Climate change and Health: Adapting to Mental, Physical and Societal challenges (CHAMPS)

Psyykkinen ja fyysinen terveys sekä yhteiskunnalliset haasteet ilmastonmuutokseen sopeutumisessa

Timo Partonen, Maria Vaalavuo, Roberto Astone, Louise Burenby, Alessia Greselin, Heini Wennman

CHAMPS Final Report of 14 December 2023
Finnish Institute for Health and Welfare (THL)
Terveyden ja hyvinvoinnin laitos

CLIMATE CHANGE AND MENTAL HEALTH

Acute hospital visits among the elderly (75 years and older) in May to September from 1998 to 2017: each additional day a month in the highest bin of daily mean temperature (>25°C) resulted in

- significant increases by 3% to 4% due to dementia or psychiatric disorder as the primary cause
- a significant increase by 2% to 3% in those having pre-existing dementia
- no significant increase in those having pre-existing psychiatric disorder.

Conflicting data on the impacts of temperature on physical activity, whereas limited data on the impacts of temperature and changes in solar radiation on nutrition and sleep.

RELEVANCE AND RECOMMENDATIONS

- For designing effective heat alert mechanisms, it is of note that the individuals most at risk may have weaker coping skills and lack cognitive capacity to react sufficiently.
- Changes in solar radiation (less in winter, more in summer) and temperature are inducing impacts on mental health which emerge gradually over the years rather than suddenly within days or weeks.
- A strategy and a plan of action are needed for countermeasures against the slow impacts.

Thus far, there are no data on such impacts of climate change on mental wellbeing, mood, mood disorders, or deaths from suicide …

… but we shall make a dash for the line.

ACKNOWLEDGEMENTS

Academy of Finland: Climate Change and Health (CLIHE) Academy Programme

CHAMPS consortium partners: Finnish Environment Institute, Finnish Institute for Health and Welfare, Finnish Meteorological Institute, University of Eastern Finland, University of Helsinki.

Colleague Principal investigators: Timothy R. Carter, Marko Elovainio, Reija Ruuhela, Marianna Virtanen.

Research colleagues: Stefan Fronzek, Lisa Haga, Christian Hakulinen, Jaana I. Halonen, Kaisla Komulainen, Kaisa Lakkala, Anna Lipsanen, Ilona Merikanto, Johanna Metsälä, Pentti Pirinen, Nina Pirttioja, Laura Pulkki-Råback, Kimmo Ruosteenoja, Reijo Sund, Soili Törmälehto, Jussi Vahtera.

PUBLICATIONS

Astone R, Vaalavuo M. Climate change and health: consequences of high temperatures among vulnerable groups in Finland. Discussion paper 40/2021. Helsinki: Finnish Institute for Health and Welfare, 2021.

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CHAMPS FINAL REPORT

Marko Elovainio, Christian Hakulinen, Kaisla Komulainen
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LONG-TERM CUMULATIVE EXPOSURE TO CLIMATIC FACTORS AND HEALTH

- Long-term residential exposure to solar radiation in adulthood was associated with
  - sleep quality and diurnal preference (Elovainio et al. 2022)
  - cognitive function (Komulainen et al. 2022a)
  - specific depressive symptoms (Komulainen et al. 2022b)

- Long-term residential exposure to solar radiation and ambient temperature in childhood was unrelated to later risk of a severe mental disorder (Komulainen et al. 2022c, Komulainen et al. [work in progress])

scientific reports

Long-term residential sunlight exposure associated with cognitive function among adults residing in Finland

Kaisla Komulainen[1,2✉], Christian Hakulinen[1,2], Jari Lipsanen[1], Timo Partonen[2], Laura Pulkki-Råback[1], Mika Kähönen[3], Marianna Virtanen[4,5], Reija Ruuhela[6], Olli Raitakari[7,8,9], Suvi Rovio[7,8,11] & Marko Elovainio[1,2,10,11]

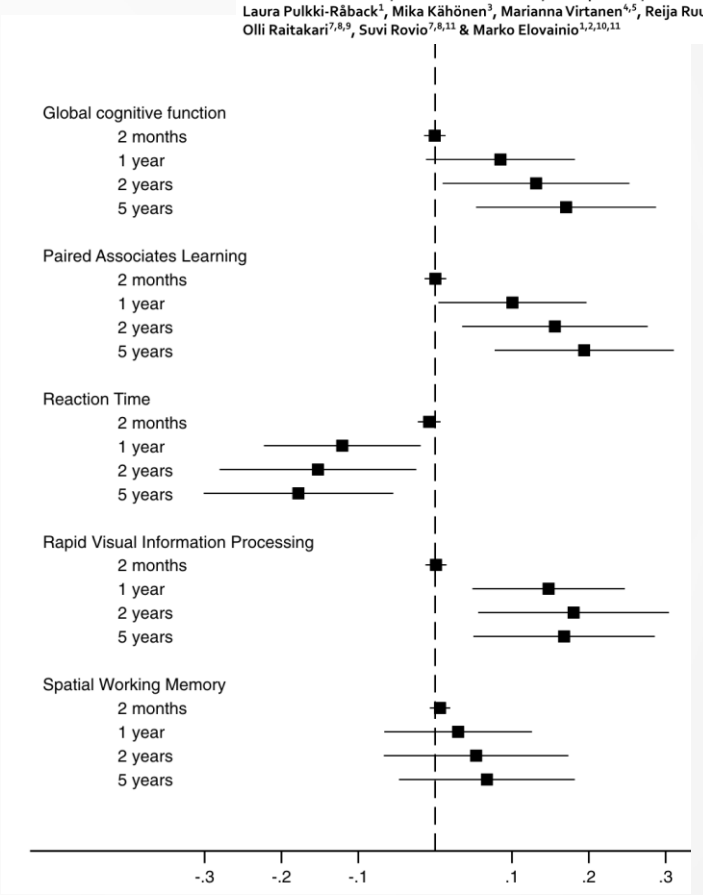


Figure 1. Associations of long-term sunlight exposure with cognitive function in the Cardiovascular Risk in Young Finns Study Abbreviations: CI, confidence interval. Estimates are differences in the rank-order normalized cognitive function scores per 1 MJ/m^2 difference in the average daily exposure to global solar radiation in residential neighborhood from linear regression analysis.

RELEVANCE & RECOMMENDATIONS

Long-term residential exposure to natural light in adulthood may be implicated in sleep, cognition and mental health in Finland.

Further studies should evaluate the associations between cumulative climatic exposures and health in populations residing in different geographical latitudes.

Mitigating confounding by other geographically distributed factors is crucial in studies utilizing area-level measurements of climatic factors.

ACKNOWLEDGEMENTS

Academy of Finland

SUOMEN AKATEMIA
FINLANDS AKADEMI
ACADEMY OF FINLAND

Principal Investigators: Timo Partonen (THL), Marianna Virtanen (UEF), Reija Ruuhela (FMI)

Collaborators and co-authors: Soili Törmälehto, Reijo Sund, Jari Lipsanen, Laura Pulkki-Råback, Anu-Katriina Pesonen, Tiina Paunio, Olli Raitakari, Suvi Rovio, Mika Kähönen, Jussi Vahtera

PUBLICATIONS

Elovainio, M., Komulainen, K., Lipsanen, J., Partonen, T., Pesonen, A., Pulkki-Råback, L., Paunio, T., Kähönen, M., Vahtera, J., Virtanen, M., Ruuhela, R., Hakulinen, C., & Raitakari, O. (2022). Long-term cumulative light exposure from the natural environment and sleep: A cohort study. *Journal of Sleep Research*, *31*(3), e13511. https://doi.org/10.1111/jsr.13511

Komulainen, K., Hakulinen, C., Lipsanen, J., Partonen, T., Pulkki-Råback, L., Kähönen, M., Virtanen, M., Ruuhela, R., Raitakari, O., Rovio, S., & Elovainio, M. (2022a). Long-term residential sunlight exposure associated with cognitive function among adults residing in Finland. *Scientific Reports*, *12*(1), 20818. https://doi.org/10.1038/s41598-022-25336-6

Komulainen, K., Hakulinen, C., Lipsanen, J., Partonen, T., Pulkki-Råback, L., Kähönen, M., Virtanen, M., Ruuhela, R., Raitakari, O., & Elovainio, M. (2022b). Associations of long-term solar insolation with specific depressive symptoms: Evidence from a prospective cohort study. *Journal of Psychiatric Research*, *151*, 606–610. https://doi.org/10.1016/j.jpsychires.2022.05.038

Komulainen, K., Elovainio, M., Törmälehto, S., Ruuhela, R., Sund, R., Partonen, T., Virtanen, M., & Hakulinen, C. (2022c). Climatic exposures in childhood and the risk of schizophrenia from childhood to early adulthood. *Schizophrenia Research*, *248*, 233–239. https://doi.org/10.1016/j.schres.2022.09.013

