

A study of thermal comfort and thermal preferences in an upland tropical climate

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In the beginning ...

- According to Genesis - In the Garden of Eden, there was no need for architecture, let alone clothes [presumably the days (and nights) were always balmy].
- In our less than perfect world where temperatures can climb above +40°C or drop below -40°C, the roof and walls are an important factor in keeping us comfortable, often resulting in specific demands from architecture.





Buildings and Climate

Climate has a profound impact on **what** we build, **where** we build, and **how** we experience them!



Buildings and Climate

- Components of engagement:
 - **Occupants**
 - Thermal Comfort
 - **Buildings**
 - Energy in Use / Environmental Performance
 - **Materials**
 - Embodied Energy/CO₂
 -



Buildings and Climate

- Components of engagement:
 - **People**
 - Thermal Comfort
 - **Place**
 - Energy in Use / Environmental Performance
 - **Stuff**
 - Embodied Energy/CO₂





Zone D



Zone E



Zone F





12

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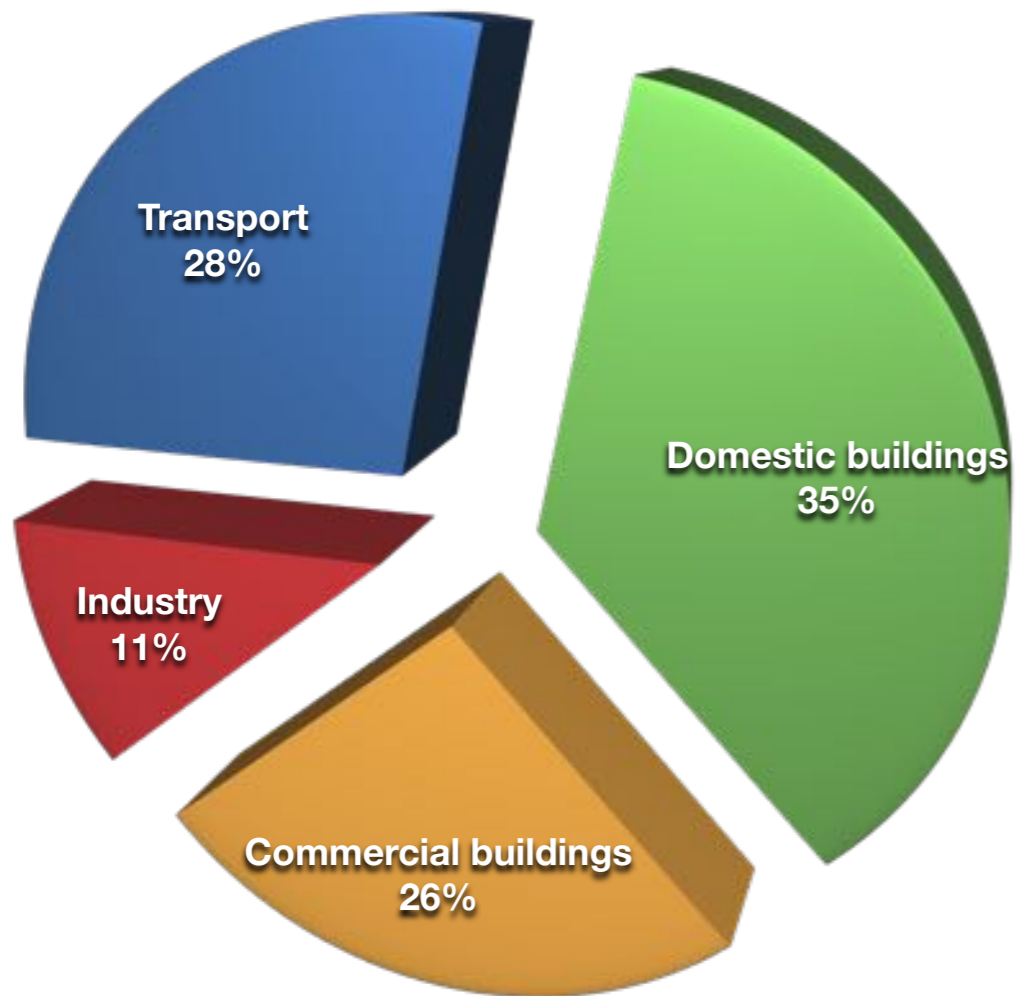
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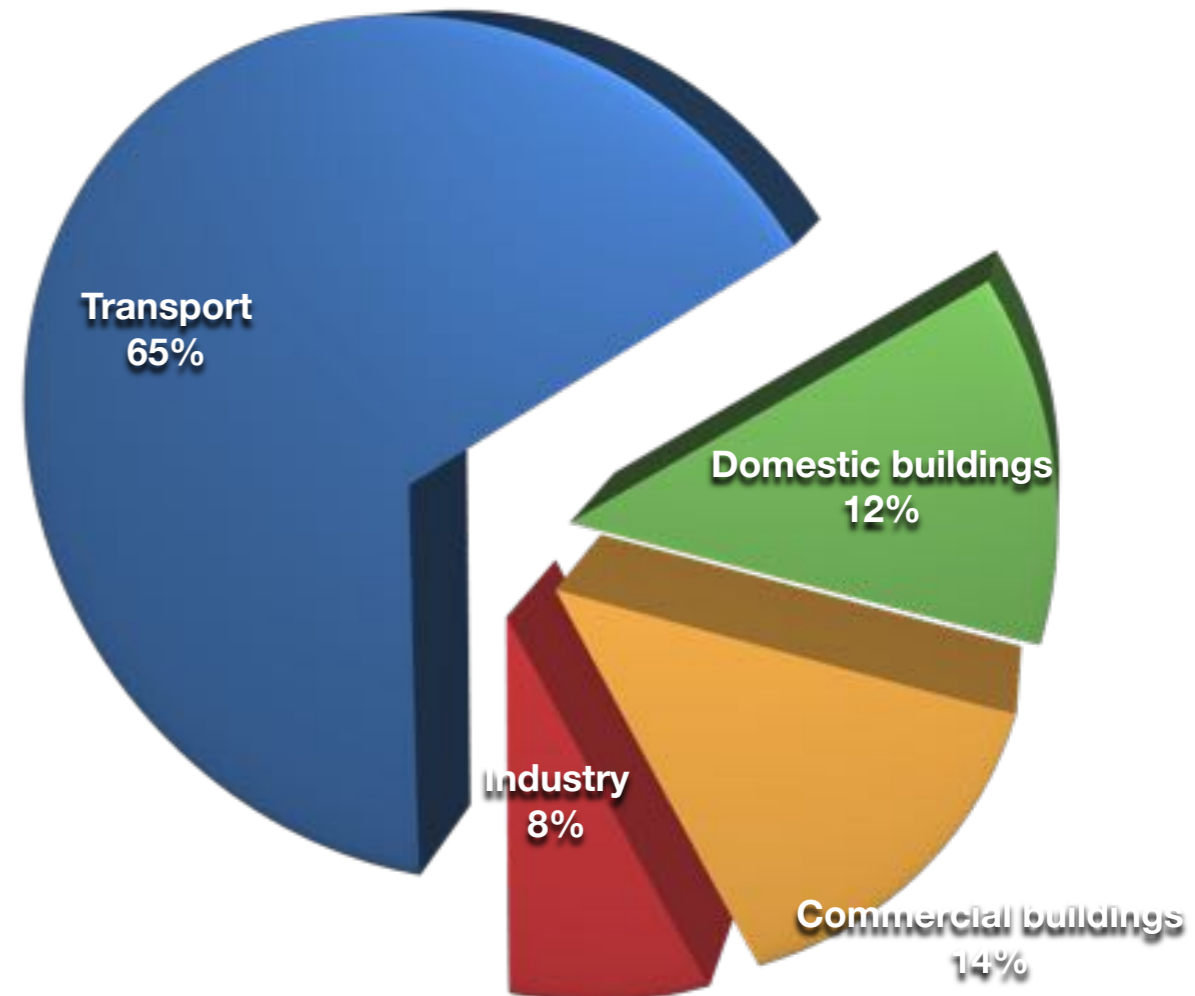
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Energy Consumption by Sector

