AQUA URBANICA 2021

Schwammstadt – Versickerung 2.0?

Latente vs. Sensible Wärme: Warum dezentrale Entwässerungssysteme mehr als nur versickern können und wie man sie optimiert

Yannick Back

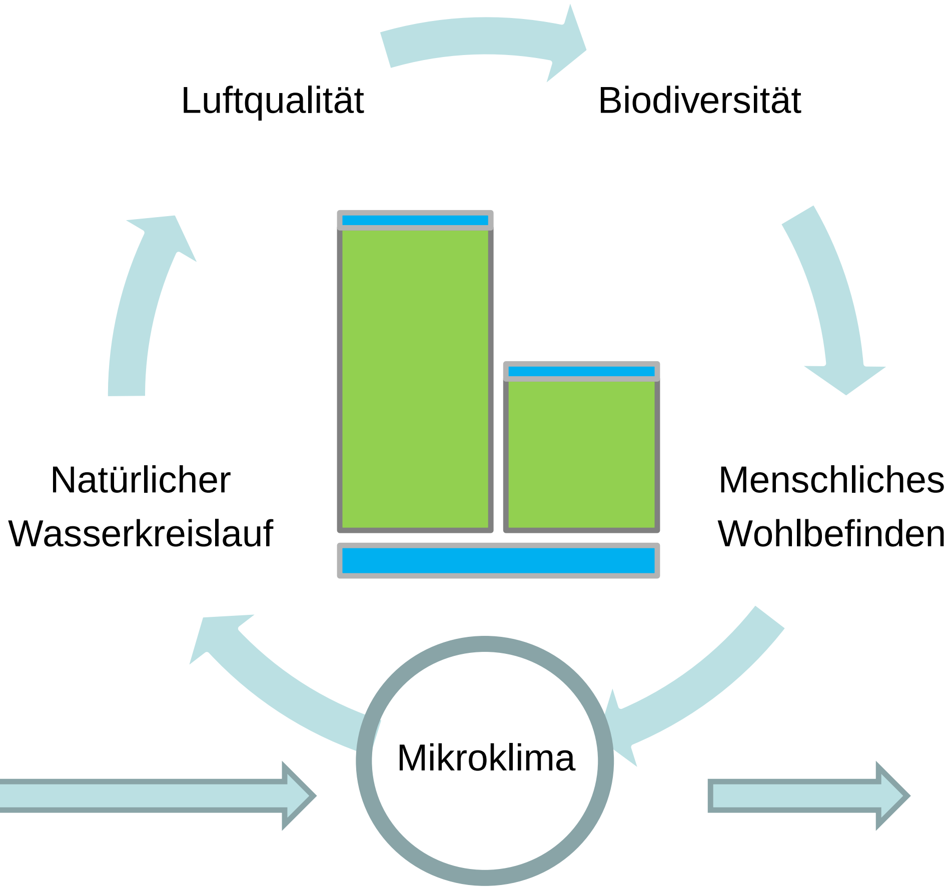
- Einleitung
- Entwicklung des Surface Thermal Contribution Index
- Beispielhafte Ergebnisse auf globaler bis mikroskalen Ebene
- Steigerung der Resilienz unserer Städte
- Zusammenfassung

Einleitung

Mehrfachnutzen durch Schwammstadtkonzepte

Verbesserung

Infiltration,
Evapotranspiration &
Speicherung von Wasser



Dezentrale Entwässerungssysteme
Grün/Blaue Infrastruktur
…

?

Wie verändert sich das Mikroklima

Einleitung

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

A rapid fine-scale approach to modelling urban bioclimatic conditions

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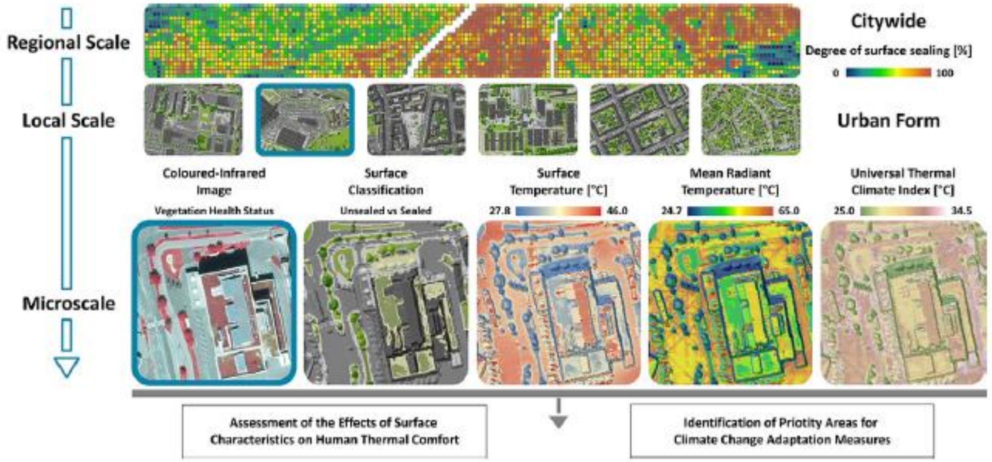
HIGHLIGHTS

- Fine-scale simulation of surface temperature (LST), mean radiant temperature (MRT) and UTCI
- Fast and detailed assessment of urban thermal comfort for different urban forms
- Identification of priority areas for climate change adaptation measures in urban environments
- Impact of sky view factor on calculations for bioclimatic conditions was substantial.
- High-albedo surfaces decrease LST but increase MRT and UTCI effecting human thermal comfort.

