



Wittgenstein Centre

FOR DEMOGRAPHY AND
GLOBAL HUMAN CAPITAL

A COLLABORATION OF IIASA, VID/ÖAW, WU

Population and Sustainable Development

Insights from Multi-Dimensional Demography

Erich Striessnig

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International Institute for
Applied Systems Analysis
www.iasa.ac.at



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Outline

1. The Population-Environment Nexus
2. The Demographic Metabolism
3. The Shared Socioeconomic Pathways (SSPs)
4. Applications
 1. Future Vulnerability and Adaptive Capacity under the SSPs
 2. Climate, Health And Population (CHAP)
 3. Parenthood and Environmental Concern
5. Conclusion



The Population-Environment Nexus

“Human beings – their numbers, distribution, and characteristics – are at the center of concern for sustainable development” (Lutz et al. 2012)

- Increasing human numbers are a major driver of climate change
- Individual contribution varies by demographic characteristics
- People suffer from demographic differential vulnerability

Understanding population heterogeneity is essential for reducing climate change impacts and improving societies' development outlook

Multi-Dimensional Demography

Pioneered at the International Institute for Applied Systems Analysis:

- *Introduction to Multiregional Mathematical Demography* (Rogers 1975)
- *Multidimensionality in Population Analysis* (Keyfitz 1979)
- *Introduction to Multistate Mathematical Demography* (Rogers 1980)
- ...
- *Global Human Capital: Integrating Education and Population* (Lutz, KC 2011)

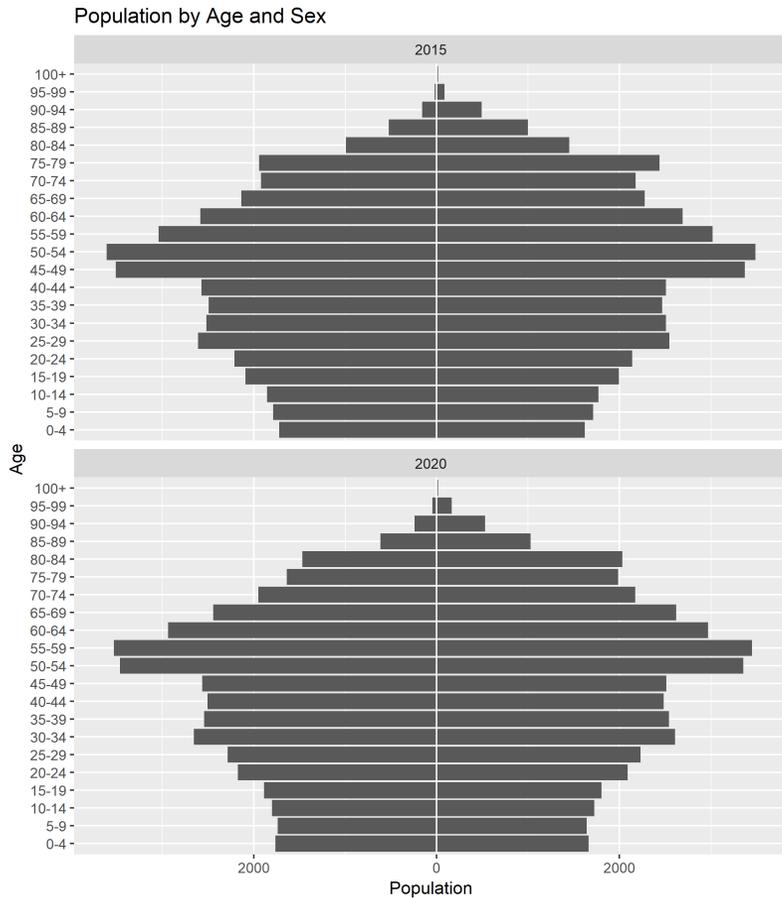
Provides the tools for modeling population heterogeneity



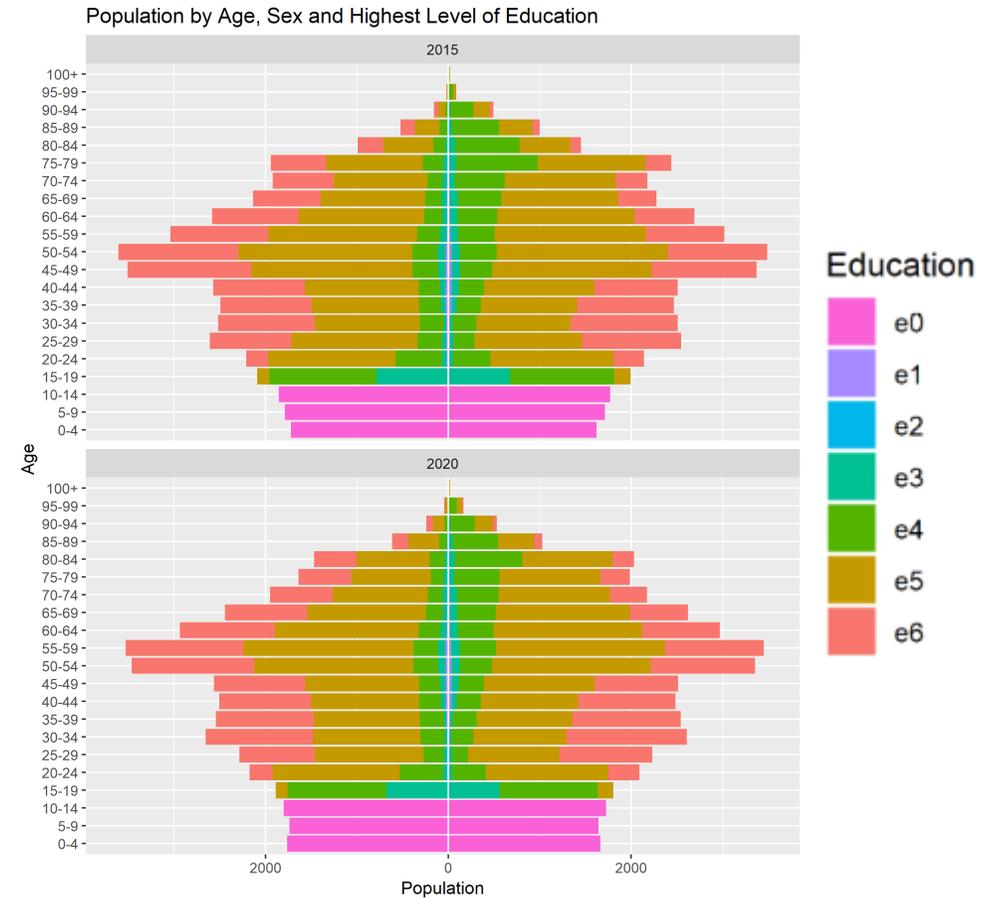
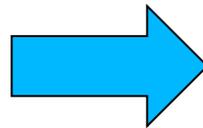
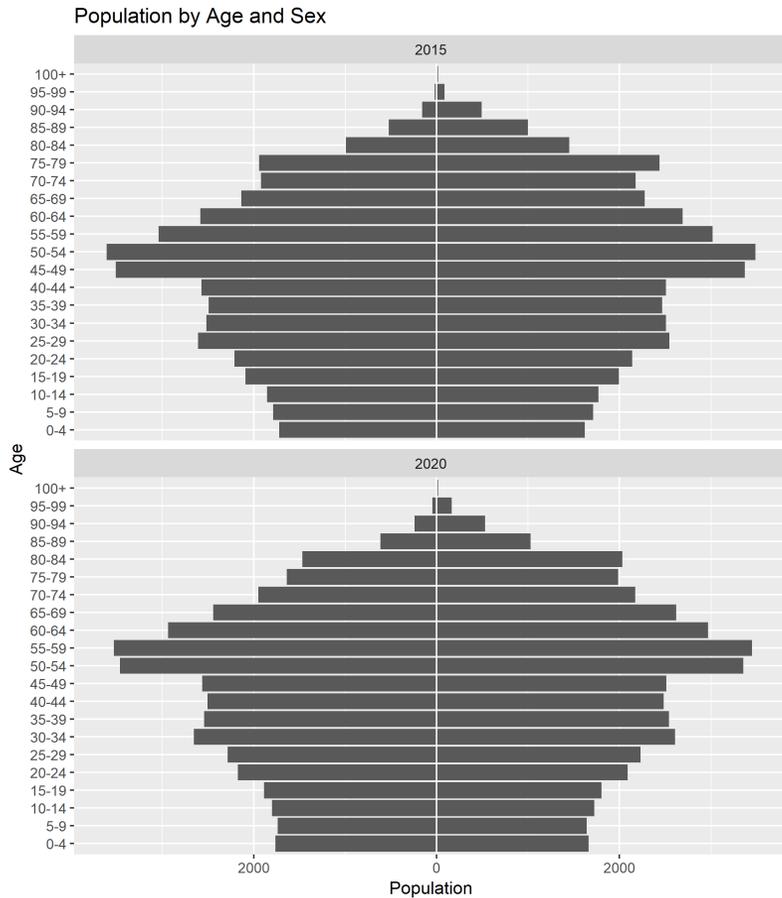
The Demographic Metabolism

- Ryder (1965), *The Cohort as a Concept in the Study of Social Change*
 - “The lives and deaths of individuals are, from the societal standpoint, a massive process of personnel replacement, which may be called ‘demographic metabolism’.”
- Lutz (2013), *Demographic Metabolism: A Predictive Theory of Socioeconomic Change*
 - “... changes resulting from cohort replacement can be modeled and projected using standard models of population dynamics.”

