Climate moderation via green infrastructure – the potential of regulating ecosystem services to mitigate the UHI effect in Dar es Salaam

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Introduction

- Urban climate and ecosystem services in sub-Saharan Africa remain relatively under-researched.
  - evidence is patchy (Cavan et al., 2011).
- Dar es Salaam (Tanzania) has some climatological and biometeorological research
  - UHII estimated to be 2-4 °C in 2001 (Jonsson, et al., 2004)
- But there are still **gaps** in our understanding, e.g. the spatial variability in local urban climates & their drivers (Ndetto & Matzarakis, 2015).

Aims & research gap

- Aims
  - To assess the nature & extent of the UHI effect, including its spatial and seasonal variability
  - To determine how urban vegetation (regulating ecosystem services) correlates with UHI intensity.
- Contributions
  - Empirically informed analysis of intra-urban distributions in air temperatures across Dar es Salaam
  - A systematic assessment of associations between UHII and surface cover over an urban transect

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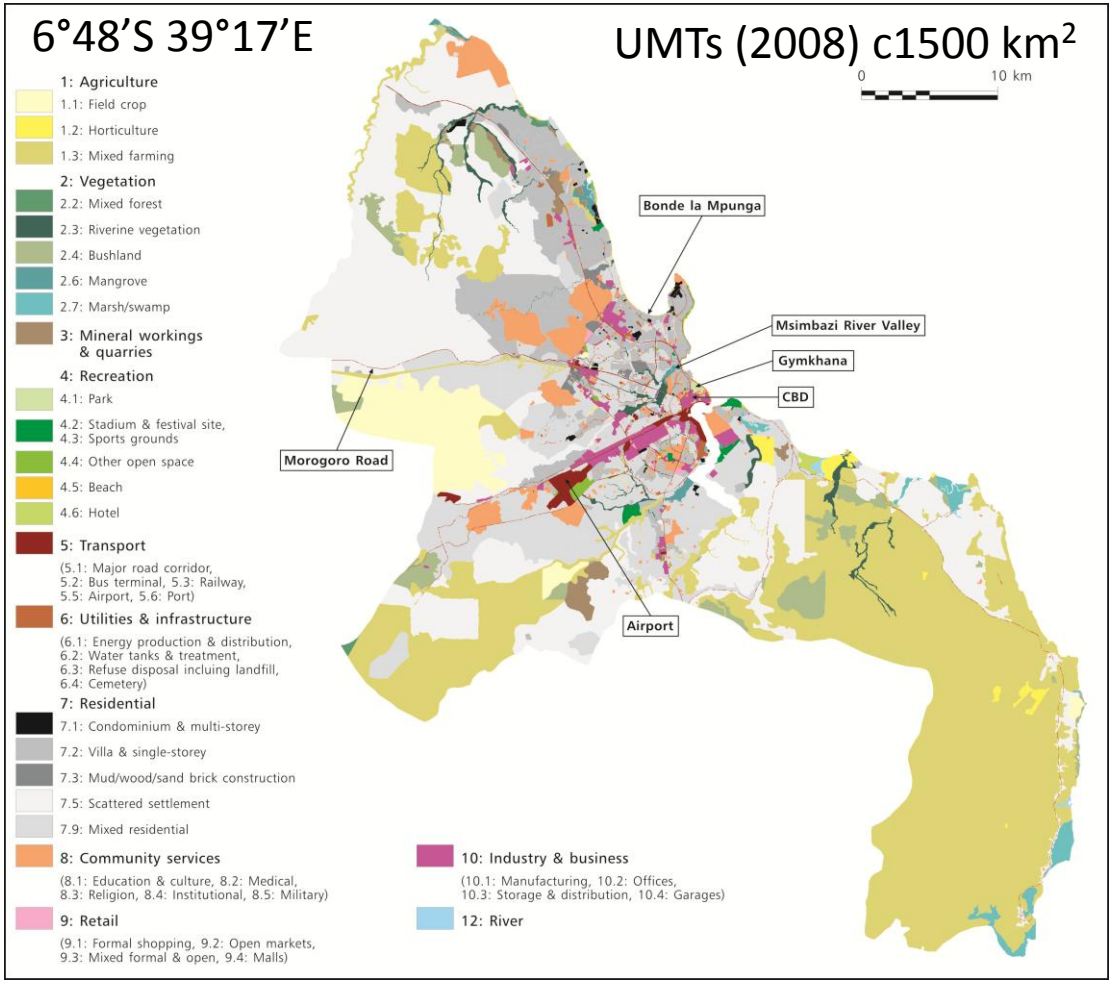
Urban character

