

An aerial photograph of a tropical coastline. The foreground shows a sandy beach curving along the edge of clear, turquoise water. The middle ground is dominated by dense, lush green vegetation covering the slopes of mountains. In the background, more mountain ranges are visible under a sky with scattered white clouds. The overall scene is vibrant and scenic.

# Climate Change & Health: Mini Med School

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(NO DISCLOSURES)



Sunday 2:00 AM  
50 mph

Lane

Winds

Saturday 2:00 AM  
70 mph

2

HAWAII

Friday 2:00 AM  
110 mph

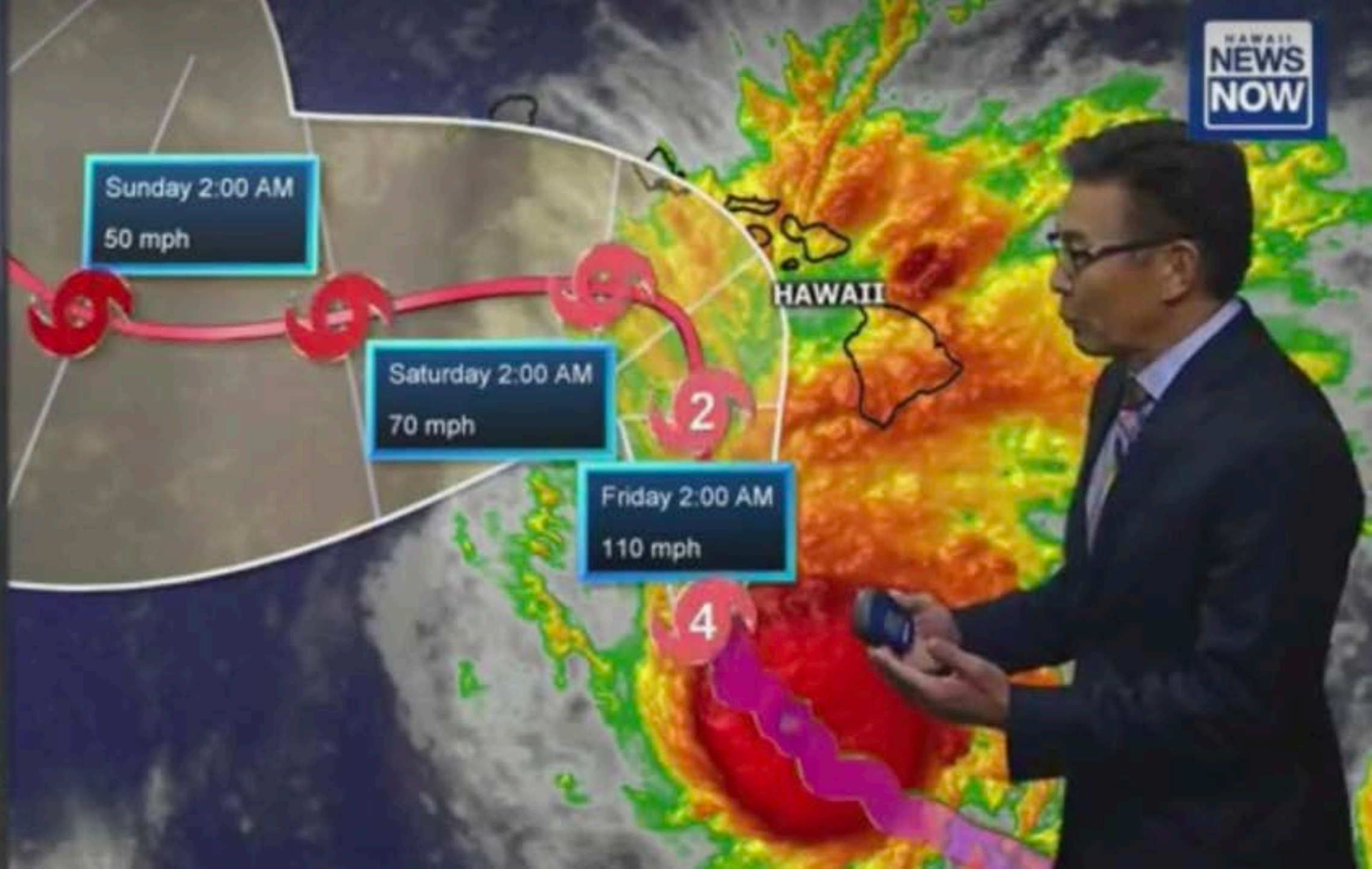
4

130 mph

Gusts  
160 mph

Moving

NW at 7  
mph









## Air Pollution & Increasing Allergens

Asthma, allergies, cardiovascular and respiratory disease. Impacts of VOG & decreasing trade winds

## Degraded Living Conditions & Social Inequities

Exacerbation of social vulnerabilities and determinants of health, economic hardship

## Extreme Heat

Heat-related illness, death, dehydration, decreased learning, increased violence, occupational hazards

## Risk of Invasive Vectors

Dengue, chikungunya, Zika, malaria, West Nile Virus

## Drought

Water supply impacts, decreased air quality

## Food System Impacts

Malnutrition, food insecurity, higher prices, foodborne illness, fragile import supply chain

## Environmental Degradation

Climate migration from Pacific Island communities, civil conflict, loss of cultural ties to land, loss of tourism economy

## Severe Weather & Floods

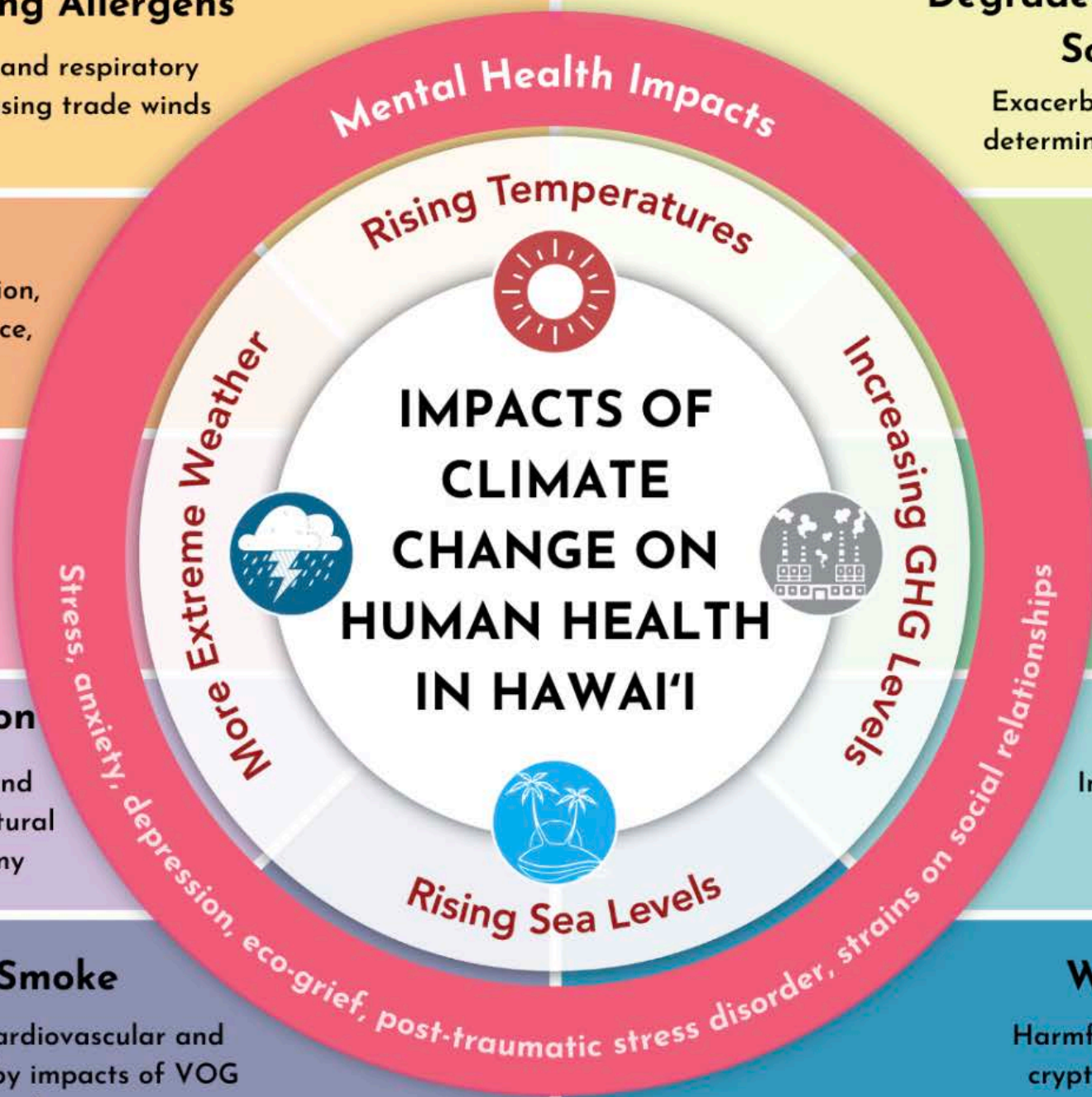
Injuries, drowning, loss of homes, indoor fungi and mold, chemical exposure, cesspool overflows

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Injuries, fatalities, loss of homes, cardiovascular and respiratory diseases. Compounded by impacts of VOG & decreasing trade winds

## Water Quality Impacts

Harmful algal blooms, campylobacteriosis, cryptosporidiosis, leptospirosis, chemical contamination



(Adapted from CDC, J. Patz; CDPH)



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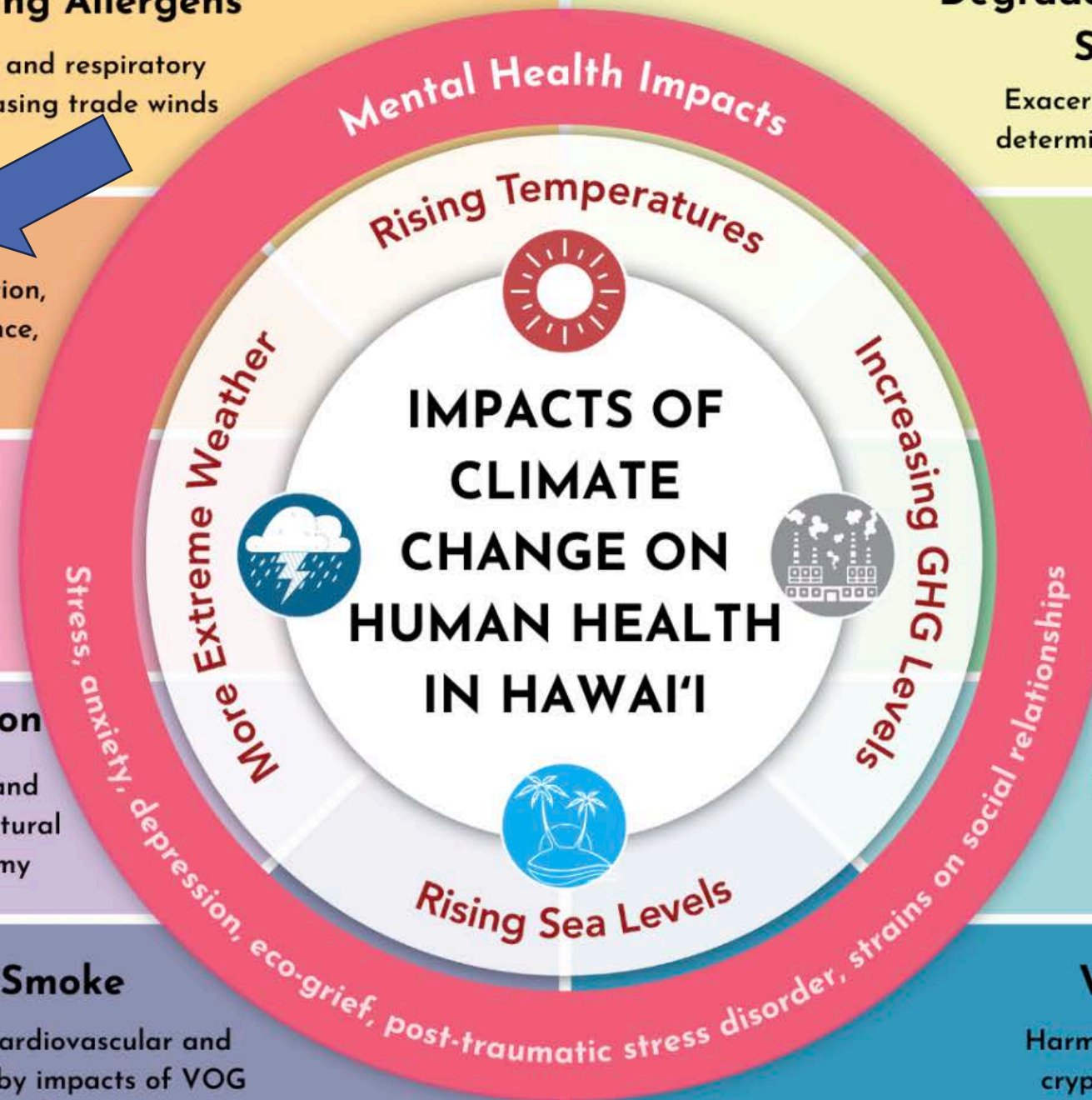
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# Deaths During Annual Hajj in Saudi Arabia Underscore Extreme Heat Dangers



