

"There are dead trees in my street."

"Adjust your clothing and diet."

"The library is the living room of the neighborhood."

"Go to a park or the beach."

"The mosque distributes water bottles!"

"Use a fan or A/C."

"Keep it calm."















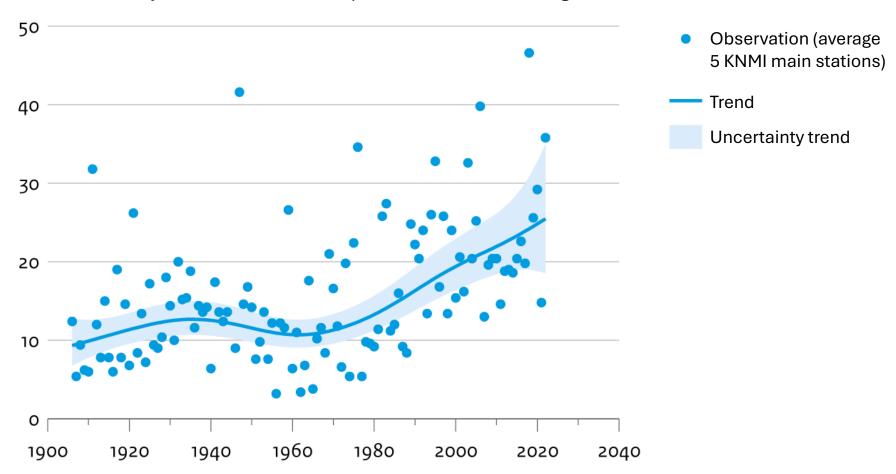




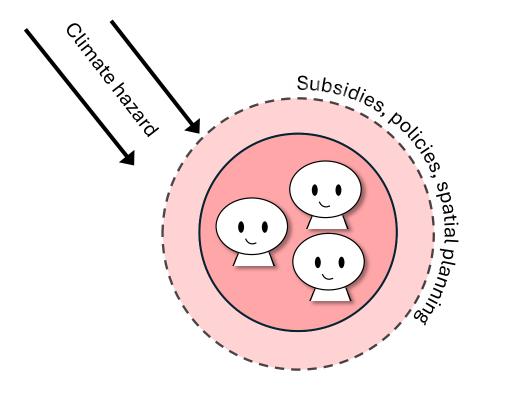


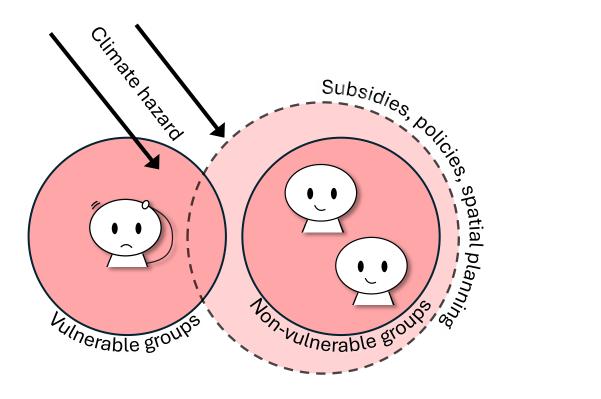


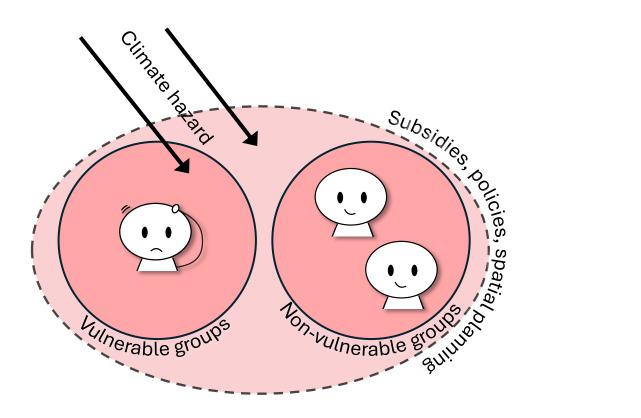
Amount of days with maximum temperatures of 25° C or higher in the Netherlands



(Compendium voor de Leefomgeving, 2023)



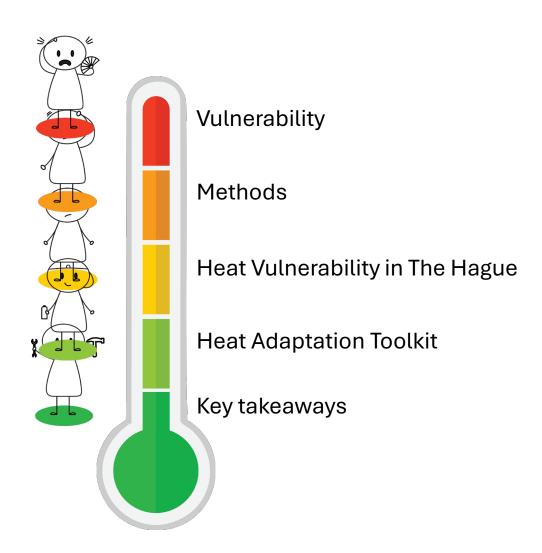




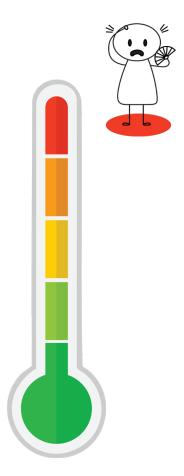
Research Question

How can a **multidimensional approach** to **climate vulnerability** in the context of **urban heat** improve **tailored adaptation strategies**?