UMTs? Biophysically & planning relevant units describing urban form & function 11 High level 43 sub-UMTs

- A rapidly growing city with a tropical climate (Aw)
- Urban core, historically constrained by riverine corridors
- Largely unplanned, low density sprawl
- Extensive peri-urban zone



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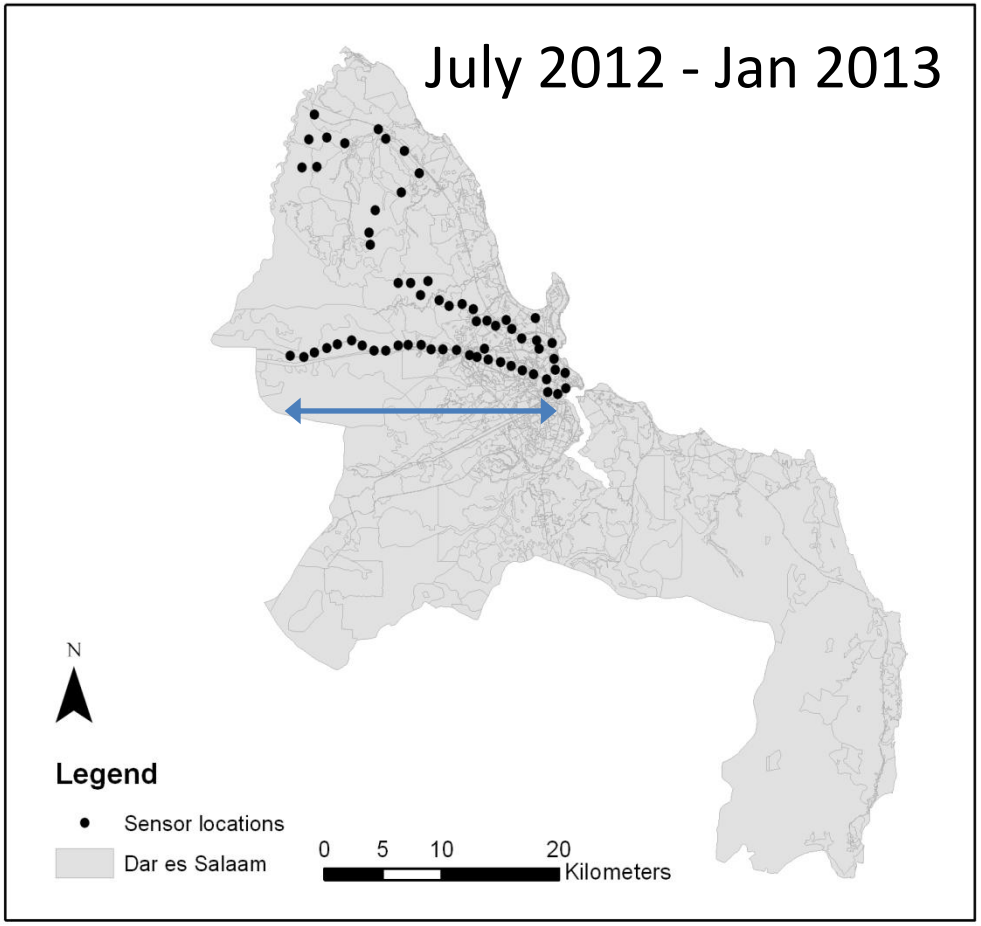
Sensor network

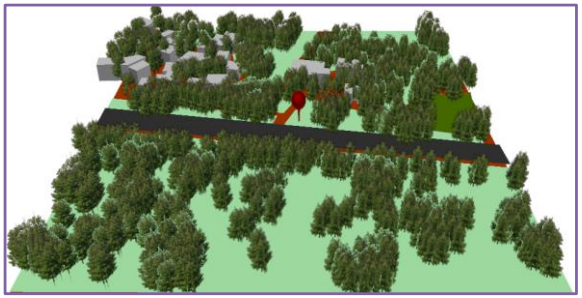
- 64 i-button sensors (T_{air})
- Housed in wooden shields, mounted @4m
- 2 transects
  - Morogoro Road 0-24km (n=21)
  - 0m – 152 m a.s.l.