GRAPHICAL ABSTRACT



Einleitung

?

Was sind die treibenden Kräfte

Ing.-Etzel Park in Innsbruck

Projekt: „**cool-INN**“

Oberflächentemperatur

21°C 32°C

Lufttemperatur = 25°C

Uhrzeit: 12:00

Einleitung

Oberflächenenergiebilanz

$Q = LE + H + G$

Latente Wärme (LE)

Sensible Wärme (H)

Bodenwärmestrom (G)

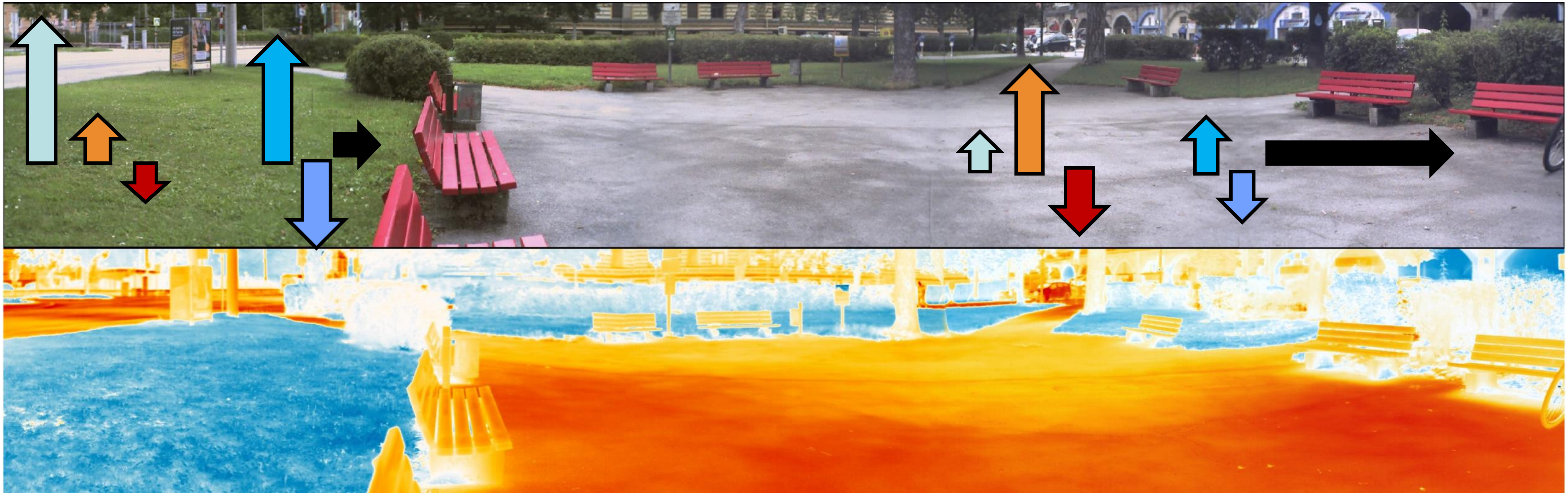
Oberflächenwasserbilanz

$P = E + R + I$

Evapotranspiration (E)

Abfluss (R)

Infiltration (I)



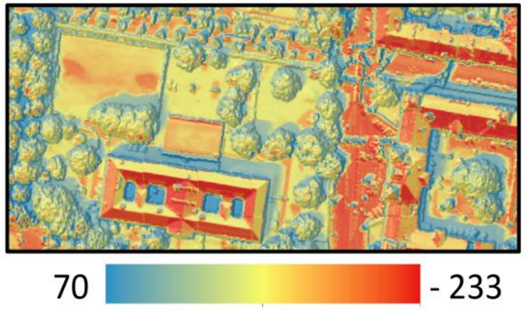
Oberflächentemperatur

21°C – 32°C

Lufttemperatur = 25°C
Uhrzeit: 12:00

Entwicklung des Surface Thermal Contribution Index

Bodenwärmestrom (G) [W/m2]

