

# Air, Mosquito, and Health: a study on the Greater Bay Area

大灣區未來空氣對人類和環境健康的啟示

11-01-2020

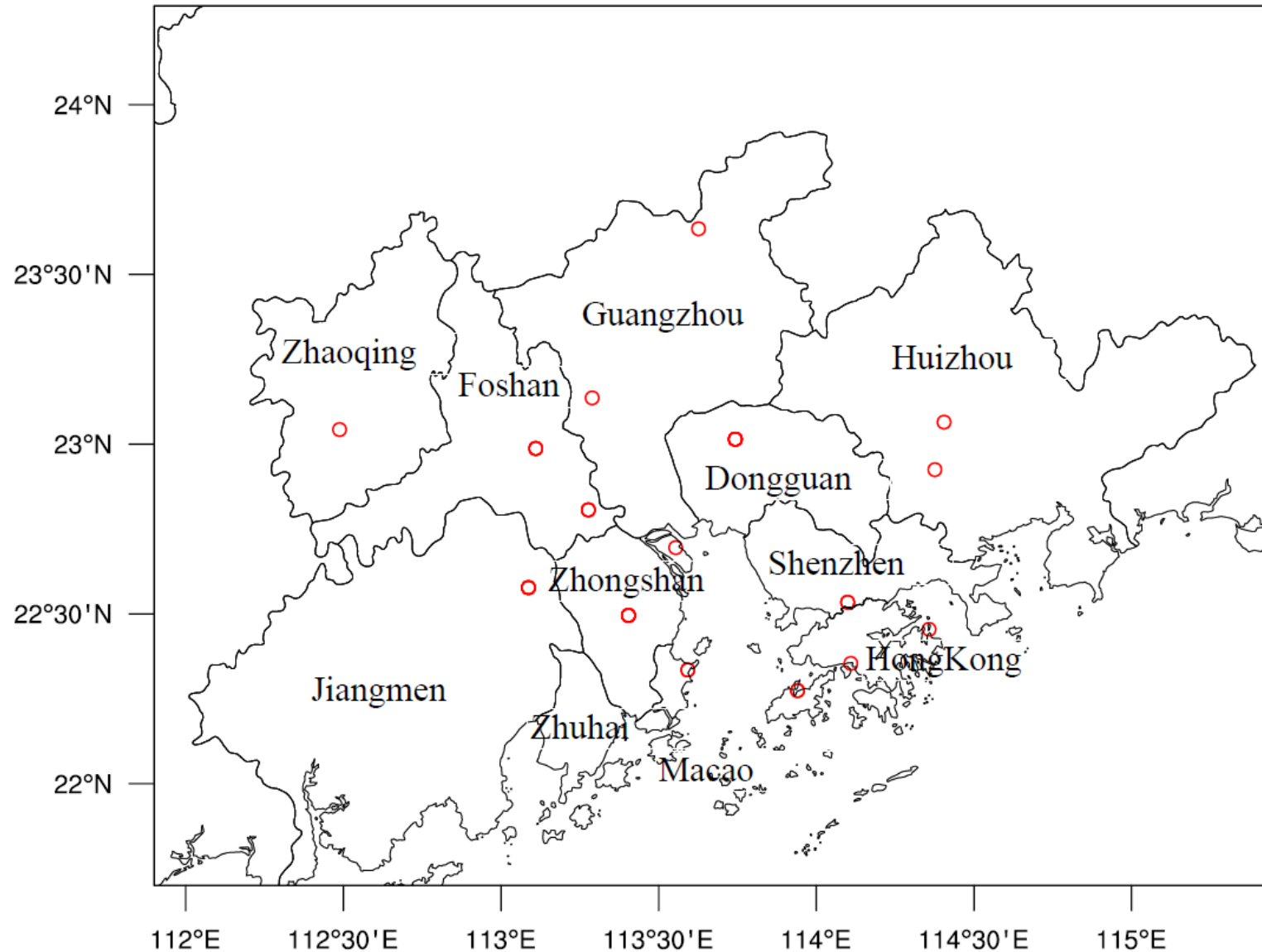
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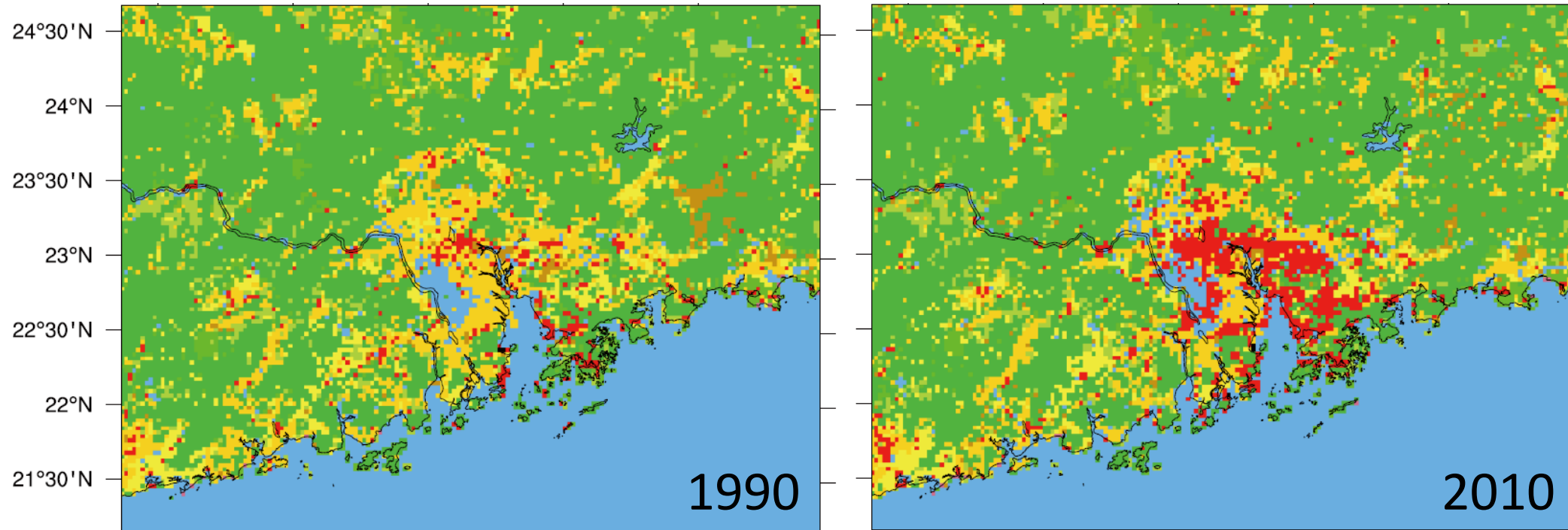


# The Greater Bay Area, China



# Urbanization

- The urban coverage in the region increased by **136%** between 1990 and 2010.



Red: urban areas

Source: Wang et al. (2019)



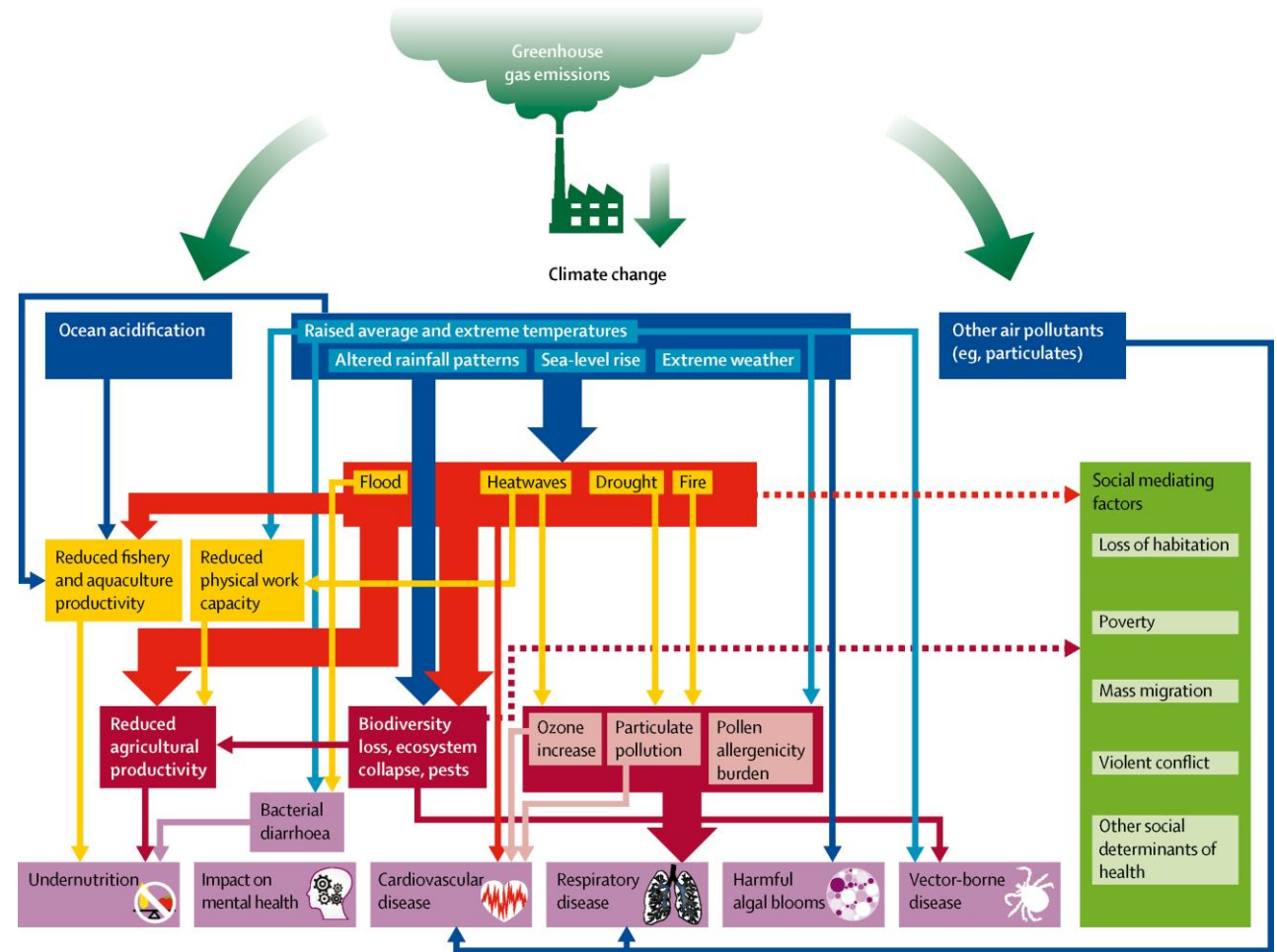
# Climate change

## The Lancet Report

The 2018 report of the *Lancet* Countdown on health and climate change: shaping the health of nations for centuries to come