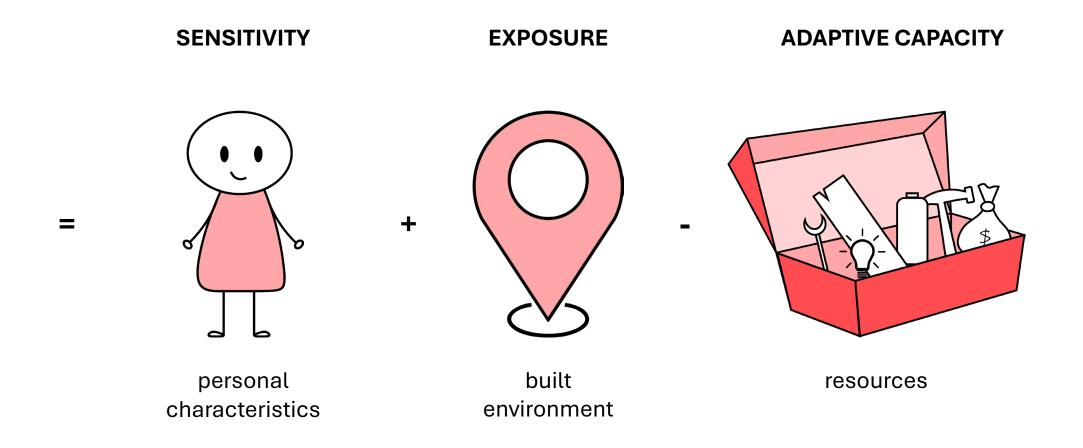
Content



Vulnerability

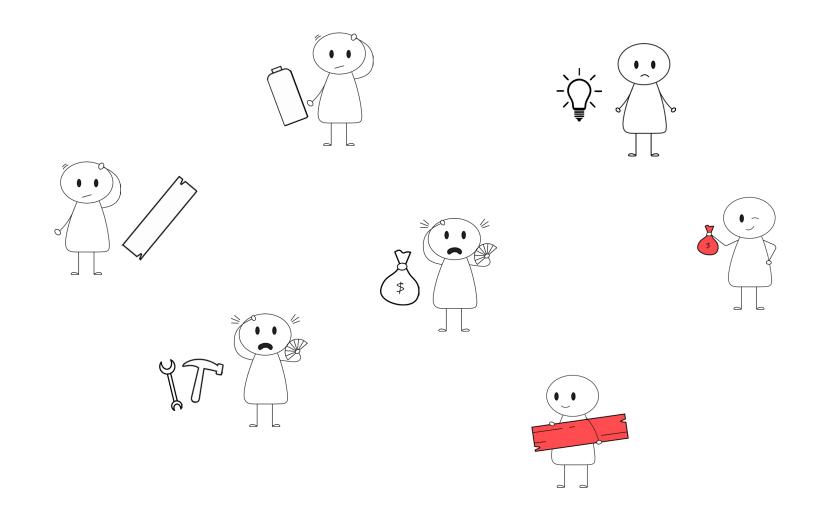






Vulnerability – Adaptive capacity





Vulnerability – Adaptive capacity

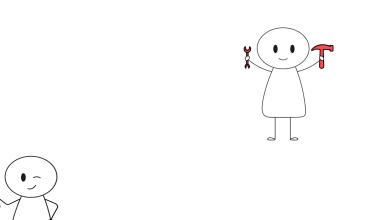












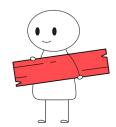






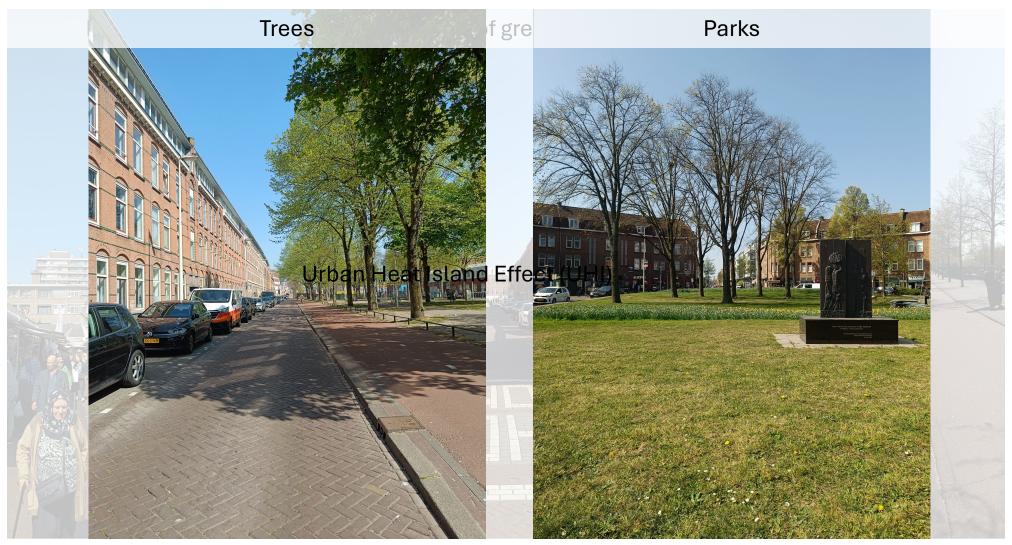






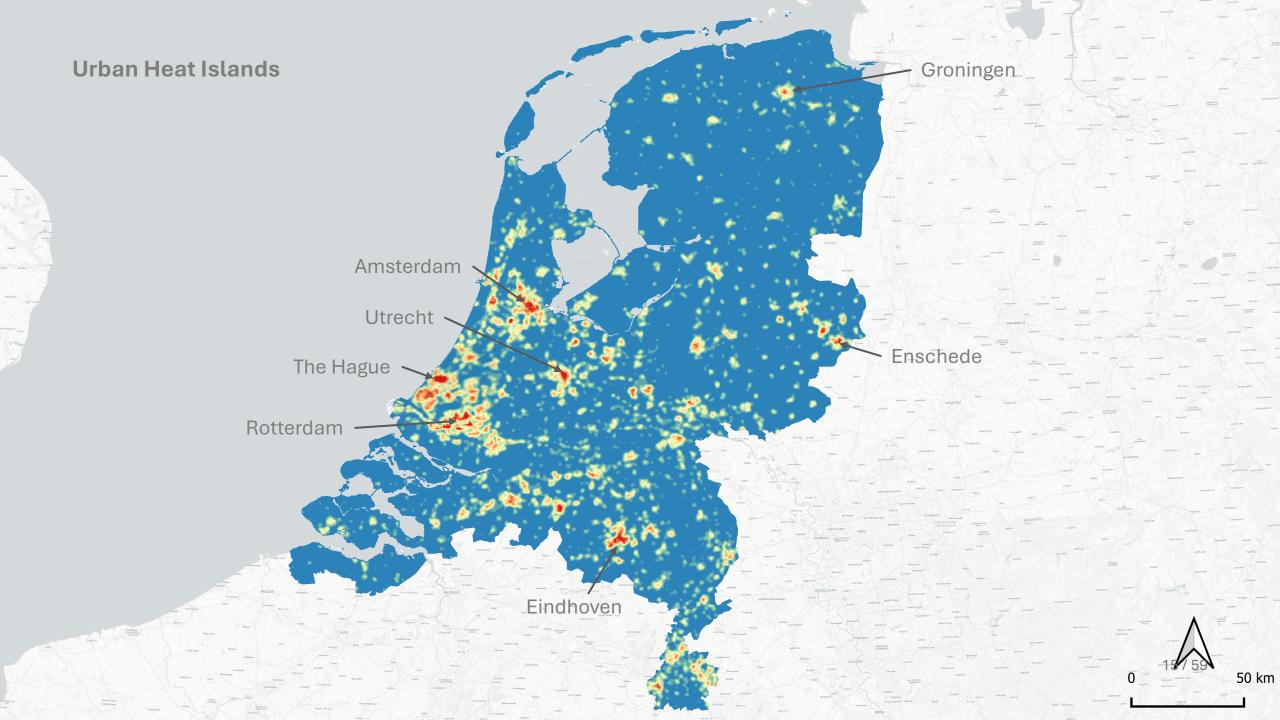
Vulnerability – Exposure

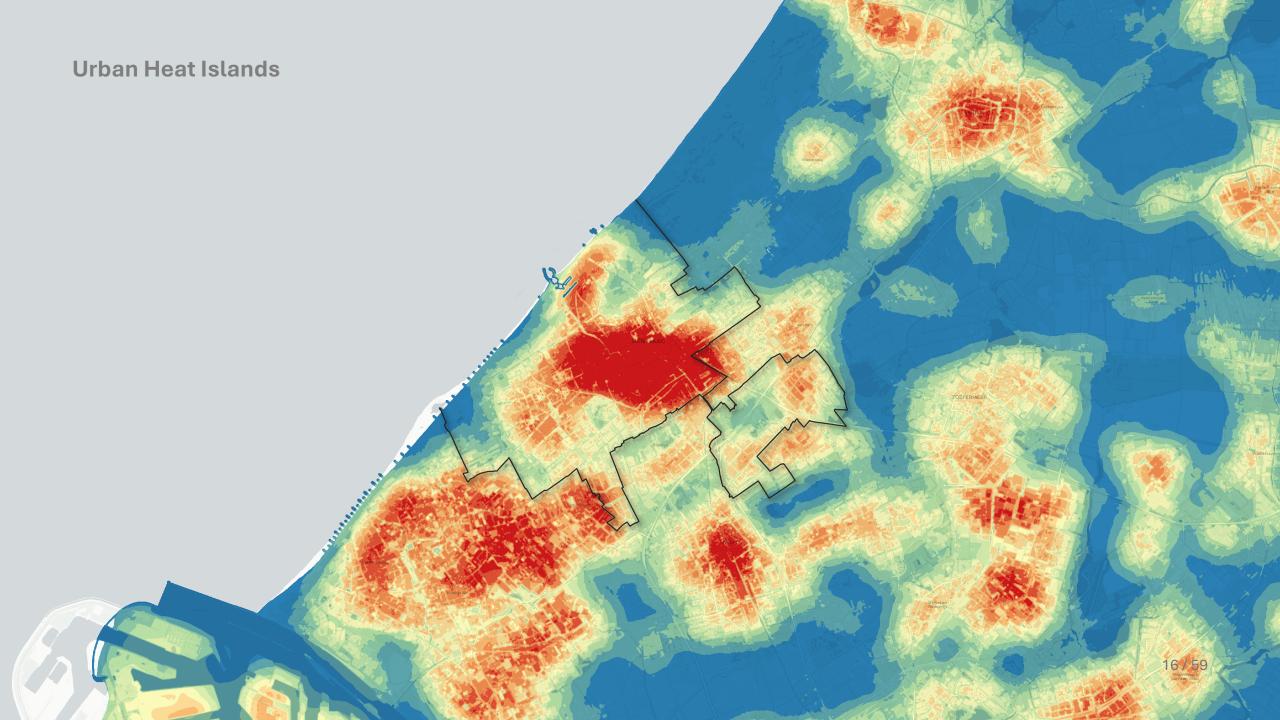




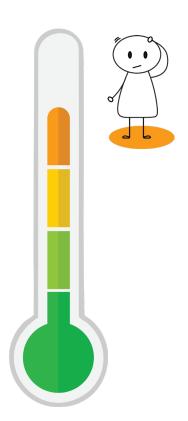
Haagse mar Delftselaan, Den Haag

Terwestenstraat, The Hagu Hobbemaplein, Den Haag Centrumring, The Hague





Methodology



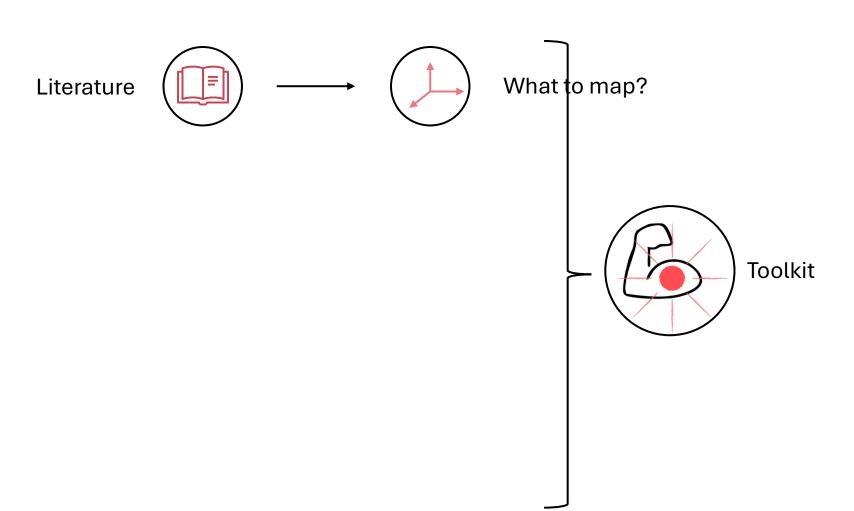




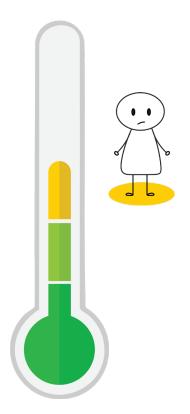






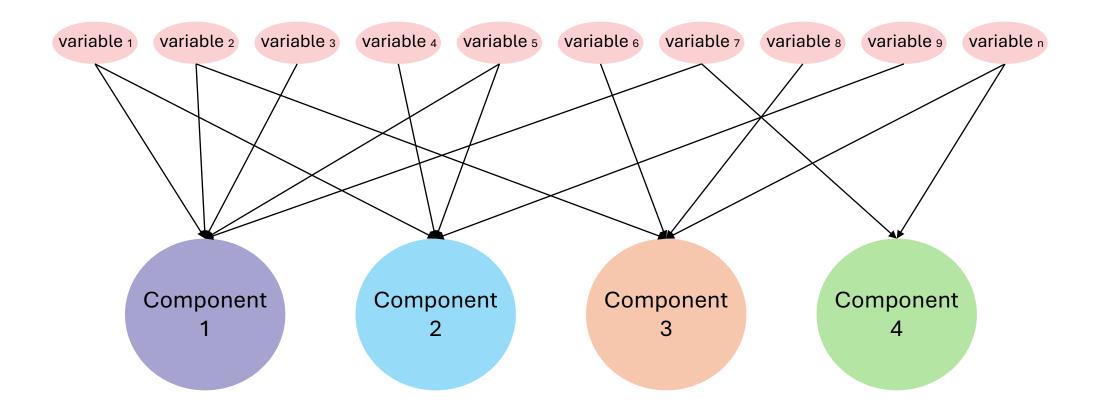






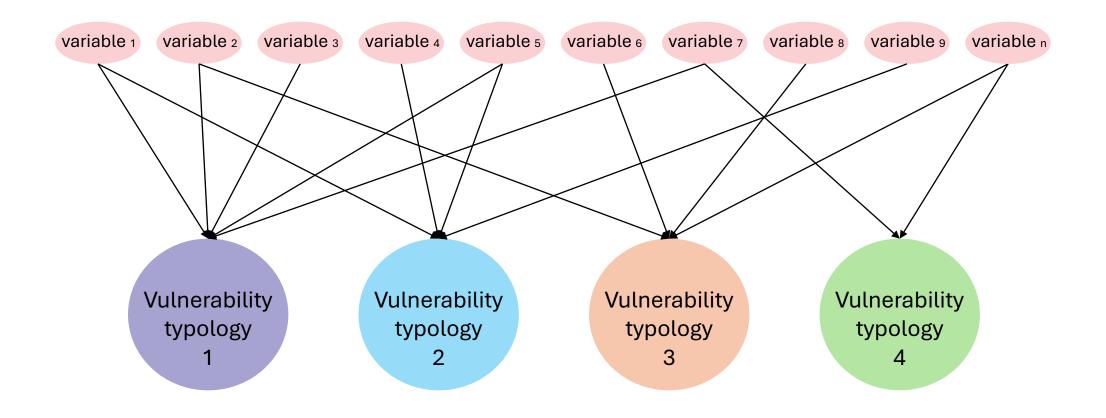
Principal Component Analysis (PCA)





Principal Component Analysis (PCA)





Vulnerability Indicators











+		So				So S		So			So So			So	So	So							So So Ac Ac			So So Ac Ac		So S	Ph			Ph E									Ph	Ph E A	c 4	c Ac	Ac	Ac	Ac
					710		J	J							Ŭ	_							no no		7.0	710 710						_									_			7.0	7.0	7.0	710
	general	of children (0-15 years)	s of elderly (65+ years)	women	16061	ackground	1st degree EU migrants	2nddegree EU migrants	1st degree non EU migrants	2nd degree non EU migrants.	pacts	sidence		of adults	of adults having 1	s of adults likely to suffer from mentales	s of adults with severe overweight	d health issues	low-income households	e of energy poor hous eholds	sumption	unem ployed ad ults (proxy: ww-benefits)	esources to airconditioning	of adults with low personal resilienc	e of adults that feel socially lonely	n ssion	single-parent households	one-person households	s of corporation-rent properties	rivate-rent pro	s of multifamily dwellings	OZ value of dwellings (inverted)	rt ation density	an activities	ne Built environment	of gray surfaces		structure low green surfaces inverted)	surfaces covered by trees (inverted)	tersurfaces (in ha) (inverted)	surfaces in shades (inverted)	rastructure	tion dwellings to hearest GP	toe from dwellings to nearest hui sartsenpost	nce from dwellings to nearest farmacy	nce from dwellings to nearest supermarket	nce from dwellings to nearest library
	ngoned	rcentage	rcentage	nount of	ucationa	gration b	centage of	centage of	centage of	centage of	nnicity Itural im	iguage igth of re	igion	rcentage	percentage disabilities	rcentage alth issu	rcentage	at cause	mber of	rcentage	ergy con	mber of	cess to re	rcentage	rcentage	rticipatio cial Cohe	ount of	ount of one-	rcentage	mber of	rcentage	erage WOZ	ergy labe	oan hum	altiy of th	rcentage	pollution	een infra	centage of	nber of wat	thway su	ysical inf	rage distar	rage distar	rage distar	rage distar	rage distar
5 S F	0 percentage of children (0-15 years)	8	8	E 5	1	Ē	ğ	be	ě	bed	ㅎ ♂	la la	- E	1	8 ¥	H E	8	운 H	2 8	2 8	. E	2	oe 1	8	Н	E 8	H	듄	8	2	8 3	à	5 Î	5	중 =	5 &	Air	5 8	. be	- E	eg.	£ .	8 1		9.46	9.46	9.0
	2 percentage of elderly (65+ years) 11 amount of women	-0.472 0.235	-0.368		Н									3 1			H H	2 H	H 1				1						н		Н				1							\vdash					+
o S 8	8 educational level 2 knowledge				н	Н				н									1							1 1																					-
o S 8	8 migration background					-					н		н						1		- "		1 1			н н			н			н		н	н			1									\pm
o S			-0.190 0 0.332 -				0.360				H		н						1				1 1	-					н			H		H	H	-		1	-	-		H	Ŧ		-	_	+
o S	- percentage of 1st degree non EU migrants	0.160	-0.474	0.264			0.149	-0.675											1			1	1 1															1				二					\pm
	- percentage of 2nd degree non EU migrants 7 ethnicity	0.533	-0.579	0.305			-0.209	-0.713	0.822		H		н						1		-	1	1 1						Н			Н		н	н	-		1		-	-	+	-				+
o S 3	3 Cultural impacts												н					\Box					1																			#					\perp
	6 language 1 length of residence																		1	+			н				\vdash						-	+		+		-	-	+		+	+		-		+-
o S :	1 religion																																									\vdash					\perp
S	9 percentage of adults with longterm health issues	-0.202	0.470	0.024			-0.302	-0.405	0.286	0.176					Н				1 1	Н		1					1						1	1			1										
o S 8	percentage of adults having 1 or more physical	0.049	-0.066	0.245			-0.079	-0.663	0.744	0.622				0.788									1																				T				
o S 5	percentage of adults likely to suffer from mental	0.084	-0.552	0.340			0.180	-0.696	0.902	0.750				0.343	0.796								н	_									_				\Box					\vdash					+
	nealth issues		-0.156						0.549							0.655					-									-	-		-	-		+	+	-	+	-		\vdash	+	-	-	-	+-