Multi-Dimensional Demography

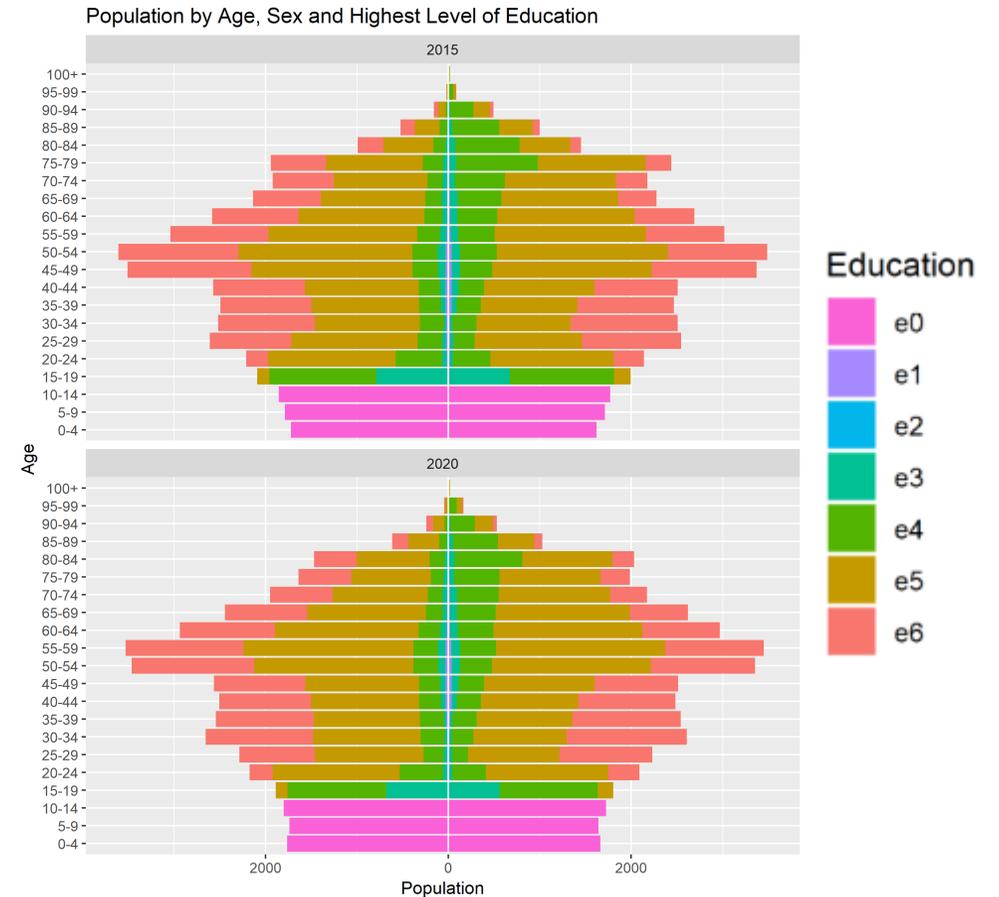


Multi-Dimensional Demography



Example: Highest Level of Schooling

- No major changes across time (no age effect)
- Important dimension of social heterogeneity
- Formal education is a good proxy for human capital





Why Education?

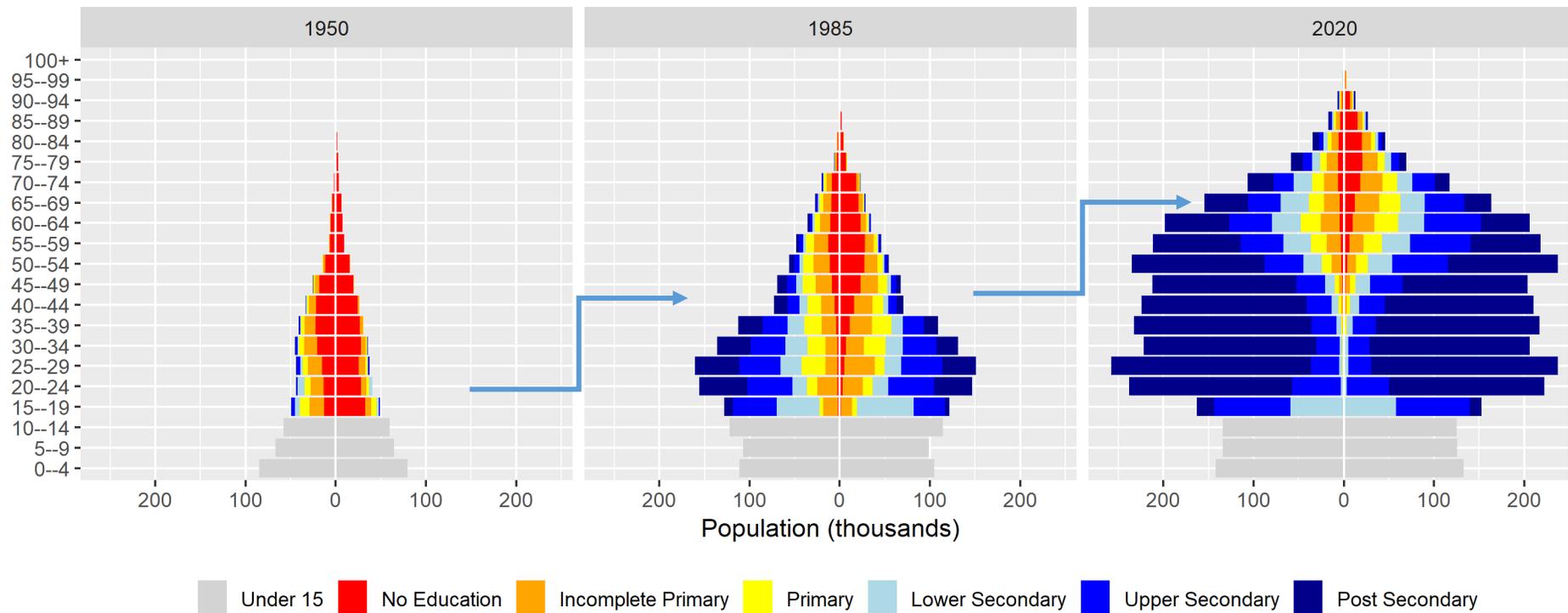
- Strong behavioral differences by level of education
- Strongly relates to human well-being
 - Health and empowerment
 - Enhanced cognitive skills and access to relevant information
- Major driver of global development
 - Increases the productivity of the workforce
 - Reduces fertility and subsequent carbon emissions
 - Facilitates and enhances the demographic dividend
- Reduces vulnerability by increasing **general** coping capacity

The Demographic Metabolism at Work

Example: Singapore, 1950-2020



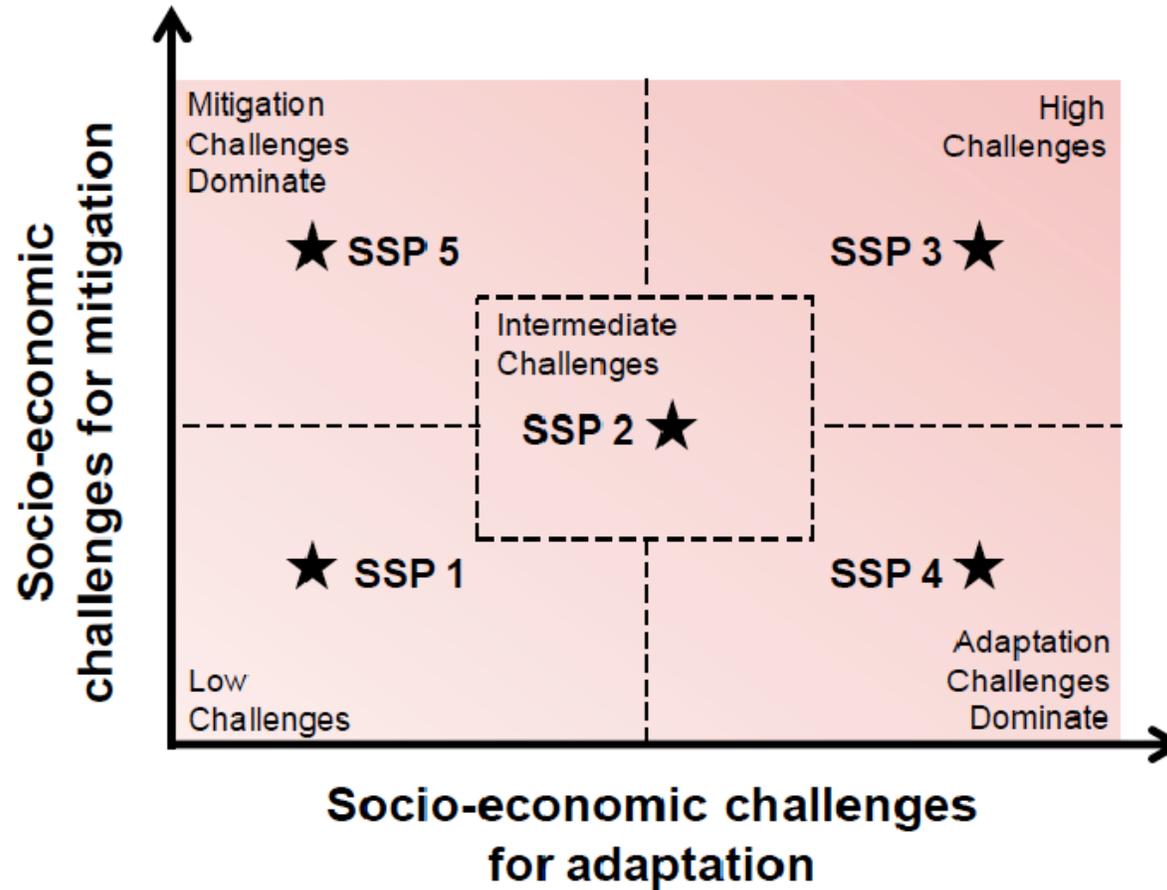
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The Shared Socioeconomic Pathways (SSPs)