*Nick Watts, Markus Amann, Nigel Arnell, Sonja Ayeb-Karlsson, Kristine Belesova, Helen Berry, Timothy Bouley, Maxwell Boykoff, Peter Byass, Wenjia Cai, Diarmid Campbell-Lendrum, Jonathan Chambers, Meaghan Daly, Niheer Dasandi, Michael Davies, Anneliese Depoux, Paula Dominguez-Salas, Paul Drummond, Kristie L Ebi, Paul Ekins, Lucia Fernandez Montoya, Helen Fischer, Lucien Georgeson, Delia Grace, Hilary Graham, Ian Hamilton, Stella Hartinger, Jeremy Hess, Ilan Kelman, Gregor Kiesewetter, Tord Kjellstrom, Dominic Kniveton, Bruno Lemke, Lu Liang, Melissa Lott, Rachel Lowe, Maquins Odhiambo Sewe, Jaime Martinez-Urtaza, Mark Maslin, Lucy McAllister, Slava Jankin Mikhaylov, James Milner, Maziar Moradi-Lakeh, Kayn Morrissey, Kris Murray, Maria Nilsson, Tara Neville, Tadj Oreszczyn, Fereidoon Owfi, Olivia Pearman, David Pencheon, Steve Pye, Mahnaz Rabbaniha, Elizabeth Robinson, Joacim Rocklöv, Olivia Saxer, Stefanie Schütte, Jan C Semenza, Joy Shumake-Guillemot, Rebecca Steinbach, Meisam Tabatabaei, Julia Tomei, Joaquin Trinanes, Nicola Wheeler, Paul Wilkinson, Peng Gong\*, Hugh Montgomery\*, Anthony Costello\**

Review



# Outline

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- Effects of urbanization and climate change on
  - Regional climate and heat stress
  - Mosquito population and health risk implications
  - Air quality and resultant health impacts



# Heatwave

AccuWeather MAPS NEWS VIDEO SEVERE WEATHER MORE

Macau Weather > Saint Lazarus Parish, Macau 19° C

NEWS VIDEOS BLOGS PERSONALITIES

**Northern India, Pakistan to endure deadly heat wave into June**

By Eric Leister, AccuWeather senior meteorologist & Adam Douty, AccuWeather senior meteorologist  
Updated Jul. 2, 2019 1:10 AM



Life-threatening heat is expected across the region. Relief is in sight.

**Times**

FOUNDER & PUBLISHER Kowie Goldenhuys EDITOR-IN-CHIEF Paulo Coutinho Macau, Friday, January 10, 2020

HOME MACAU GREATER BAY BUSINESS CHINA ASIA WORLD SPORTS INTERNATIONAL

A strong area of high pressure has taken over the region, cooling thunderstorms and allowing temperatures to rise. This is the start of the summer season in many locations.

Temperatures will continue to reach **JAPAN | RECORD HIGH AS HEAT WAVE GRIPS THE REGION**

TUESDAY, JULY 24, 2018 - 1 YEAR AGO NO COMMENTS 1,803 VIEWS



World Africa Americas Australia China Europe India Middle East United Kingdom

**Nearly 1,500 deaths linked to French heat waves**

By Inshua Berlinger, CNN  
Updated 07:21 GMT (10:21 HKT) September 16, 2019



The Washington Post  
Democracy Dies in Darkness

**Europe's killer heat waves are a new norm. The death rates shouldn't be.**

BES Biomedical and Environmental Sciences  
Volume 26, Issue 8, August 2013, Pages 647-654

Original Article  
**Impact of Heat Wave in 2005 on Mortality in Guangzhou, China**

Jun YANG<sup>a, \*</sup>, Hua Zhang LIU<sup>b, \*</sup>, Chun Quan OU<sup>a</sup>, Guo Zhen LIN<sup>b</sup>, Yan DING<sup>c</sup>, ZHOU, Qin<sup>b</sup>, Ji Chuan SHEN<sup>b</sup>, Ping Yan CHEN<sup>a</sup>

Show more

<https://doi.org/10.3967/0895-3988.2013.08.003> Get rights and content

The total number of excess deaths in 2005 was 145 with an average of 12 deaths per day.



# Climate impacts on human health

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- Exposure to rapid rises in heat gain can result in a cascade of illnesses, including heat cramps, heatstroke, and hyperthermia.
- Temperature extremes can also worsen chronic conditions, including cardiovascular, respiratory, and cerebrovascular disease and diabetes-related conditions.



# Climate impacts on human health

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**nature  
communications**

Article | [Open Access](#) | Published: 06 August 2019

## **Tens of thousands additional deaths annually in cities of China between 1.5 °C and 2.0 °C warming**

Yanjun Wang, Anqian Wang, Jianqing Zhai, Hui Tao, Tong Jiang , Buda Su , Jun Yang, Guojie Wang, Qiyong Liu, Chao Gao, Zbigniew W. Kundzewicz, Mingjin Zhan, Zhiqiang Feng & Thomas Fischer 

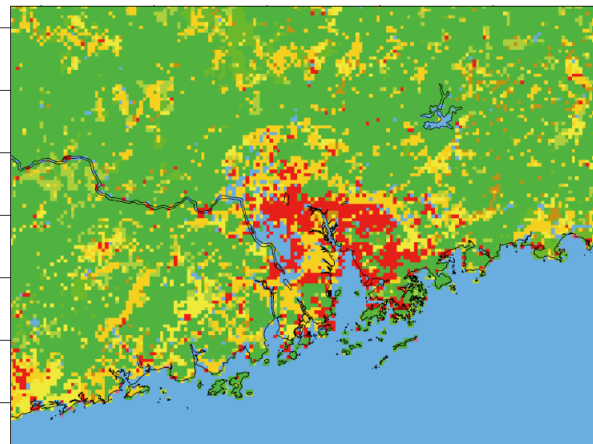
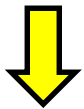
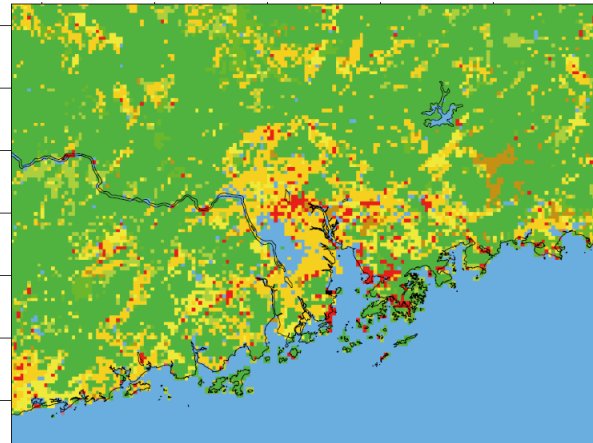
*Nature Communications* **10**, Article number: 3376 (2019) | [Cite this article](#)

“Additional warming from 1.5 °C to 2 °C will lead to more than 27.9 thousand additional heat-related deaths, annually.”





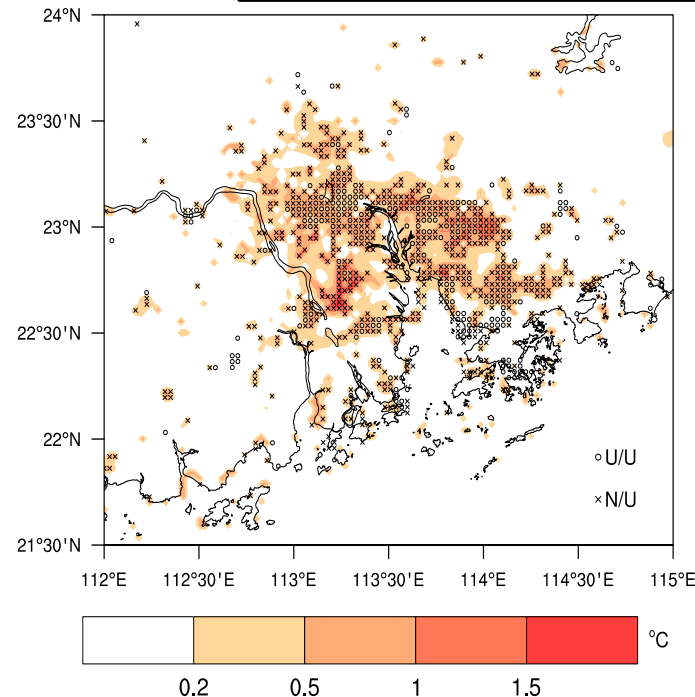
# Impacts of urbanization on regional climate