Muslim pilgrims on Sunday near Saudi Arabia's holy city of Mecca, where temperatures reached nearly 110 degrees. Fadel Senna/Agence France-Presse — Getty Images



# 'Extreme heat epidemic' hitting humanity, UN warns

07/25/2024

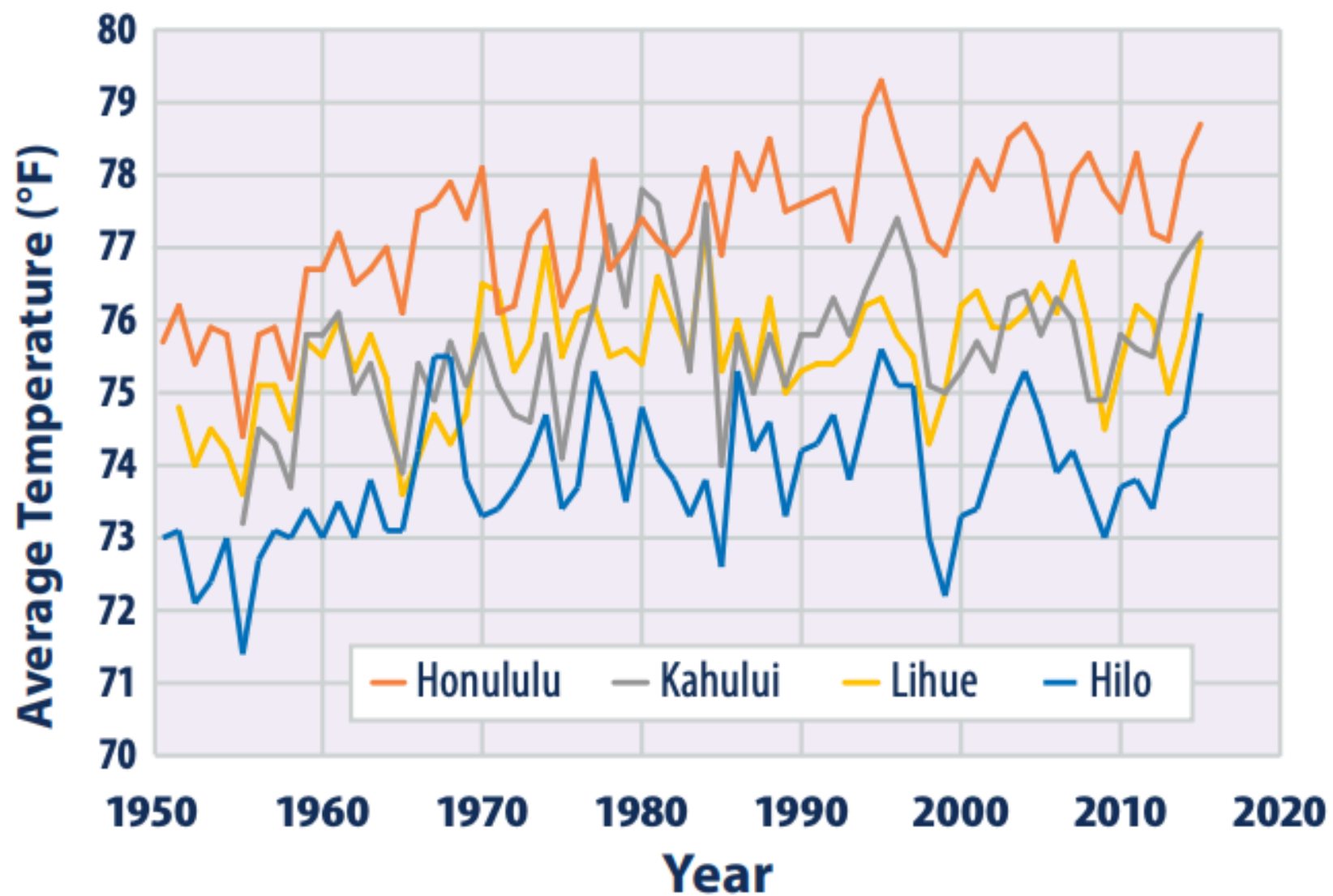


Image: Anil Shakya/AFP via Getty Images





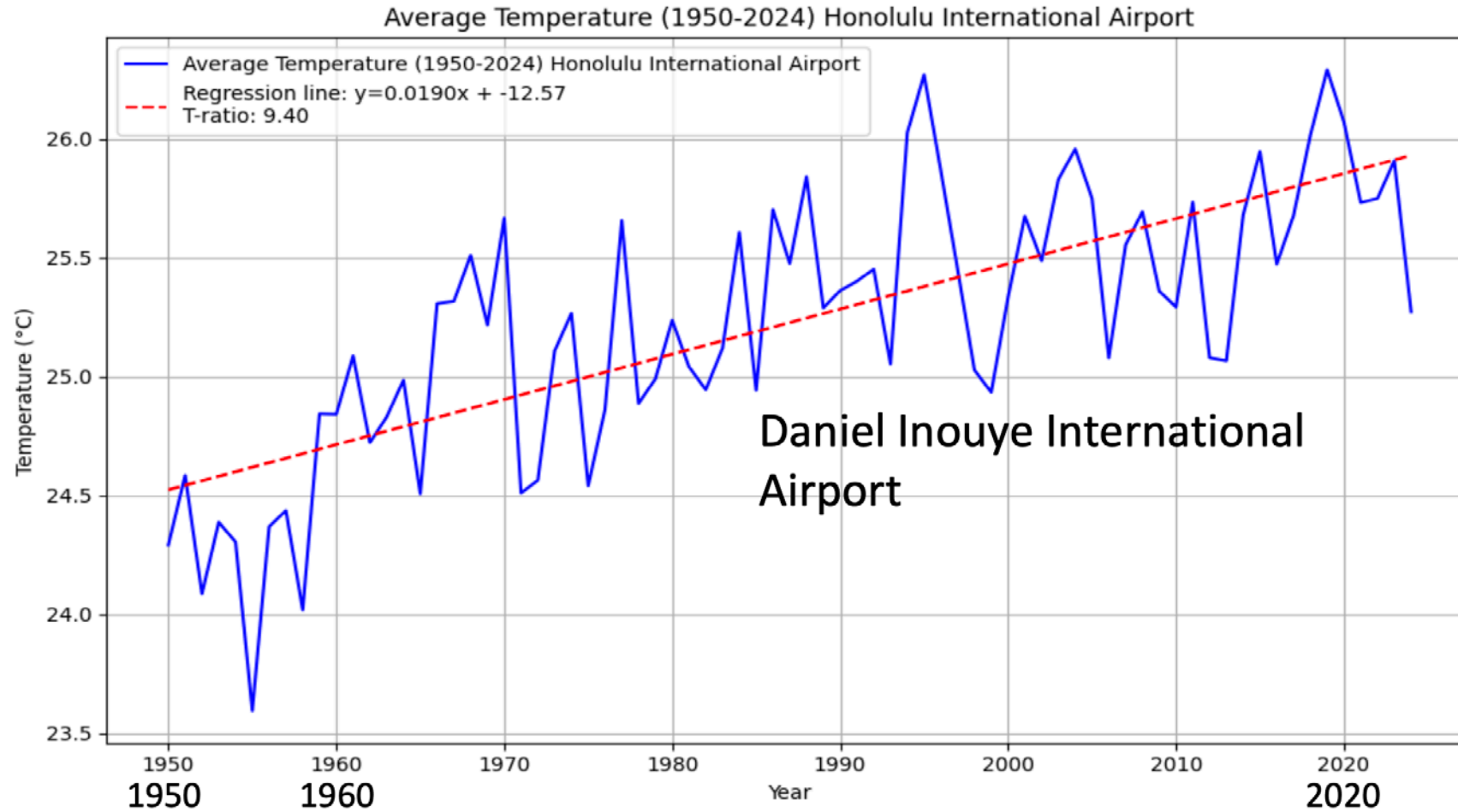




*Average annual temperatures have increased across Hawaii since 1950. Source: NOAA*



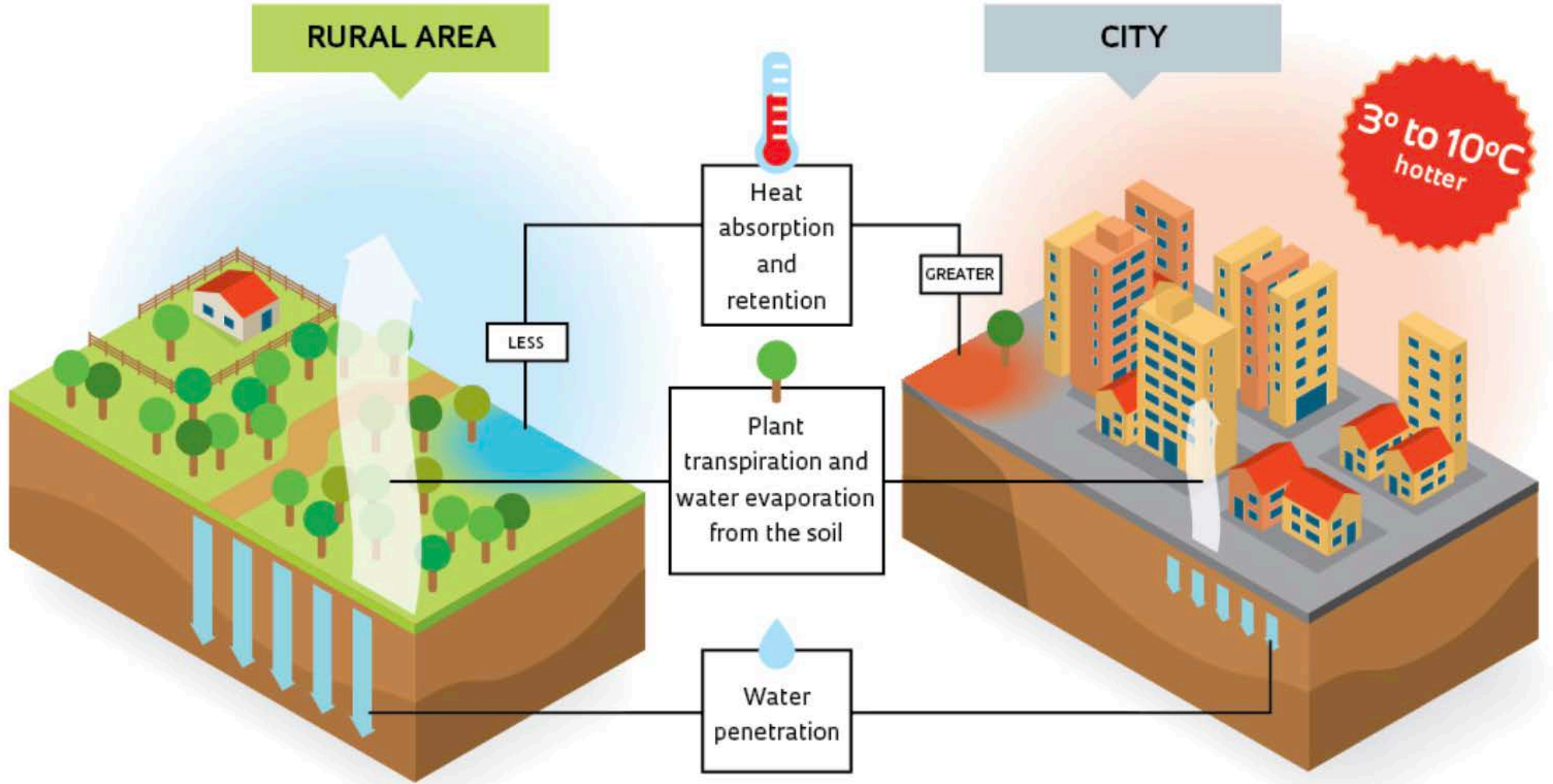
# Annual Average Temperature (°C, 1950-2024)



The overall increase is statistically significant and approximately 1.33°C over the last 75 years.