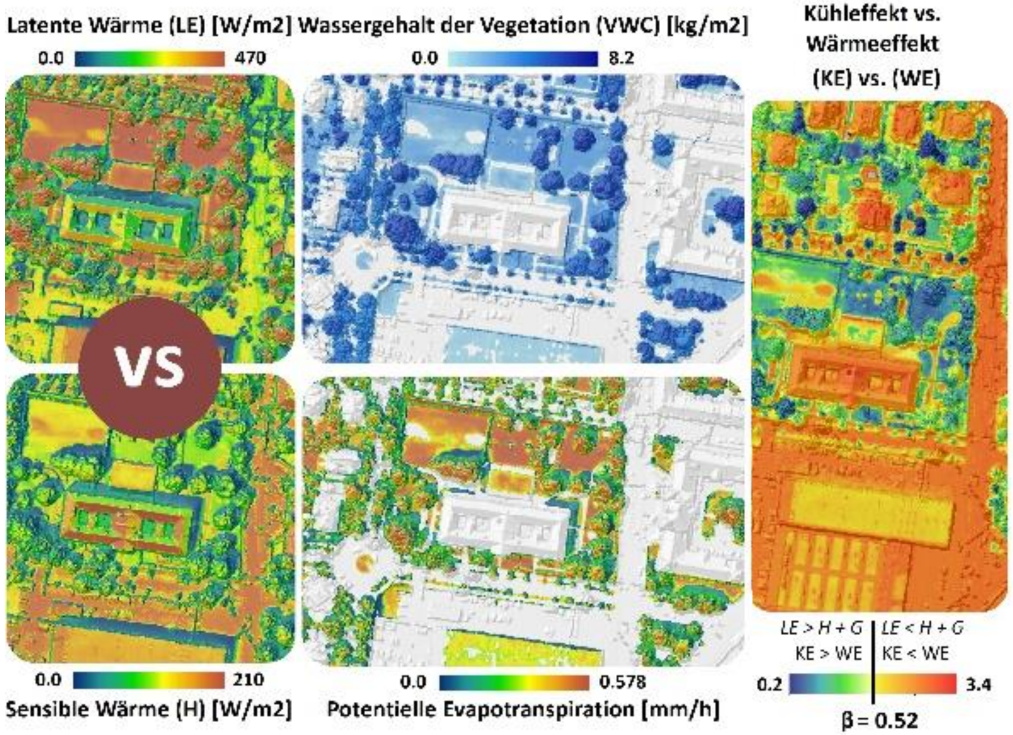


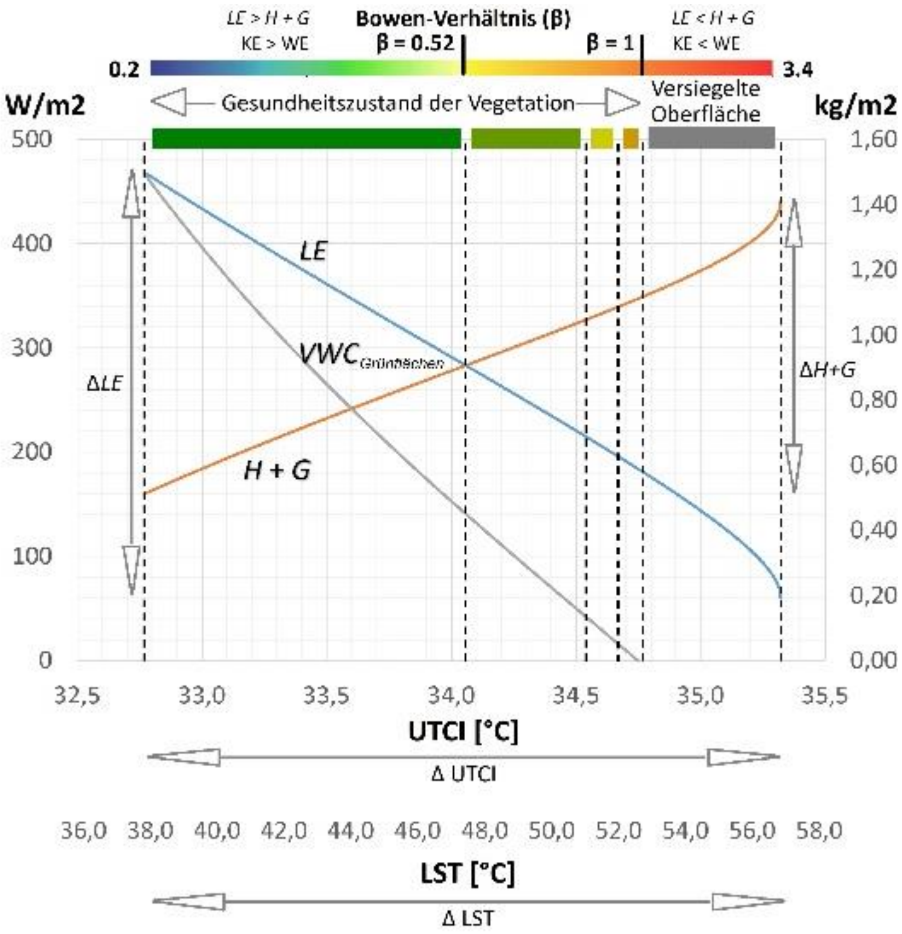
! Beeinflusst durch meteorologische Bedingungen !