Rural



Urban



$\Delta$  temperature at  
2m above ground

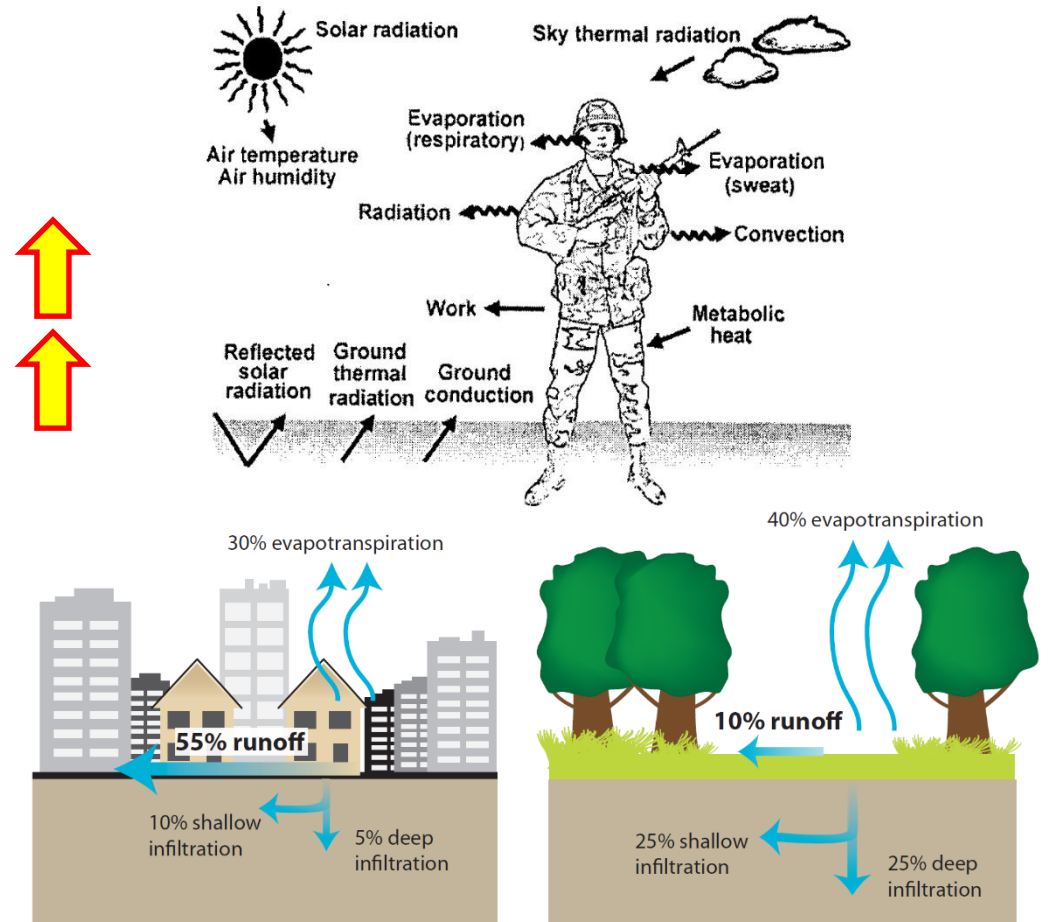
Annual	[0.62 K (0.24–1.00 K)]
Spring	[0.53 K (0.17–0.89 K)]
Summer	[0.73 K (0.36–1.10 K)]
Autumn	[0.70 K (0.25–1.15 K)]
Winter	[0.49 K (0.00–0.99 K)]

Temporal variations  
=> extreme situation



# Impacts of urbanization on heat stress

- The frequency at which the ambient temperature exceeds
  - 28.2°C (HK) (Chan *et al.*, 2012): 5.3%
  - 26.4°C (GD) (Yang *et al.*, 2012) : 5.9%
- The changes in WBGT and HKHI are marginal (<1%).
  - Offset by lower relative humidity.



Source: USEPA

(<http://www.epa.gov/hiri/resources/pdf/BasicCompendium.pdf>)



# Impacts of climate change on heat stress

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- Our model projection for 2030 showed that the regional averaged  $T_2$  in the Greater Bay Area will increase by 0.21 K.
- The frequency of extreme heat stress will increase to 8-15% under various future emission scenarios.
- These results emphasize the substantial effect of climate change on heat stress.



# Mosquito-borne diseases

- Mosquito-borne diseases significantly impact world health, accounting for approximately 17% of the global burden of infectious disease (Townson et al. 2005).
  - the 2015 outbreak of Zika virus in Brazil (Guo et al. 2016) and
  - ~430 thousand reported deaths due to malaria in 2015 (WHO 2014)



Source:  
[https://i.dailymail.co.uk/i/pix/2016/02/06/10/30CA27E400000578-3434740-image-a-3\\_1454754598752.jpg](https://i.dailymail.co.uk/i/pix/2016/02/06/10/30CA27E400000578-3434740-image-a-3_1454754598752.jpg)

## Brazil announces end to Zika public health emergency

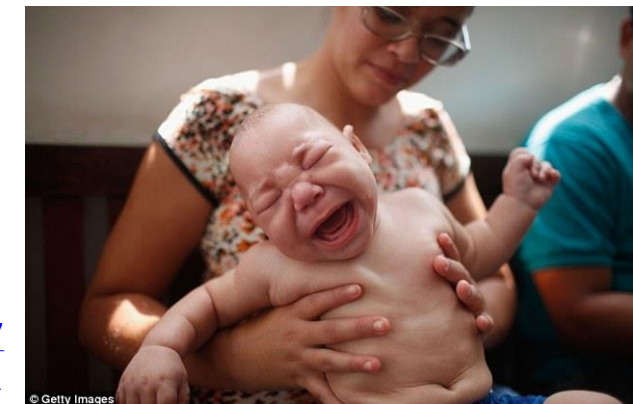
Fall in cases brings end to the emergency 18 months after the virus hit headlines around the world



▲ Aedes aegypti mosquitoes, responsible for transmitting Zika, in a petri dish at the Fiocruz Institute in Recife, Brazil. Photograph: Felipe Dana/AP

Source:

<https://www.theguardian.com/world/2017/may/12/brazil-announces-end-to-zika-public-health-emergency>



# Mosquito-borne diseases

South China Morning Post

Hong Kong / Health & Environment

## As dengue fever scare hits Hong Kong, how can you best avoid infection?

Nineteen Hongkongers have been confirmed with the virus in a single week – a spike authorities described as ‘very worrying’. What is being done to curb the spread, and how can residents protect themselves?



Elizabeth Cheung

Published: 8:00am, 23 Aug, 2018

23/8/2018



Source: South China Morning Post  
(<https://www.scmp.com/news/hong-kong/health-environment/article/2160887/dengue-fever-scare-hits-hong-kong-how-can-you-best>)

**UAE** 8/1/2020

## Massive surge of mosquitoes are back in Dubai, bugging residents

Dubai Municipality assures they are tackling the issue of mosquitos across all districts

Published: January 08, 2020 15:07

Mariam M. Al Serkal, Web Chief Reporter and Anjana Kumar, Senior Web Reporter



Silhouette of a mosquito.

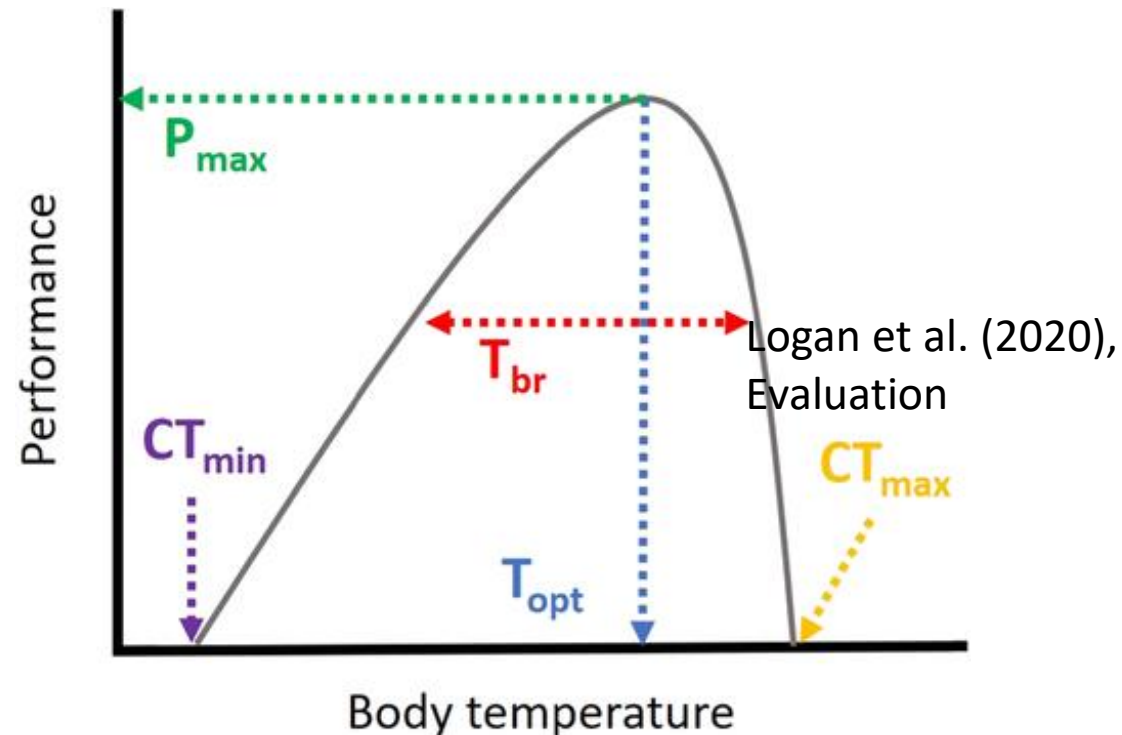
Image Credit: Pixabay

Source: <https://gulfnews.com/uae/massive-surge-of-mosquitoes-are-back-in-dubai-bugging-residents-1.1578482403748>



# Mosquito-borne diseases

- WHO has reported that diseases, such as malaria, Zika, dengue, chikungunya and yellow fever, are being reported for the first time in locations across the world (World Health Organization 2014).



# Mosquito-borne diseases in Macau



FOUNDER & PUBLISHER Kowie Geldenhuys EDITOR-IN-CHIEF Paulo Coutinho Macau, Thursday, January 09, 2020

## HEALTH | SSM DATA SHOWS DENGUE OUTBREAK RISK RISING

- THURSDAY, JUNE 20, 2019 - 7 MONTHS AGO NO COMMENTS 1,855 VIEWS

Data from the Health Bureau (SSM) shows that the risk of a dengue fever outbreak has increased in the SAR, as the bureau registered an average mosquito propagation rate of 47.4% in May, significantly higher than in April.

In May, the mosquito propagation index on the Macau peninsula was particularly high in the Inner Harbor and Tap Seac areas, at 48.4% and 47.7% respectively. However, Coloane recorded the highest, reaching 78.6%.

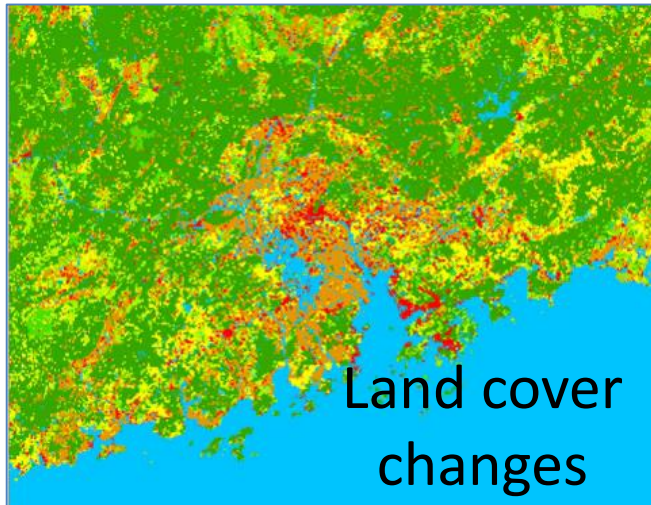
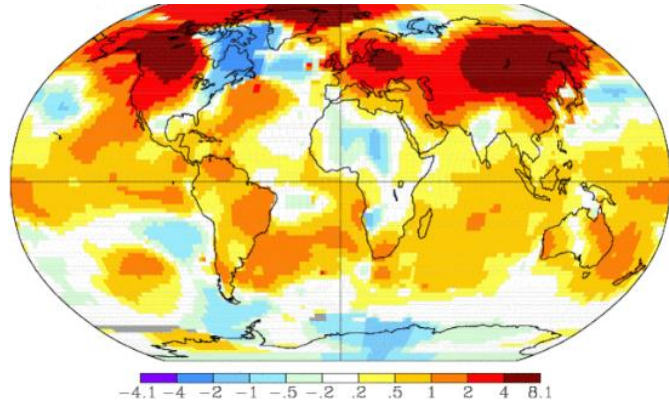
The data shows that the spread of mosquito-borne diseases, such as dengue fever, has increased in the SAR.