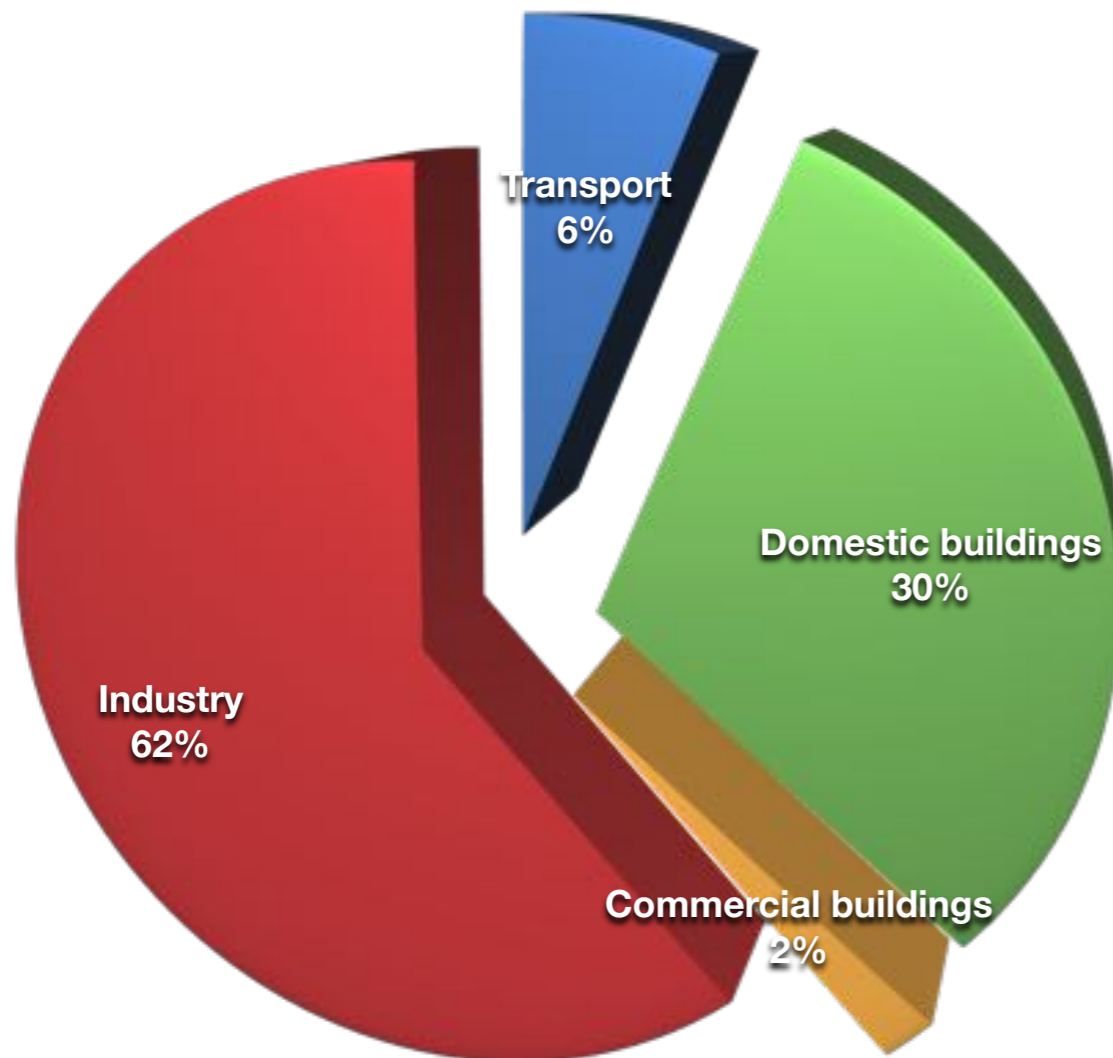


London

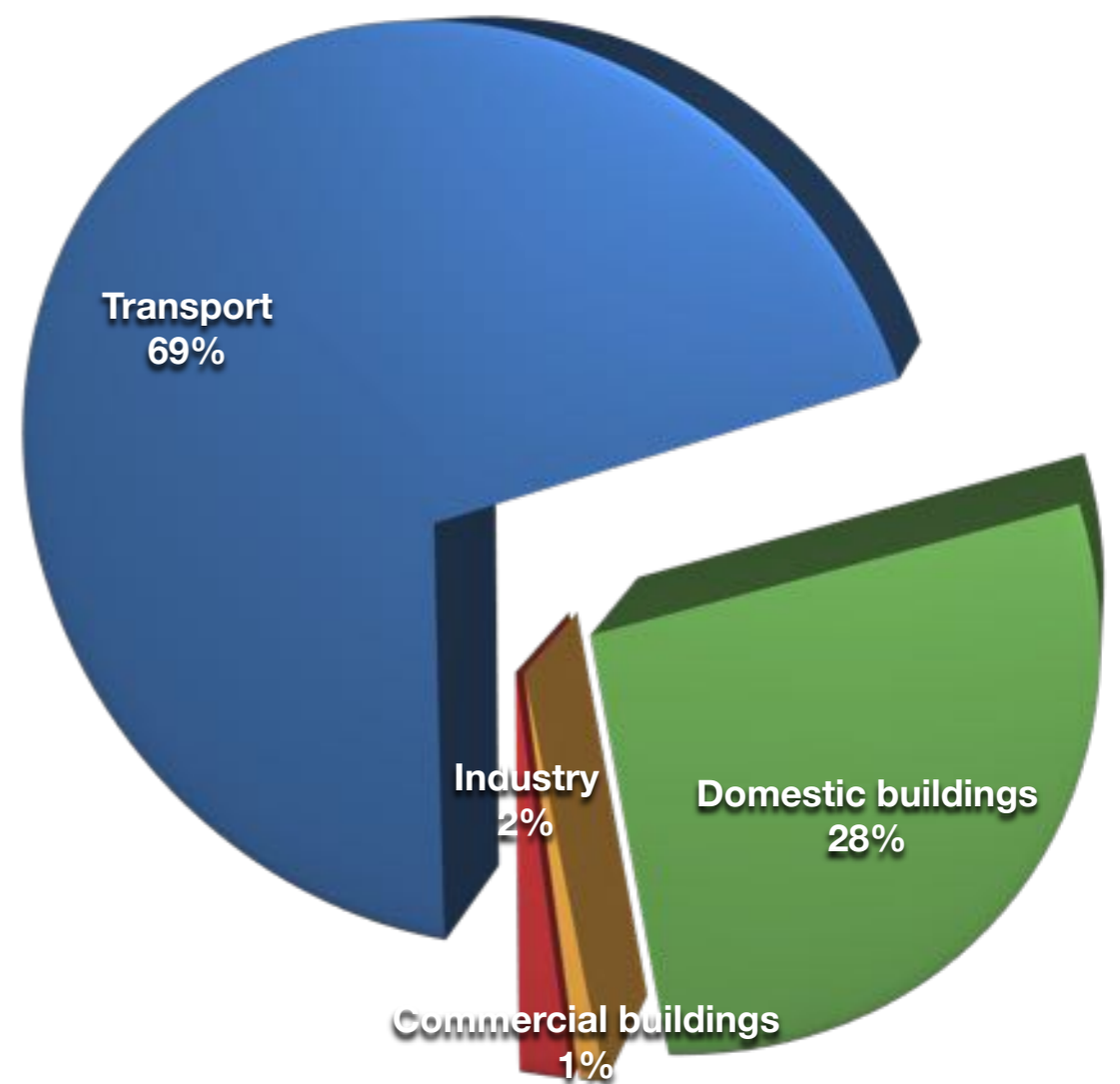


Cape Town

Energy Consumption by Sector



Jinja



Kasese



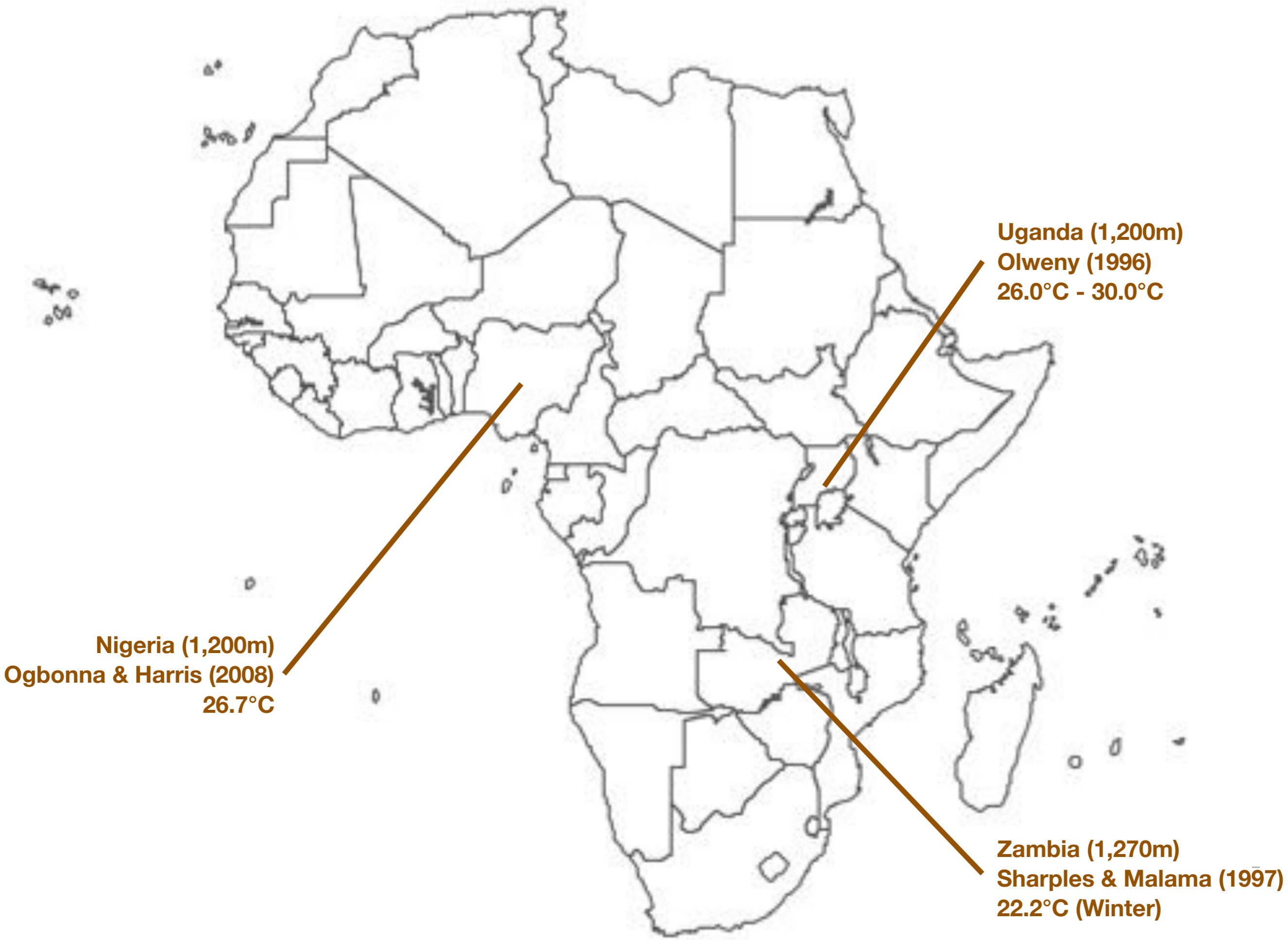


Uganda (1,200m)
Olweny (1996)
26.0°C - 30.0°C



Uganda (1,200m)
Olweny (1996)
26.0°C - 30.0°C