FINAL REPORT
CLIHE - CHAMPS

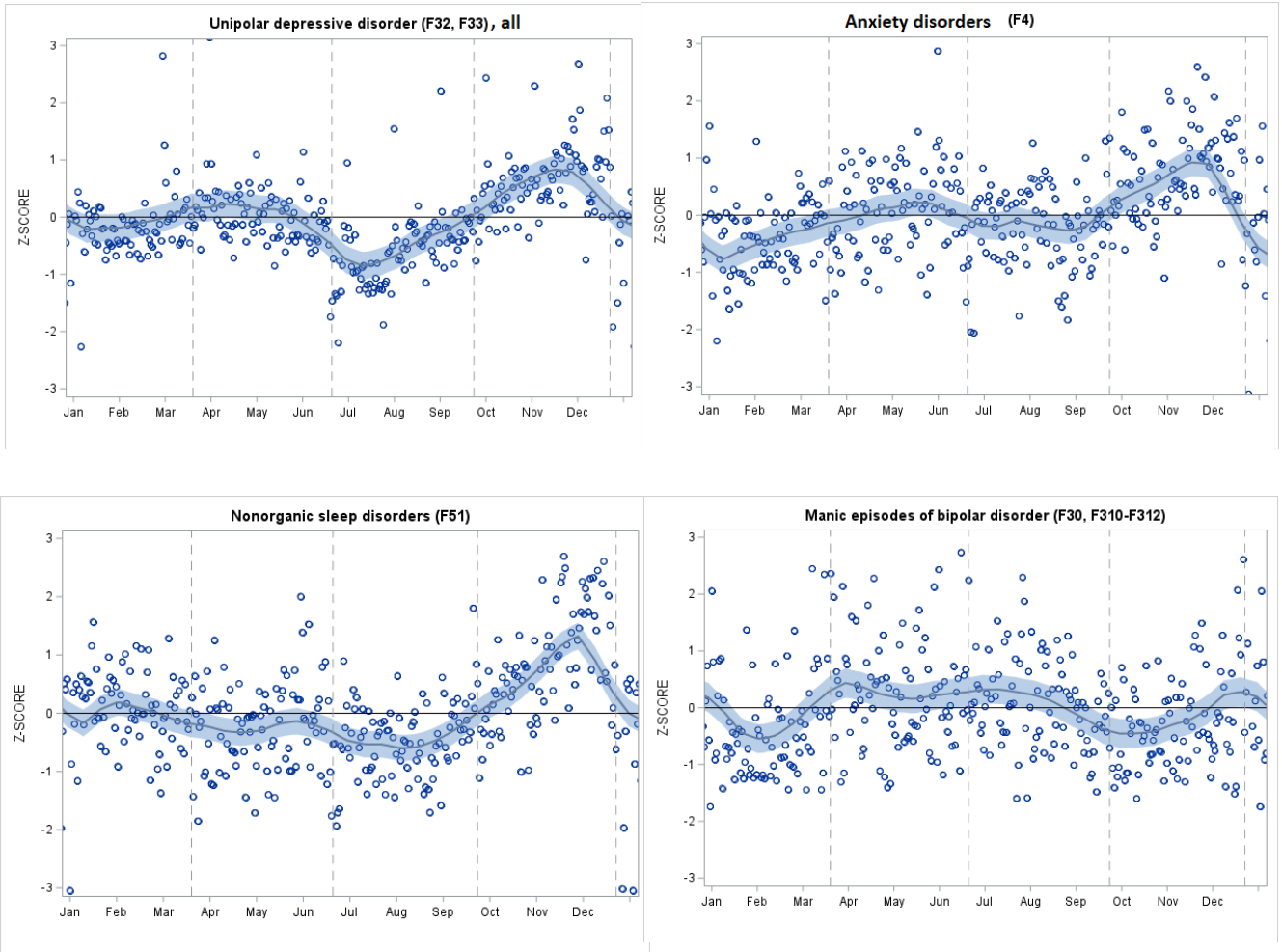
Marianna Virtanen, Soili Törmälehto, Johanna Metsälä, Ilona Merikanto, Reijo Sund

Department of Educational Sciences and Psychology & Institute of Clinical Medicine

University of Eastern Finland

Light exposure, hospitalization and sickness absence

- We found significant seasonal variation in hospital admissions and sickness absence due to mental disorders
- Larger than expected increases in November-December and decreases in spring and summer
- Opposite effects for manic episodes
- Manuscript under preparation: Cumulative individual level sickness absence & light exposure



Virtanen M *et al.* (2023). *Epidemiology and Psychiatric Sciences* **32**, e64, 1–10. https://doi.org/10.1017/S2045796023000768

Relevance & recommendations

- Mental health-related hospitalizations and sickness absence follow patterns that are related to changes in solar radiation.
- If solar radiation is going to decline in winter, this may increase hospitalizations and sickness absence due to depression, anxiety and sleep disturbances but decrease the burden of manic episodes.
- If solar radiation is going to increase in summer, people with bipolar disorder may have more manic episodes while depression, anxiety and sleep disturbances may decrease.
- Therefore, **the mental health impacts of climate change may be season- and disorder-dependent**.
- Future research needs to account for interaction effects between solar radiation and temperature.

Publications

Peer reviewed:

Törmälehto S, Svirskis T, Partonen T, Isometsä E, Pirkola S, Virtanen M, Sund R. Seasonal effects on hospitalizations due to mood and psychotic disorders: A nationwide 31-year register study. Clin Epidemiol. 2022 Oct 21;14:1177-1191.

Virtanen M, Törmälehto S, Partonen T, Elovainio M, Ruuhela R, Hakulinen C, Komulainen K, Airaksinen J, Väänänen A, Koskinen A, Sund R. Seasonal patterns of sickness absence due to diagnosed mental disorders: a nationwide 12-year register linkage study. Epidemiol Psychiatr Sci. 2023 Nov 9;32:e64.

Merikanto I, Metsälä J, Partonen T, Sund R, Elovainio M, Ruuhela R, Komulainen K, Halonen J, Raza A, Virtanen M. Cumulative exposure to solar radiation and sickness absence due to mental disorders: a case-crossover study. In preparation.

Non-peer-reviewed:

Virtanen M. Climate change and mental health (in Finnish). Työterveyslääkäri 2020; 38(4):14-16.

Keynote presentation: Virtanen M. What are the impacts of climate change on mental health and working life? Terveyspsykologian päivät 7-8 Nov, 2023, THL, Helsinki, Finland

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FINNISH METEOROLOGICAL INSTITUTE

FMI – CHAMPS for CLIHE Final Seminar – Dec, 2023

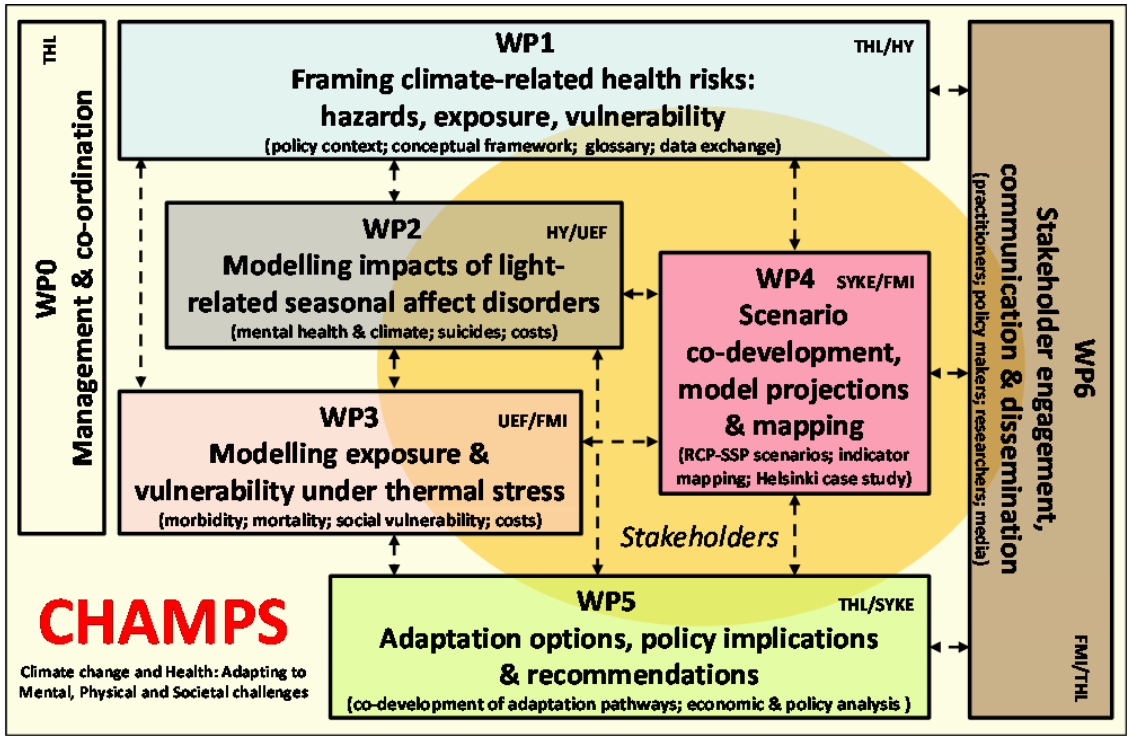
Reija Ruuhela

Pentti Pirinen, Kaisa Lakkala, Lisa Haga, Kimmo Ruosteenoja, Sanna Luhtala

29.5.2025

FMI team in CHAMPS

- Reija Ruuhela, FMI-PI
  - Human biometeorology
- Pentti Pirinen
  - Observational climate data
- Kaisa Lakkala
  - UV and solar radiation
- Lisa Haga
  - Human biometeorology, PhD student
- Kimmo Ruosteenoja
  - climate change scenarios
- Sanna Luhtala
  - science editor