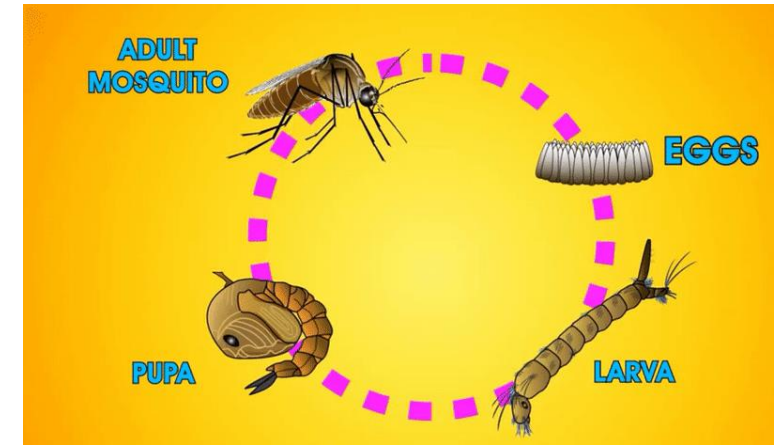
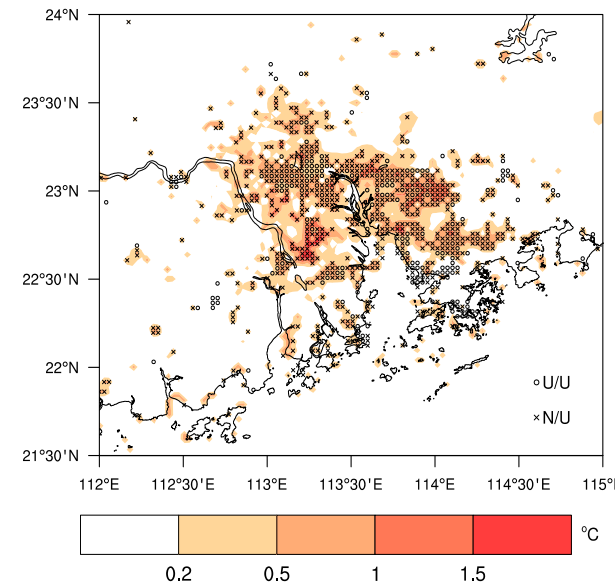
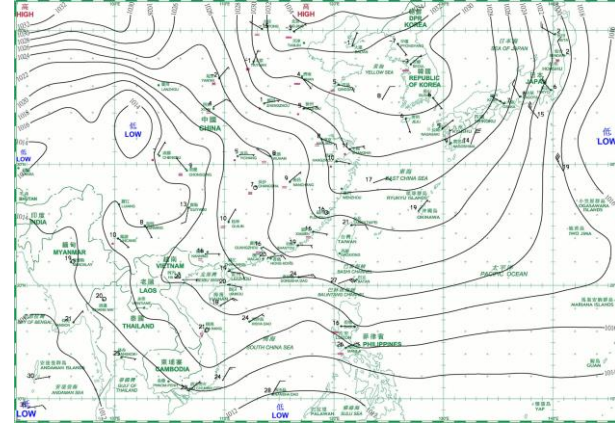
Source: <https://macaudailytimes.com.mo/health-ssm-data-shows-dengue-outbreak-risk-rising.html>

# Impacts of changes in climate on mosquito dynamics

Climate changes



日期/Date: 05.01.2020 香港時間/HK Time: 08:00 香港天文台 Hong Kong Observatory



Wang Y., Yim S.H.L., Yang Y., Morin C.W. (2019). The effect of urbanization and climate change on the mosquito population in the Pearl River Delta region of China. International Journal of Biometeorology, accepted for publication.



# *Culex (Cx.) quinquefasciatus* (致倦庫蚊)

- the southern house mosquito, is an epidemiological important vector for several arboviruses (Bartholomay et al. 2010), including West Nile virus (WNV), St. Louis encephalitis virus, and Western equine encephalitis

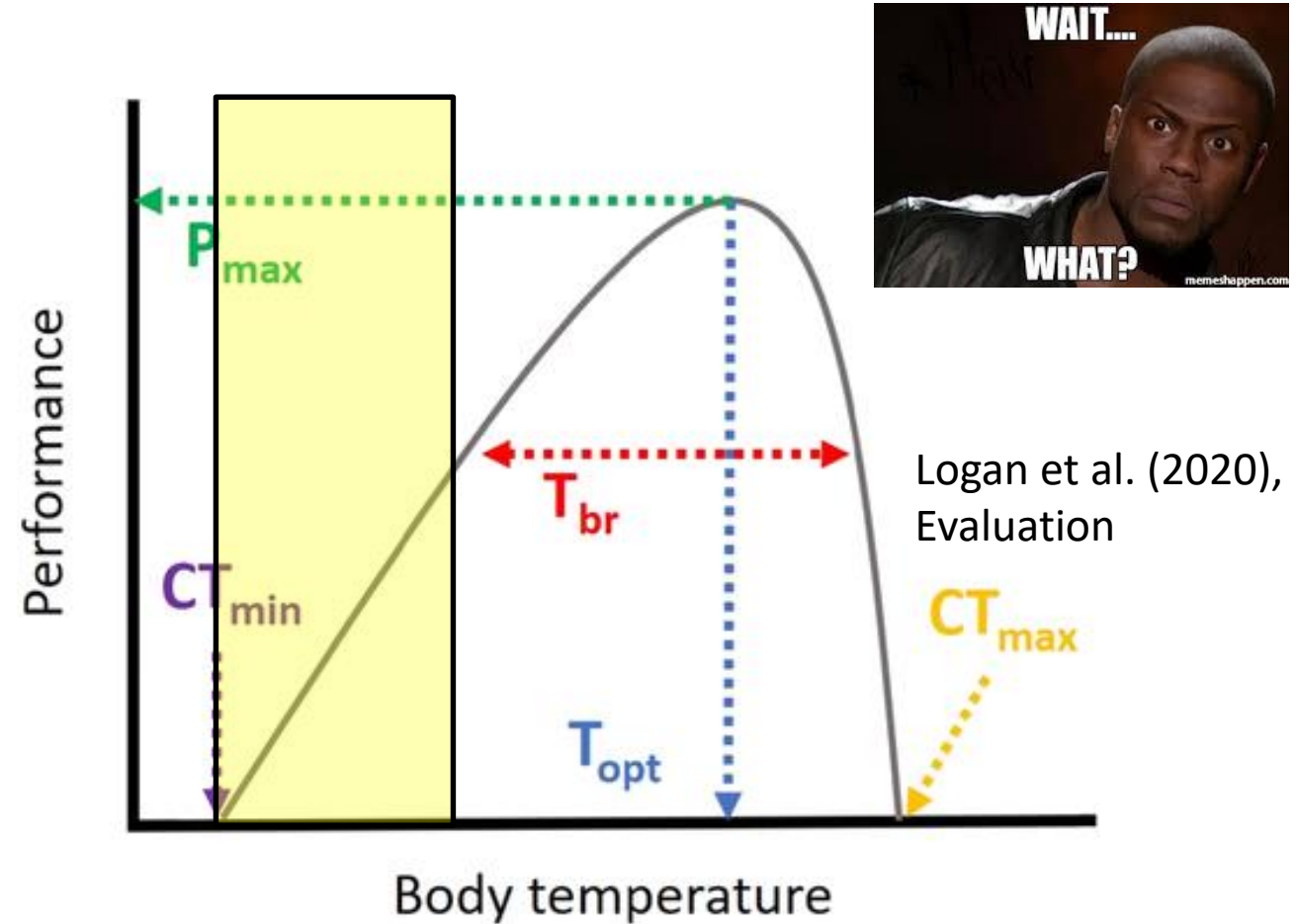
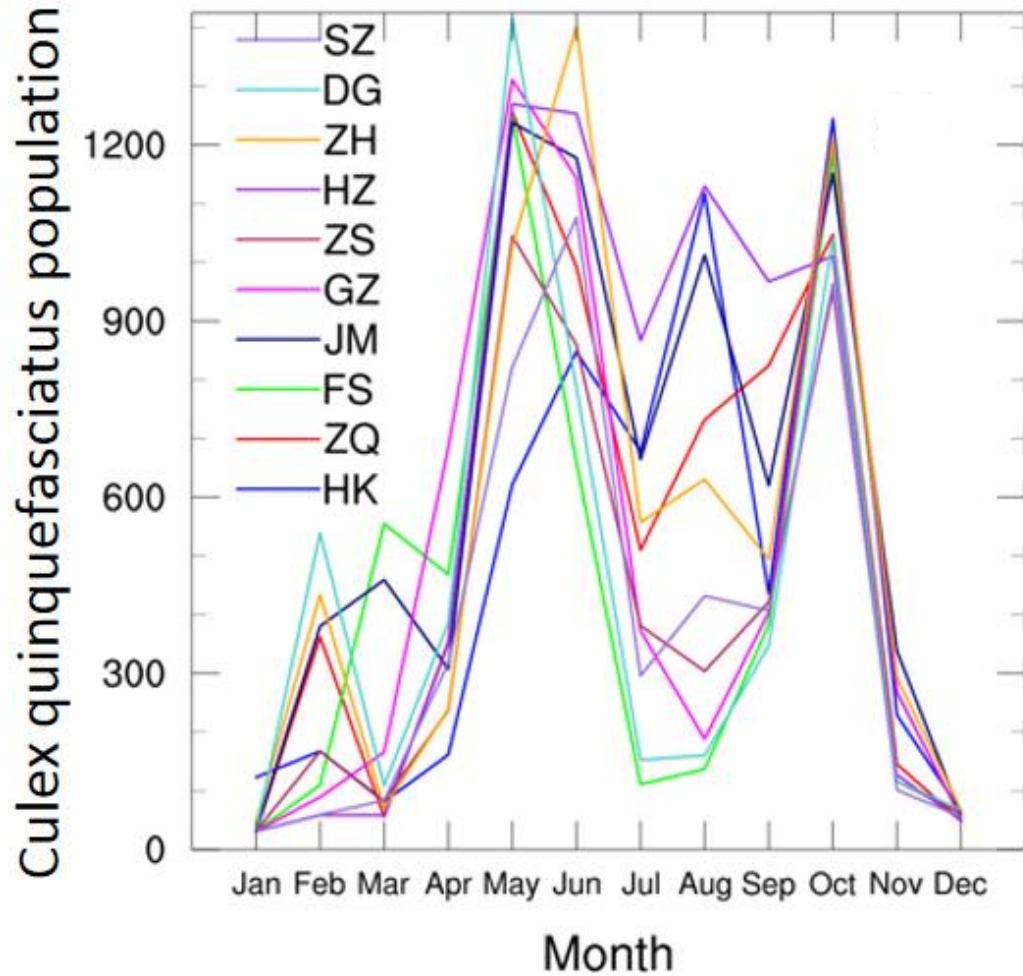