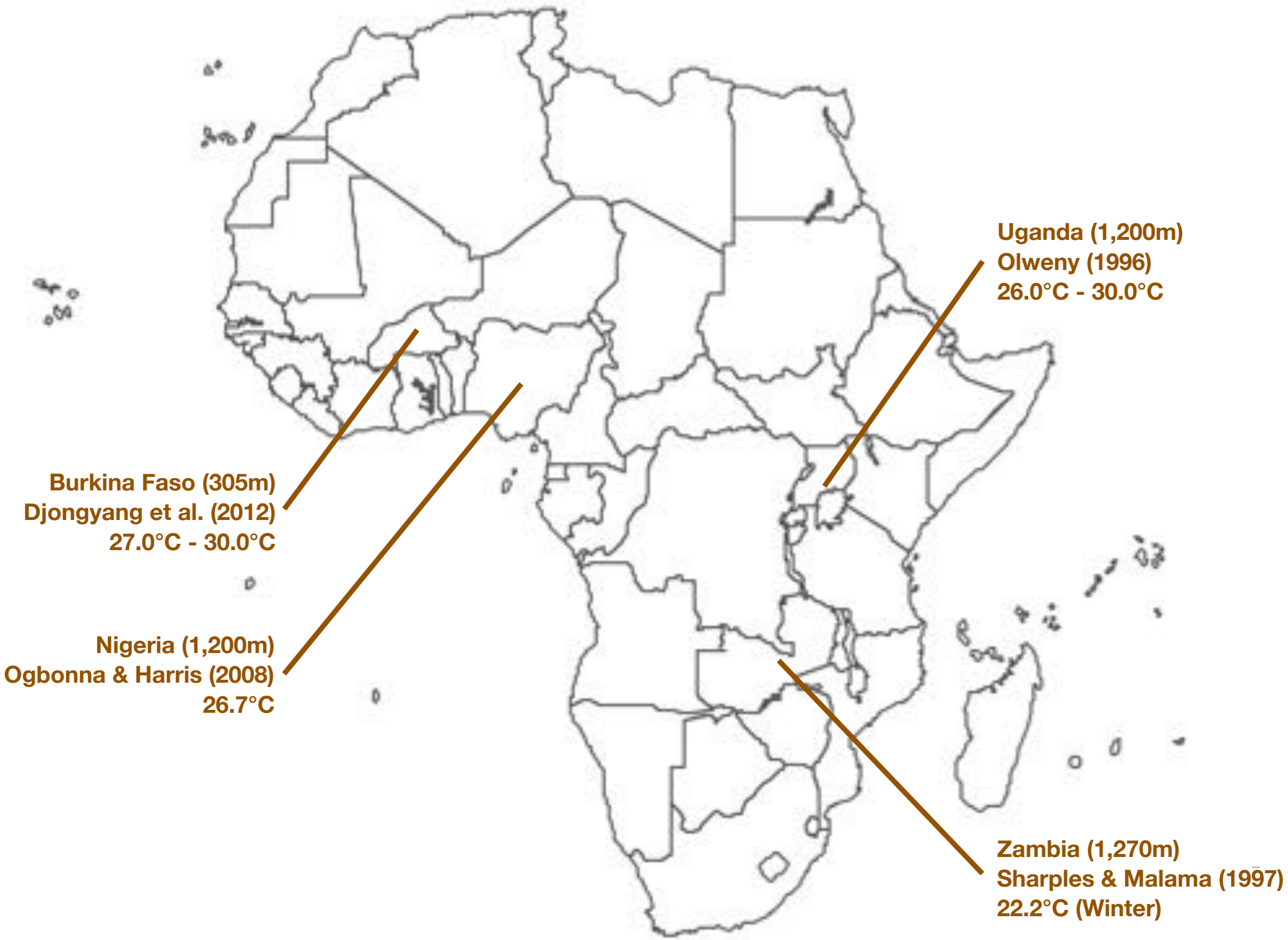
Zambia (1,270m)
Sharples & Malama (1997)
22.2°C (Winter)

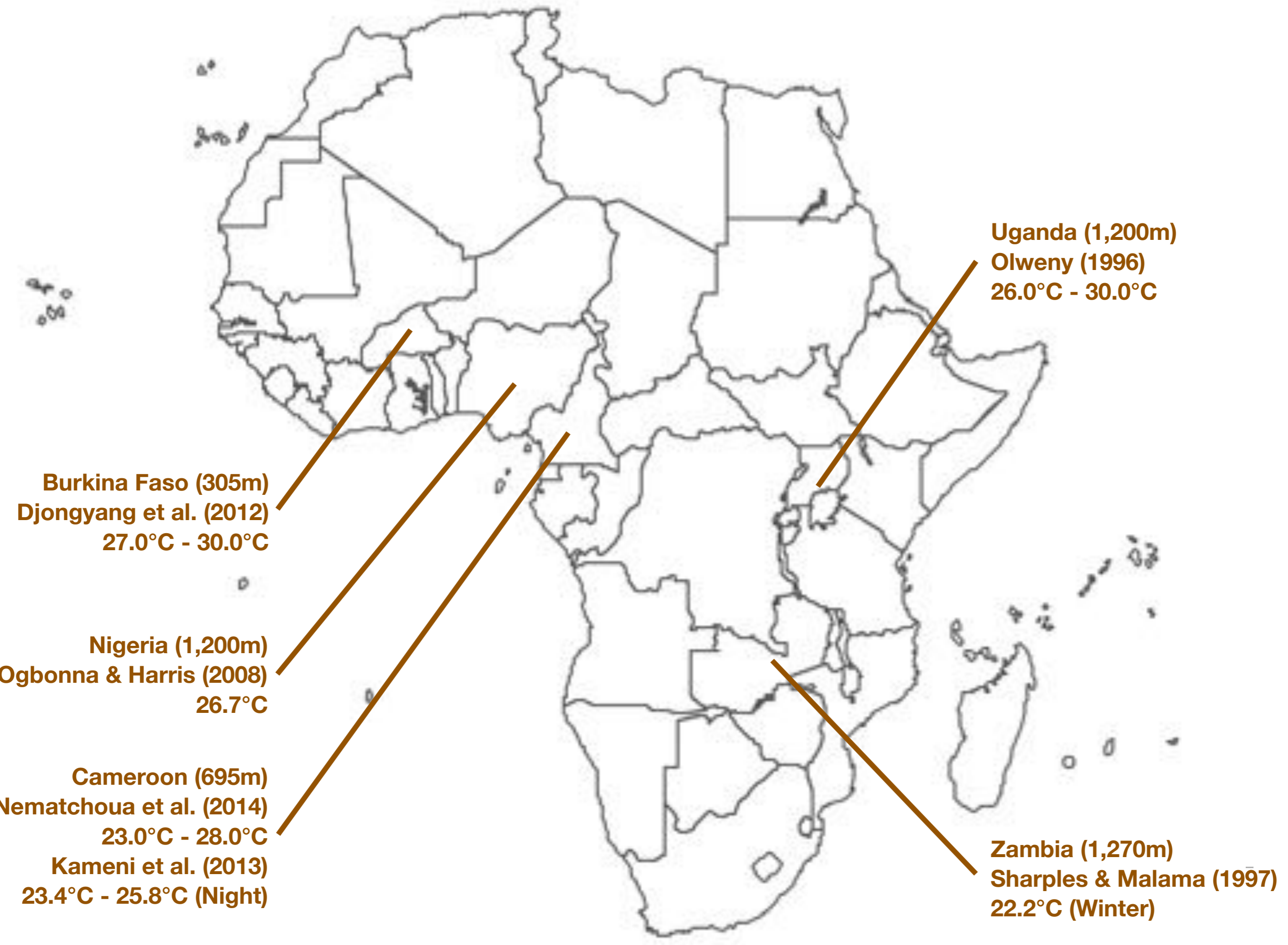


Nigeria (1,200m)
Ogbonna & Harris (2008)
26.7°C

Uganda (1,200m)
Olweny (1996)
26.0°C - 30.0°C

Zambia (1,270m)
Sharples & Malama (1997)
22.2°C (Winter)





