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# A Targeted Approach for Heat Illness Prevention

## Mapping High-Risk Population at 1 km-Grid Resolution and Policy Implications for Adaptation in Japan

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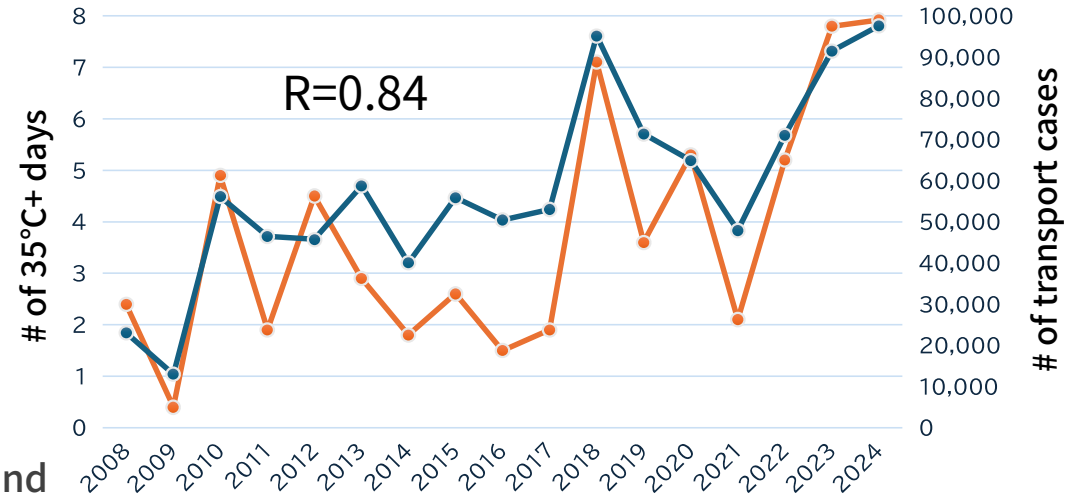
# 1. Background

# Heat Illness: A growing public health threat in Japan

- Annual mortality often exceeds 1,000 —2,000 in 2024— surpassing deaths from natural disasters (100–200).
- Emergency transports are nearing 100,000 in recent years.
- The risk is to intensify due to rising temperatures and aging.

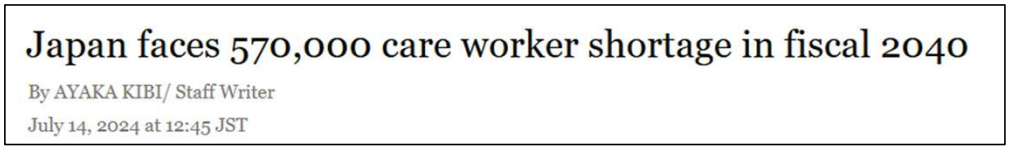



The number of 35°C+ days and transport cases (2008–2024)

Source: JMA[1], JMA[2], FDMA[3]

# Who and where needs help?

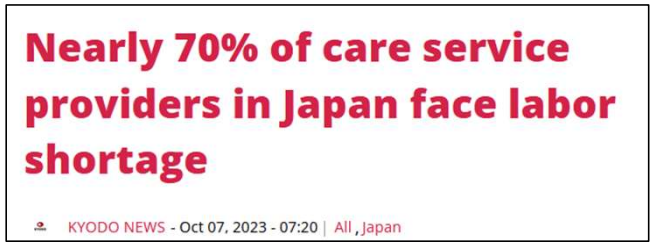
- Japan faces one of the highest aging rates in the world (30% of 65+ population) and a severe shortage of care workers.


Japan faces 570,000 care worker shortage in fiscal 2040

By AYAKA KIBI/ Staff Writer

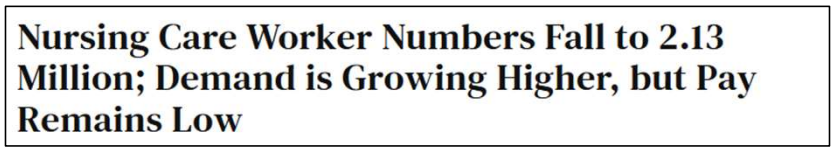
July 14, 2024 at 12:45 JST

Source: Asahi Shimbun (2024/7/14)


Nearly 70% of care service providers in Japan face labor shortage

KYODO NEWS - Oct 07, 2023 - 07:20 | All , Japan

Source: Kyodo News (2023/10/7)


Nursing Care Worker Numbers Fall to 2.13 Million; Demand is Growing Higher, but Pay Remains Low

Source: The Japan News (2025/3/19)

- High-resolution mapping of heat illness risk is urgently needed to identify vulnerable populations, yet most existing studies remain at the prefectural level.