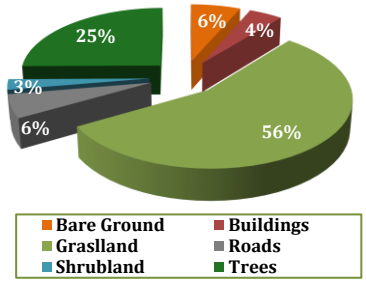


T_{air} UHII = $T_{urban*} - T_{rural*}$

*adjusted for elevation assuming free atmospheric lapse rate

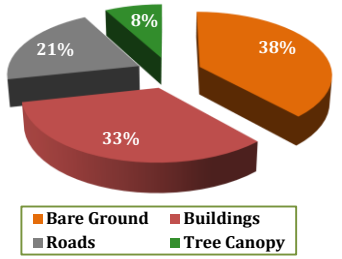
Sensor Point 58





Average building height:5 m

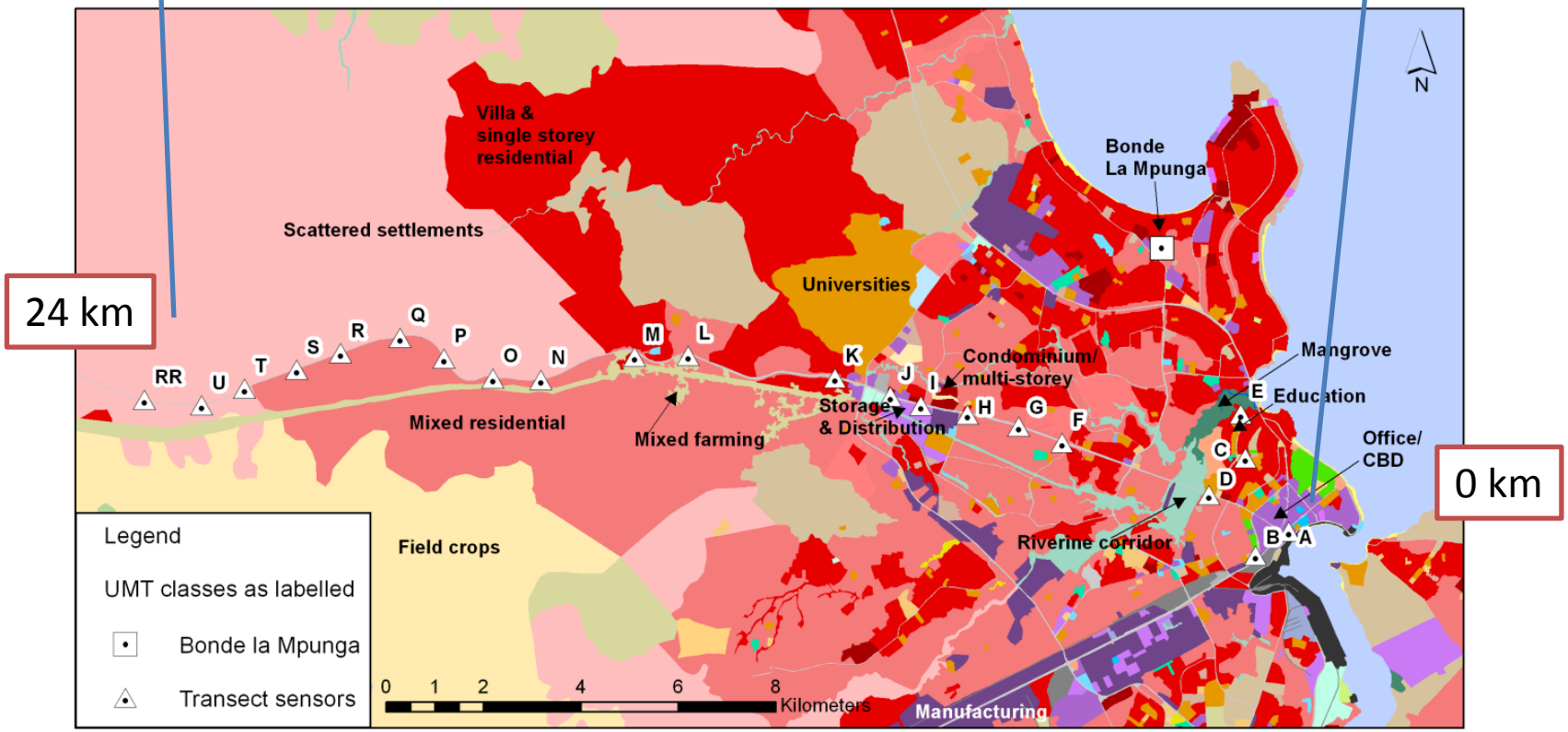
Sensor Point 22 at Kisutu



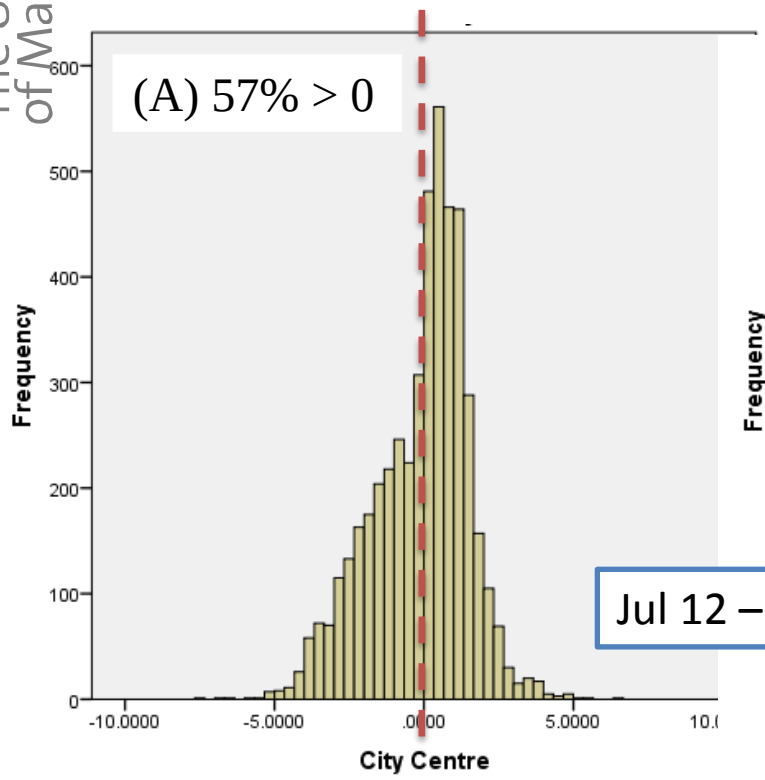
Average building height: 7 m

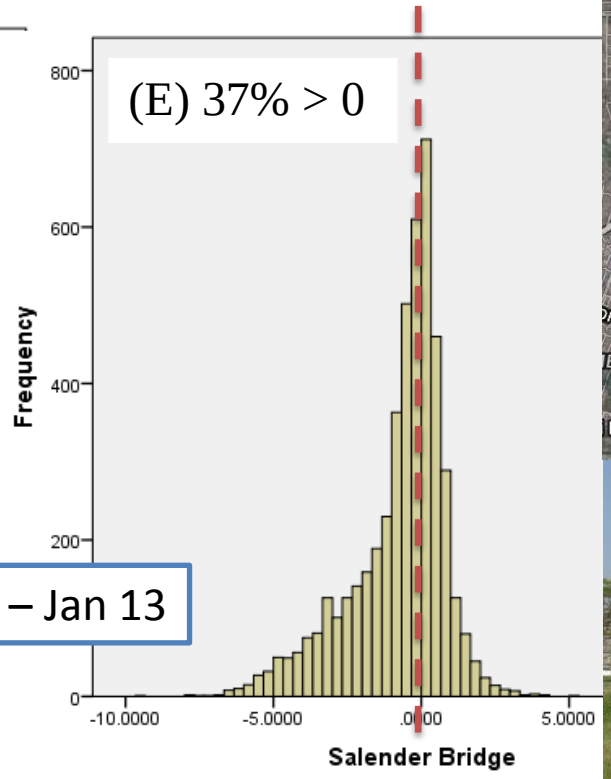
Within 50m buffer 18% large trees & 8% buildings