Burkina Faso (305m)
Djongyang et al. (2012)
27.0°C - 30.0°C

Nigeria (1,200m)
Ogbonna & Harris (2008)
26.7°C

Cameroon (695m)
Nematchoua et al. (2014)
23.0°C - 28.0°C
Kameni et al. (2013)
23.4°C - 25.8°C (Night)

Uganda (1,200m)
Olweny (1996)
26.0°C - 30.0°C

Zambia (1,270m)
Sharples & Malama (1997)
22.2°C (Winter)

General Climate Conditions

	Nov.	Dec.	Study
Temperature			
Maximum	31.0°C	30.5°C	29.9°C
Minimum	17.8°C	16.3°C	18.7°C
Mean	23.3°C	23.3°C	22.9°C
Relative Humidity			
Maximum	92.5%	93.4%	93.4%
Minimum	53.5%	46.9%	53.5%
Mean	78.8%	76.6%	80.2%

	Male	Female	All
Temperature			
Maximum	31.6	29.4	31.6
Minimum	22.5	23.8	22.5
Mean	25.7	25.9	25.8
Relative Humidity			
Maximum	76.4	77.5	77.5
Minimum	56.5	57.9	56.5
Mean	70.2	70.1	70.2

	Male	Female	All
Participants			
Number	55	56	111
Age (Max.)	29	32	32
Age (Min.)	19	19	19
Median	22	21	21

Existing Thermal Conditions

- Air Temperature
- Radiant Temperature
- Relative Humidity
- Air Speed
- Carbon Dioxide (Future)

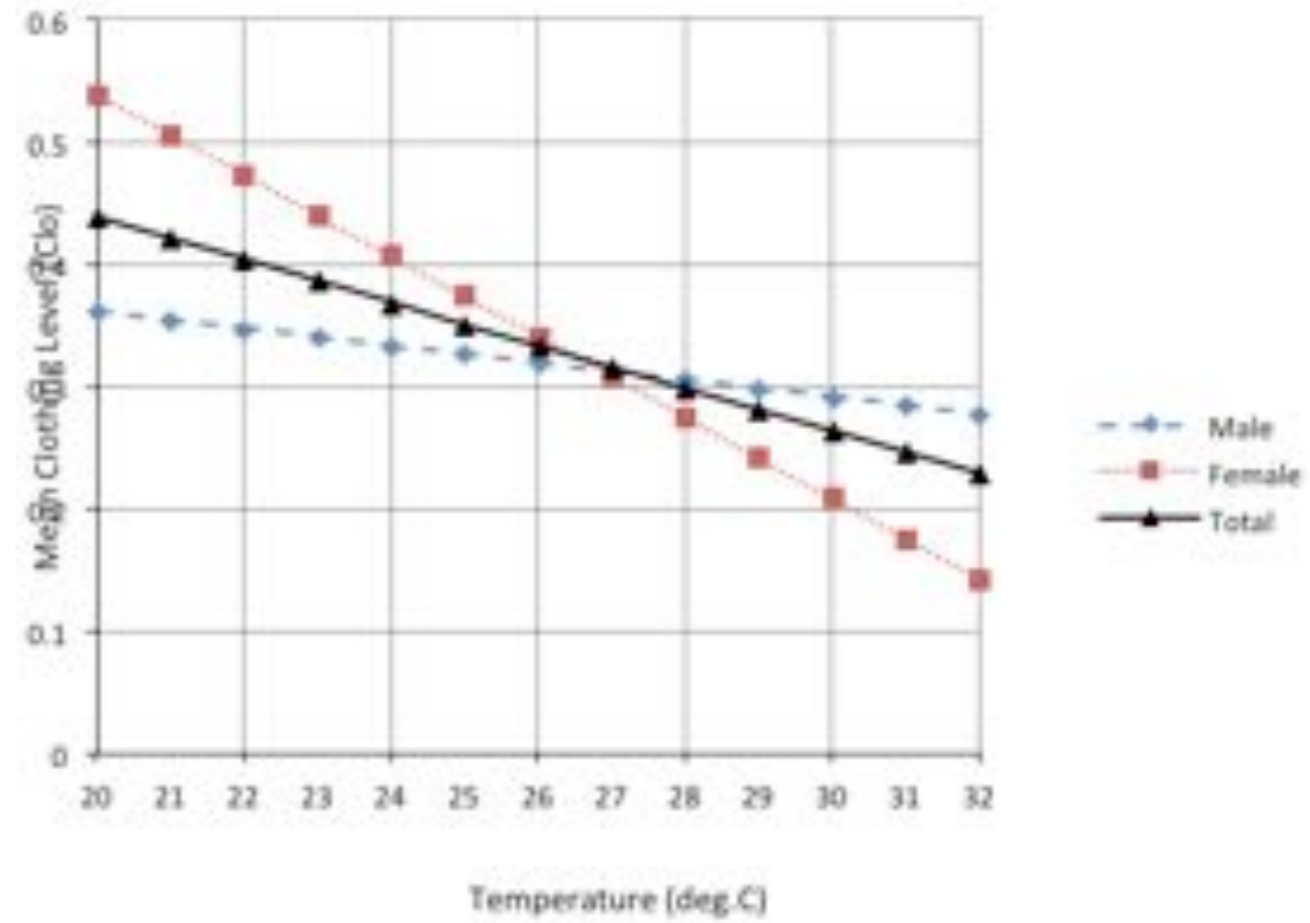
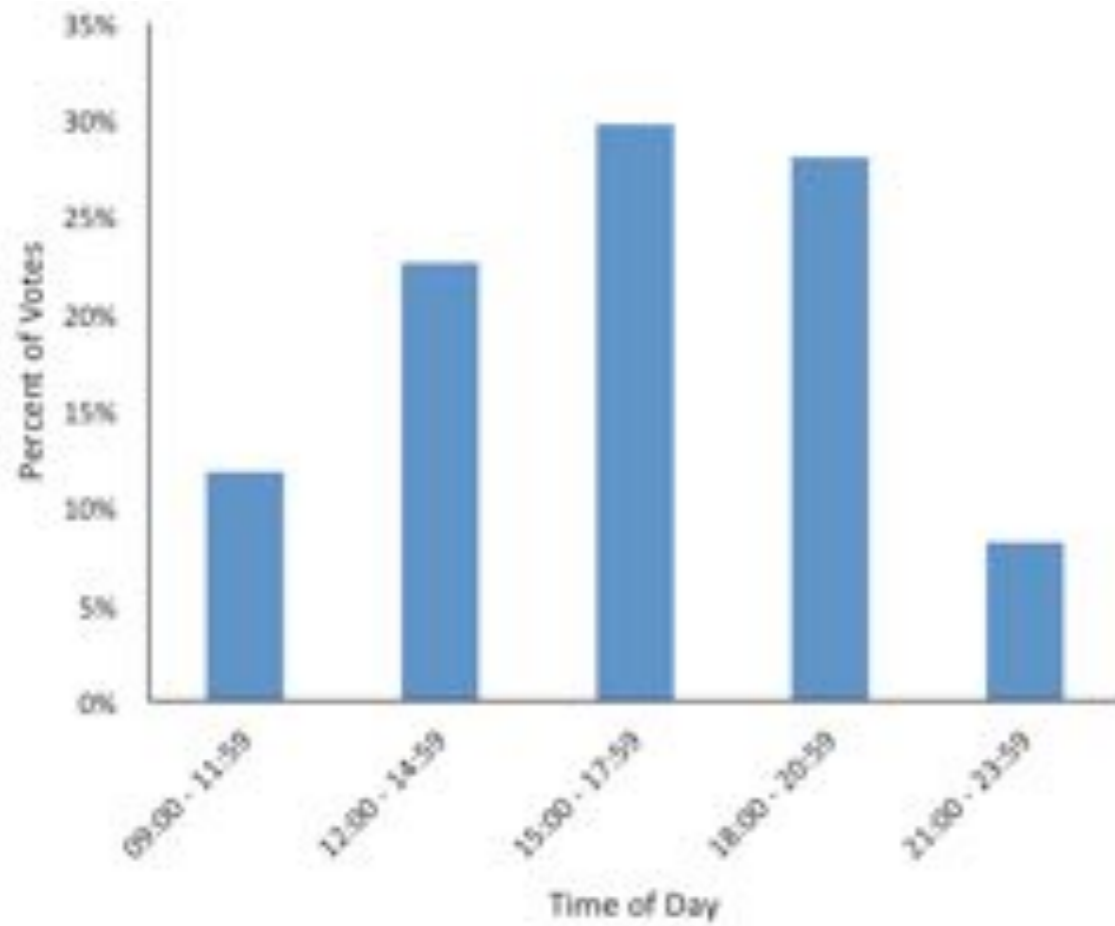