Steigerung der bodennahen Lufttemperatur

$$\beta = \frac{\text{Sensible Wärme (H)}}{\text{Latente Wärme (LE)}}$$

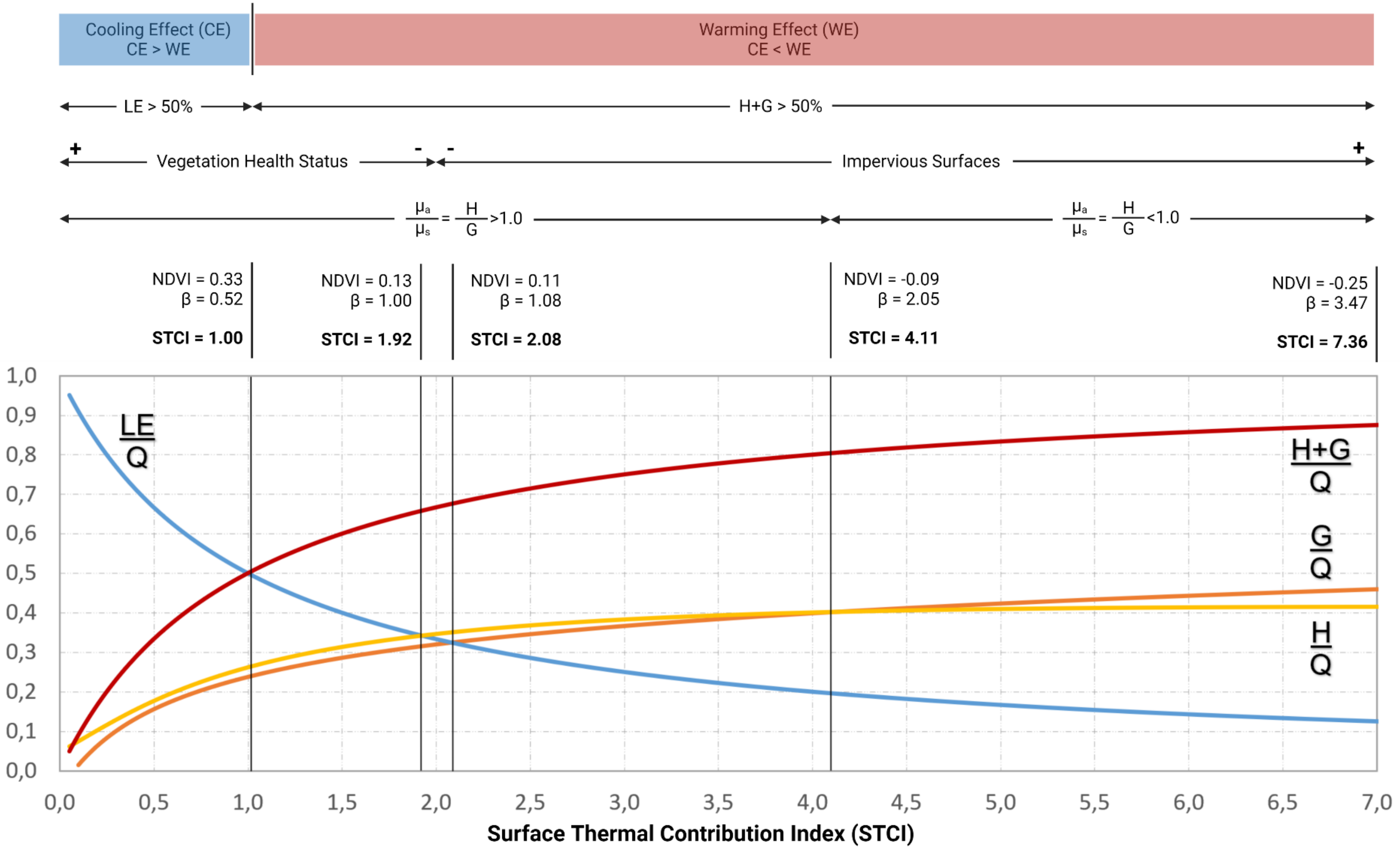
Steigerung der Evapotranspiration „Verdunstungskühlung“





Entwicklung des Surface Thermal Contribution Index

$$Q = LE + H + G \quad \Rightarrow \quad \frac{LE}{Q} + \frac{H}{Q} + \frac{G}{Q}$$