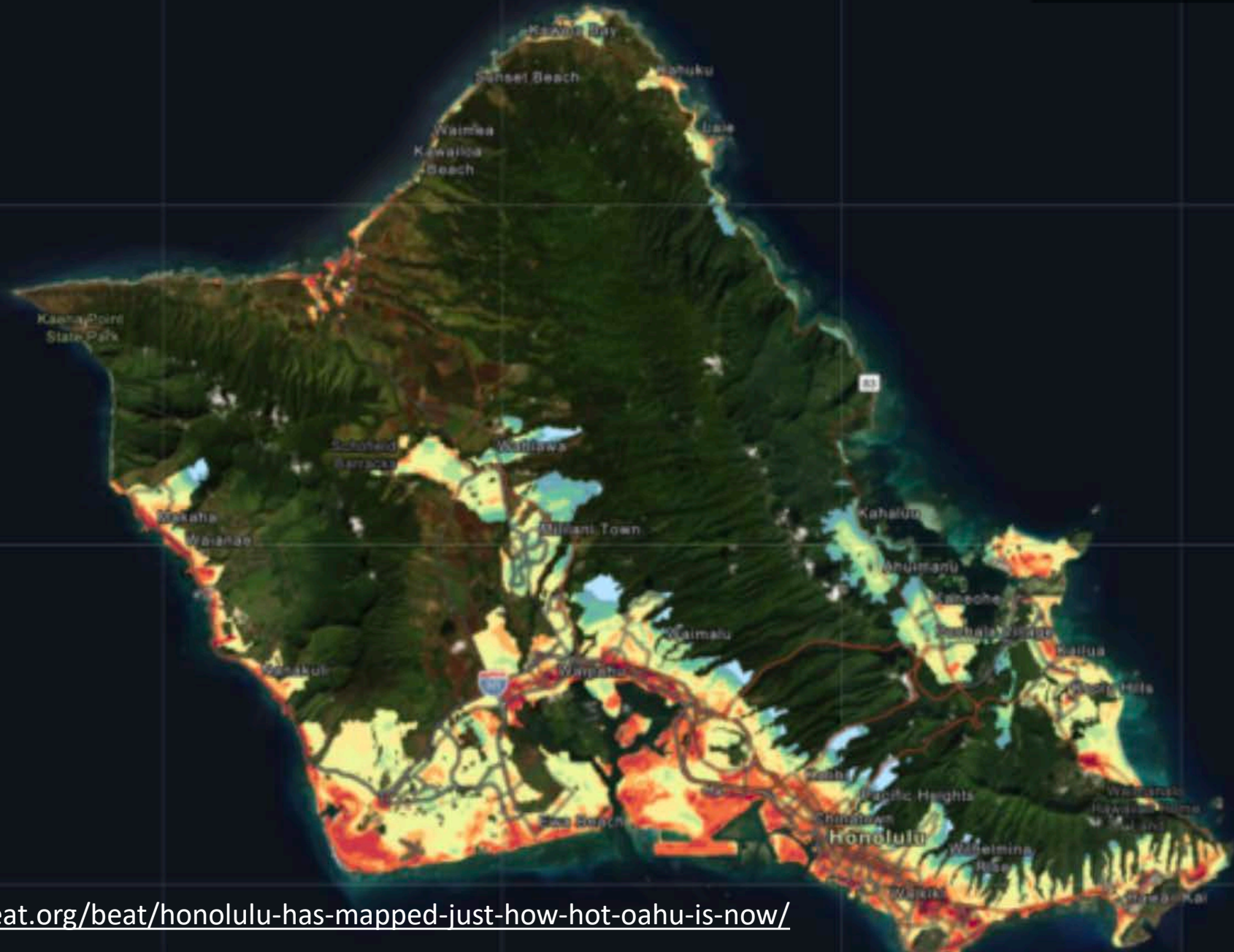


# URBAN HEAT ISLAND





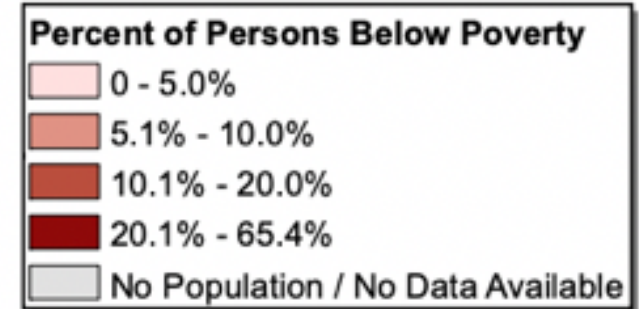
# Oahu Community Heat Map



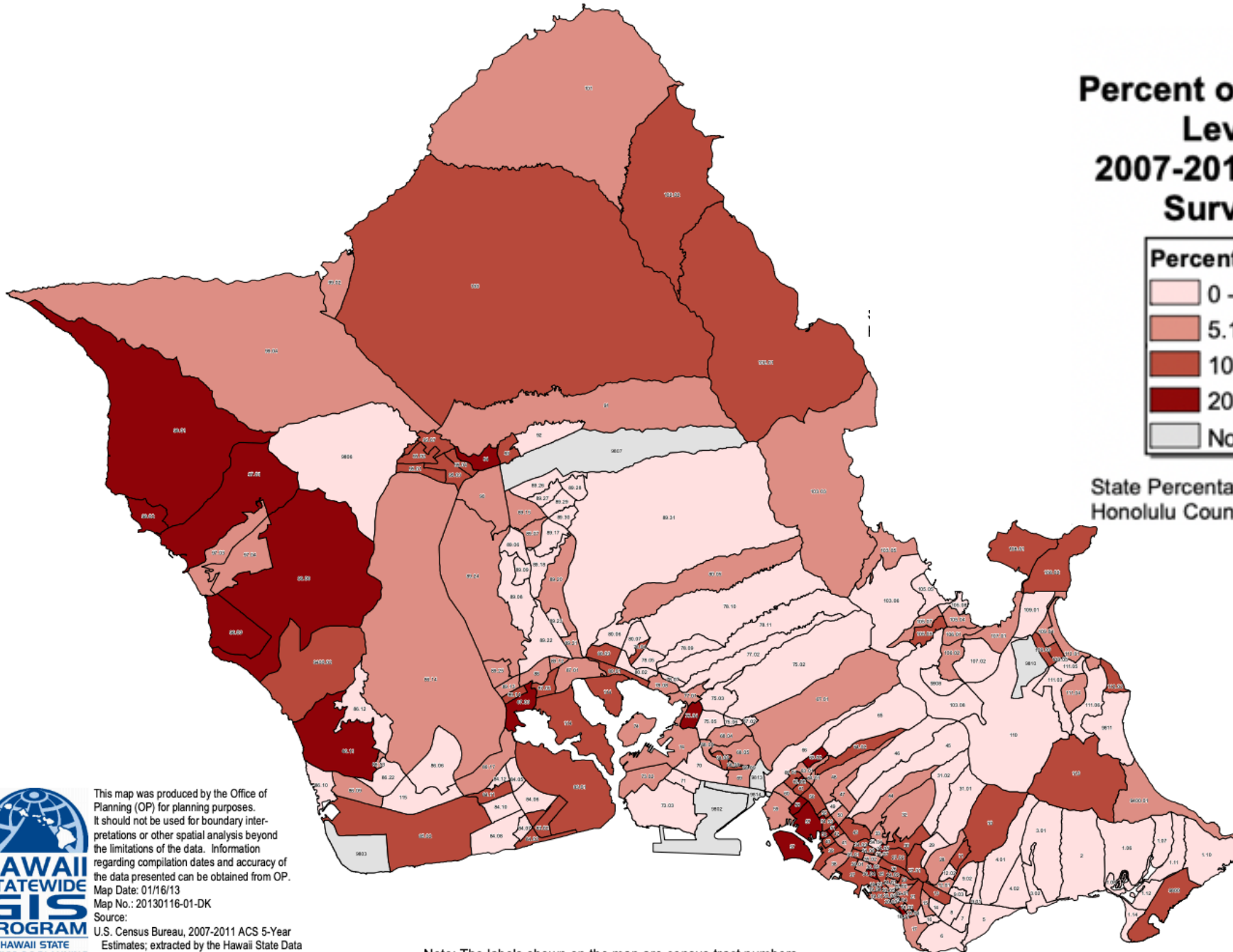
<https://www.civilbeat.org/beat/honolulu-has-mapped-just-how-hot-oahu-is-now/>



# Island of Oahu Percent of Persons Below Poverty Level by Census Tract 2007-2011 American Community Survey 5-Year Estimates

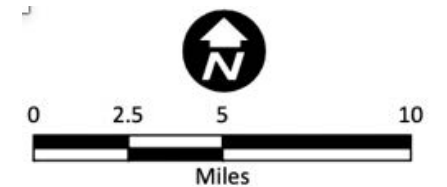


State Percentage Below Poverty Level: 10.2%  
Honolulu County Percentage Below Poverty Level: 9.3%



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Map Date: 01/16/13  
Map No.: 20130116-01-DK  
Source: U.S. Census Bureau, 2007-2011 ACS 5-Year Estimates; extracted by the Hawaii State Data Center, DBEDT.

Note: The labels shown on the map are census tract numbers.





# Heat Impacts: Vulnerable Populations



## PREGNANT

Extreme heat events have been associated with adverse birth outcomes such as low birth weight, preterm birth, infant mortality, and congenital cataracts.



## NEWBORNS

Newborns are extra sensitive to heat because their ability to regulate body temperature is limited.



## CHILDREN

Young children and infants are particularly vulnerable to heat, as their bodies are less able to adapt to heat than adults. Those under four are especially vulnerable.



## ELDERLY

Older adults, especially those who have preexisting diseases, take certain medications, live alone or have limited mobility are at higher risk for heat illness.



## CHRONIC ILLNESS

People with chronic medical conditions are more likely to have a serious health problem during a heat wave.

Source:

*The Impacts of Climate Change on Human Health in the United States, A Scientific Assessment (U.S. Global Changes Research Program)*

weather.gov





# Heat Related Vulnerability: meds

Diuretics, ACE	Dehydration
NSAIDS, ACE	Reduced renal function
Anti-psychotic	Decreased sweat, thermoregulation
Anti-Parkinsonian	Decreased sweat, thermoregulation
Anti-Emetic	Decreased sweat, thermoregulation
Anti-Histamines	Vasoconstriction
Laxatives	Electrolyte imbalance



# Heat and Mental Health



Suicide  
Depression  
Poor cognition  
Impaired memory  
Substance misuse  
Aggression : DOMESTIC VIOLENCE  
Irritability  
Sleep problems  
Poor judgement

Who is at risk? People with

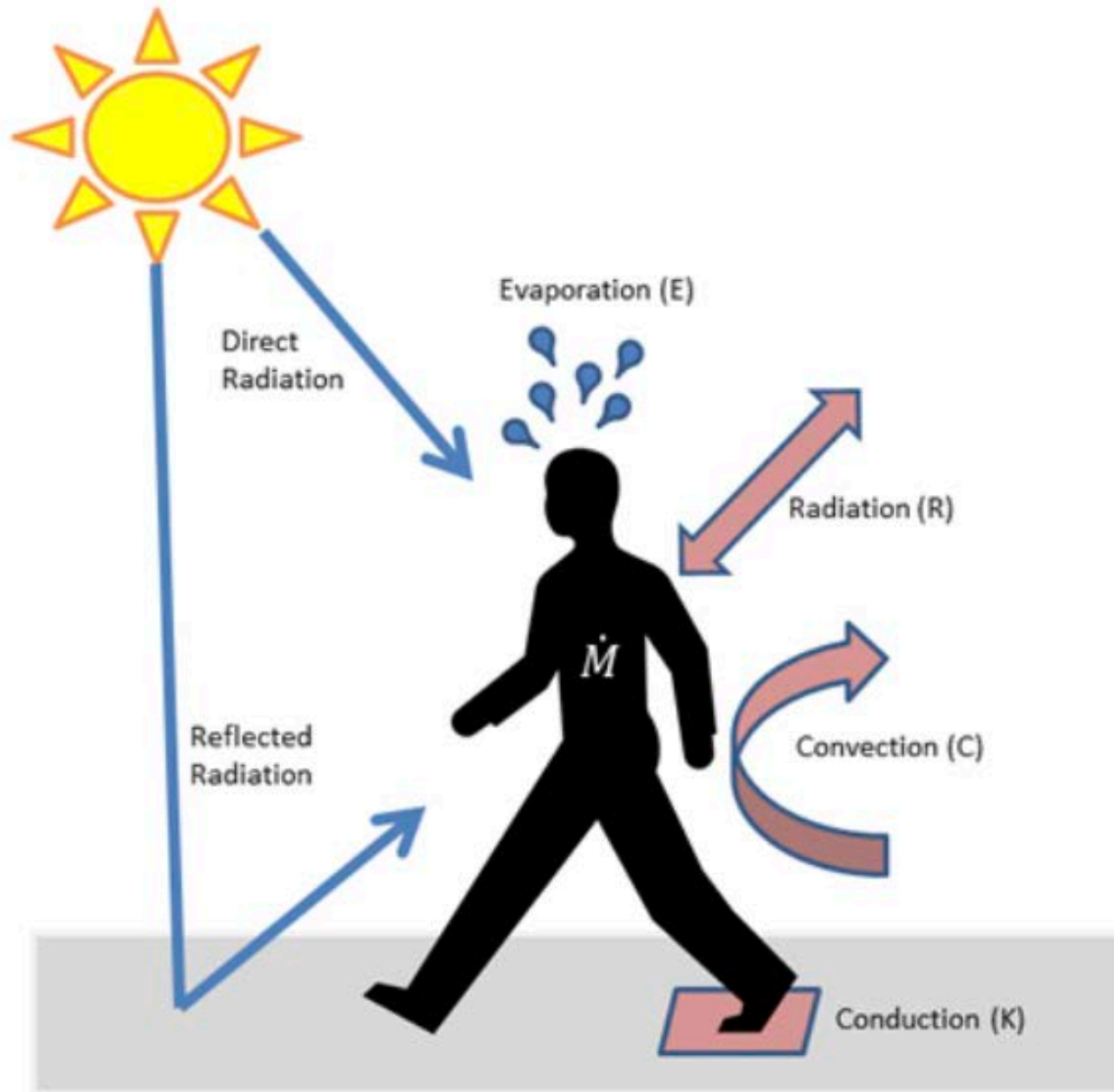
- Pre-existing mental health conditions
- Dementia
- Psychiatric meds

Worsened by:

- Poverty, substance abuse



# Physiologic Responses to Heat Strain



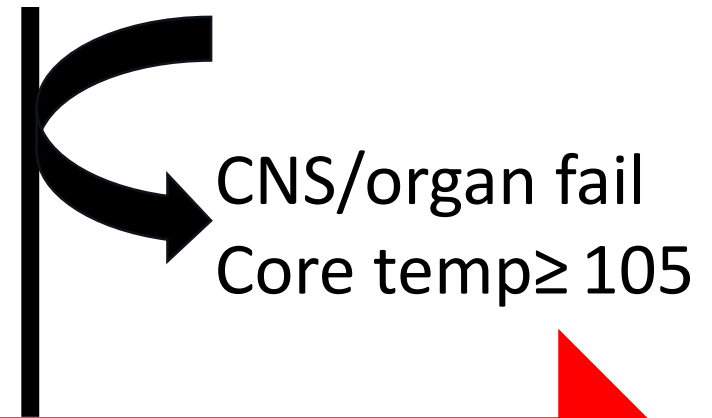
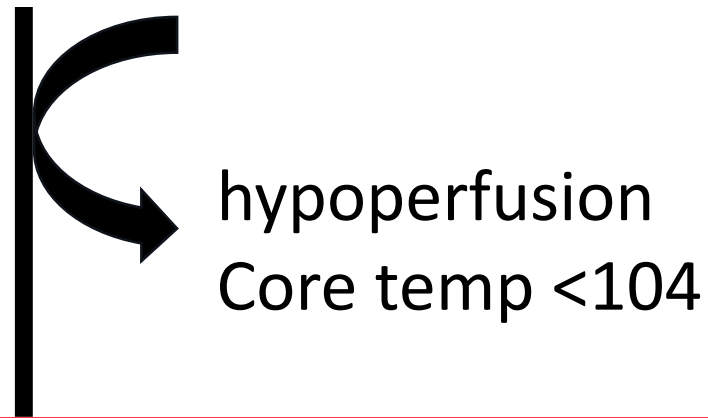
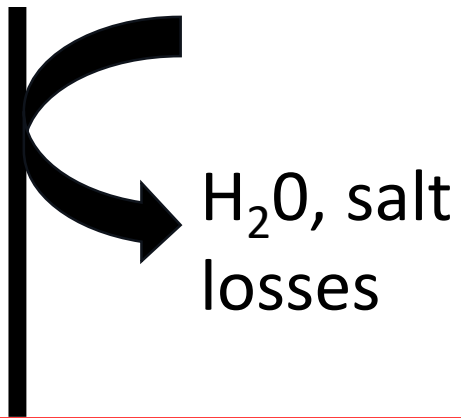
- Vasodilation/heat exchange
- Sweating/evaporation
- Conduction



Heat Cramps  
Heat Rash  
Heat Edema

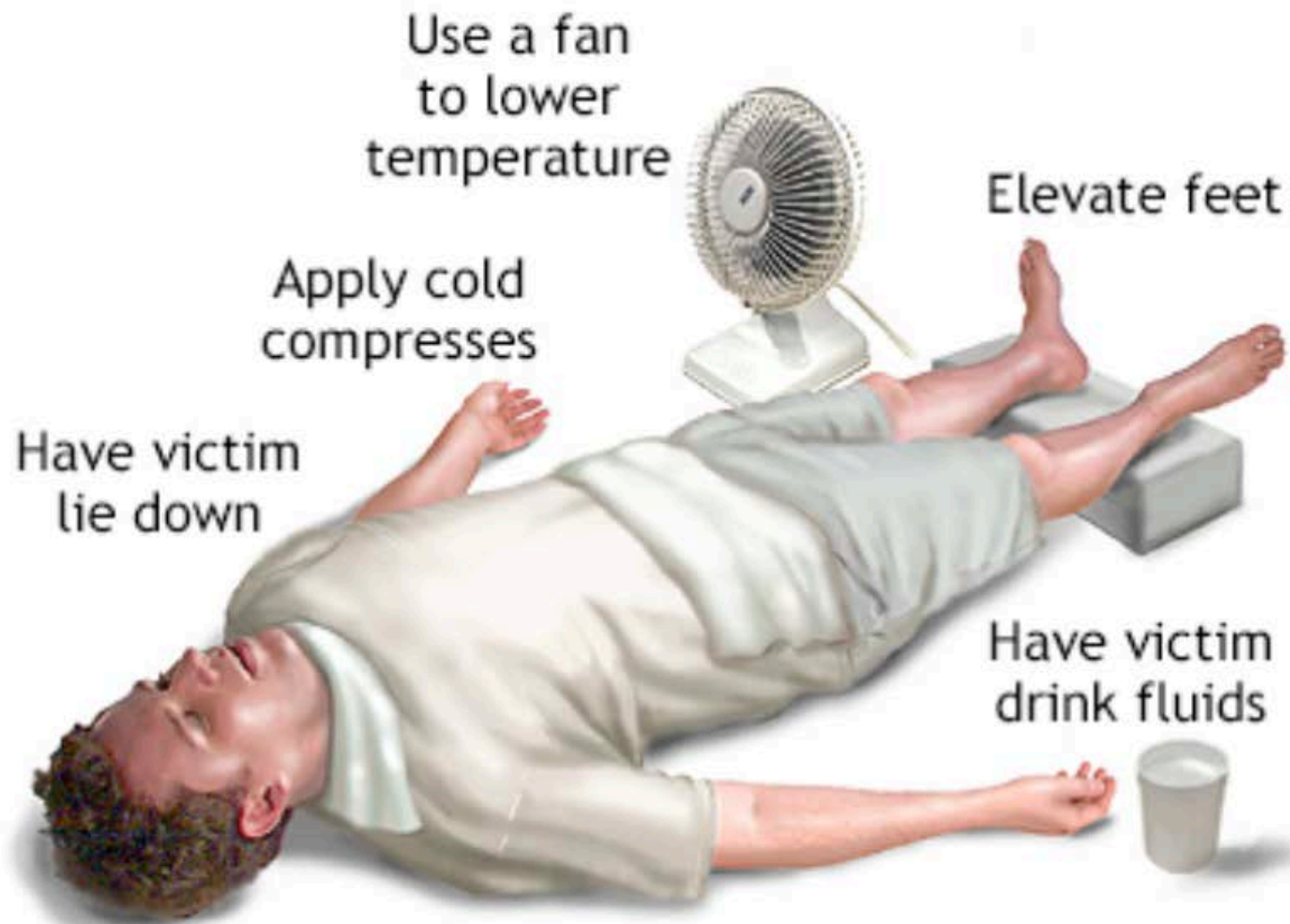
Heat Syncope  
Heat  
Exhaustion

Heat  
Stroke



Exacerbation of Chronic Diseases









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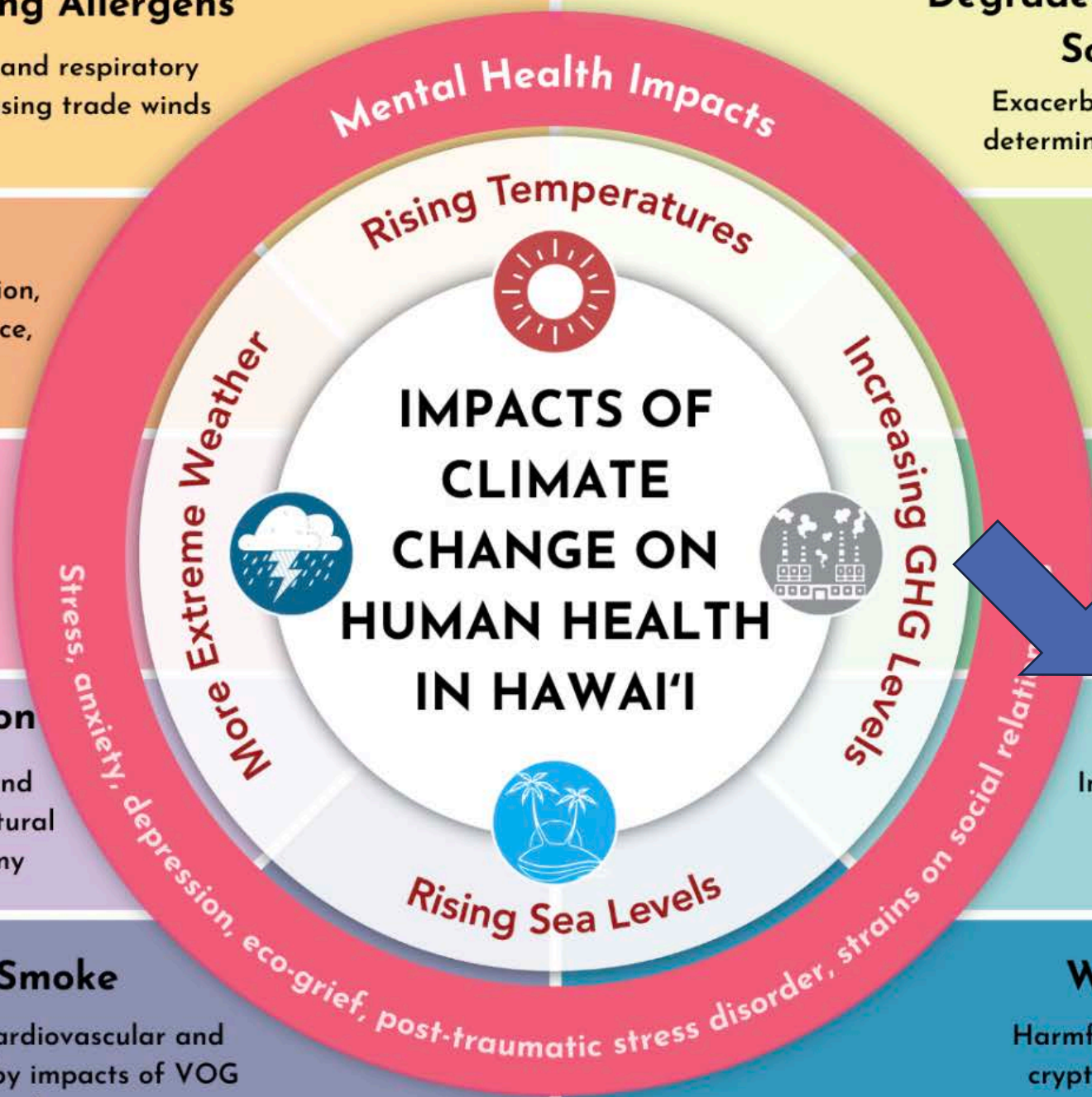
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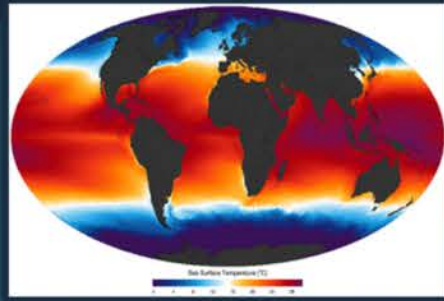


ABC News: Winton Shire Council, Fire ABC Rural Melanie Groves, Fire ABC Open Contributor: Craig Stehn)



# HURRICANES & CLIMATE CHANGE

## What we know



**Warmer water = more fuel**

**Heavier rain**



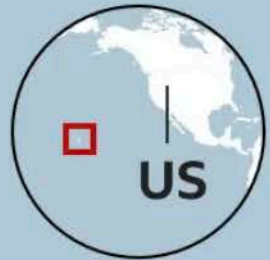
**Higher storm surge**

Clausius-  
Clapeyron  
equation:

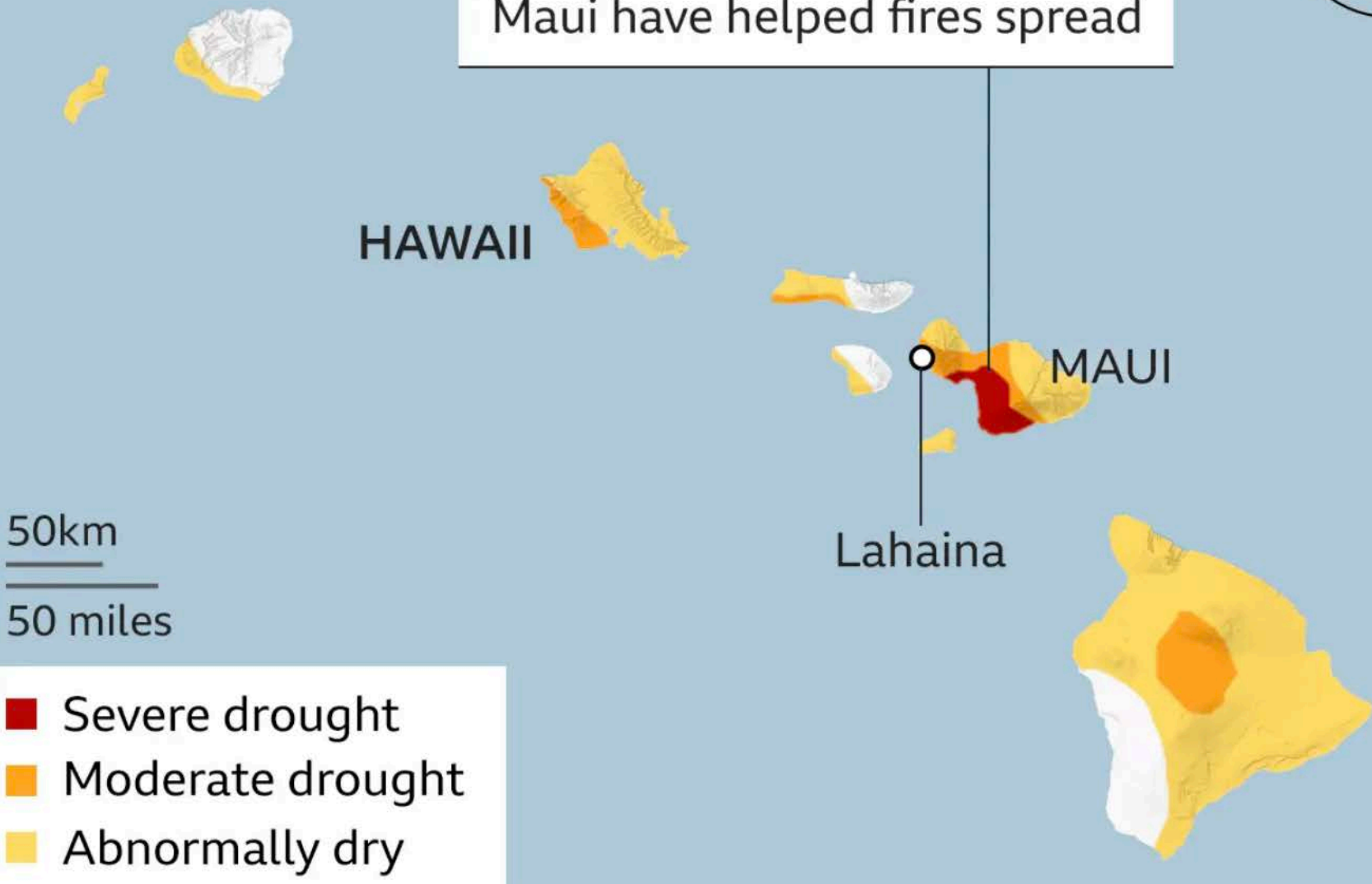
1 °Celsius  
increase =

7% more  
atmospheric  
moisture





Abnormally dry conditions on Maui have helped fires spread



Google

Source: US Drought Monitor, data released 10 Aug 2023



# Hawaii Hammered by Flash Flooding from Kona Low

December 10, 2021













# Mental Health

- Hurricane Katrina

5-7 mos after Katrina:  
30 day DSM4 Survey

	New Orleans Metro (N = 594)	Other locations (N = 449)
Any anxiety-mood disorder	49%	26%
PTSD	30%	12.5%

