Extreme heat across Tanzania

Slides by Carolina Pereira Marghidan

Red Cross Red Crescent Climate Centre

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Studies on extreme heat in Tanzania

A few studies have been done which examine heatwave trends and impacts across Tanzania (see **slide 3-7**). But, much focus on Dar es Salaam.

Still, there are a great lack of knowledge around topics such as:

- Local & specific impacts from extreme heat
- Heat vulnerability and exposure hotspots
- Urban heat island effect
- Local adaptation & traditional strategies
- And more…

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Study 1: Characteristics of Enhanced Heatwaves over Tanzania and Scenario Projection in the 21st Century (Gyilbag et al., 2021)

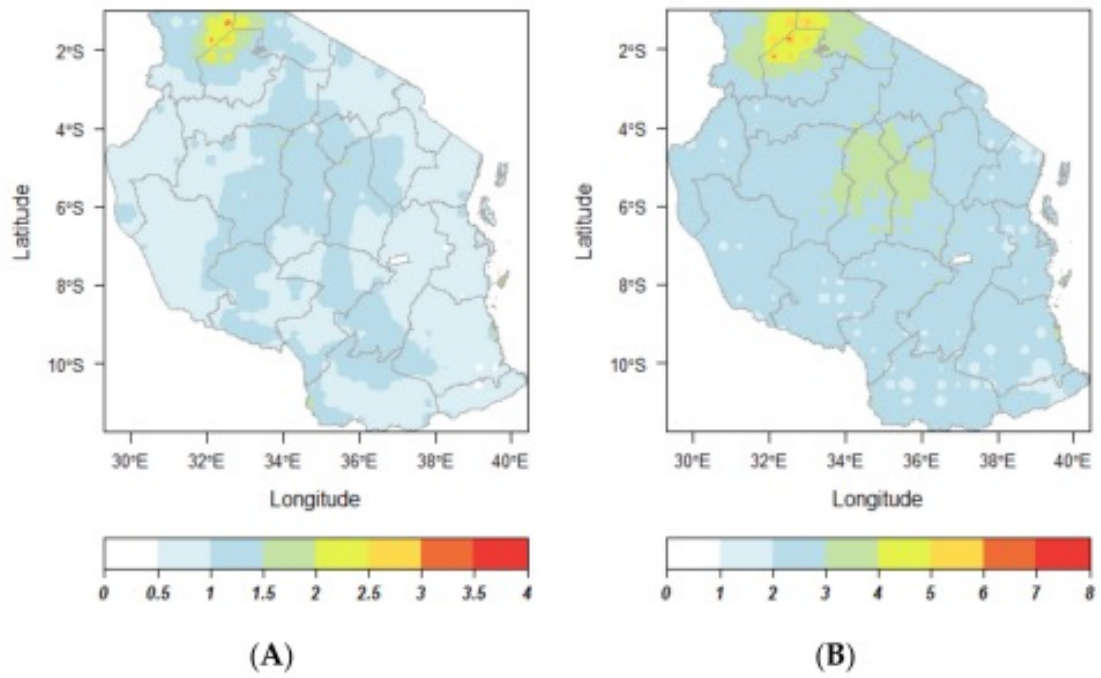


Figure 1. Heatwave climatology over Tanzania, from 1983 to 2012: (**A**) heatwave magnitude index daily (HWMId) and (**B**) heatwave duration (HWD).

Results:

- Normal heatwaves occurred in large areas of the country, while severe heatwave events occurred in Kagera, Mwanza, and parts of Mara in the Lake Victoria basin.
- The duration of heatwave events, generally around 1-5 days, has increased over the past decades. Projections show that Tanzania is likely to experience destructive heatwaves **with longer durations** during the 21st century.
- **The heatwave magnitudes vary substantially depending on location.** Whereas the mountainous areas of the north-eastern highlands could experience cooler conditions, **the Lake Victoria basin, parts of Lake Nyasa and the edges of southern, eastern and southwestern** Tanzania **are predicted to experience frequent lethal heatwaves** during the 21st century

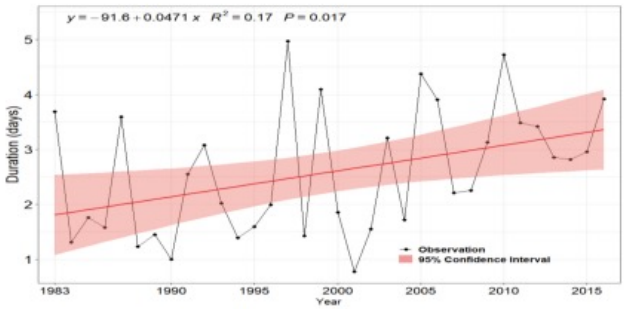


Figure 3. Duration of heatwave events that occurred in the observation period (1983–2016) over Tanzania.