Source:

[https://www.fehd.gov.hk/english/pestcontro/l/images2/mos\\_culex\\_fatigans\\_adult.jpg](https://www.fehd.gov.hk/english/pestcontro/l/images2/mos_culex_fatigans_adult.jpg)

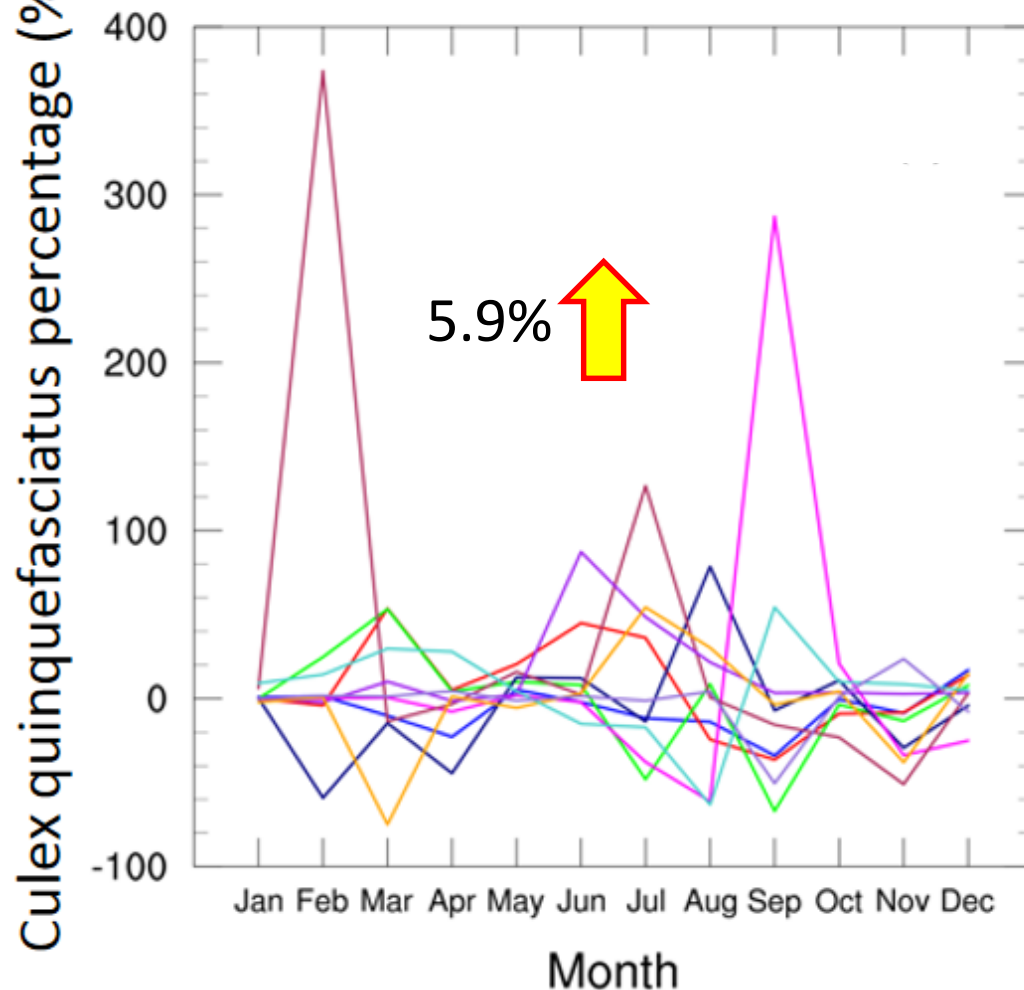


# Current mosquito population in the Greater Bay Area

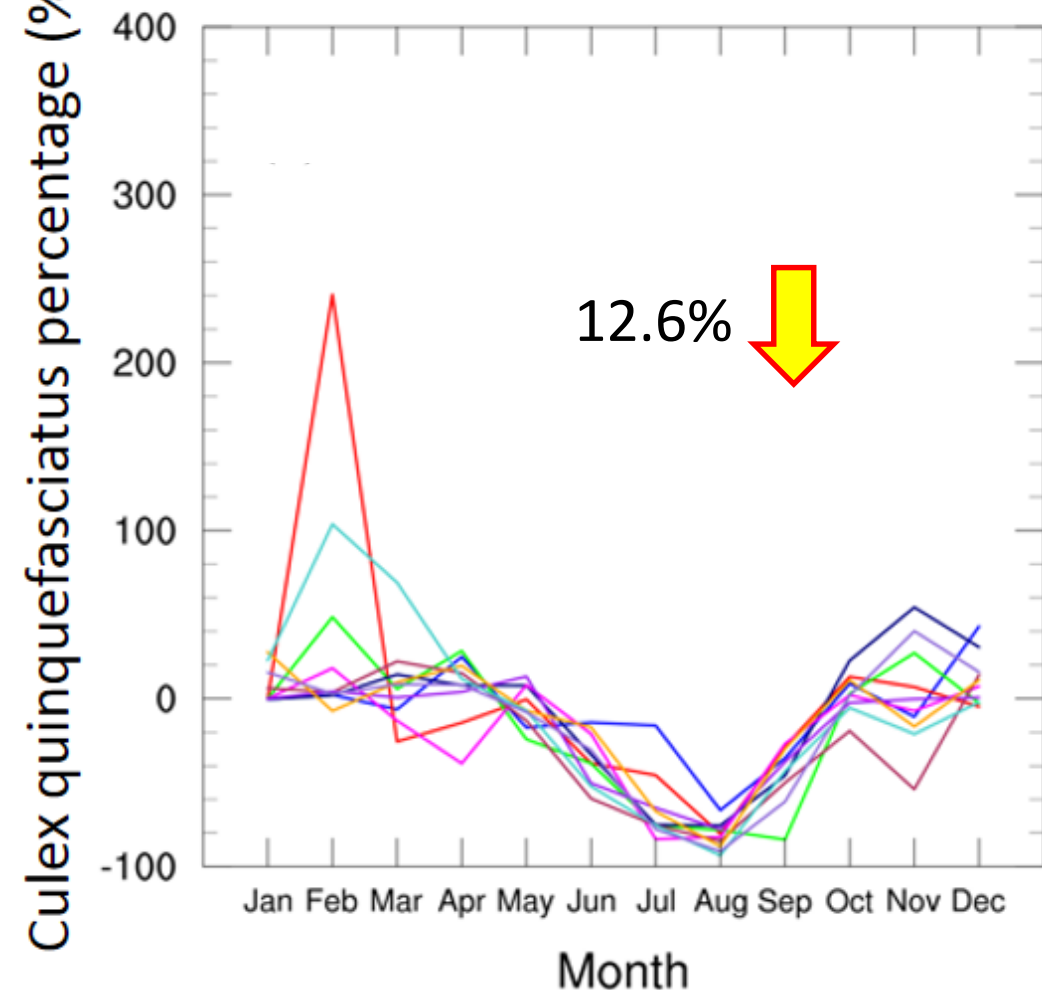


# Impacts of urbanization on mosquito population

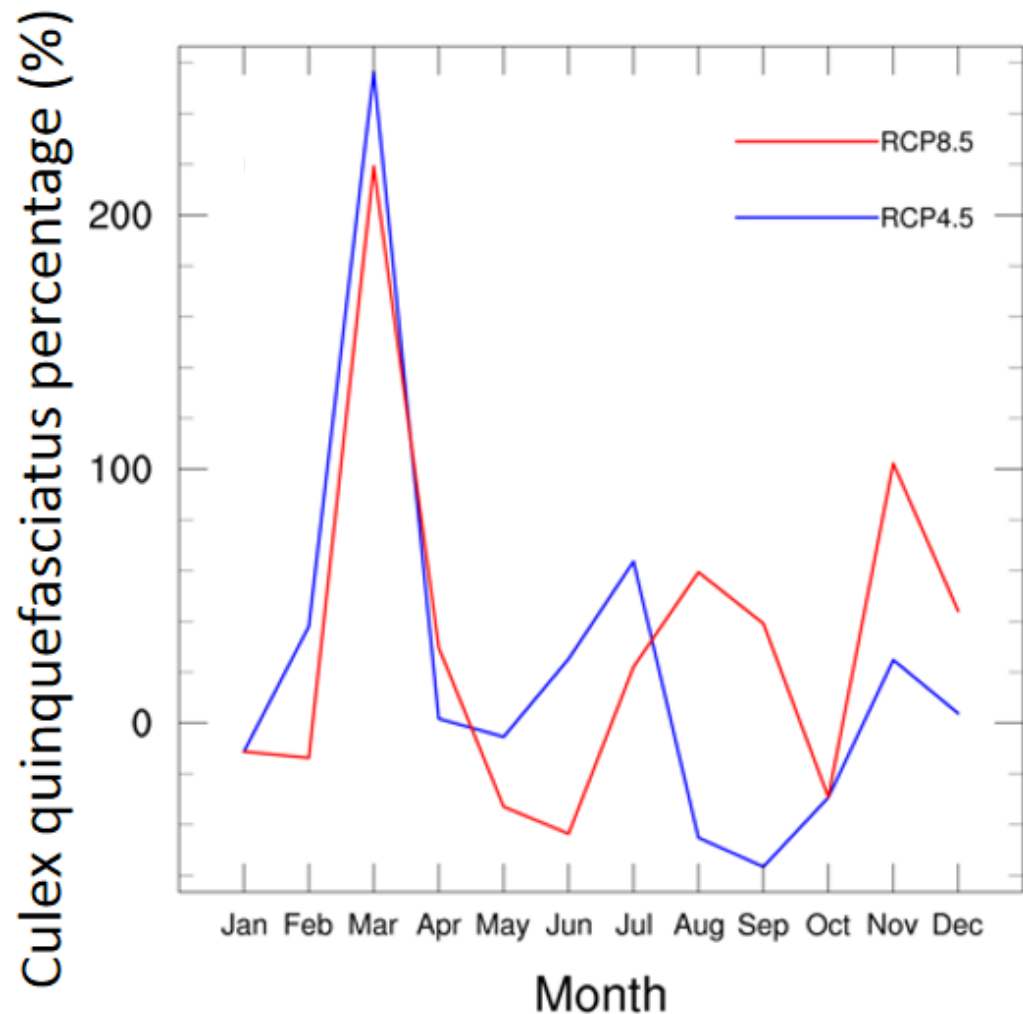
