

# Kako klimatske promjene mogu modificirati uvjete za rad na otvorenom?

Lidija Srnec

[lidija.srnec@cirus.dhz.hr](mailto:lidija.srnec@cirus.dhz.hr)

# Izvješće o stanju globalne klime 2025:

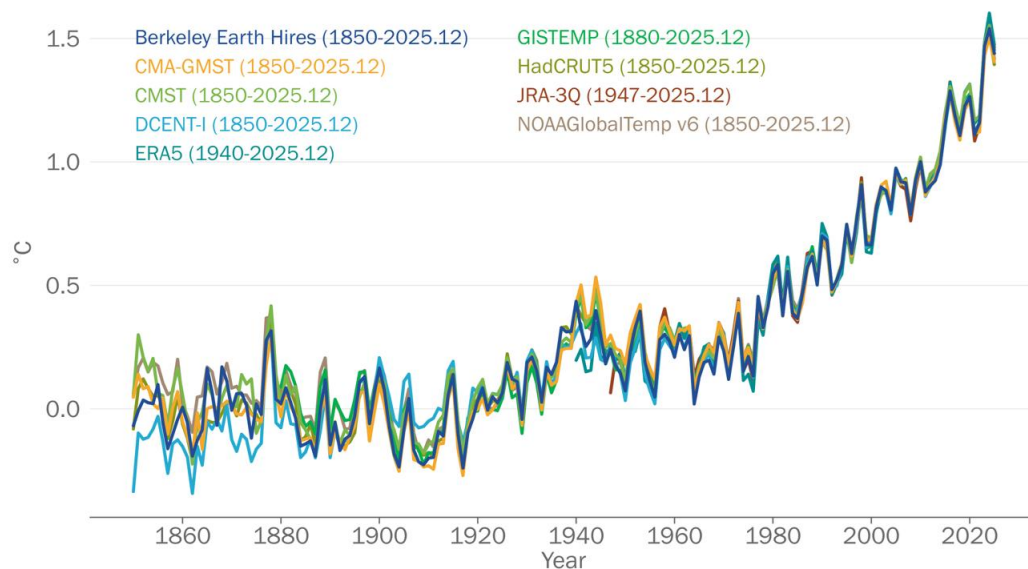
<https://youtu.be/Onz-cMFdgRs?si=h1OBO4nxXf7MSY1x>

## Ključne poruke:

- razdoblje od 2015. do 2025. bilo je najtoplijih 11 godina u povijesti mjerenja
- energetska neravnoteža na Zemlji najveća je u posljednjih 65 godina
- ocean već dva desetljeća apsorbira oko osamnaest puta više energije nego što ljudi godišnje koriste
- ekstremni vremenski uvjeti utječu na milijune i koštaju milijarde

## Global mean temperature 1850-2025

Difference from 1850-1900 average

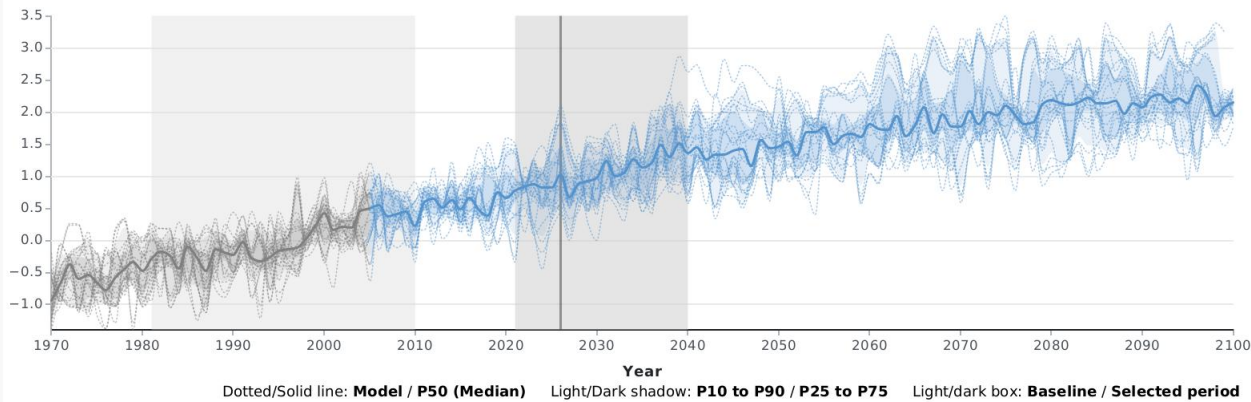


# Regionalne promjene i projekcije za buduću klimu:

MEAN OF DAILY MEAN TEMPERATURE (°C) - CORDEX-EUR-11 -  
CHANGE - REL. TO 1981-2010 - RCP4.5 - NEAR TERM (2021-2040)  
- ANNUAL FOR MEDITERRANEAN, WEST&CENTRAL-EUROPE AND N.  
EUROPE



Credit: C35/ECMWF. Atlas version 2.3



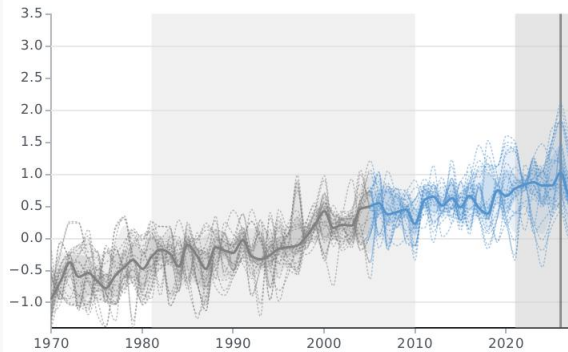
Slika 1. Odstupanja godišnje temperature zraka u povijesnoj i budućoj klimi uz primjenu RCP4.5 scenarija za Europu u odnosu na razdoblje 1981.–2010. Izvor: <https://atlas.climate.copernicus.eu/atlas>

# Regionalne promjene i projekcije za buduću klimu:

MEAN OF DAILY MEAN TEMPERATURE (°C) - CORDEX-EUR-11 -  
CHANGE - REL. TO 1981-2010 - RCP4.5 - NEAR TERM (2021-2040)  
- ANNUAL FOR MEDITERRANEAN, WEST&CENTRAL-EUROPE AND N.  
EUROPE



Credit: C3S/ECMWF. Atlas version 2.3



Dotted/Solid line: Model / P50 (Median) Lic



PROGRAMME OF  
THE EUROPEAN UNION

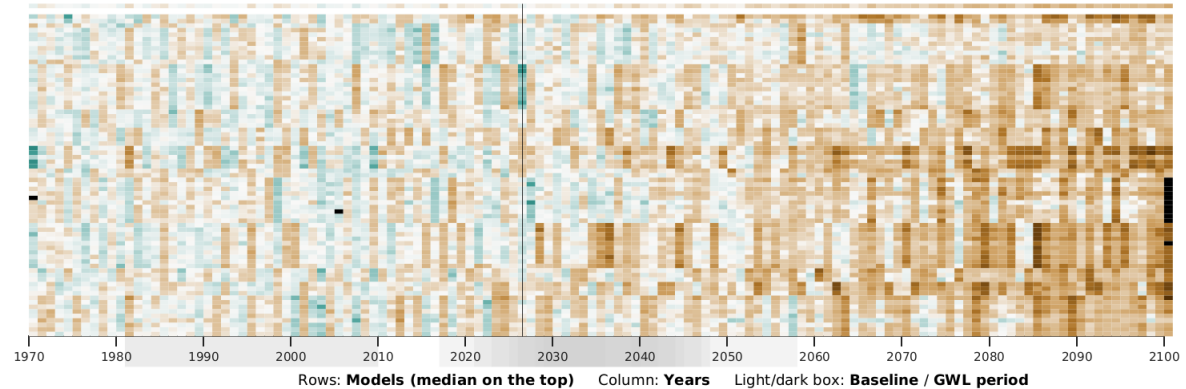


Slika 1. Odstupanja godišnje temperature RCP4.5 scenarija za Europu u <https://atlas.climate.copernicus.eu/atlas>

MEAN OF DAILY ACCUMULATED PRECIPITATION (%) - CORDEX-EUR-11 -  
RELATIVE CHANGE - REL. TO 1981-2010 - WARMING 2°C -  
ANNUAL FOR MEDITERRANEAN



Credit: C3S/ECMWF. Atlas version 2.3



Rows: Models (median on the top) Column: Years Light/dark box: Baseline / GWL period