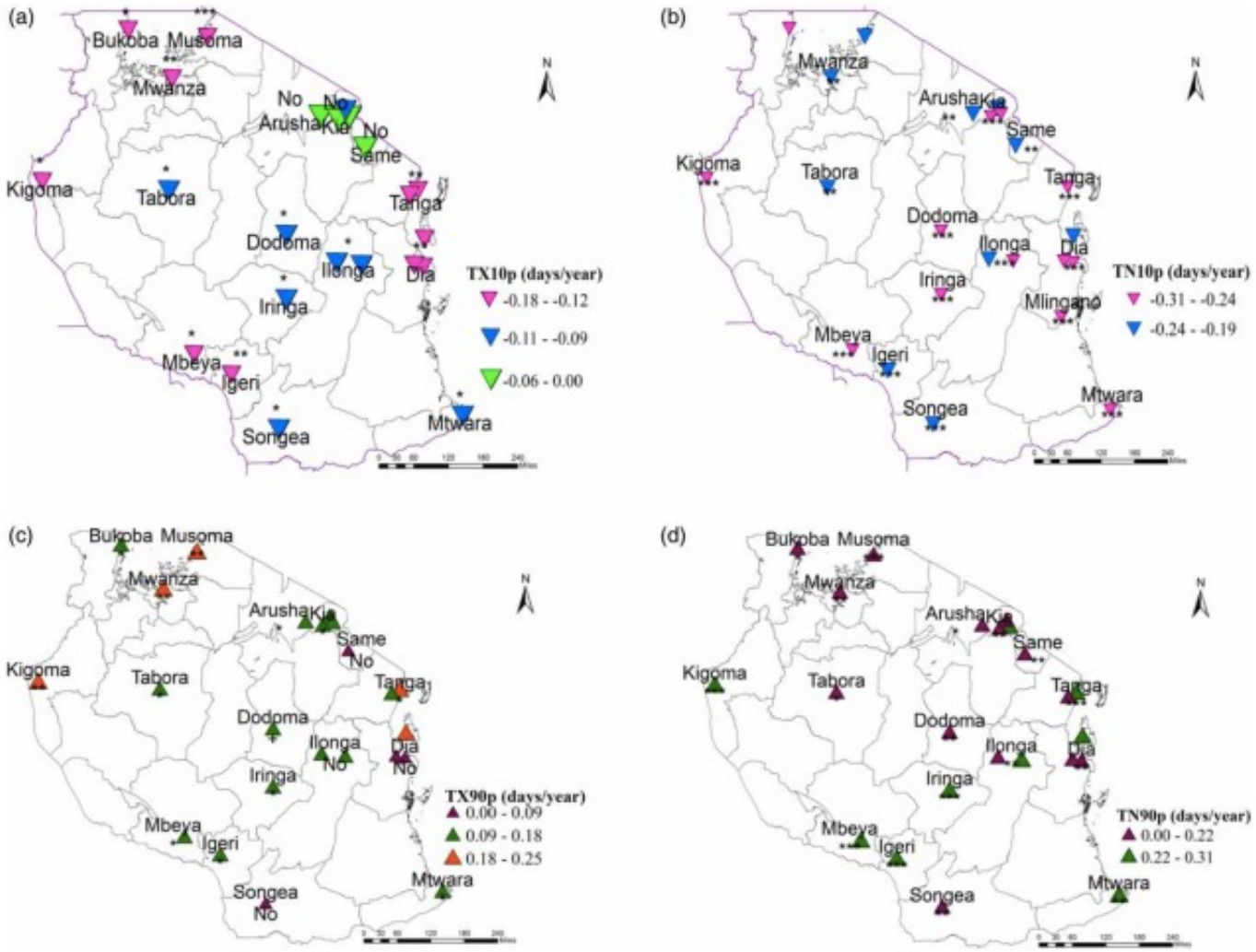


Figure 2 | Trend in spatial distribution of the number of cold days during the present century (1971–2000): (a) number of cold days, (b) number of cold nights, (c) number of warm days and (d) number of warm nights. The significant statistics are presented as (***) trend significant at α=0.001, (**) trend significant at α=0.01, (*) trend significant at α=0.05 and (+) trend significant at α=0.1.

Study 2: Projection of extreme climatic events related to frequency over different regions of Tanzania (Luhunga, 2022)

Results:

- The number of cold days (a) and cold nights (b) is decreasing across Tanzania.
- All regions of Tanzania have experienced a significant increasing trend in the number of warm days (c) and warm nights (d)
- Warm nights are increasing much ***faster*** compared to warm days.

Study 3: Responses to Heat Stress Within an Unplanned Settlement in Dar Es Salaam, Tanzania (Adegun et al., 2022)

Results of Keko Machungwa settlement in Dar:

- **Perceptions around heat stress:** most residents were aware of increases in temperature over the years.
- **Health impacts**: skin rashes, malaria, headache, high blood pressure, dizziness, lower concentration, and more
- **Other impacts:** people also mentioned increased household expenses due to heat (e.g. cooling costs), and lower work productivity
- **Individual adaptation strategies / behavioral responses:**
  - *Most popular responses*: taking showers regularly during the day, wearing light/loose clothes, taking cold drinks, opening windows/doors, and using fans.
  - *Least popular responses*: swimming, seeking information from outside the community, and use of AC

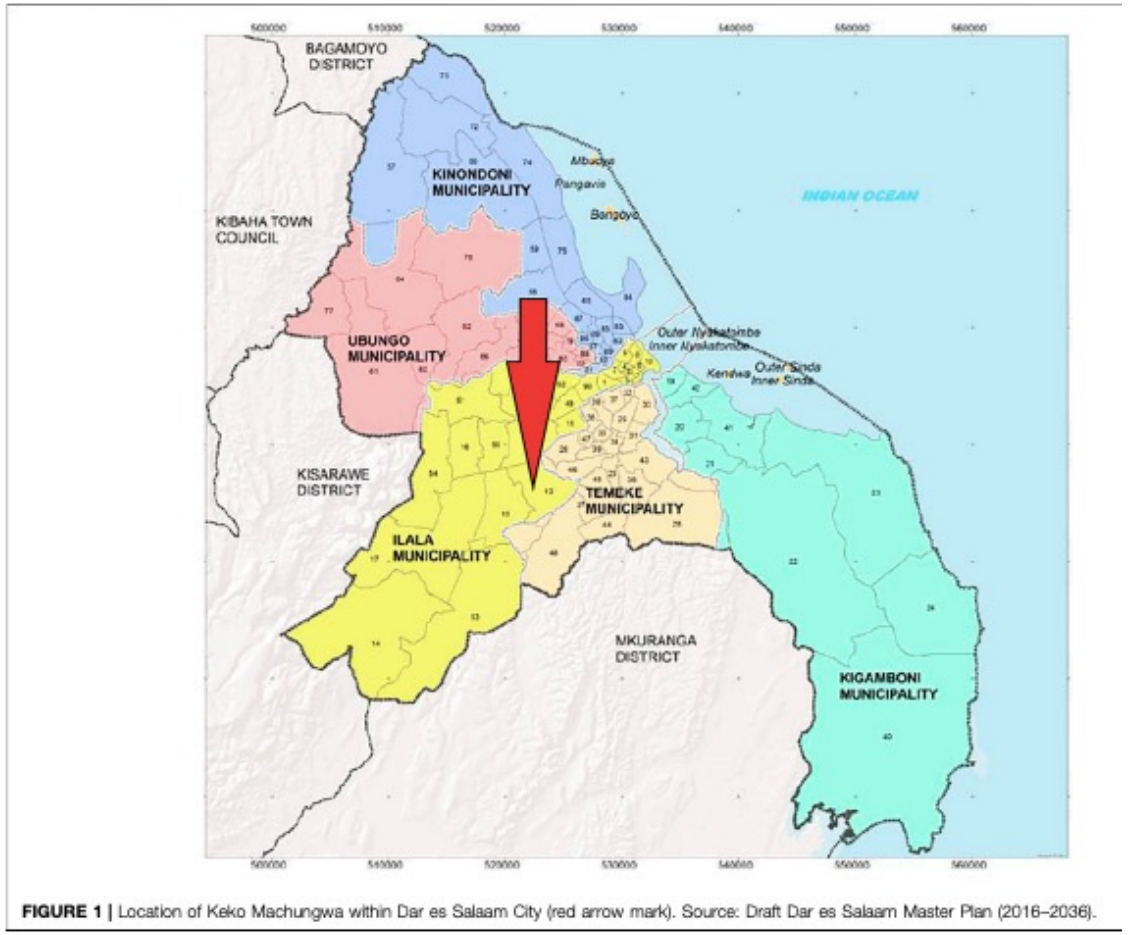


FIGURE 1 | Location of Keko Machungwa within Dar es Salaam City (red arrow mark). Source: Draft Dar es Salaam Master Plan (2016–2036).

Study 4: Emerging Climate Change-Related Public Health Challenges in Africa: A Case Study of the Heat-Health Vulnerability of Informal Settlement Residents in Dar Es Salaam, Tanzania (Pasquini et al., 2022)

Results:

- While the climate analyses confirm that Dar has a tropical climate, and as such one not generally exposed to "extreme" temperatures, the "on the ground" reality revealed by the qualitative analyses is that **the current level of exposure to heat in Dar is already too much for some local populations.**

- **Self-reported impacts on health**: heat stress in Dar has been linked to: **tiredness, skin rashes, sleep impairment, and anger/aggression**.