Within 50m buffer 0% large trees & 28% buildings



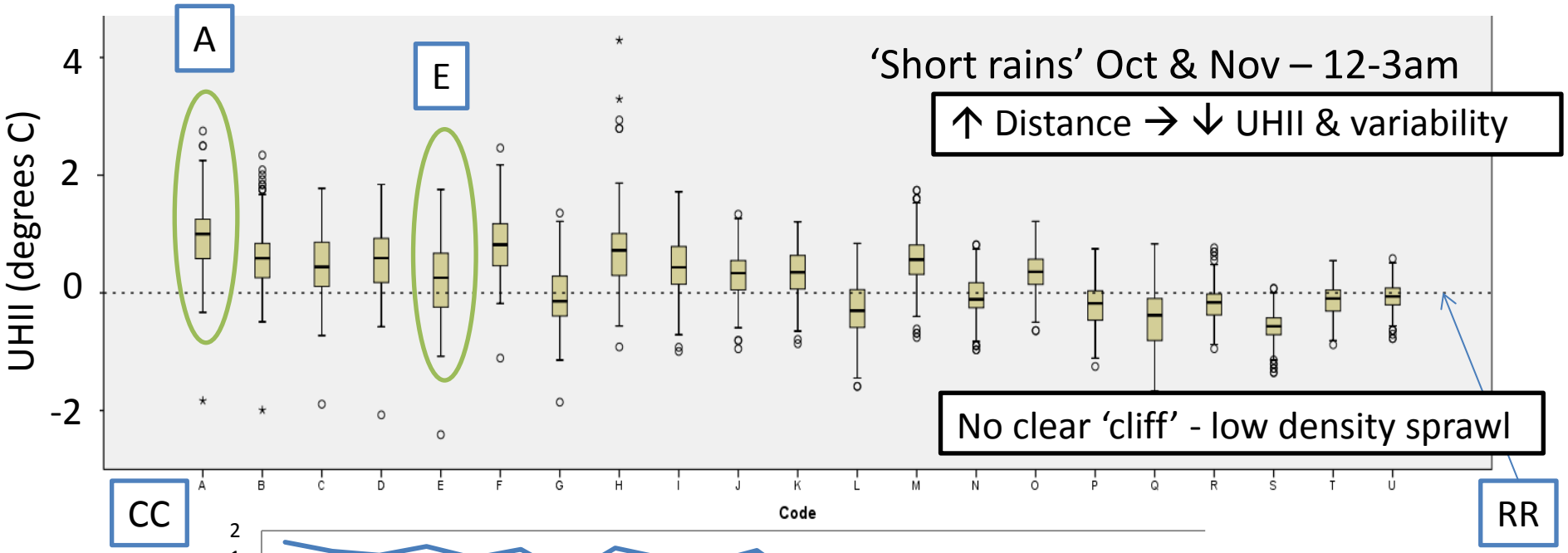
How often is there a UHI effect & how large is it?

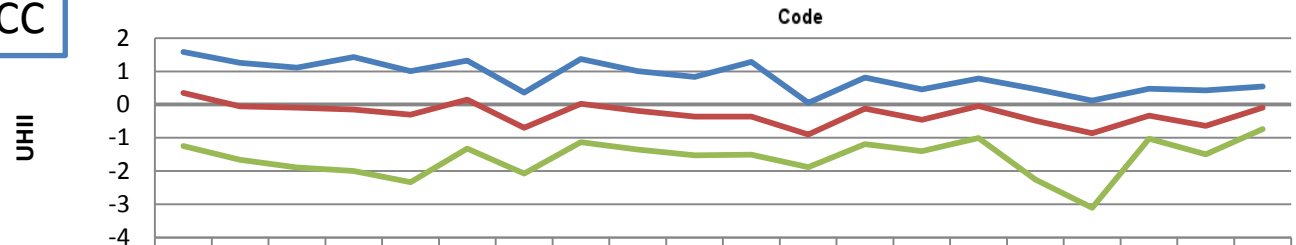




Jul 12 – Jan 13

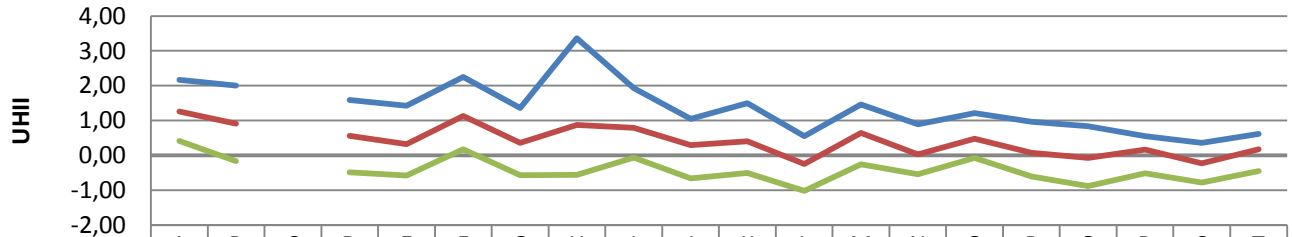
- Further analysis for
  - ‘Short rains’ Oct & Nov – 12-3am
  - ‘Dry’ July-Aug – 12-3am
  - ‘Hot’ January - 12-3am