# Objectives of this study

① AREP Mapping 

- Identify at-risk elderly populations (AREP) at 1 km-grid resolution.

  *Using region-specific thresholds or WBGT ≥ 33°C .

② Heat Stress Exposure 

- Estimate cumulative exposure under current & future climates.

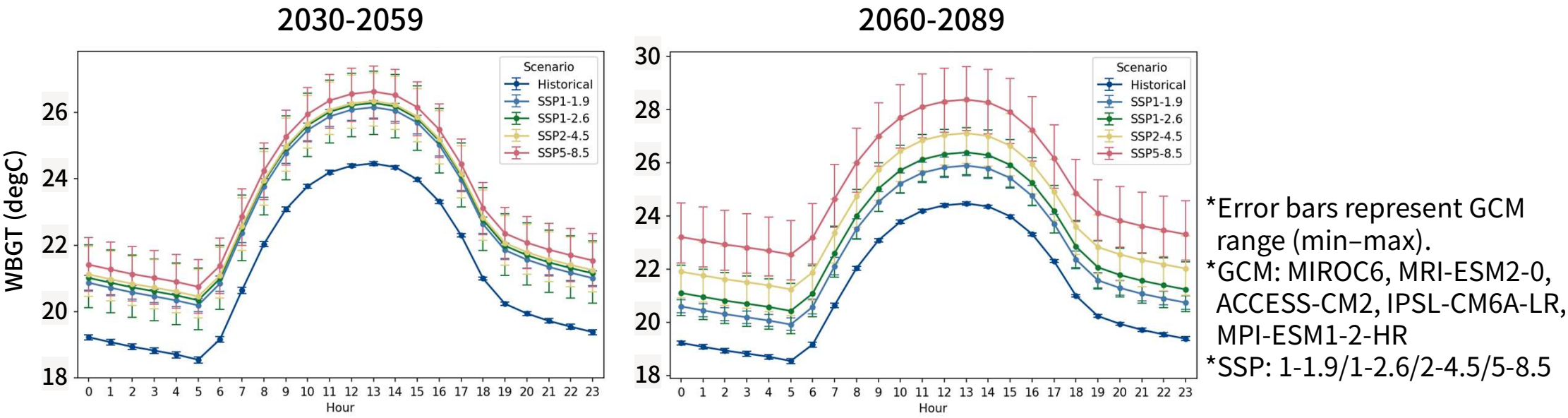
③ Intervention Costs 

- Assess costs of AC installation & electricity subsidies.

# 2. Key results

# WBGT under future climate scenarios

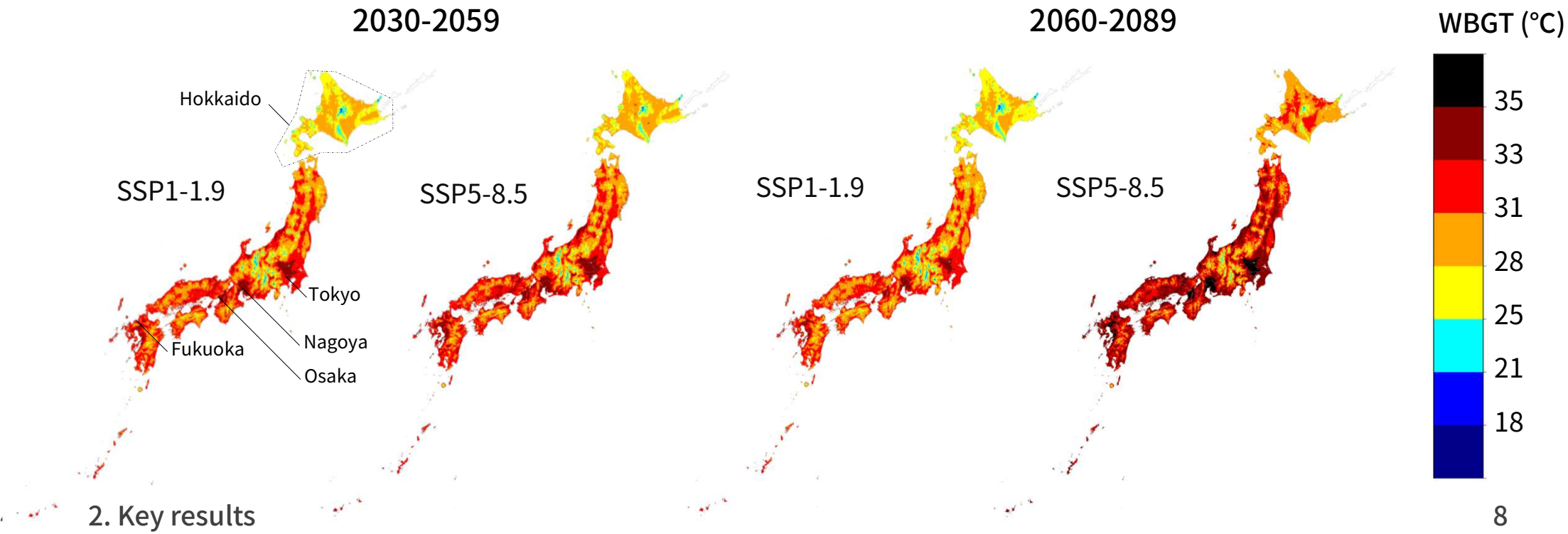
- We projected future WBGT using the ML model (gb-linear[4]: $R^2$=0.96, MAE=0.96°C) and CMIP6-based dataset (NIES2020[5]).
- Diurnal variation of WBGT in August (Japan, GCMs mean)
  - Notably increased under high emission scenarios in 60s–80s, peaks around 13:00.