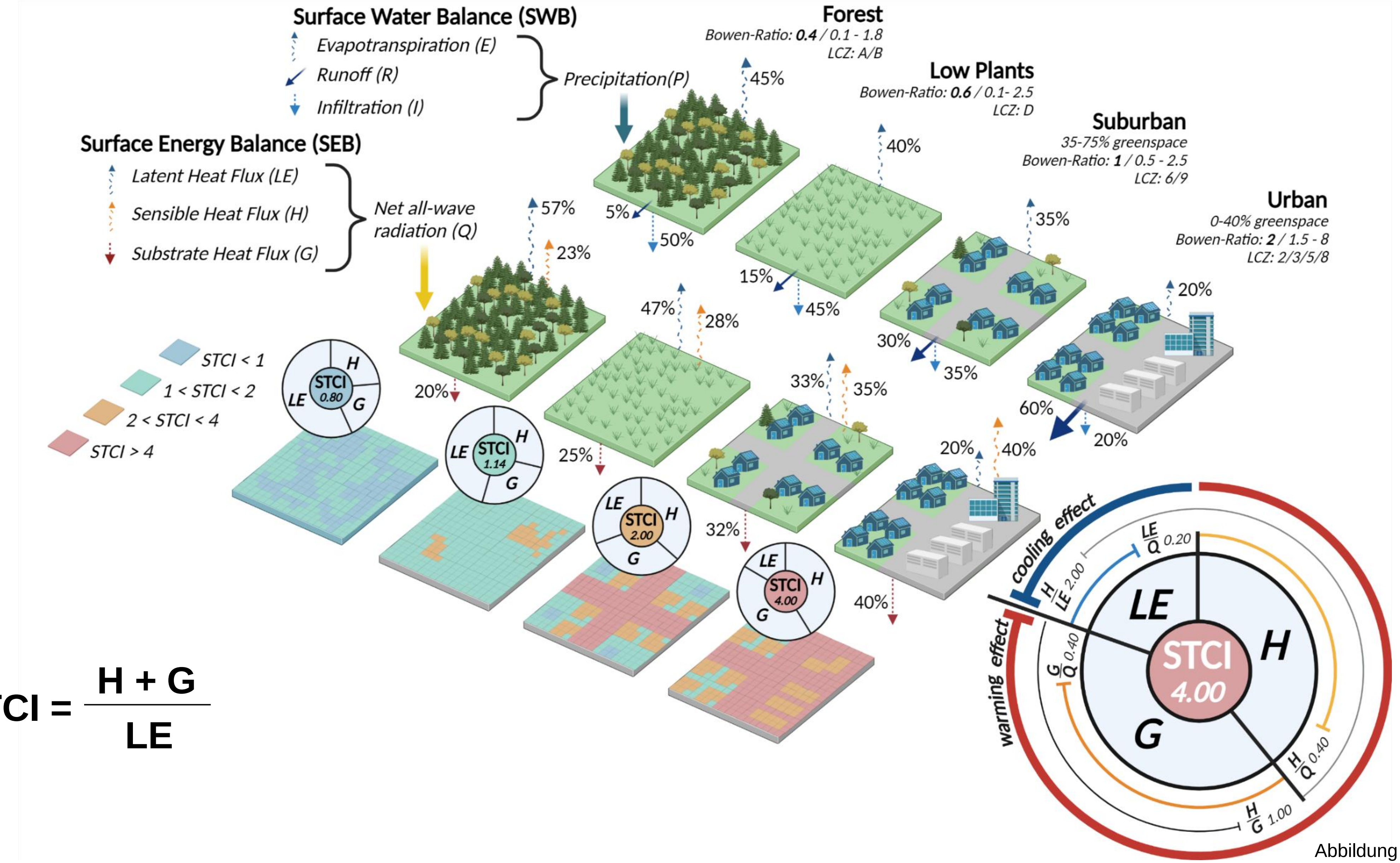


! Unabhängig von meteorologischen Bedingungen !

$$\textbf{STCI} = \frac{\textbf{H + G}}{\textbf{LE}}$$

Abbildung erstellt mit BioRender.com

Entwicklung des Surface Thermal Contribution Index



$$\text{STCI} = \frac{H + G}{LE}$$

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Beispielhafte Ergebnisse auf globaler bis mikroskalen Ebene


Article

A 10 per cent increase in global land evapotranspiration from 2003 to 2019

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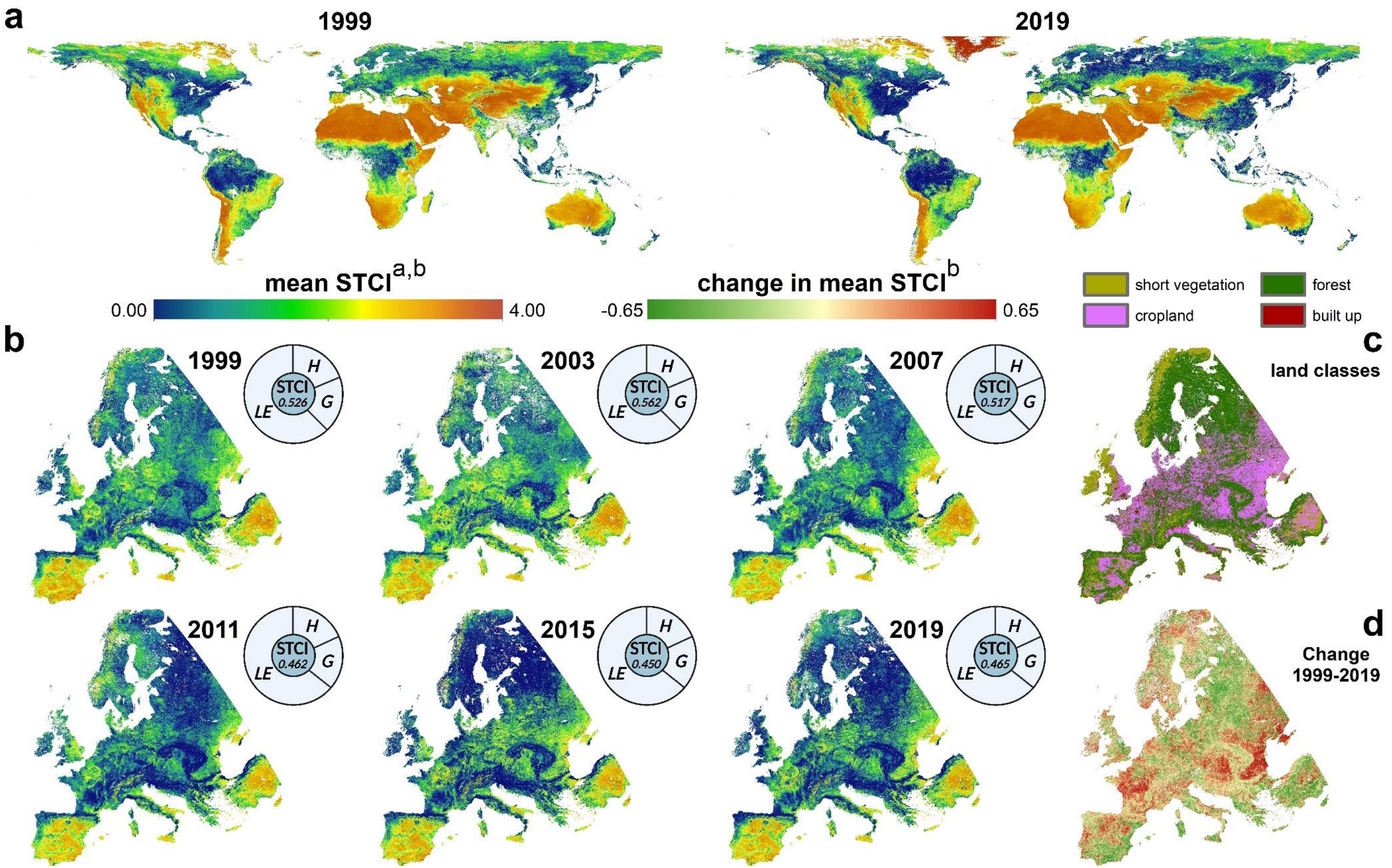
Madeleine Pascolini-Campbell[1✉], John T. Reager[1], Hrishikesh A. Chandanpurkar[1] & Matthew Rodell[2]

