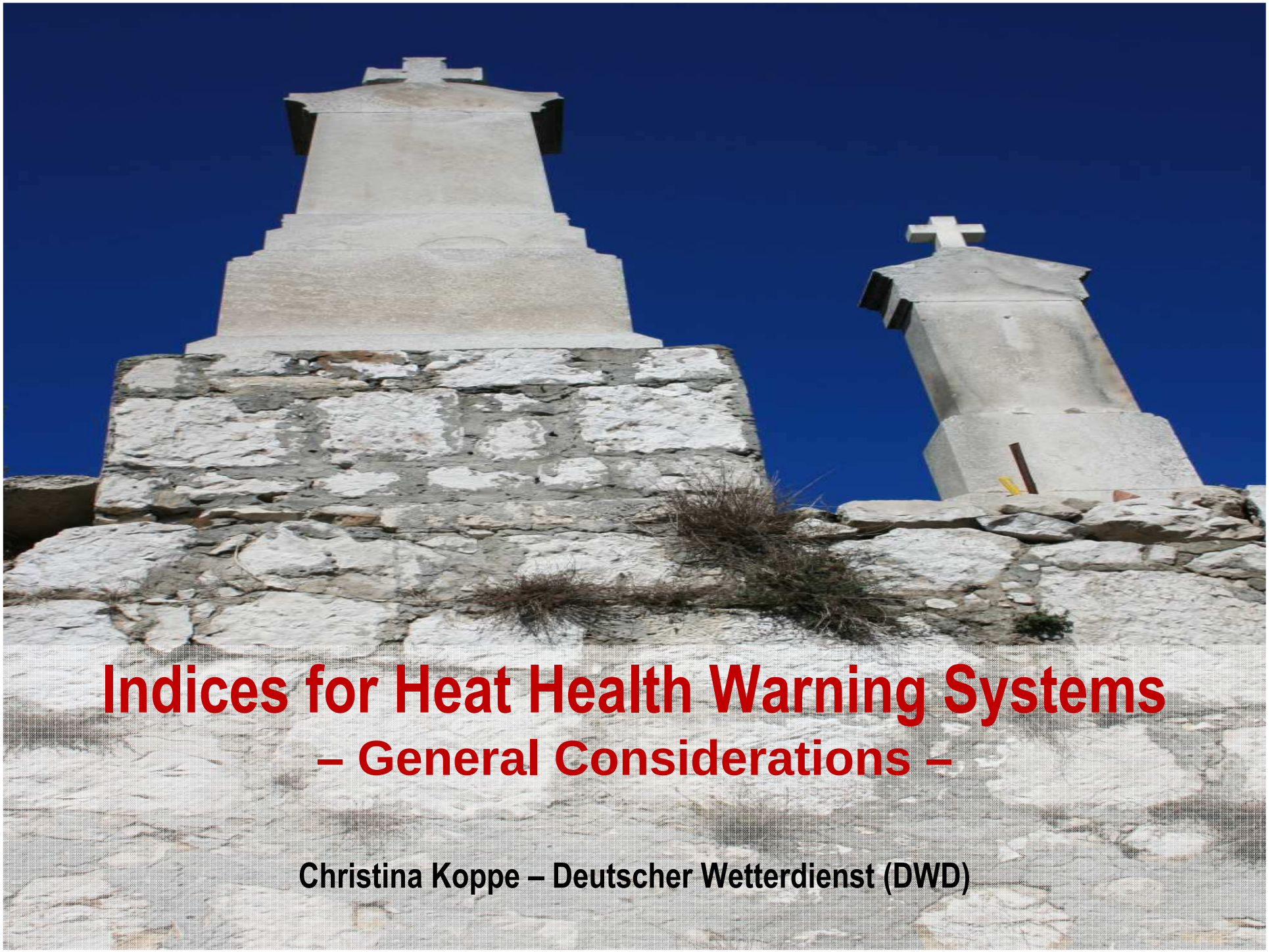


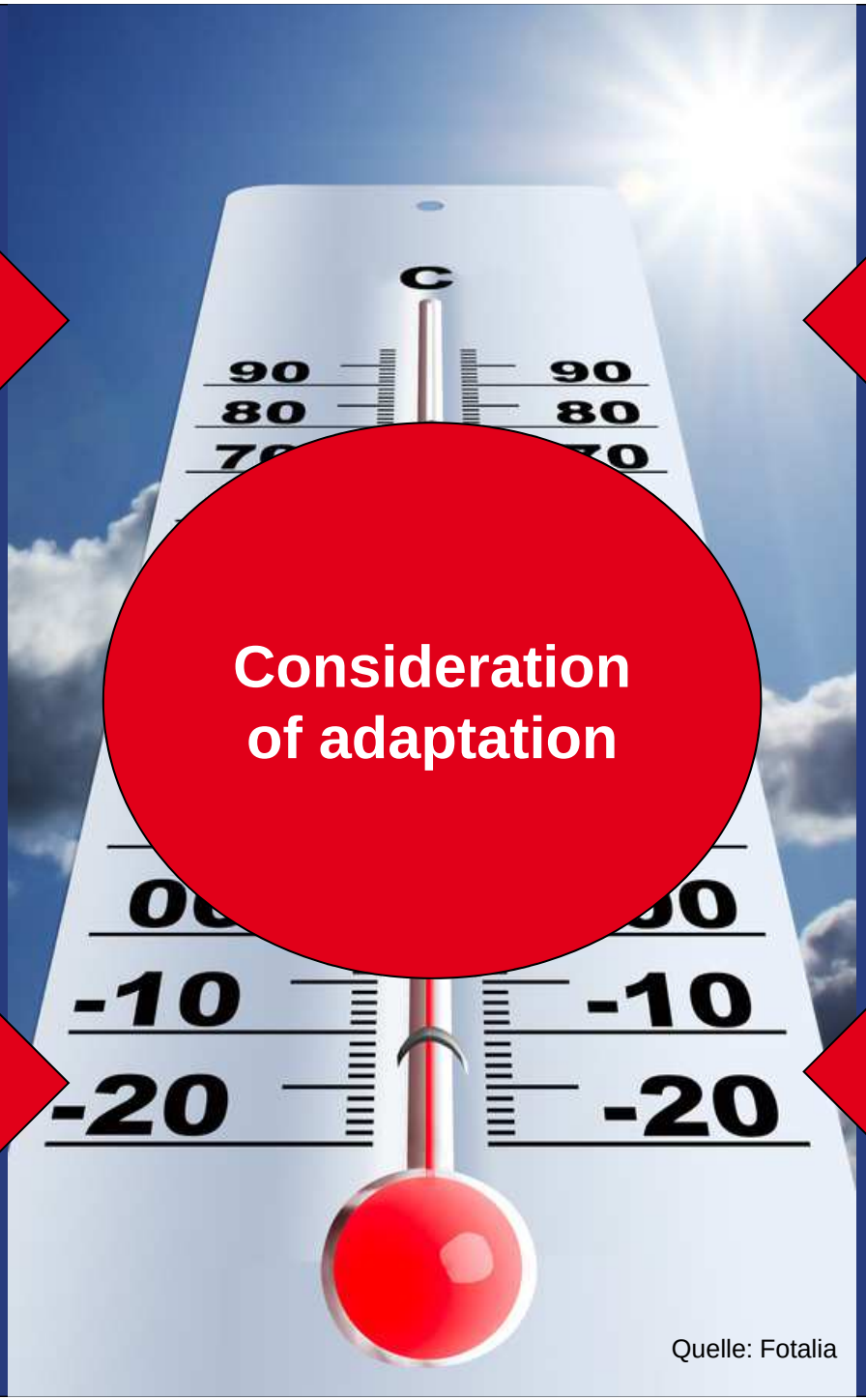
Indices for Heat Health Warning Systems

– General Considerations –

Christina Koppe – Deutscher Wetterdienst (DWD)

Single & multi-parameter indices

Holistic (air mass based) approaches



Consideration of adaptation

Simplified biometeoro-logical indices

Heat budget approaches

Quelle: Fotalia

Perfect Heat Health Warning System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Perfect Heat Health Warning System

reliable

- Forecast skill
- Health relevance

Single & multi-parameter indices

easy to handle

- No complicated modelling
- Easy to implement
- Low requirements for input data
- universal

effective

- Trigger interventions to prevent heat related health impacts
- communication
- sufficient lead time