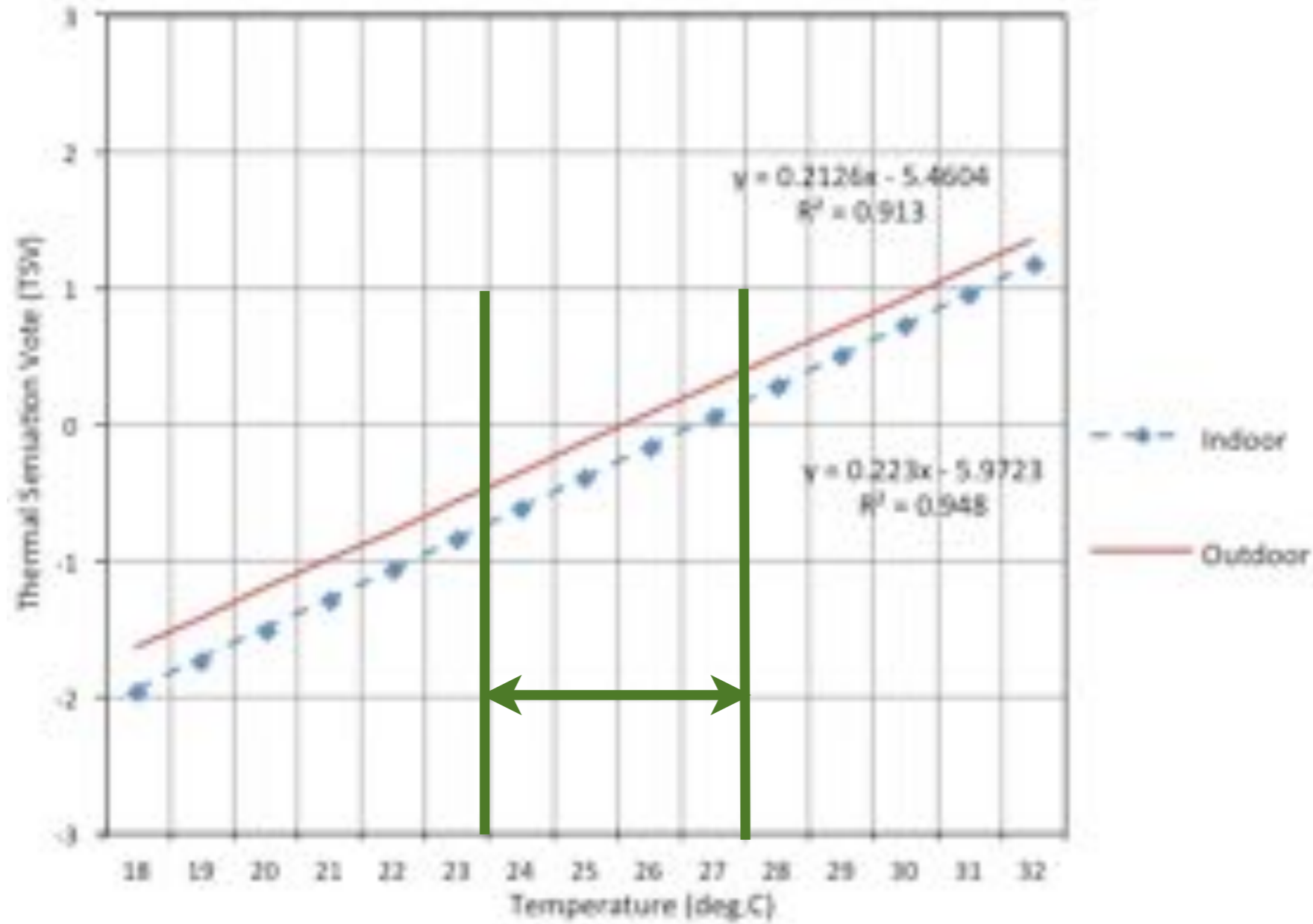
Examples of Student Housing



Process

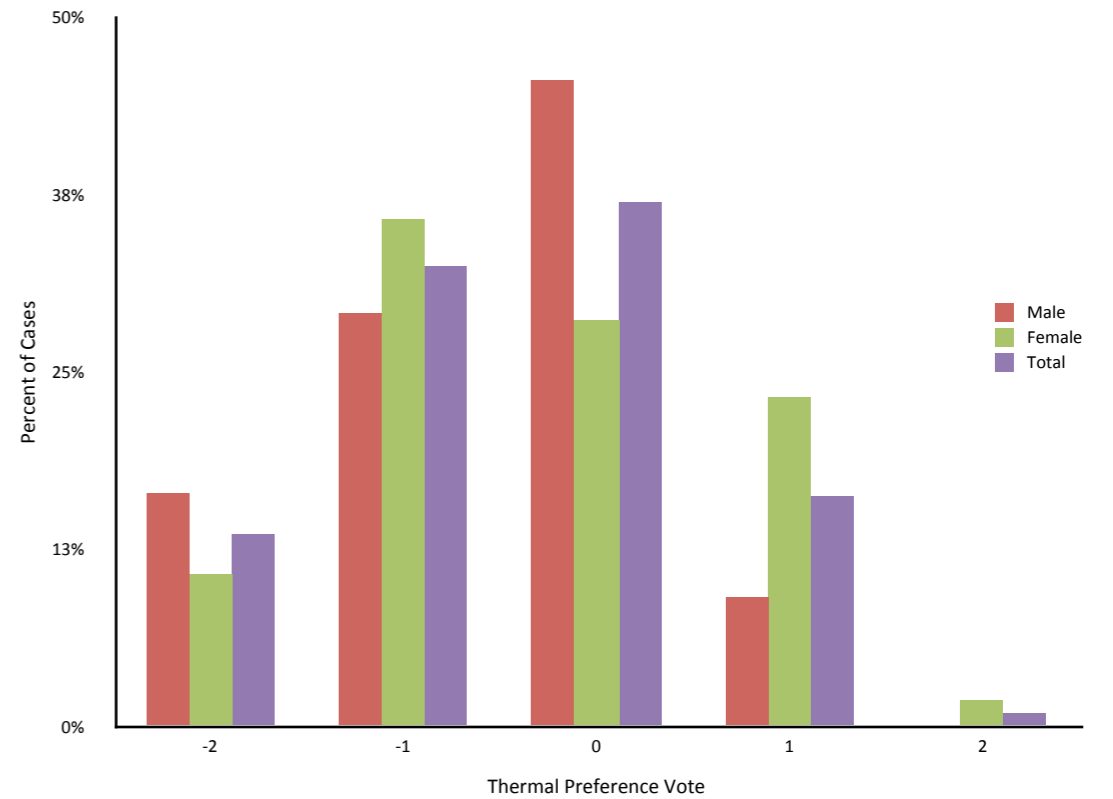
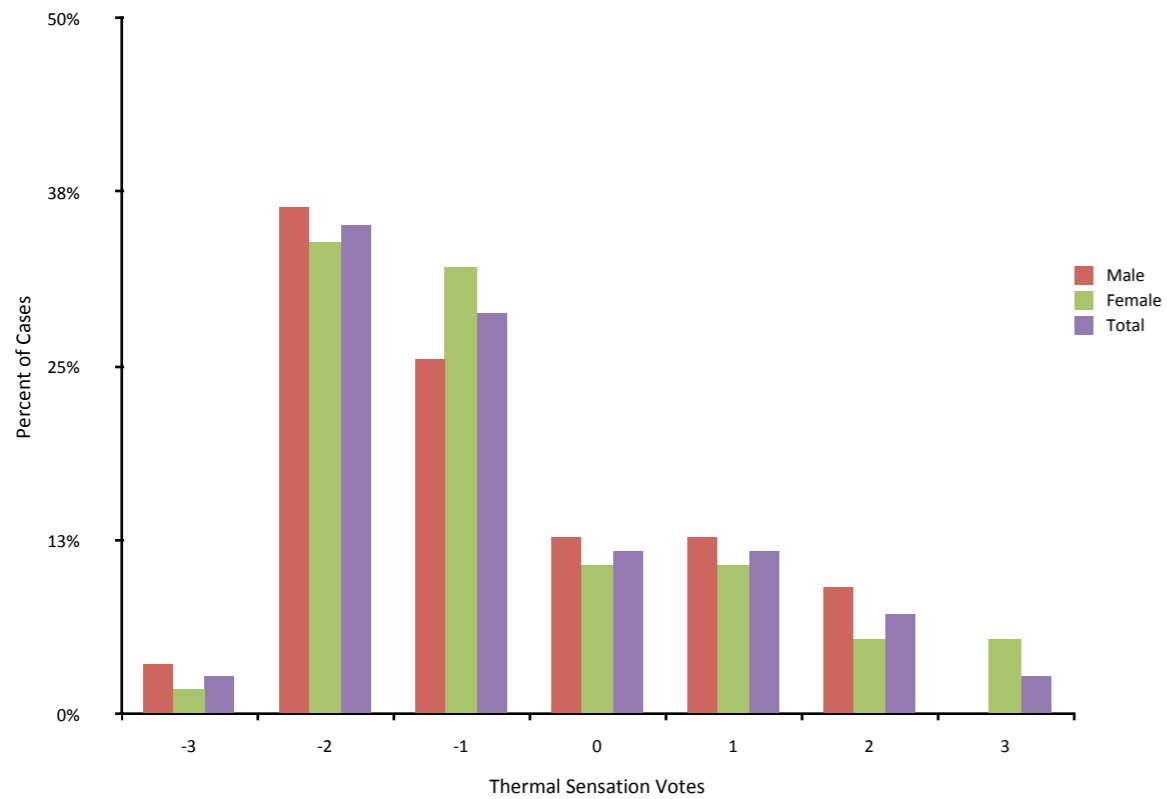


	Male	Female	All
Participants			
Maximum	0.99	0.99	0.99
Minimum	0.1	0.14	0.1
Mean	0.32	0.36	0.34
Std. Dev.	0.15	0.15	0.16