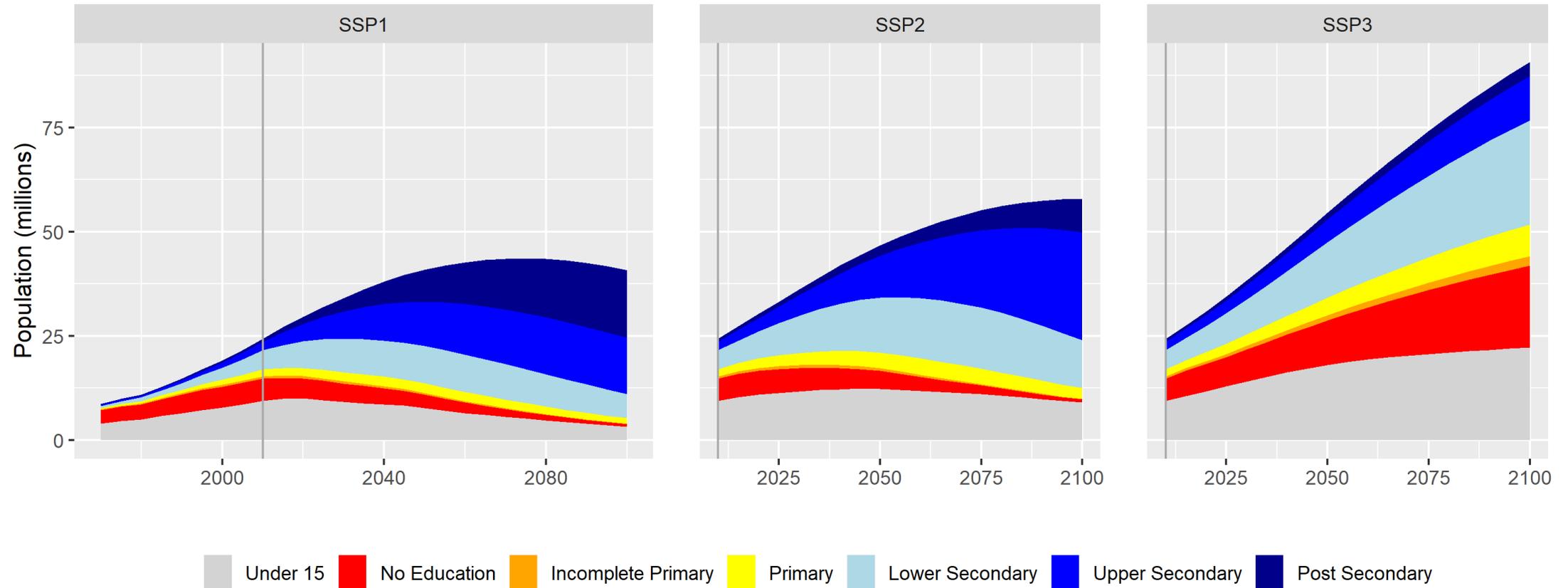
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“The Human Core of the SSPs” (KC, Lutz 2017)



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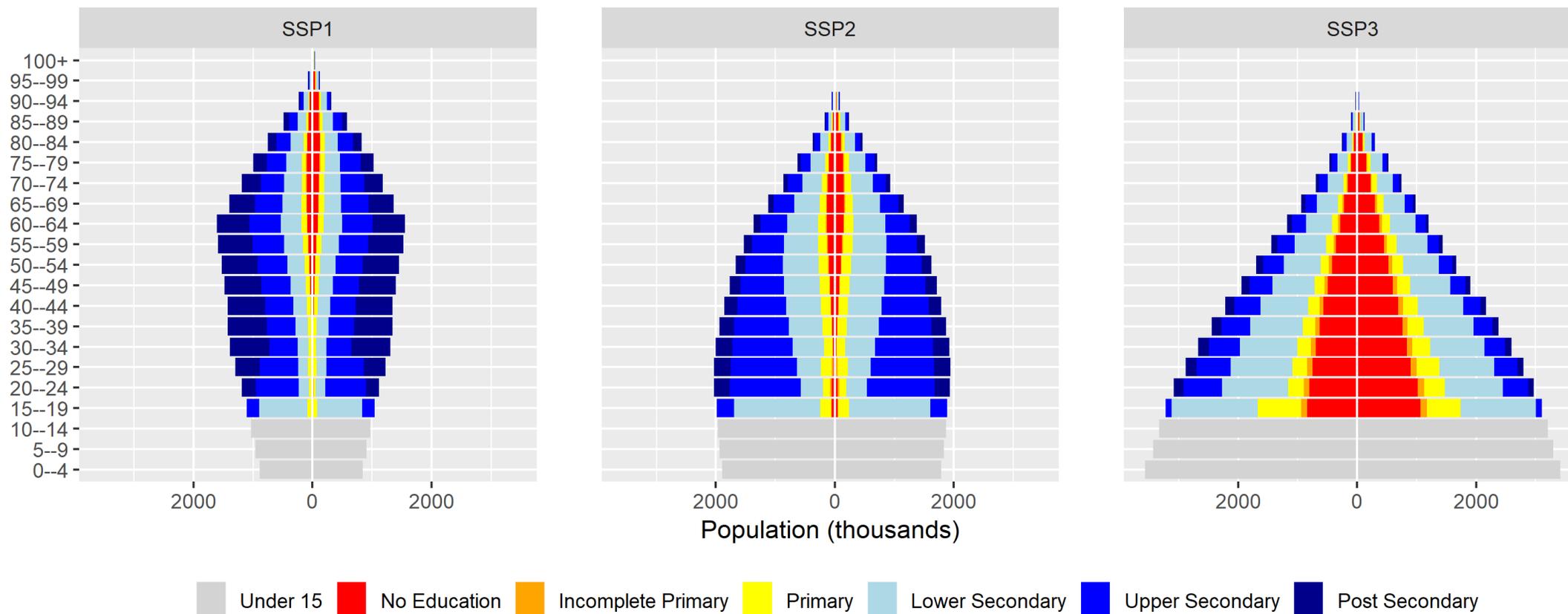


National level projections of population by age, sex, and educational attainment according to the five different SSP narratives



Can Ghana be Singapore? It depends!

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Applications

Future Vulnerability and Adaptive Capacity under the SSPs



Knowing Exposure Matters

- Adaptation cost due to climate change estimated at around \$70 – 100bn each year
- High uncertainty about the specific effects of climate change in specific locations
 - How many people live in the potential disaster zone?
 - How vulnerable are these people?
- Challenge for investments into climate-protective infrastructure
- Avoid path-dependent “solutions” by increasing people’s general coping capacity, e.g. by investing in their human capital



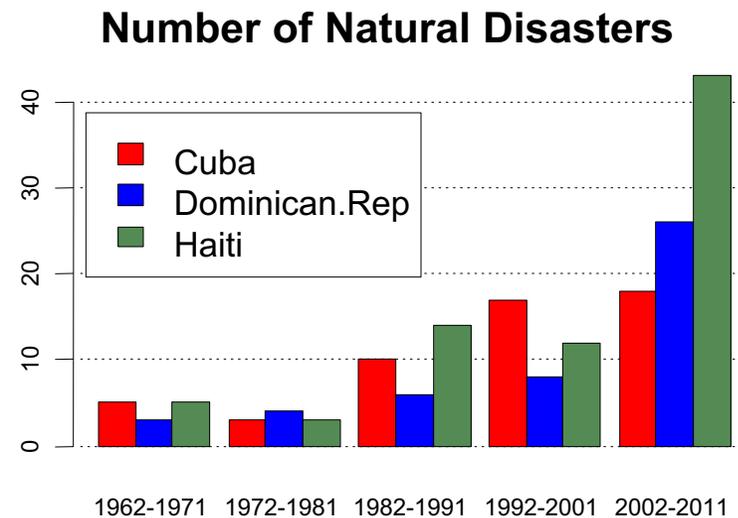
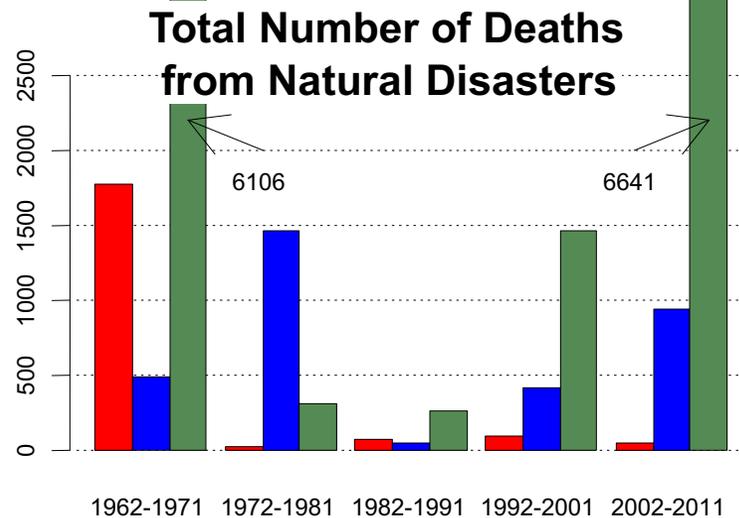
Selected Effects of Education

- Muttarak et al. (2012): better preparation and anticipation of future threats
- KC (2013): stronger impact in reducing damage than physical wealth
- Frankenberg et al. (2013): better psycho-social health 5-years after the tsunami
- Van der Land and Hummel (2013), Wamsler et al. (2012): migrating out of high-risk areas
- ...