Picture Source: Fotalia

Indices for Heat Health Warnings

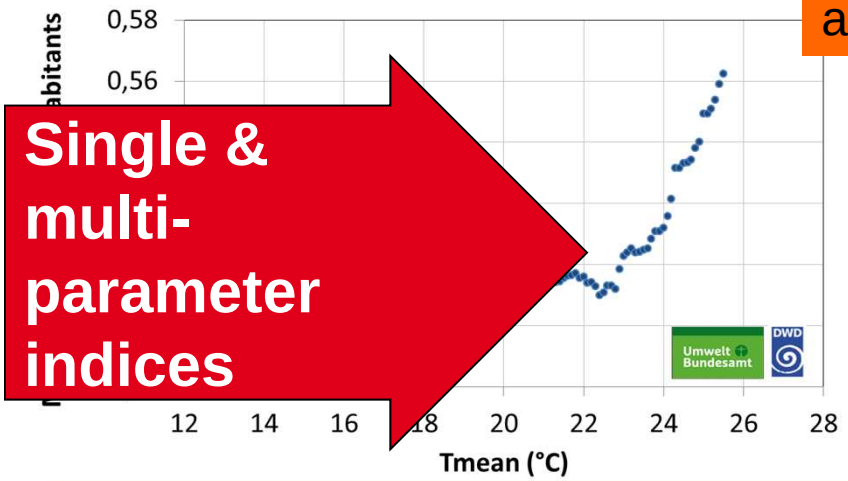
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

- Single: T_{max}, T_{mean}
- Multi: simple combination of parameters

Example single-parameter: Latvia T_{max}

Level 1 (potentially dangerous) : max air temperature between 27°C and 32°C for 2 days or more

Level 2 (dangerous): max. air temperature above 32°C



Single & multi-parameter indices

Warning-threshold has to be fitted to mortality data

Indices for Heat Health Warnings

Single & multi-parameter indices

- Single: T_{max}, T_{mean}
- Multi: simple combination of parameters

Example multi-parameter: France 3 day average of 99,5th percentile $T_{max\ (31\text{-}36°C)}$ and $T_{min\ (18\text{-}24°C)}$

Level 1: seasonal vigilance (1 June - 31 August)

Level 2: short heat wave (1 or 2 days)

Level 3: warning and action (thresholds are reached for 3 days or more)

Level 4: maximal mobilization (very long and intensive)

Perfect Heat Health Warning System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Perfect Heat Health Warning System

Single & multi-parameter indices

reliable	easy to handle	effective
⊕ Forecast skill	⊕ No complicated modelling	• Trigger interventions to prevent heat related health impacts
⊖ Health relevance	⊕ Easy to implement	⊕ communication
	⊕ Low requirements for input data	⊕ sufficient lead time
	⊖ universal	

Picture Source: Fotalia

Perfect Heat Health Warning System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Perfect Heat Health Warning System

reliable

- Forecast skill
- Health relevance

Simplified biometeoro-logical indices

easy to handle

- No complicated modelling
- Easy to implement
- Low requirements for input data
- universal

effective

- Trigger interventions to prevent heat related health impacts
- communication
- sufficient lead time

Picture Source: Fotalia

Indices for Heat Health Warnings

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

e.g. Heat Index, Humidex, wet-bulb globe temperature, apparent temperature

<u>Example Switzerland</u>: Heat Index

	maximum temperature in °C											
	27	28	29	30	31	32	33	34	35	36	37	38
8	79.6	80.6	81.9	83.2	84.7	86.2	87.9	89.6	91.3	93.1	94.8	96.6
10	79.9	81	82.2	83.6	85.1	86.7	88.4	90.1	91.9	93.7	95.6	97.4
12	80.3	81.5	82.8	84.2	85.7	87.4	89.1	90.9	92.7	94.6	96.5	98.5
			83.5	85	86.6	88.3	90.1	91.9	93.8	95.8	97.8	99.8
			84.4	86.1	87.8	89.5	91.4	93.3	95.3	97.4	99.4	101.5
			7	87.5	89.4	91.2	93.2	95.2	97.3	99.4	101.5	103.8
			7.4	89.4	91.4	93.5	95.6	97.7	99.9	102	104.3	106.5
			89.6	91.9	94.2	96.4	98.7	100.9	103.2	105.5	107.8	110.1
24	86.2	8 .5	92.5	95.2	97.8	100.3	102.7	105.1	107.4	109.8	112.2	114.6

Simplified biometeoro-logical indices

Indices for Heat Health Warnings

Simplified biometeoro-logical indices

e.g. Heat Index, Humidex, wet-bulb globe temperature, apparent temperature

Example Switzerland: Heat Index

Level 1 (considerable danger): HI > 90 for 3 consecutive days

Level 2 (great danger): HI > 93 for 5 consecutive days

Perfect Heat Health Warning System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Perfect Heat Health Warning System