*Arch Gen Psychiatry.* 2007;64(12):1427-1434. doi:10.1001/archpsyc.64.12.1427



ABC News; Dave Martin; Superdome 8/28/05

# The toxic components of wildfire smoke

Smoke from natural fuel sources like biomass contain PAHs, CO<sub>2</sub>, CO, NO<sub>x</sub>, VOCs, SVOCs, soot, and PM<sub>2.5</sub>

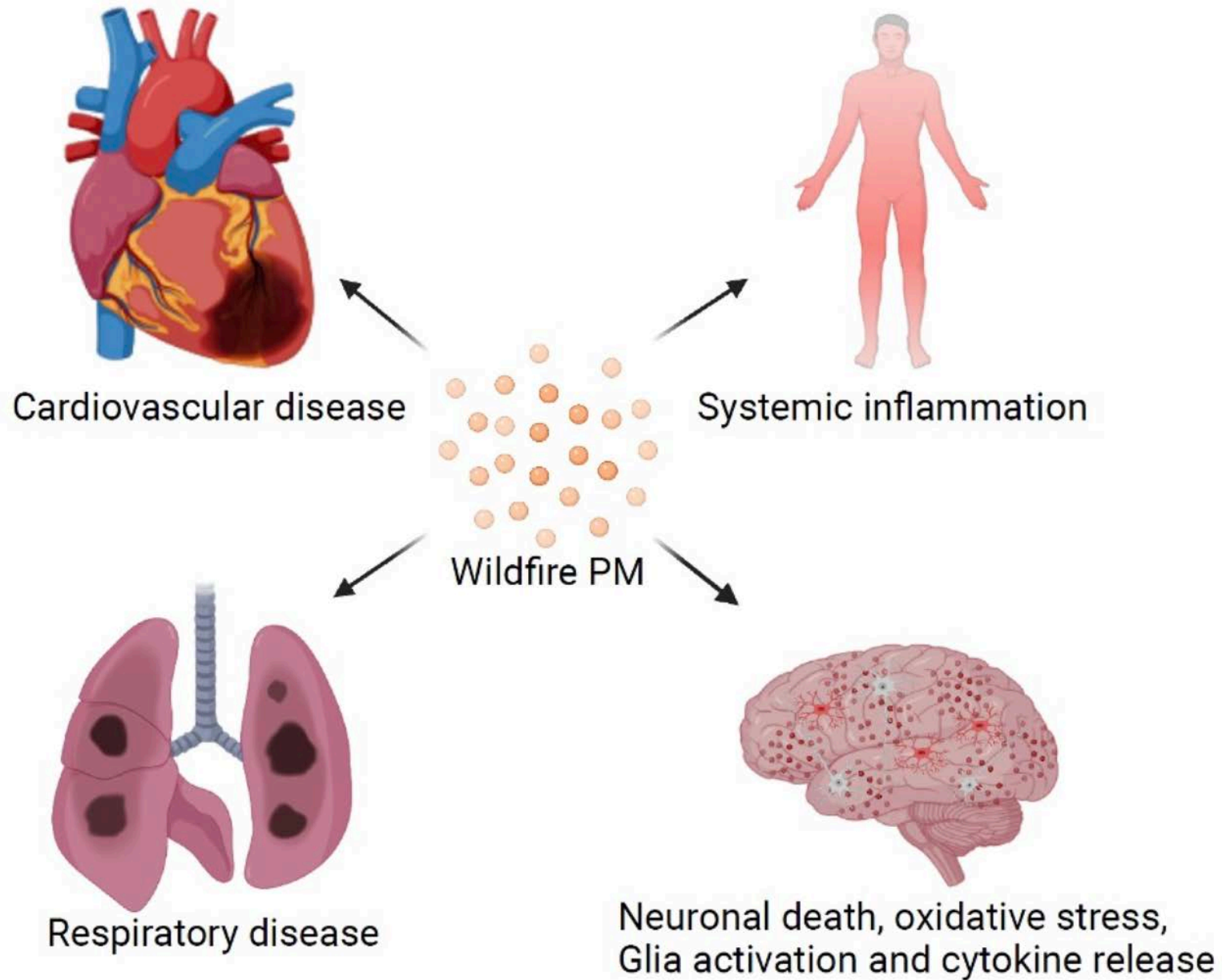
The formation of SOAs and O<sub>3</sub> occur from photooxidation of industrial emissions and/or biomass burning

Smoke from synthetic fuel sources like plastics, electronics, and building materials in homes contain toxic metals, VOCs, SVOCs, PAHs, PHHs, and much more..

Wildfires produce other toxic compounds that can infiltrate watersheds, such as ash and soot, which contain PAHs, hazardous metals, and more..

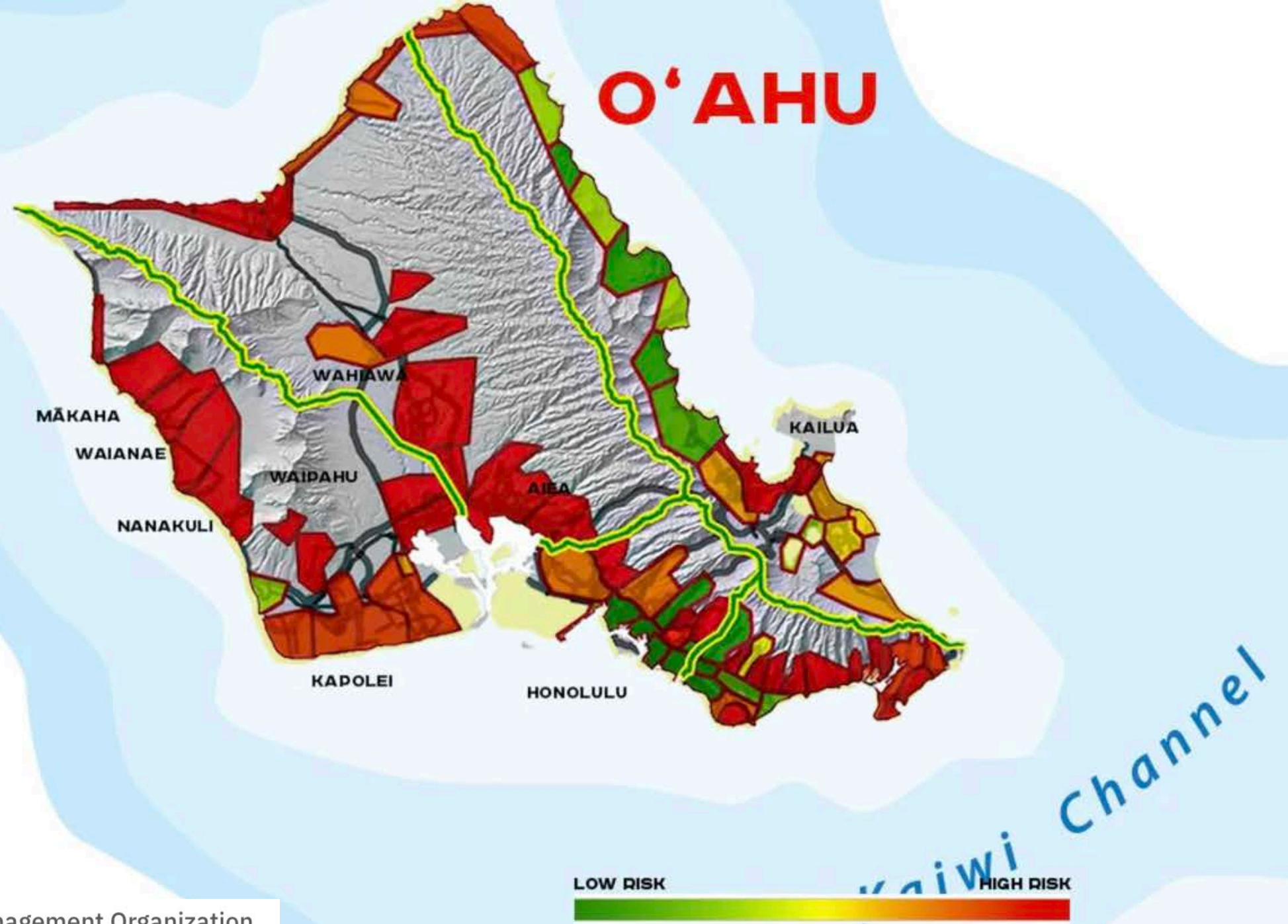
PAHs= Polycyclic aromatic hydrocarbons  
PHHs= Planar halogenated hydrocarbons  
CO<sub>2</sub>= Carbon dioxide  
CO= Carbon monoxide  
NO<sub>x</sub>= Nitrogen Oxides  
O<sub>3</sub>= Ozone  
PM<sub>2.5</sub>= Particulate matter 2.5µm in diameter  
SOAs- Secondary organic aerosols  
VOCs= Volatile organic chemicals  
SVOCs= Semi-volatile organic chemicals





*Health impacts of wildfire particulate matter (PM).*

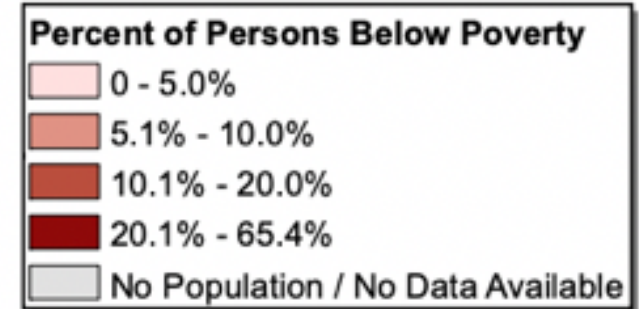
# O'AHU



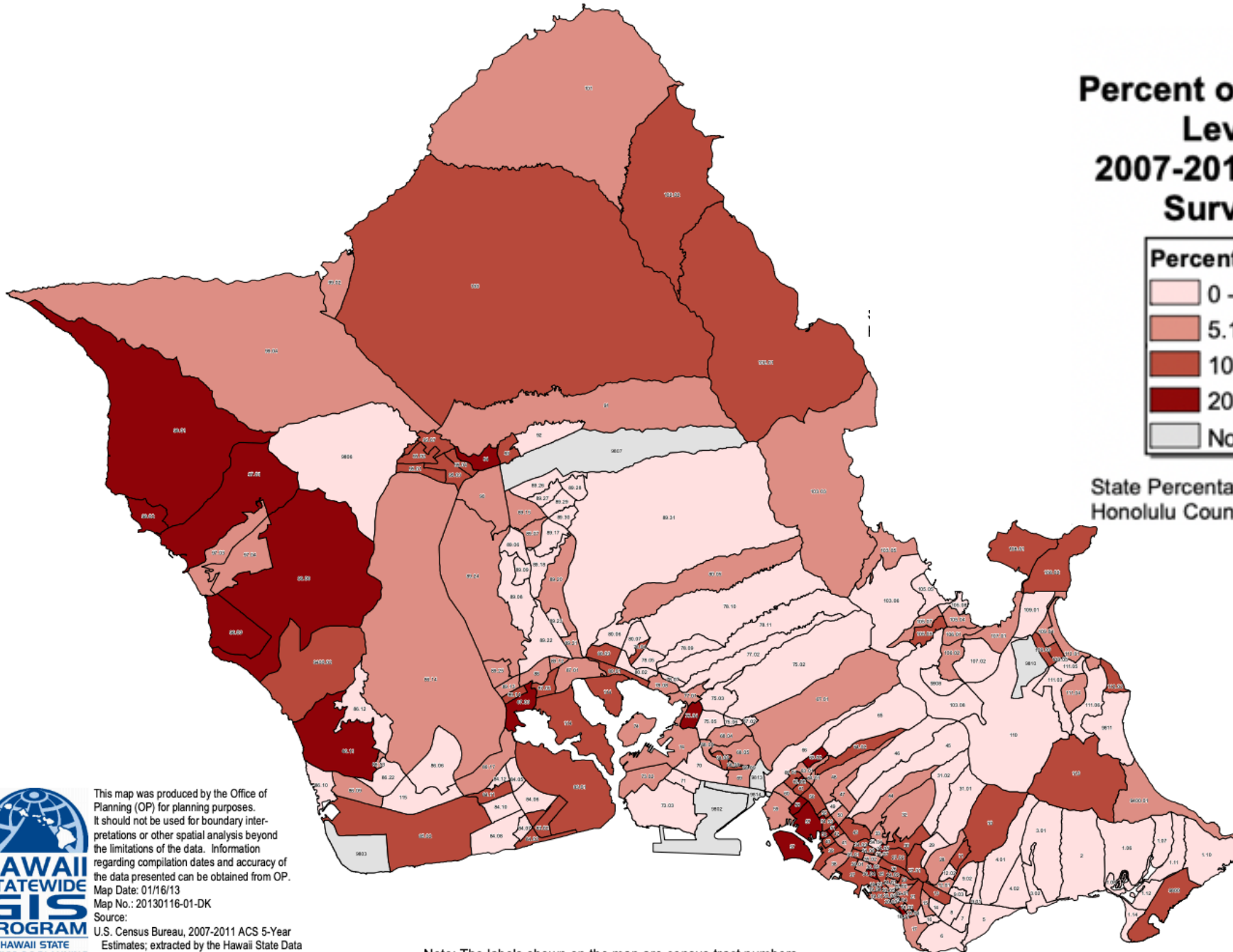
Source: Hawai'i Wildfire Management Organization