The Case of Cuba

Despite of having suffered from a similar number of disasters, Cuba has experienced far less deaths from natural catastrophes

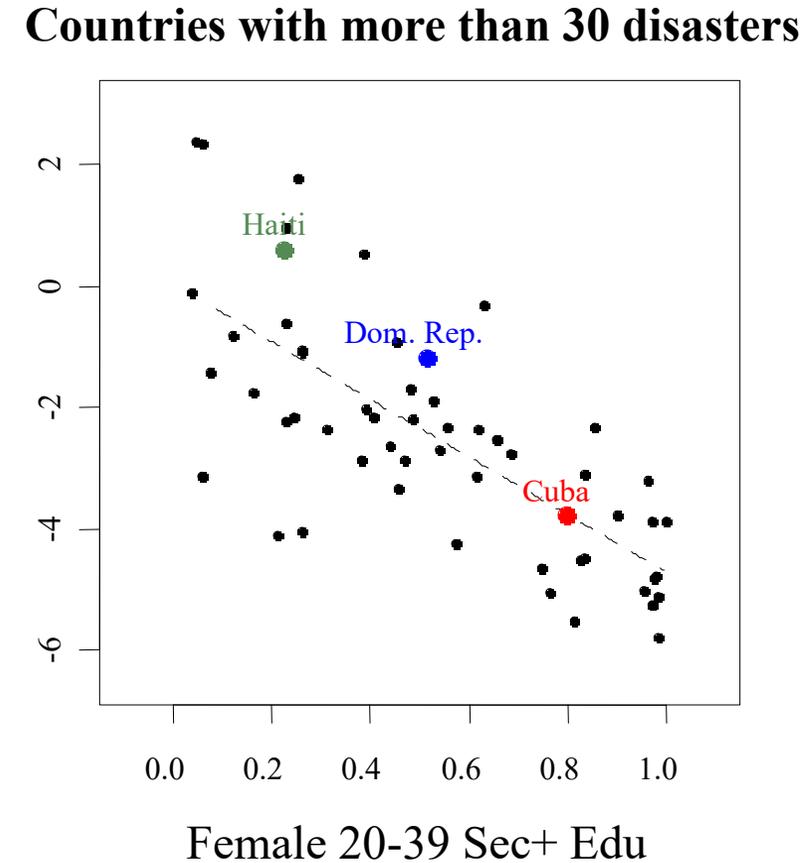
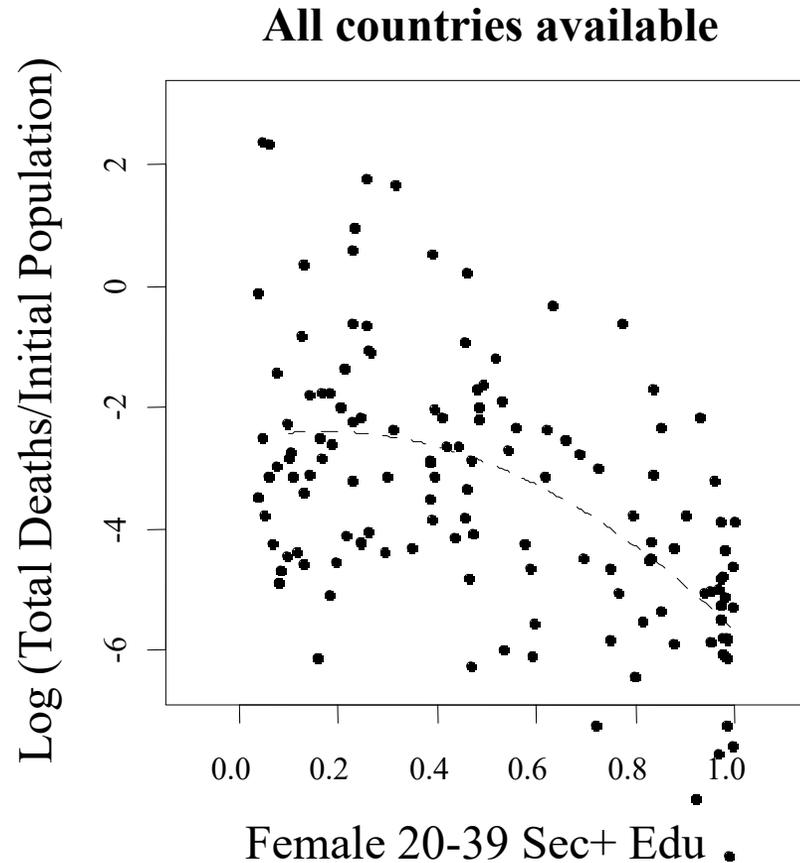


Source: Pichler, Adelheid, and Erich Striessnig. 2013. "Differential Vulnerability to Hurricanes in Cuba, Haiti, and the Dominican Republic: The Contribution of Education." *Ecology and Society* 18 (3): 31. <https://doi.org/10.5751/ES-05774-180331>.

Education and Deaths from Natural Disaster



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Source: Total number of deaths (1970 – 2010) is from the Emergency Events Database (EM-DAT) at the Centre for Research on the Epidemiology of Disasters (CRED).

Determinants of National Deaths from Natural Disaster



	Model 0	Model 1	Model 2	Model 3
Constant	1.716*** (0.395)	1.554*** (0.407)	1.330*** (0.402)	1.286*** (0.409)
Log (#Disasters/Pop)	0.633*** (0.079)	0.624*** (0.080)	0.618*** (0.078)	0.615*** (0.079)
Log (Arable Land in Km2)	0.487*** (0.078)	0.469*** (0.079)	0.463*** (0.077)	0.457*** (0.078)
Pop Growth Rate	0.144*** (0.054)	0.136** (0.054)	0.111** (0.054)	0.109** (0.054)
Land-locked Country	-0.175* (0.103)	-0.215** (0.106)	-0.216** (0.102)	-0.230** (0.105)
Log (GDP per Capita)		-0.133 (0.082)		-0.050 (0.084)
Logit (Share Fem 20-39 Sec+ Edu)			-0.327*** (0.084)	-0.312*** (0.087)
McFadden R-sq.	0.462	0.465	0.479	0.479
Nagelkerke R-sq.	0.585	0.588	0.601	0.602
phi	0.594	0.592	0.576	0.577
Likelihood-ratio	242.485	244.036	251.239	251.443
p	0.000	0.000	0.000	0.000
Log-likelihood	-582.889	-581.441	-574.611	-574.414
Deviance	282.515	280.964	273.761	273.557
AIC	1267.777	1266.883	1253.221	1254.829
BIC	1485.308	1488.679	1475.017	1480.890
N	526	526	526	526