Accurate quantification of global land evapotranspiration is necessary for understanding variability in the global water cycle, which is expected to intensify under climate change[1–3]. Current global evapotranspiration products are derived from a variety of sources, including models[4,5], remote sensing[6,7] and in situ observations[8–10]. However, existing approaches contain extensive uncertainties; for example, relating to model structure or the upscaling of observations to a global level[11]. As a result, variability and trends in global evapotranspiration remain unclear[12]. Here we show that global land evapotranspiration increased by 10 ± 2 per cent between 2003 and 2019, and that land precipitation is increasingly partitioned into evapotranspiration rather than runoff. Our results are based on an independent water-balance ensemble time series of global land evapotranspiration and the corresponding uncertainty distribution, using data from the Gravity Recovery and Climate Experiment (GRACE) and GRACE-Follow On (GRACE-FO) satellites[13]. Variability in global land evapotranspiration is positively correlated with El Niño–Southern Oscillation. The main driver of the trend, however, is increasing land temperature. Our findings provide an observational constraint on global land evapotranspiration, and are consistent with the hypothesis that global evapotranspiration should increase in a warming climate.

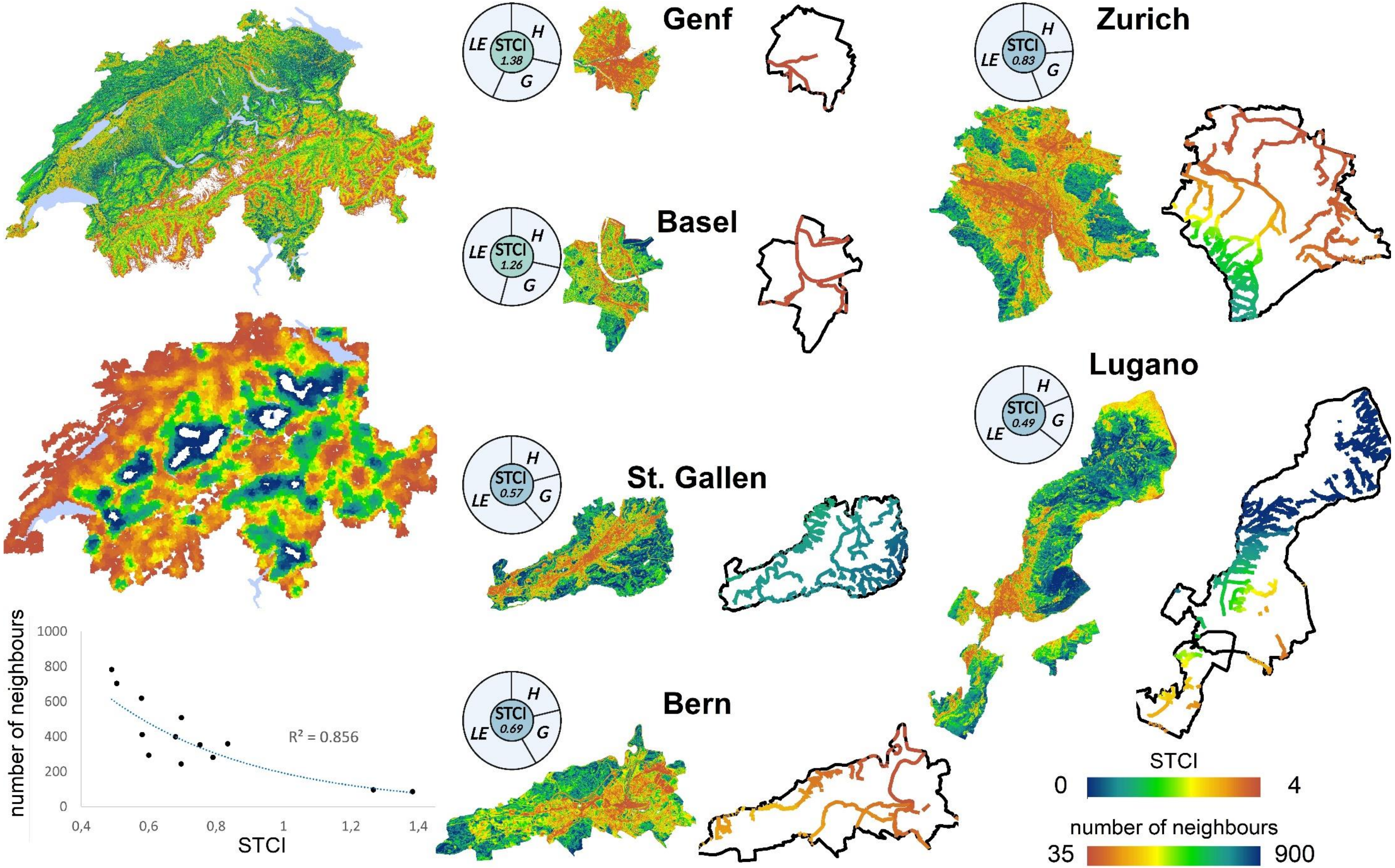

nature climate change
LETTERS
PUBLISHED ONLINE: 16 MAY 2016 | DOI: 10.1038/NCLIMATE3029

Land–atmosphere feedbacks amplify aridity increase over land under global warming

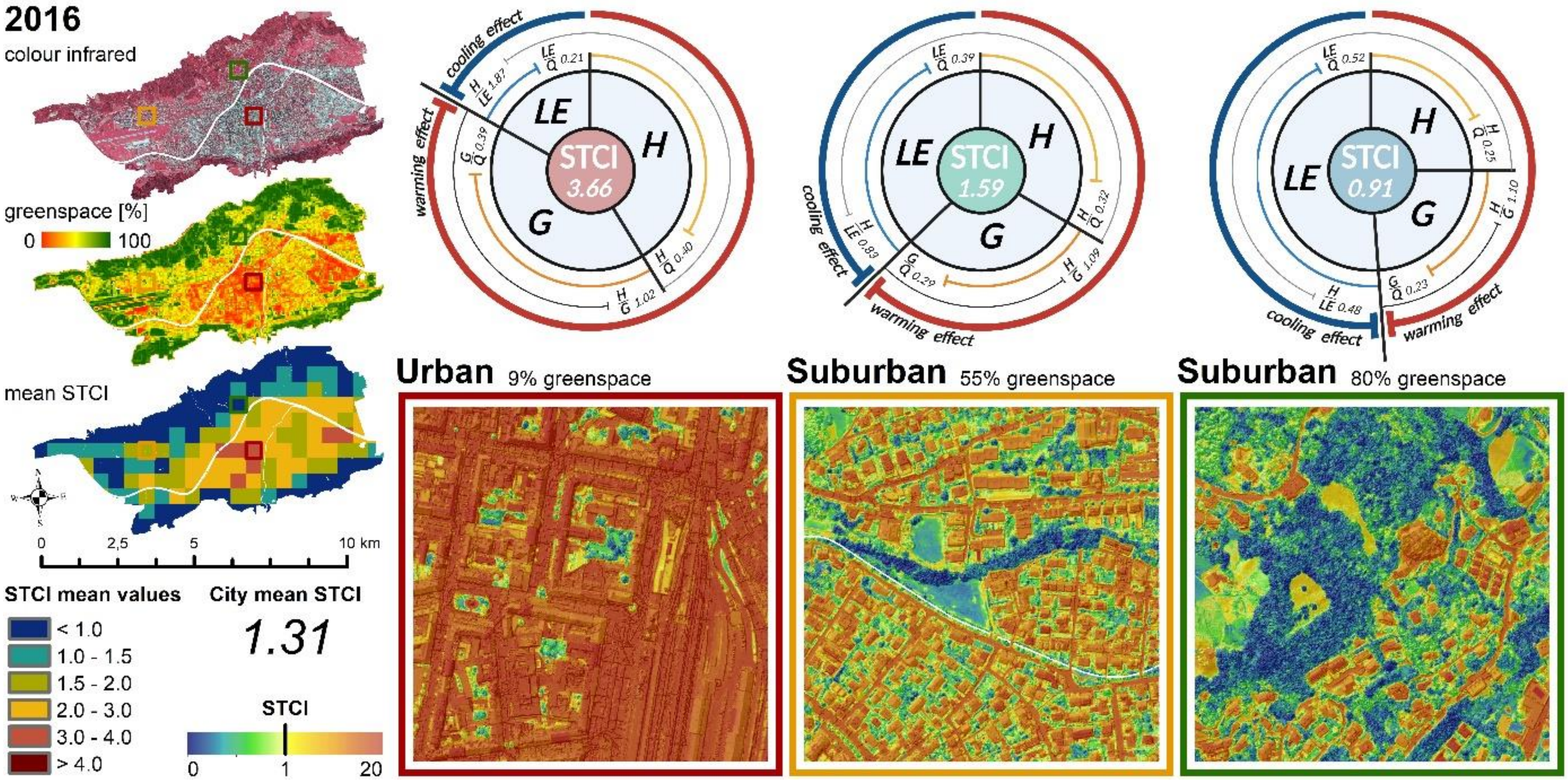
Alexis Berg[1*], Kirsten Findell[2], Benjamin Lintner[3], Alessandra Giannini[1], Sonia I. Seneviratne[4], Bart van den Hurk[5], Ruth Lorenz[6], Andy Pitman[6], Stefan Hagemann[7], Arndt Meier[8], Frédérique Cheruy[9], Agnès Ducharne[10], Sergey Malyshev[11] and P. C. D. Milly[12]