## Existing urban areas



## New urban areas



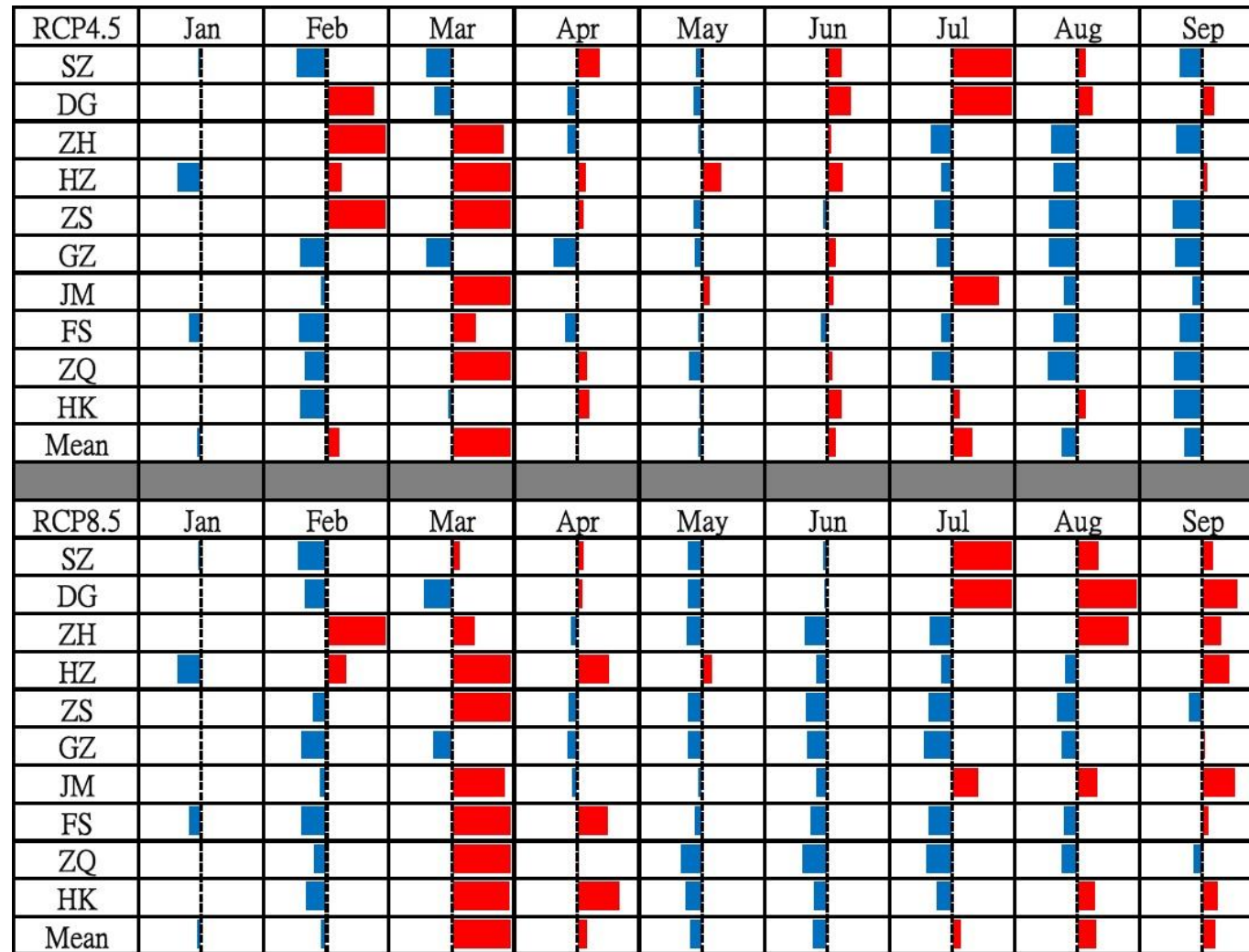
# Impacts of climate change on mosquito population



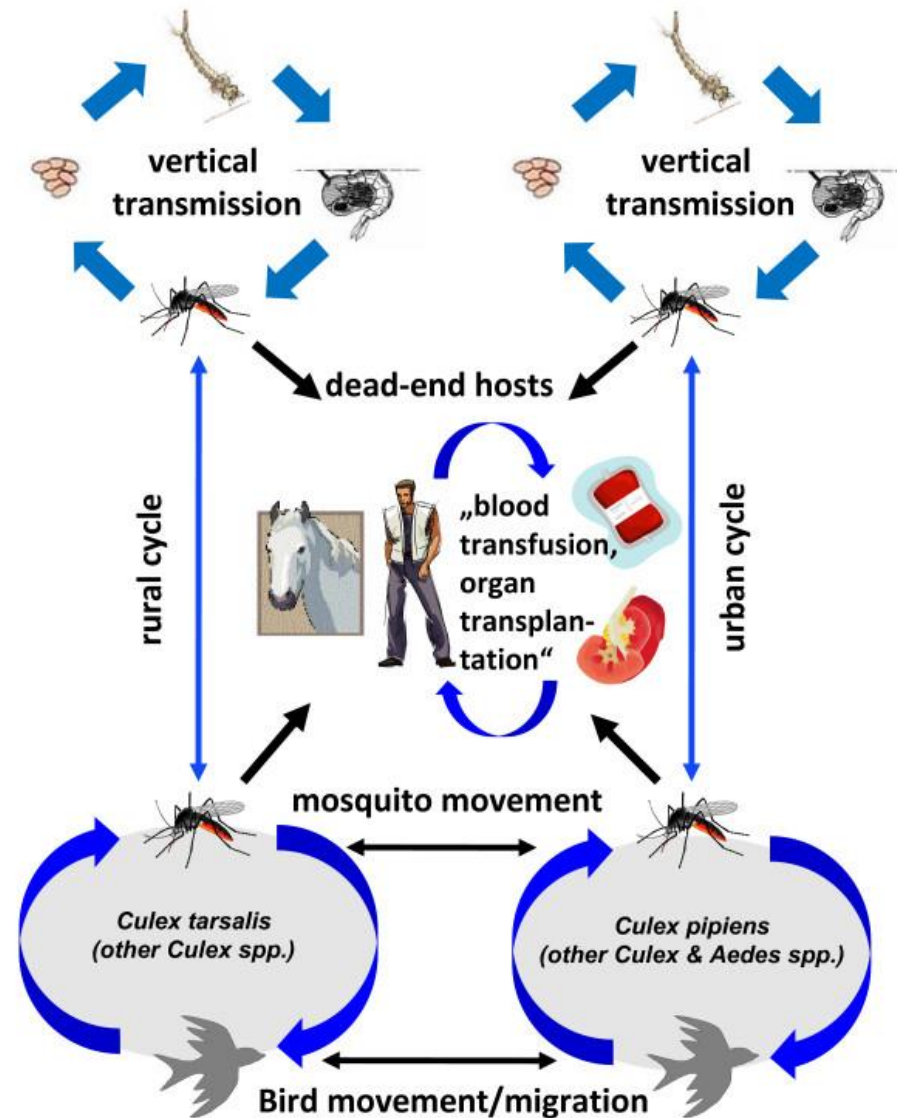
- The projections under future climate scenarios show that the annual *Cx. quinquefasciatus* population was projected to decrease by 15-17% but vary by season.
- The changes in the two peak periods will be insignificant.
- Some of the non-peak months show a significant increase.