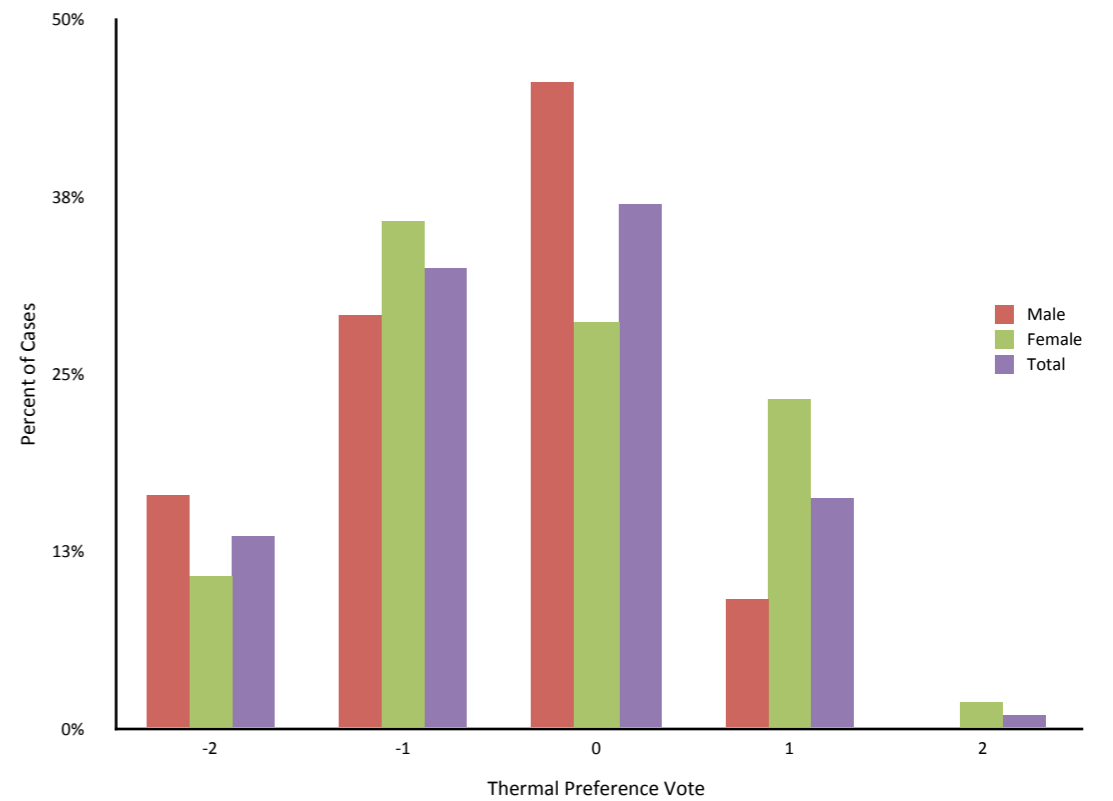
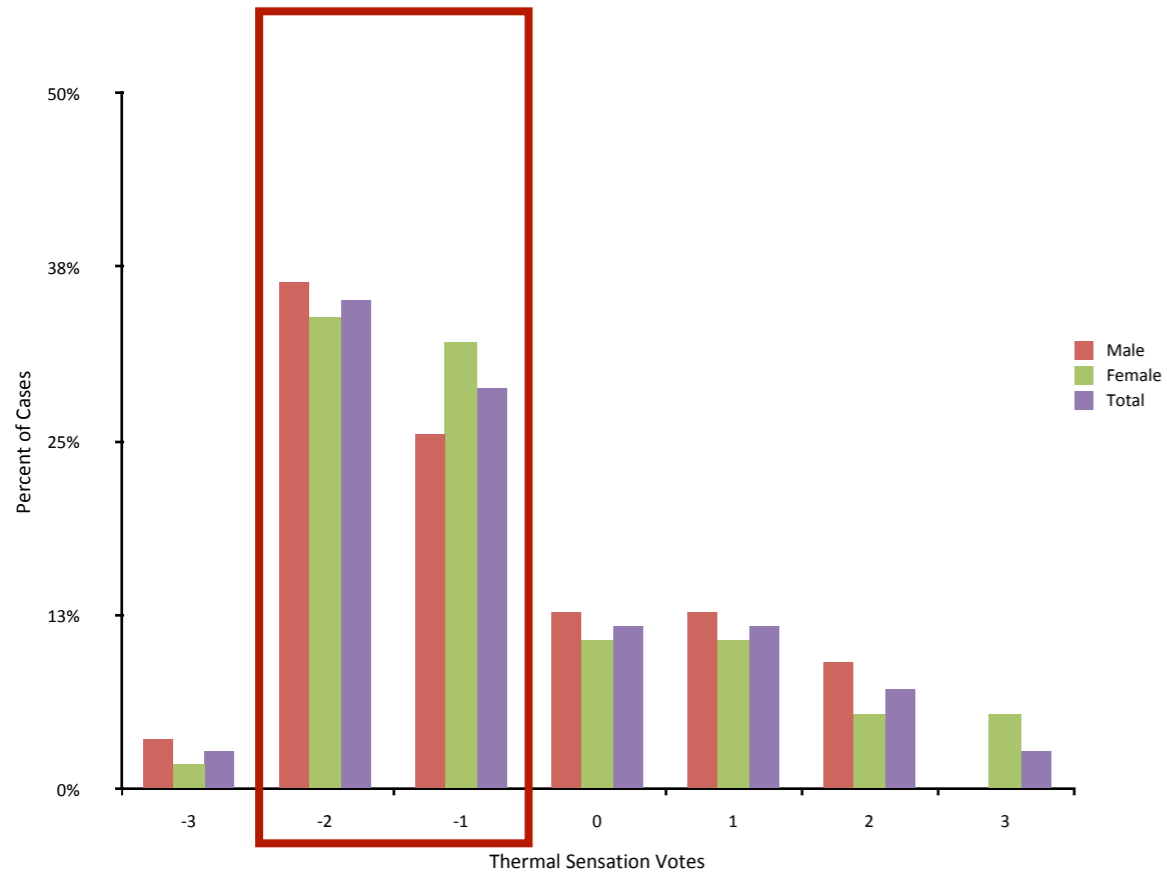
Comfort Range External Temperature (23.5°C - 27.5°C)

Cool with a "K"