Simplified biometeoro-logical indices

reliable

- ⊖ Forecast skill
- ⊕ Health relevance

easy to handle

- No complicated modelling
- ⊕ Easy to implement
- ⊕ Low requirements for input data
- ⊖ universal

effective

- Trigger interventions to prevent heat related health impacts
- ⊕ communication
- ⊖ sufficient lead time

Picture Source: Fotalia

Perfect Heat Health Warning System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Perfect Heat Health Warning System

reliable

- ⊖ Forecast skill
- ⊕ Health relevance

Holistic (air mass based) approaches

easy to handle

- ⊖ No complicated modelling
- ⊖ Easy to implement
- ⊖ Low requirements for input data
- ⊖ universal

effective

- ⊕ Trigger interventions to prevent heat related health impacts
- • communication
- ⊖ sufficient lead time

Picture Source: Fotalia

Perfect Heat Health Warning System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Perfect Heat Health Warning System

reliable

- Forecast skill
- Health relevance

easy to handle

- No complicated modelling
- Easy to implement
- Low requirements for input data
- universal

effective

- Trigger interventions to prevent heat related health impacts
- communication
- sufficient lead time

Heat budget approaches

Picture Source: Fotalia

Indices for Heat Health Warnings

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

e.g. Perceived Temperature PT (SET*, PET, UTCI)

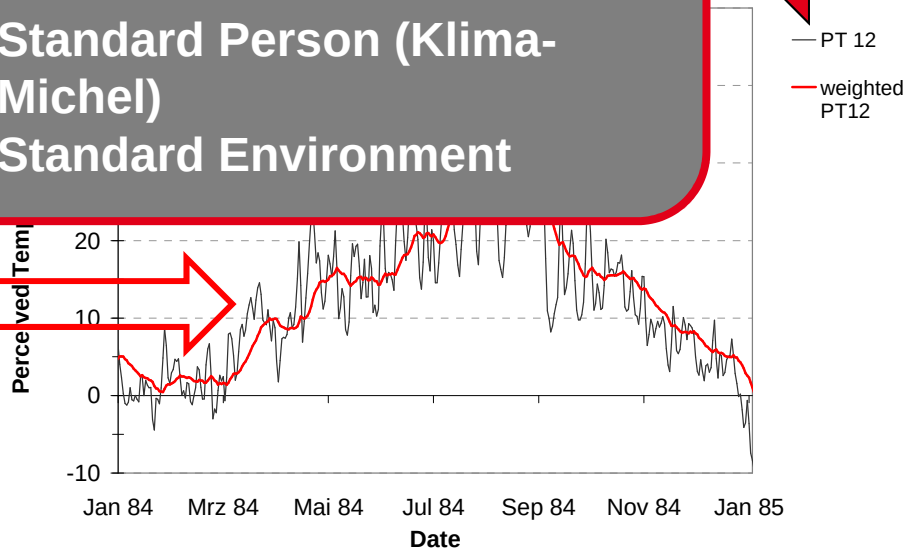
Example Germany:

PT + adaptation approach (HeRATE) + OT

Complete heat budget model of human body
Standardizations:
- **Standard Person (Klima-Michel)**
- **Standard Environment**

2/3 **absolute part** **1/3**

PT (°C)		Thermal load category
≤ -39	-4	extreme cold stress
-39 to -26	-3	strong cold stress
-26 to -13	-2	moderate cold stress
-13 to 0	-1	slight cold stress
0 to 20	0	thermal comfort
20 to 26	1	slight heat load
26 to 32	2	moderate heat load
32 to 38	3	strong heat load
≥ 38	4	extreme heat load



Index: Perceived Temperature (PT)

Indices for Heat Health Warnings

Heat budget approaches

e.g. Perceived Temperature PT (SET*, PET, UTCI)

Example Germany:

PT + adaptation approach (HeRATE) + OT

Level 1: variable threshold for strong heat load is exceeded for 2 consecutive days and indoor mean operative temperature during nighttime is higher than ~ 24°C

Level 2 : threshold for extreme heat load is exceeded (PT [12 UTC] >38°C)

Perfect Heat Health Warning System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Perfect Heat Health Warning System