PROGRAMME OF  
THE EUROPEAN UNION

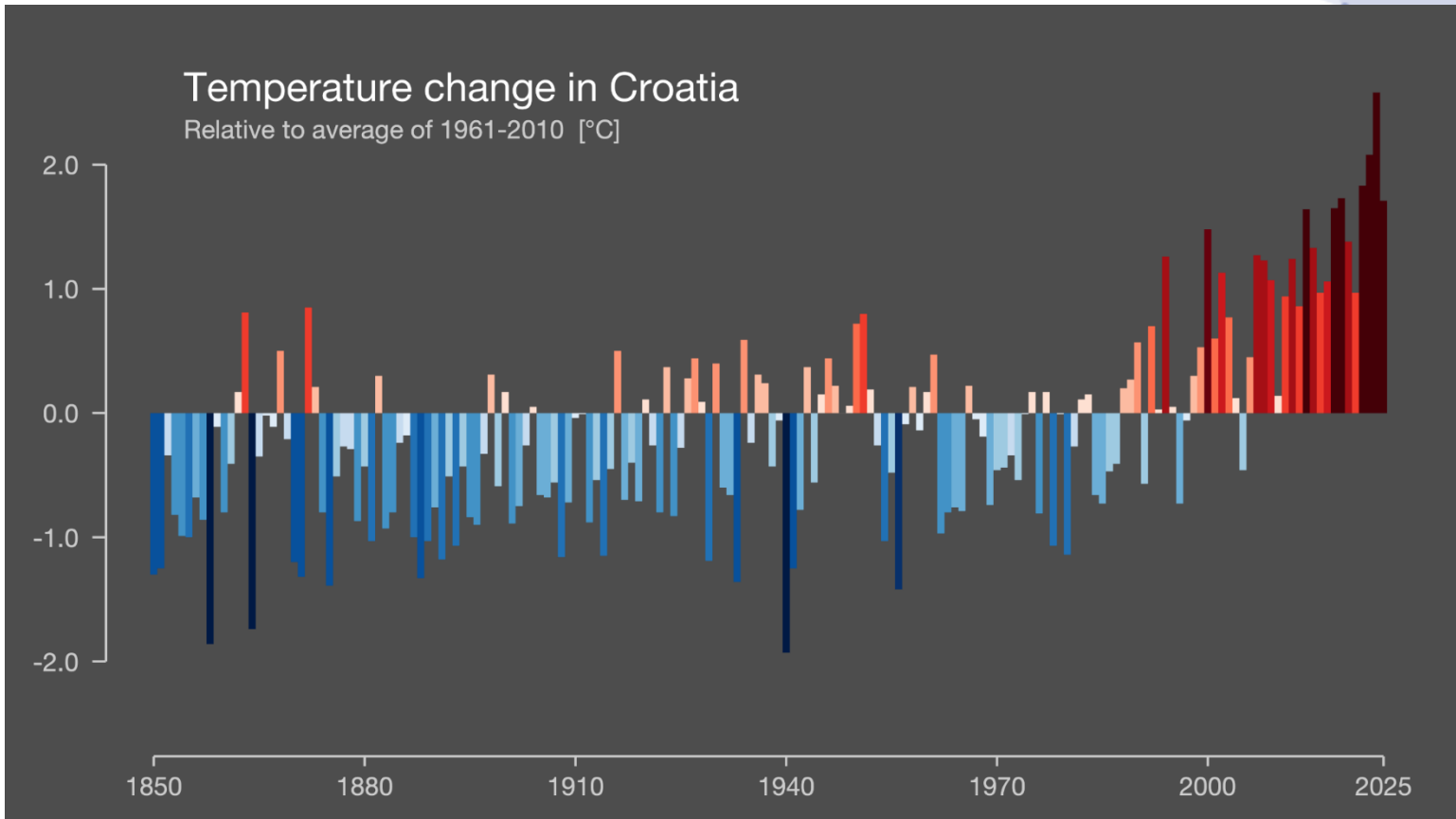


IMPLEMENTED BY



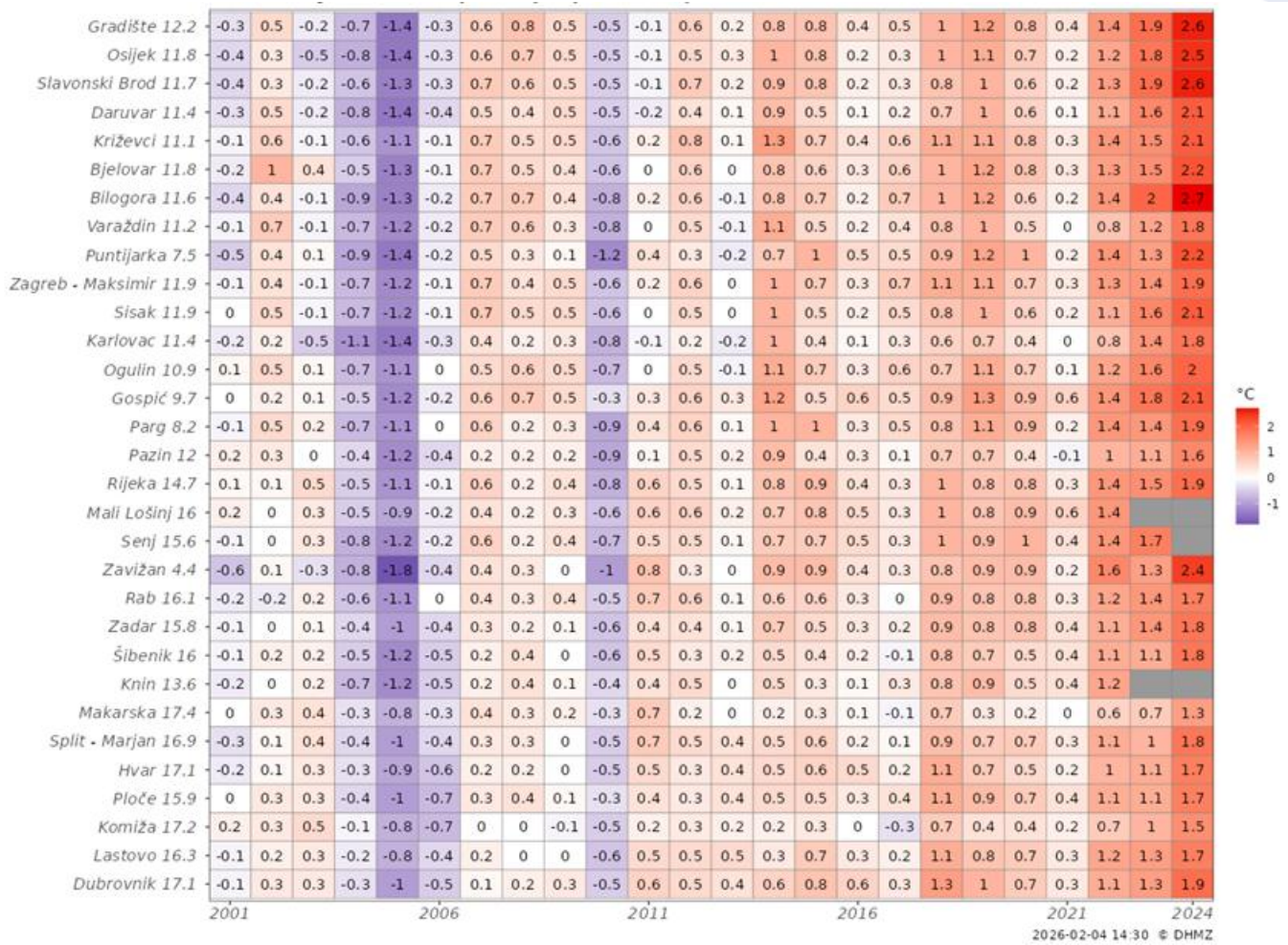
Slika 2. Relativna promjena dnevne količine oborine u povijesnoj i budućoj klimi uz primjenu RCP4.5 scenarija u Sredozemlju u odnosu na razdoblje 1981.–2010. Izvor: <https://atlas.climate.copernicus.eu/atlas>

# Promjene u Hrvatskoj:



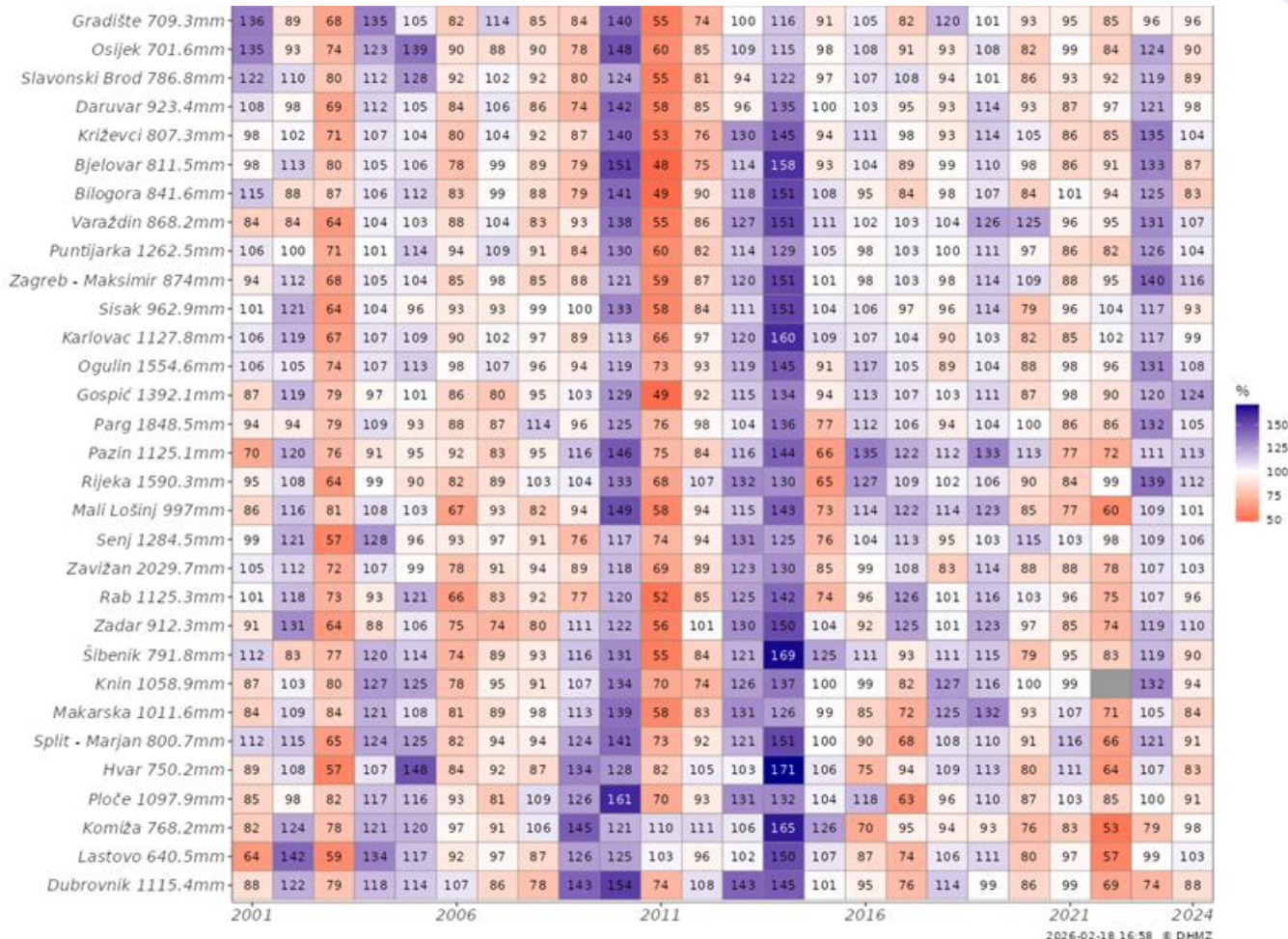
Izvor: <https://showyourstripes.info/c/europe/croatia/all>

# Promjene godišnje temperature u Hrvatskoj:



Odstupanja srednje godišnje temperature zraka [°C] od prosjeka razdoblja 1991. – 2020. tijekom 2001. – 2024. Prosječna godišnja temperatura zraka u razdoblju 1991. – 2020. naznačena je brojem kraj naziva meteorološke postaje. Izvor: [https://klima.hr/razno/publikacije/2026\\_Doprinos\\_izradi\\_gizvjescia\\_stanje\\_okolisa\\_RH2021–2024\\_v2.pdf](https://klima.hr/razno/publikacije/2026_Doprinos_izradi_gizvjescia_stanje_okolisa_RH2021–2024_v2.pdf)