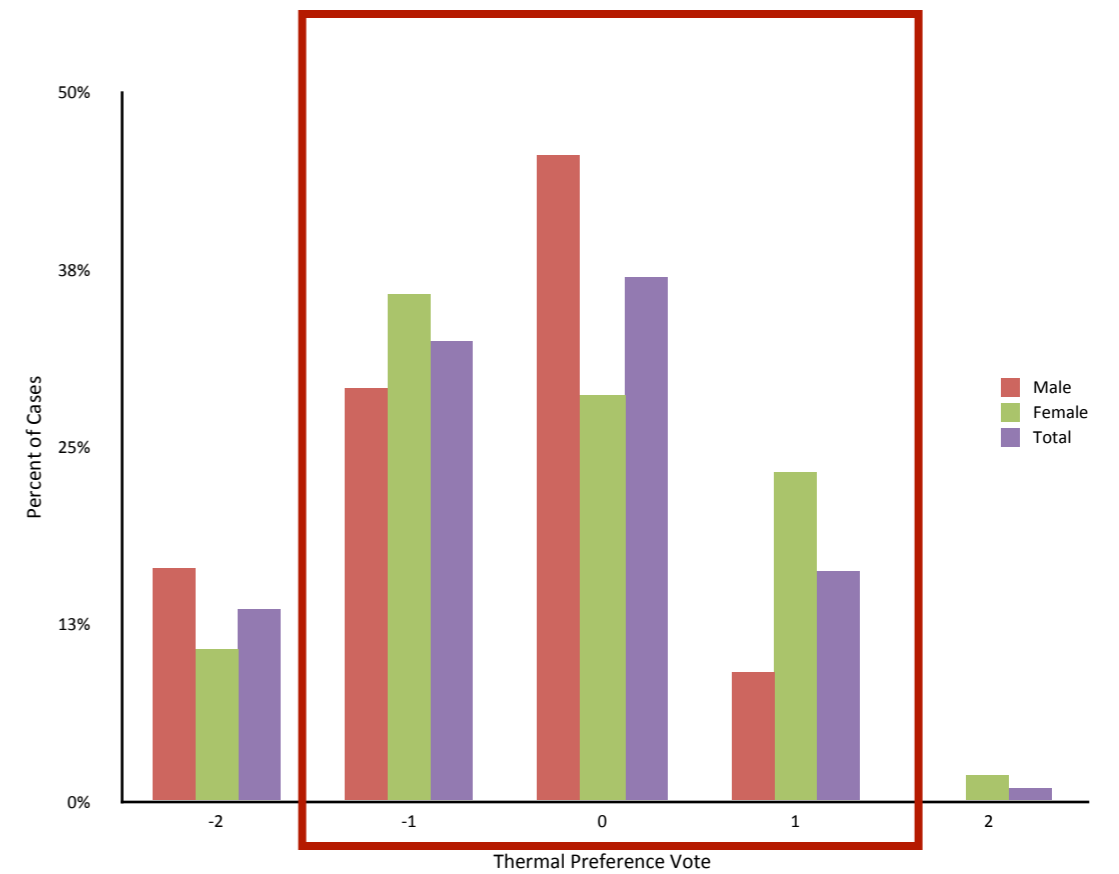
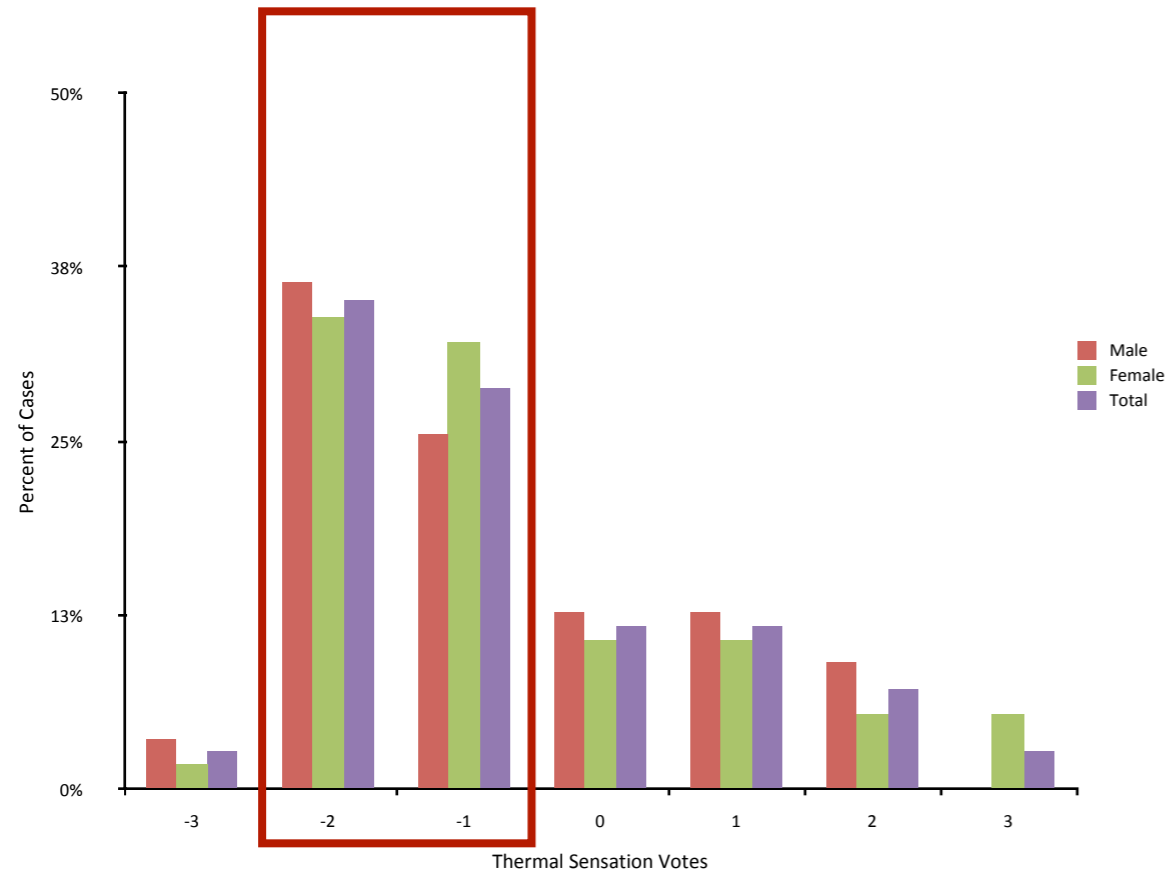
	Male	Female	Total
Thermal Sensation	-0.78	-0.68	-0.73
Thermal Acceptability	0.05	-0.09	-0.02
Thermal Preference	-0.53	-0.30	-0.41

Cool with a "K"