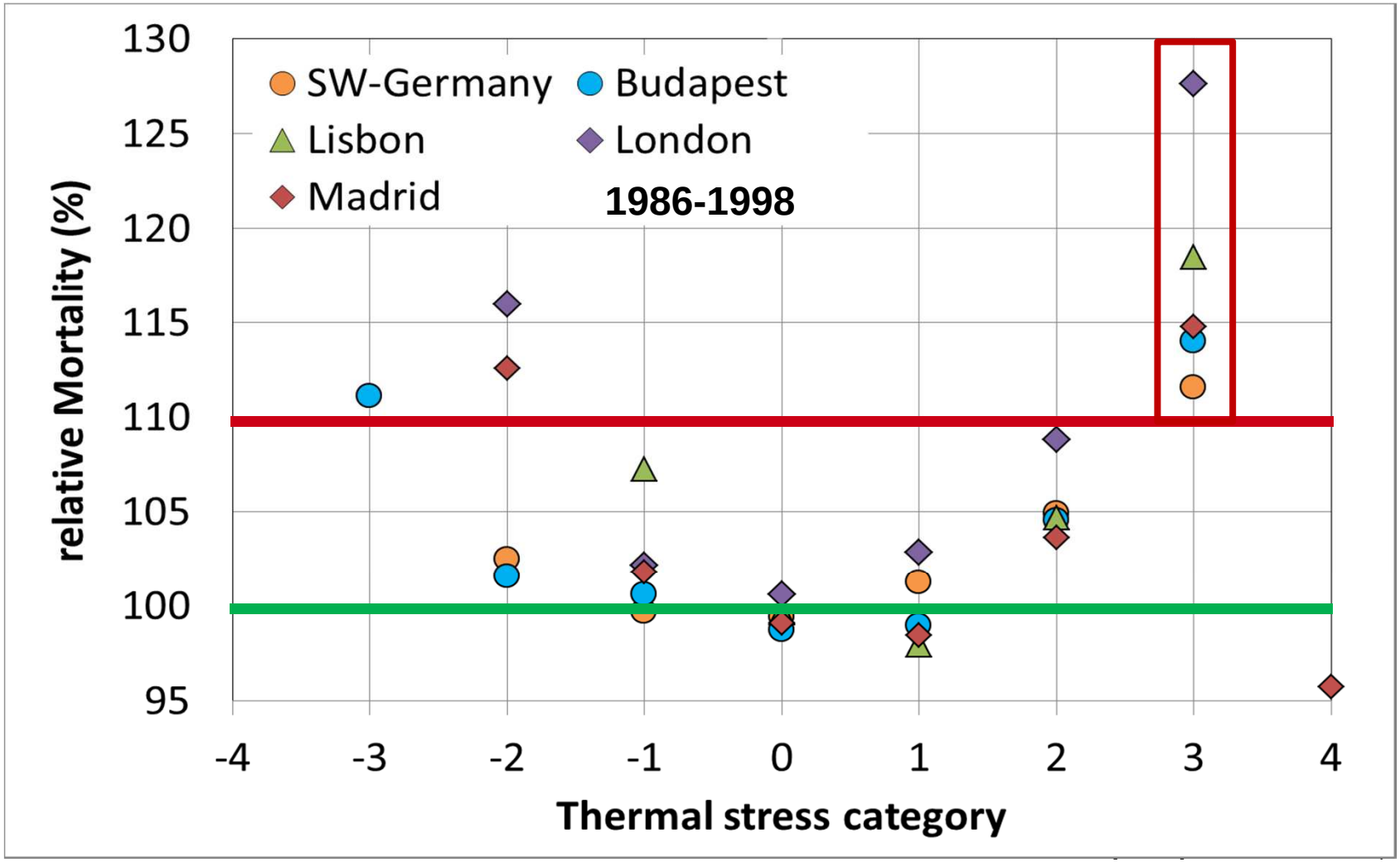
Heat budget approaches

reliable	easy to handle	effective
• Forecast skill	• No complicated modelling	• Trigger interventions to prevent heat related health impacts
⊕ Health relevance	• Easy to implement	• communication
	• Low requirements for input data	• sufficient lead time
	⊕ universal	

Picture Source: Fotalia

HHW-Indices

Heat budget approaches



Perfect Heat Health Warning System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Perfect Heat Health Warning System

reliable

- ⊖ Forecast skill
- ⊕ Health relevance

Heat budget approaches

easy to handle

- ⊖ No complicated modelling
- ⊖ Easy to implement
- ⊖ Low requirements for input data
- ⊕ universal

effective

- Trigger interventions to prevent heat related health impacts
- ⊖ communication
- ⊖ sufficient lead time