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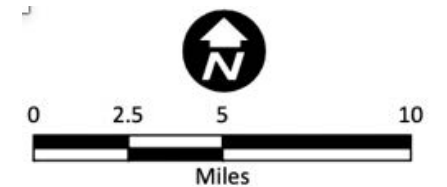


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## Mental Health Impacts

## Rising Temperatures



# IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH IN HAWAI'I

## Increasing GHG Levels



## More Extreme Weather



## Rising Sea Levels



Stress, anxiety, depression, eco-grief, post-traumatic stress disorder, strains on social relationships

## Severe Weather & Floods

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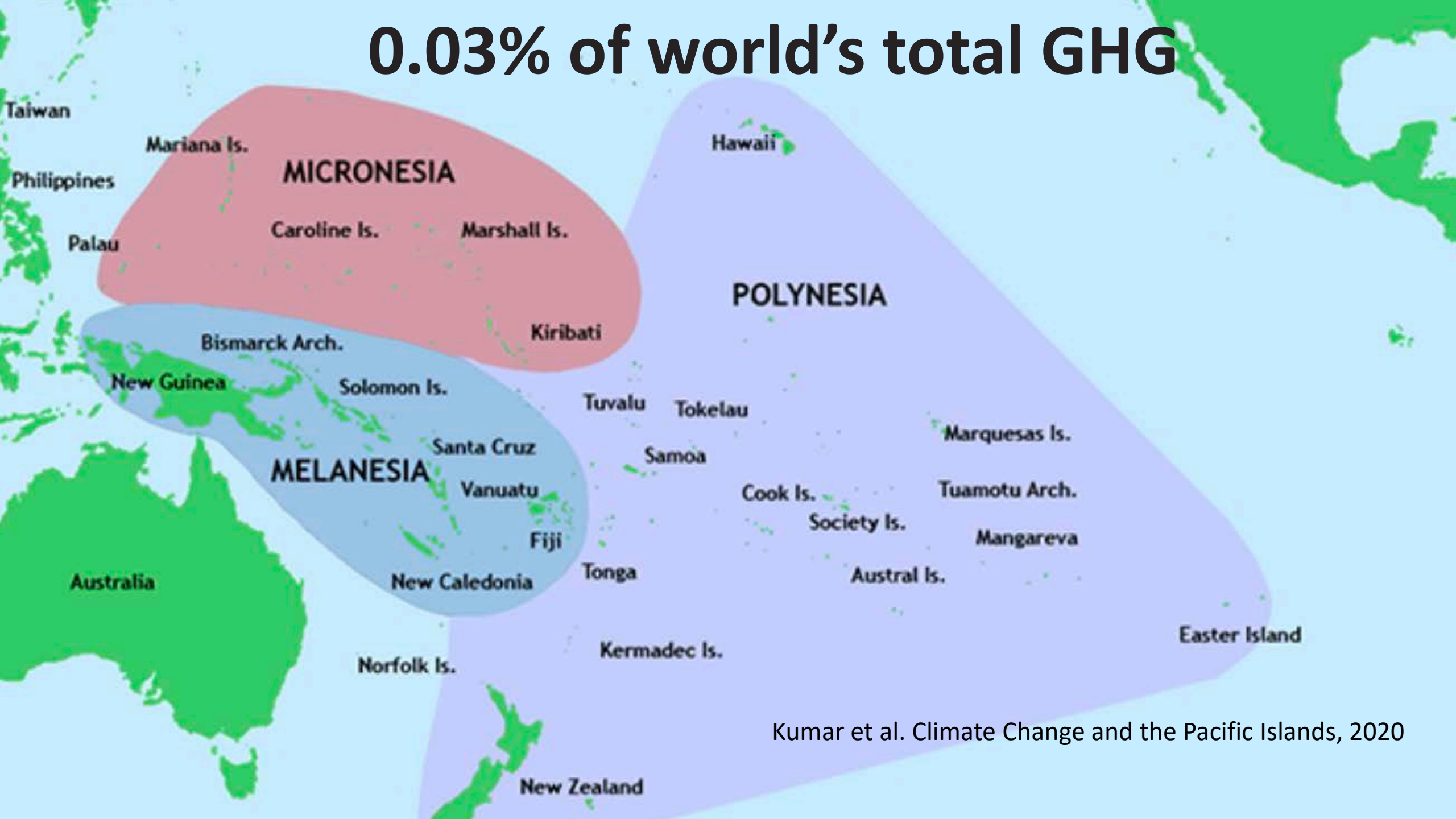
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(Adapted from CDC, J. Patz; CDPH)



# 0.03% of world's total GHG



Kumar et al. Climate Change and the Pacific Islands, 2020





Photo: Civil Beat  
Mark Edward Harris



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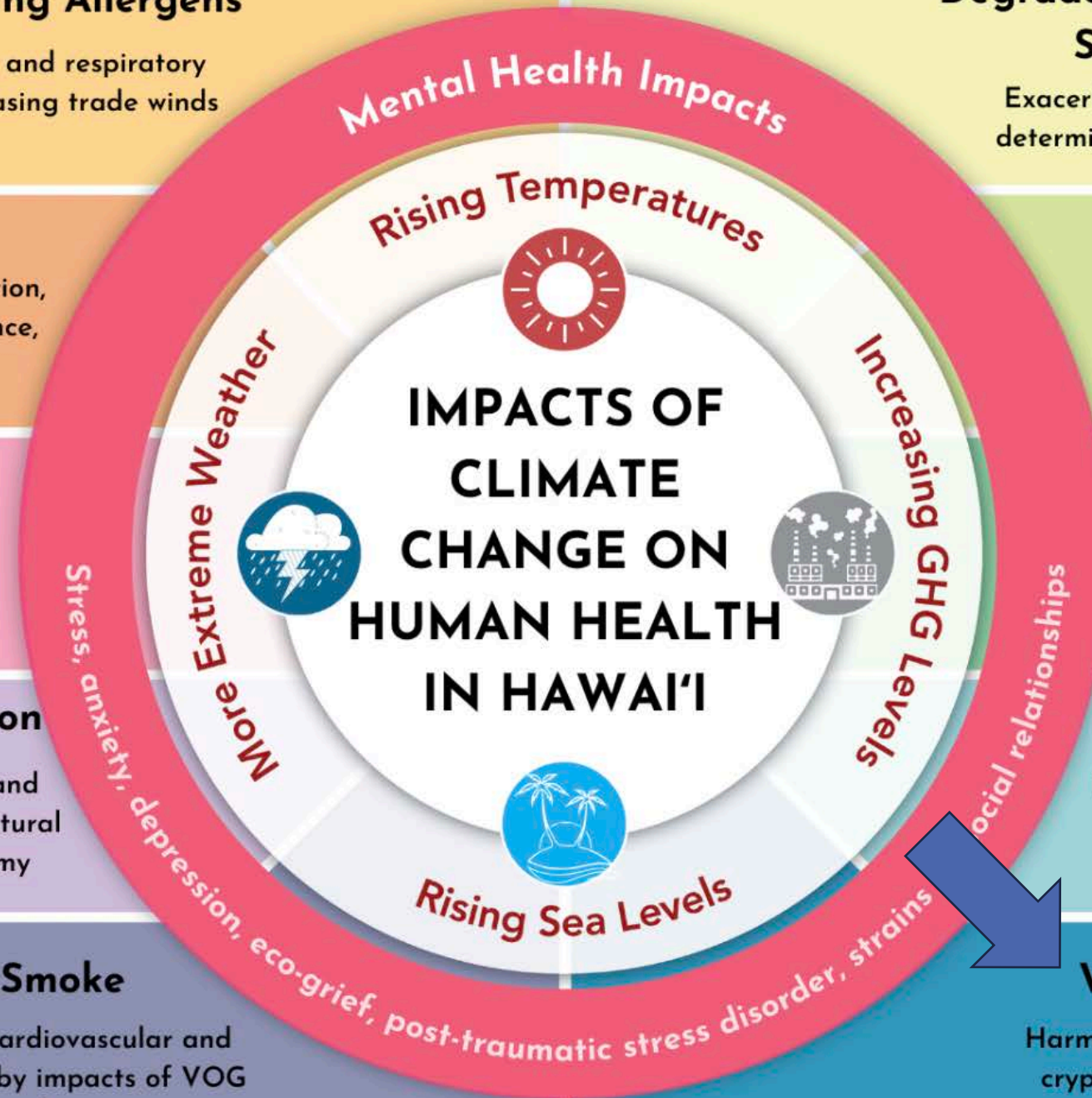
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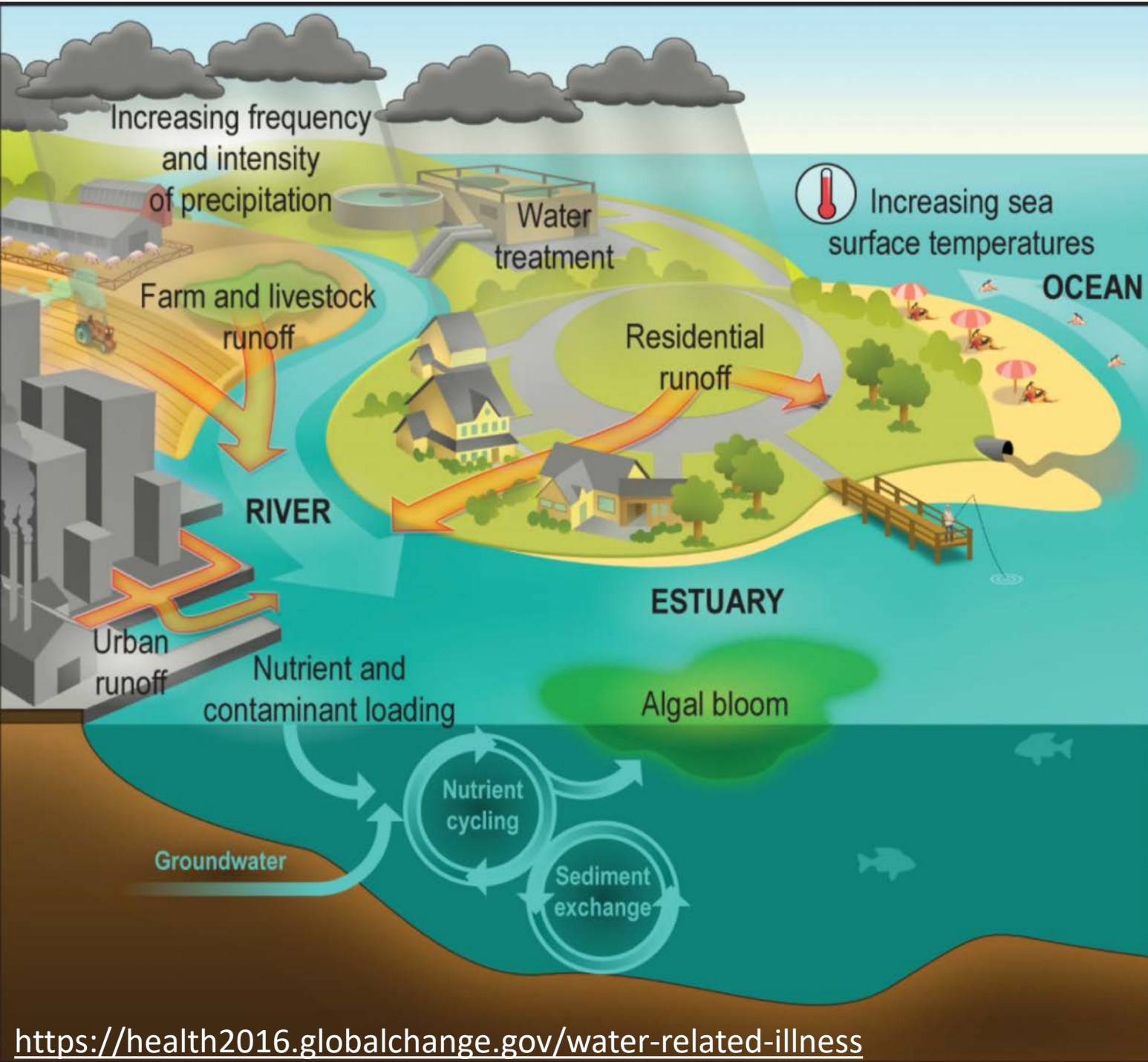
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Temperature



