SOCIETY FOR NATURAL SCIENCES STUDENT JOURNAL

Society for Natural Sciences Student Conference
University of Bath 8-9 April 2026

How will an increase in extreme weather events impact the incidence of dengue?: A Systematic Review

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Introduction

- Dengue fever (DF) is a **mosquito-borne infectious disease** which occurs in over 126 nations (Li et al., 2022)
- DF is caused by an RNA virus of the ***Flavivirus*** genus (Hossain et al., 2022), and is transmitted primarily via *Aedes aegypti* or sometimes *Aedes albopictus* (Li et al., 2021)
- Female mosquitoes **lay eggs on or next to the water surface** and feed on blood by biting humans and **transmit the virus when infected** (fig 1) (Christofferson and Mores., 2016, Chan and Johansson., 2012 and there is a **lag period** (Kao et al., 2023)
- Dengue is a **particularly climate sensitive disease** (Cheng et al., 2021)
- Many studies have analysed **climatic variables** (mainly temperature, rainfall and relative humidity) and DF (Cheng et al., 2021); however, few have analysed the **impacts of <u>extreme weather events (EWEs)</u>**
- This study analyses the literature on the impact of **heatwaves, tropical cyclones (TCs), extreme rainfall, extreme humidity and floods on DF incidence**
- I hypothesise that **all EWEs will affect DF incidence by impacting virus biology, vector dynamics and human behaviour,** however direction and magnitude of impact will **vary by region and event type**
- I aim to synthesise studies and identify patterns and potential biological mechanisms

Methods

- Systematic literature review **performed using PRISMA guidelines**
- Searched **Web of Science and Google Scholar** (first 50 articles of GS)
- Eligibility criteria of only primary literature with quantitative data
- Excluded if it didn't meet this criteria
- Extracted into Excel and analysed

Authors and year	Weather event(s) type	Region(s)
Cheng et al. (2021)	**Heatwaves**, extreme high temperatures and extreme high humidity	Guanghzou, China
Wanda et al. (2025)	Floods, landslides and extreme weather events	Jakarta, Indonesia
Wang et al. (2022)	Extreme temperatures and extreme rainfall	Singapore, Malaysia, Sri Lanka and Thailand
Ith et al. (2025)	**Heatwaves**, extreme rainfall and drought	Southeast Asia
Nosrat et al. (2021)	Extreme rainfall and temperature	Kenya
Wibawa et al. (2024)	Extreme temperatures and extreme rainfall	35 cities in Indonesia
Ouyang et al. (2025)	Daytime **heatwaves, nightime heatwaves** and extreme precipitation	Guanghzou, China
Lowe et al. (2018)	Drought and extreme rainfall	Barbados
Li et al. (2022)	Tropical cyclones (and tropical storms)	Guanghzou, China
Li et al. (2021)	Tropical cyclones (and tropical storms)	Pearl River Delta, China
Kao et al. (2023)	Typhoon (+ extreme rainfall)	Taiwan
Aumentado et al. (2015)	Typhoon	Philippines
Lorenz et al. (2025)	Climate factors and **heatwaves**	Sao Paulo and Natal, Brazil
Cheng et al. (2020)	**Heatwaves** (and high temperature)	Hanoi, Vietnam
Jia et al. (2019)	**Heatwaves**	Guaghzou, China
Seah et al. (2021)	**Heatwaves** and maxiumum temperatures	Singapore
Rosser et al. (2025)	Flooding	Indonesia and Fiji
Key	**Multiple events**	
	Cyclones/typhoons/hurricanes	
	Heatwaves	
	Flooding	

Figure 1: Summary of the existing literature on Extreme weather events and dengue from 2015-2025

Results

- The search strategy yielded **218 publications from the databases,** and 5 papers were found through other sources (fig 2)
- Finally, **18 papers met the eligibility criteria** and are included in this review (fig 1)