Picture Source: Fotalia

Perfect Heat Health Warning System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Perfect Heat Health Warning System

reliable

- Forecast skill
- Health relevance

easy to handle

- No complicated modelling
- Easy to implement
- Low requirements for input data
- universal

effective

- Trigger interventions to prevent heat related health impacts
- communication
- sufficient lead time

Consider-ation of adaptation

Picture Source: Fotalia

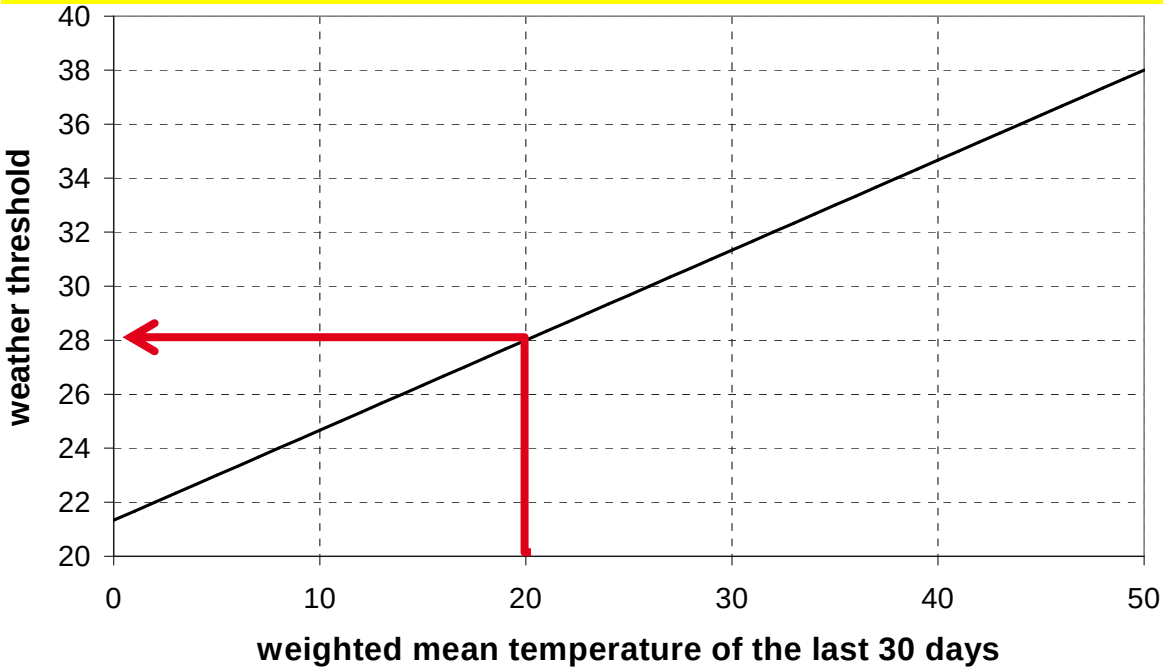
Indices for Heat Health Warnings

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

e.g. HeRATE, Excess Heat Index acclimatisation (EHI_{accl})

Example Germany / EuroHEAT: T12 UTC + HeRATE

Information about probability that threshold for heat is reached or exceeded (lead time 10 days)