Pathogen survival  
+ reproduction

Interaction between  
CC and urban sanitary  
infrastructure



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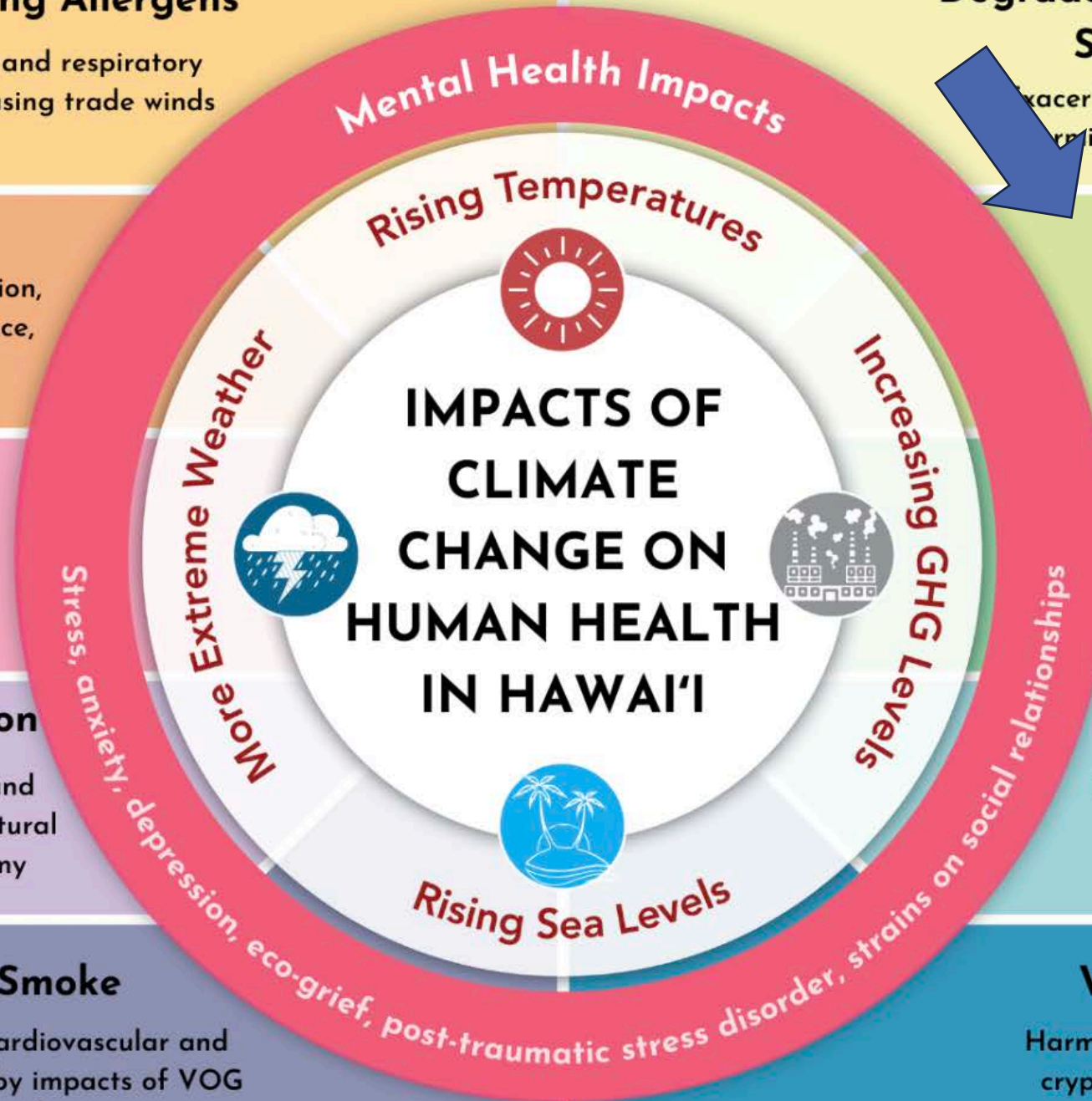
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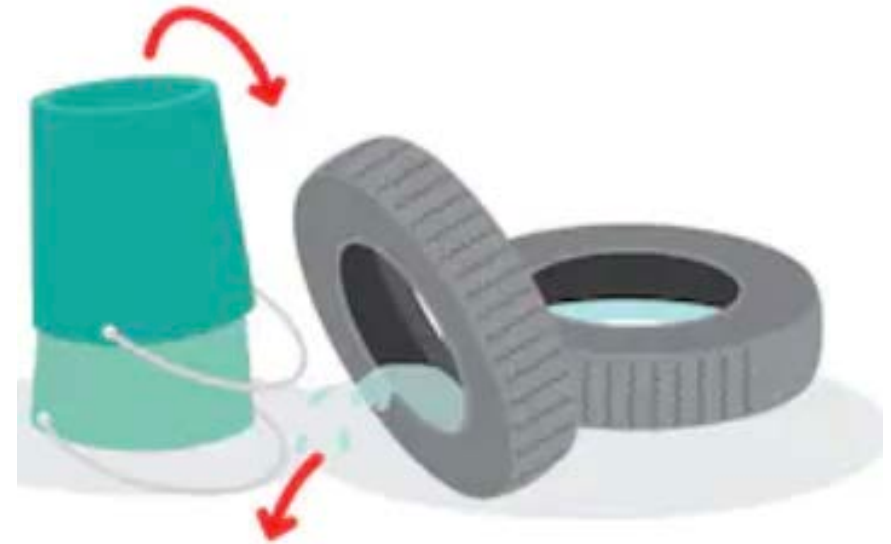


(Adapted from CDC, J. Patz; CDPH)

# Vector Borne Diseases: Mosquito



*Aedes Albopiticus*

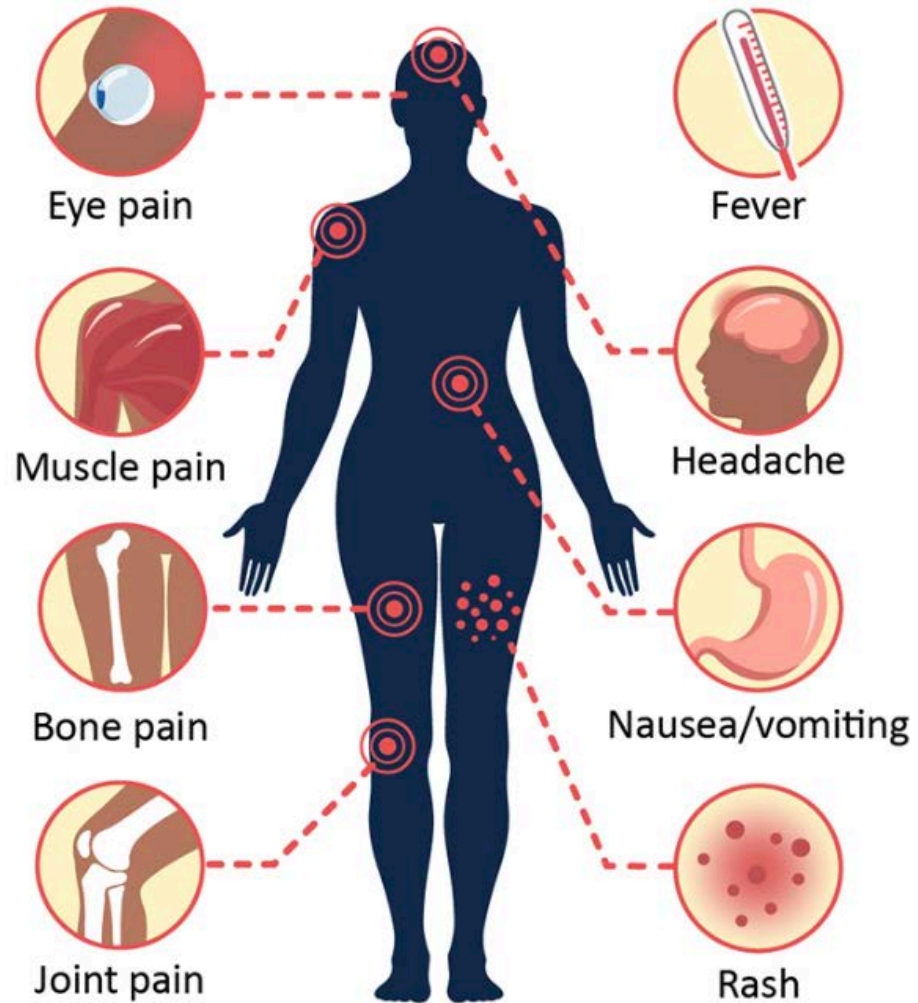


Dengue  
Yellow Fever  
Chikungunya  
Zika



# Dengue Symptoms

Fever with any of the following



The typical rash seen in dengue fever



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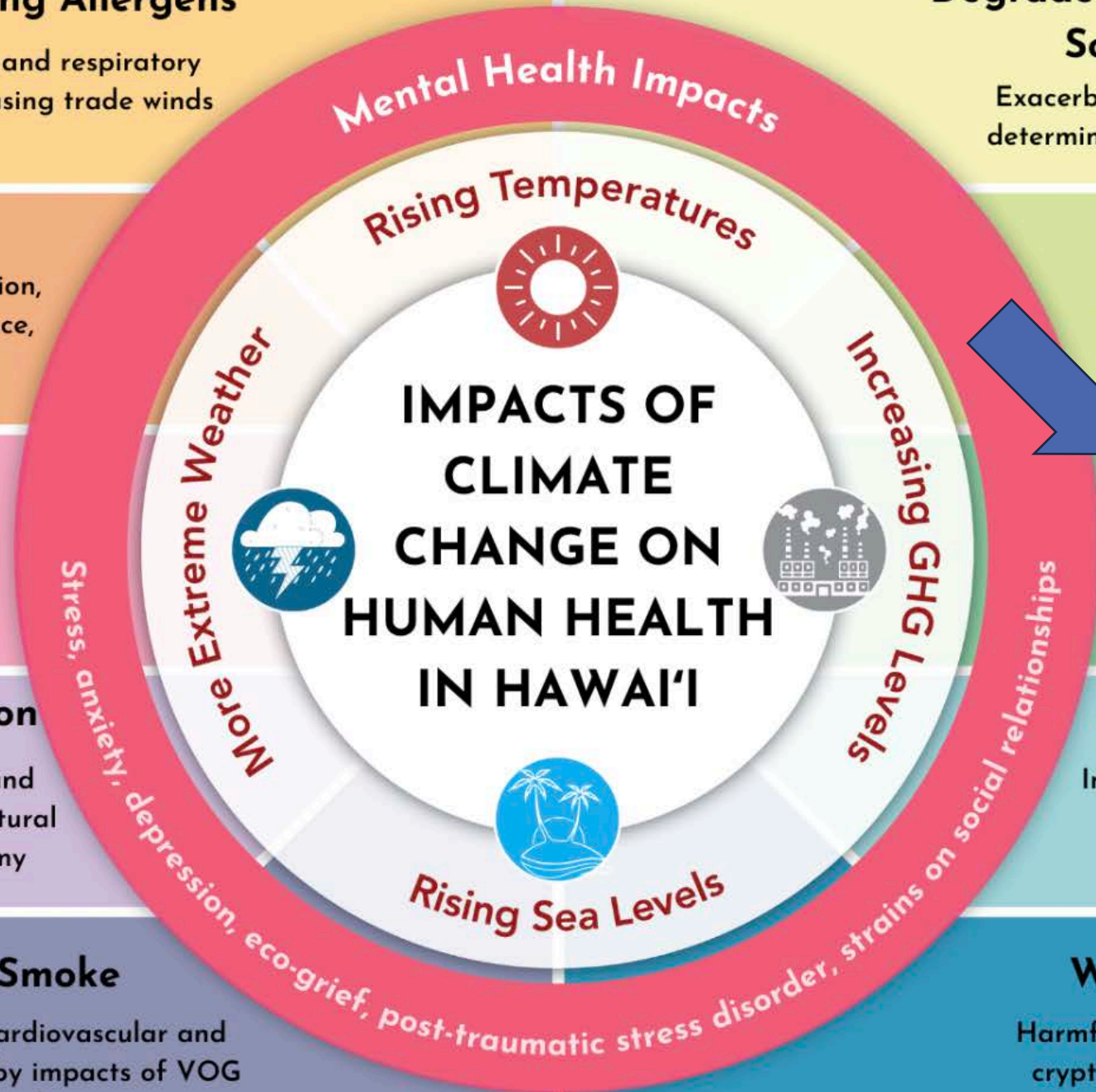
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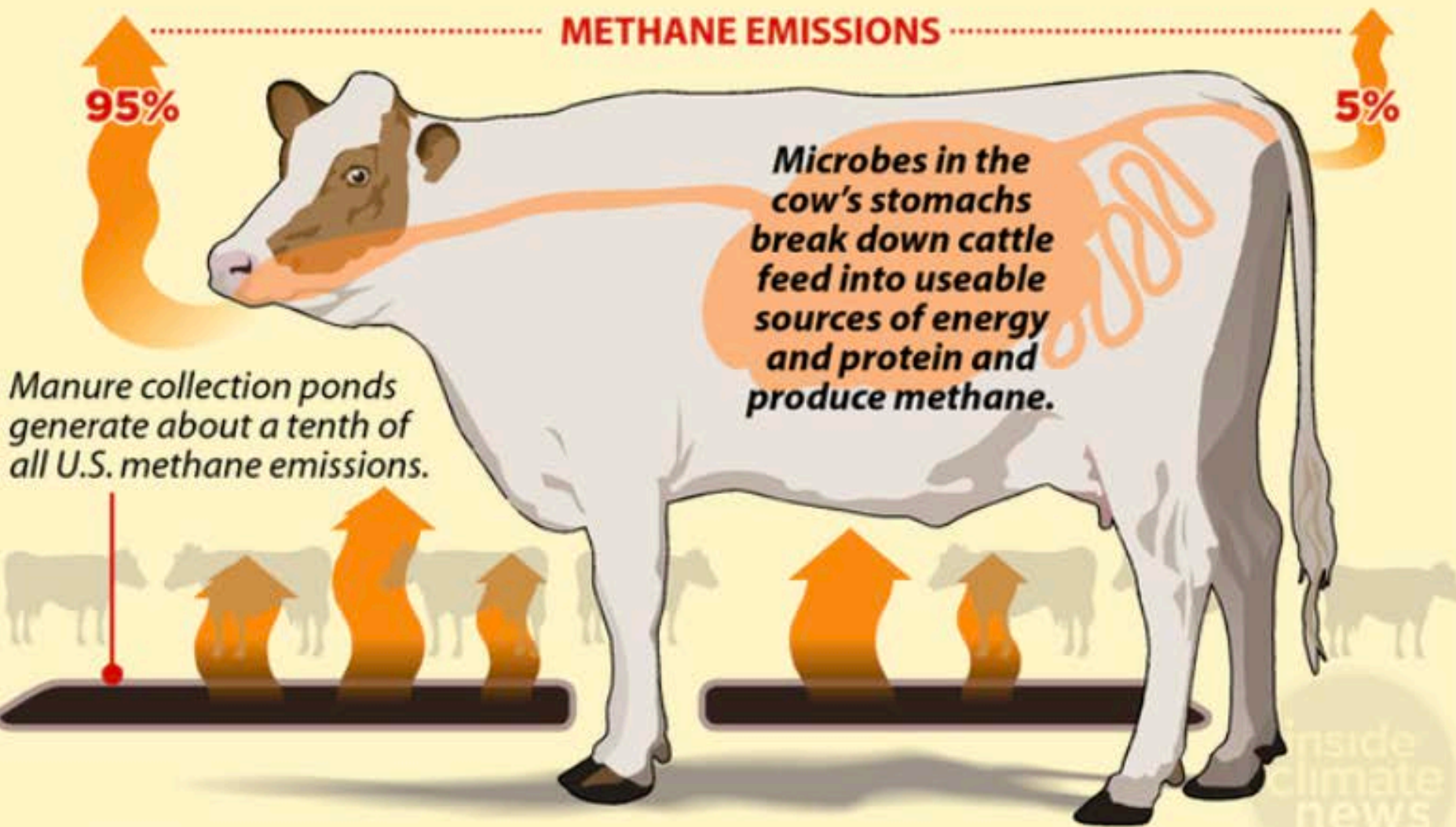


