to "unlock the value" in accumulated human potential.

Decision-makers in both the public and private sectors can do much to facilitate both the augmentation of human potential and the "unlocking of value" in humanity. **Demographics is central to the Great Escape, and demography is a discipline that can help abet it.** The **WDA's paper The Power of Demography** is an exemplary illustration of how careful thinking, aided by useful new analytical tools such as **"Demographic Heat Maps"**, can contribute to just such a process.

This valuable paper introduces a new pathway for explorations by both researchers and practitioners. **There is great promise to this investigation — and the questions this paper raises are just a beginning.**

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Foreword

by Professor Thomas Zeltner

The history of humanity is also the history of **constant demographic transformation**. Mankind has been and continues to be a migrant species and has over the centuries successfully conquered the entire planet. **Humans** are also smart and creative creatures who have succeeded in **improving their living conditions** over time such that more and more of their offspring survive the critical first years of life and enjoy a steadily increasing lifespan.

These **evolutions** have substantially gained in **speed since** the second half of the **19th century**. The development has, however, not been homogeneous, resulting in very different demographic patterns in various continents and countries. Understanding the causes and dynamics of these differences is not just of scientific interest. It also allows us to **shape the future** with custom-made interventions, respecting the local **opportunities** and values.

The tool of **"Demographic Heat Maps"** presented in this paper adds a new and promising instrument for **policy makers and business leaders** to better understand each local situation and to bring added value to the life of local communities.

It asks, however, for some level of **cooperation between different** regions and countries to address population dynamics across regions and thereby enhancing the benefits of respective interventions. Because another phenomenon needs to be considered, namely that we are "**tied together** into a single **globalized marketplace and village**"[1].

And finally, to remind us, as is so well formulated in the preamble of the Swiss Constitution, that the **strength of a population** is measured by the **well-being of its weakest members**.

Professor Thomas Zeltner
Visiting Scientist
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[1] Thomas Friedman, cited in Ryan Poll, *Main Street and Empire: The Fictional Small Town in the Age of Globalization* (Rutgers University Press, 2012), p. 160.

1. Introduction

"Population ageing is a human success story, a reason to celebrate the triumph of public health, medical advancements, and economic and social development over diseases, injuries and early deaths that have limited human life spans throughout history." (United Nations, 2019a)

Indeed, for more than 2000 years, life expectancy at birth remained relatively stable at below 30 years. Only since the early 1840s – starting in Europe – could one observe a continuous increase in life expectancy by two to three years every decade. With no sign of a slowdown, this phenomenon is assumed to continue all across the globe. Aside from the role of some critical genetic predispositions, longevity is the result of the constantly improving social, economic and health-maintaining conditions in which we live. Health-maintaining conditions are the sum of numerous measures such as public health, prevention and access to healthcare for communicable and non-communicable diseases for all age groups as well as enabling factors – known under the term "social determinants of health" (SDH).

Currently the increase in total life expectancy surpasses the growth in healthy life expectancy in absolute terms. People in developed countries live with chronic disability for about 11% of their lives (Staton, 2019). This means the years we are going to live longer are not necessarily truly healthy years without any limitations. Whether a longer life is perceived as a gift or as a burden depends on how humanity copes with it and how long we live without disabilities.

The challenge for future innovations shaping our life span, therefore, is: How can we close the gap between total life expectancy and healthy life expectancy? A second challenge that cannot be ignored refers to inequalities in living conditions, including access to health, education, employment, wealth, social security and finally happiness; the differences are striking both between countries and within their societies.

This leads to the topics analyzed in this paper:

Population dynamics

- An outlook on how population dynamics will further shape the world's population until 2050
- The contribution of different age groups to longevity gains using "Demographic Heat Maps" for selected countries

Demographic development stages

- Analysis of the five demographic stages and categorization of the in-scope countries
- Japan's role in ageing societies as an example for the world's future development

Implications for health

- Analysis of healthy life expectancy and the impact of intangible assets
- Demographic trends as drivers for achieving the Sustainable Development Goals (SDG)
- The impact of longevity on people's finances throughout their life course

Demographic development of in-scope countries

- Comparison of demographic figures between and within different regions
- Visualization of current population momentum

Implications for businesses and their strategies

- Key drivers of business opportunities in developing and developed countries
- Technology and innovation as a critical success factor for further longevity achievements

In-scope countries

In order to understand global demographic trends better, a representative group of countries across the globe was selected. It is a broad list of 18 countries (Figure 1) across all regions from low income to high income. In 2020, these in-scope countries combined represent 57% of the world population and almost 70% of the global GDP.

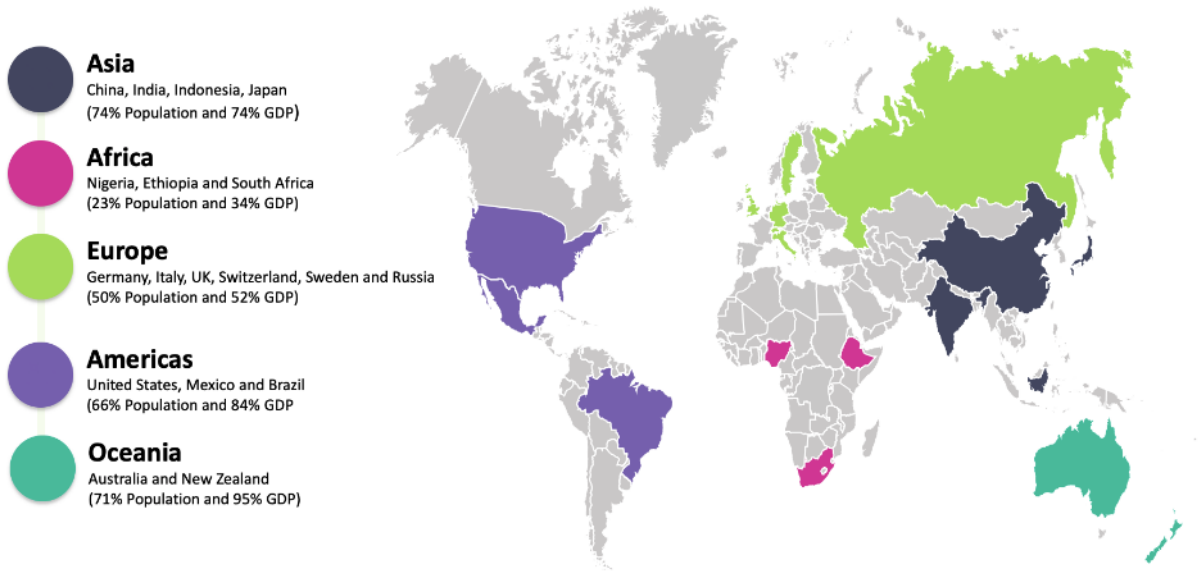


Figure 1: 18 in-scope countries with their share of the regional population and GDP

2. Current demographic trends

2.1. Population dynamics

The world population has never been as old as it is today, a trend which can be traced back to several predominant demographic factors. Declining fertility and rising life expectancy are leading to an increase in older age groups, both in absolute terms and as a proportional share of the total population (Bloom & Luca, 2016). Since 1840 the life expectancy at birth in developed countries has increased by 2.3 years every decade (The World Bank, 2019). If trends in improved old-age survival from the late 20th century persist, half of today's newborn children in developed countries such as the USA, UK, Germany, Switzerland and France will reach the age of 100 (Christensen et al., 2010). According to the UN population projection, the world's population is expected to increase from today's 7.7 billion people to 9.7 billion in 2050 in the medium scenario. As these projections are based on assumptions and different potential scenarios, the figures vary from the low scenario of 8.9 billion people to 10.6 billion in the high scenario. This development will reach its peak at the beginning of the 22nd century with nearly 11 billion people according to the UN's medium scenario (United Nations, 2019b). This substantial population increase implies the continuation of considerable population growth rates, which vary widely across world's regions due to different regional demographic stages of development.

While Sub-Saharan Africa (SSA) will double its population by 2050, Western Asia and Northern Africa are projected to increase by 50%, Southern and Central Asia by 25%, and Latin America by around 20%. In contrast, Northern America and Europe are expected to grow their population by no more than 2% (United Nations, 2019b). Figure 2 shows the past development of the world's total population since 1950 and the projection until 2100. While Asia had the biggest share of the global population growth throughout the 20th century, Africa started to catch up in the early 2000s. About 50% of the current population growth can be attributed to the following nine countries: Nigeria, Congo, Tanzania, Ethiopia, Egypt, India, Pakistan, Indonesia and the USA (United Nations, 2019a). Clearly the drivers of population growth are developing countries, which are characterized by low income, gaps in education, low industrialization and often weak governance.

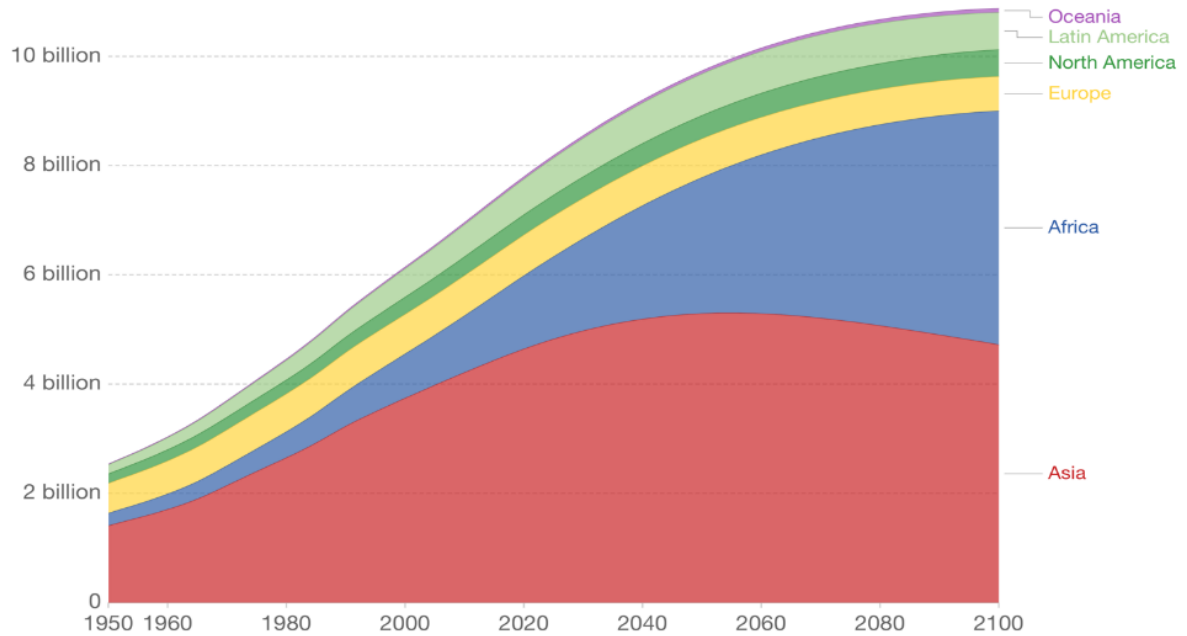


Figure 2: Projected Population to 2100 based on UN's medium Scenario (https://ourworldindata.org/future-population-growth)

The two main factors contributing to population growth are fertility and longevity (United Nations, 2019a). Migration is a third factor shaping demography. Figures from the UN suggest that migration will be the main driver of population growth in developed countries until 2050, at which point most developed countries will experience a decline in overall population size (United Nations, 2019b). For developing countries, migration often means a loss of talent. In the year 2000, two thirds of the OECD high-skilled immigrants originally came from developing countries (Docquier, 2014). In 2019, the total number of global migrants was at 270 million. Compared to 2010, this is an increase of 50 million people, which is still a small share of the world's population (UN Migration, 2019). No doubt, migration is a multifaceted topic with many parameters and with less data available for analysis.

Among all the indicators, migration is the one that is most unpredictable, which makes any projection subject to bias and errors. Due to these factors, migration is not further discussed in detail within this paper.

Fertility

The OECD (2020) defines the fertility rate as: "the total number of children that would be born to each woman if she were to live to the end of her child-bearing years."

Today's global average fertility rate lies at around 2.5 births per woman. This exceeds the rate of 2.1 which is often identified in the scholarship as replacement rate. It is assumed that 2.1 births per woman ensure a constant population size. However, the replacement rate differs across regions and can vary between 2.1 and 3.5 due to differing mortality rates (Espenshade et al., 2003). This phenomenon is called "population momentum" and is caused by the ongoing regional differences in age structure (Preston & Guillot, 1997). In total, the world's population is currently growing at a rate of around 1.1% per annum, with a range for our in-scope countries from −0.2% in Japan up to +2.1% in Nigeria and Ethiopia (The World Bank, 2019). Figure 3 shows the fertility rates of all five continents over 100 years from 1950 to 2050. With a fertility rate of almost 4.5, the African continent has the highest rate and also accounts for most of the global population growth in the coming decades. While birth rates in Africa are well above the replacement rate, all the other regions are projected to slowly converge towards the replacement fertility rate roughly of 2.1 children per woman, or fall below it (e.g. Europe with 1.61, China with 1.69 and Japan with 1.37) (United Nations, 2019b).

The declining birth rates in recent decades are due to changes in social preferences such as postponed childbearing and family formation as well as a decline in desired family size (United Nations, 2019a). From 1975 on, Africa joined the other continents in seeing a decrease in fertility rates. While the African fertility rate was at 6.7 in 1975, the current value in 2020 is 4.44 and will further decrease and is expected to approach the replacement rate in the year 2100. Every other region will be significantly below the replacement rate of 2.1 children per woman in 2100 (United Nations, 2019b). This comparison also illustrates that Africa not only demonstrates a delayed onset of fertility reduction but also a rather slow one compared to the other five continents.

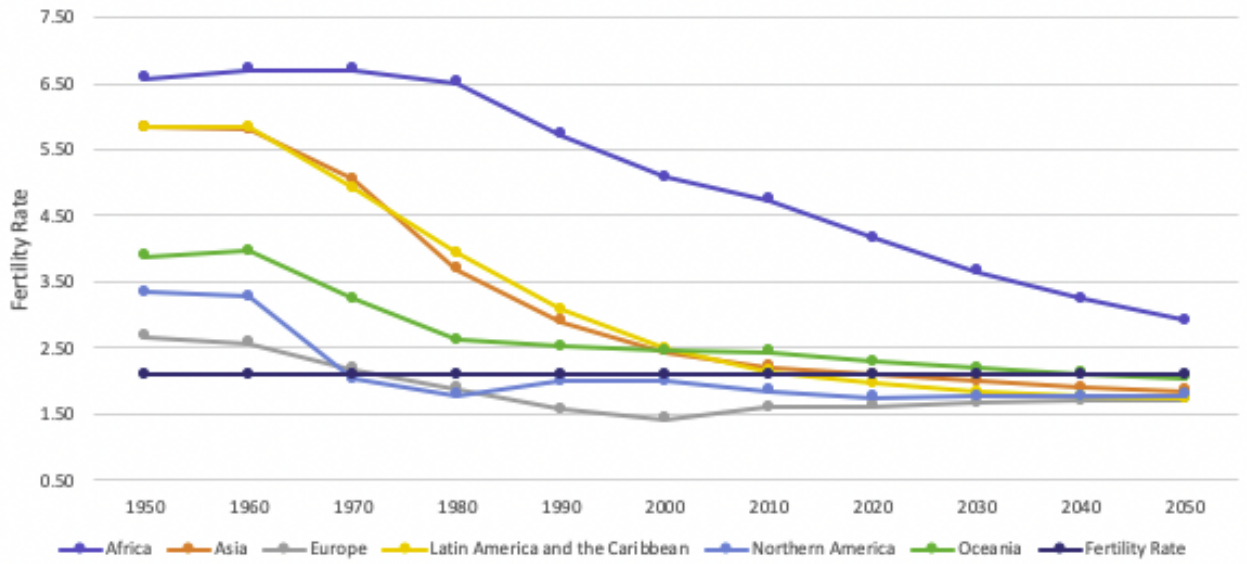


Figure 3: Fertility rate per region (United Nations, 2019b)

Longevity

Life expectancy at birth is the most solid indicator for longevity. It measures the average expected life of a newborn if current death rates are stable (OECD, 2019). Since 1950, the global life expectancy has increased from 64.2 to 72.6 years and will further rise to 77.1 years by 2050. The cohort of people aged 60+ is increasing the most. Figure 4 shows the relative share of people aged over 60 years from 2000 to 2050. The 60+ cohort grows with a positive trend across all regions. While this development is making much progress, there is still a big gap between developed and developing countries. Among the in-scope countries, Japan has the highest life expectancy with 84.2 years while Nigeria currently has the lowest with 54.3 years (United Nations, 2019b). This is largely due to high levels of maternal and child mortality, the effects of the HIV epidemic, other prevailing communicable diseases, and war or violence in crisis areas (United Nations, 2019a). The only country today with a 30% or over proportion of people aged 60 years and older is Japan. By the middle of the 21st century, other regions such as Europe and North America, as well as many Asian countries, will show similar age structure changes, although along differing timelines. There are many interdependent reasons for this longevity trend, for example public health initiatives with better healthcare and continuously evolving life courses. Again, the effects of these factors vary across the regions; increases in the older age cohort in high-income countries are currently much higher than in low-income countries (WHO, 2015).

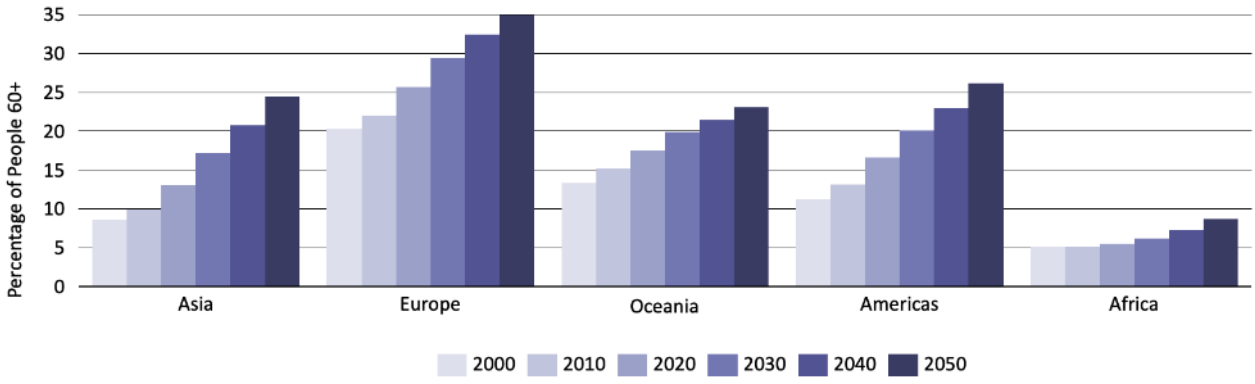


Figure 4: Development of 60+ Cohort per Region from 2000 to 2050 (United Nations, 2019b)

2.2. “Demographic Heat Map” Tool

This tool, initially developed by Rau et al. (2018), visualizes age-specific contributions to life expectancy increases over a defined period of time on a country level. As such, this type of analysis provides knowledge about which age group is driving the ongoing process of longevity dynamics. In addition, it provides insights into how age-specific health conditions or quality of life shape mortality and thus longevity in a given country. “Demographic Heat Maps” can therefore be used to understand:

- The quality of a given healthcare system across generations
- The impact of modern treatment regimens
- The effectiveness of preventive measures such as smoking cessation, alcohol restrictions, accident prevention etc.