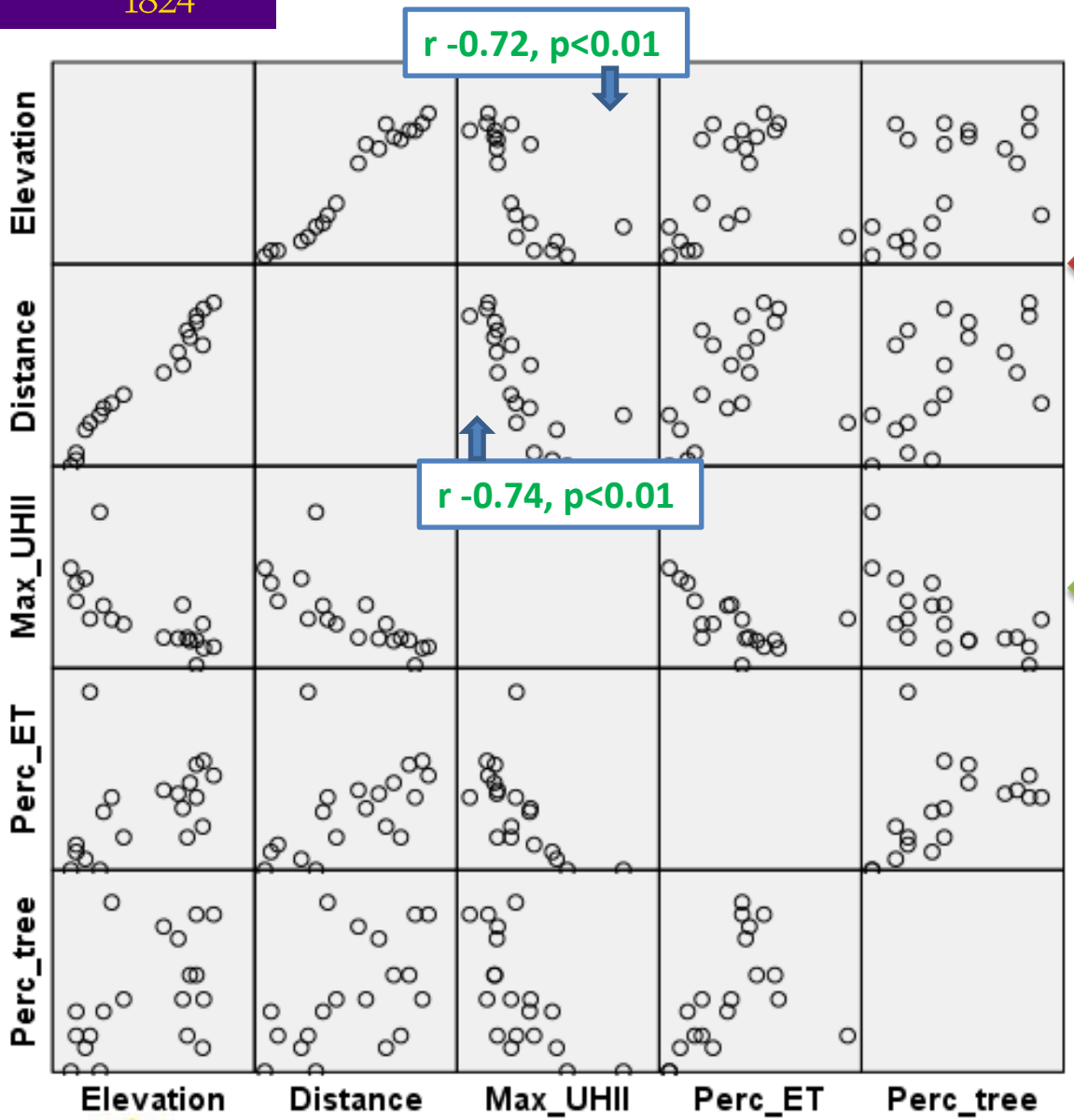
'Dry' July-Aug 12-3am

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Max	1,59	1,26	1,11	1,43	1,01	1,32	0,36	1,37	1	0,84	1,28	0,05	0,81	0,46	0,79	0,46	0,12	0,48	0,43	0,55
Mean	0,35	-0,1	-0,1	-0,1	-0,3	0,15	-0,7	0,03	-0,2	-0,4	-0,4	-0,9	-0,1	-0,5	-0	-0,5	-0,9	-0,3	-0,6	-0,1
Min	-1,2	-1,7	-1,9	-2	-2,3	-1,3	-2,1	-1,1	-1,4	-1,5	-1,5	-1,9	-1,2	-1,4	-1	-2,3	-3,1	-1	-1,5	-0,7



'Hot' January - 12-3am

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Max	2,17	2,01		1,59	1,42	2,25	1,36	3,36	1,93	1,05	1,49	0,55	1,46	0,89	1,21	0,96	0,83	0,55	0,36	0,62