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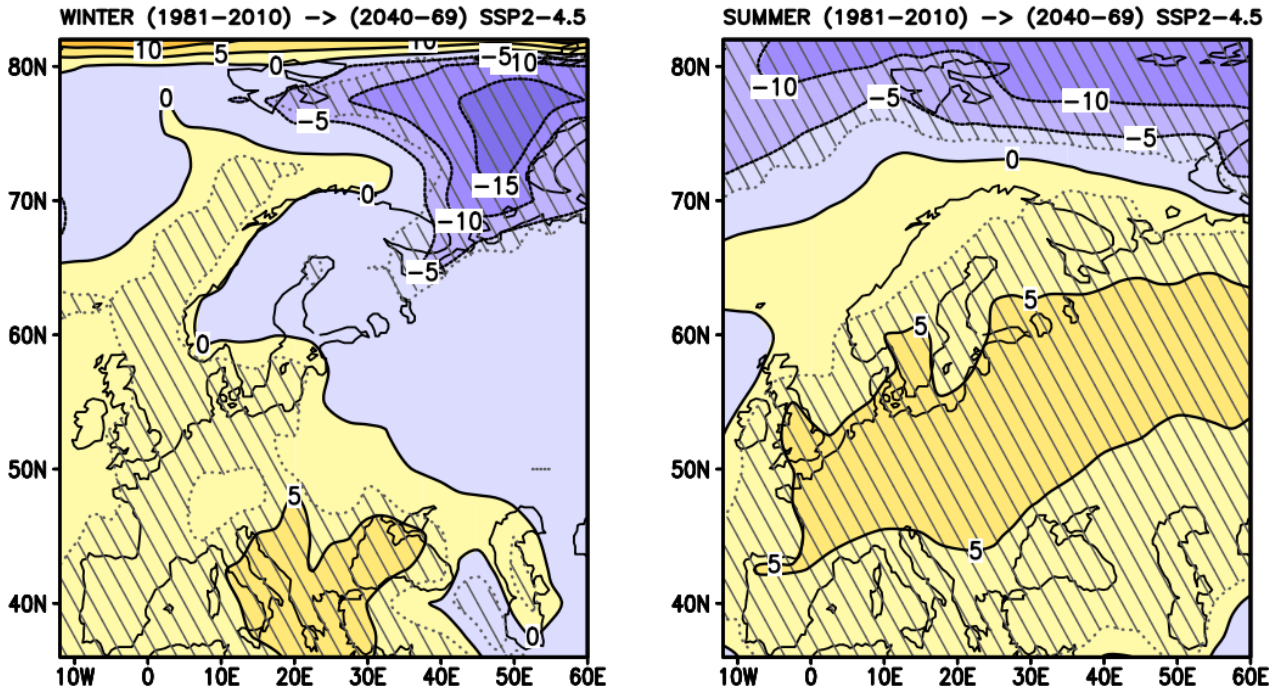
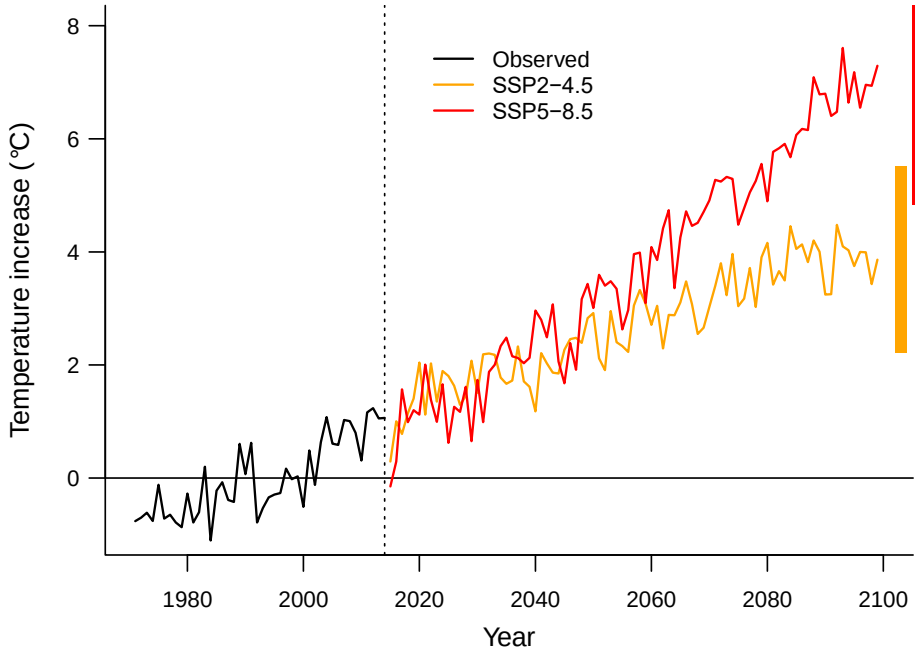
Climate change scenarios – CHAMPS focuses on impacts of solar radiation and temperature



Changes in solar radiation - winter and summer (Ruosteenoja and Jylhä, 2021)



Changes in annual mean temperature

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Association between solar radiation and suicides

Suicide data from four hospital districts in southern Finland
+
Solar radiation data, including ultraviolet radiation (UVR)

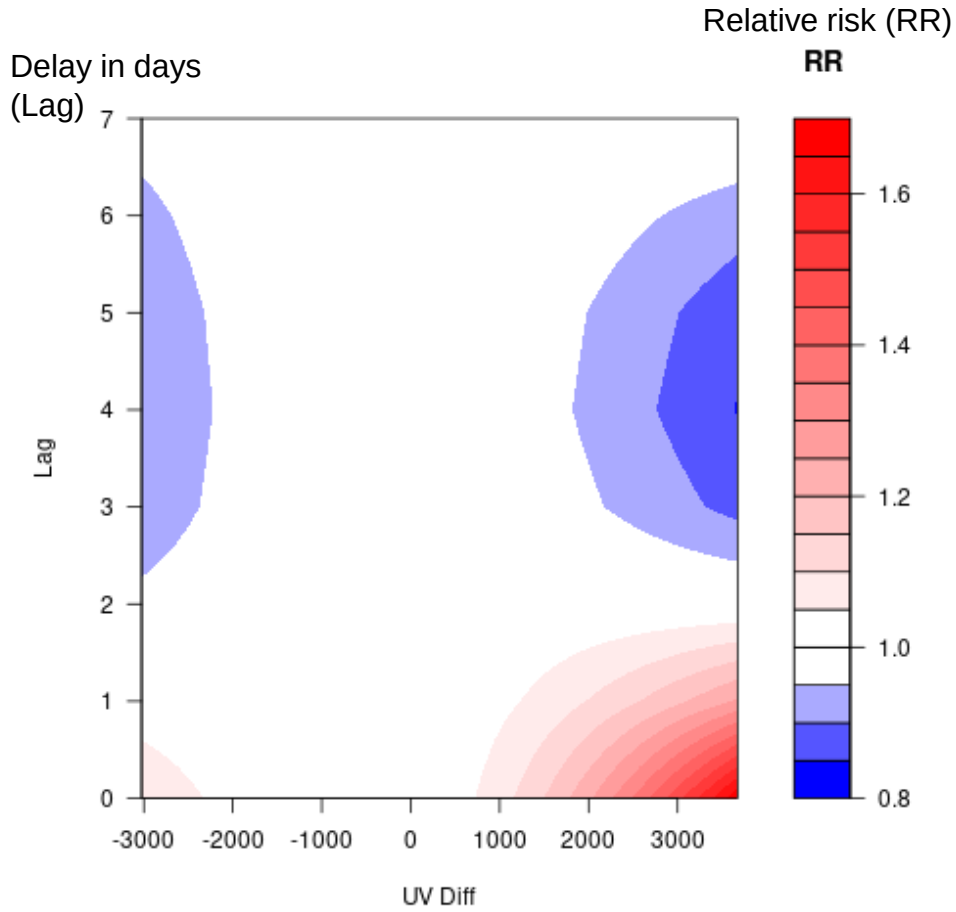
Time period: 1979-2019, March-June

→ an increased risk of suicide is associated with an increase in UVR doses on consecutive days
(actual day's UVR dose > previous day's UVR dose)

→ the risk is increased also for the following day

Strong harvesting effect

→ Sudden positive change in solar radiation can trigger suicides even though it doesn't substantially increase the total number of suicides.



Difference between UVR doses of the actual and previous days (UV Diff)

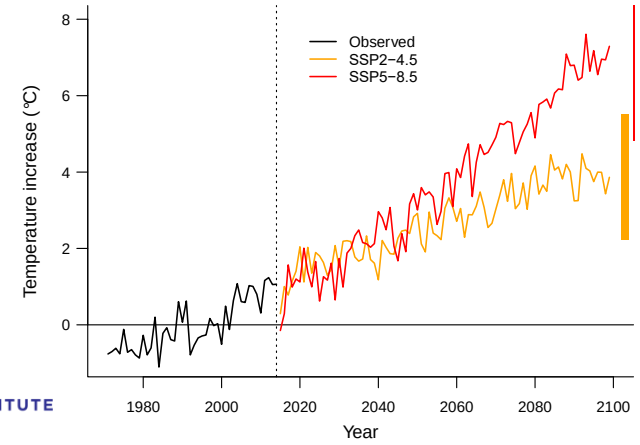
Lakkala et al., under preparation

Future projections of excess heat- and cold-related mortality in Finland

Future projections of excess heat-related mortality for all ages are expected to increase in 2090-2099 compared to 2010-2019 in SSP2-4.5 and SSP5-8.5 in majority of the Finnish wellbeing service counties.