- The results suggest that in Dar, it is possible that many people are exposed to heat due to working outside or in poorly ventilated conditions, and lacking control over their work hours/conditions.

Box 2
Broad topics covered by questions in the interview guide administered to informal settlement residents.

Questions related to:

- The level of discomfort from heat depending on the time of year, and day--time and night-time.
- The pattern to days/nights of high heat.
- The effects experienced by respondents and the community from heat on health, food stores, work productivity, community aggression/violence/-crime.
- Adaptation/coping actions (and relative barriers) for day-time and night-time heat.
- Access to water during periods of high heat.
- Access to health clinics.
- Availability and use of mosquito nets.
- Respondents' knowledge of temperature levels on hot days and nights.

Some other studies across Africa/Tanzania:

5) Thermal Exposure and Heat Illness Symptoms among Workers in Mara Gold Mine, Tanzania (Meshi et al., 2018)

The recorded average WBGT at the mining site was 28.5°C, however, 78.4% of underground miners and 69.6% of open cut miners reported to have **moderate heat illness**. High body temperature and hot and dry skin were the most frequently reported heat illness symptoms.

6) Temperature-related morbidity and mortality in Sub-Saharan Africa: A systematic review of the empirical evidence (Amegah et al. 2016)

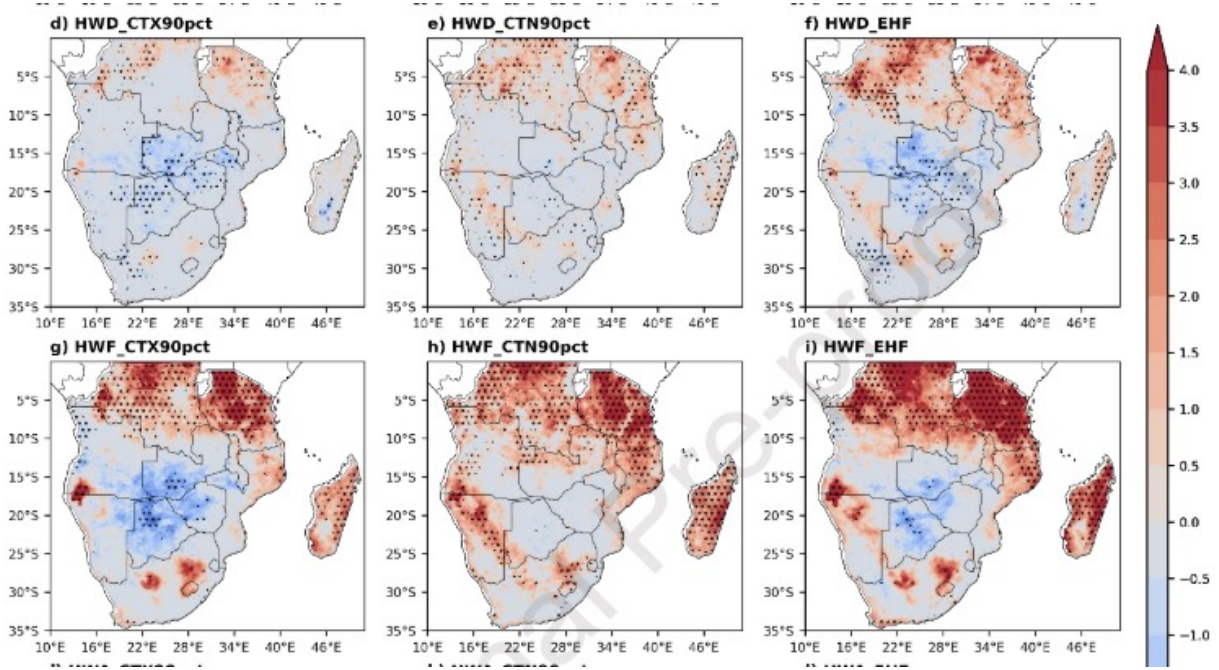
This review summarizes a few studies on Tanzania. One study highlights an increase in mortality above temperature > 26-27 °C for all age groups in Rufiji District between 1999-2010. Another study found an association between annual temperature increase and an increase in cholera.

7) Projections of human exposure to dangerous heat in African cities under multiple socioeconomic and climate scenarios (Rohat et al., 2019)

By the 2090s, exposure in African cities could increase by **20–52 times** (to over 200 billion person-days per year), depending on rates of climate change and urbanization.

8) Understanding the variability of heatwave characteristics in southern Africa (Meque et al., 2022)

Statistically significant positive trend in number of heatwaves is observed over the northern part of the southern Africa region (portion 306 of DRC, **much of Tanzania** and parts of Madagascar). The **El Niño Southern Oscillation** (ENSO) was identified as one of the **key climate drivers** associated with different heatwave characteristics over the southern African region.



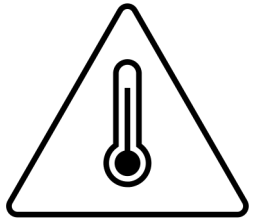
Methods & datasets for this analysis

Wet-bulb Globe Temperature (WBGT) = a type of apparent temperature used to estimate the effect of **temperature**, **humidity**, wind speed, and visible and infrared radiation (usually sunlight) on humans.

Datasets:
1) High-resultion daily extreme urban heat exposure (UHE-daily)
2) WBGT > 28, 30, and 32 °C

Developed by NASA Socioeconomic Data and Applications Center (SEDAC)
Available through: https://sedac.ciesin.columbia.edu/data/set/sdei-high-res-daily-uhe-1983-2016 (Tuholske et al., 2021)

The datasets were analyzed and visualized using Excell and ArcGIS Software.



Heat stress definition

Heat stress was defined as: WBGT > 30 °C, as this follows the **International Standards Organization** (ISO) criteria for risk of heat-related impacts.

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Wet Bulb Globe Temperature ≠ temperature

Air temperature (typical value)	WBGT	Guides to how much exercise can be safely performed	
≥ 35 ℃	≥ 31	Danger (exercise prohibited)	At a WBGT of 31 or above the actual temperature is higher than the skin temperature, so body heat cannot escape, and except for special cases, all exercise should be stopped.
31 - 35 ℃	28 - 31	Severe Warning (heavy exercise prohibited)	At a WBGT of above 28 the danger of heatillness is high, so events that require heavy exercise or events where the body temperature will rise, like endurance races should be avoided. When such events are held, rest periods should be provided often and water replenishment conducted aggressively. People who are weak or not used to the heat should stop the exercise.
28 - 31 ℃	25 - 28	Warning (rests should be provided often)	At a WBGT of above 25 the danger of heatillness increases, so rest periods should be provided often and water replenishment conducted. Rest periods should be provided every 30 minutes for events requiring heavy exercise.