The “Demographic Heat Maps” used in this analysis include data points over the period of 1950–2015. Our analyses have resulted in the categorization of five different archetypes (Japan, Germany, Eastern European followers, USA and Russia) into which most of the in-scope countries can be classified. However, they could not be generated for African and Asian countries at the moment, because consistent mortality data since 1950 could not be retrieved from a reliable source. Since the “Heat Maps” cover a 65-year period they are also a helpful source information for projecting future trends and priorities. The full list of all country analyses so far is given in the Appendix and it is worth studying them in detail to reach policy conclusions.

The “Demographic Heat Maps” follow the Lexis diagram structure which is often used in the studies of population. It is a two-dimensional diagram to represent events that occur to individuals belonging to different cohorts. The presented “Demographic Heat Maps” illustrate age-specific contributions to life expectancy increases in a given country. Moderate/average increases are depicted in «green», above average contributions are depicted in brown while negative contributions are given in «blue». As such this type of analysis provides hints which age group is driving the ongoing process of longevity. Every “Demographic Heat Map” shows a contribution of single ages to the increase in life expectancy over a period of 10 years

Archetype “Japan”

The first archetype – a guiding one – is named after the pioneer of longevity: Japan. Japan has been leading the way for the last 50 years with its successful reduction of mortality rates across all age groups. The demographic transition in Japan is already so advanced that future longevity increases will exclusively come from further mortality reductions in the 70+ age groups. Most European countries will very likely follow this vanguard with a delay of 10–20 years or even more, with countries from other regions following sooner or later as well.

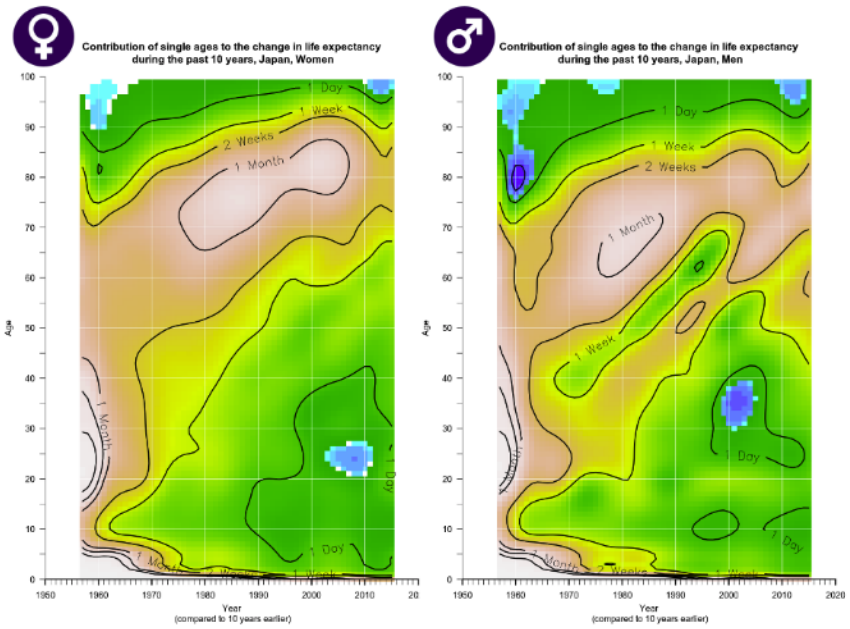


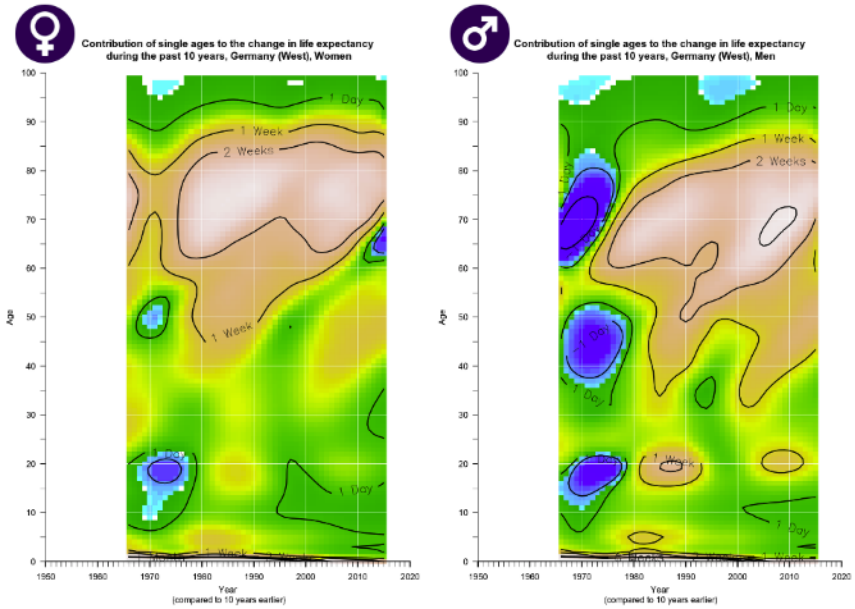
Figure 5: Demographic Heat Map of Japan

Archetype "Germany"

Germany is a model mirroring two different societal systems. Until 1990 the country was divided and the health differences between the two sides were considerable – including in the realm of longevity. In the past 50 years West Germany's life expectancy gains were driven by the working and old aged generations. It is a pattern which results from unrestricted access to modern healthcare without any periods of scarcity. Many European countries, alongside Canada, Australia and New Zealand, show similar patterns. While in all these countries, the working male class pulled down the age average from 1960 until 1990, they are now closing this gap and slowly catching up to the female life expectancy. Since 2000 further increases in longevity are driven by older age groups which means that Germany as well the other European countries, Australia and New Zealand are about to follow the Japanese path.

The longevity evolution in East Germany was characterized, particularly for working men, by increased mortality rates in the time period 1965–1975. With the reunification in 1990 East Germany immediately had access to a West German type of infrastructure and started to converge to the West German longevity pattern.

The "German" model is therefore a special example. It depicts the outcome of unrestricted access (West Germany), the impact of gaps in access to healthcare and the timeline for changes to become visible (East Germany).



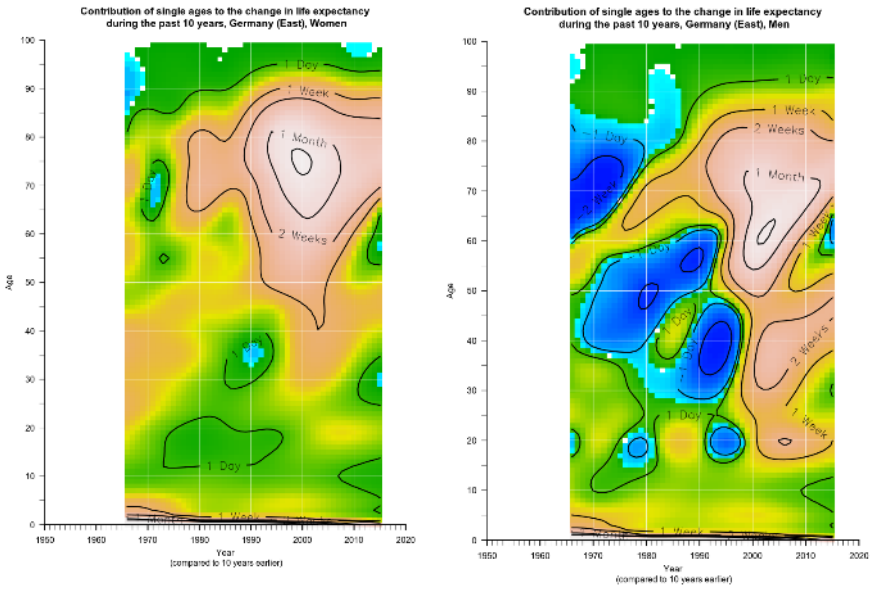


Figure 6: Demographic Heat Map of Germany (East and West)

Archetype "Eastern European followers"

Eastern European countries had declining life expectancies starting during the 1960s and continuing until 1990 across all age groups, but particularly for working men. Since 1990, the region has started to close the gap between its life expectancy gap and that of Western European countries and will converge in a pattern similar to the archetype "Germany" over the coming decades if unrestricted access to quality healthcare is increasingly available.

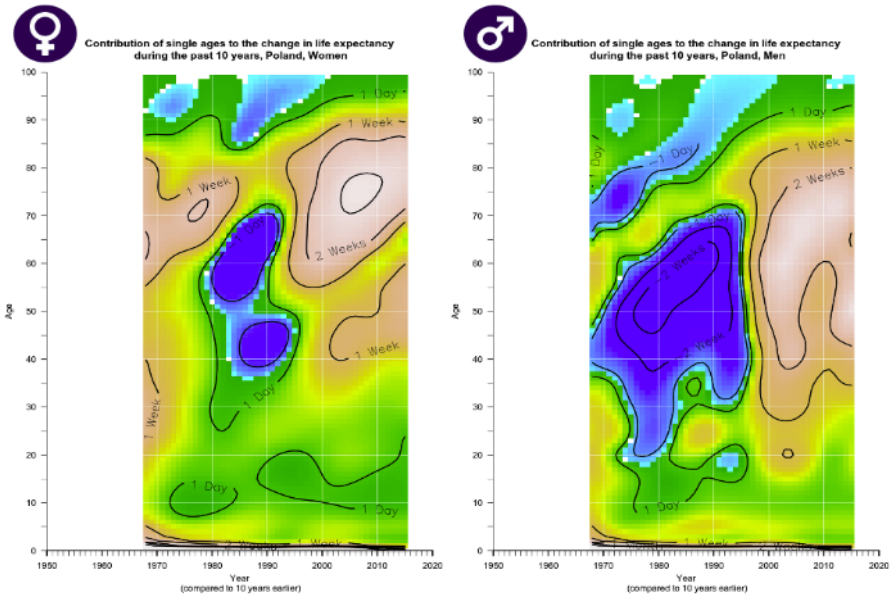


Figure 7: Demographic Heat Map of Poland

Archetype "USA"

The United States demonstrate what can happen if certain population groups are continuously excluded from access to modern healthcare. In the case of the USA this results in a situation where working-age groups often do not contribute to longevity gains, while older age groups are strong drivers for further increases in longevity.

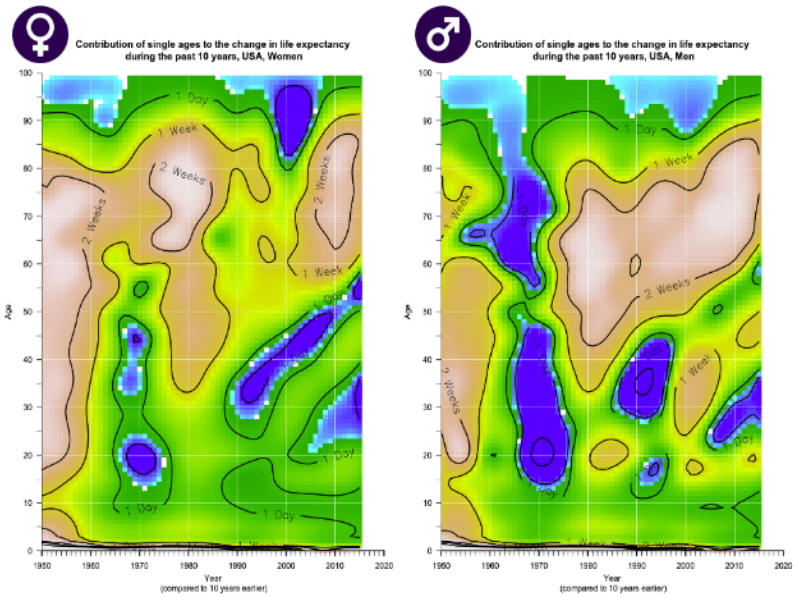


Figure 8: Demographic Heat Map of the USA

Archetype "Russia"

Russia is an example of unprecedented life expectancy deterioration for both women and men in the time period 1970–2000. Living conditions and their social and health impact are the most likely explanation. The future of longevity in the decades to come is unclear but highly related to the quality of access to healthcare and social security.

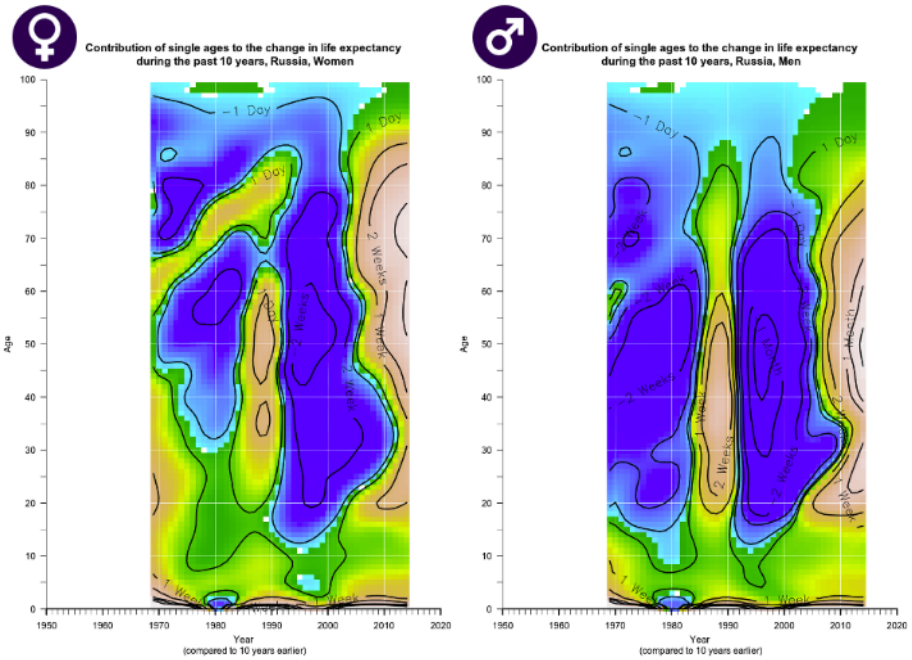


Figure 9: Demographic Heat Map of Russia

2.3. Stages of life

Population ageing is a world-wide phenomenon and almost every country is going to experience an absolute and relative shift towards an older society (United Nations, 2019a). Even though demographic changes show a similar trend across the globe, the dynamics of change vary on a regional and even national level. While France needed 115 years (1865–1980) to double the proportion of its 65+ population from 7% to 14%, China achieved this in just 27 years (1970–1997).

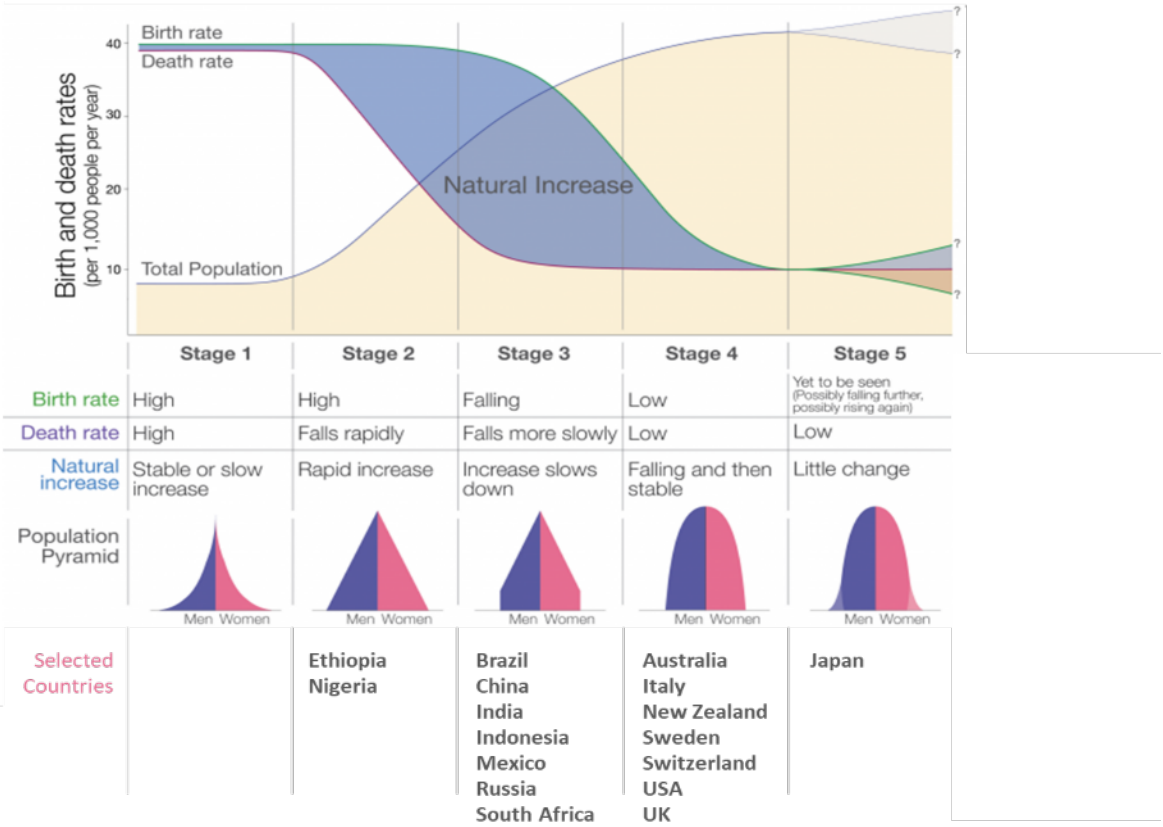


Figure 10: The five stages of the demographic transition (Roser, 2020)

Nevertheless, most countries can be grouped into categories based on their demographic stage. Figure 10 shows the five stages of the demographic transition. The graph shows how the country's demographic structure changes over time, driven by declining birth and death rates. Countries in the same stage face similar challenges and will eventually move to the next stages (Roser, 2020). However, the transition from one stage to another is a fluid process with differing speeds. Thus, researchers often do not come to consistent conclusions as to whether a certain country belongs to a specific stage.

Stage 1
This covers the majority of human history. Birth rates are high and death rates are high too, because of frequent food shortages, communicable diseases and accidents.
Example: No country is in this stage anymore, but some isolated indigenous people (e.g. in the Amazon) still display this "classic" population pyramid (BC, 2020).

Stage 2
The death rates drop dramatically due to societal and economic progress enabling access to medicine, better nutrition and hygiene. Most Western countries entered this stage in the course of the industrial revolution from 1800 onwards. Developing countries entered this stage due to their medical revolution in the 1950s. Populations grow rapidly in this stage.
Example: Less developed Sub-Saharan countries like Nigeria or Ethiopia are still in this stage, while Asian countries have already passed this stage.

Stage 3
Death rates are still falling. In addition, fertility starts to drop due to transitions in society and families who decide to have less children because of cultural changes, urbanization and economic limitations in supporting dependents. The population is still growing but at a declining speed.
Example: Countries in this stage can be found in many places, from Latin America to Africa to Asia. All BRIC (Brazil, Russia, India, China) countries are currently in this stage.