*Error bars represent GCM range (min–max).
*GCM: MIROC6, MRI-ESM2-0, ACCESS-CM2, IPSL-CM6A-LR, MPI-ESM1-2-HR
*SSP: 1-1.9/1-2.6/2-4.5/5-8.5

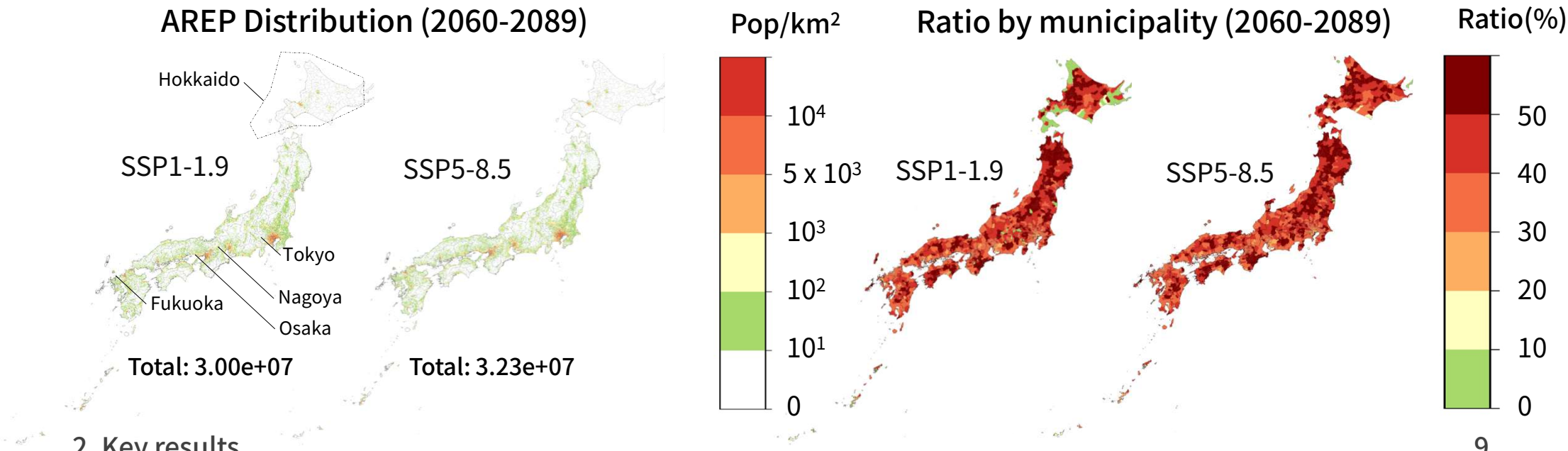
# WBGT under future climate scenarios

- Spatial WBGT distribution in August (GCMs mean, 13:00, monthly max)
  - Higher in urban and low-latitude areas. Many areas may exceed 35°C.