WBGT > 30 °C can already be deadly and dangerous (even for healthy adults)

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RESULTS

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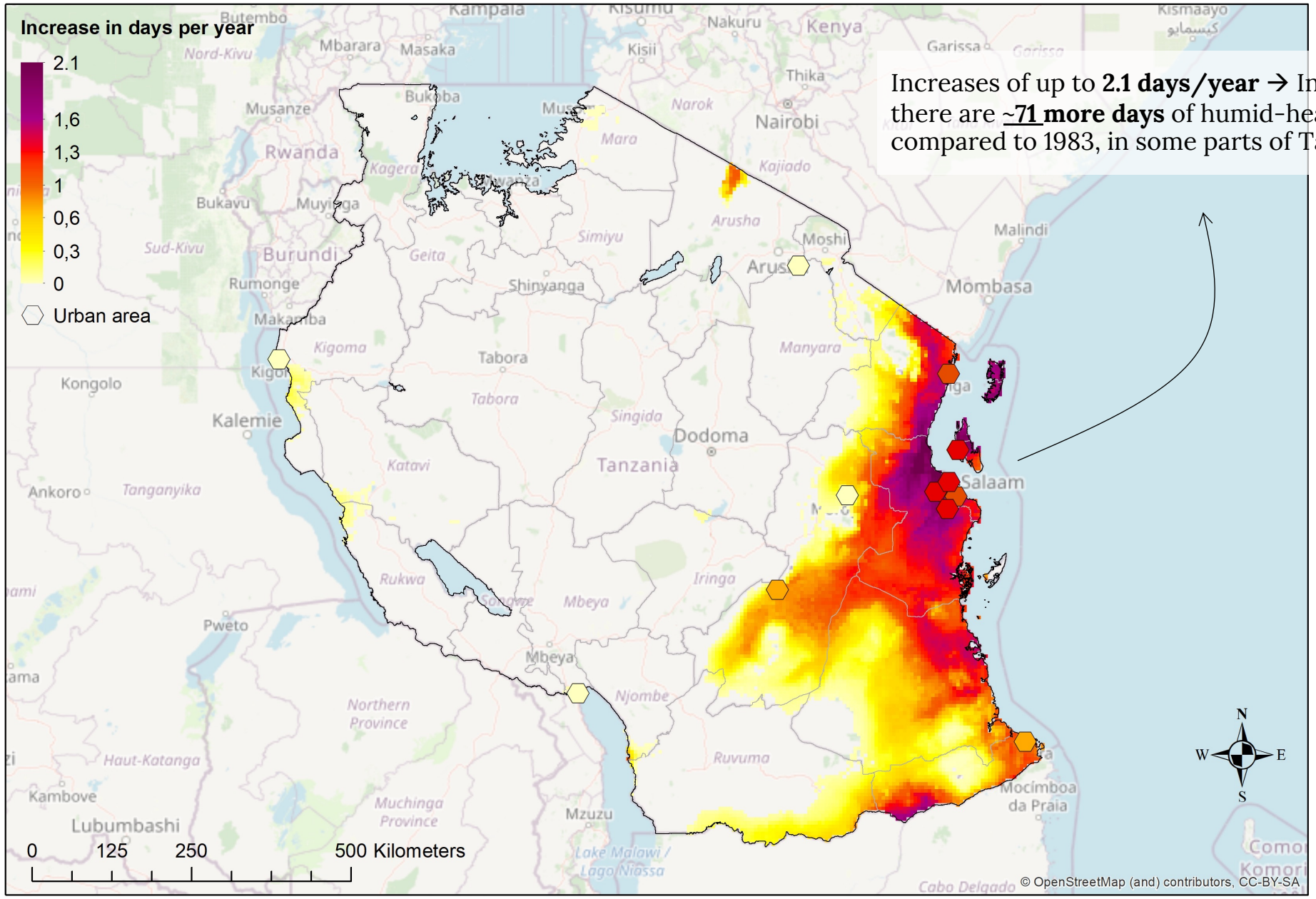
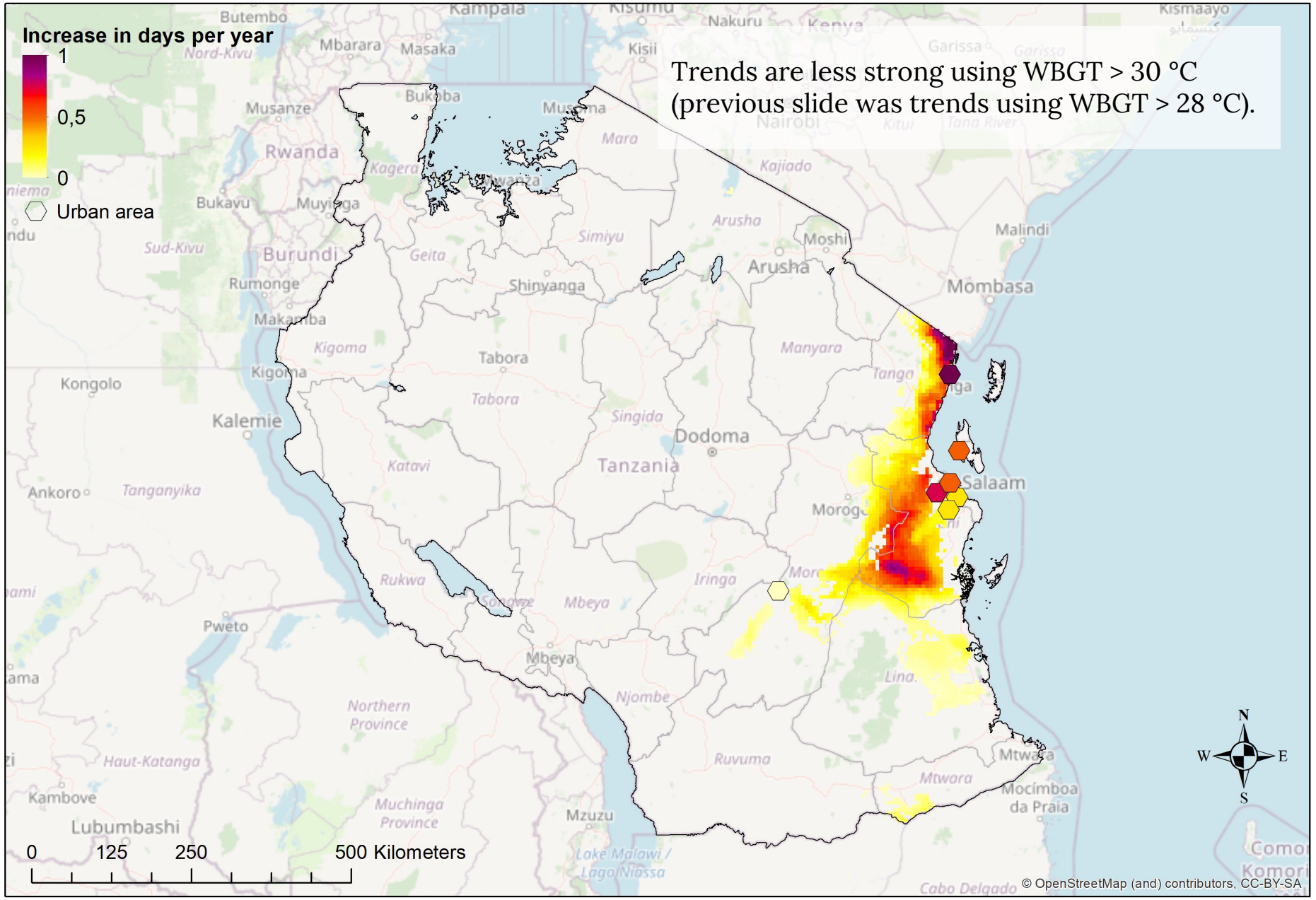
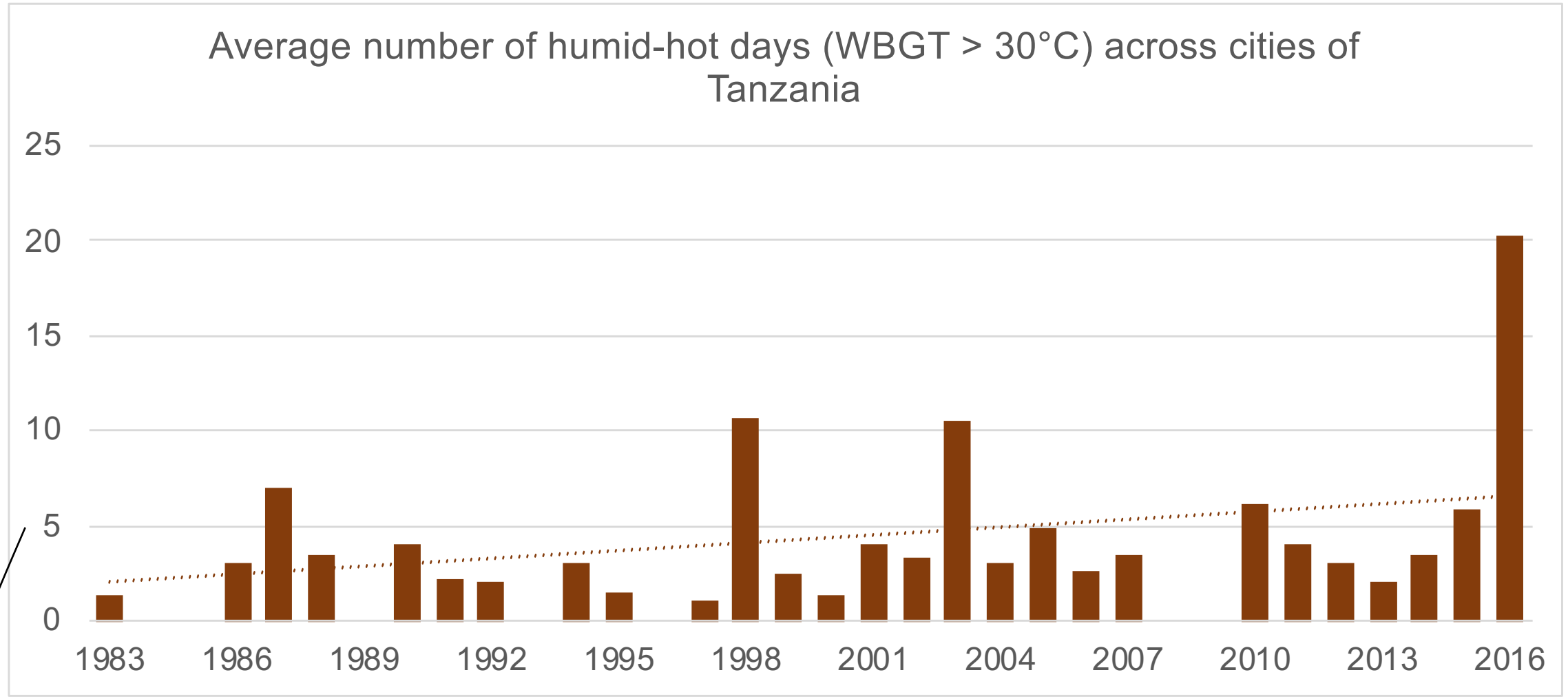
Annual increase in humid-hot days (WBGT > 28 °C) from 1983 - 2016