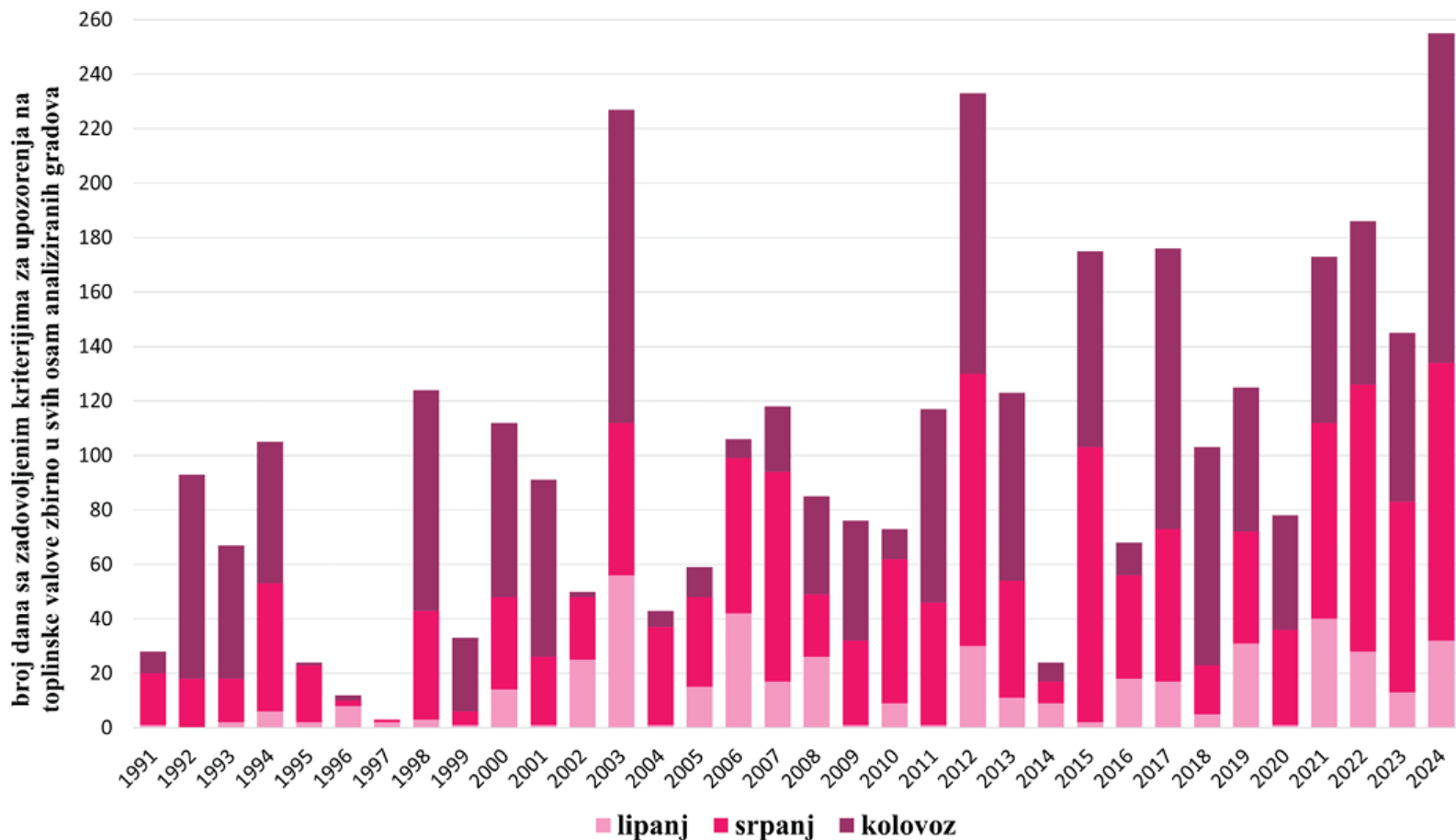
# Promjene godišnje oborine u Hrvatskoj:



Odstupanja godišnje količine oborine od prosjeka razdoblja 1991. – 2020. tijekom 2001. – 2024. Prosječna godišnja količina oborine u razdoblju 1991. – 2020. naznačena je brojem kraj naziva meteorološke postaje.

Izvor: [https://klima.hr/razno/publikacije/2026\\_Doprinos\\_izradi\\_gizvjescia\\_stanje\\_okolisa\\_RH2021-2024\\_v2.pdf](https://klima.hr/razno/publikacije/2026_Doprinos_izradi_gizvjescia_stanje_okolisa_RH2021-2024_v2.pdf)

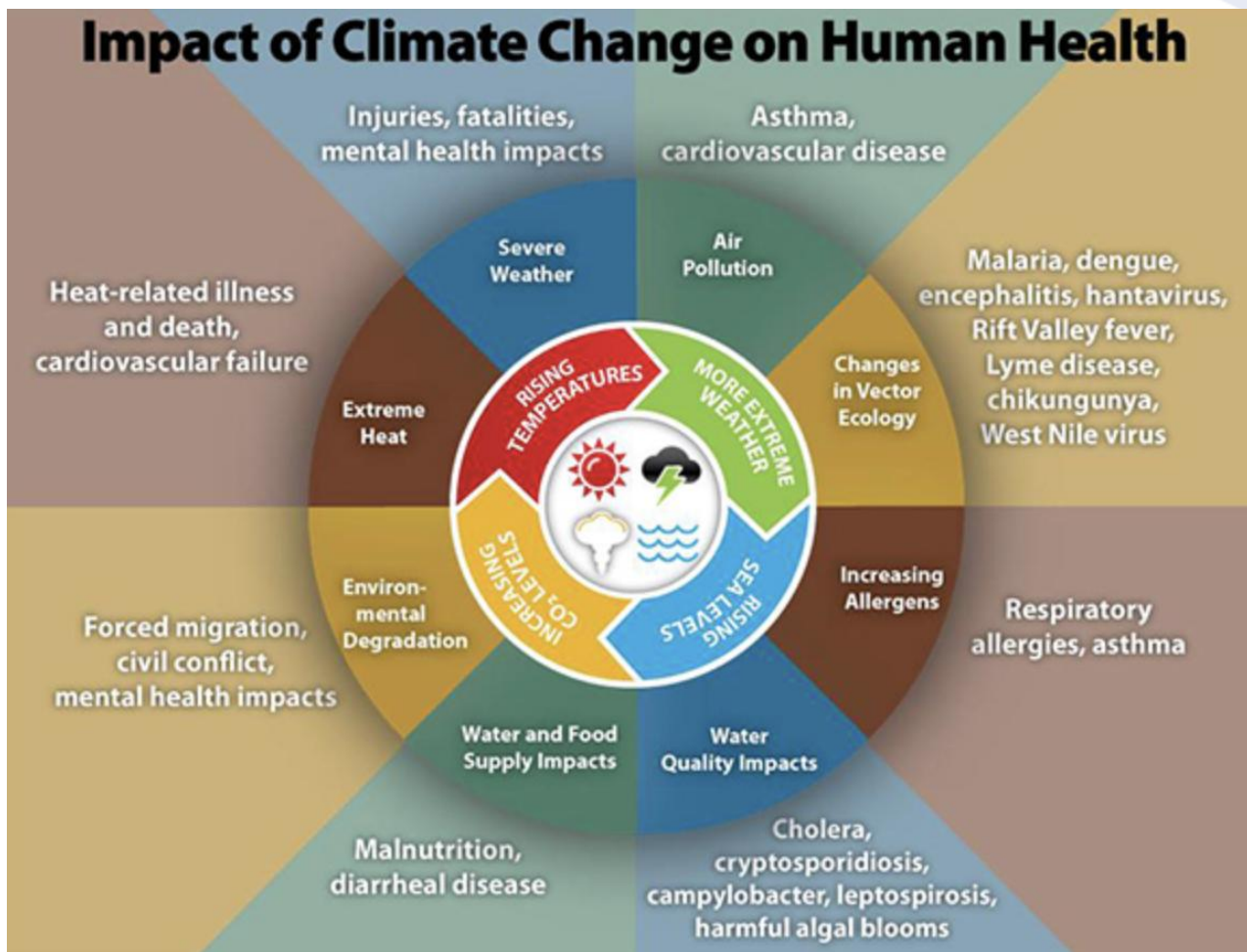
# Broj dana s rizikom od vrućina u osam gradova u Hrvatskoj, razdoblje 1991-2024



Izvor: DHMZ, 2024, Prikazi

[https://klima.hr/razno/publikacije/prikazi/prikazi\\_36\\_2024.pdf](https://klima.hr/razno/publikacije/prikazi/prikazi_36_2024.pdf)

# Utjecaj klimatskih promjena na ljudsko zdravlje



Source: [https://www.weforum.org/agenda/2023/11/health-day-climate-change-impacts-health-cop28/?utm\\_content=14%2F11%2F2023+18%3A45&utm\\_medium=social\\_scheduler&utm\\_source=linkedin&utm\\_term=COP28](https://www.weforum.org/agenda/2023/11/health-day-climate-change-impacts-health-cop28/?utm_content=14%2F11%2F2023+18%3A45&utm_medium=social_scheduler&utm_source=linkedin&utm_term=COP28)

# IPCC AR6 Climate Change 2022: Impacts, Adaptation and Vulnerability

(<https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/>)

## Sadašnji i budući utjecaj ekstremnih vrućina na ljudsko zdravlje:

1. Vrućine predstavljaju velik rizik za zdravlje
2. Klimatske promjene signifikantno povećavaju izloženost toplinskim valovima
3. Pojedine skupine su suočene s nerazmjerno visokim rizikom od ekstremnih vrućina
4. Porast stanovništva u tropskim i subtropskim regijama uskoro će doprinijeti velikim geografskim razlikama u smrtnosti uzrokovanoj vrućinama
5. **Utjecaj topline na radnu učinkovitost i BDP izaziva sve veću zabrinutost**
6. **Utjecaj urbanog toplinskog otoka će povećati toplinski rizik u gradovima**
7. Ekstremne vrućine pogoršavaju utjecaj COVID-19 pandemije
8. **Akcijski planovi za zaštitu od vrućina koji uključuju sustave ranog upozorenja i zaštite, važna su rješenja prilagodbe**
9. Dugoročno urbanističko planiranje i projektiranje mogu upotpuniti kratkoročne odgovore na zdravstvene rizike od vrućina
10. Višesektorski pristupi će doprinijeti dugoročnim odgovorima na zdravstvene rizike od vrućina

# Utjecaj klimatskih promjena na sigurnost i zdravlje na radu:

## Porast temperature

- Ekstremne vrućine mogu uzrokovati umor, dehidraciju, pogoršanje kroničnih bolesti i teške toplinske bolesti.
- Fizički rad povisuje tjelesnu temperaturu, dok toplinski stres narušava prosudbu i povećava rizik od nesreća.
- Loš oporavak između smjena, posebno kada radnici žive u nedovoljno hladjenim domovima, dodatno opterećuje.