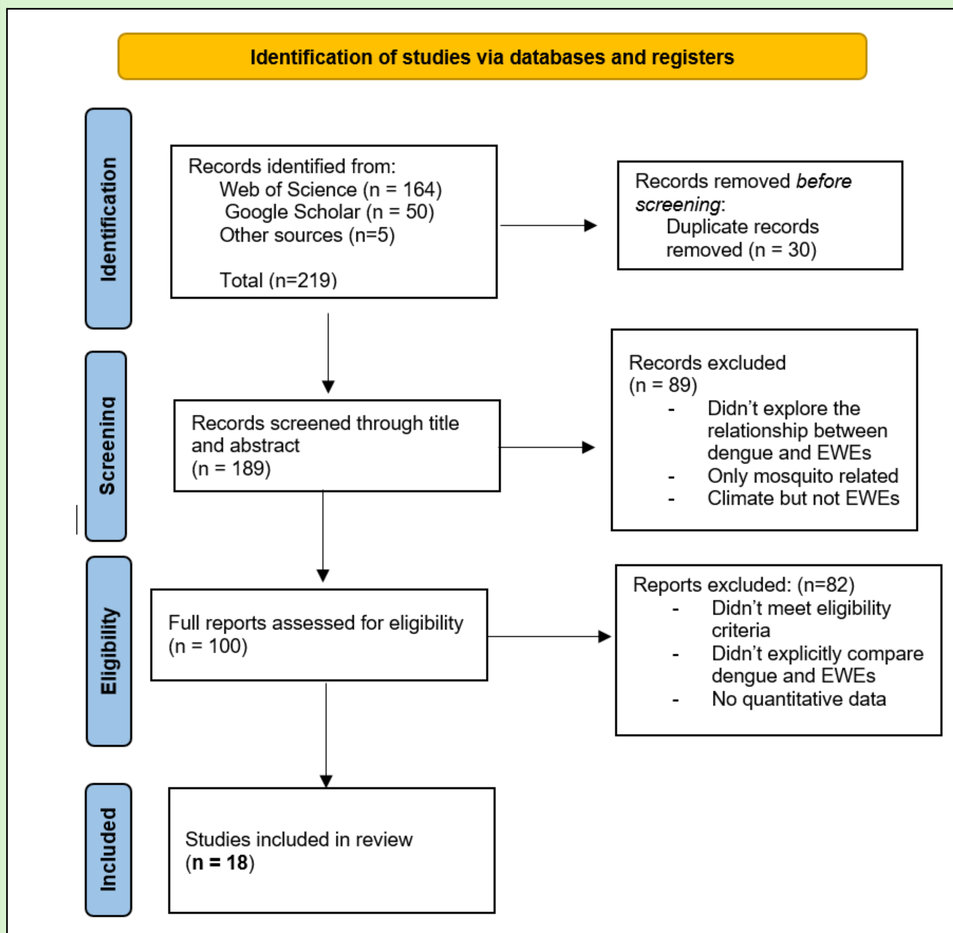


Figure 2: PRISMA chart (Page et al., 2021) of record selection process and inclusion/ exclusion criteria

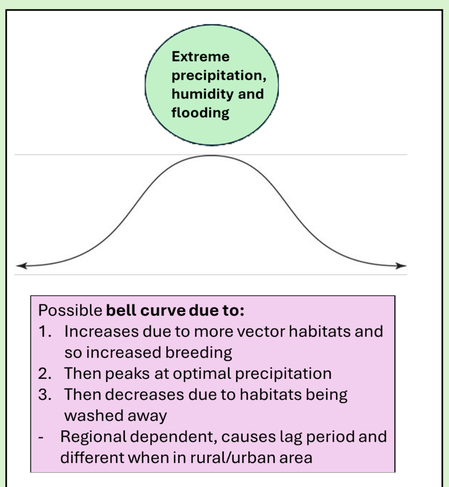


Figure 5: Bell curve, potentially explains discrepancies in extreme precipitation impacts