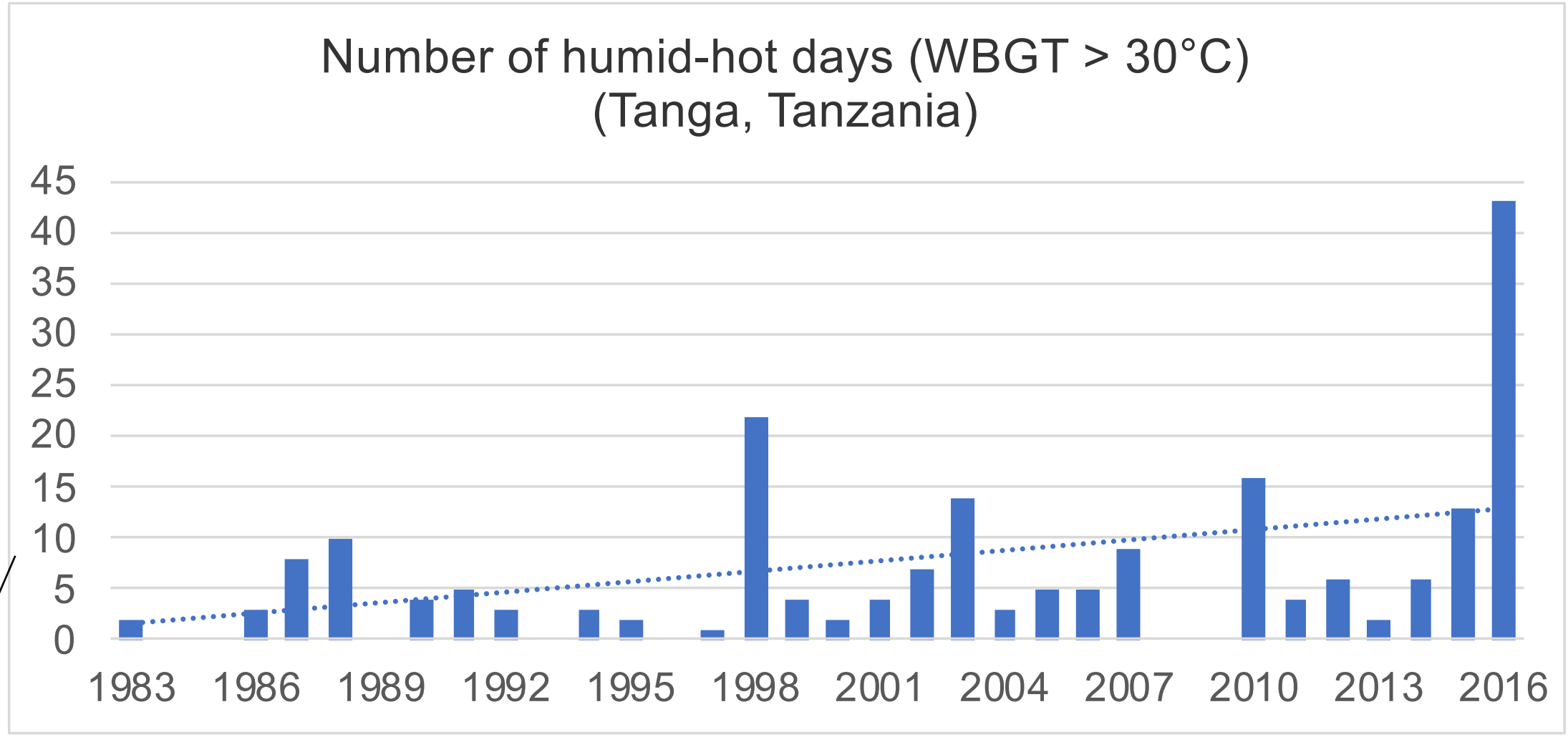
Increases of up to **2.1 days/year** → In other words, there are **~71 more days** of humid-heat in 2016 compared to 1983, in some parts of Tanzania