Consider-ation of adaptation

Indices for Heat Health Warnings

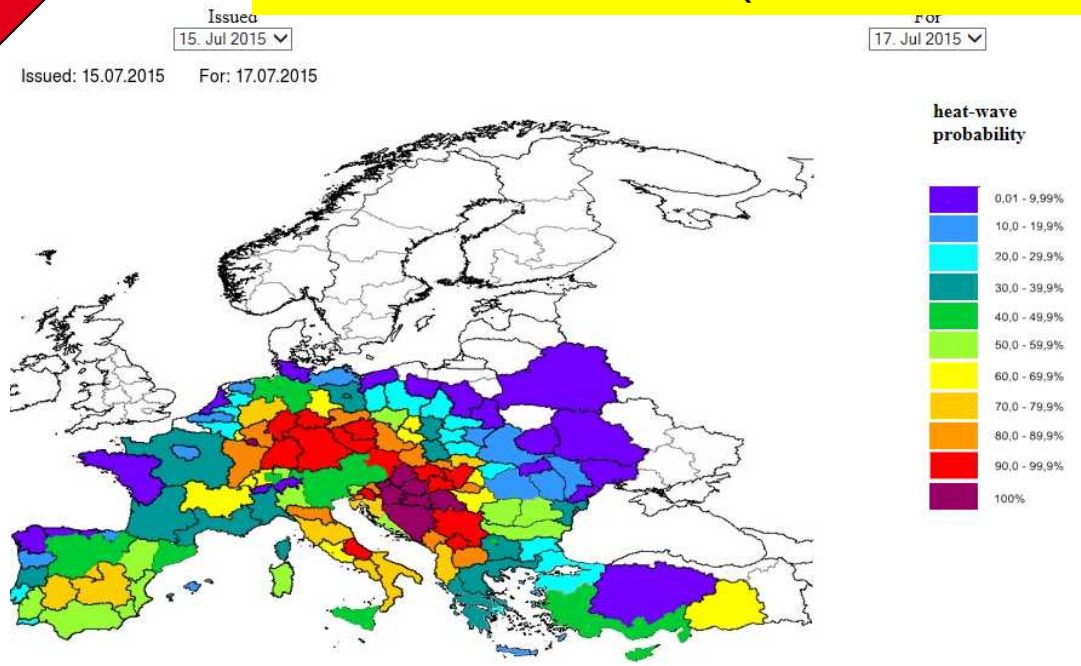
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Consider-ation of adaptation

e.g. HeRATE, Excess Heat Index acclimatisation (EHI_{accl})

Example Germany / EuroHEAT: T12 UTC + HeRATE

Information about probability that threshold for heat is reached or exceeded (lead time 10 days)



Perfect Heat Health Warning System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Consider-ation of adaptation

Perfect Heat Health Warning System

reliable

- Forecast skill
- Health relevance

easy to handle

- No complicated modelling
- Easy to implement
- Low requirements for input data
- universal

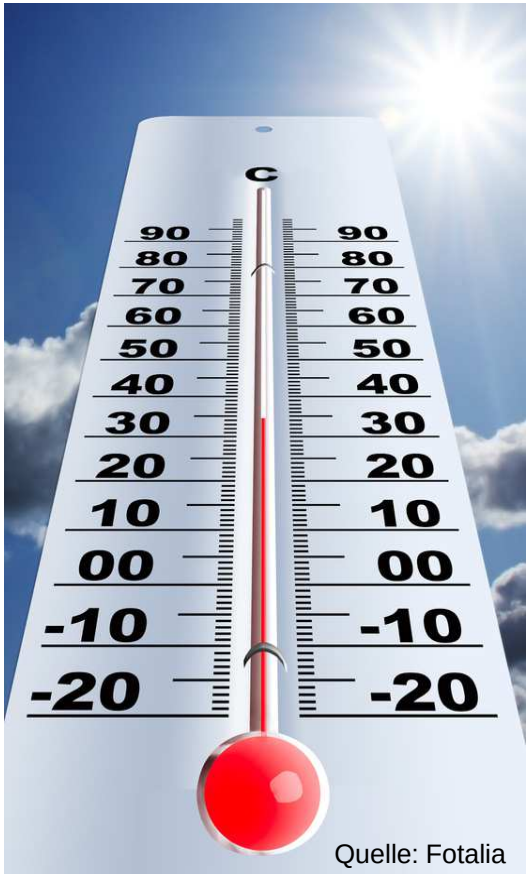
effective

- Trigger interventions to prevent heat related health impacts
- communication
- sufficient lead time