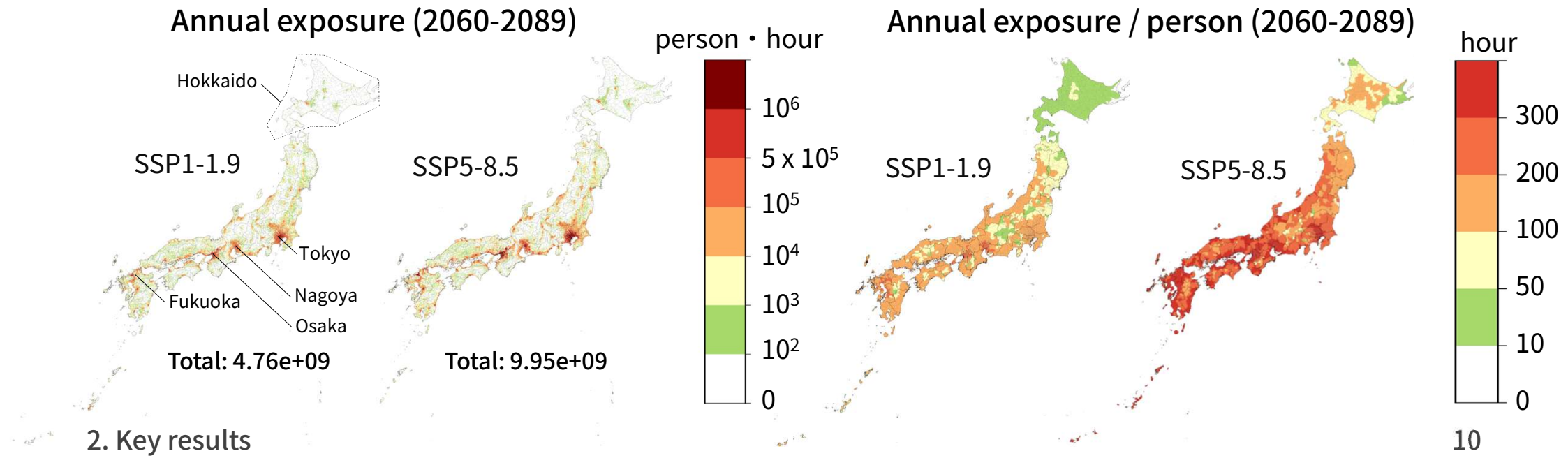
# At-Risk Elderly Population (AREP) distribution

- Mainly concentrated in major urban areas.
- AREP: 30 million (SSP1-1.9) to 32 million (SSP5-8.5) in 60s to 80s.
- AREP ratios: Over 40–50% will be widely distributed across Japan.



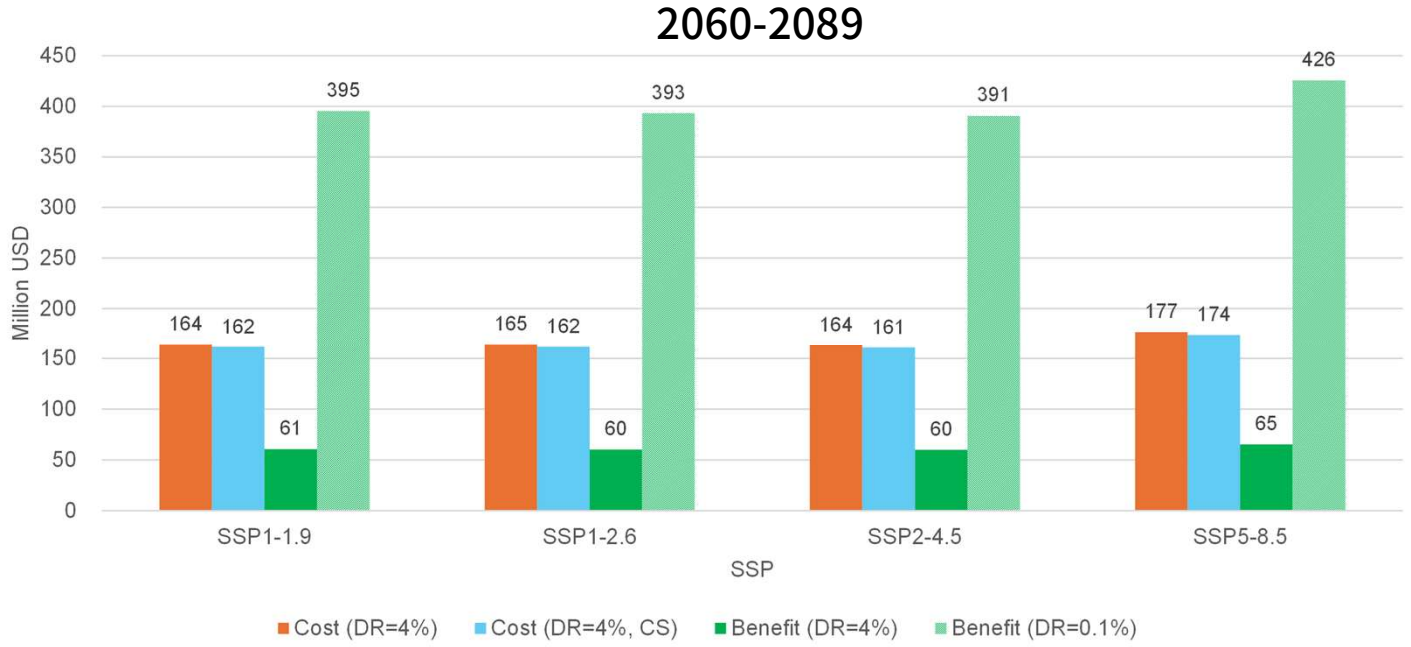
# Heat stress exposure (potential cumulative exposure)