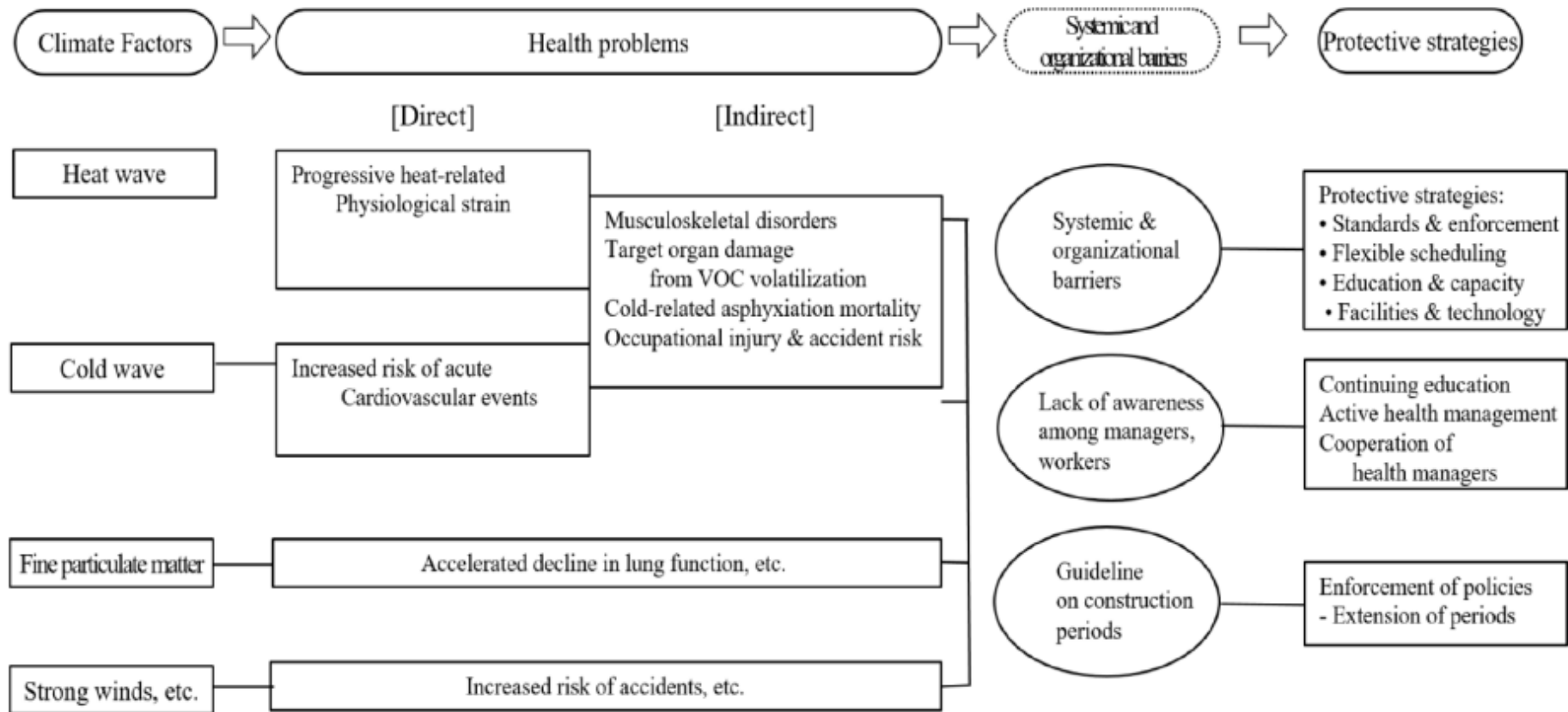
## Ekstremni vremenski događaji

- Porast broja i intenziteta poplava i šumskih požara dovodi do većeg broja ozljeda i smrtnih slučajeva.
- Teški vremenski uvjeti mogu povećati rizik od utapanja, opekline ili ozeblina. Radnici hitnih službi suočavaju se s dodatnim rizicima od otrovnih plinova, eksplozija i opasnosti od požara.

## Zagađenje zraka

- Povišeno onečišćenje zraka i rastuće razine aeroalergena (npr. više razine ili povećana alergenost peludi), zbog klimatskih promjena u kombinaciji s drugim čimbenicima, povećavaju rizik od respiratornih bolesti i drugih zdravstvenih problema

# Utjecaj klimatskih promjena na sigurnost i zdravlje na radu:

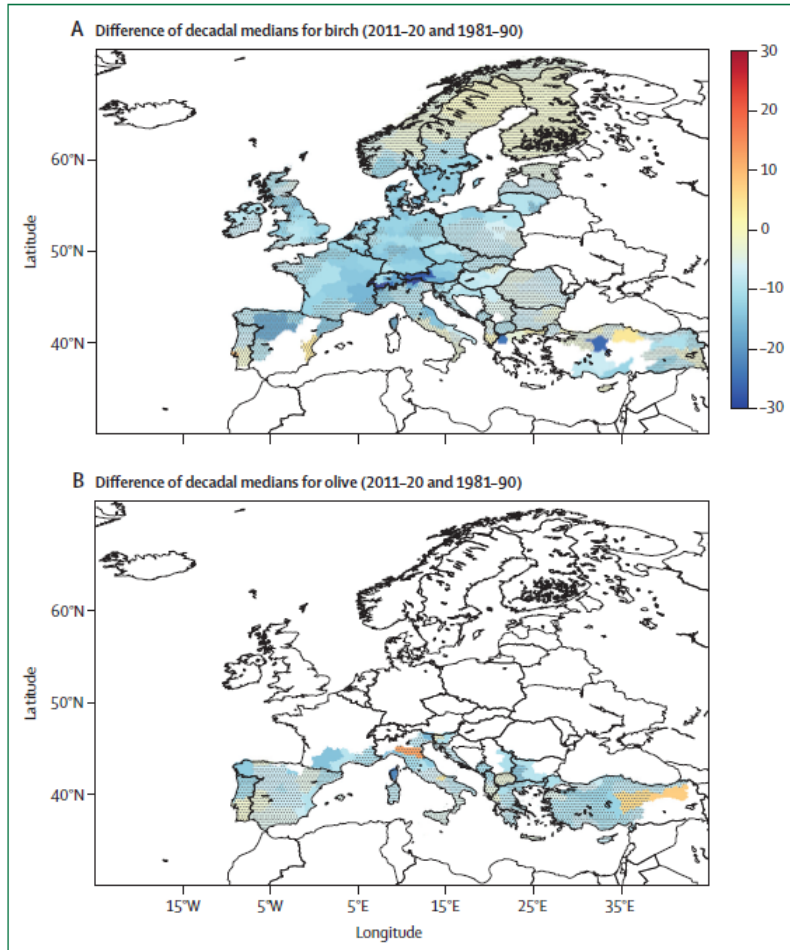


**Izvor:** Baek, S., Choi, EH. Climate change health risks and workplace protective strategies for construction workers. *Sci Rep* 16, 3423 (2026). <https://doi.org/10.1038/s41598-025-33471-z>

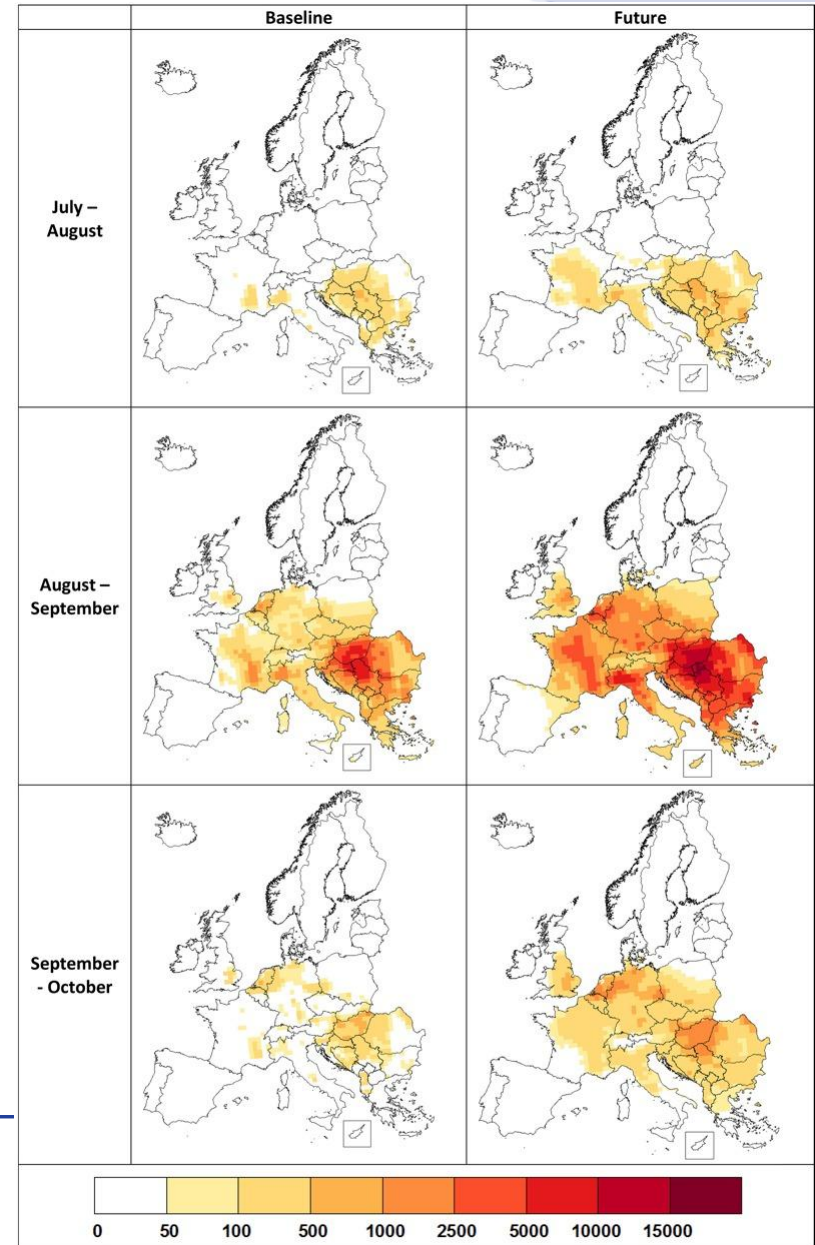
# Promjena klime i njezin utjecaj na cvatnju biljaka:

# Broj peludnih zrnaca ambrozije

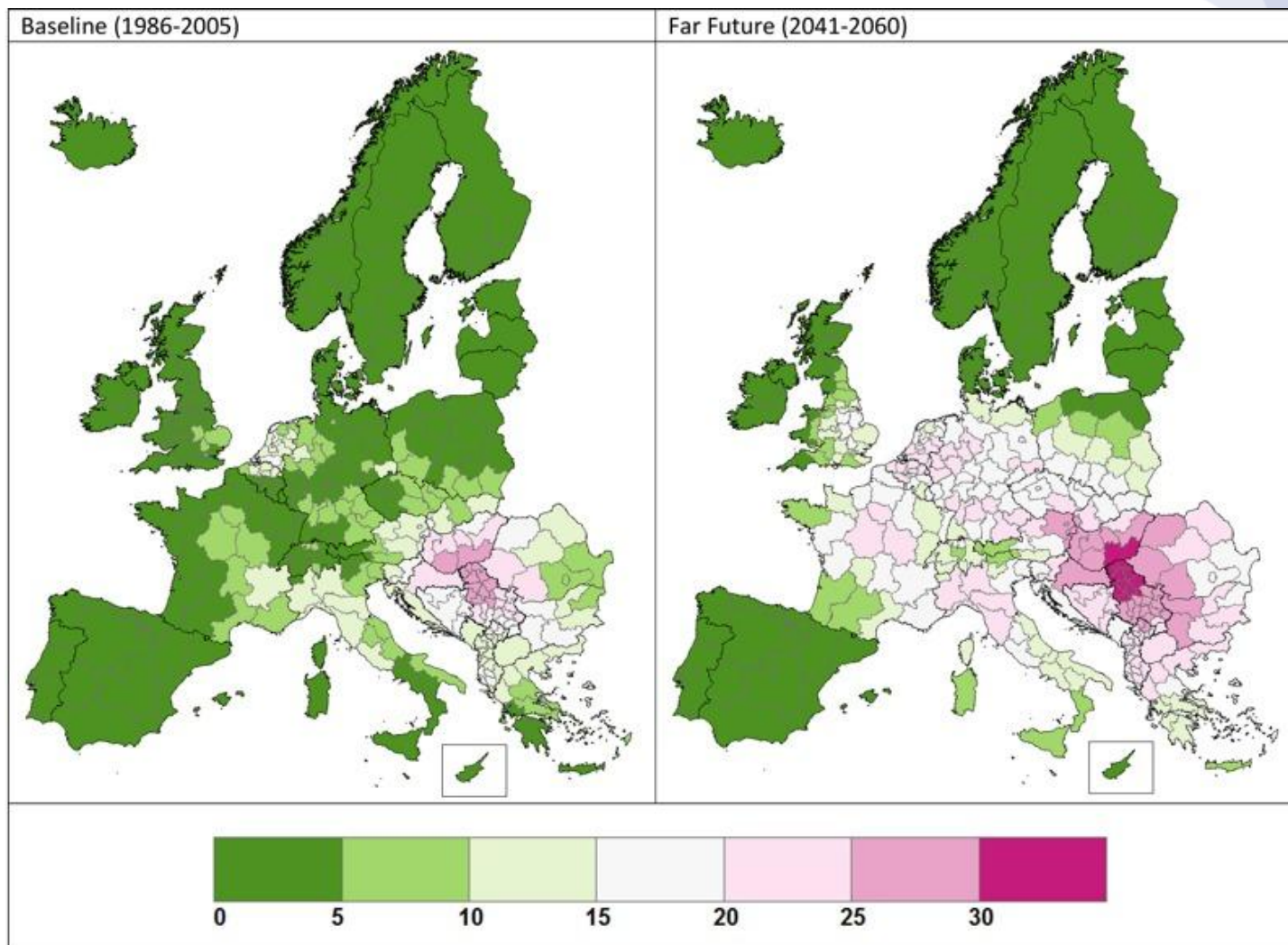
Environ Health Perspect (2017) doi: 10.1289/EHP173  
 Buduće razdoblje: 2041-2060, prema RCP4.5



**Figure 4:** Difference of decadal medians (days) in the start of clinically relevant pollen seasons in Europe. Change of decadal medians in start of clinically relevant pollen season (days) for (A) birch and (B) olive in Europe at NUTS level 2, comparing 2011-20 with 1981-90. Dot-shaded areas have statistically insignificant trends (p value >0.1). White areas (without shade) had clinically relevant seasons that occurred less than 5 times between 1981 and 1990 or 2011 and 2020.

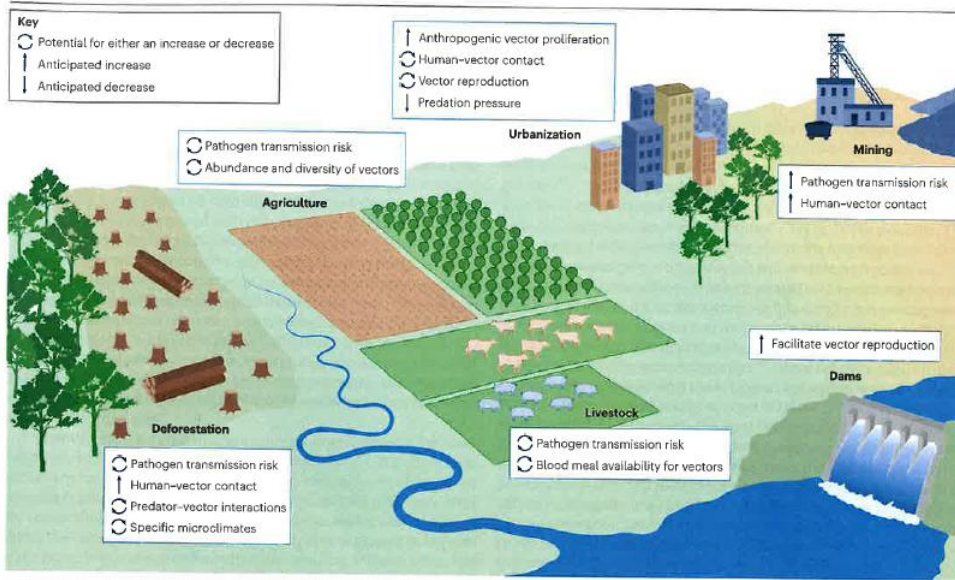


## Postotak populacije osjetljive na pelud ambrozije danas i u budućnosti:



Izvor: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5332176/>

# Promjena klime i njezin utjecaj na vektorske bolesti:



**Fig. 4 | Potential impact of land use on vectors and vector-borne diseases.** Circular pairs of upward and downward arrows indicate the potential for either an increase or decrease due to anthropogenic changes such as deforestation, livestock production, agriculture, urbanization, mining and dams. Vertical arrows indicate a more consistent change anticipated.

# Promjena klime i njezin utjecaj na vektorske bolesti:

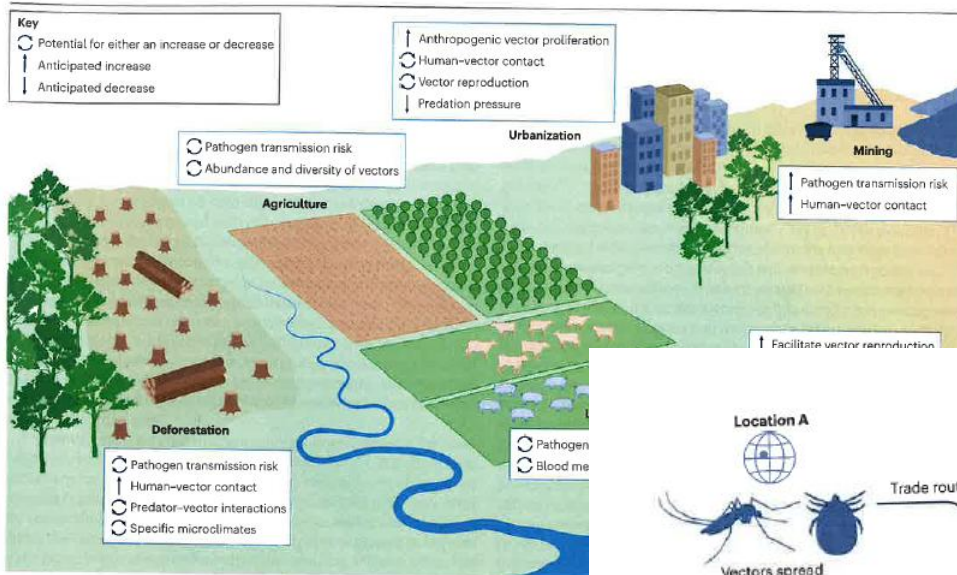


Fig. 4 | Potential impact of land use on vectors and vector-borne diseases. Circular pairs of upward increase or decrease due to anthropogenic changes such as deforestation, livestock production, agriculture more consistent change anticipated.