Stage 4
Death rates and birth rates are both low. While urbanization still continues, women get more roles in society, start to work and have less time to have children. This has a direct impact on fertility. The population is still growing on a very low level, driven by the increase in the life expectancy of older adults.
Example: Most Western countries are in this stage, e.g. USA, UK, Germany, Italy, Sweden, Switzerland etc.

Stage 5
While the death rate stays low the birth rates are under replacement rate, with uncertainty about their future trajectory. Whether the population is still growing or not is uncertain but what is sure is that the population is ageing.
Example: Japan is the textbook example of a stage 5 country. While the country has had a declining birth rate since 1974, researchers forecast a slightly raising birth rate (below replacement rate) from 2029 on (United Nations, 2020).

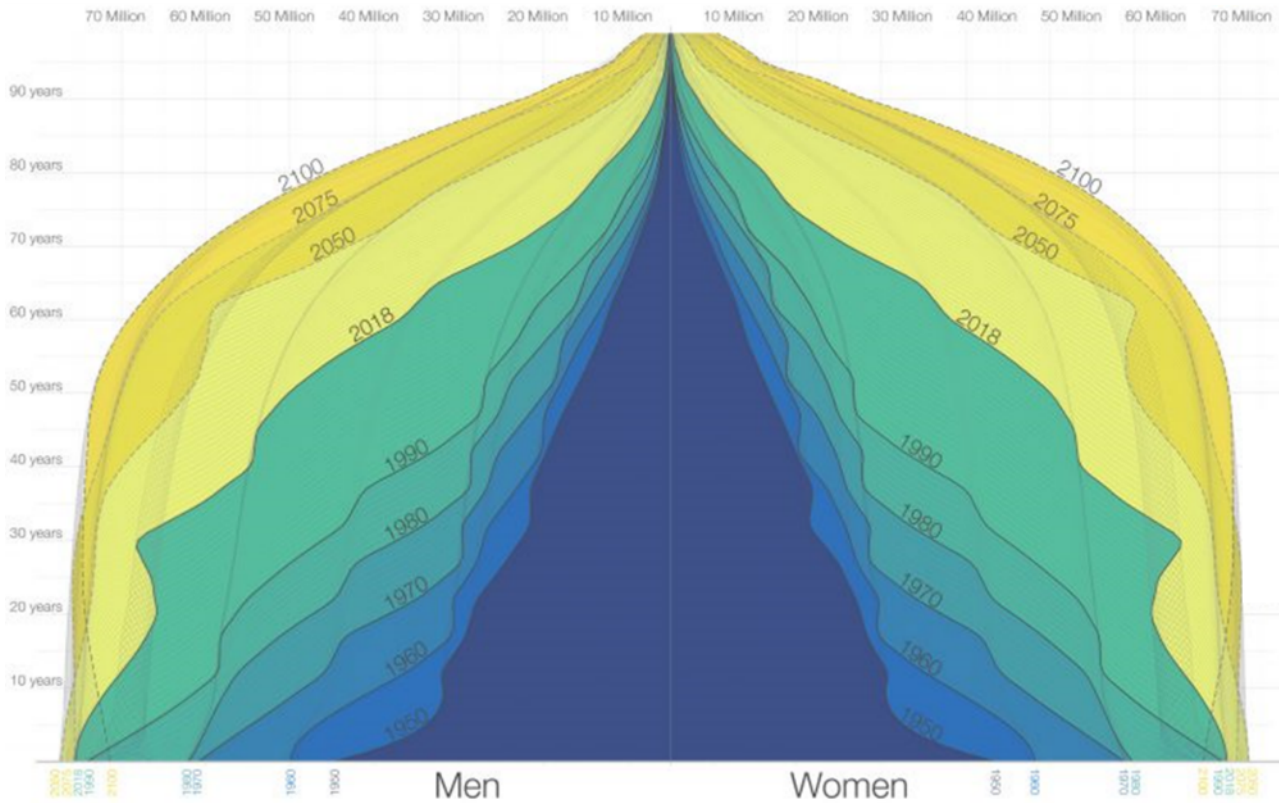


Figure 11: The demography of the world population from 1950 to 2100 (Roser, 2020)

Figure 11 shows a demographic pyramid of the world population from 1950 to 2100. It is another perspective on the five stages of demographic transition – an aggregated view. When comparing the population dynamics of the five stages of the demographic transition (Figure 5) with the world population, one can clearly observe the different stages the world population has been through over time.

Transition from stage 1 to 2
In 1950 the worldwide population was in the transition from stage 1 to stage 2. There were many newborns compared to the sum of older people. The rapid fall just above the base is caused by a relatively high child mortality (1 in 5 died before the age of 5). The narrowing of the pyramid towards the top reflects the high risk of death in all age groups (Roser, 2020). In the following four decades the death rate declined continuously with the effect of people living longer; at the same time birth rates were still high. Those are typical characteristics of stage 2.

Transition from stage 2 to 3
The transition to stage 3 happened in the last three decades. Continuous improvement in knowledge, science and technology led to better access to healthcare worldwide. Thus, the death rate declined in all age groups leading to a wider population pyramid. At the same time the absolute number of newborns remained almost the same despite a larger population. Thus, the birth rate declined.

Transition from stage 3 to 4
Experts expect that the transition to stage 4 will happen by 2050. The worldwide birth rate will fall in developing countries and stay stable at a lower rate. At the same time the death rate will further decline due to better living conditions and access to healthcare. This leads to an oval-shaped population pyramid.

Transition from stage 4 to 5
The development after 2050 is uncertain. Researchers forecast a low death rate. Whether the birth rate stays at a low level or not is unknown. What is certain is that the population is still ageing.

Japan as role model for ageing societies

From the middle of the 20th century until recently, Japan had the highest global life expectancy. Although now surpassed by the city state of Hong Kong, Japan has been and still is a pioneer of expanding the human life span. The decline in the birth rate started in Japan as early as 1950. At the same time life expectancy increased rapidly due to continuing improvements in the public health system while immigration stayed at a very low level (Groth, 2012). This development is still ongoing; more than a third of citizens will be 65 or older by 2040 (Japan Times, 2018). The improvement in life expectancy is mainly driven by older adults, as the "Demographic Heat Map" of Japan above clearly demonstrates. However, Japan faces different challenges like labor shortages, an unsustainable pension system, how to make its infrastructure truly age-friendly and social isolation among older people. Japan's problems are not an isolated case: Many developed countries like Australia, Germany, the USA and Switzerland will face quite similar challenges in the coming decades (Hamada & Kato, 2007). Therefore, this Asian country can be seen as a source of inspiration for how to manage longevity, including the necessary transformation in society and business.

2.4. Implications for health and healthy life expectancy

Health and quality of life

A human lifetime can be broken down into two parts, the healthy years and the years with disease and chronic disability. Both the so-called "healthy life expectancy" and the "years lived with disability" have increased in all countries across the globe (Roser, 2019). However, the increase of absolute life expectancy surpasses the growth in healthy life expectancy. This means the years we are going to live longer are not necessarily years in good health.

	Total Life Expectancy at Birth (LE)		Healthy Life Expectancy at Birth (HALE)		Years in Poor Health		Increase 2016 to 2000	
	2000	*2016*	*2000*	*2016*	*2000*	*2016*	*LE*	*HALE*
Africa								
Ethiopia	51.9	65.5	44.5	57.5	7.4	8.0	26.1%	29.2%
Nigeria	46.3	53.5	41.5	48.9	4.8	4.6	15.7%	17.8%
South Africa	56.0	63.2	51.2	55.7	4.8	7.5	12.7%	8.8%
Americas								
Brazil	70.1	75.2	61.5	66.0	8.6	9.2	7.3%	7.3%
USA	76.6	78.5	67.4	68.5	9.2	10.0	2.5%	1.6%
Mexico	74.3	74.9	65.6	67.7	8.7	7.2	0.8%	3.2%
Asia								
China	71.4	76.2	64.8	68.7	6.6	7.5	6.7%	6.0%
India	62.5	68.9	53.5	59.3	9.0	9.6	10.2%	10.8%
Indonesia	65.8	71.0	58.7	61.7	7.1	9.3	8.0%	5.1%
Japan	81.1	84.0	72.5	74.8	8.6	9.2	3.6%	3.2%
Europe								
Germany	77.9	81.0	69.2	71.6	8.7	9.4	3.9%	3.5%
Italy	79.8	83.2	70.6	73.2	9.2	10.0	4.3%	3.7%
Russia	65.5	71.7	58.0	63.5	7.5	8.2	9.4%	9.5%
Sweden	79.6	82.3	70.4	72.4	9.2	9.9	3.3%	2.8%
Switzerland	79.7	83.6	70.1	73.5	9.6	10.1	4.9%	4.9%
United Kingdom	77.7	81.2	69.0	71.9	8.7	9.3	4.4%	4.2%
Oceania								
Australia	79.2	82.4	70.3	73.0	8.9	9.4	4.1%	3.8%
New Zealand	78.6	81.6	69.8	72.8	8.8	8.8	3.8%	4.3%

Figure 12: Comparison between LE and HALE (own graphic using data from United Nations, 2019b; The World Bank, 2019)

Figure 12 shows the development of life expectancy at birth and healthy life expectancy at birth from 2000 to 2016. The last columns show the difference between life expectancy at birth and the healthy life expectancy, thus, the years lived with disease and chronic disability.

The insights can be summarized as follows:

- Citizens from all countries are going to live longer.
- Healthy life expectancy increases but the growth rate will not surpass the life expectancy increase. Thus, the years we are going to live longer are not all healthy years.
- In countries with advanced healthcare systems people not only have a higher life expectancy, they also spend longer periods with disabilities.
- In developed countries, the proportion of the average person's lifetime spent living with diseases or chronic disability (bad health) remains stable at around 11% (Staton, 2019).

To illustrate, in 2000 Japanese had a life expectancy of 81.1 years and a healthy life expectancy of 72.5 years (meaning 10.6% of a lifetime was lived with disease or chronic disability). In 2016 the life expectancy increased to 84 years, while the healthy life expectancy increased to 74.8 years. This means that 10.9% of a lifetime was spent with disease or chronic disability (Tokudome et al., 2013). On average in this period Japanese are going to live 2.9 years longer, of which only 2.3 are without physical and medical restrictions.

It follows that the ultimate goal has to be for healthy life expectancy to grow at a higher rate than life expectancy. In other words, "Adding Life to Years, not just Years to Life!" is what we should aim for. However, this is a big challenge as the prevalence of diseases increases with age (Christensen et al., 2010). The biggest burden for adults over 60 is the impact from non-communicable diseases (NCDs) (WHO, 2019a). Dementia for example will eventually have a paramount impact on the socioeconomic development of all nations (Groth, 2020). Additionally, this disease can be overwhelming for families of affected people, having a considerable impact on their emotional, physical and financial stability (WHO, 2019a).

An often unaddressed health problem is social isolation and loneliness in old age. Every third older person experiences loneliness with 5% of those feeling constantly alone (Jansson et al., 2017). Older people are more likely to live on their own and often do not participate in wider social life due to increased mental or physical health concerns. Additionally, those with depression, heart disease, anxiety and dementia are most prone to experience loneliness (Berg-Werner & Morley, 2020). Research shows that long-term loneliness (over four years) is positively correlated with an increase in alcohol and drug use, high blood pressure and depression weight gain, and negatively correlated with physical activity, heart health, sleep and cognition (Cigna, 2018). To reduce the reasons for loneliness both social interventions and medical solutions to improve quality of life are required.

Although health is one – if not the most – important factor, there are other aspects that influence the quality of life. For instance, Gratton and Scott (2016, p. 67) state that in order to live a long, happy and productive life in the era of longevity, the key is to find a balance between tangible and intangible assets. They are interconnected and create substantial synergies. Tangible assets refer to the financial situation of an individual (e.g. house, car, savings, rent). Intangible assets are, for example, relationships, skills, knowledge, mental and physical health.

Better healthcare to achieve the Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) were adopted by all United Nations member states in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030 (UN Development Program, 2015). The 17 goals for sustainable development (with their 169 sub-goals) are the core of Agenda 2030 and are to be achieved globally and by all UN member states by 2030. This means that all states are equally called upon to solve the world's pressing challenges together. Incentives should also be created to encourage non-state actors to make a greater active contribution to sustainable development. Successfully achieving the SDGs is closely linked to current demographic trends regarding world population. Longer life expectancy, different life courses and appropriate inclusion of old aged people will shape the global agenda beyond the 2030 SDG agenda. There are already several planned demographic policy implications to make progress on the SDGs. How governments address the impact of an ageing population on distribution and intergenerational inequity, counteract the shrinking proportion of the workforce or eliminate age-based discrimination to increase economic growth are just a few examples (United Nations, 2019a).

The healthcare sector in particular should focus on achieving certain SDGs. Therefore, the demographic change brings responsibilities for the sector but also creates a wide range of opportunities. Supporting lifelong health and preventive care are essential to increasing health and wellbeing in order to maximize the functional capacity of individuals. A growing old aged cohort and longer life expectancy in general require equitable access to disease prevention and treatment throughout all stages of life. As discussed before, healthy life expectancy remains the primary focus of longevity development. There needs to be an alignment of health and long-term care systems in order to provide an integrated health service for all people. In this field it is increasingly important to include the health needs of older people with age-friendly treatments and to not sideline that older population (United Nations, 2019a).

Longevity and people's finances

A longer life requires more monetary assets for food, accommodation, clothes, mobility, insurance and healthcare. For example, costs related to dementia are estimated to be 1.1% of the worldwide GDP (WHO, 2019b). Although health expenditures are generally higher for older people than younger people (especially in developed health systems), researchers have found that population ageing will not become the main driver of the increase in health expenditures (Williams et al., 2019).

The UK parliament describes the issue of financing longevity in a pragmatic way: it means more spending for retirees and less tax revenue (resulting from a decline in the working population) (UK Parliament, 2015). This is a cause for concern as it will place a higher burden on the working population if the current pension system remains unchanged. Indeed, many retirement systems were designed based on the underlying age structure at the time of their implementation. The UK is a good example. In 1999 3.7 people were of working age per person of retirement age (65 years or above). In 2040 this so-called dependency ratio will decrease by 43% to 2.1 (Pettinger, 2019). The two most likely solutions to this challenge are either to increase the retirement age or for people to save more money during their working life (Gratton & Scott, 2016, p. 27f). As saving more during their working life is not feasible for everyone (e.g. those with a low salary or supporting a family) the first solution is more probable. In a system with increasing reliance on private savings inequality is fostered (Pettinger, 2019). Thus, societies must become ready for a transition towards a different – and notably longer – working life. However, this will only be possible if the population continues to make progress in healthy life expectancy.

Another challenge arising from the ageing society involves the declining working population, which could result in a labor shortage. Without new work models this could lead to lower economic growth rates and put additional pressure on public finances (Pettinger, 2019). In the end this can harm the competitive advantages of a country (Groth, 2013).

3. Development of in-scope countries

The analysis of the demographic development of the 18 in-scope countries provides further helpful insights for strategic planners in business and policymaking, in combination with what we can learn from the "Demographic Heat Maps" and the demographic stage model.

Asia

With the four Asian in-scope countries, 74% of Asia's population and 74% of its GDP are covered. Asia is a region which is diversely developed from a demographic perspective. There is **Japan** with the second highest life expectancy (84.2 years) which already in 1960 had a fertility rate below the replacement rate. Nevertheless, Japan had a growing population until 2010 that can mainly be attributed due to the longevity of the people. Japan's "Demographic Heat Map" reveals that males aged from 70 to 80 and females from 75 to 85 are the principal drivers of Japan's rising longevity. On average, those groups are responsible for an increase in life expectancy by an additional one month per year over the past 10 years. The 65+ cohort contribute the most to the increasing life expectancy with approximately one month per year in addition. This indicates that Japan's older age groups are continuously improving at least some aspects of their living conditions.

China follows a similar demographic pattern as Japan, but with a higher momentum. It currently has a significantly lower life expectancy of 76.7 years. However, China manages to increase its life expectancy 2.6 months per year while Japan only gains one month per year. 2030 is the year in which China is projected to reach its population peak with about 1.46 billion inhabitants. Typically for stage 4 and 5 countries, China and Japan show slightly rising fertility rates (from below replacement level) with an annual compounded growth since 2000 of 0.3% and 0.2% respectively.

Dynamics in **Indonesia** and **India** are not yet so far advanced, which can also be seen from their categorization in the five stages model. With 69.4 years, India has the lowest life expectancy of all analyzed Asian countries, while Indonesia has 71.5 years. During the last 20 years, India had an average decline in fertility rate of −2% per year, which results in a current fertility rate of 2.08, slightly below replacement rate. Indonesia had a yearly decrease of only −0.44% and remains at a relatively high fertility rate of 2.3 which will result in a population peak of 340 million – of which 210 million in the workforce – by 2070. India is expected to reach its population peak right after 2050. With 1.1 billion people in the working population, almost every fifth worker in the world will be located in India.

Africa

There is a big difference between the 6 North African and 48 Sub-Saharan countries. While the demographic patterns in North Africa are similar to Europe, the Sub-Saharan countries still have a long way to go to catch up with the demographic status quo of the rest of the world. According to the demographic stages model, Nigeria and Ethiopia are relatively near the beginning of their demographic development which indicates an impending population growth in the future.

From a demographic perspective, **Nigeria** is the country with the most extreme population figures of among the in-scope countries. With 54.3 years, Nigeria has the lowest life expectancy of all countries analyzed. Nevertheless, the country shows a positive development, adding 4 months per year to the population's life expectancy. The current low life expectancy is also one reason for the fertility rate of 5.4, which marks the highest figure out of all discussed countries. Nigeria is a good example that confirms the connection between the current development situation and the demographic stage with its population pyramid. For the year 2050, Nigeria is projected to have 400 million people, which would make it the third largest national population after India and China. It will have 250 million people in the workforce. By the year 2100 the Nigerian population will even reach 730 million (United Nations, 2019b).

Not only Nigeria but also **Ethiopia** is currently still in the second stage of the demographic stage model. However, the life expectancy of Ethiopia is the largest out of the three analyzed African countries. On average, Ethiopian people born today will live to 66, while the current trend is showing a yearly increase in life expectancy of around 4 months. The reason Ethiopia is still in stage 2 is its high fertility rate of 4.3, which is more than twice the replacement rate. In 2050, the country will have around 205 million people with 135 million people of working age.

The third analyzed African country is **South Africa**, which has the lowest fertility rate of the three countries. With a value of 2.4, it is slowly approaching the replacement rate. Nevertheless, at 63.9 years, its life expectancy is notably lower than Ethiopia's. This indicates structural problems in the healthcare system, including its relative inaccessibility. In 2050, South Africa will have 75 million people, with 50 million people of working age.