Annual increase in humid-hot days (WBGT > 30 C) from 1983 - 2016

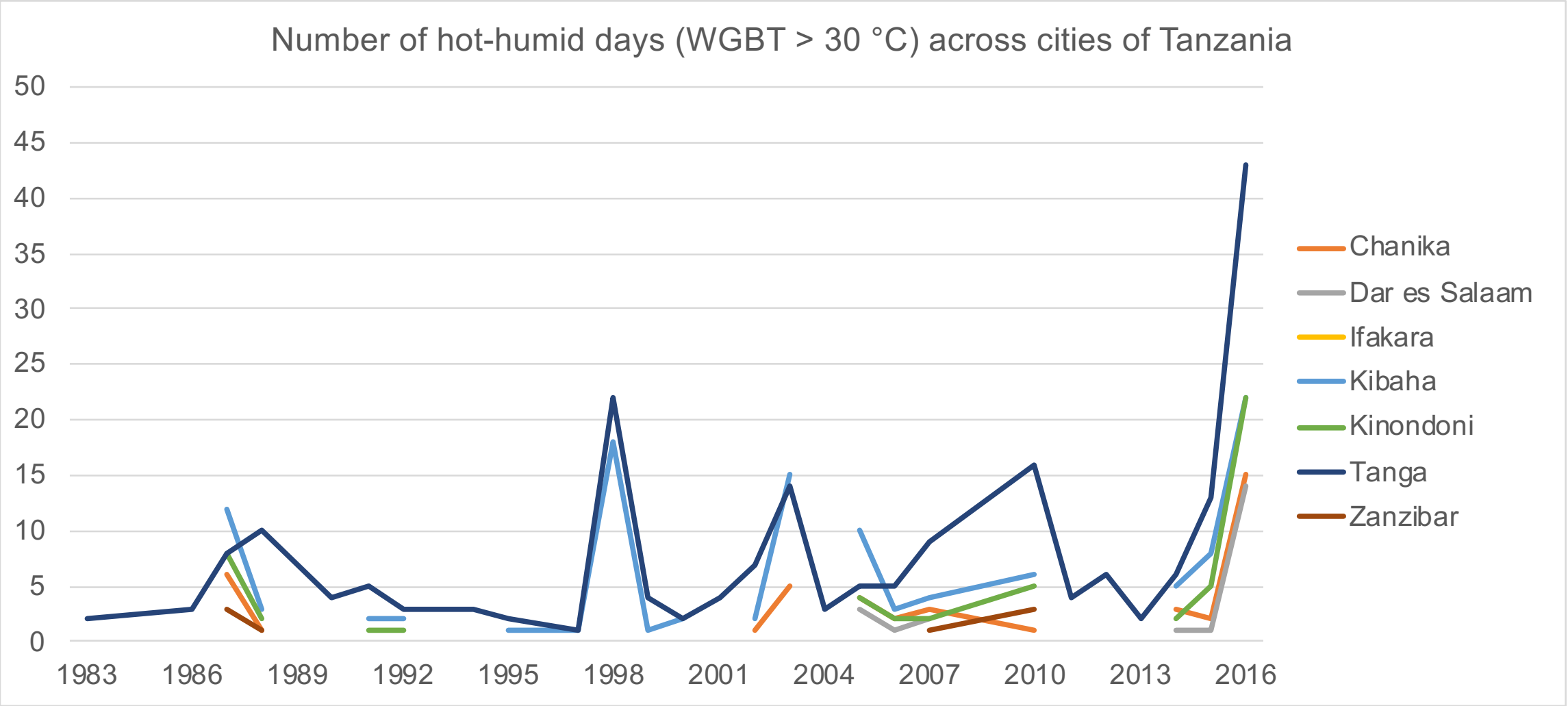




Over time, the number of humid-hot days has increased across Tanzania



Over time, the number of humid-hot days has increased with ~0.3 days/year.