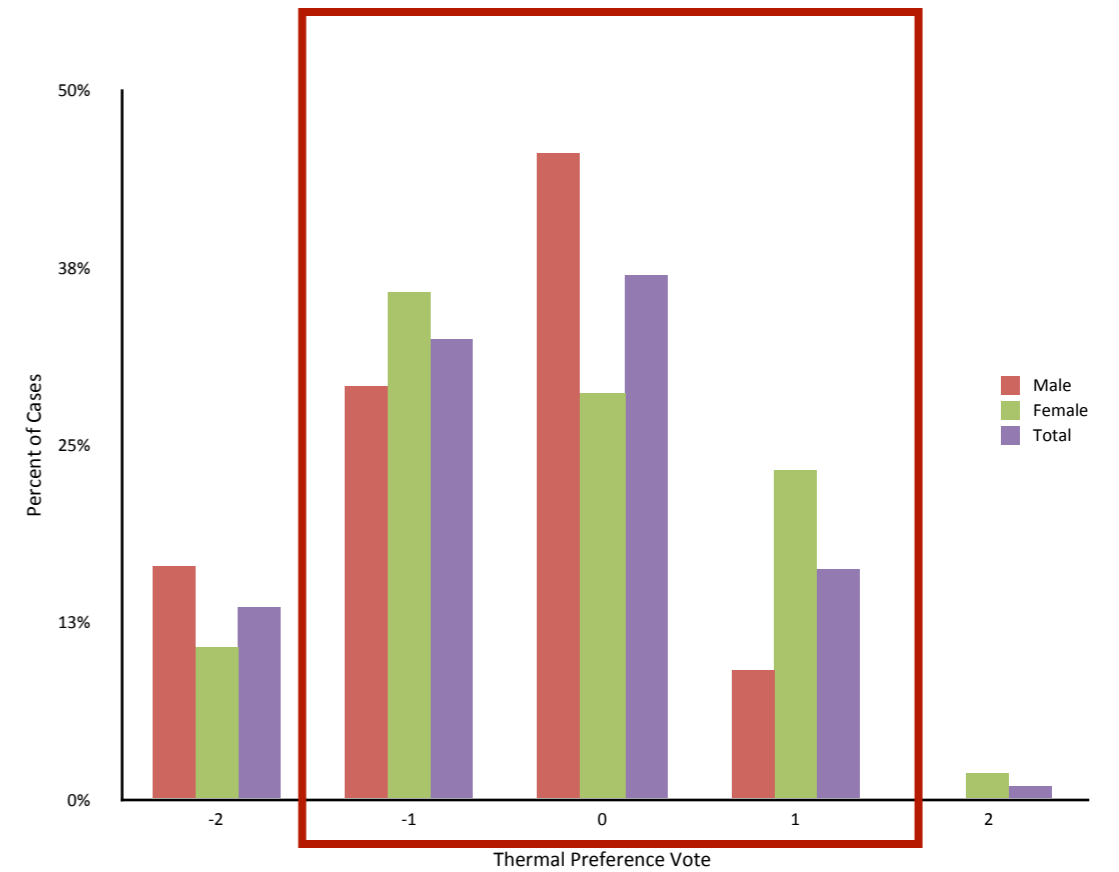
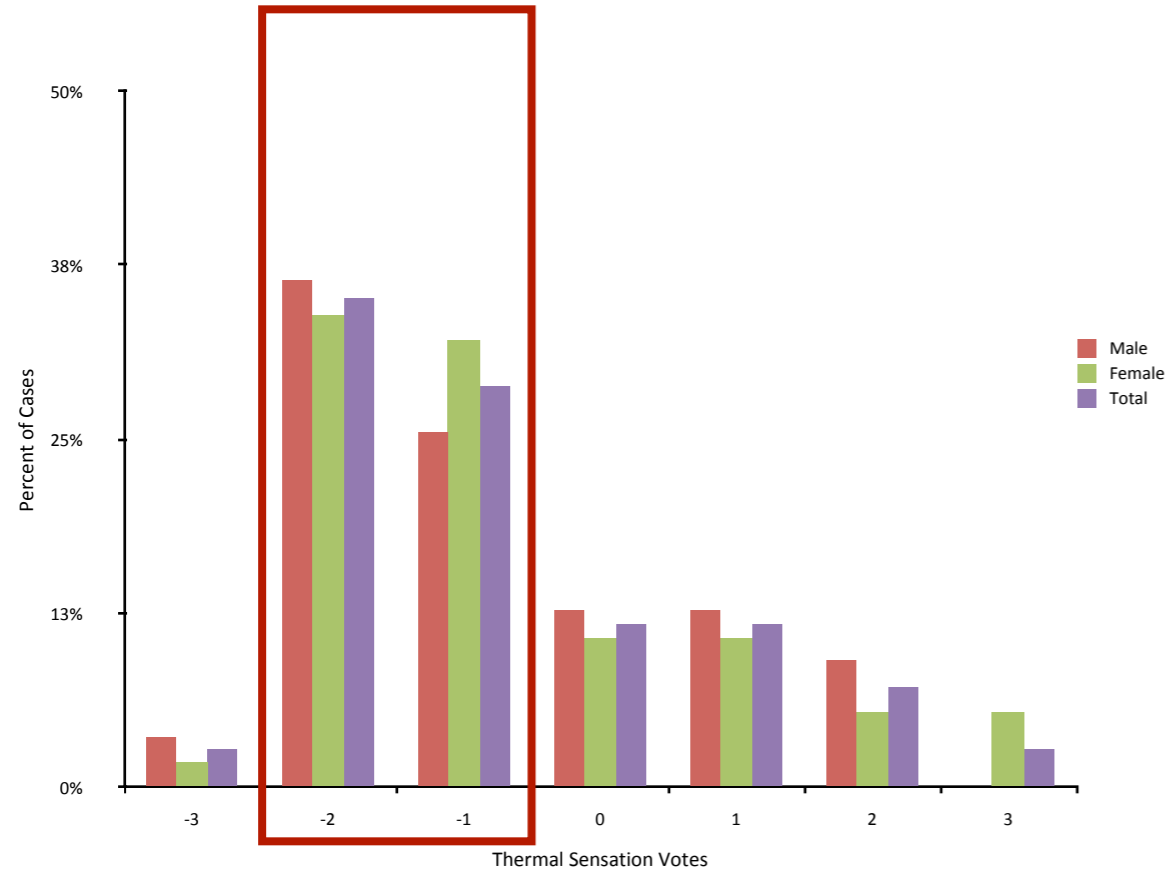
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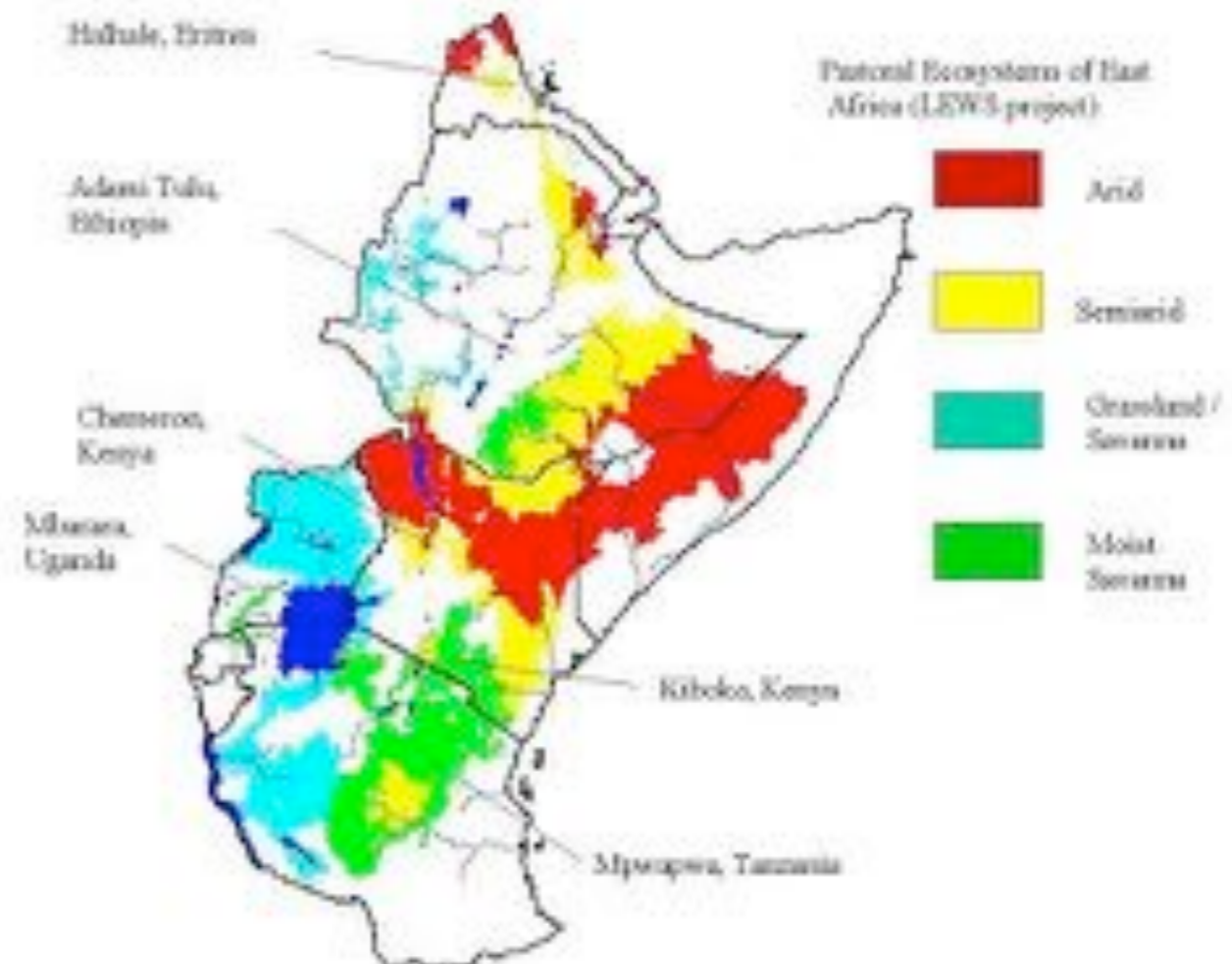
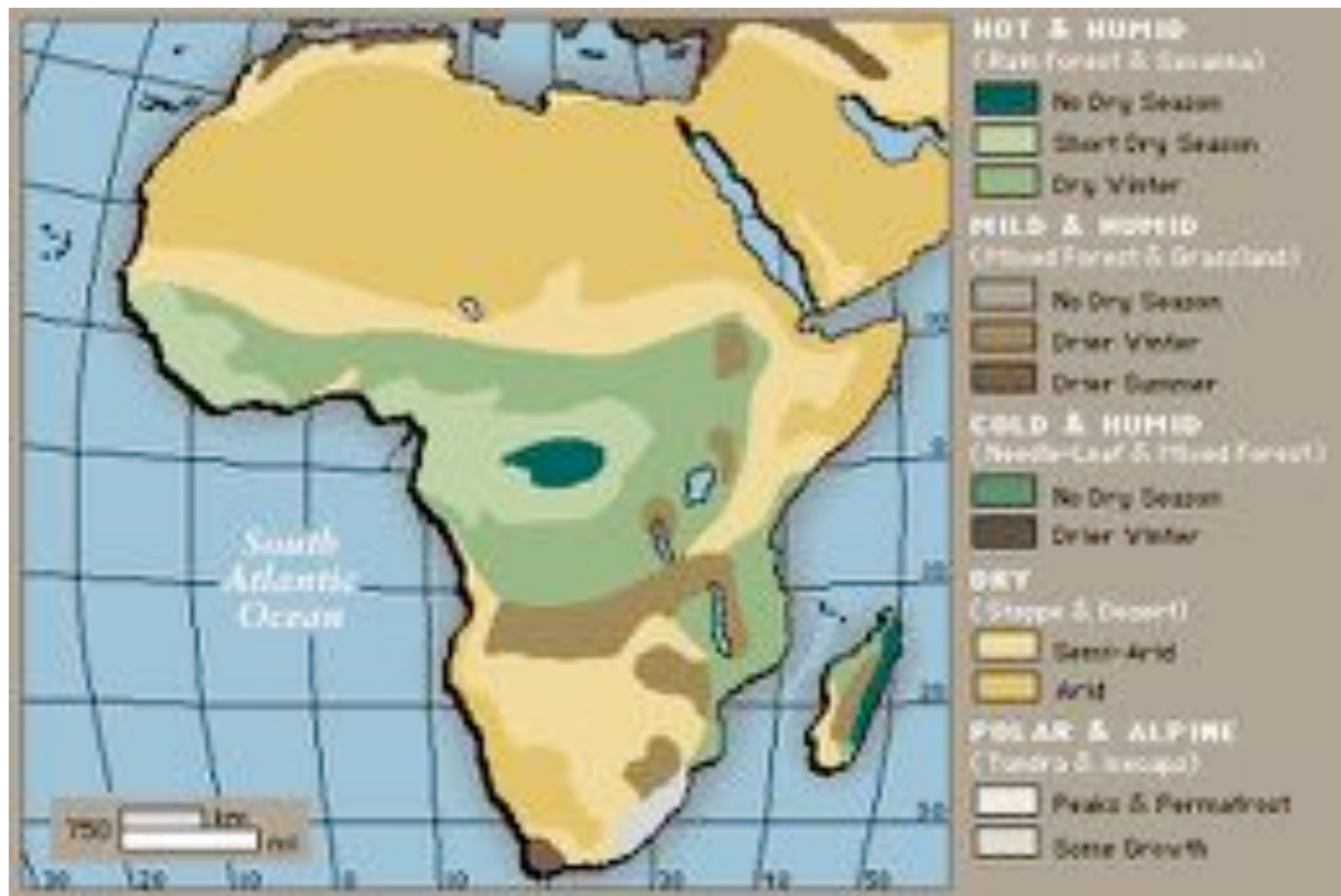
Cool with a "K"



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Adaptive Responses

- Adjust Windows / Doors
- Adjust Clothing
- Change Location
- **Turn on the fan**
- Take a Cool Drink
- Fan yourself
- Adjust Clothing
- Enter Bed
- Adjust Windows / Doors
- Take a Hot Drink



This Study

- Looking to gain an understanding of the comfort conditions in an upland tropical climate
- Lack of adequate data on thermal performance of buildings, or general building performance data
- Break away from the **Big Data / Generalist** Approach ...













**THIS BUILDING
HAS BEEN DESIGNED
USING AN
ALTERNATIVE
SOLUTION**

Implications

- Currently many are working on air-conditioning standards from North America and Europe.
- Having real figures is an important part of the development of policies.
- Any talk of sustainable building design without any indication of what we are aiming for is potentially catastrophic.



Thank You