Europe

Except for Russia, all the analyzed European countries have reached the fourth stage of the demographic transition. Falling birth rates and low death rates are responsible for this trend, which can be traced back to the good healthcare system and their broad accessibility. **Switzerland** has the highest life expectancy of all the European countries and from a global perspective, only Hong Kong and Japan have higher values. Even though Switzerland already has an 83.8-year life expectancy, the country continues to increase this by 1.3 months per year. The country's fertility rate is relatively stable at 1.52 with a slight negative trend. The Swiss "Demographic Heat Map" shows that in the early 2000s men aged 20 to 30 had the most influence on the increase in the country's life expectancy. Almost the same male age group was responsible for a small decrease in life expectancy during the 1980s and 1990s. For the decades to come it is most likely that particularly older age groups will become the drivers of increases in longevity. In order words: "Switzerland goes Japan!"

After **Switzerland**, **Italy** has the second highest life expectancy. However, compared to Switzerland, Italy's present expectancy growth is only 0.6 months per year. Its fertility rate is at around 1.3 with a strong negative trend during recent years, which is one reason for Italy's current shrinking population. Due to this trend, Italy is expected to decrease its population to 35 million (medium scenario) compared to today's 60 million by the year 2100. While the "Demographic Heat Map" of Italy's female population shows a consistent pattern, the male "Heat Map" shows completely different patterns since 1950. While many men aged 60+ were responsible for a decrease in Italy's life expectancy in the 1960s they have now become the driver of Italy's longevity, contributing one month per 10 years to the increasing life expectancy.

Sweden has the third highest life expectancy of the discussed European countries with 82.6 years. Due to the highest fertility rate of the European countries (1.76), Sweden's population growth will constantly continue and will reach 13.1 million people by 2050 which is a 13% increase compared to today's population. Sweden's "Heat Map" shows that in the 1970s men aged 35 to 60 brought down the life expectancy of the country. Since 1990, this trend has changed and men aged 60 to 80 are now the key drivers of further life expectancy increases in the country. On the other side, men and women between 20 and 30 started to negatively contribute to Sweden's life expectancy.

Within the past 5 years, life expectancy in the **United Kingdom** has slightly fluctuated between 81.3 and 80.9 years and is now back at 81.3. The country has the most rapidly decreasing fertility rate, resulting in a current value of 1.68, which is nonetheless still the second highest in Europe. The UK will experience population growth until 2050 which will aggregate in 74 million people compared to today's 68 million (medium scenario). The "Heat Maps" of both women and men in the UK are very inconsistent and have changed a lot over the last 70 years. In the last 20 years, the pattern became more consistent due to the high life expectancy contribution of women and men aged 60 and above.

Like in Great Britain, life expectancy in **Germany** has slightly fluctuated over the last 5 years and is now at 80.9 years. Germany has an average fertility rate of 1.57; as such, the country will experience a continuous decrease in population which will result in 80 million people in the year 2050 (medium scenario) compared to today's 84 million. The German population has already proven to be stable in the past; 30 years ago, the country already had almost 80 million inhabitants. The Eastern and Western German "Demographic Heat Maps" both display a completely different pattern. After the reunification of Germany, Eastern Germany quickly started to close the life expectancy gap to Western Germany. Today, the women in Eastern Germany have the same life expectancy as women in Western Germany. On the other side, Eastern German men still live on average one year less than Western German men. A study by Rau and Schmertmann (2020) shows that the difference between Eastern and Western Germany could be due to socio-economic indicators at the district level, which refer to the situation of poorer population groups. This explains the differences in life expectancy better than GDP per capita, population density or doctor density.

Russia marks the outlier out of all the European countries. With a life expectancy of 72.7 years it is almost 10 years behind all the other European countries. This gap was even bigger in the early 2000s, when Russia was separated from the other countries by almost 15 years. Russia's "Demographic Heat Map" shows that all age structures, regardless of gender, were responsible for decreases in life expectancy. For comparison, many Eastern countries such as Poland, Hungary and the Czech Republic managed to turn around this development and now have the biggest life expectancy growth out of all analyzed countries with almost five months per year. However, these countries have very low birthrates and, in combination with the effect of working-age migration, this means those countries will shrink in population size.

Americas

In terms of life expectancy, there is only a small gap between the countries compared to the other regions. The **United States** have a life expectancy of 78.5 years which marks the highest value out of the three countries. Similar to Germany and the United Kingdom, the expected lifetime of the population has remained stable over the last 5 years. The country's "Demographic Heat Map" shows that the old aged cohort contributes to the improvement in the expectancy while people

aged between 20 and 35 are negatively compensating this progress. However, the USA is projected to grow its population to 380 million people by 2050 from today's 330 million (medium scenario). One reason for this increase is the relatively high fertility rate of 1.73 and immigration. The working population of the United States will fluctuate from 230 to 250 million in the years 2050–2100.

People living in **Mexico** currently have an expected lifetime of 75 years with a current tendency to grow further. The country currently gains 2.3 months of life expectancy per year. Mexico also has a relatively high fertility rate of 2.1, which is one of the main reasons the country will increase its population from today's 129 million to 155 million in 2050 (medium scenario).

With a population of 213 million people, **Brazil** is the second largest country in the Americas region. The country has a life expectancy of 75.6 years and this value currently increases 2.3 months per year. With a fertility rate of 1.73 and ongoing strong ageing Brazil is expected to have a population of 230 million in the year 2050.

Oceania

Both analyzed countries from the continent of Oceania are categorized as being in the fourth stage of the demographic transition model. **Australia** surpassed the 80-year mark for its life expectancy back in the early 2000s and now has an expectancy of 82.8 years. The country is still able to add around one month per year to this value. With its fertility rate of 1.74, an advanced healthcare system and a clear immigration policy, Australia is expected to grow its population by almost 30% by the year 2050 (medium scenario).

New Zealand shows a very similar pattern as Australia. The life expectancy is at around 81.9 years while the country is still able to increase this figure by more than one month per year. New Zealand's fertility rate of 1.71 is also very close to the Australian one. The projected population growth until 2050 is slightly lower with 25% compared to 30% in Australia. Both countries currently show similar "Heat Map" patterns. Men and women aged 60+ are responsible for a high increase in the life expectancy in recent decades. For the last 10 years, men aged 20 to 30 have also had an increased positive impact on both countries' life expectancy.

4. Business implications – Key Opportunities in developing and developed Countries

After analyzing population dynamics on a global, regional and country level, the following chapter will guide through resulting strategies in developing countries as well as in developed countries. The demographic momentum comprises many different megatrends such as globalization, urbanization or sustainability, which all have a high impact on today's demographics. Some of the most influential drivers are technology, innovation and digitalization. Therefore, this chapter will dive into current healthcare developments and what new technologies offer, and where the journey could go to in the era of longevity.

Opportunities in developing countries

Developing markets demonstrate and will continue to demonstrate the most dynamic development with above replacement fertility rates and increasing longevity due to growing access to healthcare. Developing countries are the global driver when it comes to **population growth**; they are accountable for 97% of the total population increase from 2015 to 2030 (United Nations, 2019b). Another main factor for the geopolitical importance of developing countries is their increase in **working-age population**. In absolute terms, the working-age population will expand by 725 million people by 2030 while the relative share will remain at 65%. A higher work population also indicates a potential for accelerating wealth accumulation with an increase in economic growth potential and therefore an **expansion of the so-called "middle class**". The growing middle class will benefit from growing wages which allows more consumer spending, higher demand for consumer products and also for higher expenditure on healthcare (Muller, 2018). The OECD estimates an increase in spending by the middle class of developing countries from 25% of global consumption in 2009 to around 70% by the year 2030 (Kharas, 2010).

Figure 7 shows the projected GDP distribution across all regions until 2050. The developing regions Asia and Africa gain a significant share of the global GDP. One aspect of this growth can be attributed to the rising working population in these countries. Growing population figures also mean increasing market size for health services and products. While some countries were neglected in the past due to their population and GDP figures, increasing population and growing GDP per capita are indicators of the economic attractiveness of a country (Roland Berger, 2017).

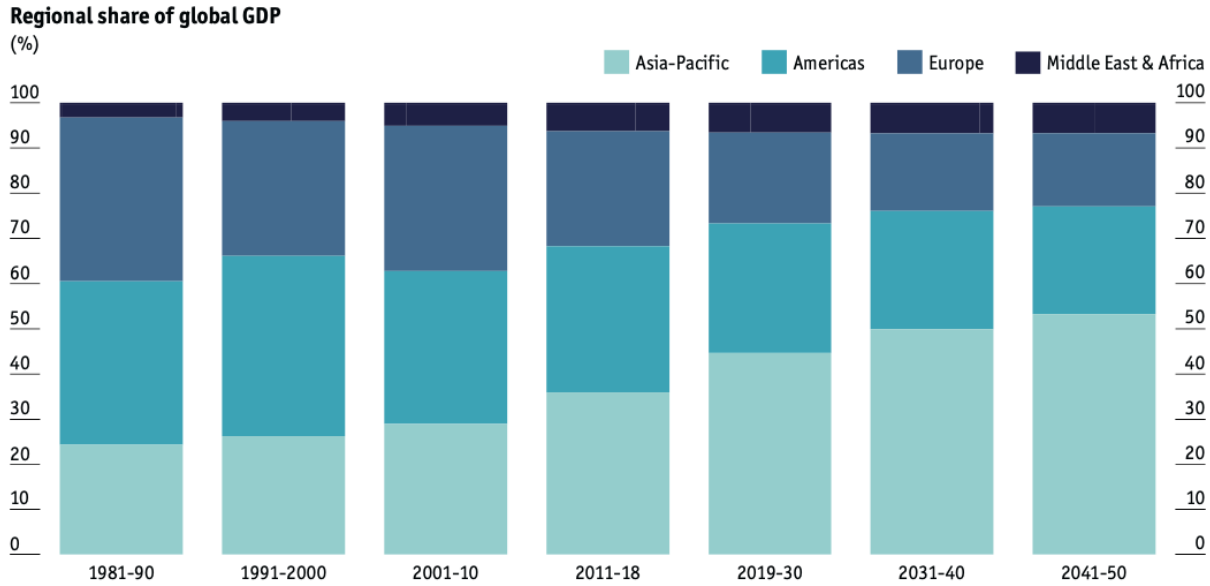


Figure 13: Development of regional GDP share (The Economist, 2015)

Opportunities in developed countries

The world population is projected to grow to 8.4 billion by 2030; this is an increase of 1.2bn (18%) compared with 2015. Only 37 million (3%) of this **population growth** is forecasted to come from developed countries (Roland Berger, 2017). This low growth rate is caused by low fertility. At the same time people in developed countries age healthier and life expectancy increases due to improvements in healthcare and technology. The combination of stagnating birth rates and rising life expectancy is the reason for the aging society and has a significant impact on the relative age structure and new consumer demand. The old aged cohort will further grow and in 2030 the median age will be 44 years (Roland Berger, 2017). This is 12.8 years older than in developing countries.

The **working-age population** will drop from 66% in 2015 to 61% in 2030. The dependency ratio will further increase, and this bears the biggest challenge for developed countries – they have to finance growing older age non-working groups. However, an **upside of an ageing population** is that the older age groups save less and spend more. The driving force is the demand of healthier agers who live longer and longer and can contribute longer to society and to economic growth. Additionally, citizens aged 80 or above spend more on healthcare and general care (United Nations, 2019). This results in an aggregated consumption shift towards older age people. By contrast, the older age people in developing countries are not able to spend more as they have a lower level of savings and a poor social security system.

5. Technology – prevention/cure/care

Knowledge, science and technology are the main drivers that have increased life expectancy over the last 200 years (Cutler et al., 2006). Many modern tools – like the polio vaccine, heart procedures, antibiotics, chemotherapy, radiation, and medical devices such as joint replacements – were developed in the past 5 to 8 decades (Dutta et al., 2019). Today medical innovations are driven by big data, artificial intelligence and machine learning and represent an immense business opportunity (World Intellectual Property Organization, 2019). The global market size of artificial intelligence in healthcare was USD 5.9 billion in 2018, growing at a compound annual growth rate of 41.5% (2019–2025) (Grand View Research, 2019). Declining hardware cost, the importance of lowering healthcare costs and advancement in big data are just some factors that contribute to this high growth rate. The following section will discuss three segments of healthcare provision that are of special importance in the area of longevity: prevention, cure and care.

Prevention

The underlying idea is to shift from treatment to prevention. The main drivers are disruptive new therapies, advances in technology and increased access to patient data. One application is to use tracking devices to monitor health conditions which give an alert to prevent diseases. Wearables like smartwatches or other fitness tracking devices are becoming more popular all around the world with the consequence of allowing companies to gather a vast amount of data (Groth, 2018). Artificial intelligence (AI) and machine learning are used to analyze the data and allow medical professionals to make evidence-based decisions to prevent health issues early (World Intellectual Property Organization, 2019).

Low- and middle-income countries spend on average 12% of all health spending on prevention, including immunization, early disease detection, health condition monitoring, information and education, and other collective services (WHO, 2018). OECD countries on the other hand spend only 2.8% on prevention actions (OECD, 2017). This significant discrepancy comes from the fact

that in low- and middle-income countries the overall budget for healthcare is lower and preventive measures like vaccinations and information offer the best value for money. Additionally, there are not enough resources to treat people with more complex and thus expensive diseases. Not so in more advanced countries: in the United States 90% (USD 3.15 trillion) of annual health costs are caused by patients with chronic diseases, which could be avoided if detected early (Buttorff et al., 2017). Livongo is a pioneering company in this field. They are using smart, connected devices to collect customer data. They are then using AI and machine learning to interpret the data and provide this information to health professionals. This allows them to personalize guidance for people at risk or already living with chronic conditions, thus improving their lives (Livongo, 2020). Prevention has the potential to significantly lower the demand for care, thus, costs.

Cure

AI and machine learning can accelerate the drug discovery and development process which is long and extremely costly: pharmaceutical companies spend on average 12 years and billions in research and development for one new medicine (Groth, 2018; World Intellectual Property Organization, 2019). AI and Big Data are increasingly being used for simulations to find better drug molecules quicker (World Intellectual Property Organization, 2019). Another promising approach to cure diseases is gene editing, which has many different applications. For example, researchers have succeeded in implanting a deadly gene in malaria-transmitting mosquitoes hereby extinguishing all malaria-transmitting mosquitoes in the study within seven generations (Kyrou et al., 2018). Gene editing technology can also be used to develop gene therapy which enables correction of genetic defects. Gene therapy is still in the early stages of development and extensive research must be conducted to access its full potential.

Care

An ageing society where life expectancy grows quicker than healthy life expectancy implies a growing demand for elderly care. New technologies are mainly used to enable people in need of care to stay home longer as related costs are 50% lower than in-hospital care (Levine et al., 2018). Digitalization has made in-home care possible; portable monitoring tools and improved communication systems enable medical professionals to supervise patients remotely (De Arruda, 2019). Age-tech will play an important role in ensuring quality of life while reducing costs for care.

6. Outlook

The progress in **longevity is one of the greatest achievements of human history.** Improved living conditions, public health and successful medical interventions are some of many factors contributing to declining death rates and rising maximum and average ages. Through the targeted analysis of "Demographic Heat Maps", age patterns can be examined retrospectively and conclusions for future developments can be drawn. In particular, this analytic tool shows that in developed countries the reduction of death rates among the elderly is the main driver of gains in life expectancy in the decades to come. The "Demographic Heat Maps" also reveal that longevity increases are already in progress in the developed countries for some decades while the developing countries are adapting their pattern with some time delay - but with unprecedented speed to catch up.

Africa will be the region with the largest demographic movement in the 21st Century – in terms of overall population growth, the size of the working-age population, the growing older age groups and also migration.

There is a considerable difference between developed and developing countries when it comes to the composition of population. While almost all **developing countries are still in the early stages of their demographic transition**, the developed countries have completely different challenges to deal with. To increase life expectancy in developing countries, relatively simple health improving solutions, which are already accessible in the more developed regions should be adopted. This access to health services has another huge benefit: It enables economic growth and development (starting from low levels) thereby capturing partially the productive potential of massively growing working-age populations in the developing countries (mainly Africa).

In developed countries, the focus lies more on **converting the comparably high life expectancy into healthy years** that actually create value for people. Current and past demographic dynamics have proven that **healthy years and life expectancy can be expanded.** Further improvements in public health, prevention and better medical treatments as well as new digital technologies such as AI and machine learning continue to be or will become promising tools. With these options available it will be possible to not only live longer but also benefit from the advantages a longer life span offers.

A common misinterpretation of the healthcare sector's goal is to help people live longer. In fact, it is to **keep people younger for longer**. Scott and Gratton (2020) argue that understanding health is less about illness and more about building strength. According to them, the healthy life course can be cumulatively expanded by our own habits such as good diet and exercise. In the future we are not just going to live longer, we are also going to live differently. According to Gratton and Scott (2016) the classic 3-phase model of childhood, employment, retirement is outdated, and more agile **solutions must be found in order to live a happy, fulfilled, financially stable life** in the era of longevity. The financial aspect stands out; due to the decreasing working population in industrialized countries, the traditional principle of a pension at 65 years old is becoming difficult to maintain. Today's retirement systems in developed countries were established with the underlying age structure of decades ago in mind, and longevity development was not taken into account. Since the healthy life expectancy is increasing at a slower pace than the normal life expectancy, it is vital to have an old population that is healthy and capable of working longer and differently. This illustrates once more, how important **health solutions for people aged 65 and older** are.

As progress is being made towards longer and healthier lives, nations, their **societies and citizens need to start developing a new vision of how to capitalize on longevity** – socially, culturally and economically.

7. About the Authors

Patrick Friedli: Currently enrolled at the University of St. Gallen, Patrick is pursuing his Master Studies in Accounting and Finance. Previously, he worked for the BMW Group in supply chain management and did a consulting traineeship at PwC in the field of financial services. After his degree, Patrick strives to work in asset management with a focus on sustainable finance.

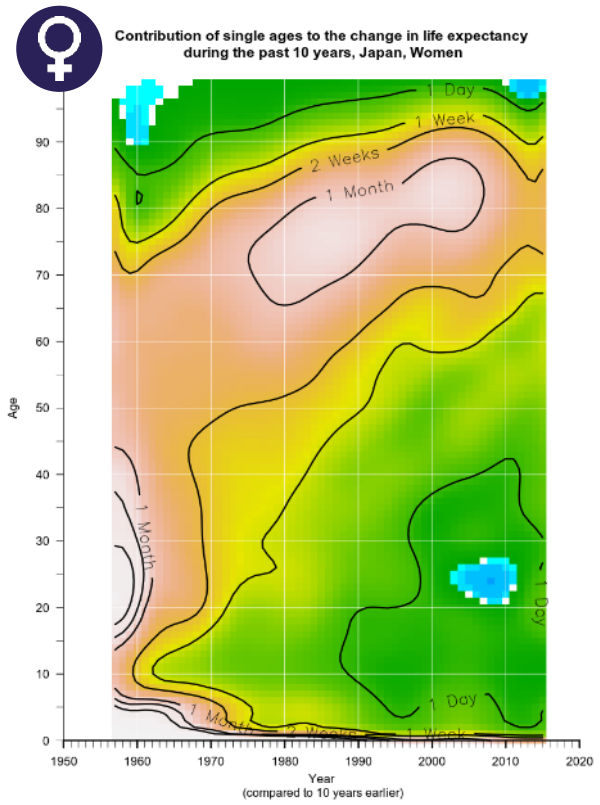
Lucas Binggeli: Student at the University of St. Gallen of "CEMS" Master in International Management and Master in Business Innovation. Currently working in a MedTech startup with the vision to improve wellbeing and extend the duration of human life. Lucas Binggeli has several years of work experience in the banking and insurance industry.