o S 2	2 Heat caused health issues																			н		н	н		н							н			н н			н			н						\pm
	number of low-income households Poverty	0.082	-0.332	0.856			0.199	-0.307	0.492	0.401				0.260	0.518	0.603	0.423			1 1 H	Н	3 H	2 1 H H			Н	Н				H	2	2 H	1	Н	+	1	1	+	+		+	-	-	-	+	+-
o S 2	2 percentage of energypoor households	0.047	-0.234	0.320			0.229	-0.426	0.658	0.494				0.473	0.778	0.736	0.576	0	.635				н									1	1									\Box					\perp
o S :	1 energy consumption number of unemployed adults (proxy: ww-	0.400	-0.477				0.004	0.047	0.407	0.000				0.005	0.040	0.506	0.000		.892	0.47											2		Н	+				1		+	1	\vdash	+		-		+
	benefits) 3 access to resources	0.192	-0.477	0.910			0.284	-0.214	0.407	0.386				0.025	0.346	0.506	0.323	0	.892	0.47	ъ.					Н			н			н	_	-		-			-	-		\vdash	_	-	-	-	+-
	3 access to resources 3 less access to airconditioning																								Н		н		1				1														
D Ac	- percentage of adults with low personal resilience	0.126	-0.443	0.348			0.047	-0.749	0.888	0.780				0.505	0.893	0.973	0.782	0	.613	0.75	18	0.492																					T				
		0.040	-0.423	0.286			0.202	-0.671	0.917	0.731				0.451	0.853	0.964	0.716	0	.580	0.76	15	0.465		0.967		н н																					\pm
	4 participation 2 Social Cohesion																									н				- 1				-	н	+	\Box		-			\vdash	-				+
o S 2	2 amount of single-parent households		-0.432						0.338							0.442			.862	0.41		0.902		0.467				Н	Н			Н	н														
			0.108 0 -0.200 0						0.333 -							0.478 0.752			.343	0.45		0.133		0.422			-0.031	0.297			_	14	н	-	н	+	+	1	+	-		\vdash	-	-	+	+	+
h S 4	4 number of private-rent properties	-0.222	-0.283	0.651			0.517	0.089	0.103 -	0.079				-0.244	-0.067	0.198	-0.198	0	.644	0.17		0.722		0.111	0.140		0.519	0.359	-0.198													\vdash					\pm
h S 4	4 percentage of multifamily dwellings 1 building year	-0.420	0.069	0.175			0.505	-0.079	0.357 -	0.003				0.344	0.432	0.466	0.135	0	.460	0.52	19	0.292		0.431	0.490		0.151	0.846	0.230	0.424		H	1 H	н	Н			1				+			_		+
h E 6	6 building quality	-0.078	-0.324	0.355			0.049	-0.603	0.615	0.501				0.463	0.717	0.788	0.716	0	.581	0.64	16	0.477		0.809	0.796		0.447	0.539	0.639	0.229 0	0.569		1		н			1			1	一					\pm
	1 energy label																																	- 11			П				Н		Ŧ				+
h E 2	6 High population density 2 urban human activities	-0.238	-0.284	0.414			0.481	-0.254	0.497	0.222				0.177	0.439	0.601	0.140	0	.604	0.52	24	0.564		0.560	0.543		0.393	0.534	0.200	0.582 0	0.641	0.515			Н 1			н									
h E 4	4 Qualtiy of the Built environment 8 UHI																																			2	1	2			1						_
h E 3	3 percentage of gray surfaces	-0.007	-0.510	0.398			0.262	-0.236	0.269	0.218				-0.114	0.174	0.448	0.121	0	.408	0.26	12	0.477		0.375	0.322		0.380	0.198	0.076	0.483 0	0.294	0.419		0.609		2	1	2			1						\pm
h E 3	3 Air pollution																																									\vdash	1				\perp
	Green infrastructure percentage of low green surfaces (inverted)	-0.383	-0.141	0.233			0.539	0.035	0.236 -	0.026				0.021	0.184	0.349	-0.048	0	.346	0.37	15	0.329		0.263	0.294		0.183	0.492	-0.043	0.459 0	0.614	0.331		0.699		0.616				+		+	+	+	+	+	+
	- percentage of surfaces covered by trees (inverted)	0.247	-0.602	0.330			-0.055	-0.387	0.215	0.344				-0.198	0.085	0.356	0.202		.249	0.04		0.374		0.315	0.228		0.345	-0.101	0.146	0.296 -0	0.088	0.331		0.299		0.833		0.13	3 040			\vdash					\perp
a E			0.022 0						0.101 - -0.074 (0.172 -0.016			.226	-0.30		0.115 -0.048		-0.021					0.011 0.030 -			0.108 -0.012		0.346 -0.271		0.418			9 0.13 21 0.69			\vdash	-	-	+	+	+
h E :	1 physical infrastructure																																														=
			0.132 -						-0.265 -							-0.336 -0.336			398	-0.30		-0.291 -0.268		-0.318 -0.316					-0.072 - -0.061 -			-0.311	-	-0.572 -0.573		-0.39					0.145		156		+	+	+
Ac			0.027						-0.378 -							-0.474			0.539	-0.50		-0.422		-0.480					-0.236 -			-0.248		-0.573		-0.17			53 0.01					22			+-
Ac	1 average distance from dwellings to nearest farmacy	0.040	0.120	0.317			-0.306	0.107	-0.352 -	0.184				-0.271	-0.418	-0.439	-0.237	-0	0.461	-0.4	11	-0.384		-0.436	-0.433		-0.319	-0.395	-0.250 -	0.295 -0	0.545	-0.422		-0.593		-0.40		-0.3	62 -0.21	5 -0.546	0.221	0.8	119 0.4	46 0.48	В		
Ac			0.003						-0.330 - -0.291 -							-0.417 -0.390			0.501	-0.46		-0.419 -0.280		-0.399 -0.398					-0.193 - -0.211 -			-0.467 -0.450		-0.560 -0.482		-0.43					0.297			93 0.57 94 0.37			