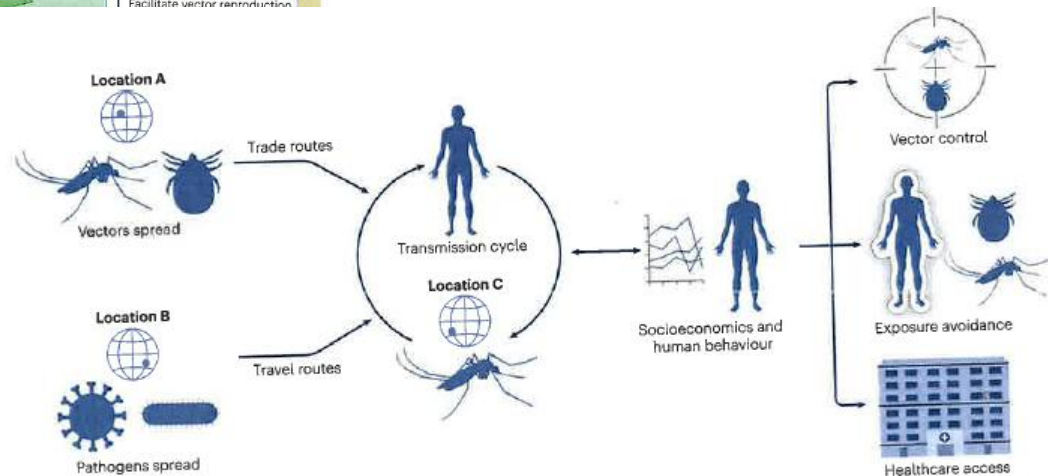
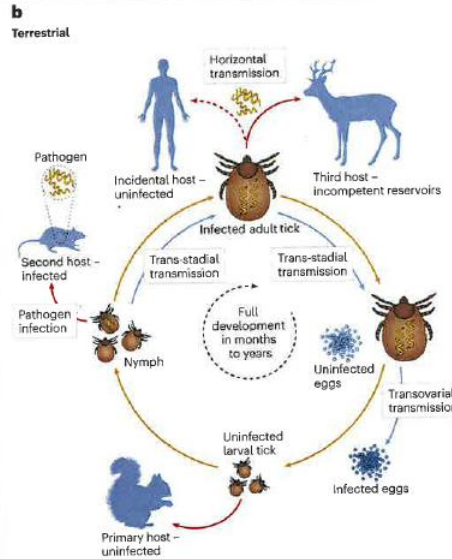
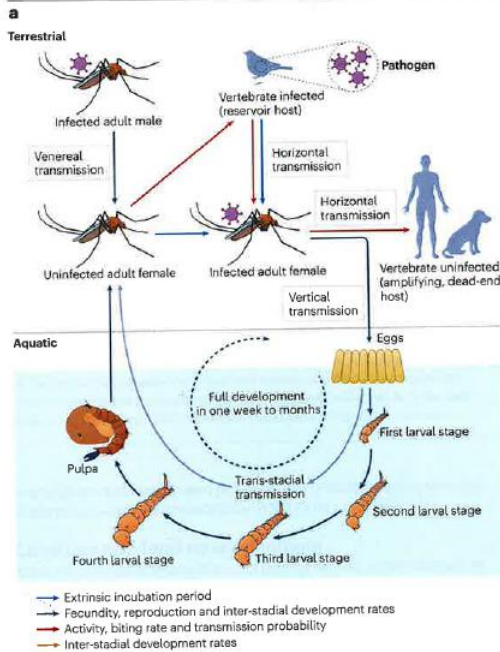


Fig. 5 | Potential effects of human mobility and behaviour on vectors and vector-borne diseases. The introduction of vectors or pathogens can be a result of trade and travel routes from multiple sources. The newly established transmission cycle usually occurs with the introduction of an invasive vector species, such as a mosquito or tick, from location A to location C through trade routes. Next, the pathogen itself arrives in location C, carried by infected humans (travel routes) or infected livestock (trade routes) from location B. If both the introduced vector and a suitable host (humans or animals) are

present in location C, the pathogen can establish a transmission cycle, leading to disease outbreaks and endemicity. The intensity of this transmission can be influenced by various socioeconomic factors and human behaviours in location C, including vector control efforts, healthcare access and individual behaviours such as exposure avoidance (for example, repellent use). Also, native vector species in location C could play a role in transmitting the introduced pathogen instead of or in addition to the invasive species. Likewise, invasive vectors may become vectors of native pathogens in location C.

# Promjena klime i njezin utjecaj na vektorske bolesti:



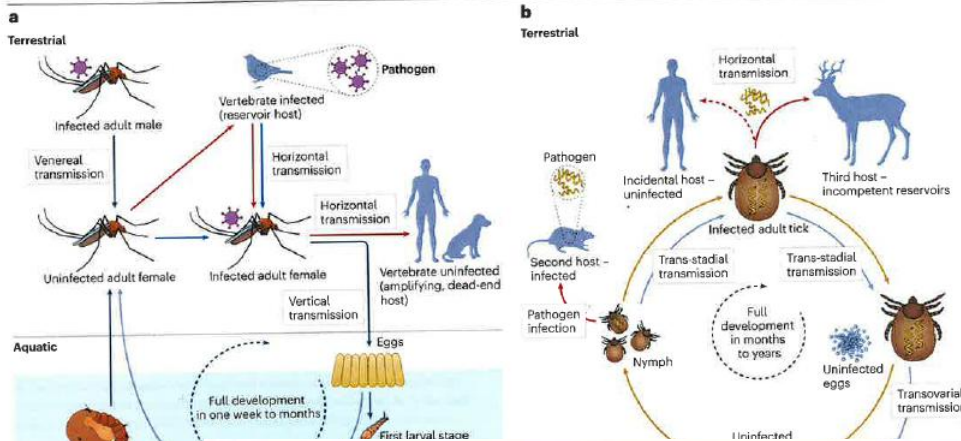
**c**

	<i>A. aegypti</i>	<i>A. albopictus</i>	<i>C. pipiens</i>
Pathogens:	Dengue, Zika and chikungunya viruses	Dengue, Zika and chikungunya viruses	West Nile and Usutu viruses
Biting rate:	33.8 °C (13.8–40.0 °C)	31.8 °C (10.4–38.1 °C)	32.7 °C (9.4–39.6 °C)
Fecundity:	29.6 °C (14.7–34.4 °C)	29.4 °C (7.9–35.6 °C)	22.1 °C (5.3–38.9 °C)
Mosquito dev. rate:	32.7 °C (11.6–33.0 °C)	32.6 °C (8.7–39.6 °C)	30.9 °C (0.1–38.5 °C)
Immature survival:	25.9 °C (13.6–38.3 °C)	24.2 °C (9.1–39.3 °C)	23.1 °C (7.8–38.4 °C)

**d**

	<i>I. scapularis</i>	<i>A. americanum</i>	<i>D. variabilis</i>
Pathogens:	<i>Borrelia burgdorferi</i> and Powassan virus	<i>Francisella tularensis</i> and Heartland virus	<i>Francisella tularensis</i> and <i>Rickettsia rickettsii</i>
Lower lethal temperature:	-15 °C	-15 °C	-20 °C
Upper lethal temperature:	41 °C	45 °C	43 °C
Greatest activity:	30–40 °C	30–40 °C	30–40 °C
Thermal preference:	10–14 °C	15–20 °C	20–24 °C

# Promjena klime i njezin utjecaj na vektorske bolesti:



**c** *A. aegypti*

Pathogens: Dengue, Zik and chikung viruses

Biting rate: 33.8 °C (13.1)

Fecundity: 29.6 °C (14.7)

Mosquito dev. rate: 32.7 °C (11.6)

Immature survival: 25.9 °C (13.4)

**High temperatures**

**Altered vector activity and bite rates** (for example, mosquitoes, ticks and midges)

**Increased transmission risk** (for example, dengue, tularemia and leishmaniasis)

**Altered extrinsic incubation period** (for example, mosquitoes and midges)

**Increased survival of adult female vectors** (for example, mosquitoes)

**Floods**

**Altered suitable aquatic environment for reproduction** (for example, mosquitoes, sandflies and midges)

**Altered dipteran vector population** (for example, mosquitoes, sandflies and midges)

**Increased exposure to vector bites** (for example, mosquitoes)

**Decreased tick vector populations** (for example, hard ticks and soft ticks)

**Droughts**

**Increased dipteran vector population** (for example, mosquitoes)

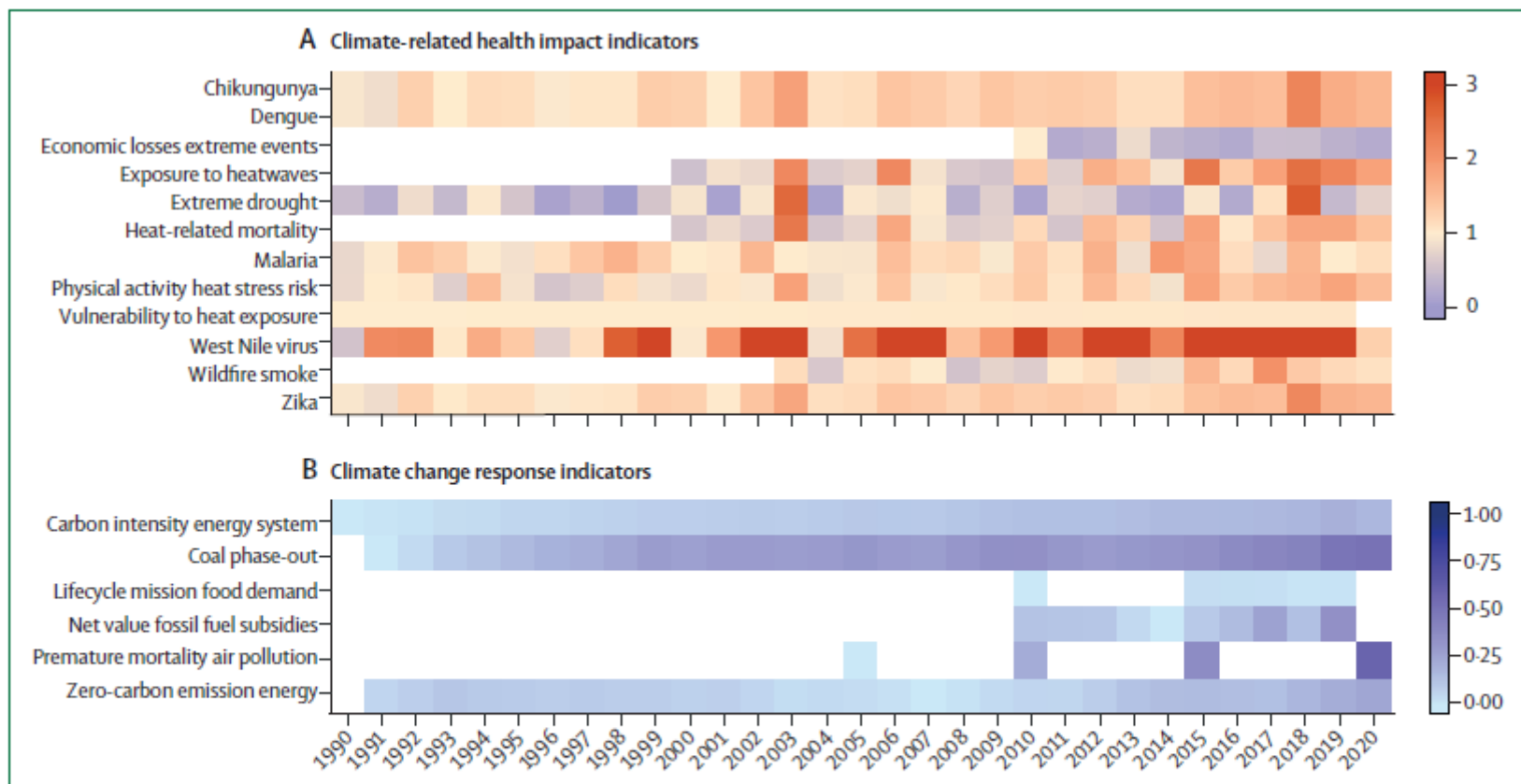
**Increased transmission risk** (for example, West Nile and dengue viruses)

**Increased exposure to vector bites** (for example, mosquitoes)

**Decreased tick vector populations** (for example, hard ticks and soft ticks)

**Fig. 2 | Impact of extreme weather on vectors and vector-borne diseases.** The effects of higher temperatures, floods or droughts on vector groups (for example, mosquitoes, ticks, midges and sandflies) and vector-borne disease risk<sup>14,20,17,28,32</sup>.