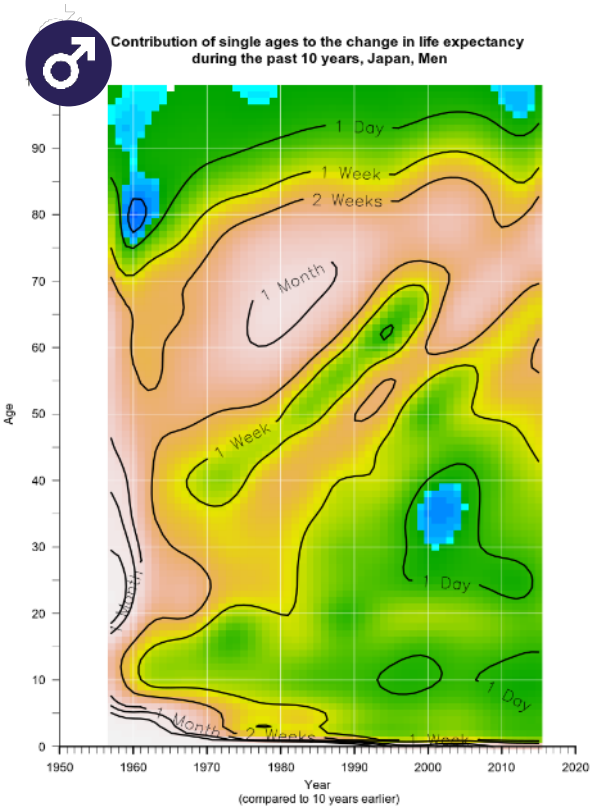
Pol Vandenbroucke: Chief Medical Officer for Pfizer's Global Hospital Business Unit. He also serves on the Board of the American Federation for Ageing Research and is a Fellow of the Faculty of Pharmaceutical Medicine of the Royal Colleges of Medicine of the United Kingdom. A frequent speaker on health, aging and policy issues, he is also a Visiting Senior Lecturer at King's College London.

Hans Groth: Chairman of the Board of Directors of the WDA Forum (World Demographic & Ageing Forum) associated with the University of St. Gallen. For more than 20 years Hans Groth has been dealing with the interplay between global demographic change, economic development, securing prosperity and social stability. Since 2009 he has been a guest lecturer at the University of St. Gallen on the topic "Mega-trend Demographic Change".

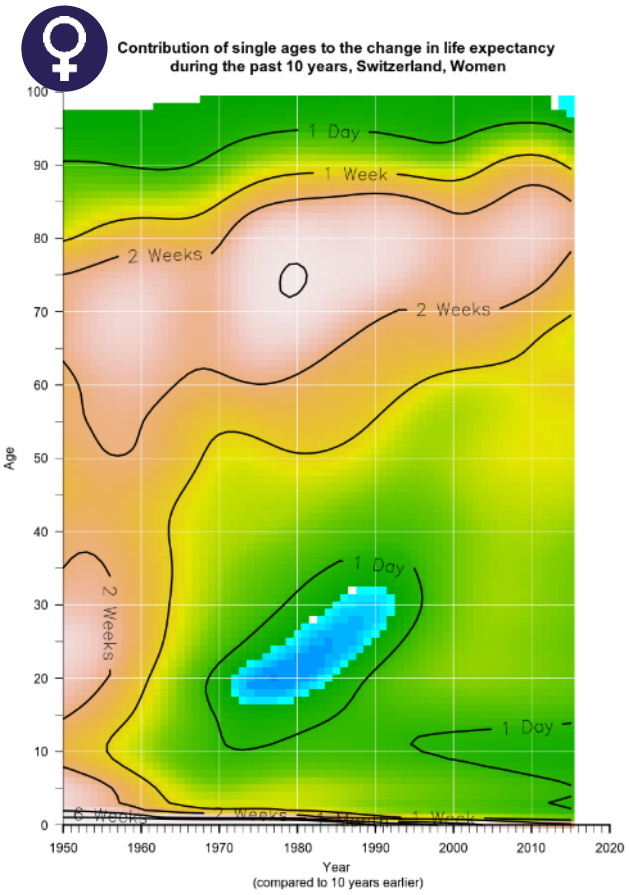
8. Appendix

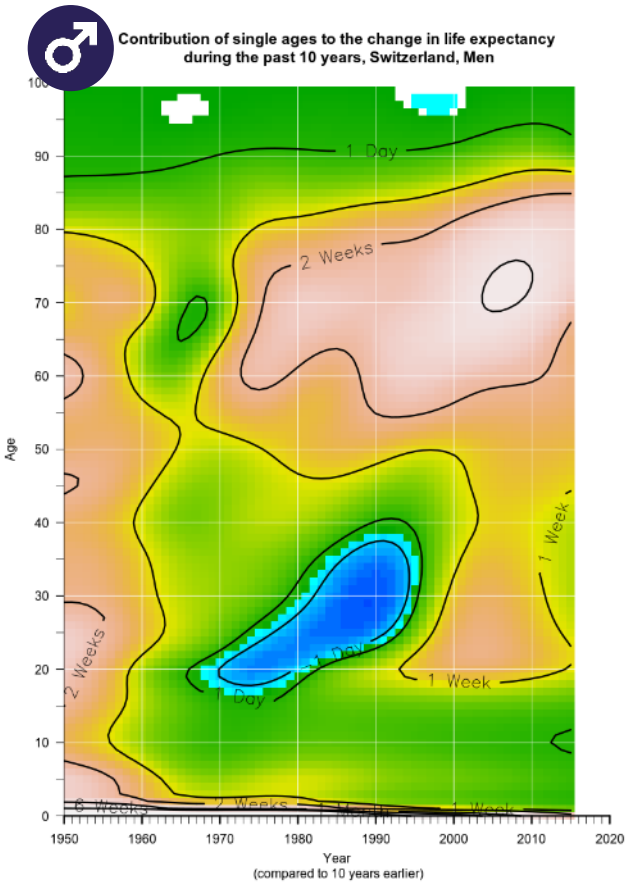
Heat Map Japan



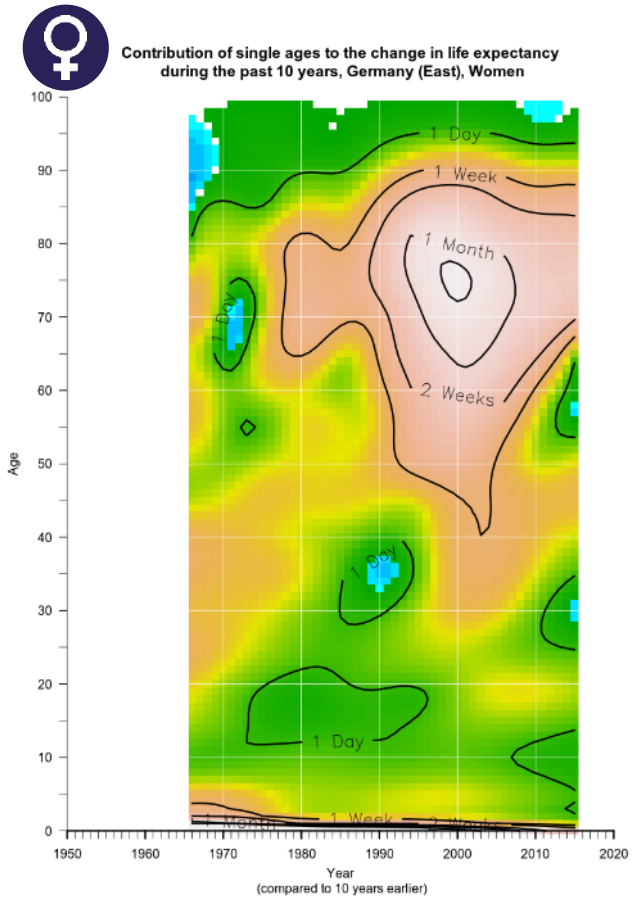


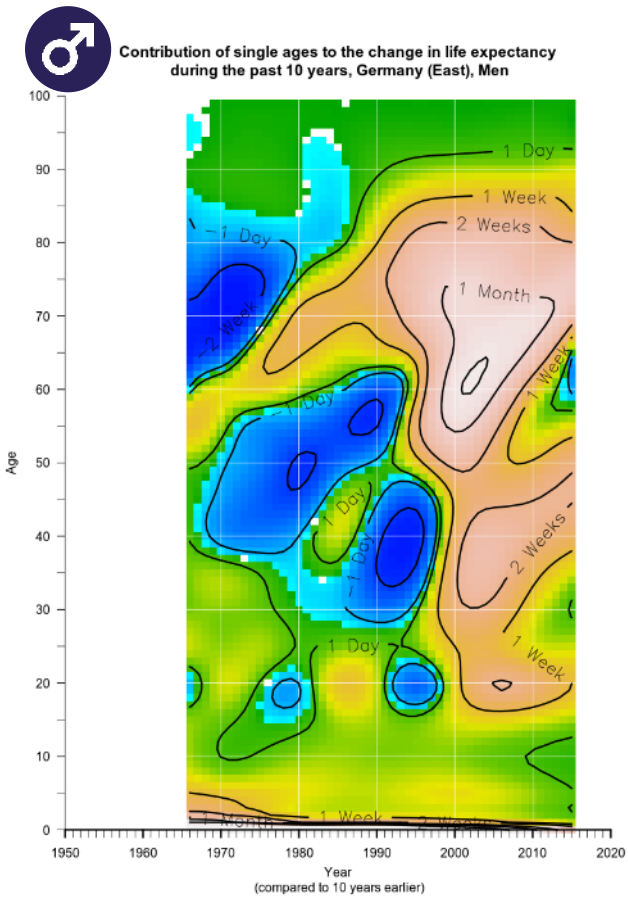
Heat Map Switzerland



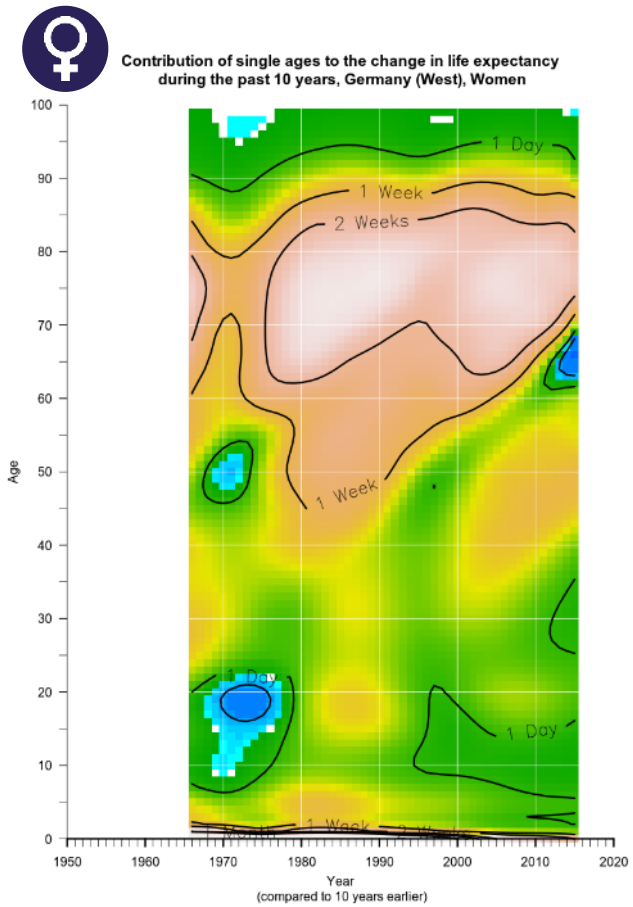


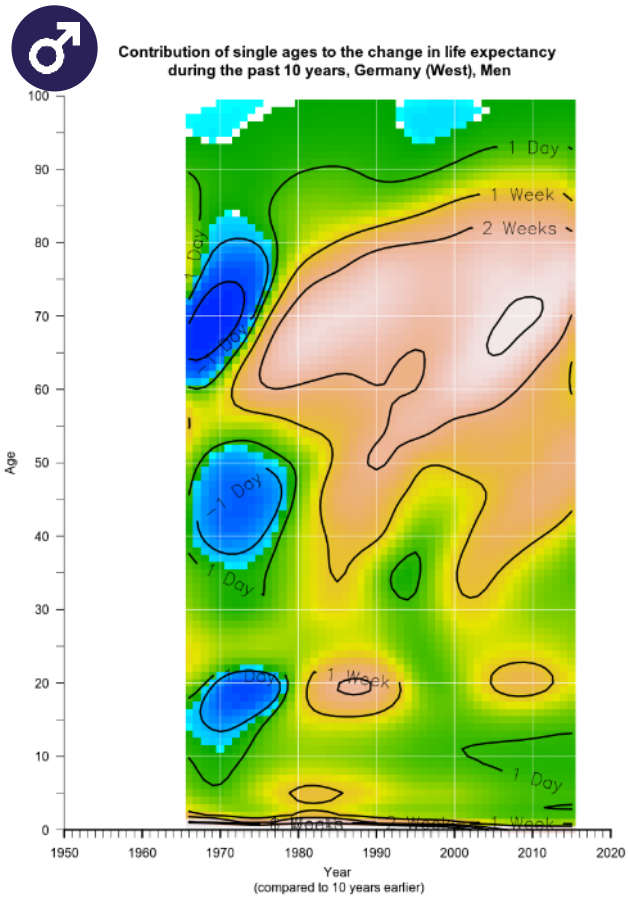
Heat Map Germany (East)



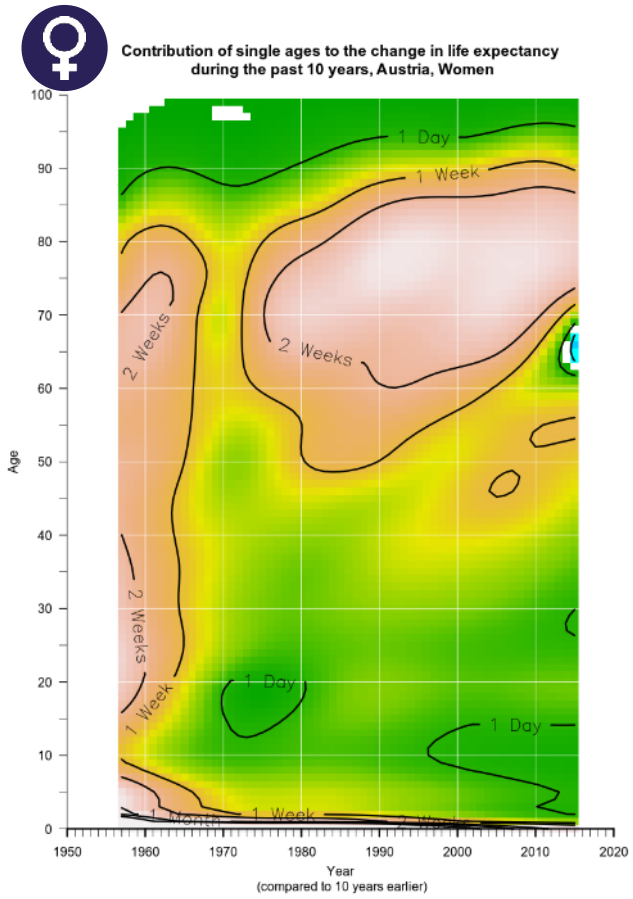


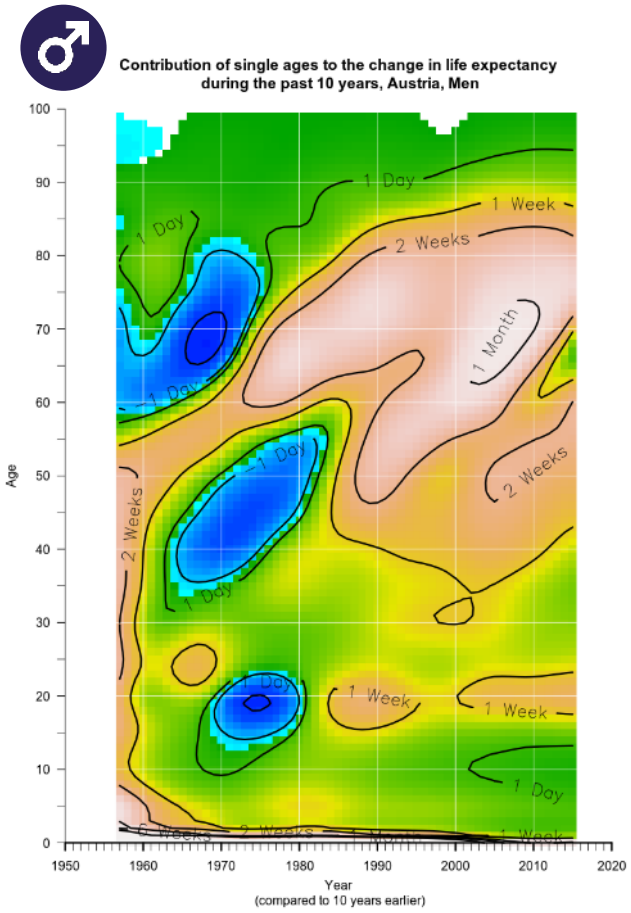
Heat Map Germany (West)