Excess cold-related mortality will decrease in most of the Finnish wellbeing service counties.

Annual mean temperatures changes in SSP2-4.5 and SSP5-8.5 scenarios for sub-set of CMIP6 model runs (plot below).



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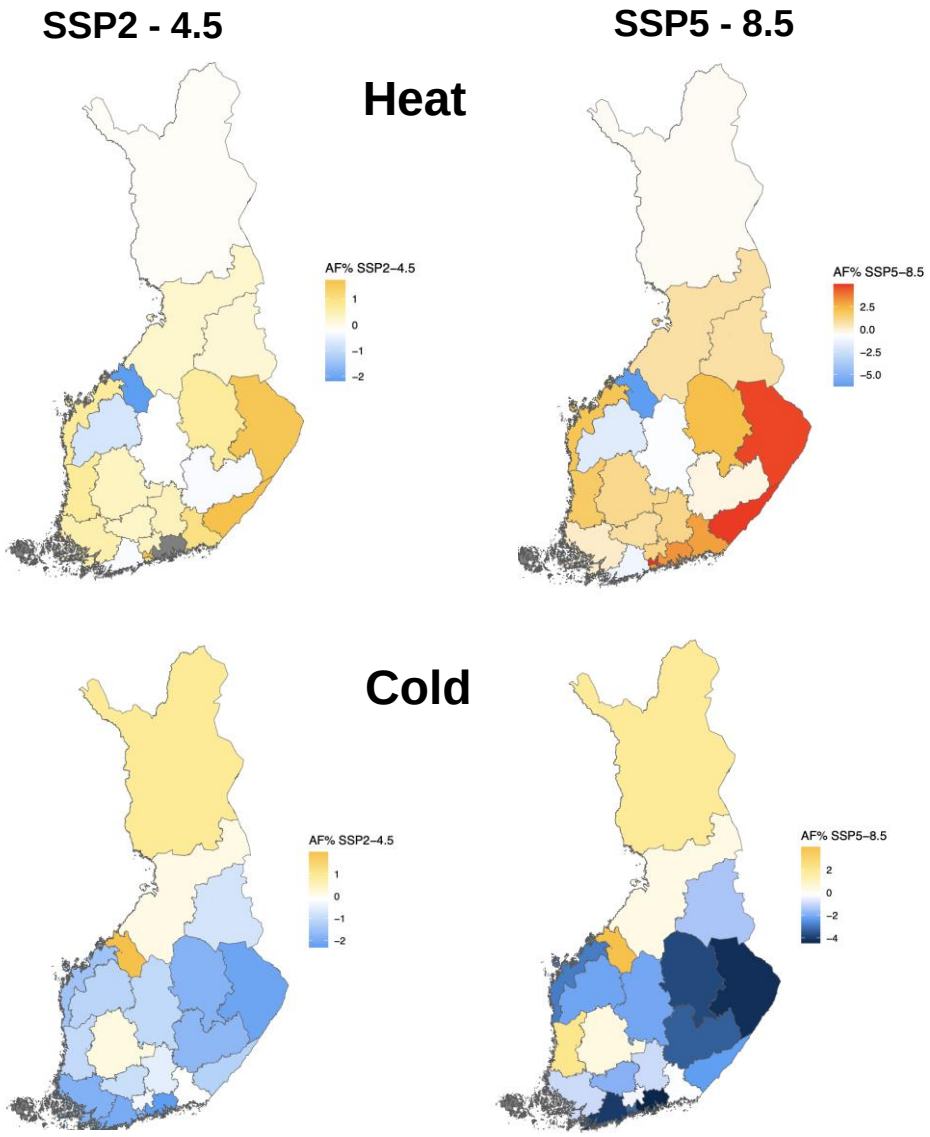

Haga et al. (in preparation)

CHAMPS Stakeholder engagement

- Series of workshops with **City of Helsinki**, **Climate unit and SoTePe** (Social Services, Health Care and Rescue Services Division)
  - May 2023 – health impacts of heat stress, urban heat island (UHI), social vulnerability
  - Oct, 2023 – climate change, UHI and urban growth, vulnerability, buildings, overheating
    - Crossdiciplinary workshop – also HKI units for urban planning and building engaged
    - Heatclim and Smartland contributions as well
  - Spring, 2024 (under planning) – mental health

- Contribution to the WHO-WMO Study Group on Climate Services for Health

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CHAMPS Communication

- Hiilikasasymposium – Uniarts, Helsinki, spring 2022

- Numerous media interviews - TV, radio, print media
  - UEF Media release 11 Dec, 2023
  - https://www.uef.fi/fi/artikkeli/valoisuuden-muutokset-yhteydessa-mielenterveyteen-tulevaisuudessa-myos-ilmastonmuutos-voi-vaikuttaa

- Podcast - Ikioma ilmastokriisimme – Jakso 7 – Tappohelteet ja ikuinen marraskuu – ilmasto lisää terveyshuolia. https://areena.yle.fi/audio/1-50933811

- Presentations in various forums
  - Including policy-makers and decision-makers
  - FMI climate change seminar for journalists

- Contribution to ClimaHealth.info –portal
  - Mental health –pages (under preparation)

Valoisuuden muutokset yhteydessä mielenterveyteen – tulevaisuudessa myös ilmastonmuutos voi vaikuttaa

11.12.2023 | TERVEYS JA HYVINVOINTI

Suomalaisten masennus-, ahdistus- ja unihäiriöihin liittyvät sairauspoissaolot kasvavat selvästi loka–marraskuussa, kun taas kesä–syyskuussa poissaoloja on odotettua vähemmän. Loppusyksyn sairauspoissaoloja on kesään verrattuna lähes kaksinkertainen määrä ja alkusyksyyn verrattuna noin neljännes enemmän. Kaksisuuntaiseen mielialahäiriöön liittyviä maniajaksoja esiintyy puolestaan valoisaan aikaan keväällä ja kesällä odotettua enemmän ja pimeän aikaan odotettua vähemmän.

Tulokset selviävät Suomen Akatemian rahoittamasta *Climate Change and Health* -tutkimusohjelmassa tehdystä tutkimuksesta. Tavoitteena oli tutkia, miten valoisuuden muutokset ovat yhteydessä mielenterveyteen. Ilmastonmuutoksen myötä talviaikojen ennustetaan muuttuvan Suomessa pimeämmiksi ja kesäaikojen valoisammiksi.

Mielenterveys

Unihäiriöt ja masennusoireet yleistyvät Suomessa, ennustavat tutkijat – tästä se johtuu

Alustavien tutkimustulosten mukaan vaikuttaa siltä, että masennusoireilu voi yleistyä, kun tulevaisuudessa talvet ovat synkempiä. Myös unihäiriöt saattavat lisääntyä.

https://yle.fi/a/74-20056173

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Publications

- Ruuhela R., K. Ruosteenoja, K. Lakkala, 2023: Projected changes in incident solar radiation in Northern Hemisphere high-latitude areas, FMI's Clim. Bull. Res. Lett., [preprint], https://doi.org/10.35614/ISSN-2341-6408-IK-2024-02-RL
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CHAMPS Climate change and Health: Adapting to Mental, Physical and Societal challenges

ACADEMY OF FINLAND CLIHE

Finnish institute for health and welfare · Suomen ympäristökeskus Finlands miljöcentral Finnish Environment Institute · Ilmatieteen laitos Meteorologiska institutet Finnish Meteorological Institute · Helsingin yliopisto Helsingfors universitet University of Helsinki · University of Eastern Finland

SYKE progress report & key results

Timothy Carter, Anna Lipsanen, Nina Pirttioja, Stefan Fronzek, Stefan Fagerström, Daniel Haaranen & Arto Viinikka
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Susanna Kankaanpää
City of Helsinki

Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

CHAMPS Climate change and Health: Adapting to Mental, Physical and Societal challenges

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Scenarios for Climate Change & Health Analysis in Finland

CLIHE Virtual Workshop on Scenario Co-ordination, 16 December 2020

- ~30 participants from CLIHE projects & AKA
- Aims: To exchange information on scenarios, to explore opportunities for collaboration & exchange of scenarios & to discuss use of common scenarios in CLIHE
- Scenario needs were surveyed among seven projects
- Report at: https://www.syke.fi/projects/champs