Vulnerability Indicators

















Age

Gender

Migration background



issues

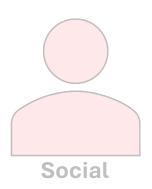
Housing situation



















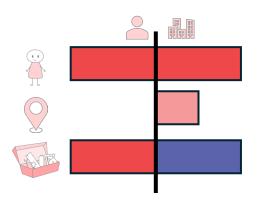


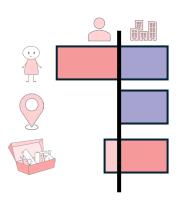
1) Socio-spatial Vulnerability in Urban Areas

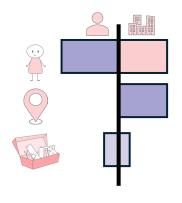
2) Social Vulnerability in Suburban Family Neighborhoods

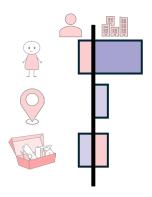
3) Social Vulnerabilities among Single Mothers in Mixed Urban Contexts

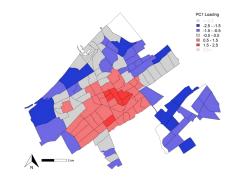
4) Socioeconomically Fragile Families in Green, Low-Density Areas

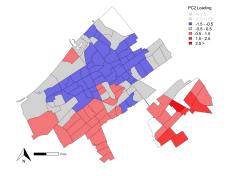


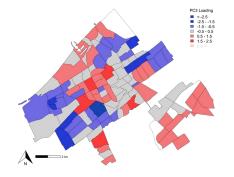


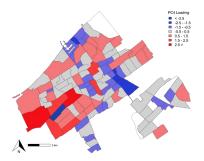












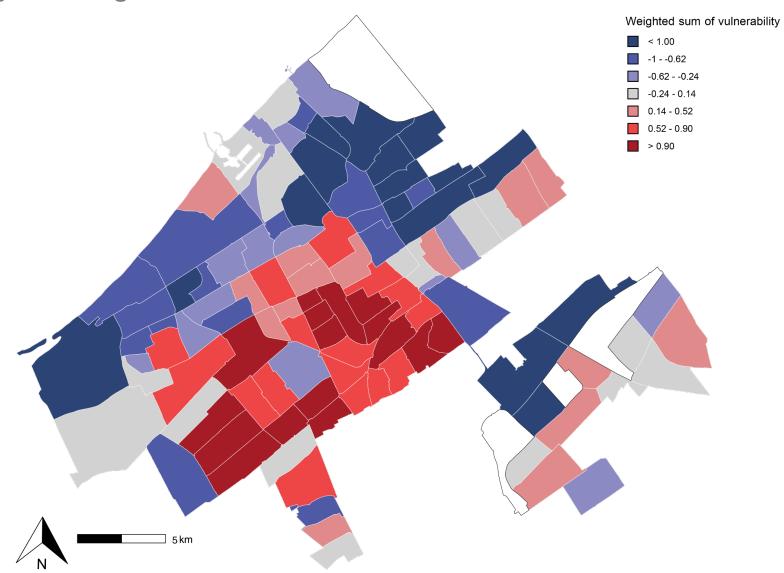












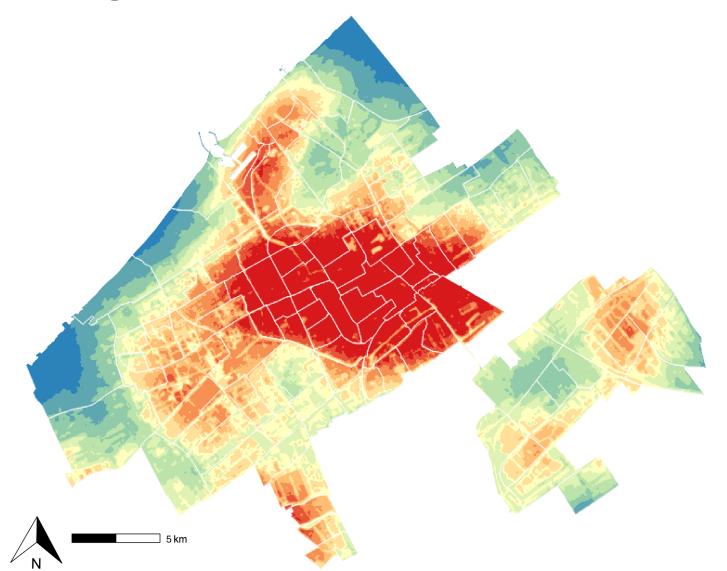














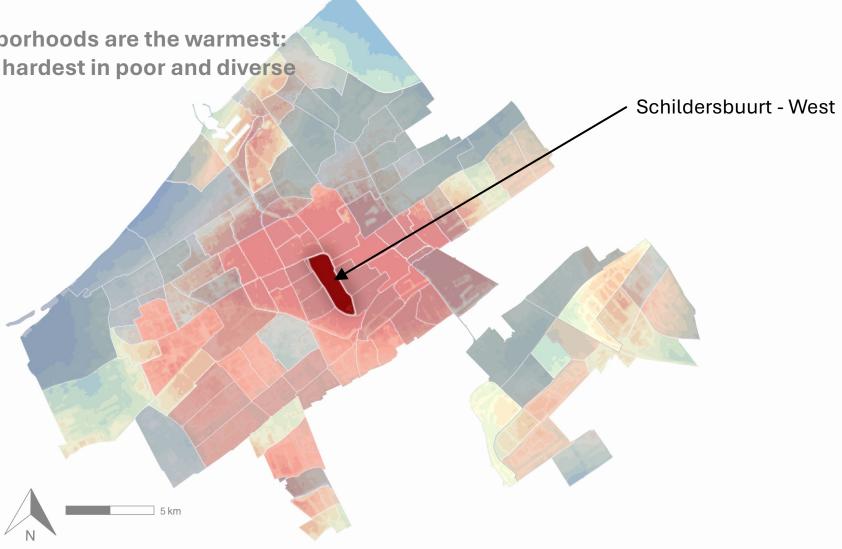












Fieldwork - Interviews

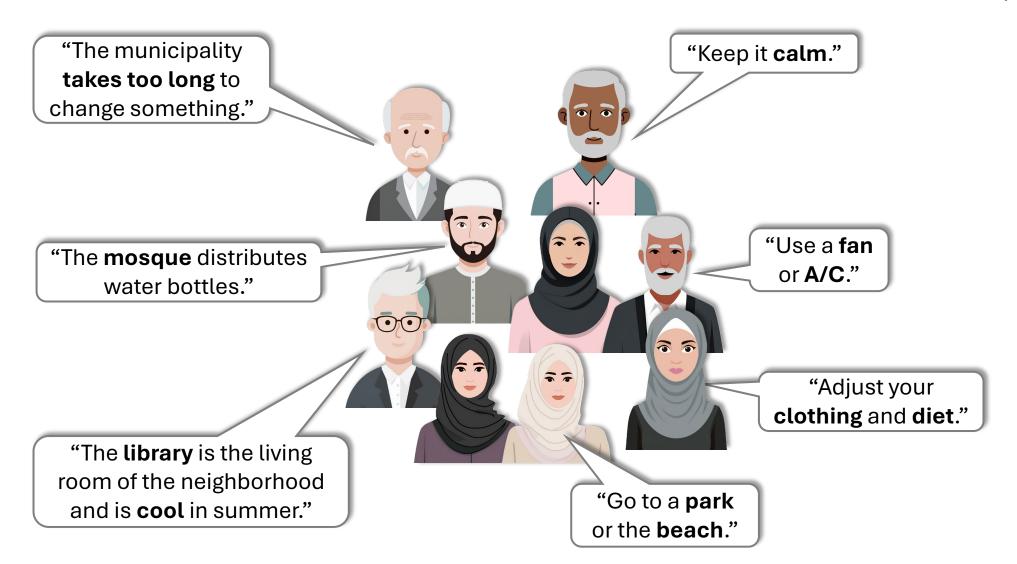












Fieldwork - Observations

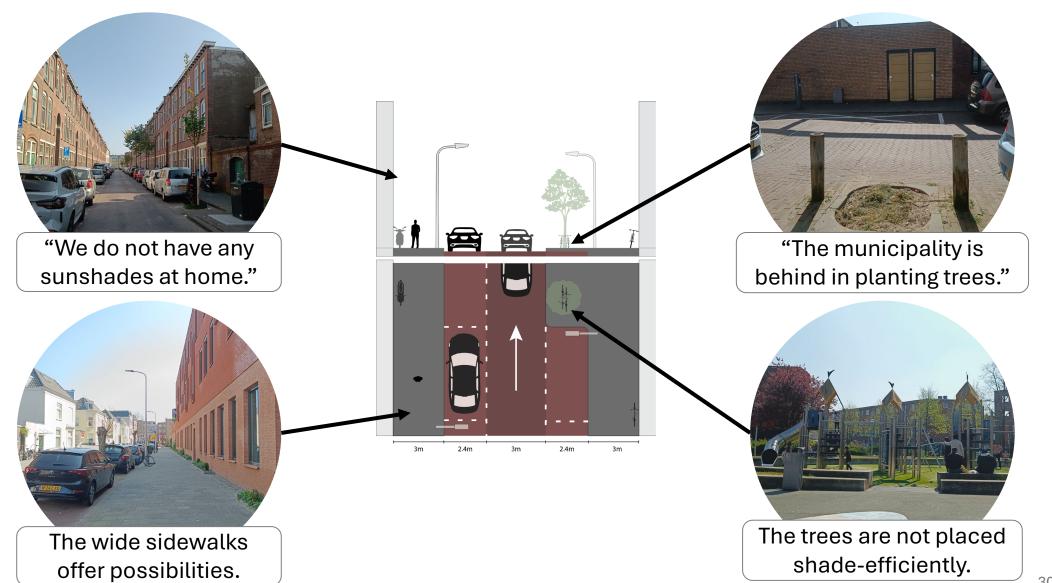












Existing Strategies







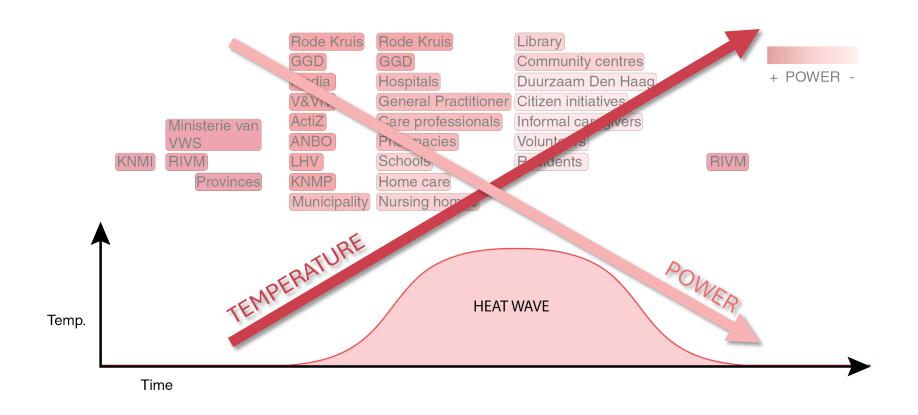


- **Separation** of target groups and stakeholders
- Lack of user-friendly tools for residents
- Limited awareness of the diversity of residents and their housing situation

Klimaatadaptatie Nederland, n.d. 31/59

Stakeholders Involved





Conclusion - What should the toolkit focus on?













What to look for?



Who? Where?



Local insights