# Impacts of climate change on mosquito population



# Impacts of changes in mosquito population on health



Pfeffer & Dobler (2010)  
Parasites & Vectors



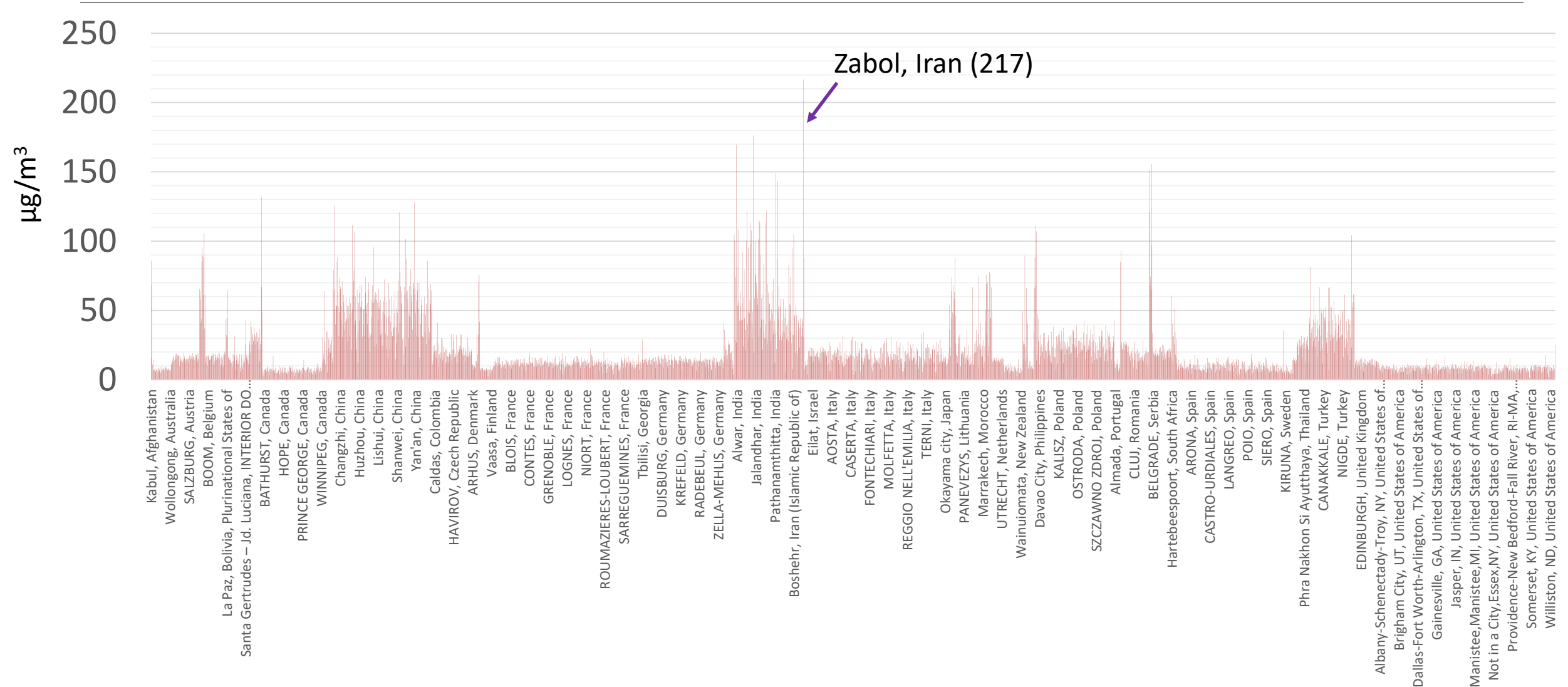
# Air pollution

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- According to WHO, 4.2 million premature deaths globally are linked to ambient air pollution.
- Worldwide ambient air pollution accounts for:
  - 29% of all deaths and disease from lung cancer
  - 17% of all deaths and disease from acute lower respiratory infection
  - 24% of all deaths from stroke
  - 25% of all deaths and disease from ischaemic heart disease
  - 43% of all deaths and disease from chronic obstructive pulmonary disease



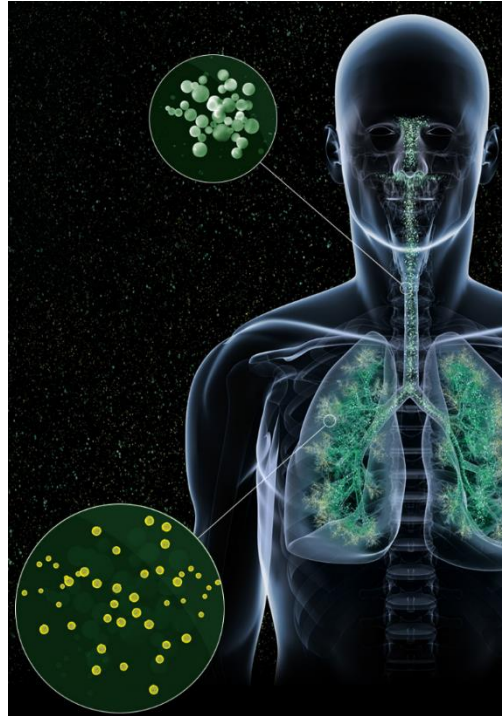
# Fine Particulate Matter (PM<sub>2.5</sub>)



Source: World Health Organization (<http://apps.who.int/gho/data/view.main.AMBIENTCITY2016?lang=en>)



# Air pollutant examples: fine particulate matter (PM<sub>2.5</sub>)



- Health effect:
  - respiratory and cardiovascular morbidity, such as aggravation of asthma, respiratory symptoms and an increase in hospital admissions;
  - mortality from cardiovascular and respiratory diseases and from lung cancer
- All-cause daily mortality is estimated to increase by 0.2–0.6% per 10 µg/m<sup>3</sup> of PM<sub>10</sub> (Samoli et al., EHP, 2008).
- Long-term exposure to PM<sub>2.5</sub> is associated with an increase in the long-term risk of cardiopulmonary mortality by 6–13% per 10 µg/m<sup>3</sup> of PM<sub>2.5</sub> (Beelen et al., EHP, 2008).

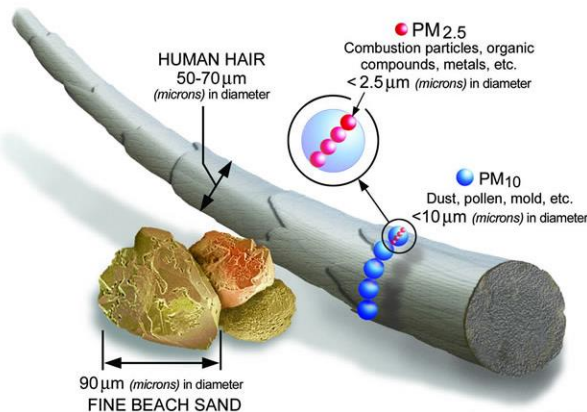
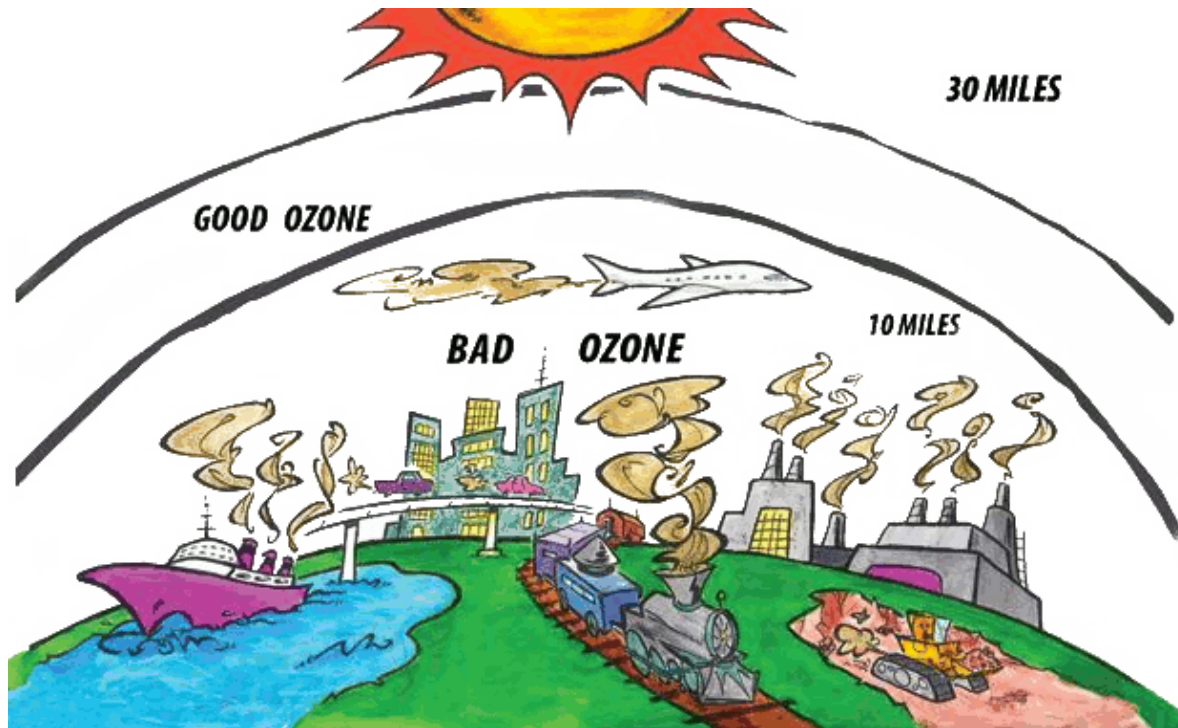