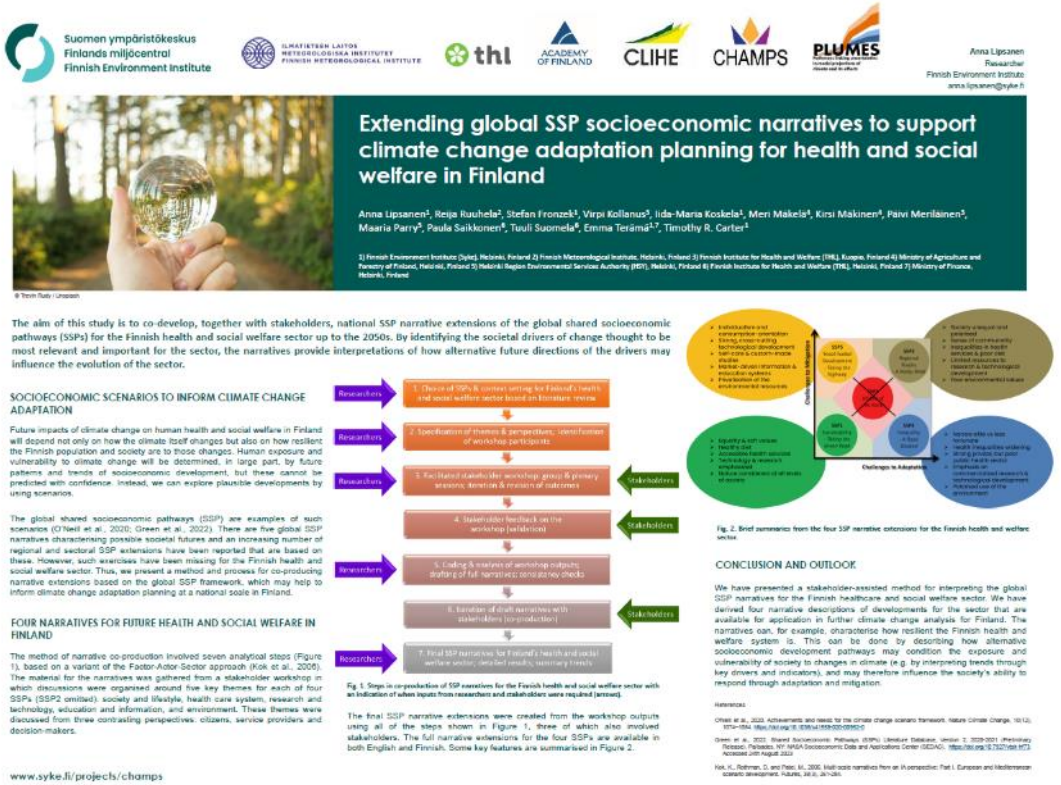
Table 1. Overview of the main objectives and suggested scenario needs of seven CLIHE consortium projects based on workshop presentations (see hyperlinks)

Consortium	Main objectives	Suggested scenario needs
ALL-IMPRESS[1]	To evaluate how the allergen burden (focusing on grasses) will change over the next decades and what are the potential public health interventions and adaptation measures	Climate projections: Variables affecting e.g. growth seasons, growing belts, spread of invasive plants and pollination → Temperature, CO_2; Other potentially interesting projections: Socioeconomic scenarios (land use, biodiversity, health care)
CHAMPS[2]	To analyse: effects of darker winters on mental illnesses, sick leaves and suicides, effects of social factors on heat and cold stress-related health risks now and in the future, and how to reduce negative health impacts of climate change	RCP-based climate variables: (e.g. global radiation, cloud, air pressure, snow depth, windspeed, max, min, mean ´& "effective" temperature, humidity, precipitation); SSP-based narratives, exposure & vulnerability indicators (e.g. of health, demographic, social, economic & technological factors; adaptation pathways; Reference: 1991-2020; 2020; Time horizon: 2060s +; spatial (site to regional council) & temporal (sub-daily to daily) resolution
Diseases-on-Wings[3]	To undertake species distribution surveillance and modelling of birds and bats that carry diseases and to relate this to microbiome characterisations of bird intestine and bat feces samples using citizen science methods	Projections of key climate variables based on RCP trajectories for RCP2.6, 4.5 and 8.5
ECOCIDE[4]	To examine how building design impacts indoor microbiota and to 'future-proof' building design to meet challenges posed by climate change	Future changes in Finland of: climate, building materials and design policy & drivers; Projections for Finland (2030, 2050, 2080)
HEATCLIM[5]	To produce new knowledge on the current and future health effects of heat in different population groups and to provide cost-effective and socially acceptable adaptation solutions	Climate: e.g. daily mean temperature (+min/max), heatwaves, relative humidity; Demographic: e.g. population, age and sex distribution, chronic diseases, employment, single-person households; Technical: e.g. mechanical cooling, passive cooling, all households (by type of housing), social and health care facilities; Economic: national & regional economy, public finance; 18 regions, three future time-points (2070-2079), likely value (+min/max)
HERCULES[6]	To examine past and possible future changes in pattern and intensity of climate-related health risks in six cities: Helsinki, Espoo, Tampere, Vantaa, Turku & Oulu, to develop a dynamic pathways model of different policy outcomes, and to catalyse chances for improved evidence-based decision making	RCP-based climate projections: EURO-CORDEX regional climate model (RCM) with RCP4.5 at 12.5 km grid resolution & daily time resolution; 6 models; current focus temperature; other variables also available; HARMONIE-Climate (HCLIM) RCM data for RCP8.5 at 3 km & 12 km grid resolutions & 1–3 h time resolution downscaled from 2 global models for studying heatwaves and urban heat island (publicly available 2021); Focus on period 2040-2060
VECLIMIT[7]	To quantify, analyse and model climate change-dependent factors affecting the spatio-temporal dynamics of vector-borne diseases (VBDs) in Finland in order to predict and mitigate their effects on human health	Observed climate: FMI: temp (min, max, mean), precipitation (month/season), humidity, snow, growing season – 1 km resolution; WorldClim & CHELSA; Climate projections: WorldClim & CHELSA [CMIP5] - 0.30 seconds gridded GIS-ready format (GeoTiff); four global models; RCPs 4.5 & 8.5; WorldClim-[CMIP6] - 2.5 minutes bio-climatological dataset for 2041-2060, 2061-2080 & 2081-2100; IPSL-CM6A-LR for SSPs 1-26, 2-45, 3-70 & 5-85 Which future model-based projections are best suited for Finland? How does species distribution model performance differ when using alternative sources of climate projections?

[1] Aeroallergens and immunological preparedness for future climate scenarios: implications for public health promotion (UEF, FMI, UTU); [2] Climate change and health: adapting to mental, physical and societal challenges (THL, FMI, SYKE, UH, UEF); [3] Diseases-on-Wings (HU, UTU); [4] Effect of climate change on building design and indoor health (UJ, UEF, UO); [5] Heat and health in the changing climate (UEF, Aalto, THL, FMI); [6] Health, risk and climate change: understanding links between exposure, hazards and vulnerability (UTU, FMI, UH); [7] Vector-borne diseases and climate change in Finland: mapping, modelling, mitigation (UH, UJ, FMI, Luke, FFA, UT, THL, AVIA GIS, BNI)

SSP-based socioeconomic narratives for Finland

- Work led by Anna Lipsanen, SYKE (PhD research)
- Based on Workshop held in May 2019 (SA PLUMES project)
- Presentation at Scenarios Forum, IIASA, Austria, Jul 2022
- Poster presentation at Adaptation Futures, Montreal, Oct 2023



CHAMPS Climate change and Health: Adapting to Mental, Physical and Societal challenges

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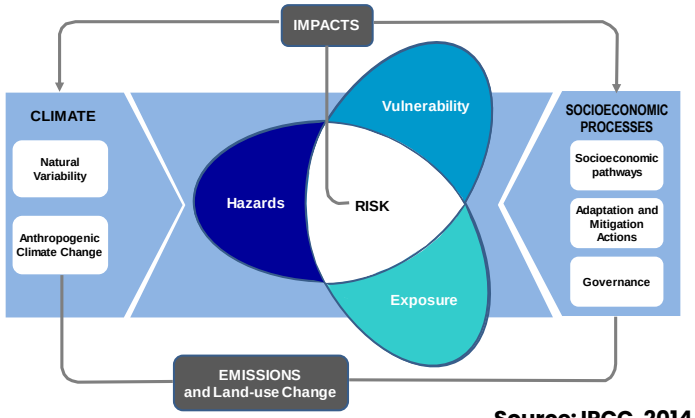
Helsinki case study of climate change risks to health

Heat risk in Helsinki Metropolitan area

- Work by led by Nina Pirttioja
- Mapping of heat risk in the Helsinki Metropolitan area
- Review of indicators of vulnerability, exposure and hazard
- Data set of socio-economic and health indicators at postal code resolution (2000-2017) from THL
  - Visits to specialized care per year for different diagnosis groups that affect heat vulnerability
  - Number of people per postal code area for different socio-economic and demographic indicators
- Surface temperatures during heatwave conditions based on Landsat images (hazard)
- Maps of long term means and observed trends of indicators; standardised and combined into risk indices
- Projecting selected indicators to the future to represent future heat risk under climate and socio-economic changes