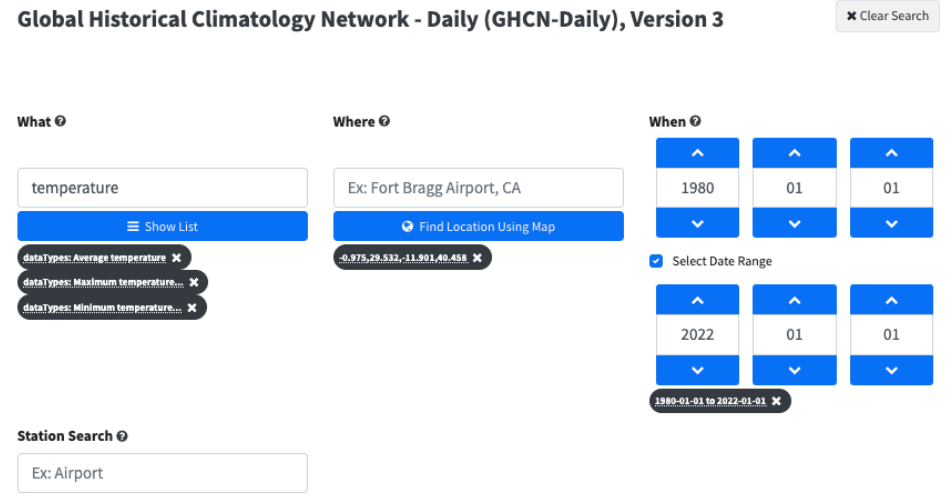


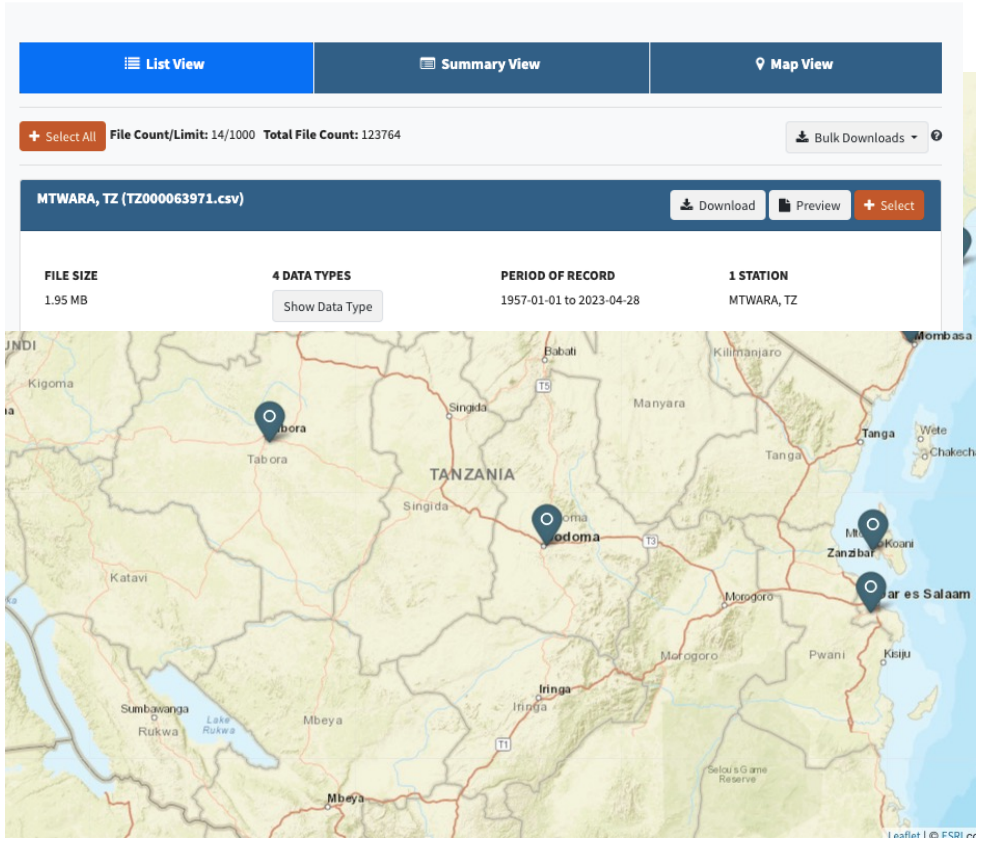
Years with most hot-humid heat stress include 1998, 2003, 2009-11, and 2016

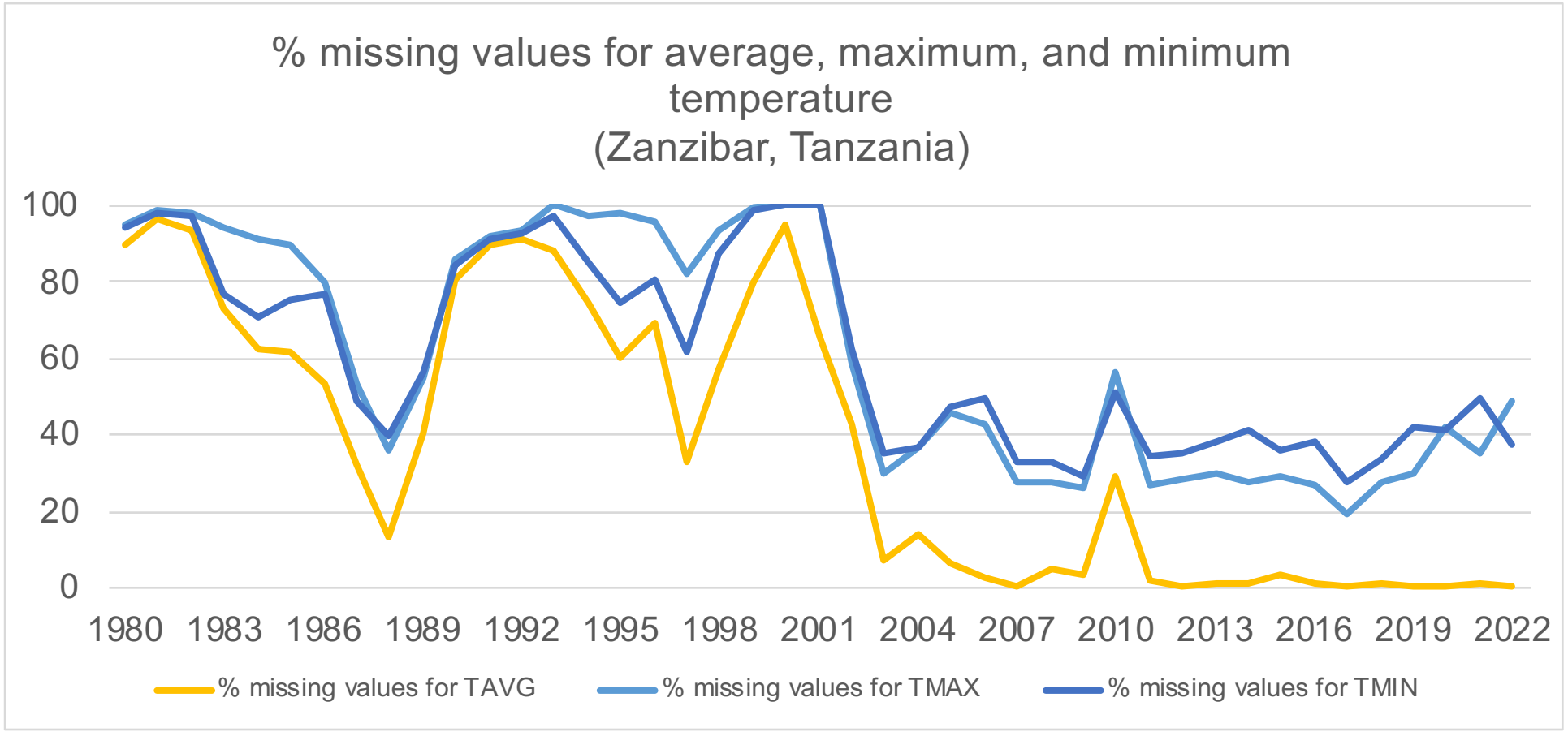
Weather station data

Available through NOAA (GHCN-Daily): https://www.ncei.noaa.gov/access/search/data-search/daily-summaries

Only 7 weather stations with temperature data found across Tanzania… None for Tanga & Unguja.