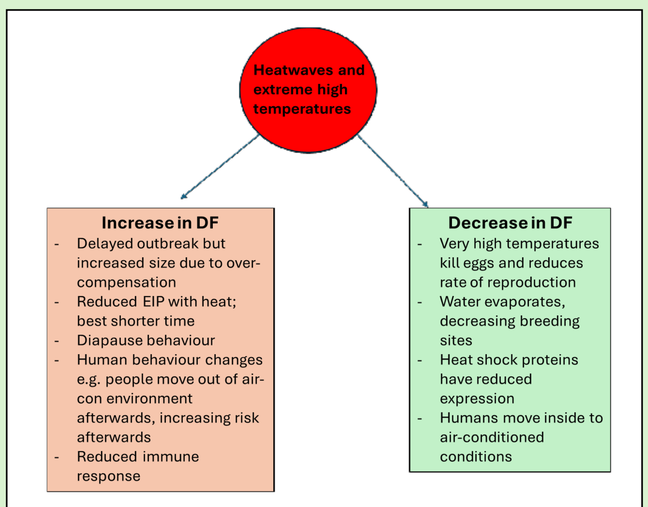


Figure 4: Possible mechanisms caused by heatwaves and extreme high temperature that change DF incidence

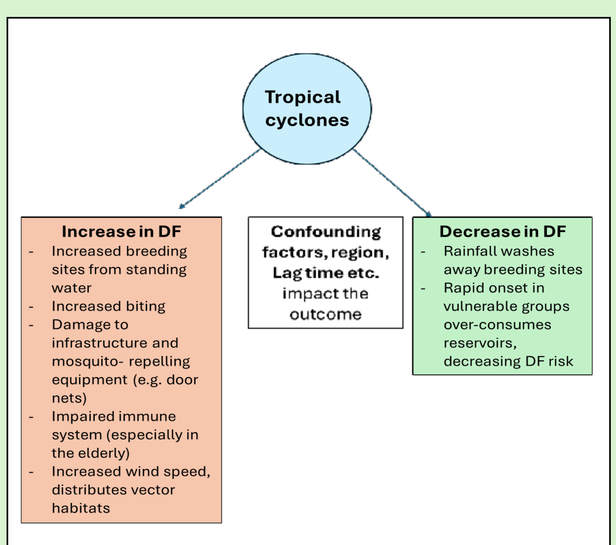


Figure 3: Possible mechanisms that change incidence of DF from TCs

Discussion

- **TCs:** Some papers found an **increase in severity of DF,** others found a **decrease** or a mixture depending on **demographics** of the population (age, gender)
  - The **increase** was associated with **more breeding sites** from stagnant water, **destruction of anti-mosquito equipment,** people **being outside more, impaired immune system** and **distributing vector habitats**
  - The **decrease** was attributed to **rainfall washing away breeding sites** and **rapid onset overconsuming the reservoirs** (fig 3)
- **Heatwaves:** of 7 papers, **three found reduction** whilst **four found increases**
  - The **increase** was attributed to **diapause behaviour,** delayed outbreak but **increased size, human behaviour change** and **reduced immune response**
  - The **decrease** was associated with **high temperatures killing eggs** and **evaporating breeding sites,** heat **shock proteins** having reduced expression and **humans moving indoors** (fig 4)
- **Extreme precipitation and humidity:** of 8 studies under this category, results varied significantly between region and were **heavily influenced by lag time**
  - The varied results suggested that there is an **optimal level of precipitation/humidity** at which precipitation provides more breeding sites, and beyond this they are **washed away**, **forming a bell curve** (fig 5)

References

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Limitations and Conclusion

- **Limitations**
  - Most studies were **conducted only in Asia**
  - The **lag period used** differed greatly
  - 54% of DF cases are **asymptomatic** so may have gone undetected
  - **Many confounding factors not controlled for** like socioeconomic background, human interventions etc.
- **Conclusion**
  - EWEs were seen to influence the incidence of DF; however, the direction of change was complex and depended on **lag time** and **location**
  - More research is needed to **reduce confounding factors and identify causal mechanisms** more succinctly
  - **Climate change** is making **EWEs more intense and frequent,** so this research is increasingly important