*Food prices were seen as a contributing factor in the Arab spring uprising in 2011*



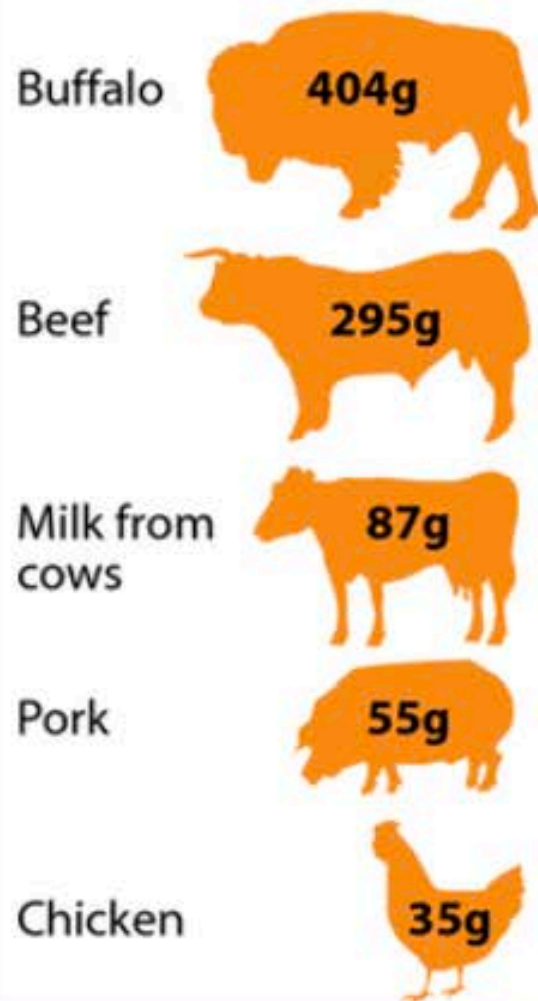
# Livestock-Based Methane Emissions

About a quarter of U.S. methane emissions come straight out of livestock, most of it from belching.



## METHANE EMISSIONS PER GRAM OF PROTEIN

Global estimates in grams, CO<sub>2</sub>-equivalent









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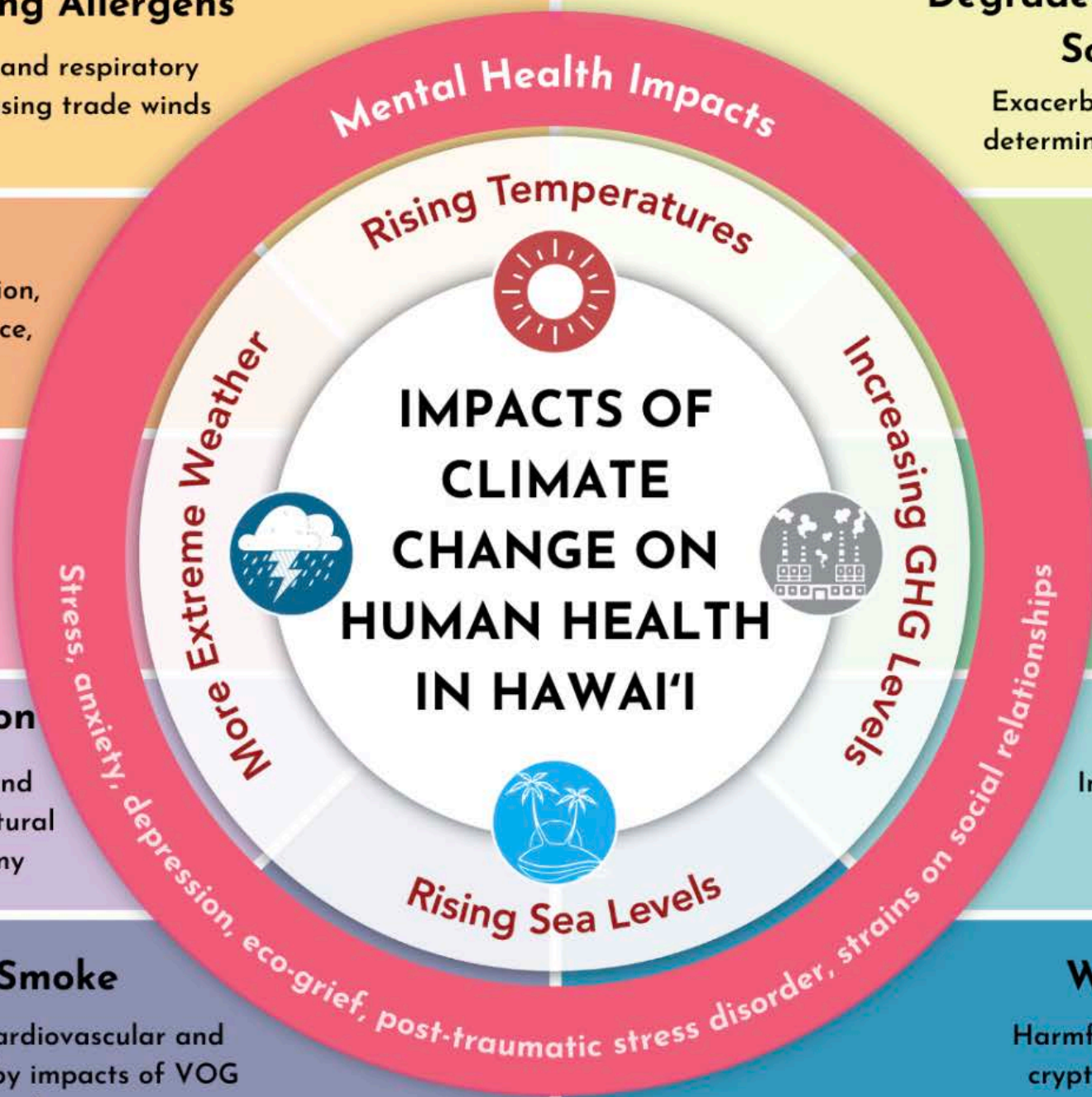
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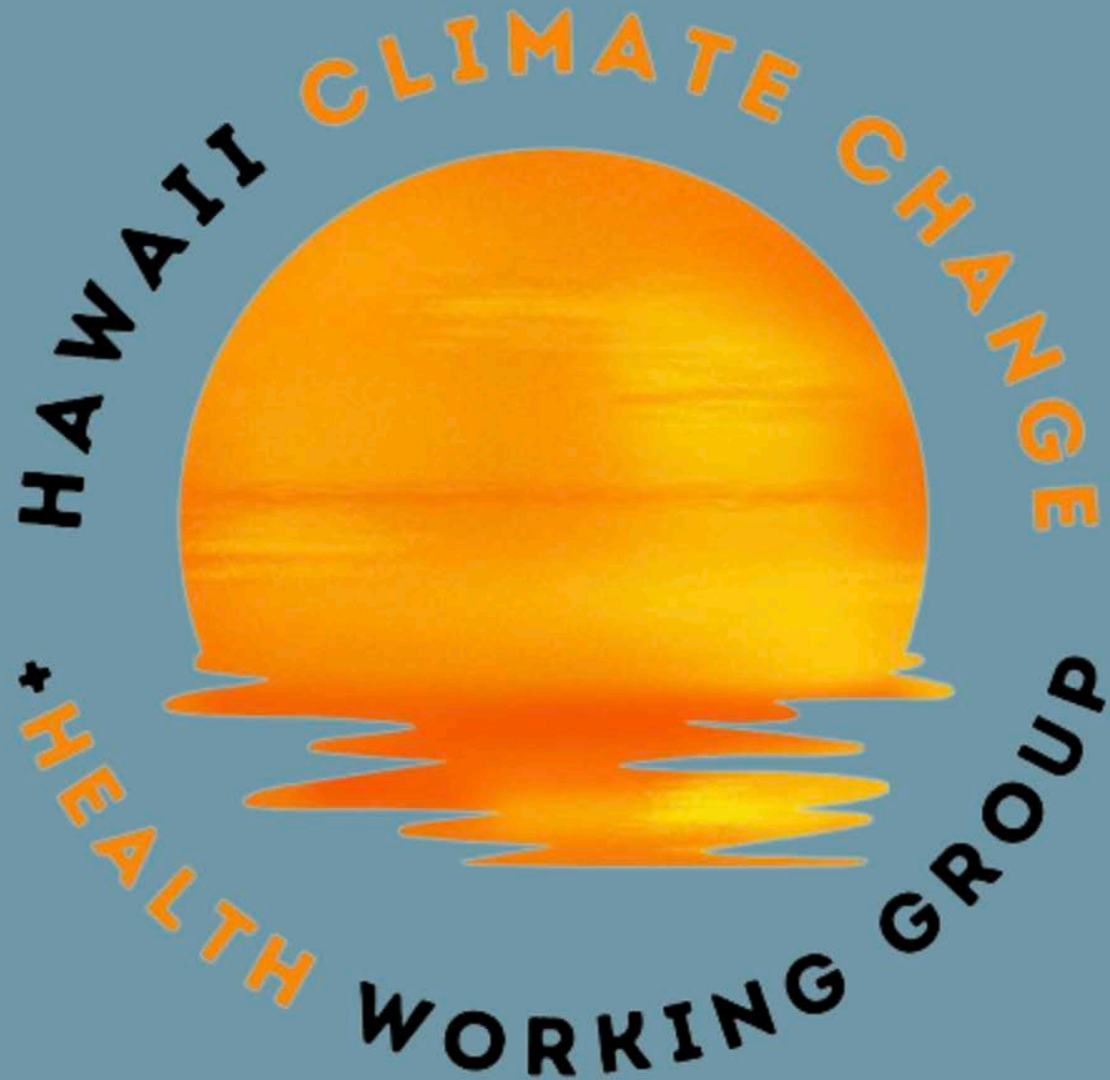




# Turning to traditional Hawaiian wisdom for input on climate change

Apprentice Nanea Keli weeds chard at MA'O Organic Farms in Waianae. The farm is one of the recipients of a letter from a special committee of Democratic U.S. senators seeking input on climate change.





## Mission

Research + communicate the human health impacts of climate change

Advocate for policy solutions

Prioritize our most at-risk community members