Mean	1,26	0,91		0,56	0,32	1,13	0,35	0,87	0,79	0,30	0,40	-0,2	0,64	0,03	0,48	0,07	-0,0	0,16	-0,2	0,18
Min	0,42	-0,1		-0,4	-0,5	0,18	-0,5	-0,5	-0,0	-0,6	-0,5	-1,0	-0,2	-0,5	-0,0	-0,6	-0,8	-0,5	-0,7	-0,4



No statistically significant correlation % large tree & elevation or distance

Statistically significant correlation between Max UHII & % large tree cover

'Short rains' Oct & Nov – 12-3am

Correlation matrix

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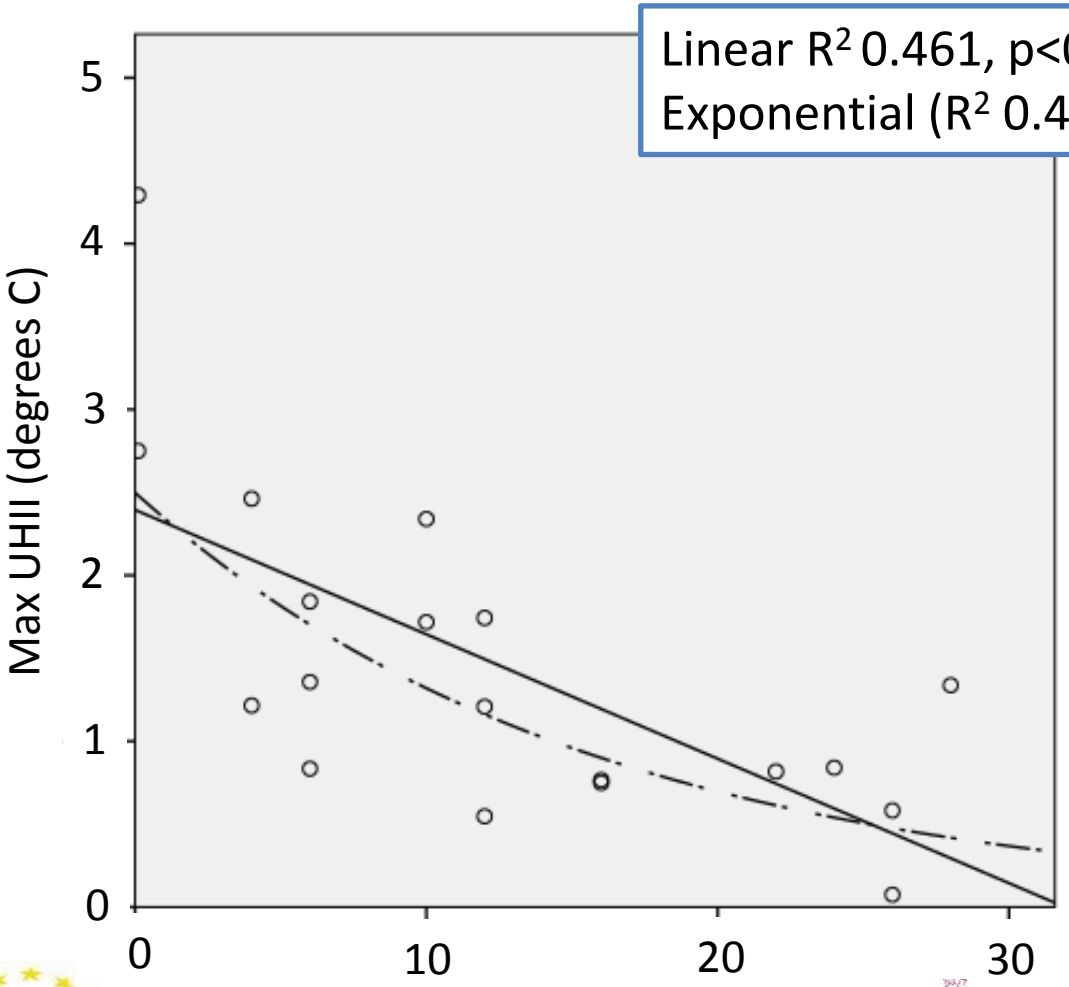
Association between large tree cover & Max UHII