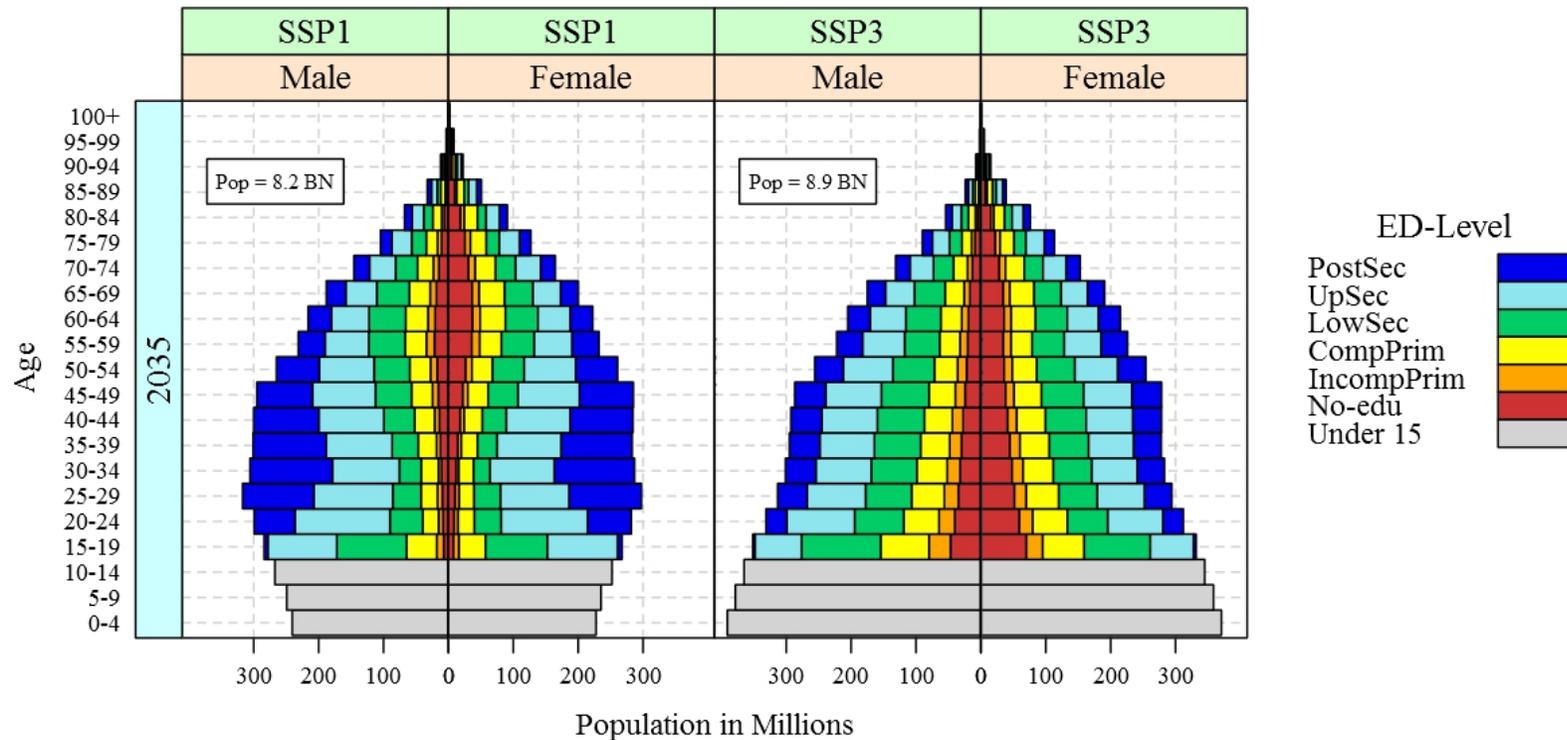
Panel regression for 167 countries over 10-year intervals between 1970 and 2010 using time fixed effects. The dependent variable is the logged value of deaths per million of population. Coefficient values are standardized. Numbers in parentheses are standard errors based on the heteroskedasticity- and autocorrelation-resistant covariance matrix. Other independent variables not reported here are dummy variables for 43 world regions.

Significance level: *** p<0.001, ** p<0.01, * p<0.05

World Population by Age, Sex, and Level of Education, 2035



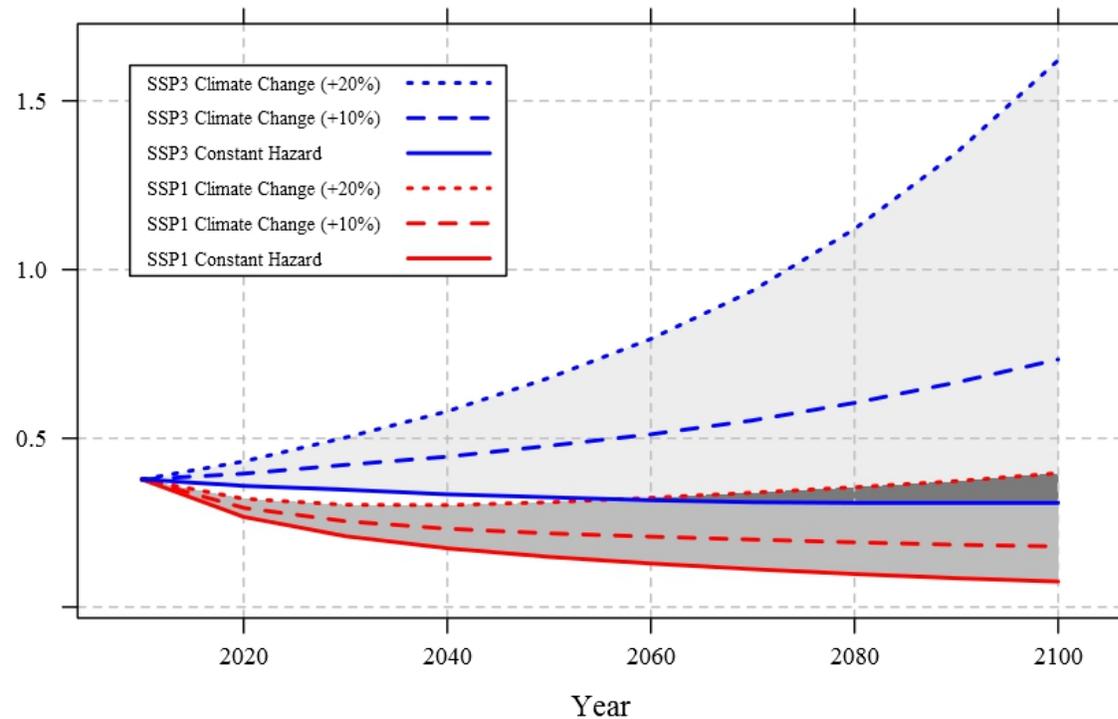
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Predicted Decadal Number of Deaths (in Millions)



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Lutz, Wolfgang, Raya Muttarak, and Erich Striessnig. 2014. "Universal Education Is Key to Enhanced Climate Adaptation." *Science* 346 (6213): 1061–62. <https://doi.org/10.1126/science.1257975>.

Applications

Climate, Health And Population (CHAP)

Motivation



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ÖSTERREICH

24.07.2018

Österreich: Mehr Tote durch Hitze als im Straßenverkehr

Erstmals gibt es ein Berechnungsmodell in Österreich. Es soll auch als Warnsystem dienen.

Wort der Woche

Klimawandel und Gesundheit

KOLUMNE Der Zusammenhang zwischen Klimawandel und Gesundheit wurde nun erstmals in einer umfassenden Studie dargestellt. Die Lage ist demnach zwar ernst, aber nicht hoffnungslos.

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 Suchbegriff

150 bis 800 Todesfälle mehr pro Hitzewelle

Ab kommendem Jahr plant die AGES ein kontinuierliches Mortalitäts-Monitoring. Probeläufe mit historischen Daten zeigen, dass bei jeder Hitzewelle 150 bis 800 Menschen mehr sterben als sonst, berichtet der „Falter“.

DERSTANDARD

ABO

IMMOSUCHE

JOBSUCHE

INTERNATIONAL INLAND WIRTSCHAFT WEB SPORT PANORAMA KULTUR ETAT WISSENSCHAFT LIFESTYLE DISKUR

STATISTIK

Sommerhitze 2018 forderte in Österreich 766 Todesopfer

Laut Berechnungen der Agentur für Gesundheit und Ernährungssicherheit führte die Hitzewelle im Vorjahr zu einer Übersterblichkeit

Wien – Der außergewöhnlich lange und heiße Sommer des Jahres 2018 hat in Österreich zu einer Übersterblichkeit geführt. Den Berechnungen von Statistikern der Agentur für Gesundheit und Ernährungssicherheit (AGES) zufolge dürfte die Übersterblichkeit bei 766 Todesopfern liegen. Das berichtet das Wiener



Motivation

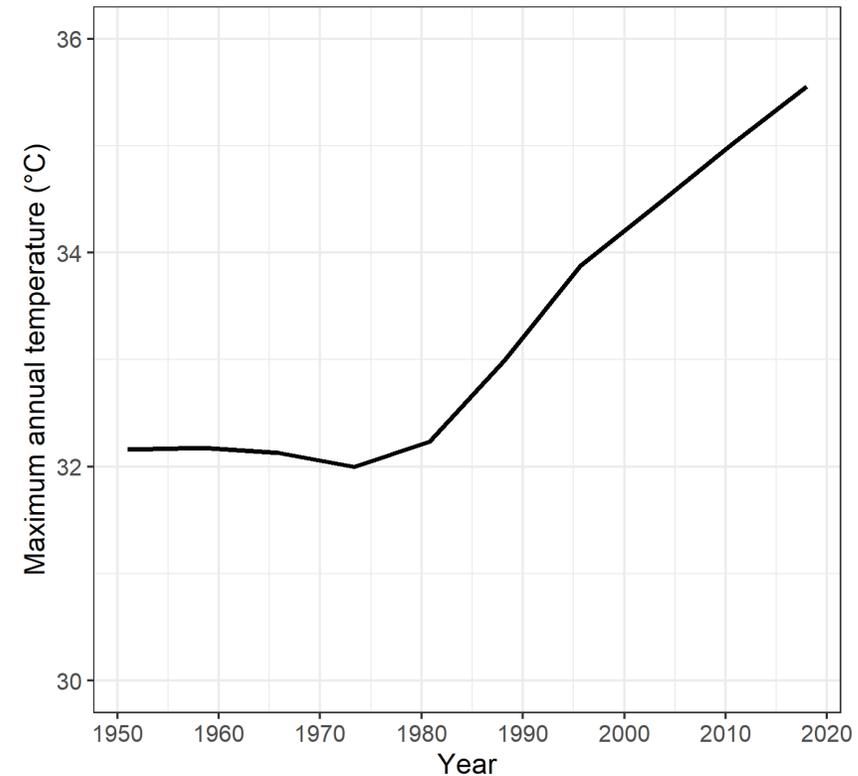
- Climate change as one of the most pressing challenges of our times is affecting populations globally
- Extreme weather events, such as heat waves, cold spells, heavy rainfalls, expected to become more frequent and more intense
- Also, Austria is increasingly affected by changing climatic conditions, particularly with respect to thermal hazards (Chimani et al. 2016; APCC 2018)
- Change particularly affecting fast growing cities like Vienna, which are characterized by specific climatic conditions