IPCC Risk Framework



Source: IPCC, 2014

Photo: Pixabay

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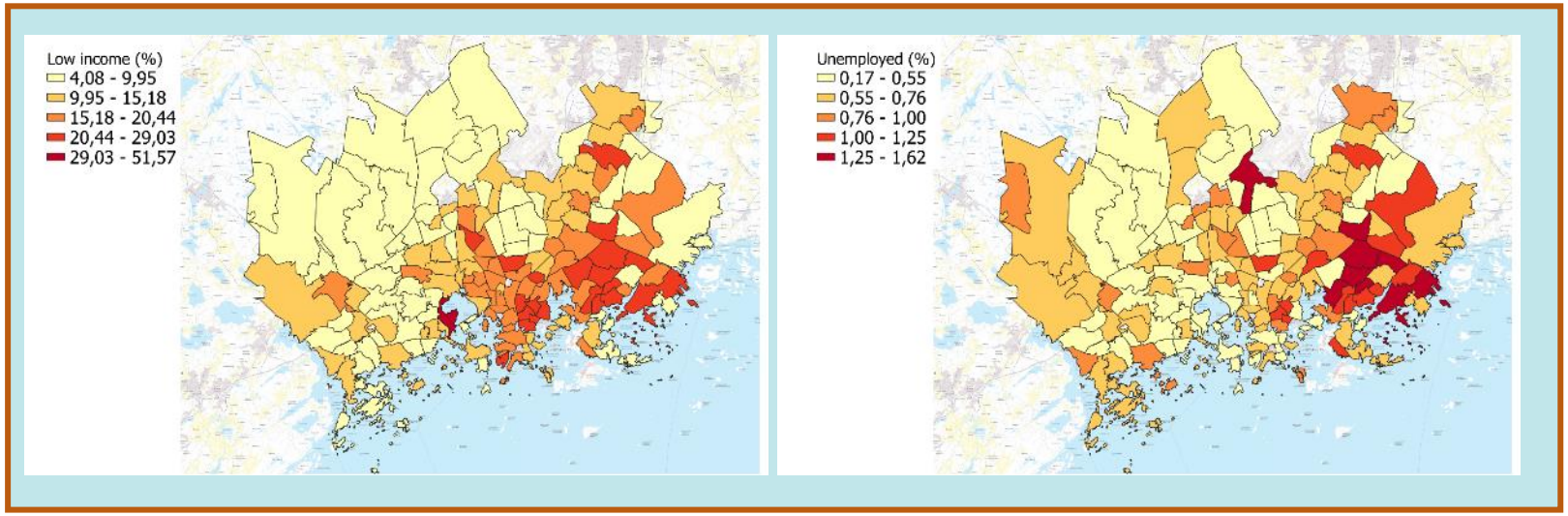
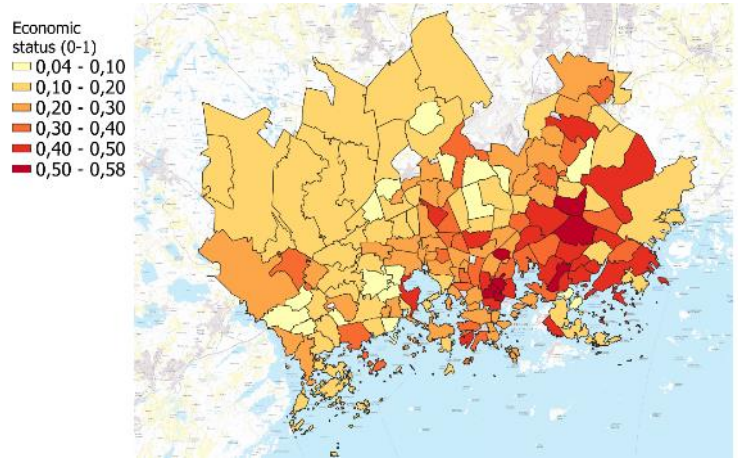
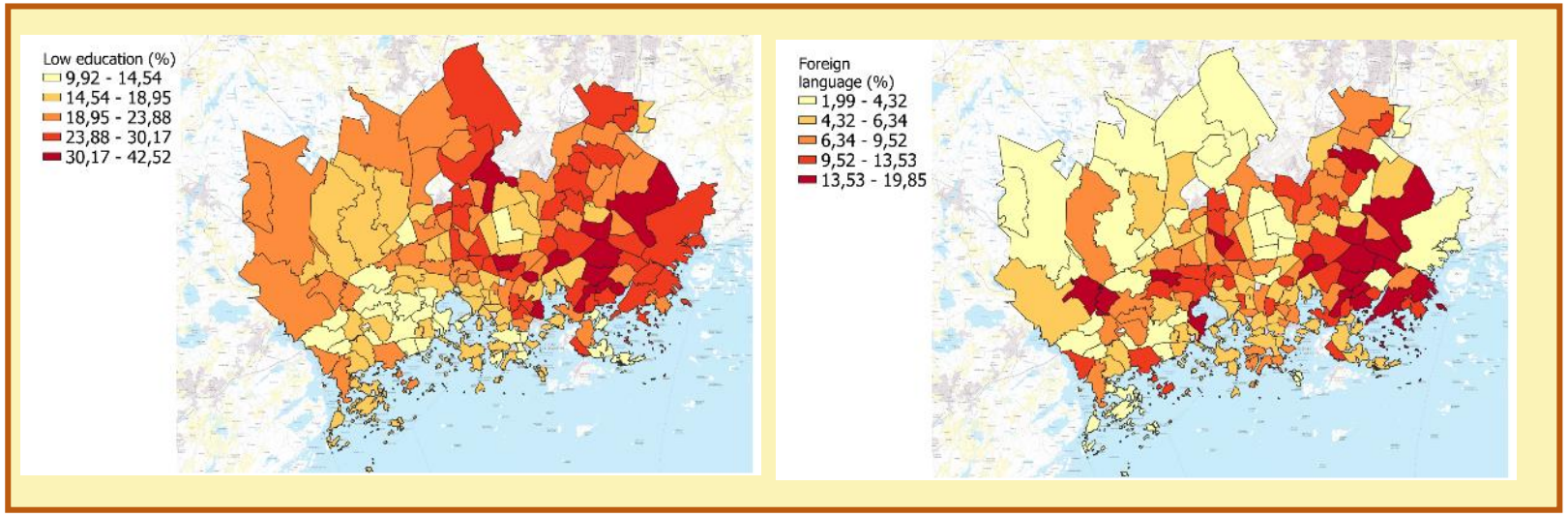
Heat risk in Helsinki Metropolitan area

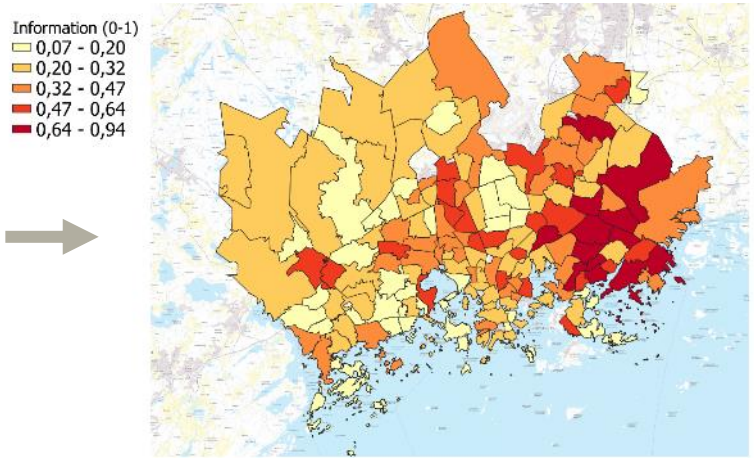
Vulnerability indicators





Before combining, values of all indicators are normalized to range from 0 to 1

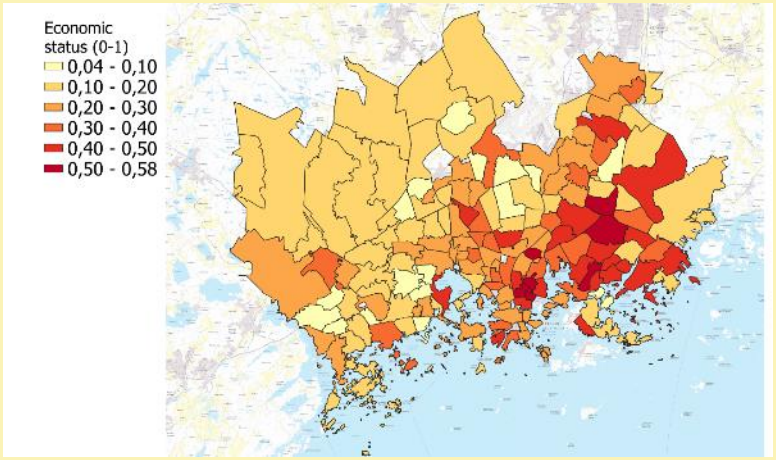


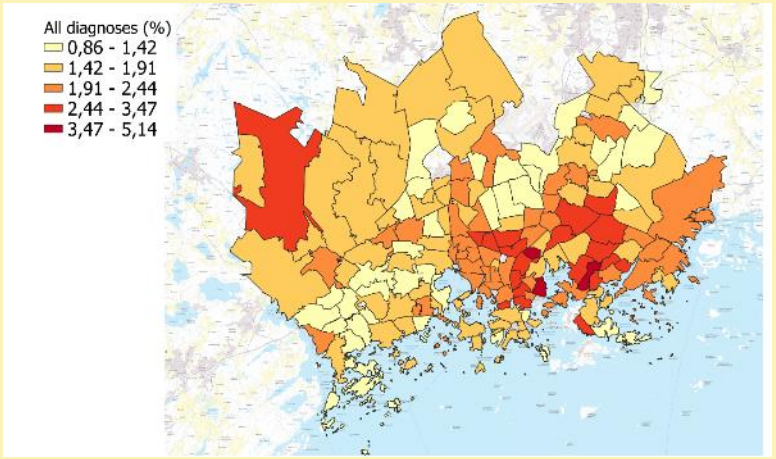


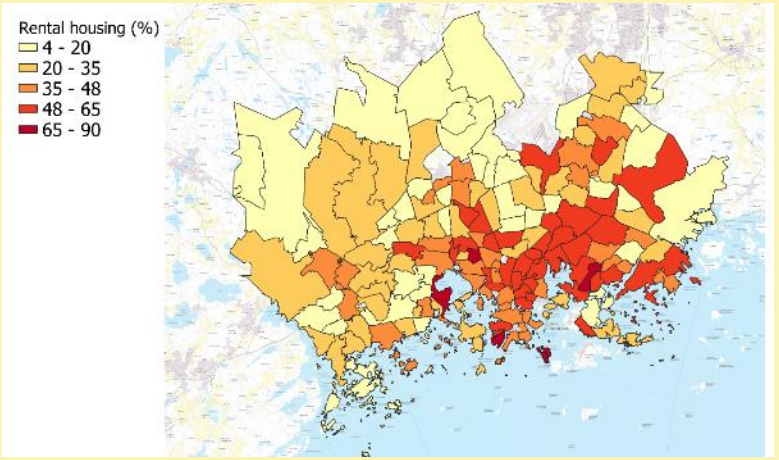
Source: FOLK database - acknowledgements: R. Astone, THL & C. Hakulinen, HY