Image courtesy of the U.S. EPA



# Air pollutant examples: ozone (O<sub>3</sub>)

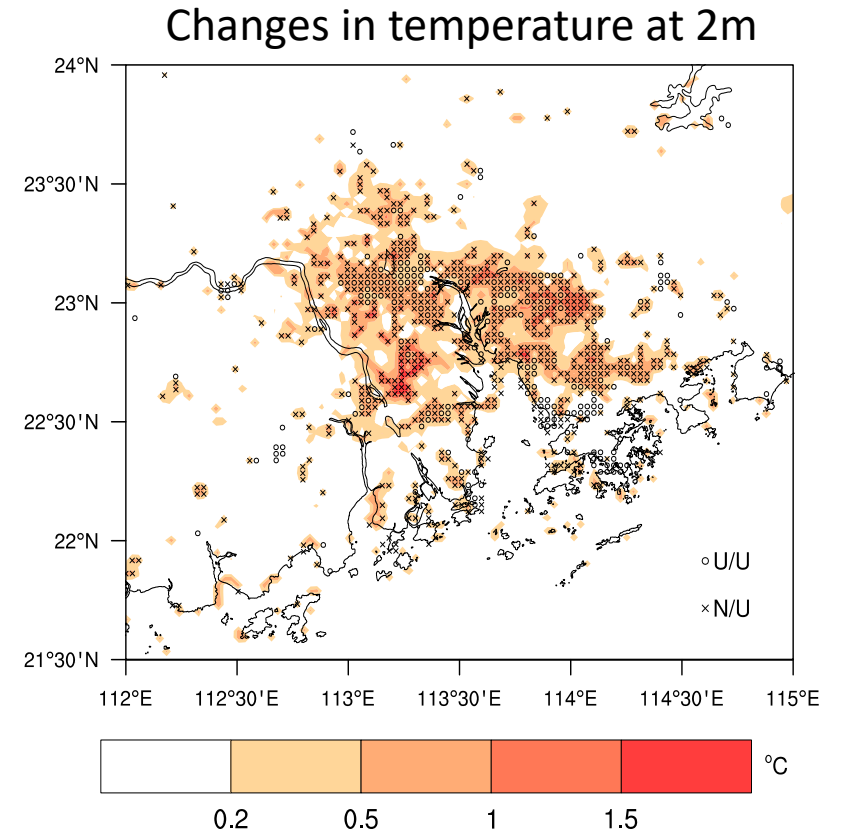
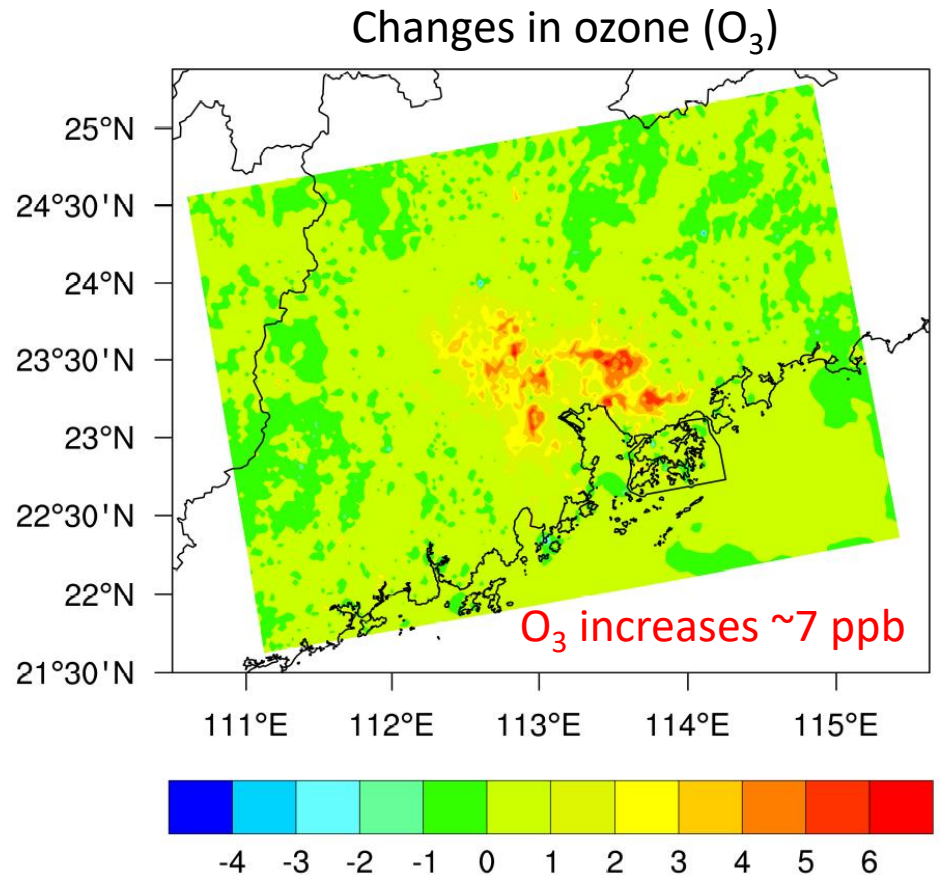
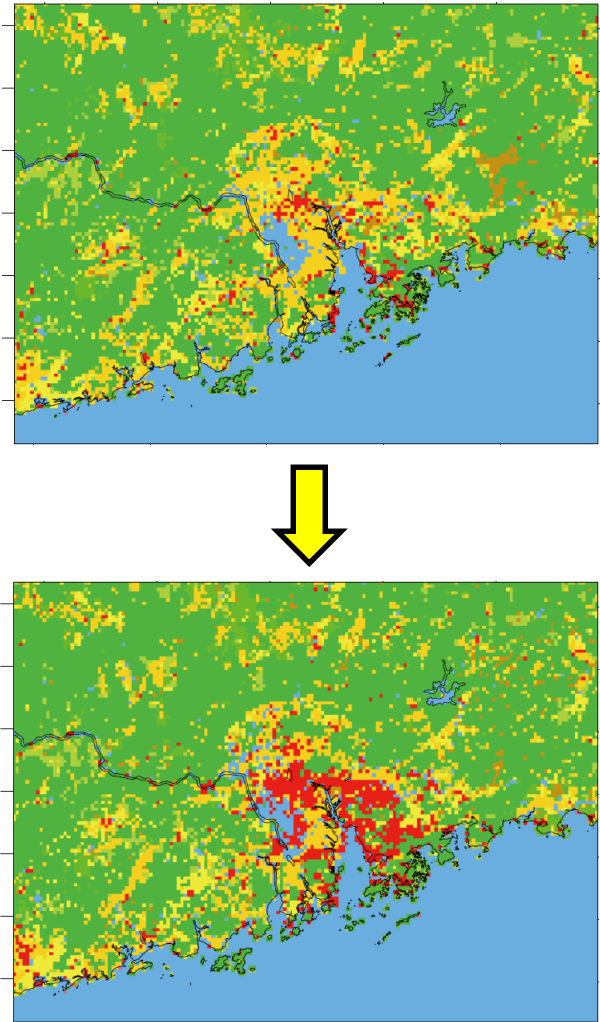


Source: Houston Clean Air Network

- Ozone has the greatest impact on the respiratory system, where it irritates the mucous membranes of the nose, throat and airways.
- Symptoms: cough, chest pain, and throat and eye irritation. Ozone can also increase susceptibility to respiratory infection.
- Acute adverse effects may impair normal functioning of the lungs and induce respiratory inflammation.



# Effect of urbanization on ozone



# Impact of increased ozone on human health

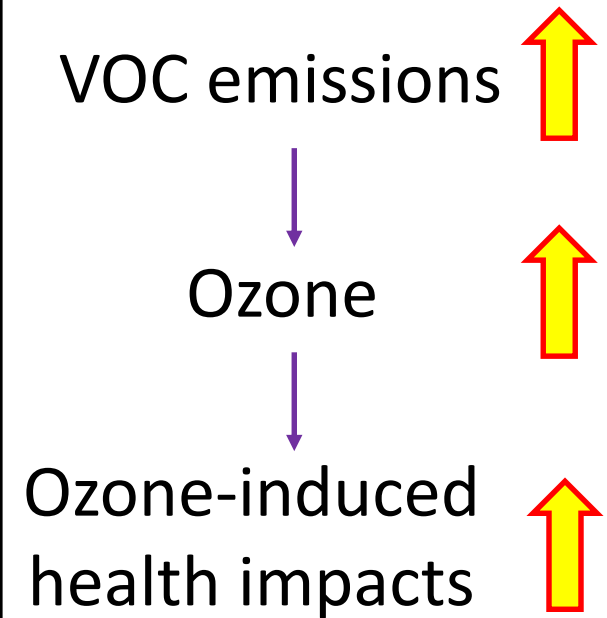
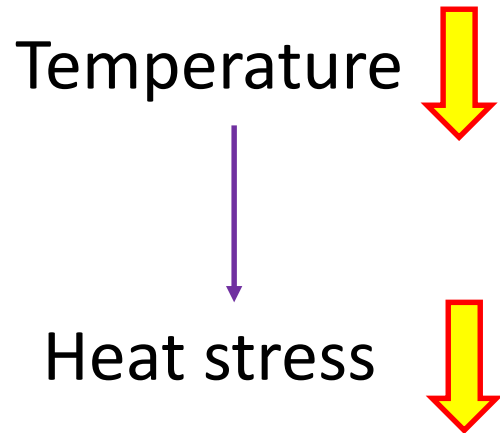
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- Ozone pollution caused ~4,000 premature mortalities every year.
- Urbanization led to an increase in O<sub>3</sub>, increasing 39.6% premature mortality due to O<sub>3</sub>-exposure that was translated to ~1,100 deaths.



# Effect of urbanization on ozone

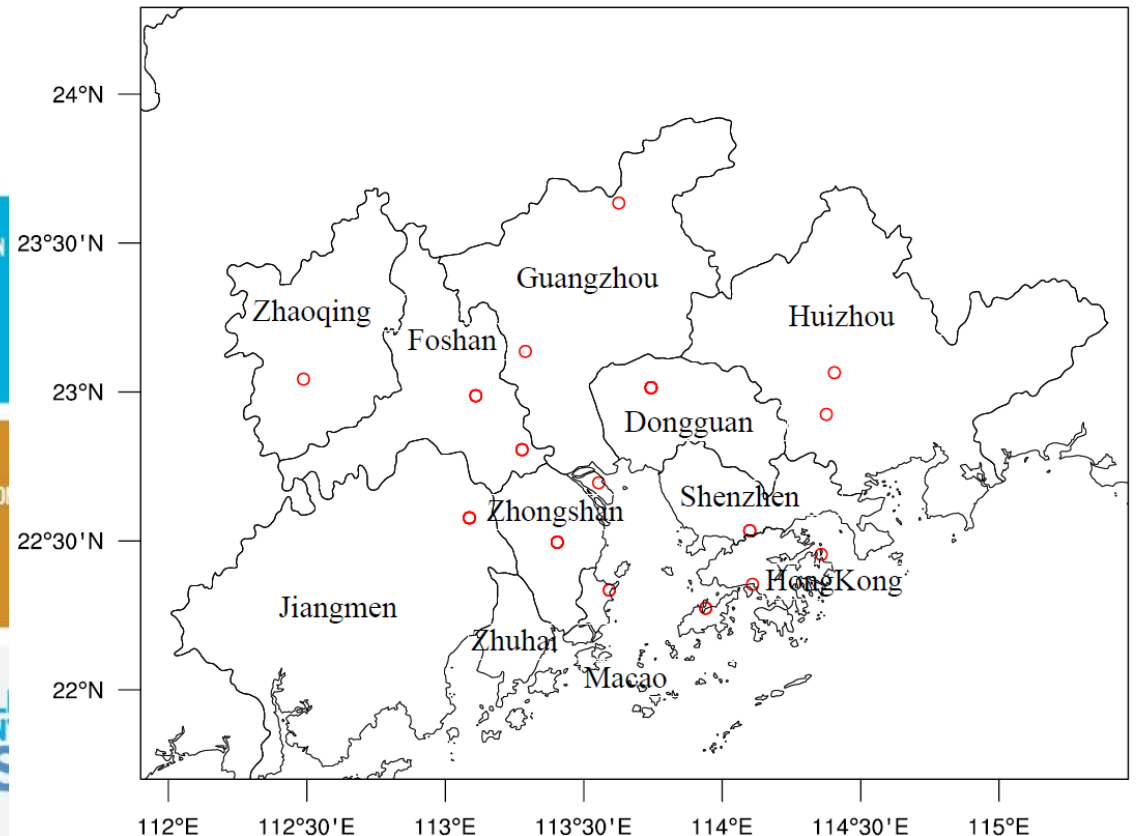
- Urban O<sub>3</sub> sensitivity to NO<sub>x</sub> emissions ↓
- Urban O<sub>3</sub> sensitivity to VOC emissions ↑



New concept: Precision Environmental Management

# Sustainable development in the Greater Bay Area

## SUSTAINABLE DEVELOPMENT GOALS



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# Thank You

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[http://www.grm.cuhk.edu.hk/eng/people/ppl/fac\\_YimSteve.html](http://www.grm.cuhk.edu.hk/eng/people/ppl/fac_YimSteve.html)