Climatic Changes in Austria

- +2°** Change in average yearly temperature since the 1980s
- +17d** Change in heat days (>30°) from the 1960s to 2010s
- 50d>** Expected number of heat days in Austria by 2100
- 30d>** Expected number of tropical nights (>20°) by 2100

Maximum annual temperature in Vienna: 1950-2018



Health Implications

Direct Effects

- Exposure to cold temperatures can lead to myocardial infarction, ischemia, as well as cardiovascular and respiratory diseases
- Extreme heat can lead to exhaustion, dehydration, hyperthermia, and cardiovascular problems

Indirect Effects

- Changes in ecosystems affecting disease vectors/pathogens
- Pollution and air quality
- Economic impacts worsening health care provision



Project Aims

1

Historical Analysis

- Analyse the influences of temperature extremes on morbidity and mortality using historical data
- Understand differential health vulnerabilities by socioeconomic and structural factors

2

Projections and Future trends

- Building on the evidence from the first part, project future climate and population dynamics on small spatial scale
- Estimate the expected health burden for the city of Vienna and its surrounding areas



Data

Climate data

- ZAMG climatological data INCA 2006-2019, 1x1km grid, various meteorological measures, including temperature, precipitation, humidity
- ÖKS15 climate scenarios for Austria up to year 2100, 1x1km grid

Health data

- Federal Social Insurance Association (Dachverband SV) data 2009-2019, hospitalization data with ICD 10 diagnosis and patient information
- Accident data (Allgemeine Unfallversicherungsanstalt) 2009-2019, occurrence of work related accidents by district and industrial sector

Further data

- Statistik Austria & City of Vienna: Sociodemographic data for districts
- Land-use satellite data, remote sensing
- Abgestimmte Erwerbsstatistik: information about industrial sectors

Preliminary Results

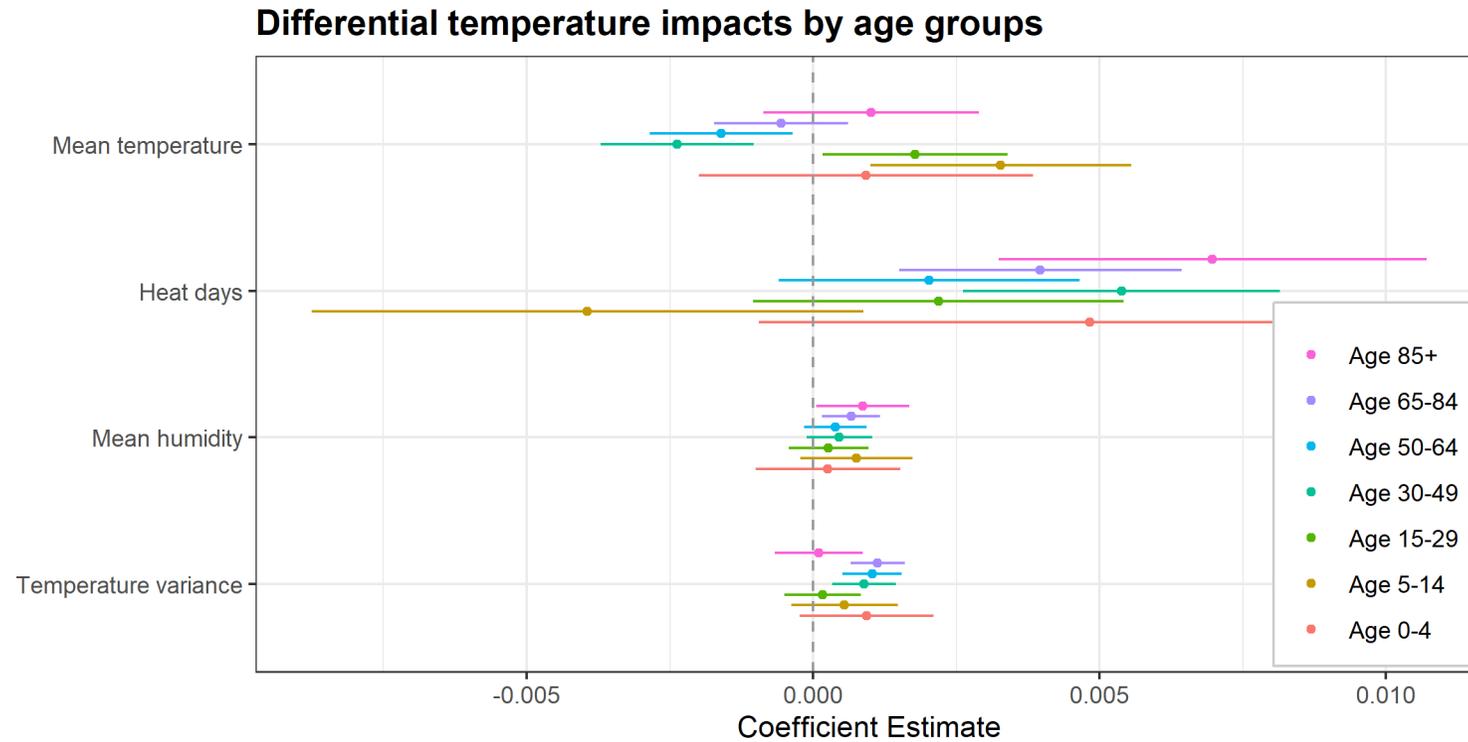


Number of hospital admissions per population					
	<i>coefficient</i>				
	<i>test</i>				
	(1)	(2)	(3)	(4)	(5)
<u>temp.max</u>	0.0001 (0.0002)			-0.001** (0.0003)	-0.001*** (0.0003)
<u>heatdays</u>		0.003*** (0.001)		0.005*** (0.001)	0.005*** (0.001)
<u>humid.mean</u>			0.0003* (0.0001)	0.001*** (0.0002)	0.001*** (0.0002)
<u>temp.var</u>					0.001*** (0.0002)
<u>prec.mean</u>	-0.001** (0.0005)	-0.001 (0.0005)	-0.002*** (0.001)	-0.002*** (0.001)	-0.002*** (0.001)
<u>prec.var</u>	0.00004** (0.00001)	0.00004** (0.00001)	0.0001*** (0.00002)	0.0001*** (0.00002)	0.0001*** (0.00002)
Constant	-5.260*** (0.010)	-5.258*** (0.009)	-5.275*** (0.013)	-5.277*** (0.018)	-5.263*** (0.018)

Note: * ** *** p<0.01

All models are poisson with population number as offset and year, month and PLZ as fixed effects. Standard errors are sandwich corrected. Sample restricted to May until September.

Preliminary Results



Applications

Parenthood and Environmental Concern



Do you have to be a parent to care about the long-term climate?

- Research on how environmental concern affects demographic behavior, especially fertility, so far is scarce
- Limited research on longitudinal data shows that – if anything – young parents' carbon footprint **increases** after they had a baby
- But what about the long-term implications of parenthood?
- What does #birthstrike imply for future environmental concern?

Data: European Social Survey

ESS Round 9 (2018)

ESS Round 8 (2016)

ESS Round 7 (2014)

ESS Round 6 (2012)

ESS Round 5 (2010)

ESS Round 4 (2008)

ESS Round 3 (2006)

ESS Round 2 (2004)

ESS Round 1 (2002)

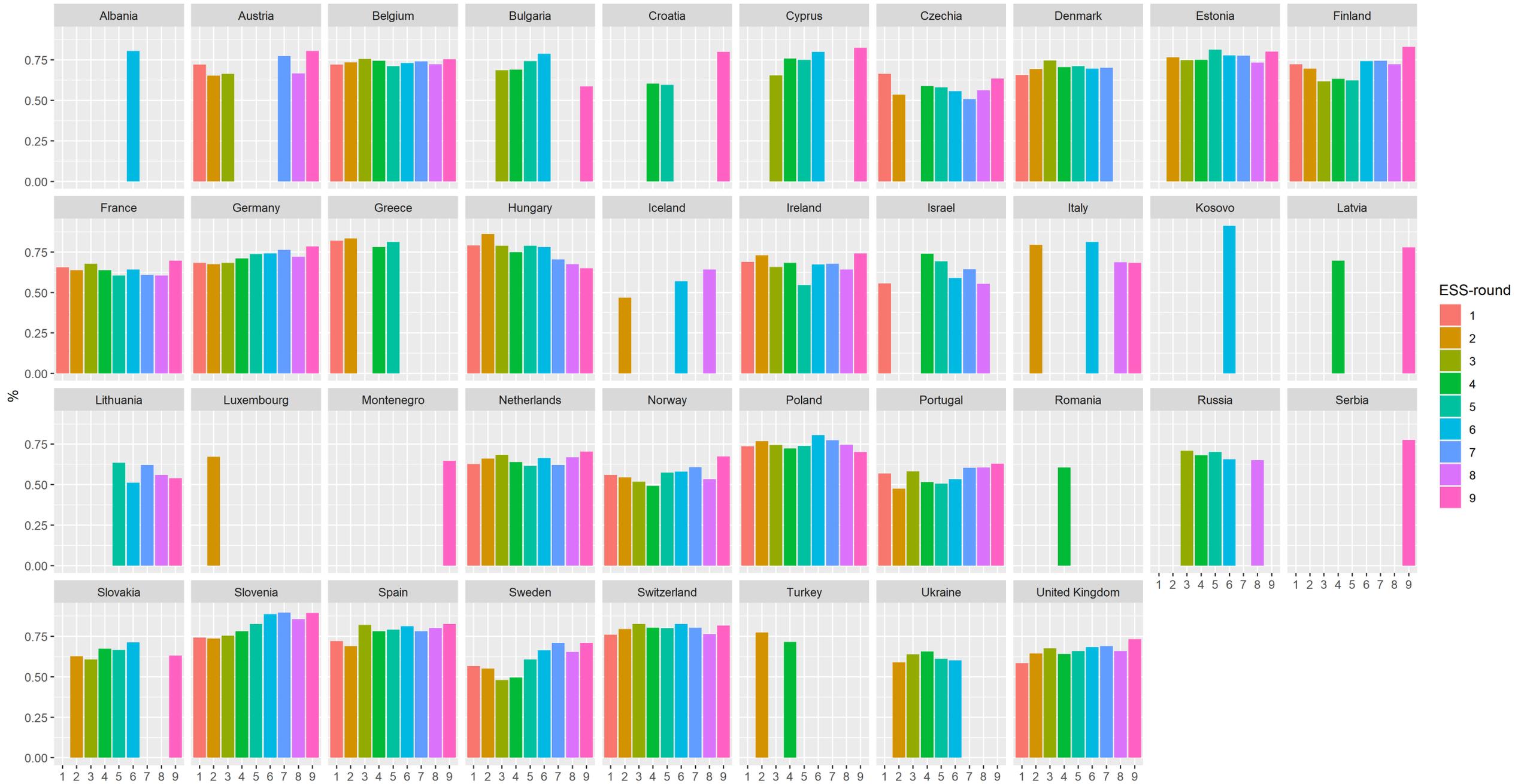
Key variable: “Caring for nature and the environment”