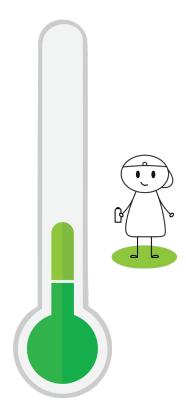


Current strategies



Power-shift

Heat Adaptation Toolkit





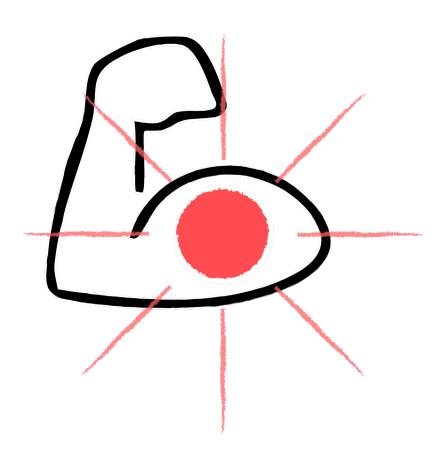










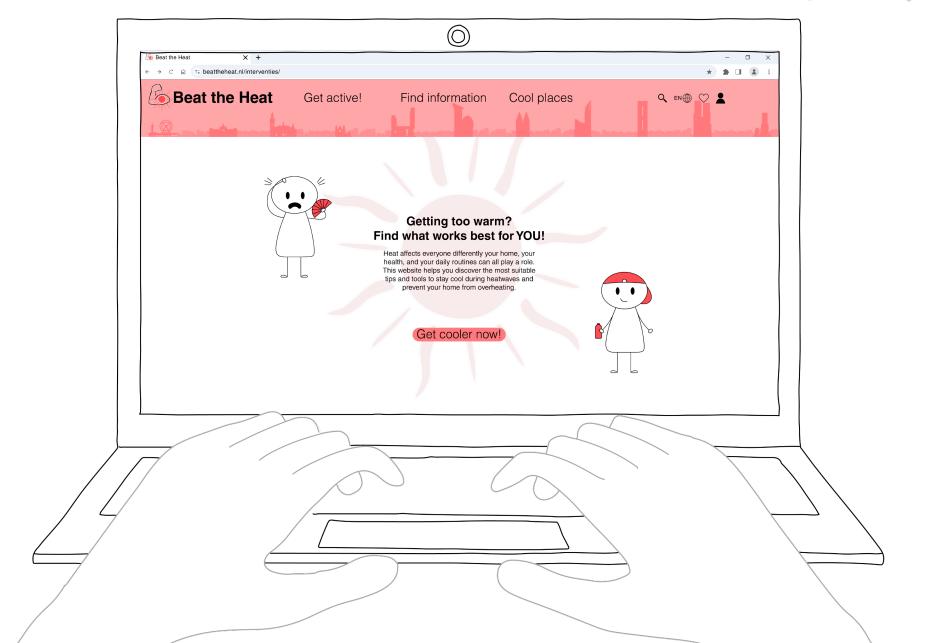


Interventions

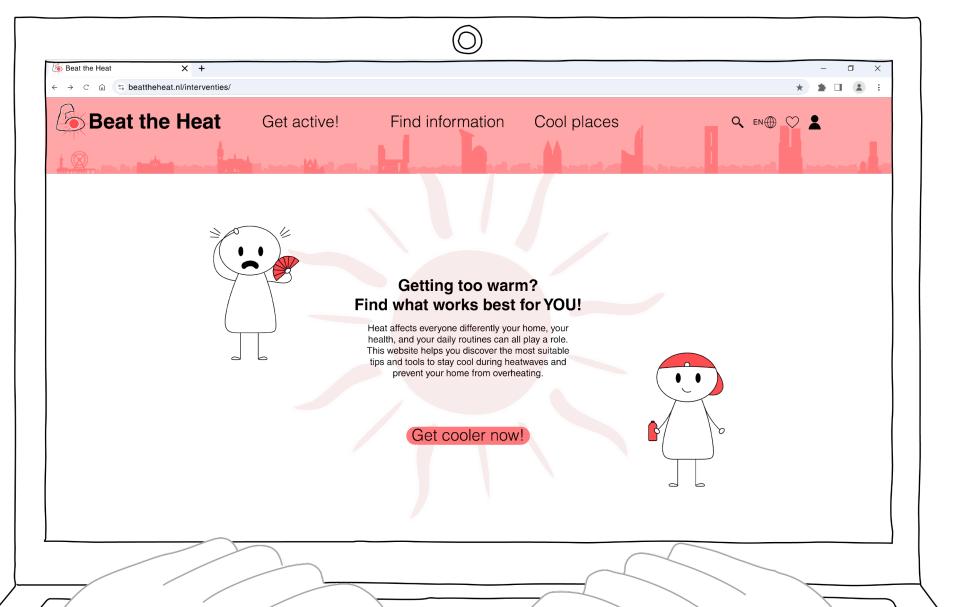


Title	Description	Scale	Domain	Cooling effect	Costs	Responsiblity	Additional stakeholder	Target group	Vulnerability group	Prevention / response
IT STARTS WITH YO	OUR BEHAVIOR									
Cook outside or eat salad	Cooking adds heat and moisture. Cook briefly, outside if possible, or eat a cold meal like salad.	behavior	social	1	0	resident		all, adults, elderly, migration background, women		prevention
KEEP YOUR HOUS	E COOL									
Small subsidies	Offer small subsidies for items like fans or blackout curtains.	house	political	0	2	municipality		all, low SES	1, 4	response
BALCONY & GARD	EN									
Add shading to your balcony	Create shade on your balcony using a parasol, sun tarp, or canvas to prevent heat from entering your home.	balcony, garden	physical	2	2	resident	house owner/ VVE, housing corporation	all, elderly, health issues		prevention
AN ADAPTIVE STR	EET									
From parking to park	Convert parking spots into small green areas.	street	physical	2	2	municipality	urban planner	all		prevention
A COOL NEIGHBO	RHOOD									
Summer holiday activities	Organize indoor or shaded summer activities for	neighbor hood	social	1	2	municipality	community centers, libraries, schools, volunteers	children	2, 3, 4	prevention