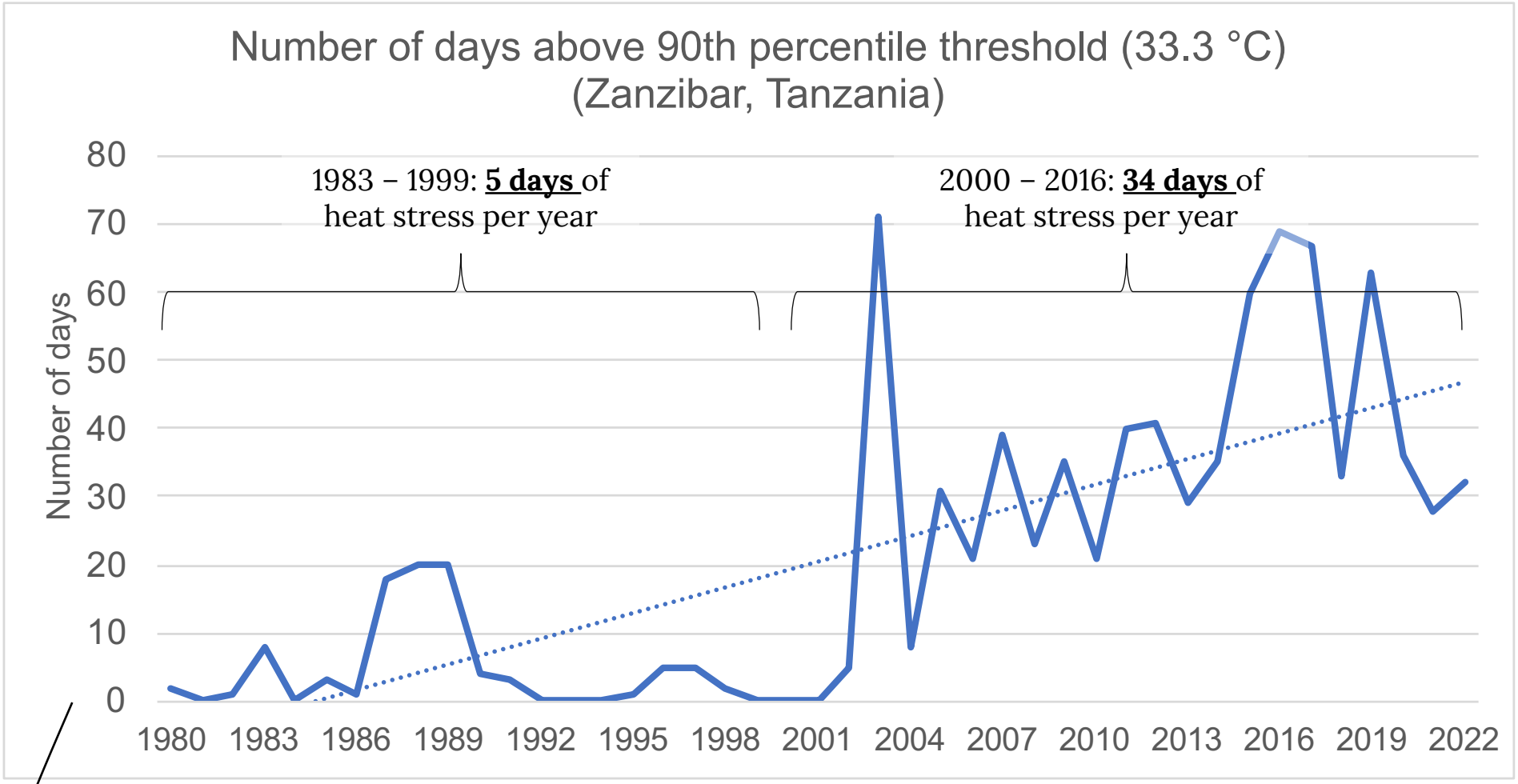




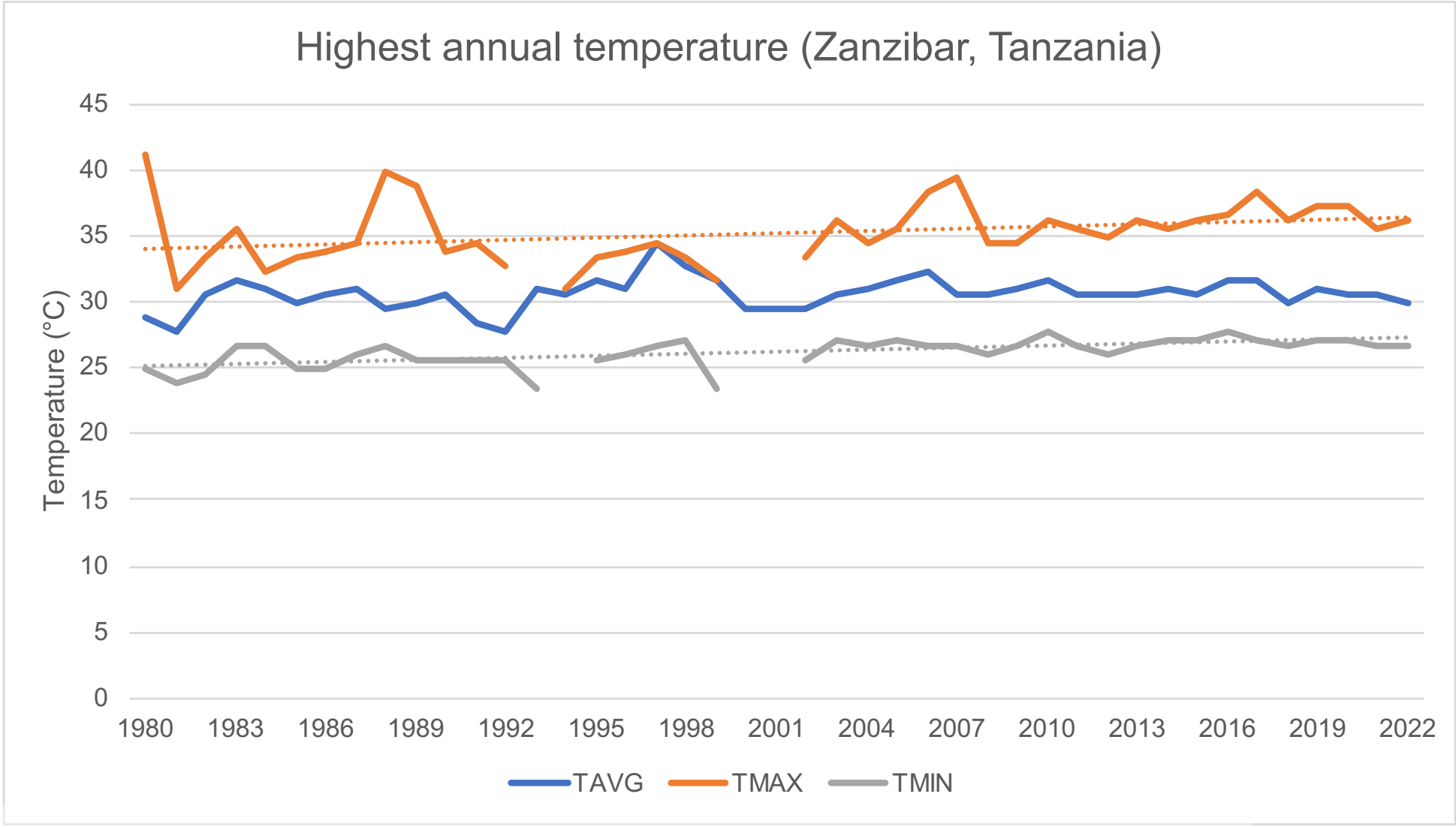
Maximum and minimum temperatures contain 20-100% missing values

>30% missing is already considered unusable

If you have Tmax/Tmin AND Tavg, missing values can be filled in using the formula: (TMAX + TMIN)/2 = TAVG



Large increase in number of days > 33.3 °C increased across Zanzibar, but keep in mind the number of missing values.



Minor increasing trends, but not possible to make any conclusions due to large number of missing data.

Discussion

- Are these maps/research findings useful? What other type of information would be useful?
- Is there a heat warning issues by your local meterological service?
- What temperatures are considered “hot” across Tanzania?
- From your perspective, what is the general perception aroundextreme heat?
- What are some of the most vulnerable groups in Tanzania?
- Are there ventilated/air conditioned areas in the cities of Tanzania?
- ….

Source: Singh et al. (2019)

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