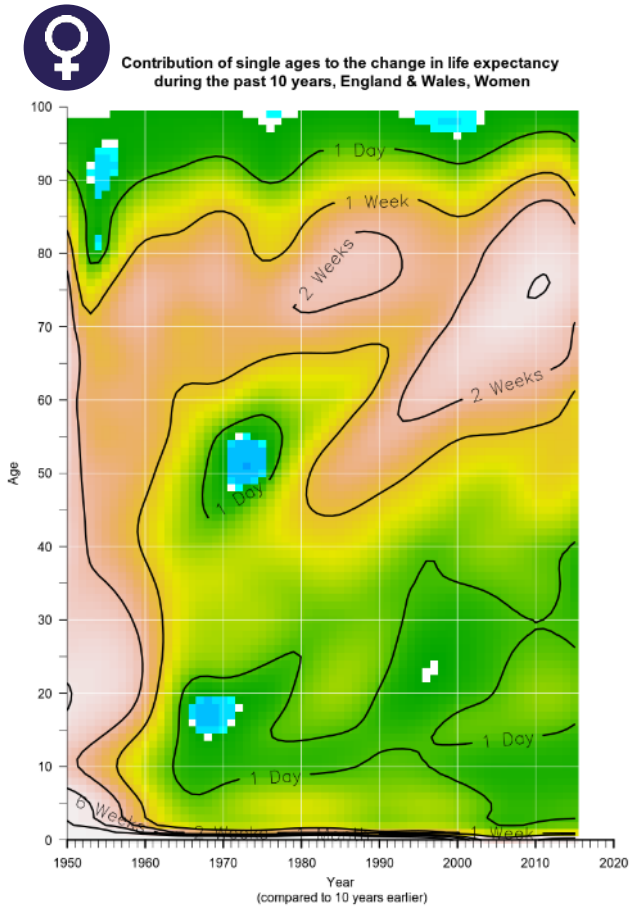


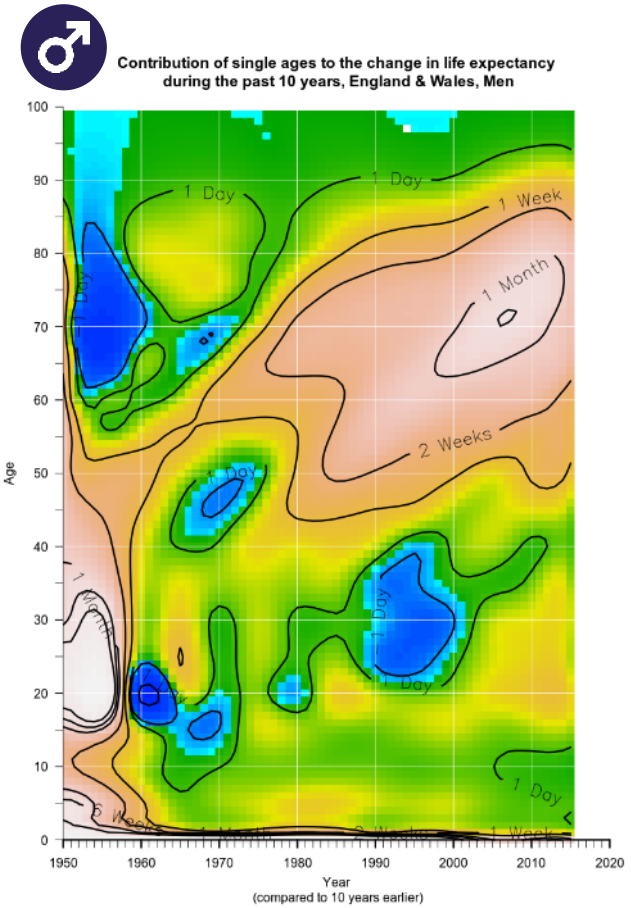
Heat Map Austria



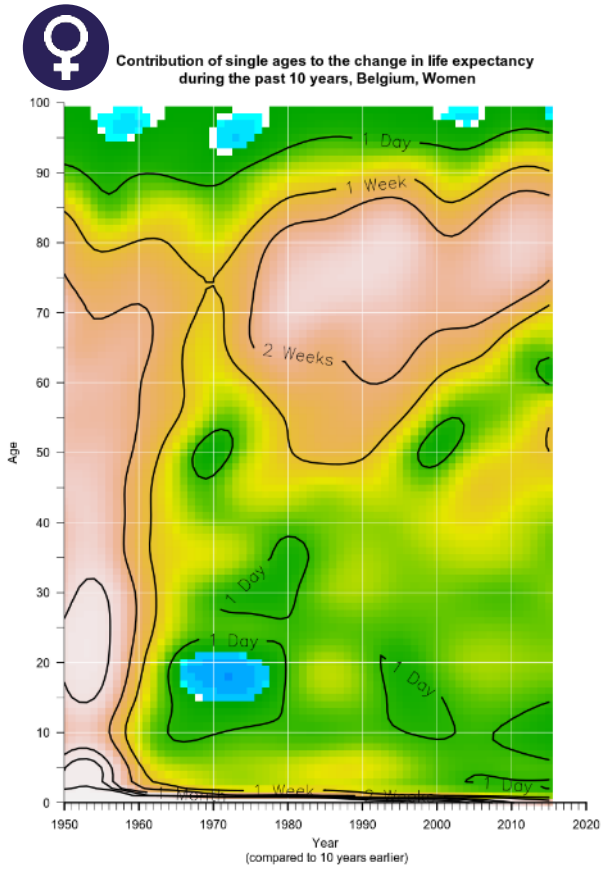


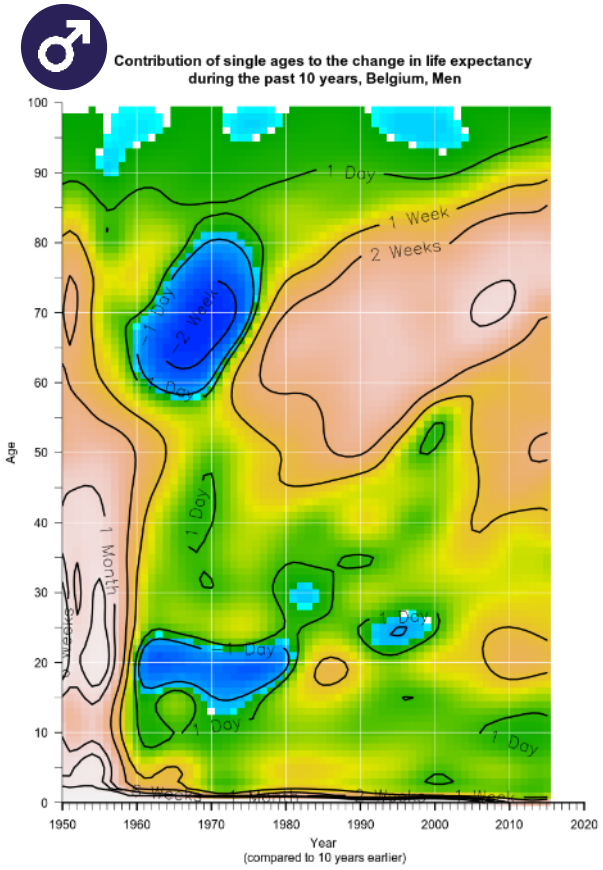
Heat Map England & Wales



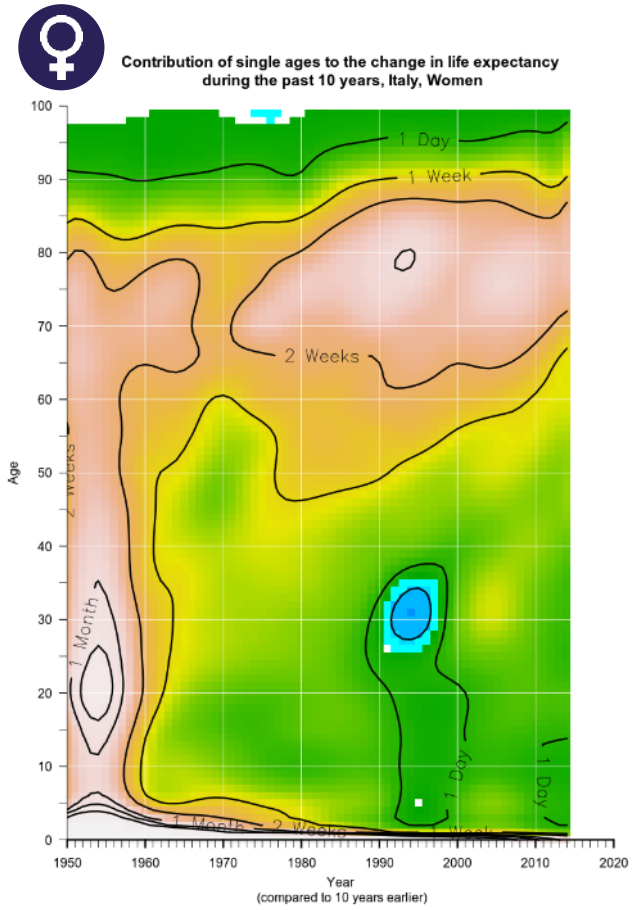


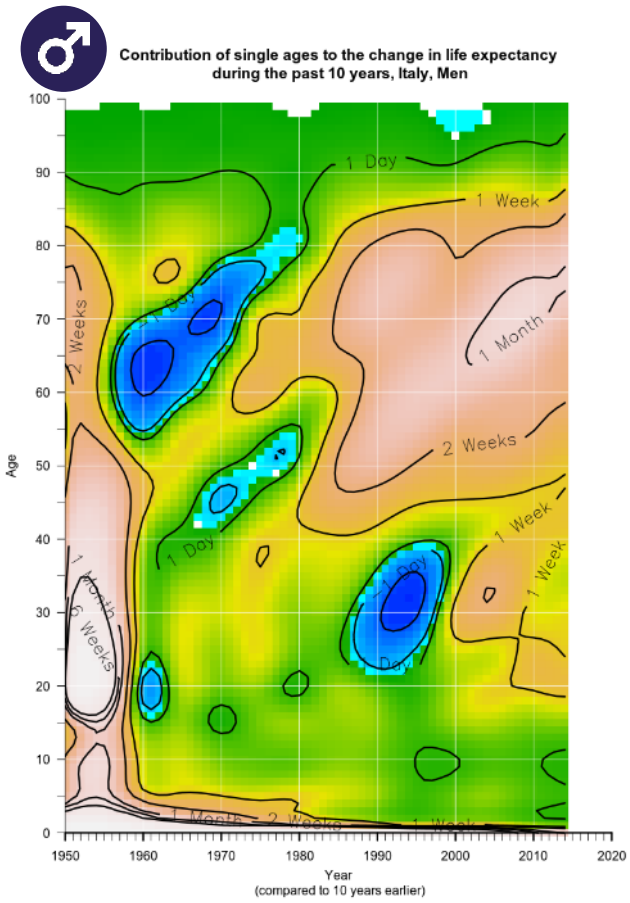
Heat Map Belgium



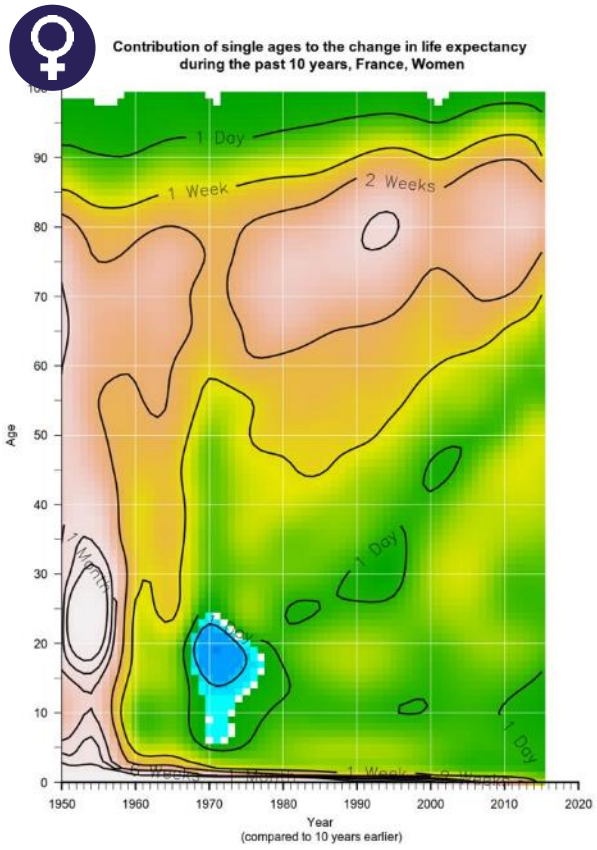


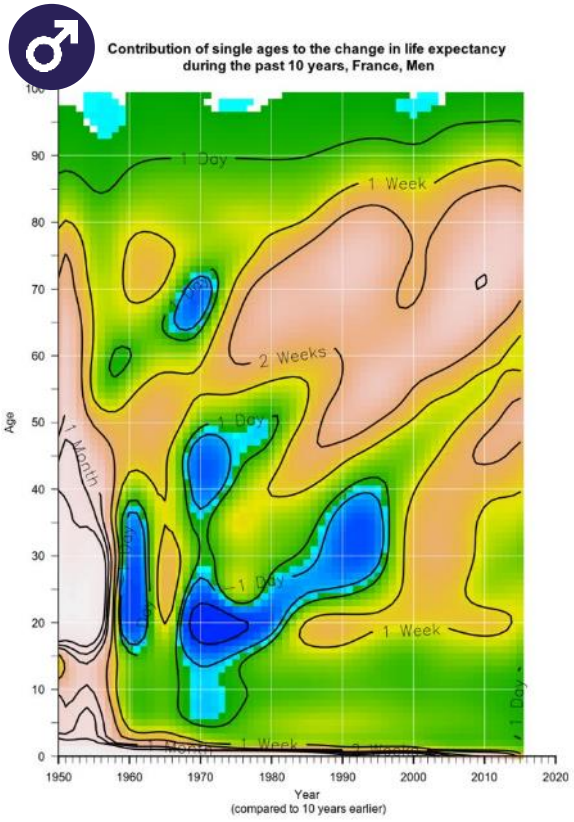
Heat Map Italy





Heat Map France





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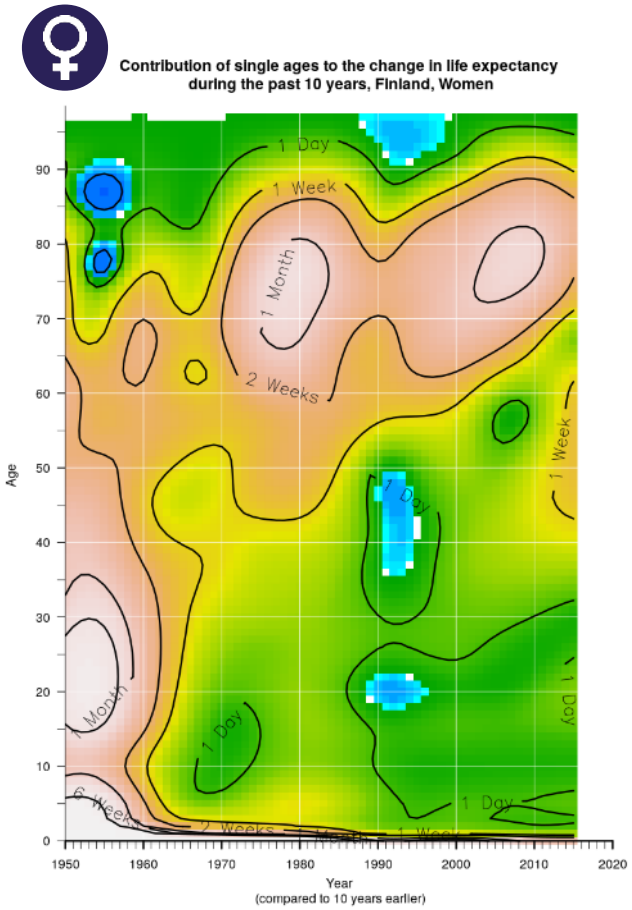
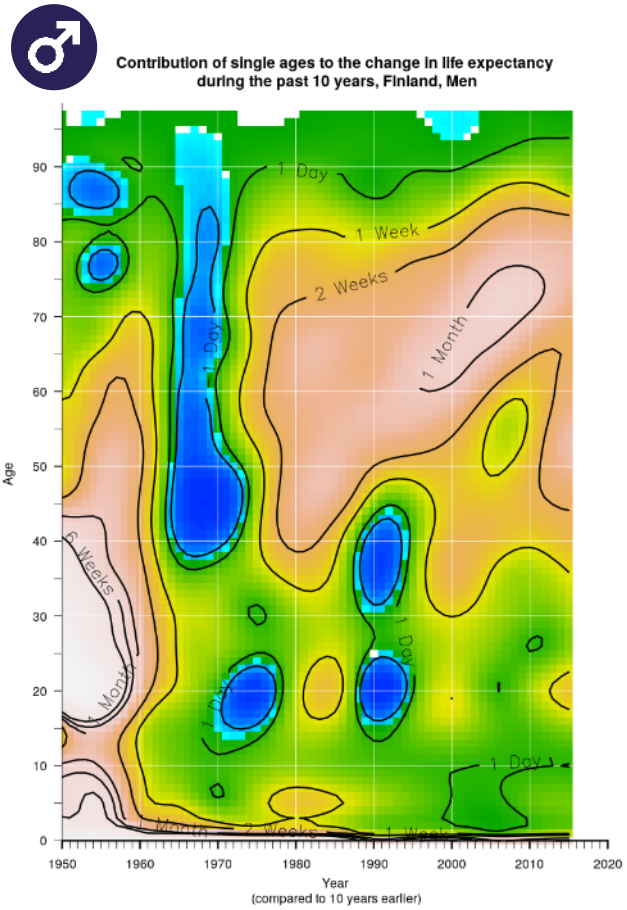
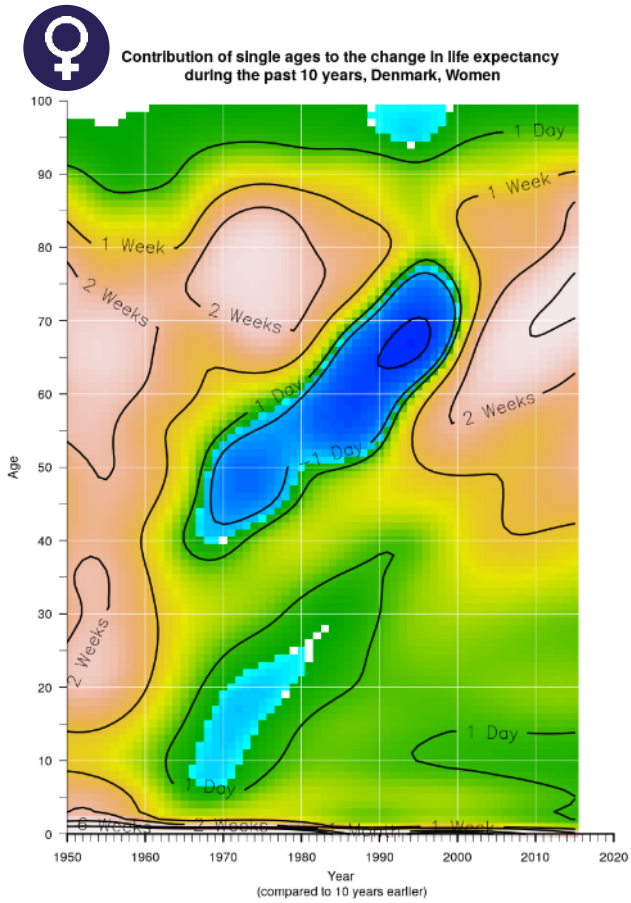
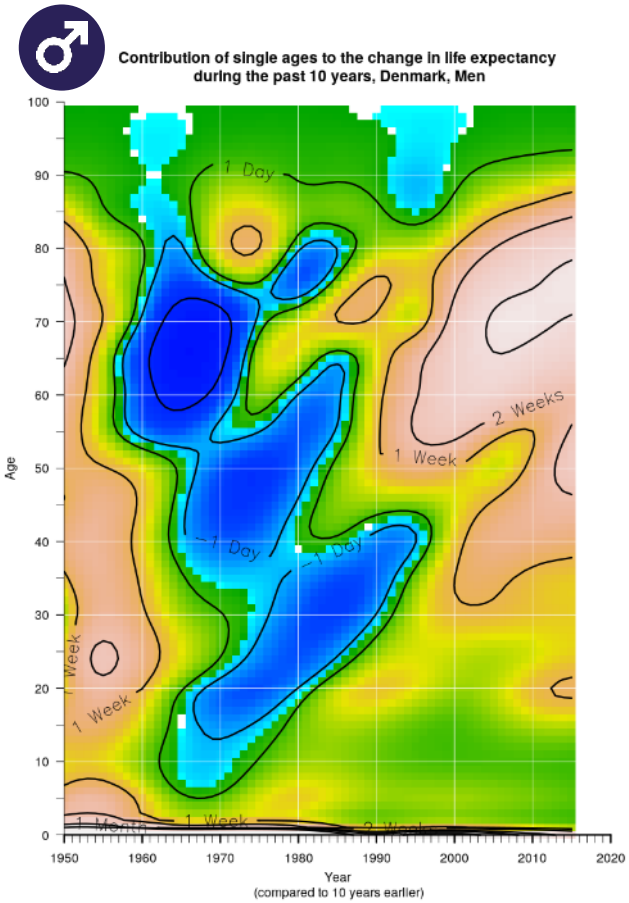