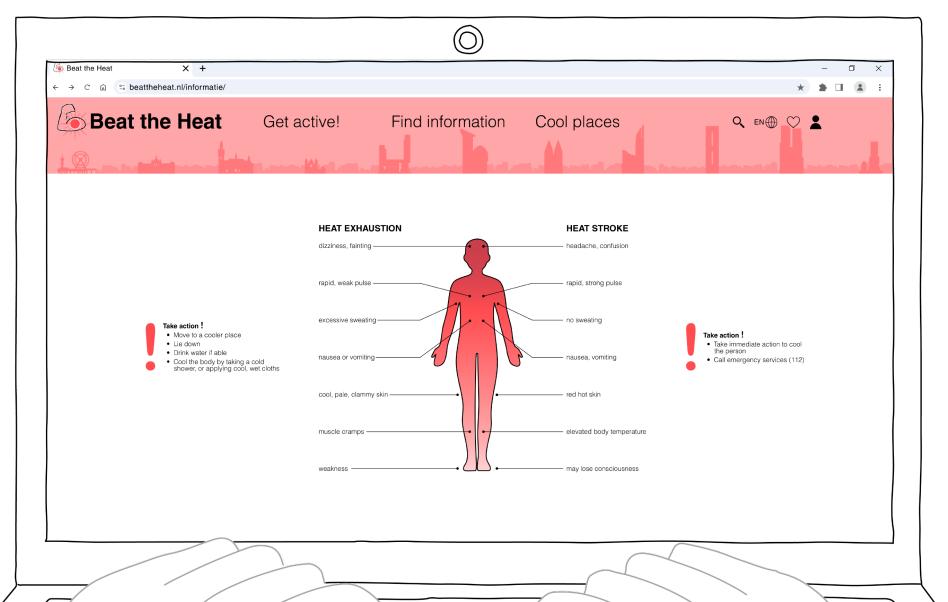




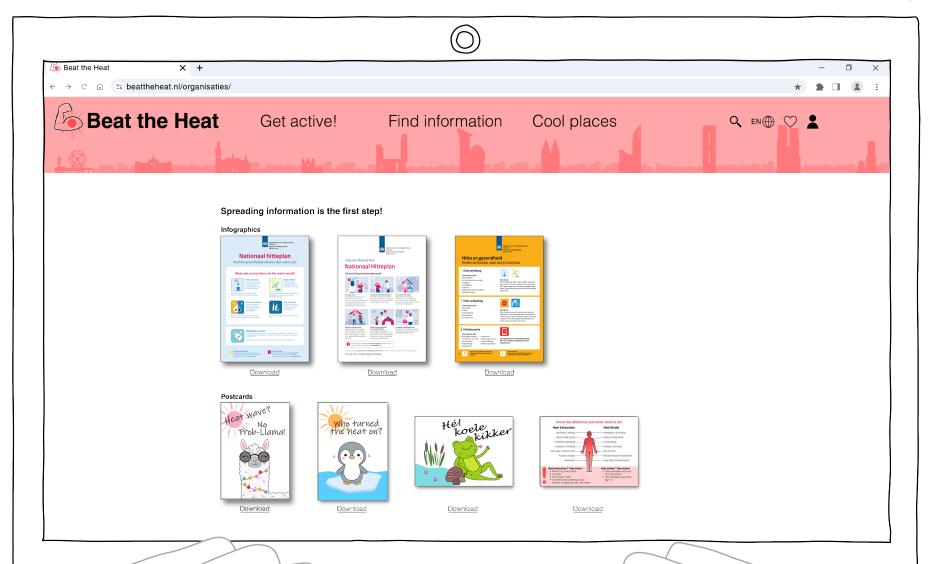












Postcards







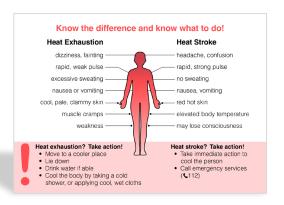












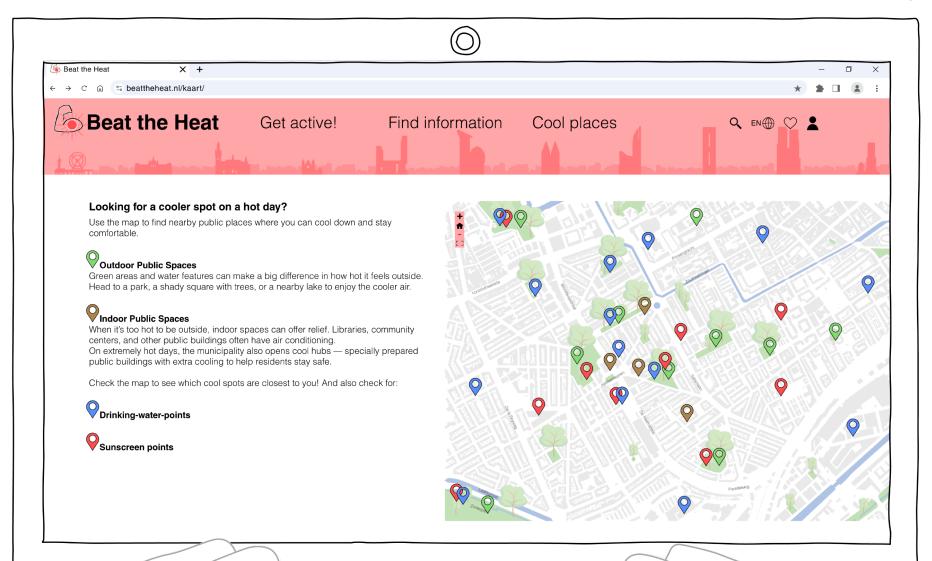




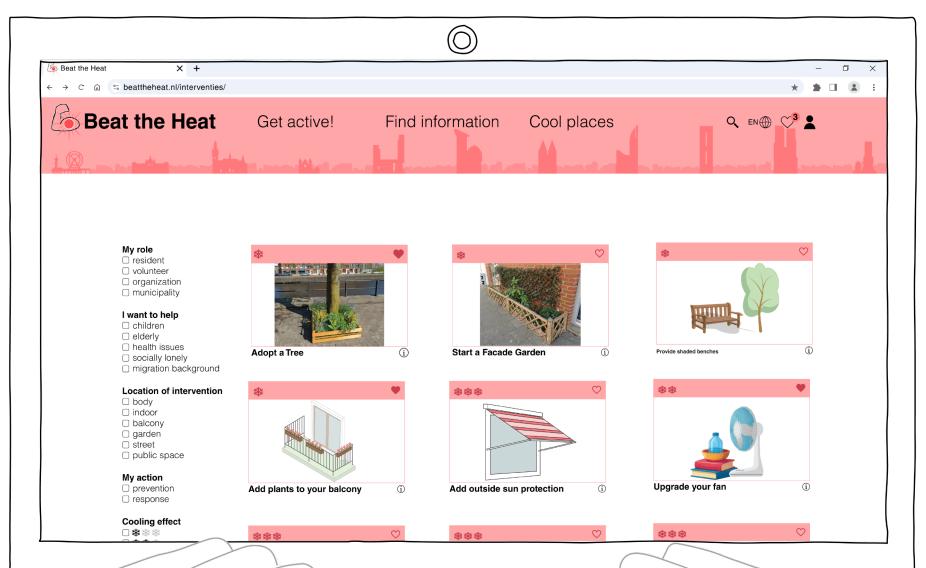




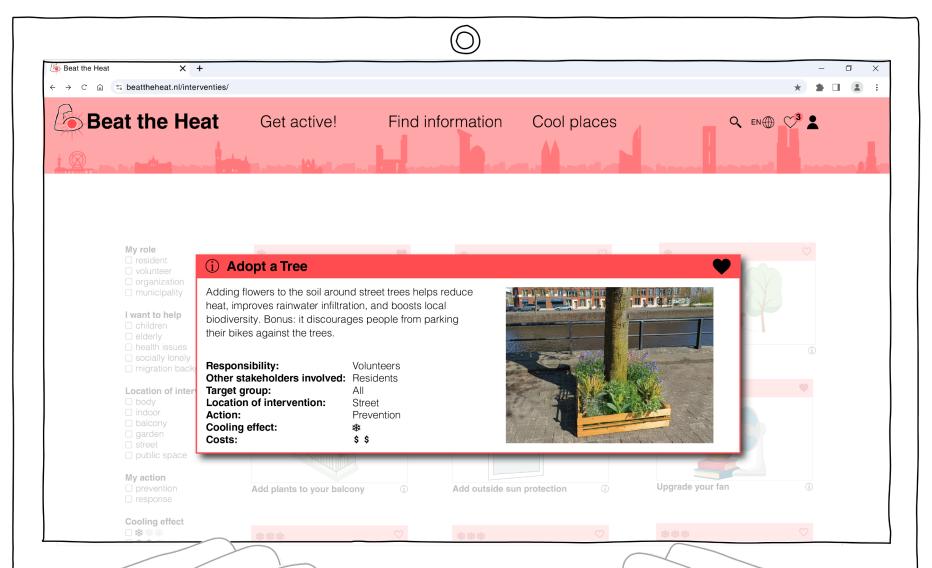




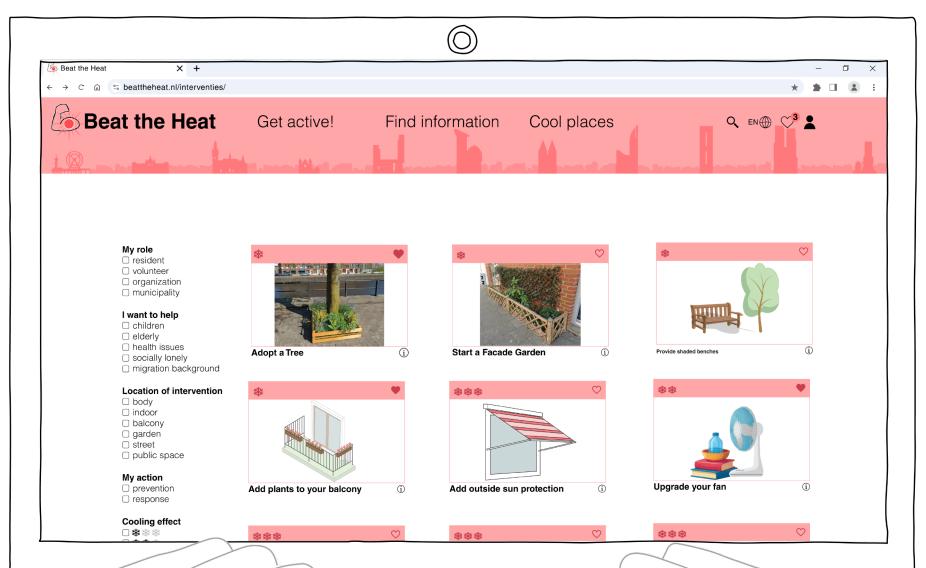












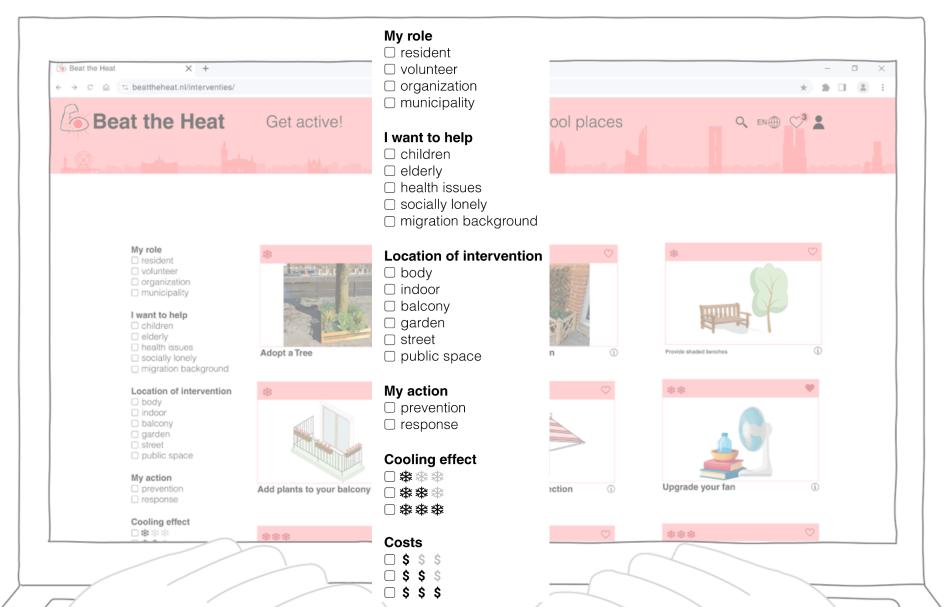




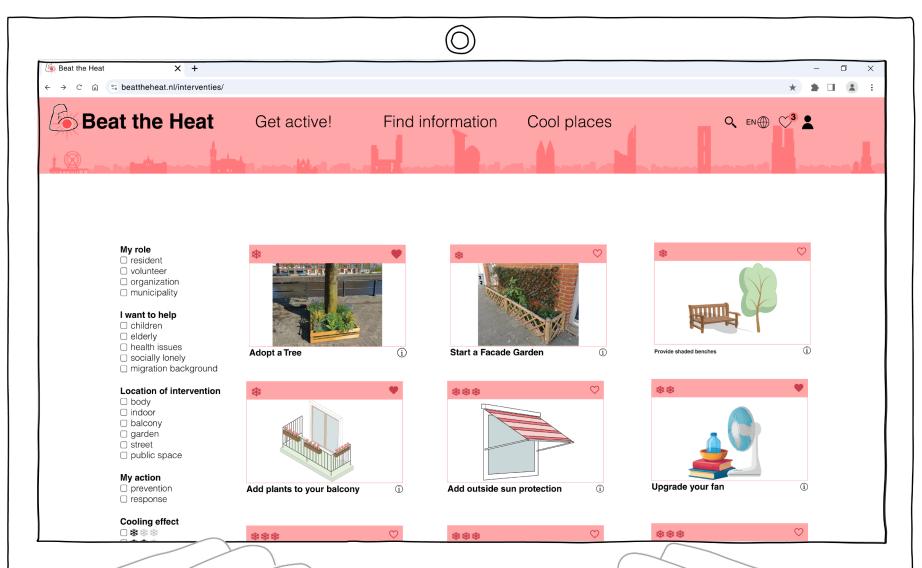




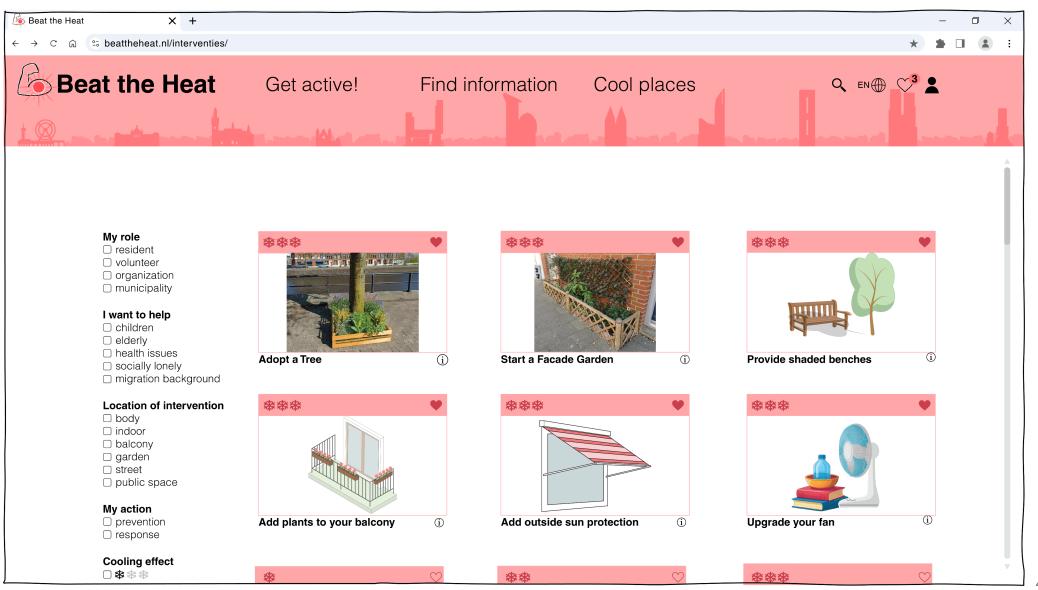






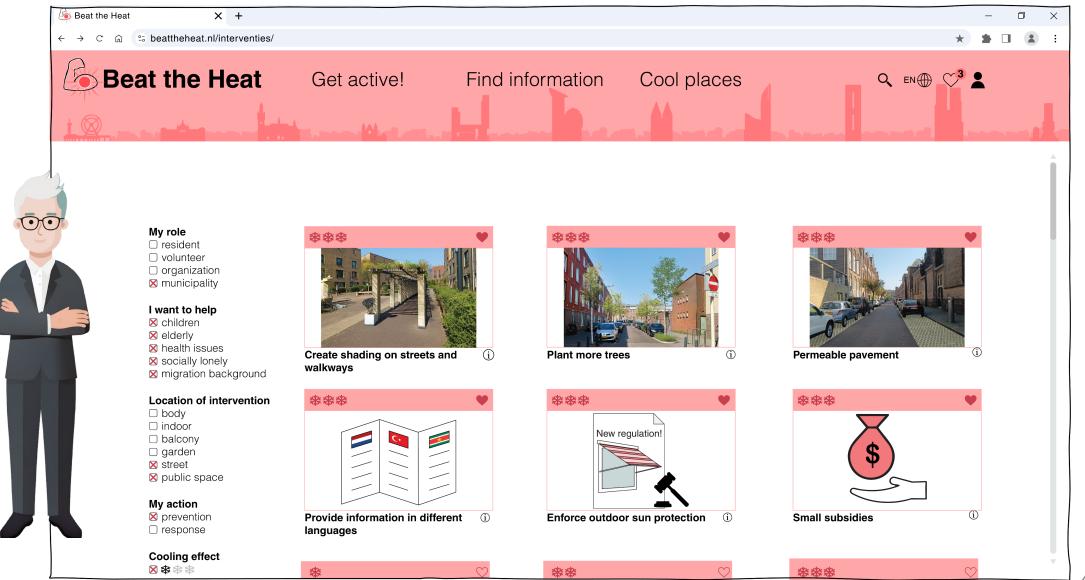






Example - Municipality





Example - Municipality





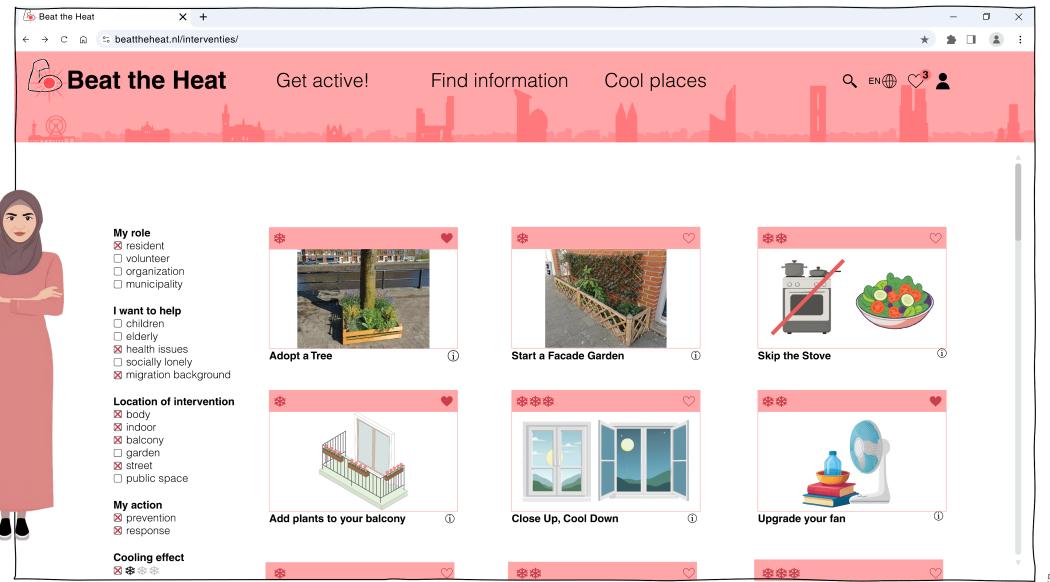






Example - Meryem





Example - Meryem











Example - Meryem



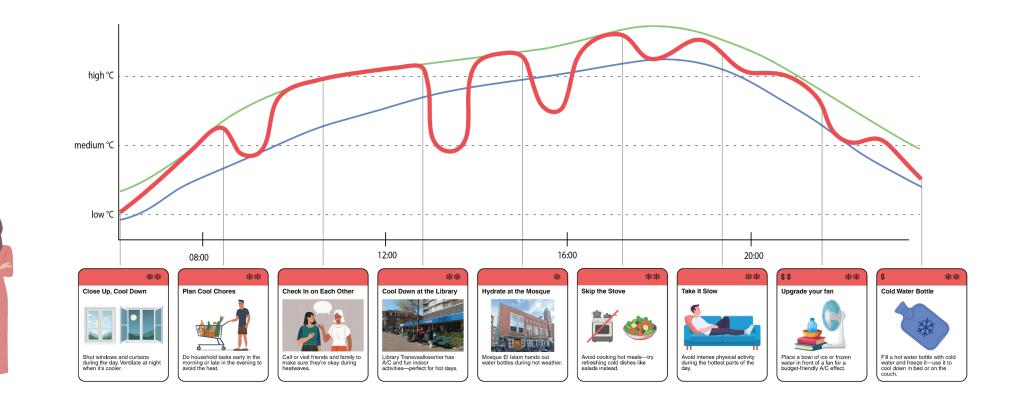








- Temperature
- Wet Bulb Globe Temperature (WBGT) with relative humidity of 75%
- Changed perceived temperature