Question wording:

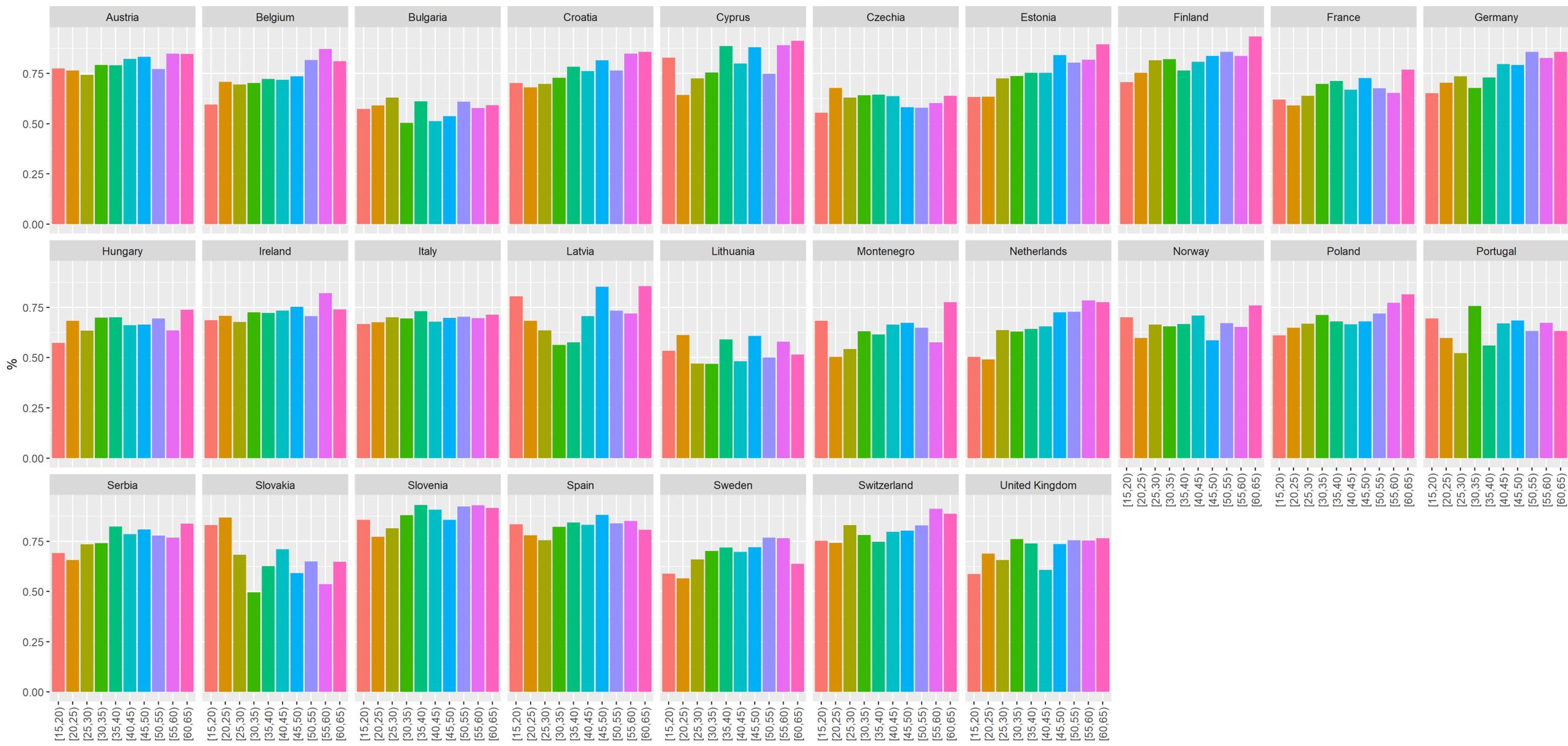
Now I will briefly describe some people. Please listen to each description and ***tell me how much each person is or is not like you***. Use this card for your answer. *She/he strongly believes that people should care for nature. Looking after the environment is important to her/him.*

Response options: ‘*Very much like me*’ to ‘*Not like me at all*’ (6-categories)

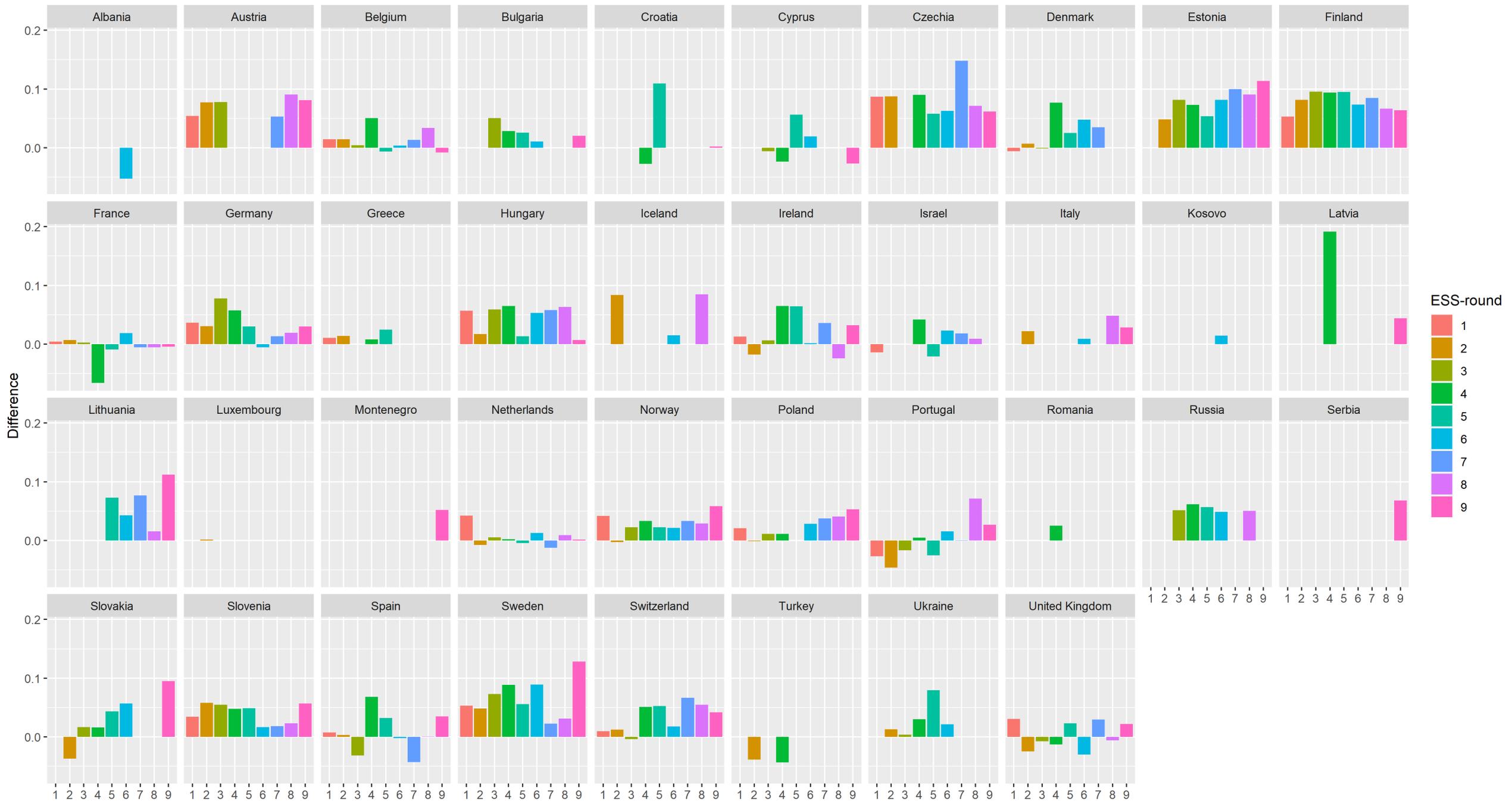
Proportion reporting to be pro-environmental by country and ESS-round
 Results based on combined design- and population-weights