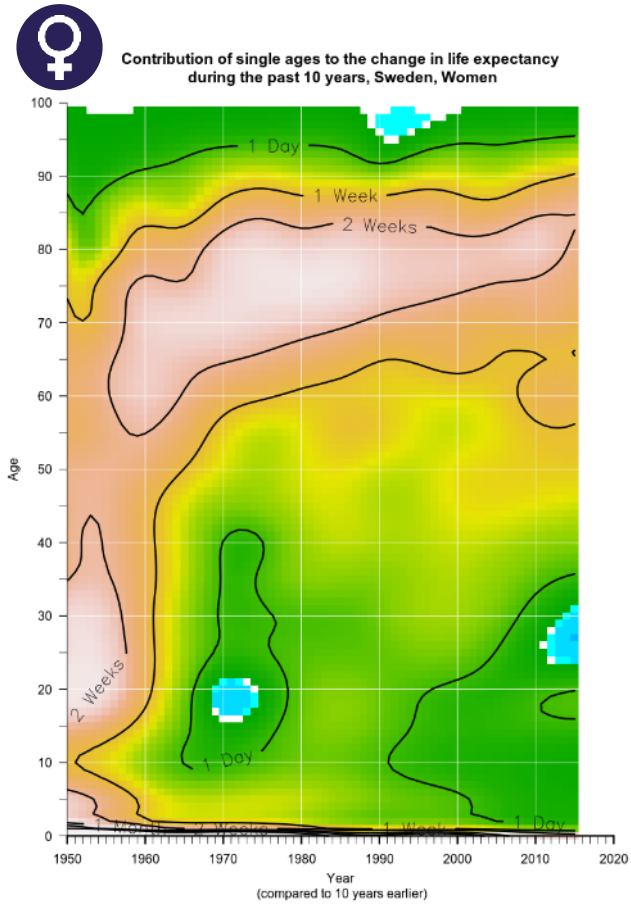


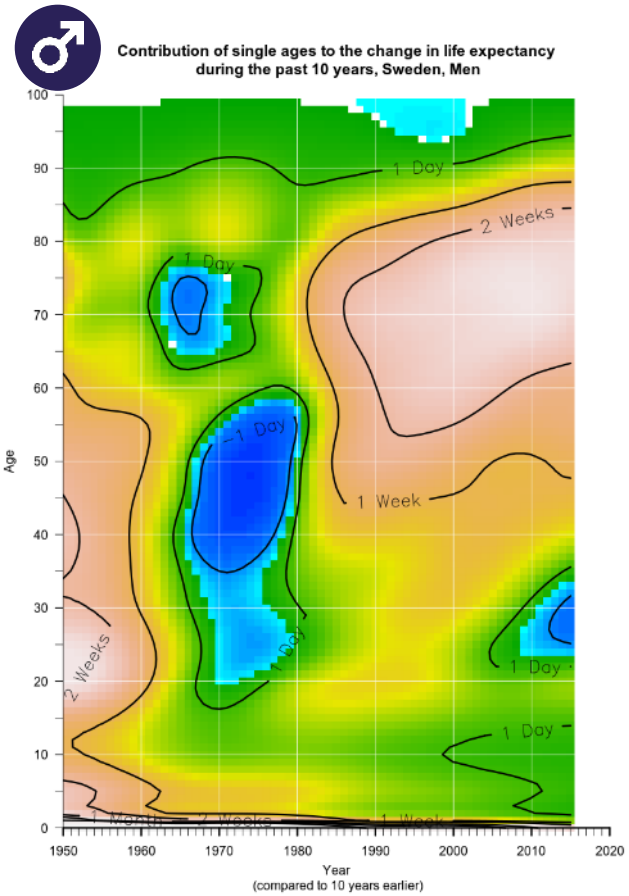
Heat Map Denmark



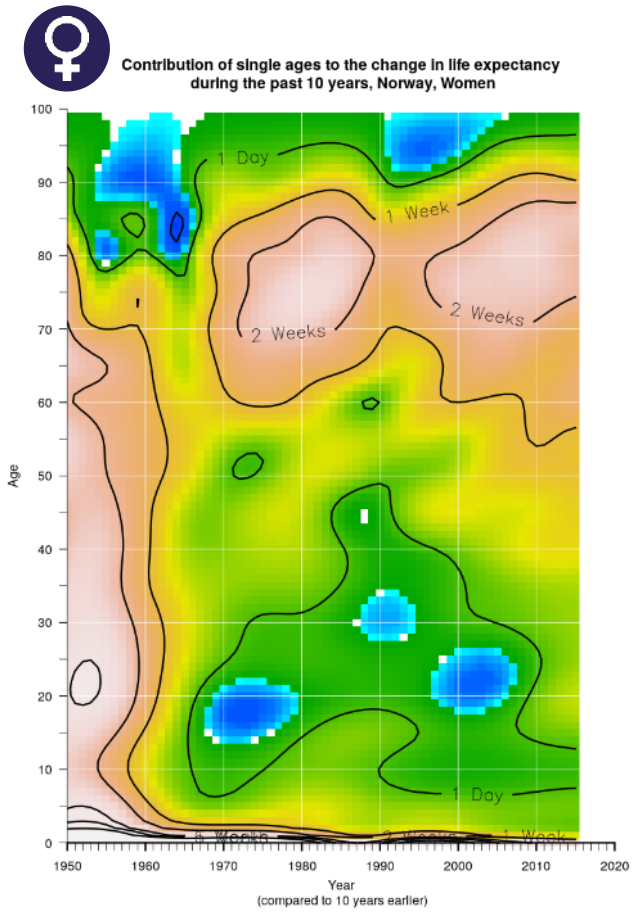


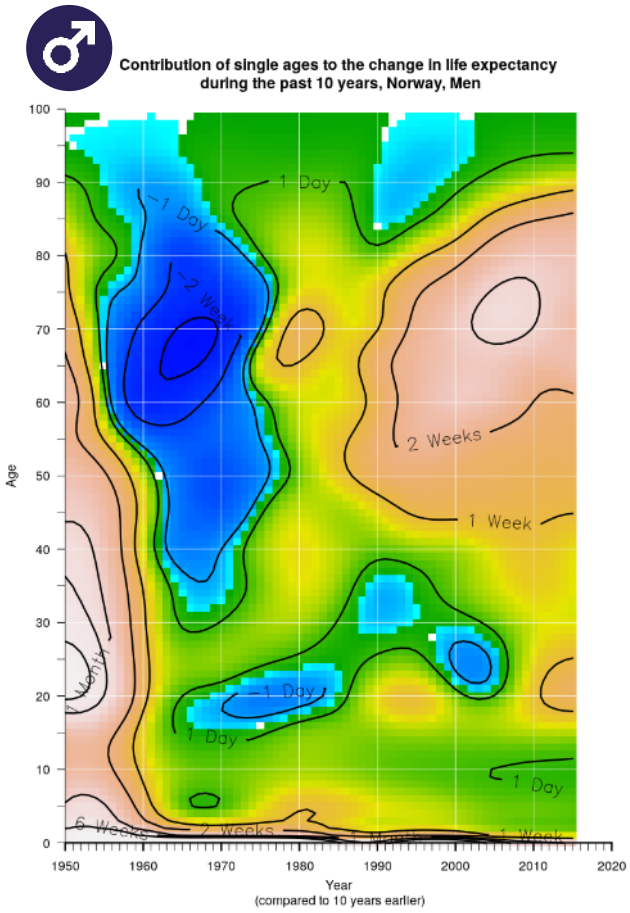
Heat Map Sweden



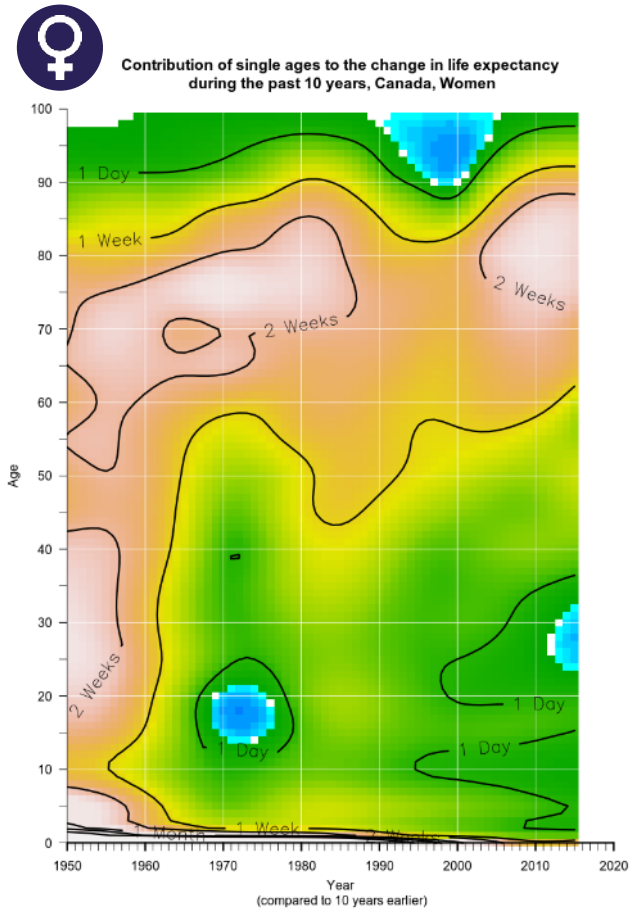


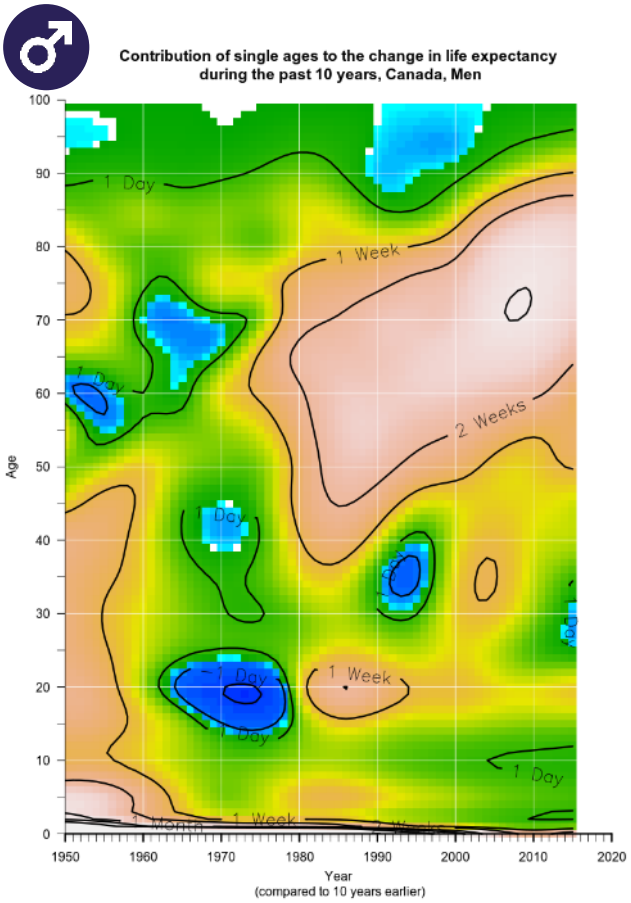
Heat Map Norway



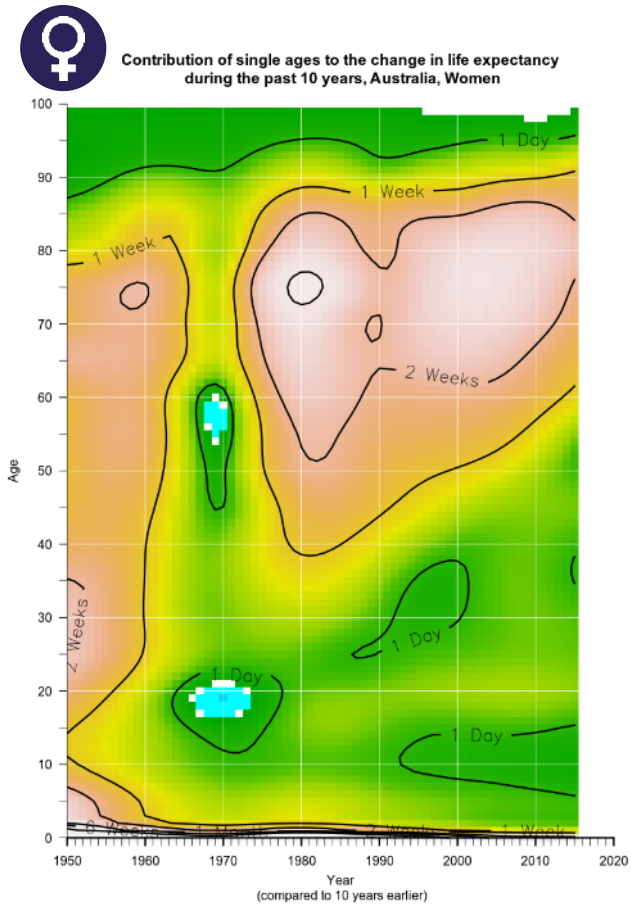


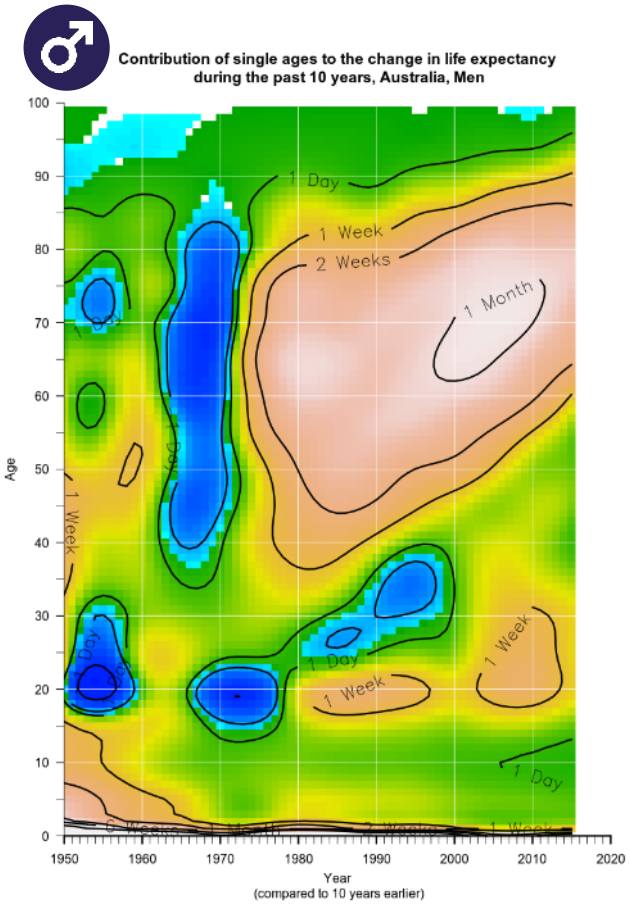
Heat Map Canada



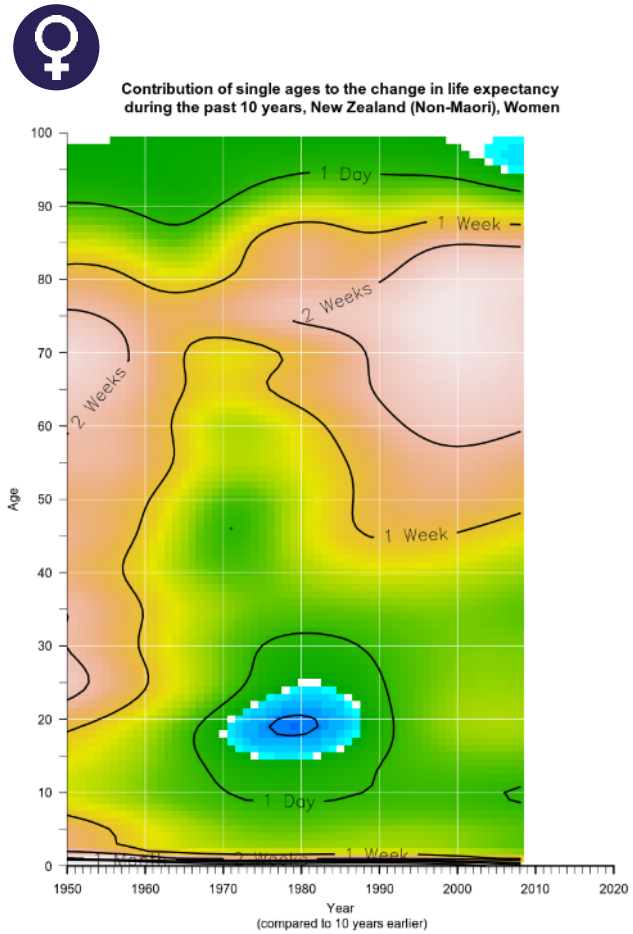


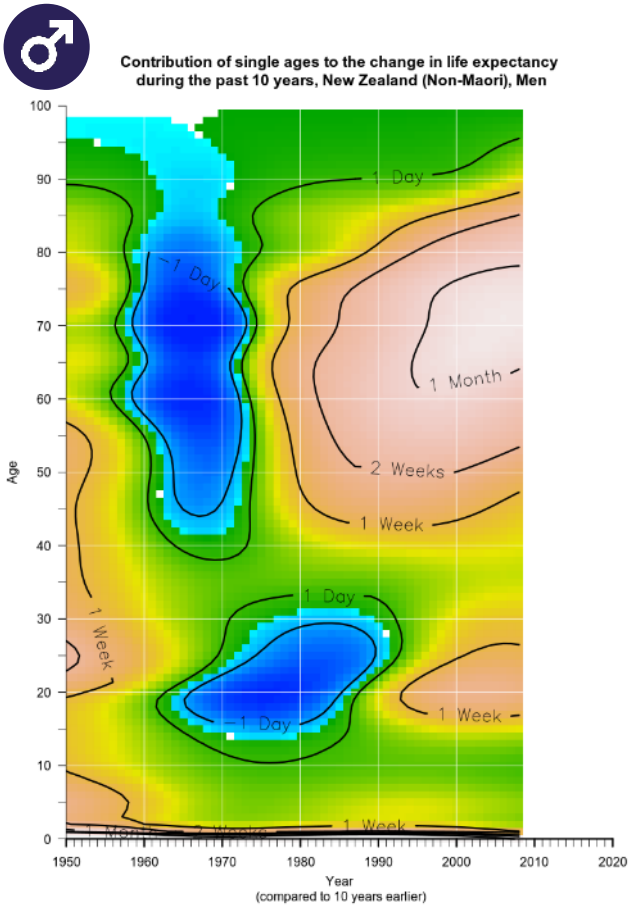
Heat Map Australia



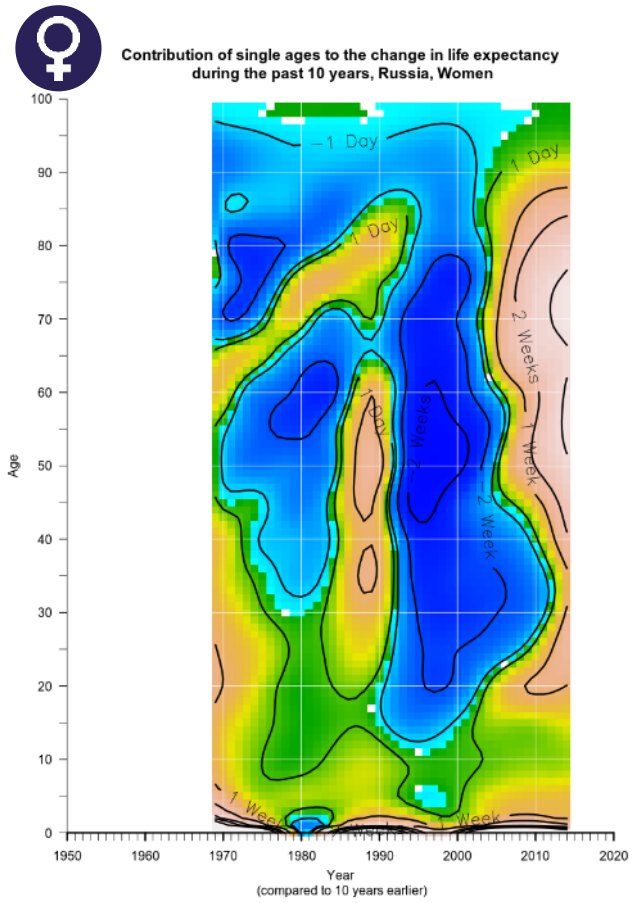