Access to Interface

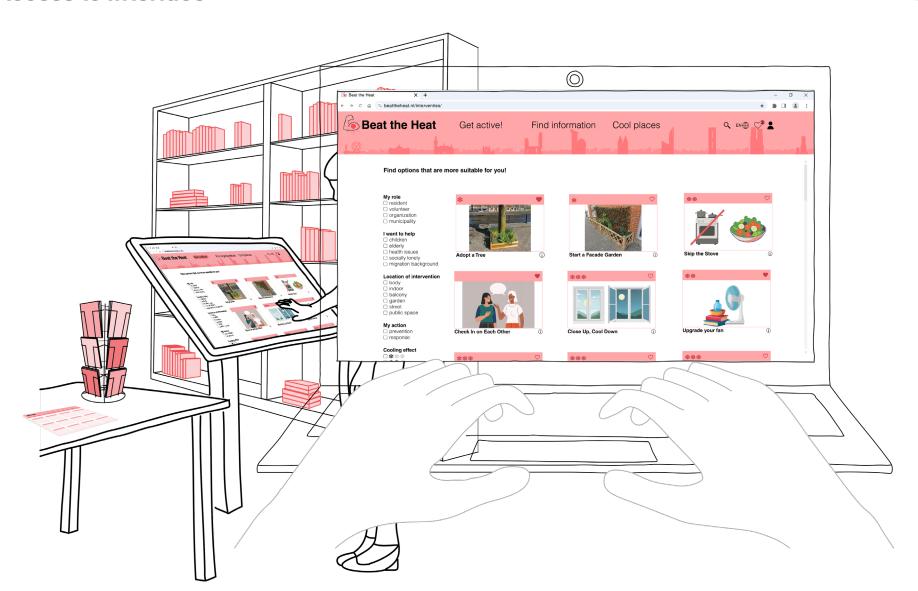




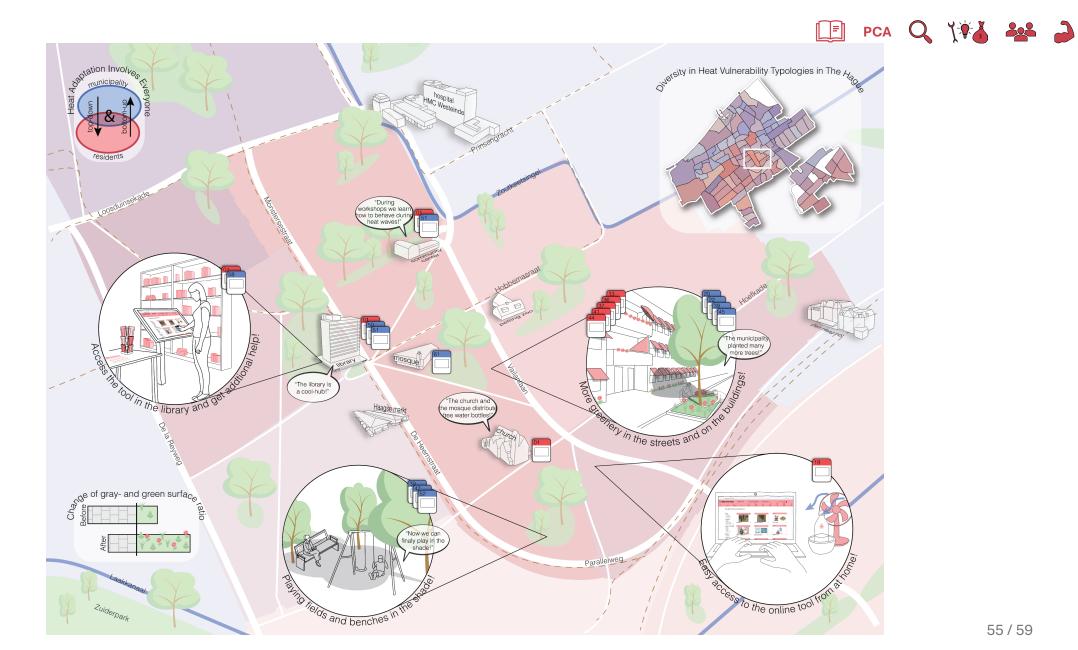






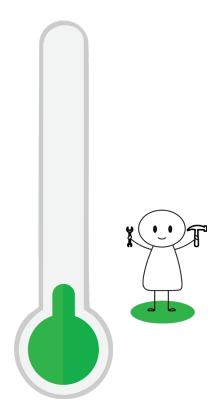


Wrap-up





Key takeaways



Key takeaways



Not just the elderly are vulnerable to heat, **everybody** can be vulnerable

I Take the **diversity of people and situations** into account when creating new tools

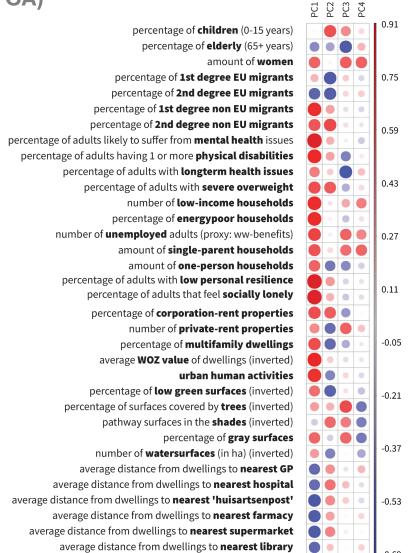
Liverybody needs to be onboard: Heat adaptation happens throughout all the scales, with all stakeholders



Sources

- Slide 3:
 - Ijs: https://indebuurt.nl/delft/eten-drinken/aantal-ijsjes-per-inwoners-delft~193443/
 - Scheveningen: https://www.ad.nl/den-haag/verkeersdrukte-richting-het-strand-parkeergarages-scheveningen-vol-en-ook-geen-plek-meer-op-kijkduin~a90b5dc1/
 - Vondelpark:https://www.expedia.co.uk/Vondelpark-Amsterdam-South.d6046536.Attraction