Picture Source: Fotalia

Summary and Conclusions

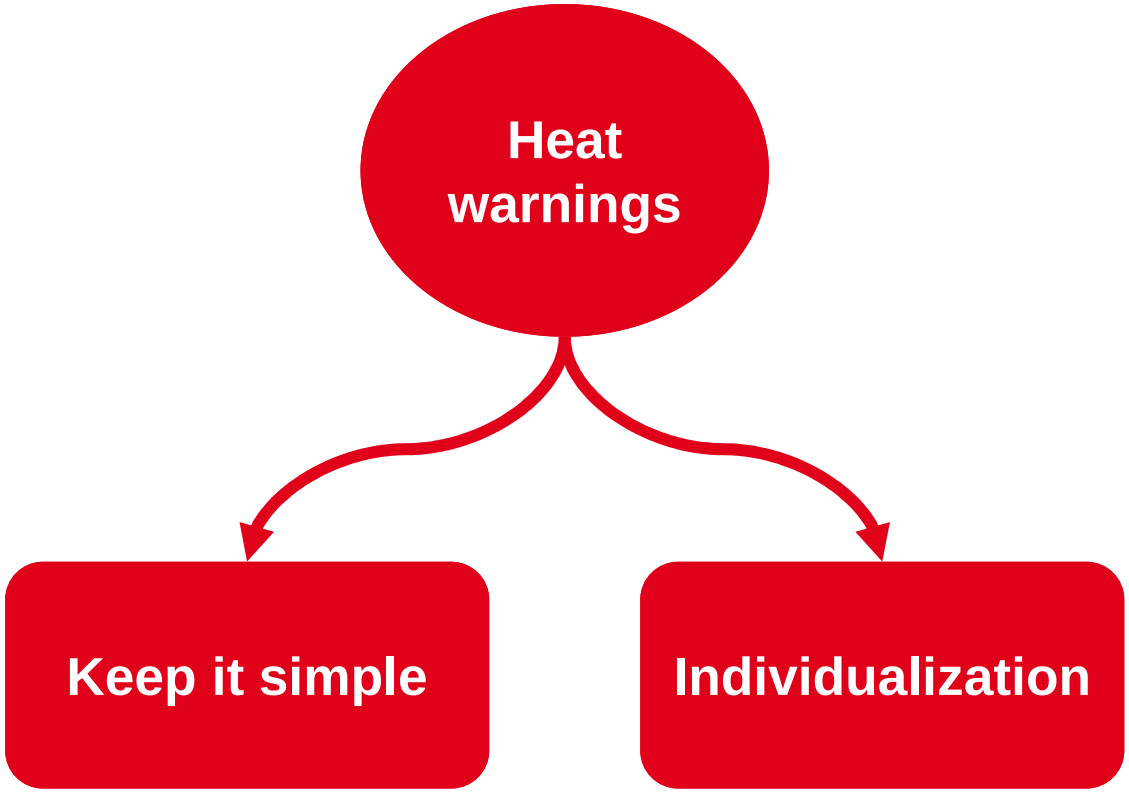
- There are many indices / methods used for HHWS
- Perfect index / method should:
  - ➔ directly linked to health impacts
    - ➔ include adaptation / acclimatization
    - ➔ model individual thermal stress level
  - ➔ be universally applicable and easy to handle
  - ➔ good forecast / prediction skill on all time scales
- All indices have the problem that they try to assess the thermal load on populations basis
- Warning method should be tailored to local requirements (health interventions) and data availability (forecasts, historical data, health data)

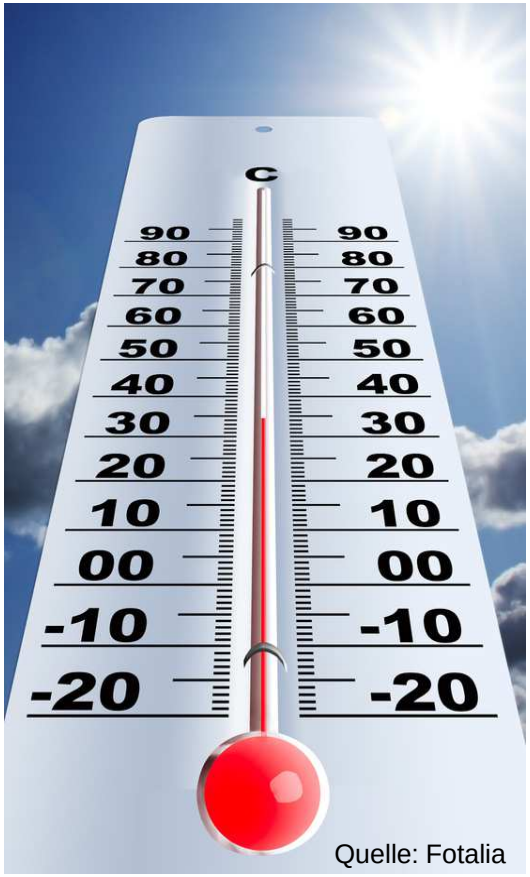


Quelle: Fotalia

There is no best method for triggering heat warnings

Future





There is no best method for triggering heat warnings


Thank You