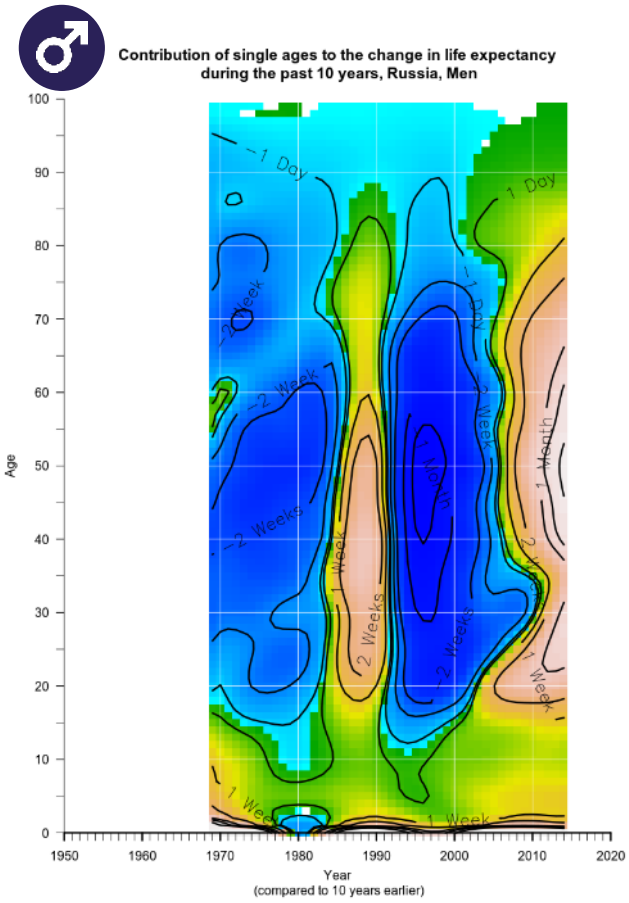
Heat Map New Zealand



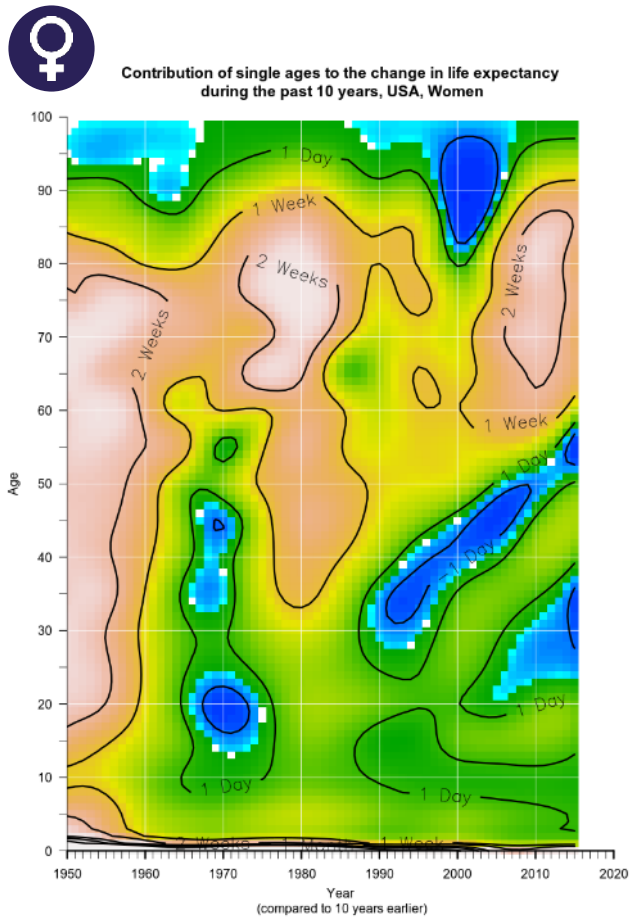


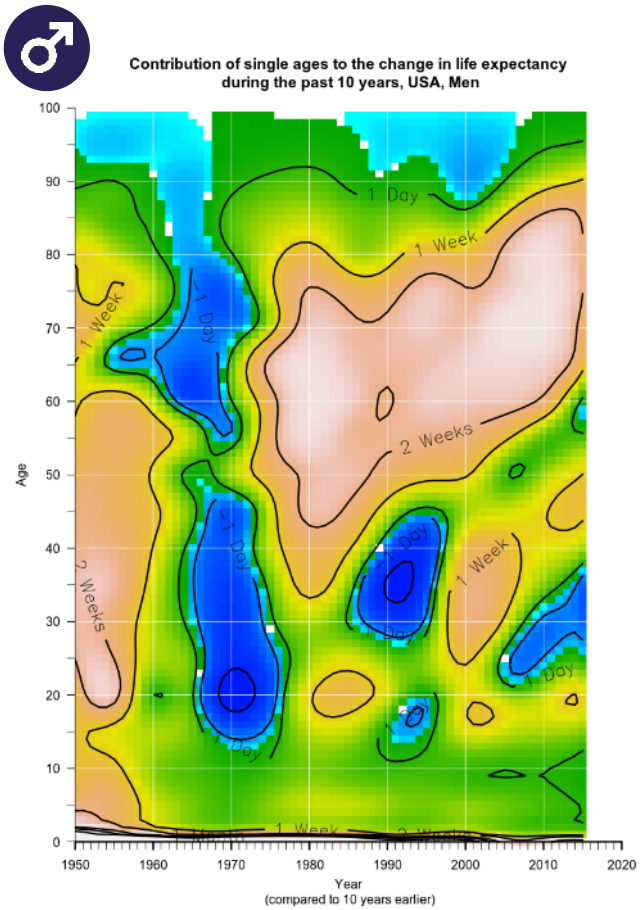
Heat Map Russia



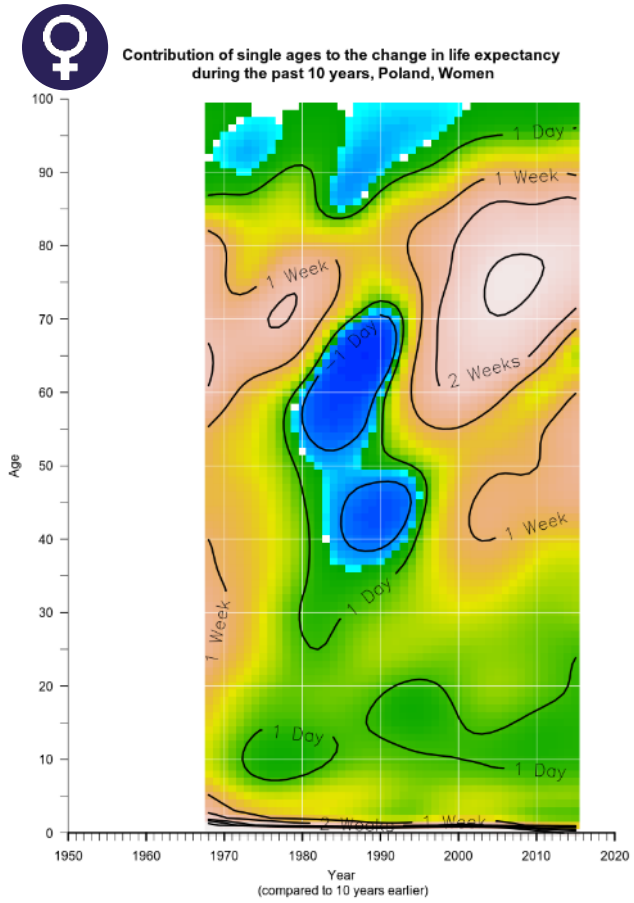


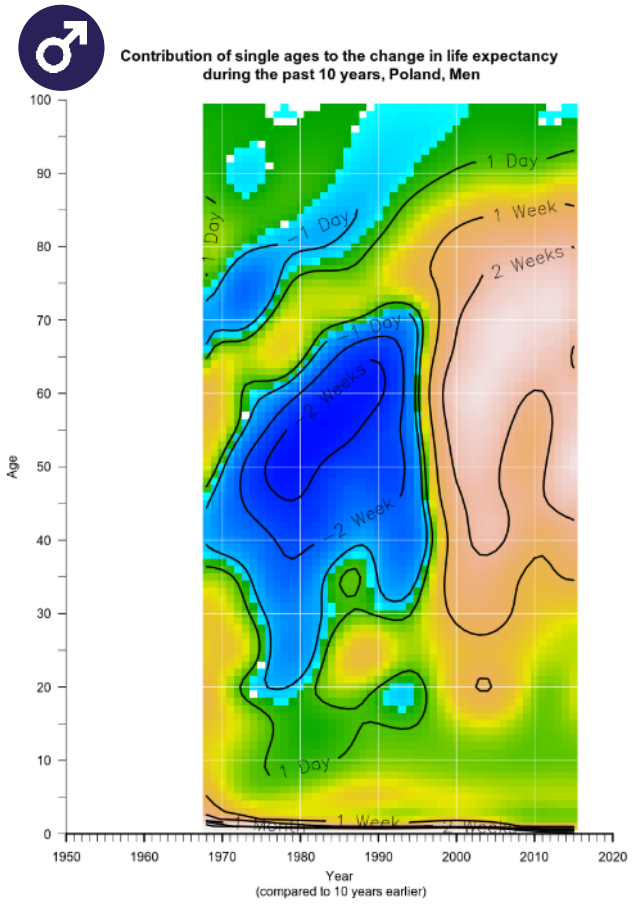
Heat Map USA



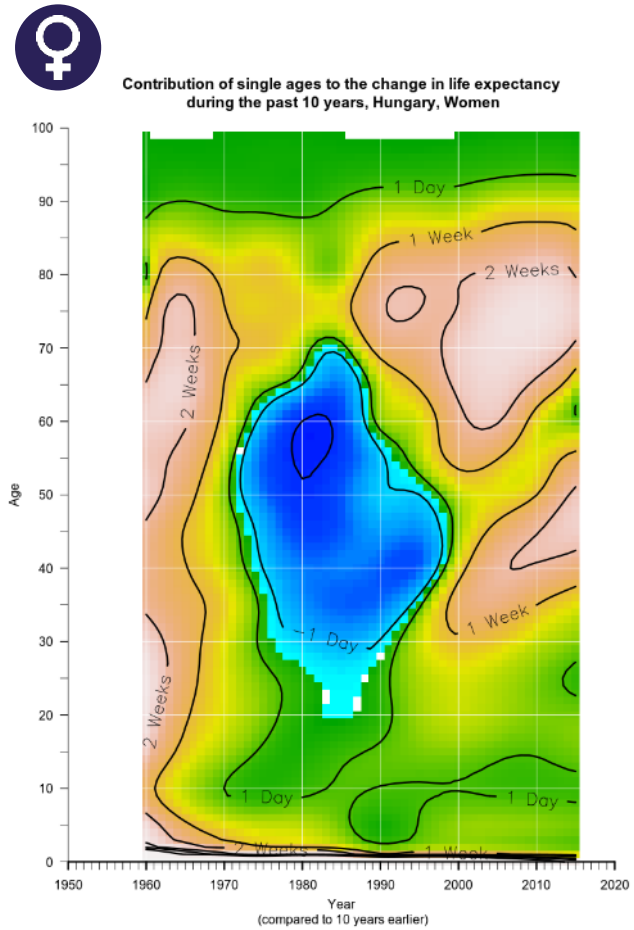


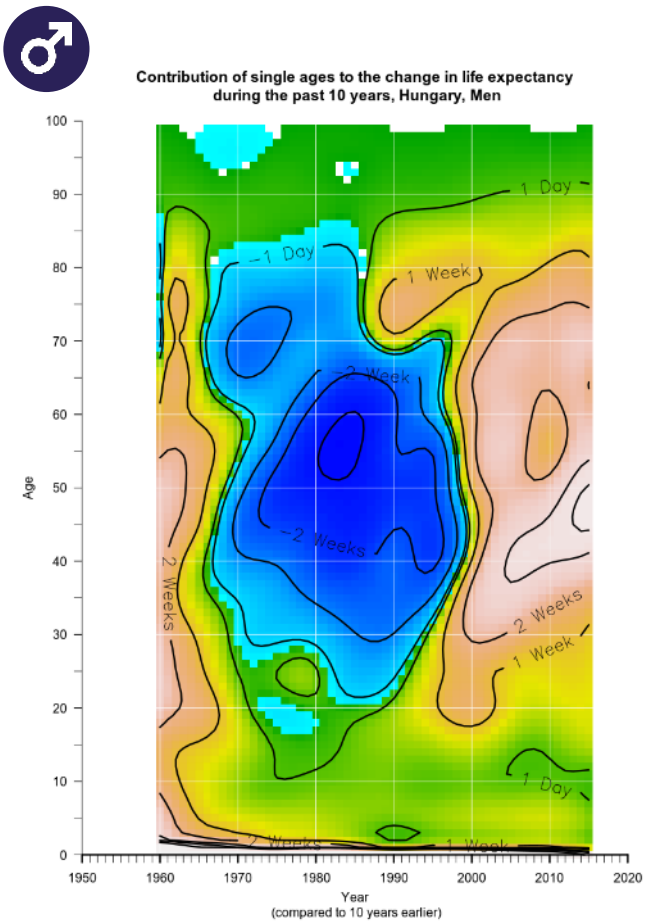
Heat Map Poland



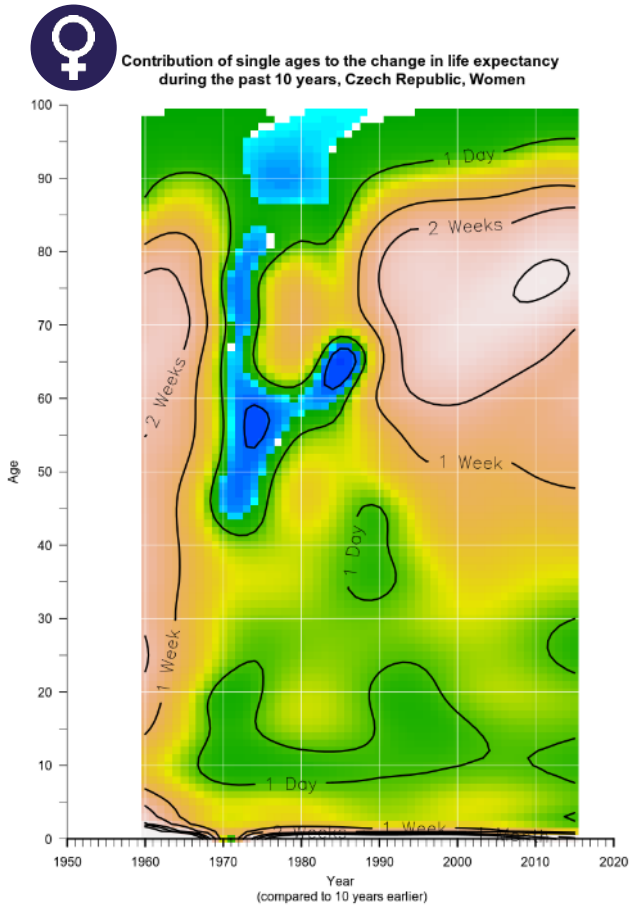


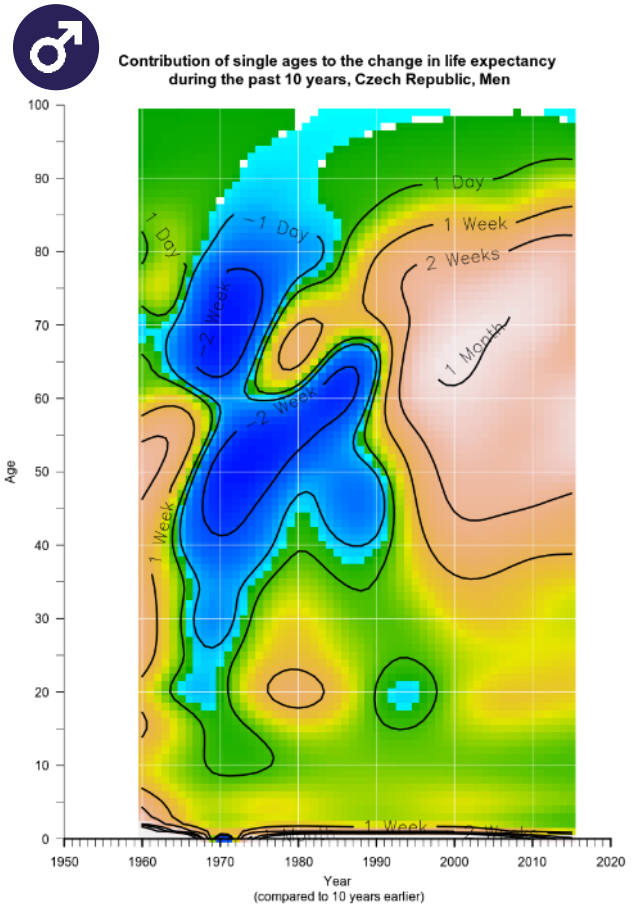
Heat Map Hungary





Heat Map Czech Republic





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