# Što možemo očekivati:



**Figure 10: Overview of standardised impacts and responses tracked in the 2022 European report of the Lancet Countdown**

(A) Climate related health impact indicators, with higher values corresponding to worsening of the indicator tracked. (B) Climate change response indicators, with higher values corresponding to improvement in the indicator tracked (appendix p 198). Each indicator has been standardised to generate a yearly score. Standardisation was based on the yearly value divided by the baseline value for climate-related health impact indicators (A) and the yearly value divided by the worst case value (or target value) minus the worst case value for the climate change response indicators (B).



Zagreb 19. srpnja 2023. Foto: Emica Elvedji/Pixsell



Srušena skela u Osijeku 7. srpnja 2025., Foto: Glas Slavonije



Nevrijeme poharalo Karlovac 19. srpnja 2023., Foto: Trend Mediji



Nasukana jedrilica zbog nevremena u Zadru  
8. kolovoza 2024., Foto: Luka Gerlanc, Cropix



Vjetar na području Varaždina srušio stablo 18. kolovoza 2024.,  
Foto: DVD Varaždinbreg/Facebook



Poplavljene ulice u Glini 19. kolovoza 2024.

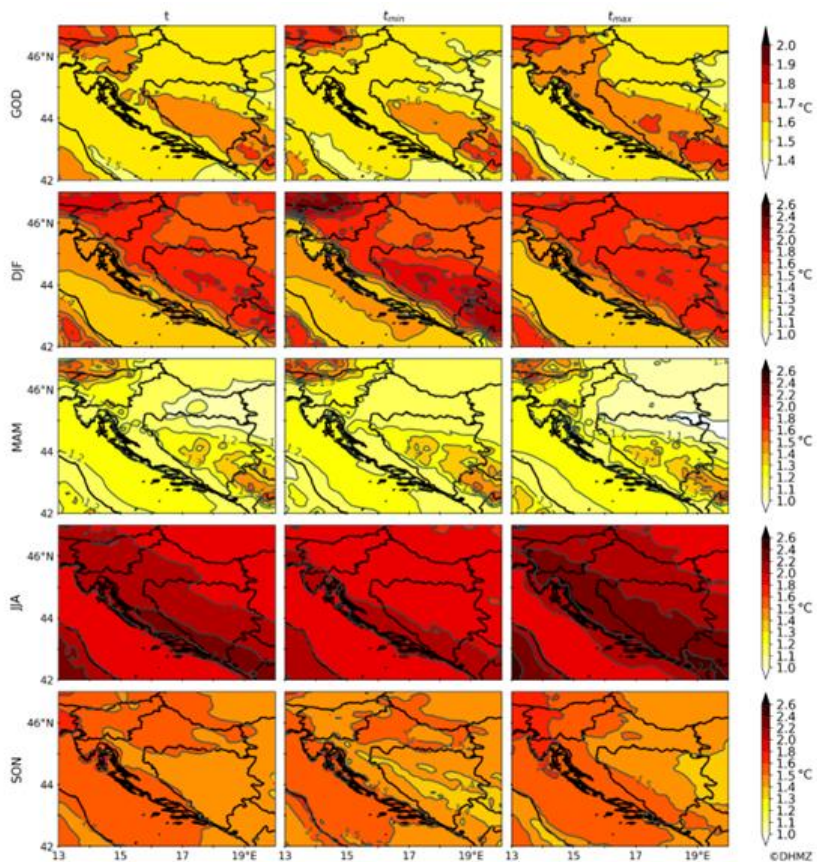
Izvor: Ivan Janković/Facebook



# Hvala na pozornosti!

# Što možemo očekivati:

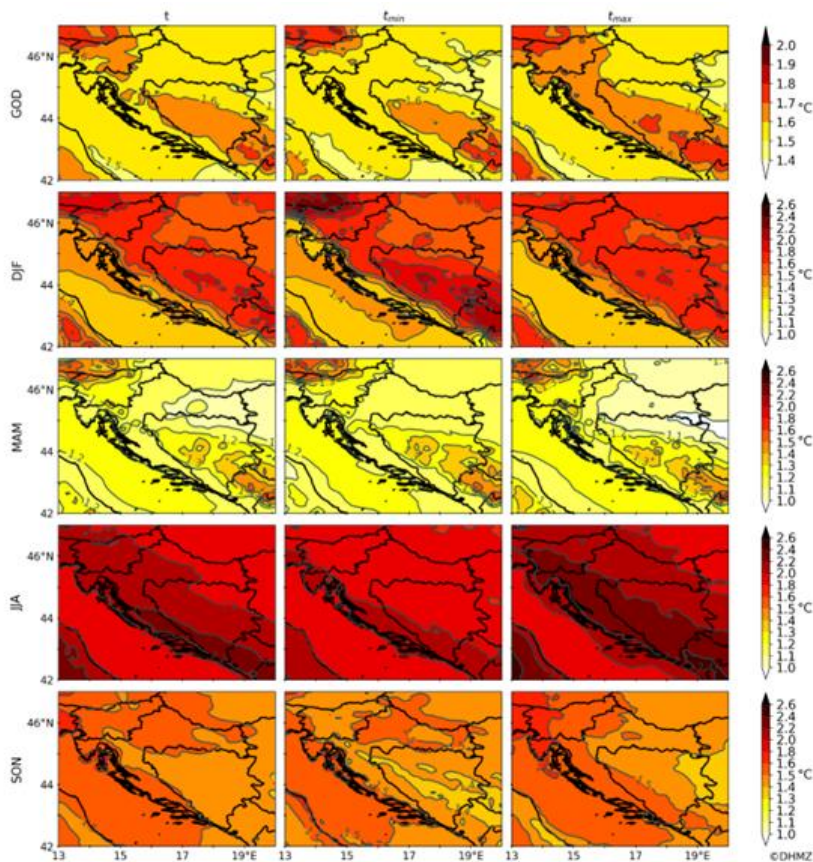
[https://klima.hr/razno/publikacije/8NIKP\\_DHMZ.pdf](https://klima.hr/razno/publikacije/8NIKP_DHMZ.pdf)



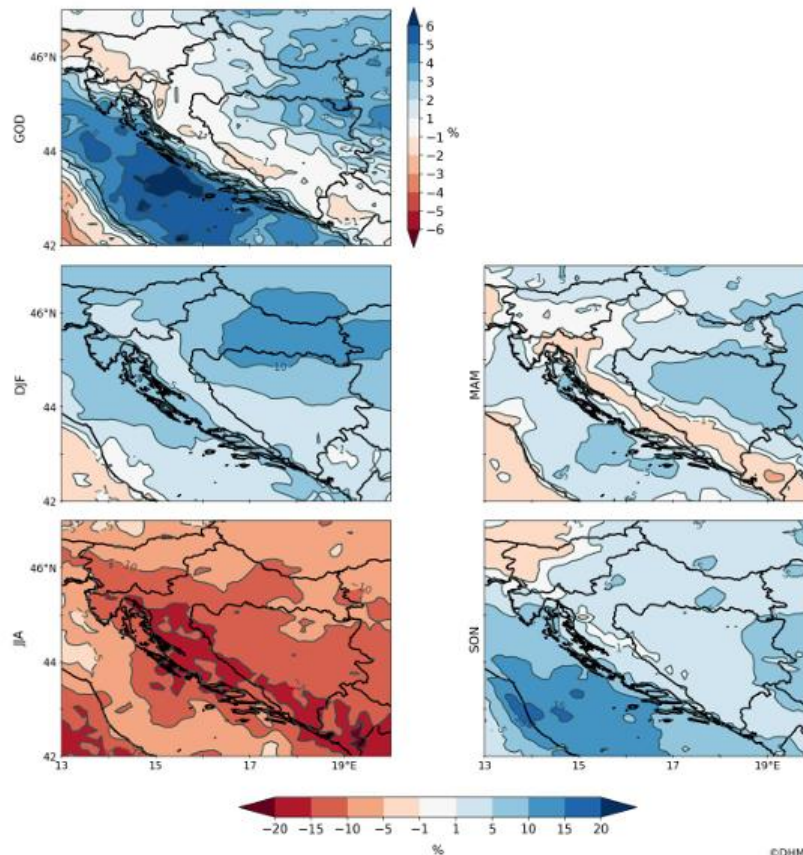
Slika 6.1.3.3. Promjena srednje temperature zraka na 2 m ( $t$ ; prvi stupac), minimalne temperature zraka na 2 m ( $t_{min}$ ; drugi stupac) i maksimalne temperature zraka na 2 m ( $t_{max}$ ; treći stupac) u srednjaku ansambla korištenih modela za razdoblje 2041. – 2070. u odnosu na referentno razdoblje 1981. – 2010. za scenarij RCP4.5. Godišnja promjena (GOD; prvi redak), promjena zimi (DJF; drugi redak), u proljeće (MAM; treći redak), ljeti (JJA; četvrti redak) i u jesen (SON; peti redak).

# Što možemo očekivati:

[https://klima.hr/razno/publikacije/8NIKP\\_DHMZ.pdf](https://klima.hr/razno/publikacije/8NIKP_DHMZ.pdf)



**Slika 6.1.3.3.** Promjena srednje temperature zraka na 2 m ( $t$ ; prvi stupac), minimalne temperature zraka na 2 m ( $t_{min}$ ; drugi stupac) i maksimalne temperature zraka na 2 m ( $t_{max}$ ; treći stupac) u srednjaku ansambla korištenih modela za razdoblje 2041. – 2070. u odnosu na referentno razdoblje 1981. – 2010. za scenarij RCP4.5. Godišnja promjena (GOD; prvi redak), promjena zimi (DJF; drugi redak), u proljeće (MAM; treći redak), ljeti (JJA; četvrti redak) i u jesen (SON; peti redak).