 - Thuis: https://www.cosmopolitan.com/uk/body/health/a33570977/how-to-keep-cool-heatwave/
- Slide 4:
 - Compendium voor de Leefomgeving, 2023

Principal Component Analysis (PCA)















S Sensitivity

E Exposure

Adaptive Capacity

S

S

E E E E E

Ac

Ac

physical

social

Multidimensional Framework



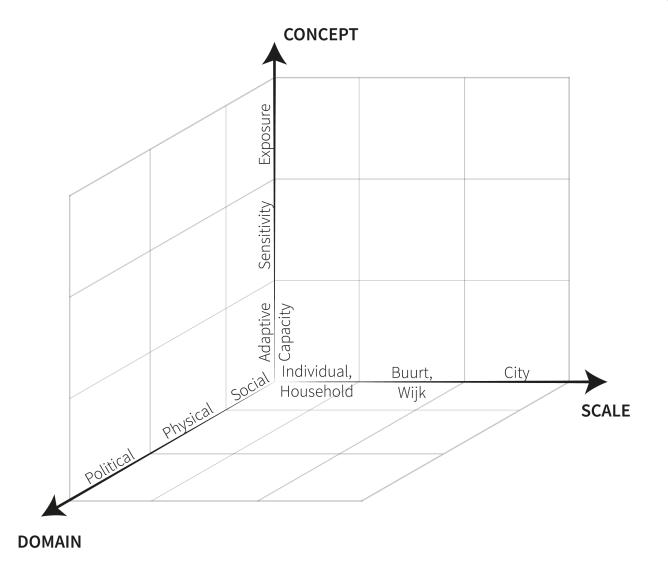












Existing instrument analysis













- government g professionals
- provinces
- waterboard
- municipalities
- ☐ GGD
- housing corporations
- urban designers
- **project** developers
- residents

Concept

- sensitivity
- exposure
- adaptive capacity

Scale

- behavior
- house
- street
- 🗹 neighborhood
- ☐ city

Domain Climate Problem

- social
- physical
- political
- ✓ heat drought
- **flooding**
- biodiversity

107 existing instruments were analyzed (Kennisportaal Klimaatadaptatie, 2025)