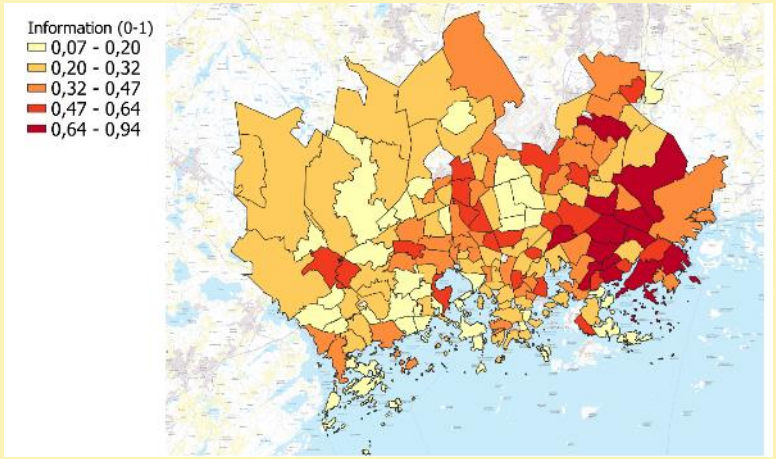
Heat risk in Helsinki Metropolitan area

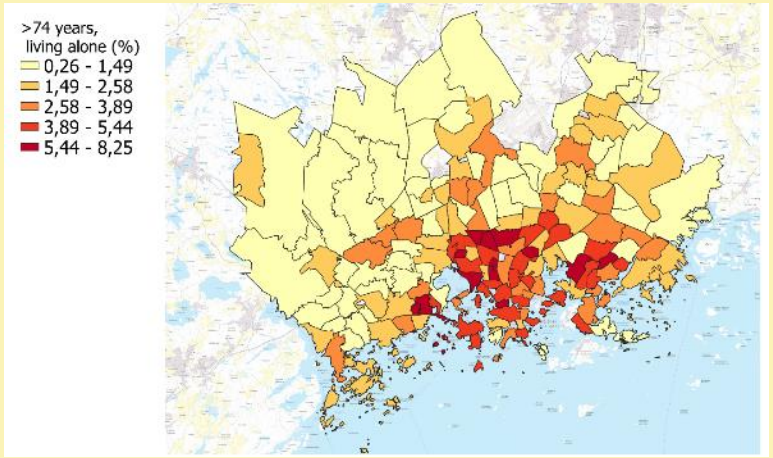
Vulnerability indicators

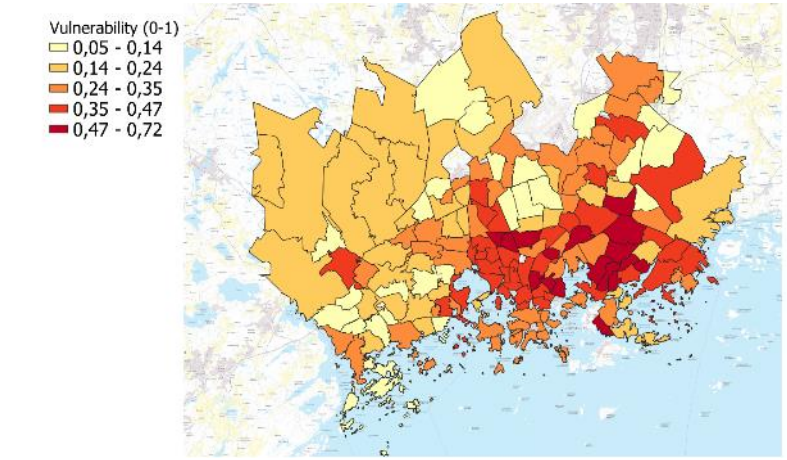








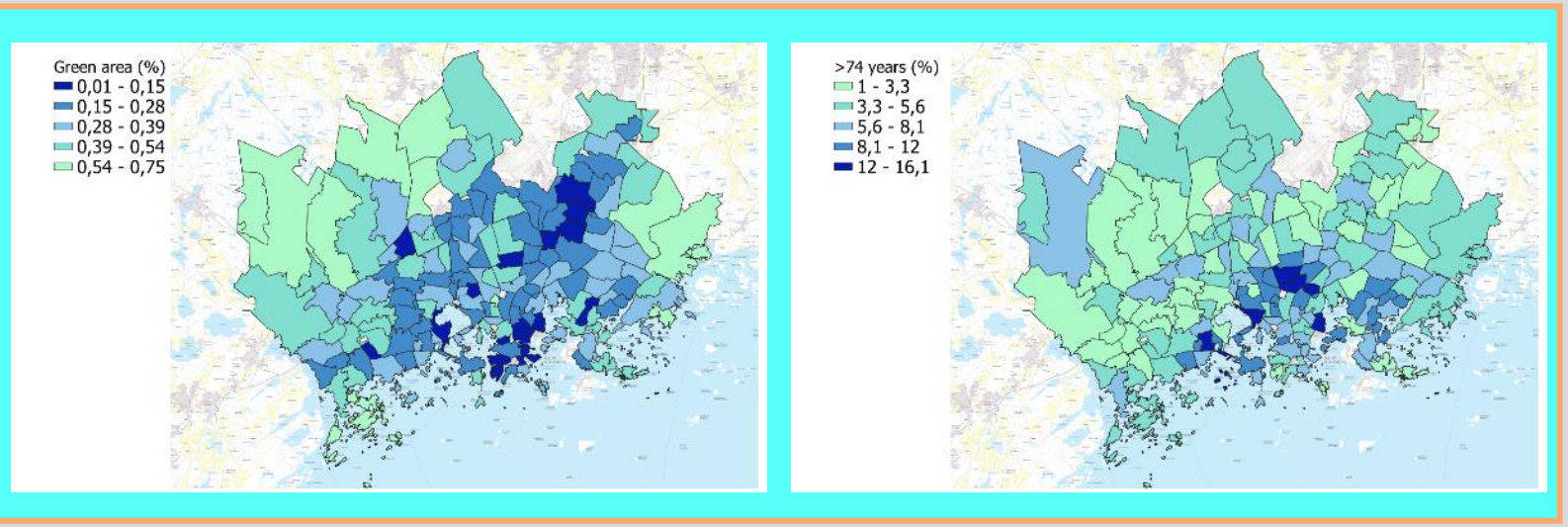


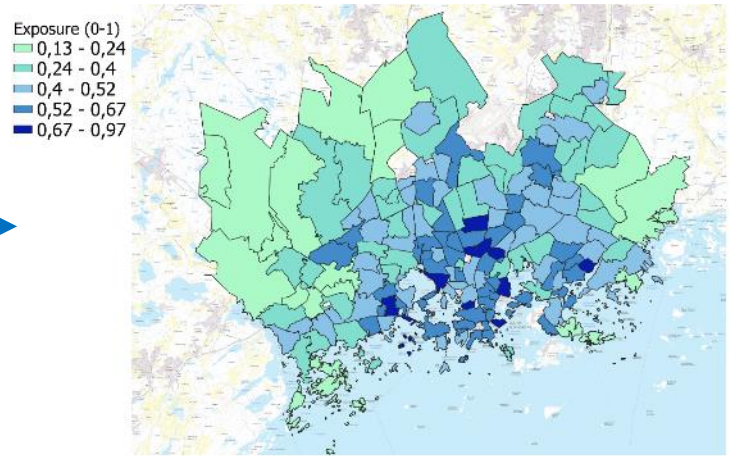


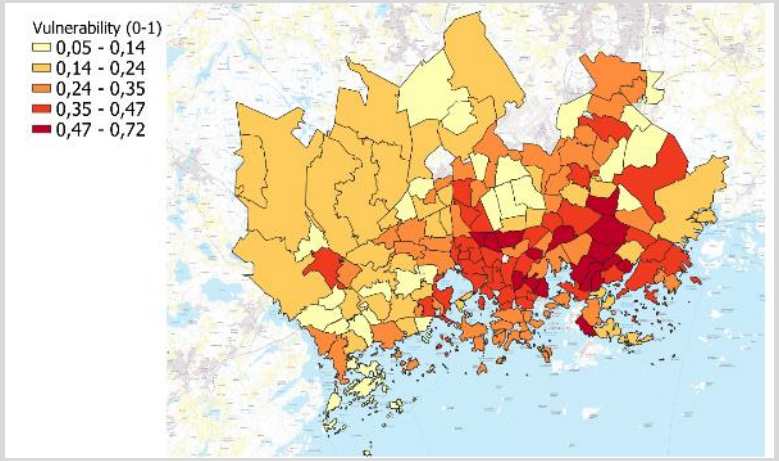
Source: FOLK database - acknowledgements: R. Astone, THL & C. Hakulinen, HY