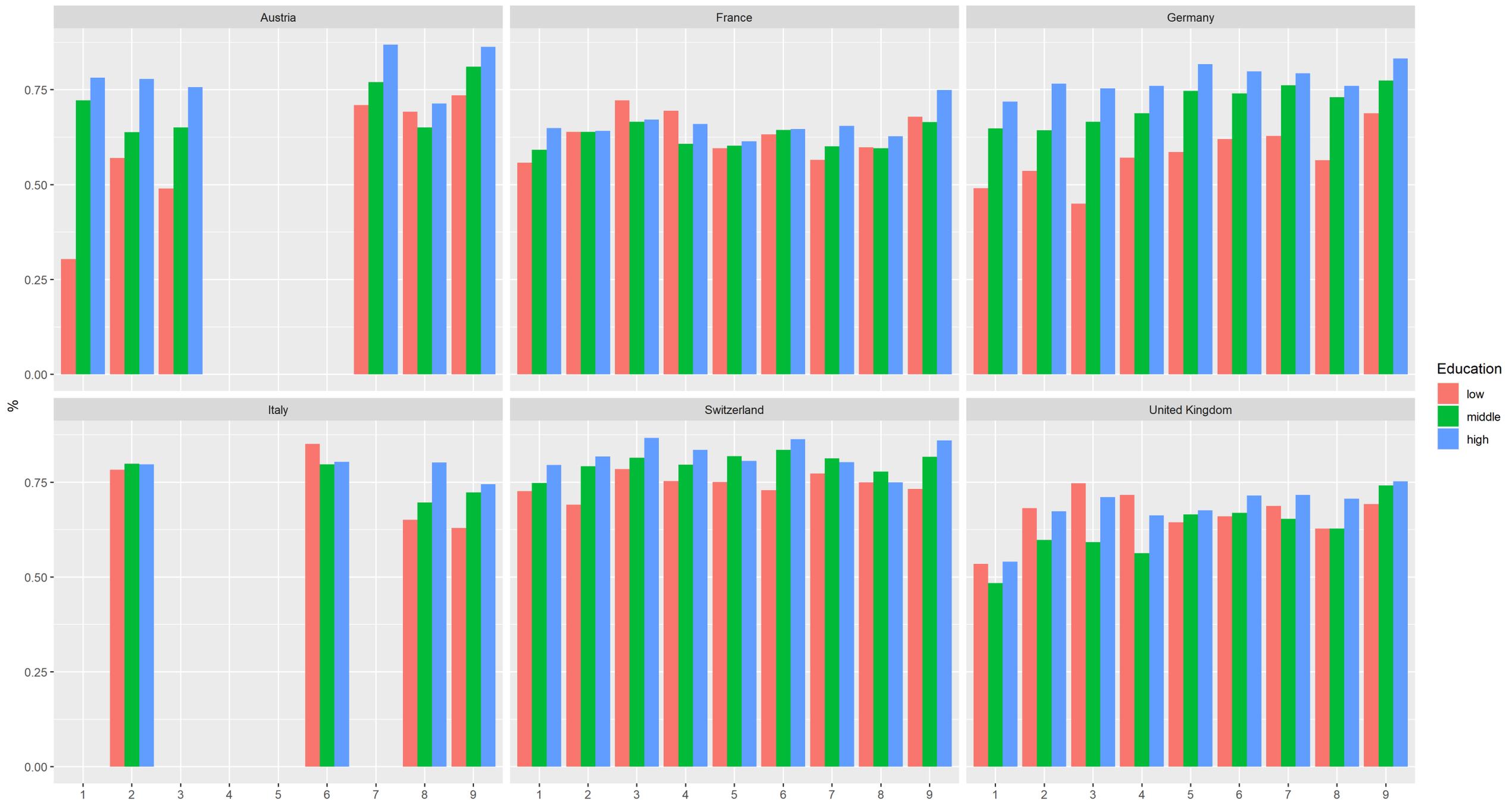
Proportion reporting to be pro-environmental by age



Difference in the proportion reporting to be pro-environmental between women and men by country and ESS-round

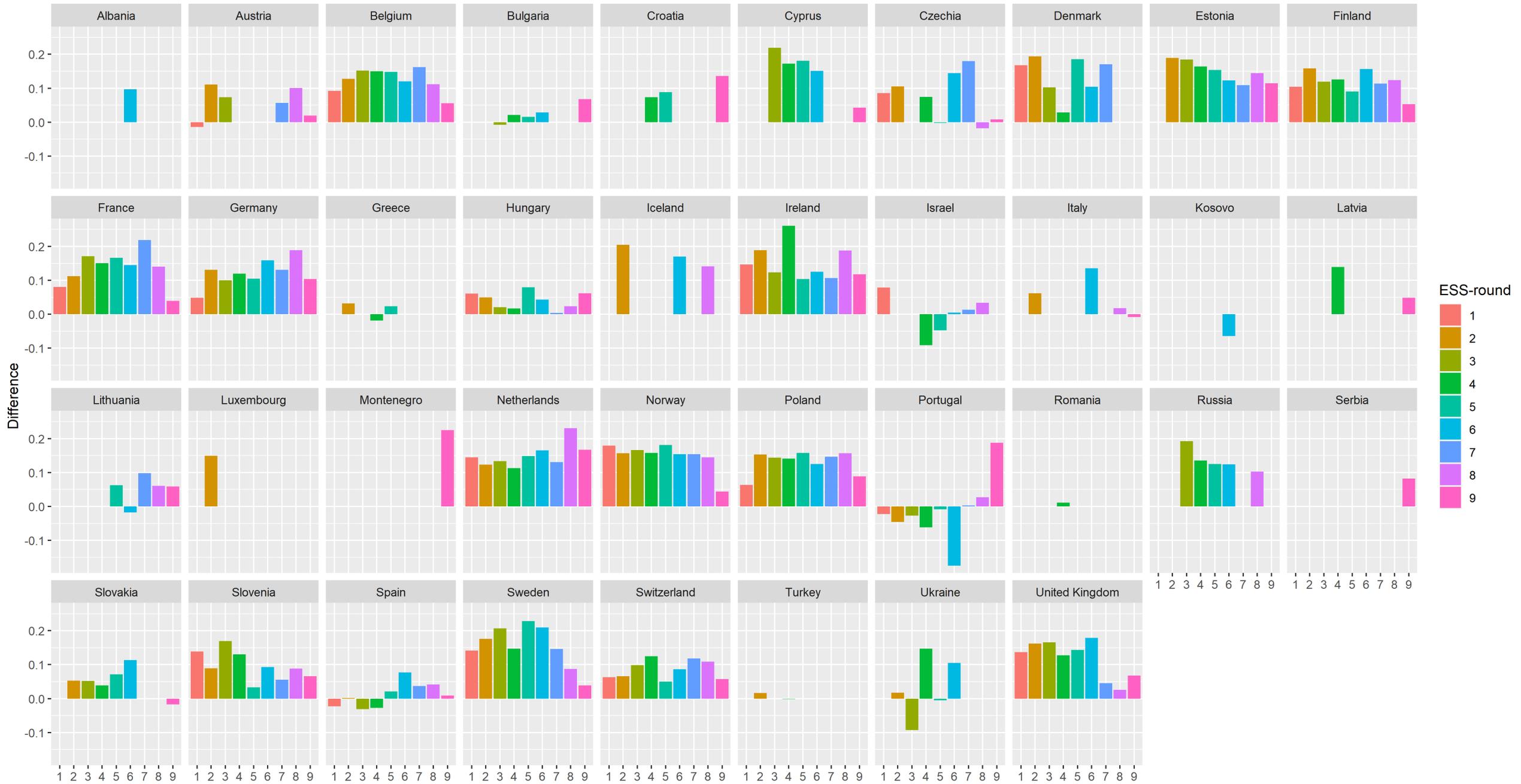


Proportion reporting to be pro-environmental by level of education



Difference in the proportion reporting to be pro-environmental between parents and non-parents by country and ESS-round

We consider those to be parents who reported that they >>Ever had children living in household<<





Conclusion I

- Over the coming decades, large amounts of money will be spent on climate change adaptation programs
- Rather than investing in specific adaptation strategies with hard to predict consequences, we should focus on general adaptive capacity
- Sustainable Development Goals have to be more ambitious if serious reductions in human well-being ought to be avoided



Conclusion II

- Environmental and demographic change are happening in parallel
- To avoid future increases in climate-related causes of death and hospitalizations, we need to adapt to the challenges of increasing extreme weather prevalence
 - Focus on risk populations (elderly, small children)
 - Focus on people “trapped” in urban heat islands
 - Invest in urban greening



Conclusion III

- To ensure the socio-ecological transformation necessary to tackle climate change, we need “parenting for sustainability”
- In addition, schools – fostering the intergenerational knowledge transfer – are instrumental
- But once the children get older, the learning effect might be directed the other way round (*Fridays for Future*)



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erich.striessnig@univie.ac.at



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