- 4.8 billion (SSP1-1.9) to 10.0 billion (SSP5-8.5) in 2060–2089.
- Annual exposure per person increases from ~200 hours (SSP1-1.9) to 300+ hours (SSP5-8.5), especially in southern regions.



# Intervention costs (AC and electricity subsidy for AREP)

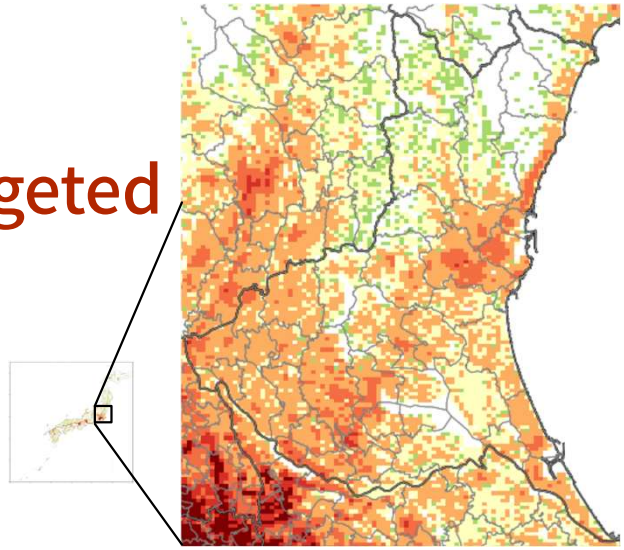
- 164 million (SSP1-1.9) to 177 million USD/year (SSP5-8.5), prominent in Hokkaido region, where AC ownership is low (40%).
- Costs were outweighed by benefits only when a low discount rate of 0.1% for health impacts (4% for costs).



# 3. Discussion

# Key Findings & Policy Implications

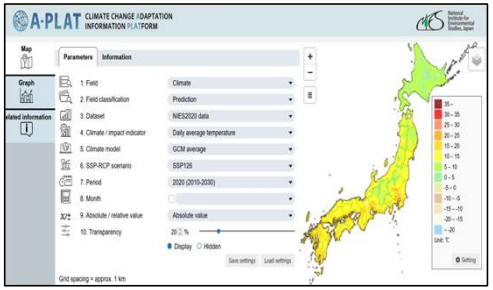
- Our high-resolution projections support targeted interventions for 10–32 million AREP across Japan.
- Intervention costs are hard to justify under conventional discount rates—ethical considerations for future gens are needed.
- Integrating more sustainable solutions (other than AC) is also essential.



Heat exposure distribution in Prefecture level

# Future Directions

- Enhance accessibility via public online GIS system “Climate & Impact Atlas” (planned on April 2026; data already available on repository).
- Prioritize regions based on local capacity and develop tailored strategies on field.
- Expand focus to other vulnerable groups (e.g. infants, youth) and other countries/regions.



# Kia ora & Thank you

*For more details, please refer to our recently-published paper.
*Nationwide High-Resolution Heat Risk Projections and Intervention Cost Analysis for the Elderly in Japan Under Climate and Demographic Changes*

# References


1. Japan Meteorological Agency. Changes in Extreme Phenomena Such as Heavy Rainfall and Extreme Heat Days (*in Japanese*).
2. Japan Meteorological Agency. Number of extremely hot days, midsummer days, etc. in 2024 (*in Japanese*).
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4. Chen T. and Guestrin C. (2016), XGBoost: a scalable tree boosting system. Proc. ACM SIGKDD Int. Conf. on Knowledge Discovery and Data Mining, vol. 13–17 (Association for Computing Machinery), pp 785–94.
5. Ishizaki N. (2021), Bias corrected climate scenarios over Japan based on CDFDM method using CMIP6, Ver.1.2, (2021). https://doi.org/10.17595/20210501.001
6. Oyama T. (2025), Projected high-resolution hourly wet-bulb globe temperature, population heat exposure, and adaptation costs in Japan, ver. 1.0, NIES, https://doi.org/10.17595/20250718.001