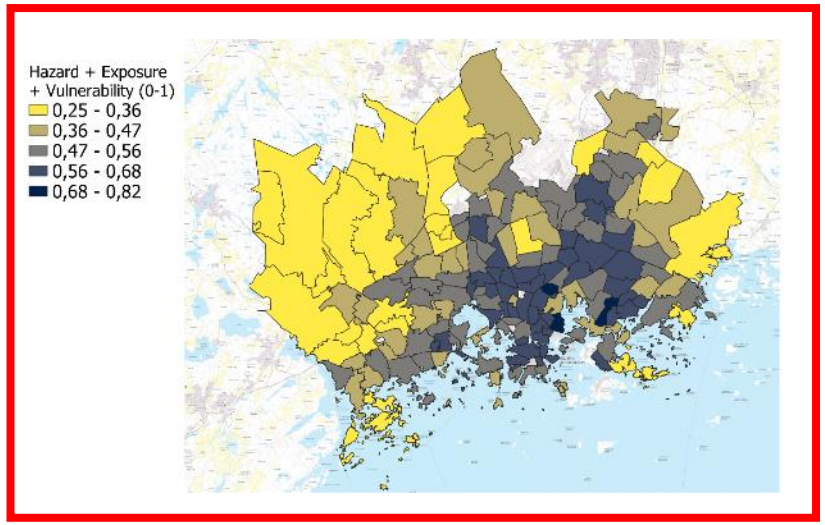
Heat risk in Helsinki Metropolitan area

Vulnerability









Sources: FOLK database: (R. Astone, THL, C. Hakulinen, HY) except for Green area: Corine 2018 (Syke) & Surface temperature: Landsat-8 (Syke)

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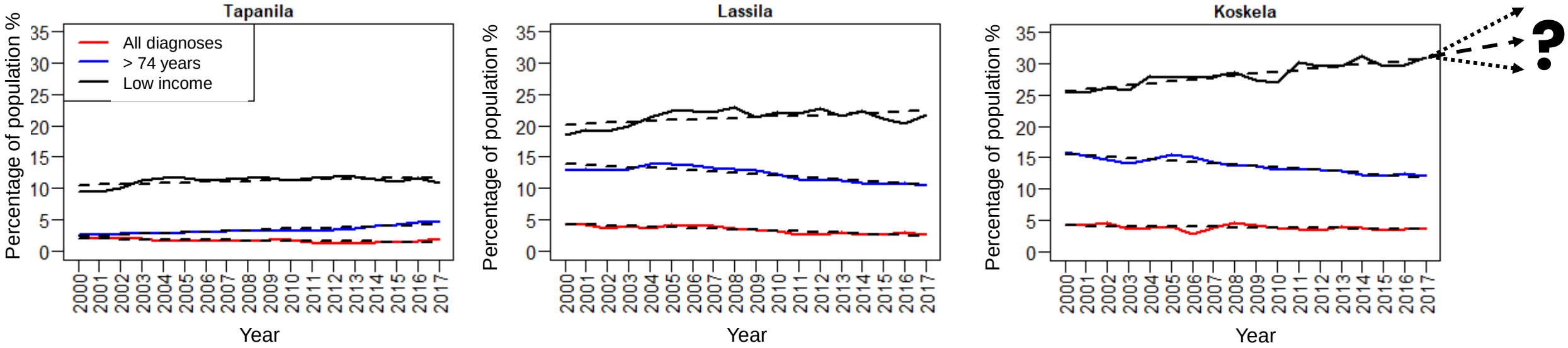
Temporal trends to inform future projections of heat risk



Source: FOLK database - acknowledgements: R. Astone, THL & C. Hakulinen, HY

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Helsinki case study of climate change risks to health

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- Maps of long term means and observed trends of indicators; standardised and combined into risk indices
- Projecting selected indicators to the future to represent future heat risk under climate and socio-economic changes

Stakeholder engagement

Series of workshops with **City of Helsinki, Climate unit and SoTePe** (Social Services, Health Care and Rescue Services Division)

- May 2023 – *Helteiden terveysvaikutukset ja niihin varautuminen muuttuvassa ilmastossa - Tietoiskuja tutkimuksesta*
  - health impacts of heat stress, urban heat island (UHI), social vulnerability
  - Cross-disciplinary workshop (City of Helsinki, Climate Unit; SoTePe personnel, researchers from Syke and FMI)
- Oct 2023 – *Miten luodaan hyvinvoivaa elinympäristöä kaupunkilaisille?*
  - Heat risks and links to urban planning and buildings from design and maintenance to adaptation
  - Cross-disciplinary workshop – also HKI units for urban planning and building engaged
- Spring 2024 (under planning) – mental health

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Syke Publications

Peer reviewed publications that acknowledge CHAMPS

Fronzek S, Honda Y, Ito A, Nunes JP, **Pirttioja** N, Räisänen J, Takahashi K, **Terämä** E, Yoshikawa M, **Carter** TR, 2022. Estimating impact likelihoods from probabilistic projections of climate and socio-economic change using impact response surfaces. *Climate Risk Management*, 38, https://doi.org/10.1016/j.crm.2022.100466

O'Neill BC, **Carter** TR, Ebi K, Harrison PA, Kemp-Benedict E, Kok K, Kriegler E, Preston BL, Riahi K, Sillmann J, van Ruijven BJ, van Vuuren D, Carlisle D, Conde C, Fuglestvedt J, Green C, Hasegawa T, Leininger J, Monteith S, Pichs-Madruga R, 2020. Achievements and needs for the climate change scenario framework. *Nature Climate Change*, 10: 1074-1084, https://doi.org/10.1038/s41558-020-00952-0

In preparation

Lipsanan A, et al., (in prep.) Socioeconomic narratives for future Finnish health and social welfare to inform climate change adaptation.

Non-refereed publications that acknowledge CHAMPS

Burenby L, Partonen T, **Carter** TR, Ruuhela R, Halonen J, 2021. Climate change and mental health. Finnish Institute for Health and Welfare (THL), *Discussion paper 32/2021*, 20 pp. Helsinki, Finland, https://www.julkari.fi/handle/10024/143459

Carter TR, 2021 (Ed.) *Scenarios for Climate Change and Health Analysis in Finland: Report of the CLIHE Virtual Workshop on Scenario Co-ordination*, 16 December 2020, Climate Change and Health Academy Programme (CLIHE), 13 pp. https://www.syke.fi/projects/champs

Carter TR, **Lipsanen** A, Ruuhela R, 2020. Socioeconomic scenarios for health and social welfare in a changing climate: Progress since the PLUMES Scenarios Workshop, May 2019. *CHAMPS Information Sheet No. 1*, CHAMPS (Climate change and Health: Adapting to Mental, Physical and Societal challenges), 4pp. https://www.syke.fi/projects/champs

Lipsanen A, **Carter** TR, Ruuhela R, **Fronzek** S, Kollanus V, Koskela I.-M, Mäkelä M. Mäkinen K, Meriläinen P, Parry M, Saikkonen P, Suomela T, Terämä E, 2020. Socioeconomic narratives for future Finnish health and social welfare to inform climate change adaptation. *Strategic Research Scientific Conference 2020: Preparing for the future: analyzing and identifying responses to societal challenges using scenarios and other tools for future scanning*, October 7-8 2020, Helsinki, Finland, https://drive.google.com/file/d/1WCuawGF9dtd4ryU9PcYU0dru9dpFkIHV/view?usp=sharing, [Extended abstract]

Ruuhela R, **Carter** TR, Rantanen M, Polade S, **Lipsanen** S, Jylhä K, Laurila TK, Luomaranta A, **Fagerström** S, Luhtala S, Gregow H, 2023. Ilmasto- ja sosioekonomiset skenaariot ilmastonmuutokseen sopeutumisen suunnittelussa (Climate and socioeconomic scenarios for climate change adaptation planning), *Publications of the Ministry of Agriculture and Forestry 2023:4*, Ministry of Agriculture and Forestry, 43 pp. (in Finnish with English summary). https://julkaisut.valtioneuvosto.fi/handle/10024/164670

Other climate & health-related publications

Ringsmuth AK, Otto IM, van den Hurk B, Lahn G, Reyer CPO, **Carter** TR, Magnuszewski P, Monasterolo M, Aerts JCJH, Benzie M, Campiglio E, **Fronzek** S, Gaupp F, Jarzabek L, Klein RJT, Knaepen H, Mechler R, Mysiak J, Sillmann J, Stuparu D, West C, 2022. Lessons from COVID-19 for managing transboundary climate risks and building resilience. *Climate Risk Management*, 35, https://doi.org/10.1016/j.crm.2022.100395.

van den Hurk B, Otto IM, Reyer CPO, Aerts J, Benzie M, Campiglio E, **Carter** TR, **Fronzek** S, Gaupp F, Jarzabek L, Klein RJT, Knaepen H, Lahn G, Mechler R, Monasterolo I, Mysiak J, Shepherd TG, Sillmann J, Stuparu D, West C, 2020. *What can COVID-19 teach us about preparing for climate risks in Europe?* Policy Brief, RECEIPT and CASCADES projects. https://www.cascades.eu/wp-content/uploads/2020/11/Cascades-Combined-file.pdf

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