'Short rains' Oct & Nov – 12-3am

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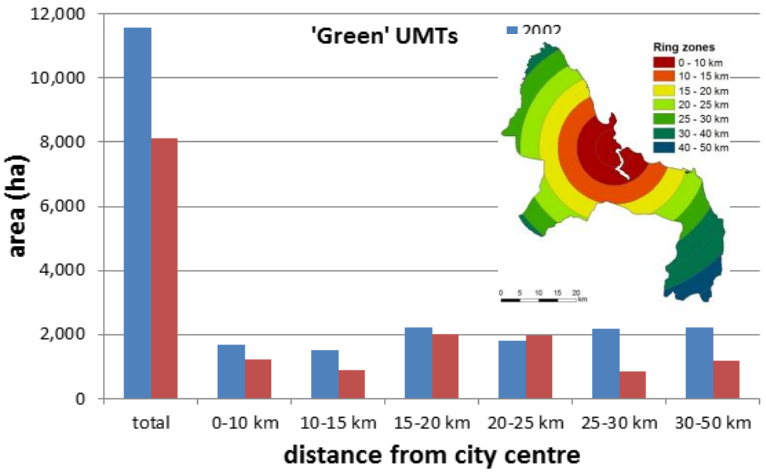
Conclusions

- City scale assessment
  - Complementing research at neighbourhood scale & on biometeorology
- Key findings (so far...)
  - T_{air} UHII in Dar es Salaam can > +4°C
  - Nocturnal T_{air} UHII, most pronounced in 'hot' & 'short rains' periods
  - No clear urban/rural demarcation in the air temperature UHI effect
  - Riverine corridors demonstrably assist cooling
  - Max UHII shows a statistically significant negative association with tree cover (even during the night time)
- Challenge is to retain/enhance regulating ES
  - Vegetation loss & urban growth



- 9-12 % of all woody coverage & around 30 % of woody biomass in Dar es Salaam has been lost between 2002 & 2008

Source: Florian Renner

Technische Universität München

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More information

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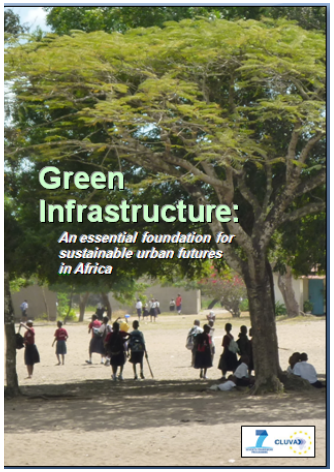
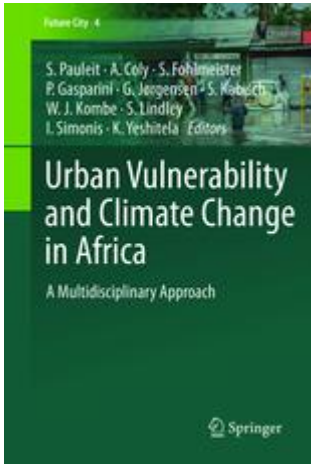
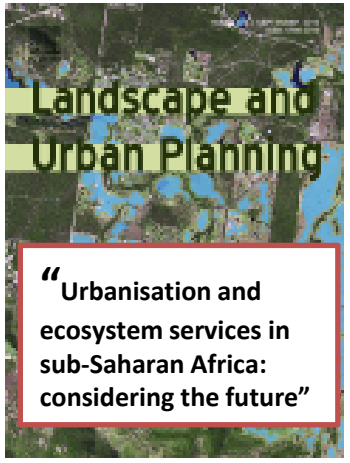


Practitioner Summary



Book (2015)



LUP SI (2016)