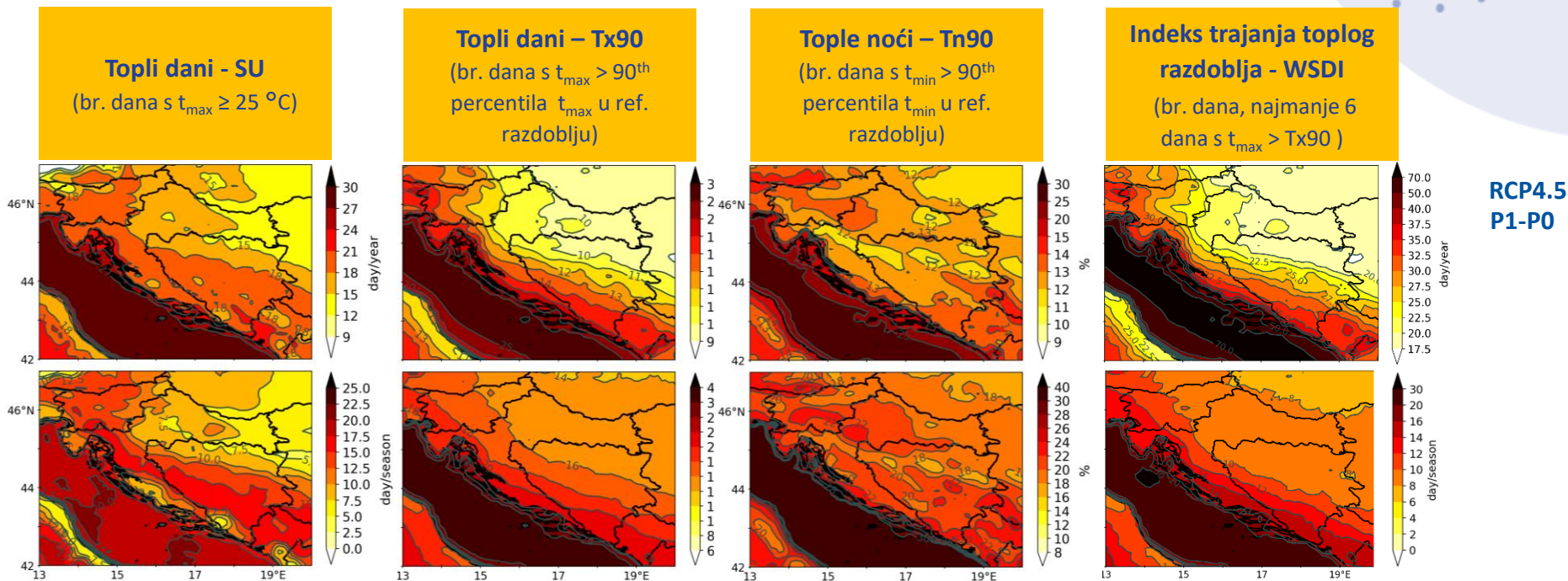


**Slika 6.1.3.5.** Relativna promjena ukupne količine oborine u srednjaku ansambla korištenih modela za razdoblje 2041. – 2070. u odnosu na referentno razdoblje 1981. – 2010. za scenarij RCP4.5. Godišnja promjena (GOD; gore lijevo), promjena zimi (DJF; sredina lijevo), u proljeće (MAM; sredina desno), ljeti (JJA; dolje lijevo) i u jesen (SON; dolje desno).

# Što možemo očekivati:

## Temperaturni indeksi – topli ekstremi

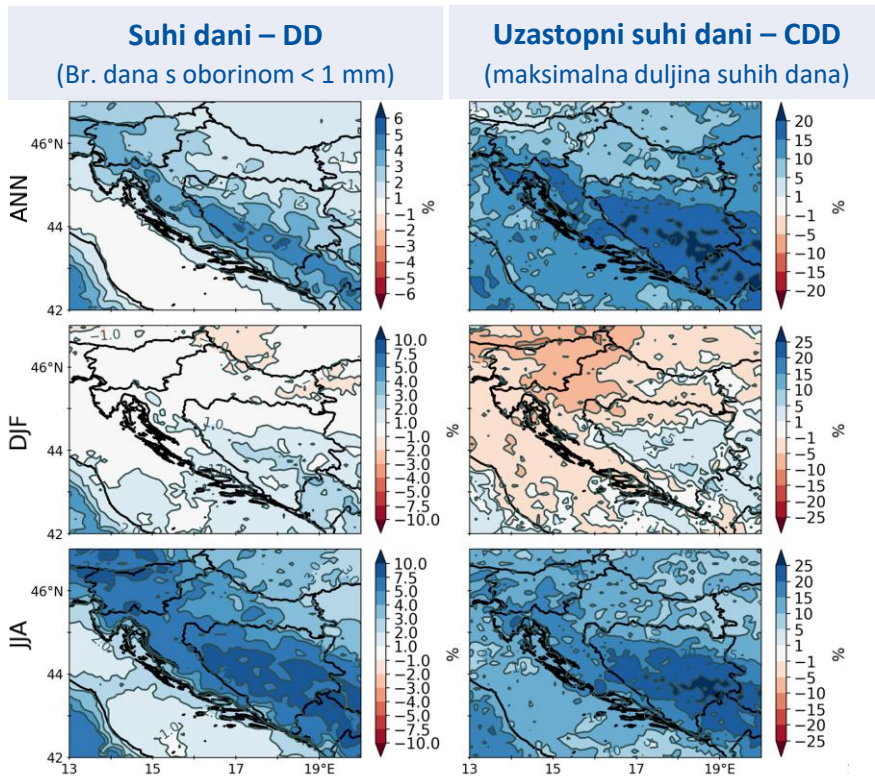
### - Porast trajanja toplih razdoblja, broja toplih dana i toplih noći



[https://klima.hr/razno/publikacije/8NIKP\\_DHMZ.pdf](https://klima.hr/razno/publikacije/8NIKP_DHMZ.pdf)

# Što možemo očekivati:

## oborinski indeksi – suhi ekstremi



- Porast suhих dana i trajanja suhих razdoblja na razini godine u cijeloj HR
- Najveći porast u gorskim predjelima i u Dalmaciji
- Zimi je promjena u suhim danima zanemariva, uočava se smanjenje uzastopnih suhих dana u središnjim predjelima
- Promjena ljeti je slična kao i na razini godine

RCP4.5  
(P1-P0)/P0

[https://klima.hr/razno/publikacije/8NIKP\\_DHMZ.pdf](https://klima.hr/razno/publikacije/8NIKP_DHMZ.pdf)

# Što možemo očekivati:

## oborinski indeksi – kišni ekstremi

### Dnevni intenzitet oborine – SDII

(ukupna god. kol. oborine / br. kišnih dana)

### Maksimalna jednodnevna količina oborine – Rx1d

### Maksimalna petodnevna kol. oborine – Rx5d

→ Porast na razini godine i zimi, posebno u istočnim predjelima

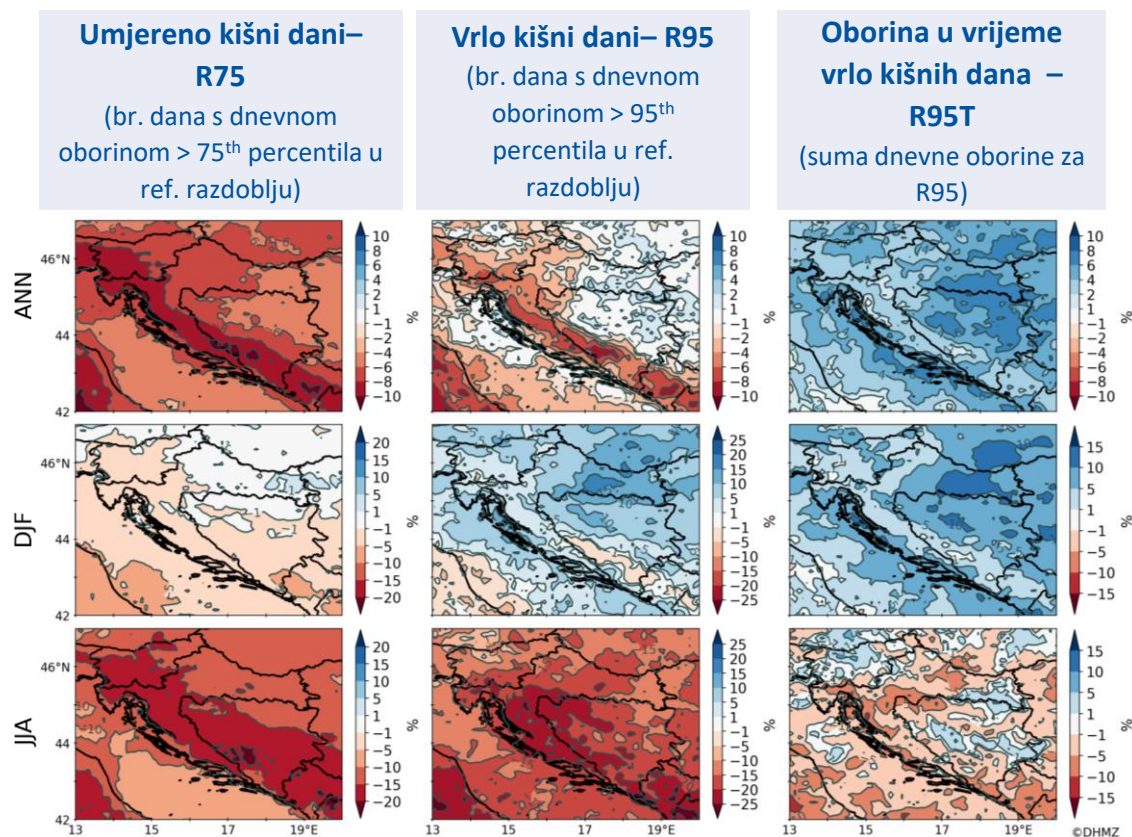
→ Smanjenje ljeti iznad planinskih predjela, obalnih područja i u Dalmaciji

RCP4.5  
(P1-P0)/P0

[https://klima.hr/razno/publikacije/8NIKP\\_DHMZ.pdf](https://klima.hr/razno/publikacije/8NIKP_DHMZ.pdf)

# Što možemo očekivati:

## oborinski indeksi – kišni ekstremi



→ Broj umjerenih i vrlo kišnih dana pokazuje smanjenje signala na godišnjoj razini i u ljeto, dok oborina zbog vrlo kišnih dana raste tijekom godine i i zimi, a smanjuje se ljeto

RCP4.5  
(P1-P0)/P0

[https://klima.hr/razno/publikacije/8NIKP\\_DHMZ.pdf](https://klima.hr/razno/publikacije/8NIKP_DHMZ.pdf)