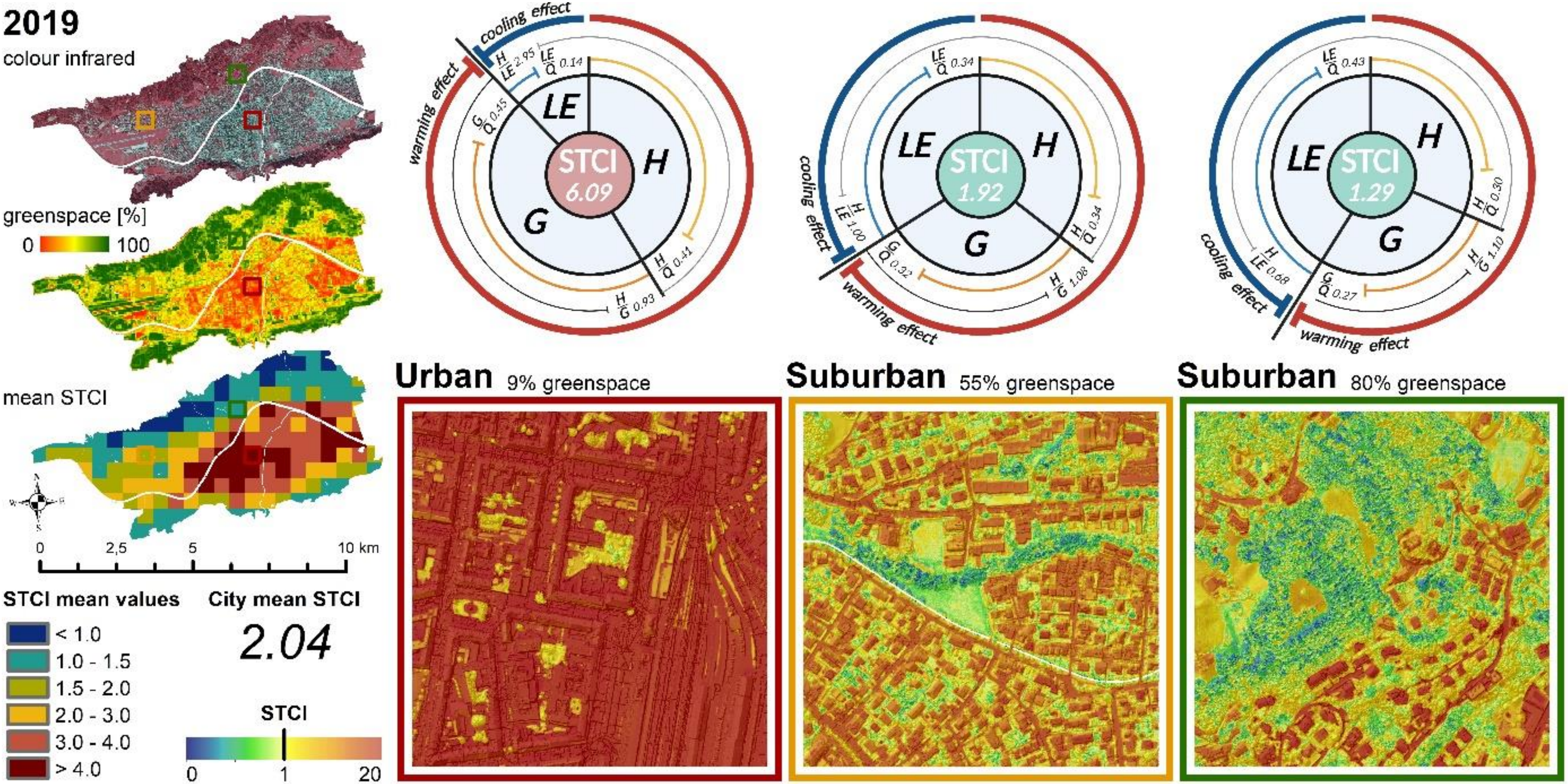
Beispielhafte Ergebnisse auf globaler bis mikroskalen Ebene



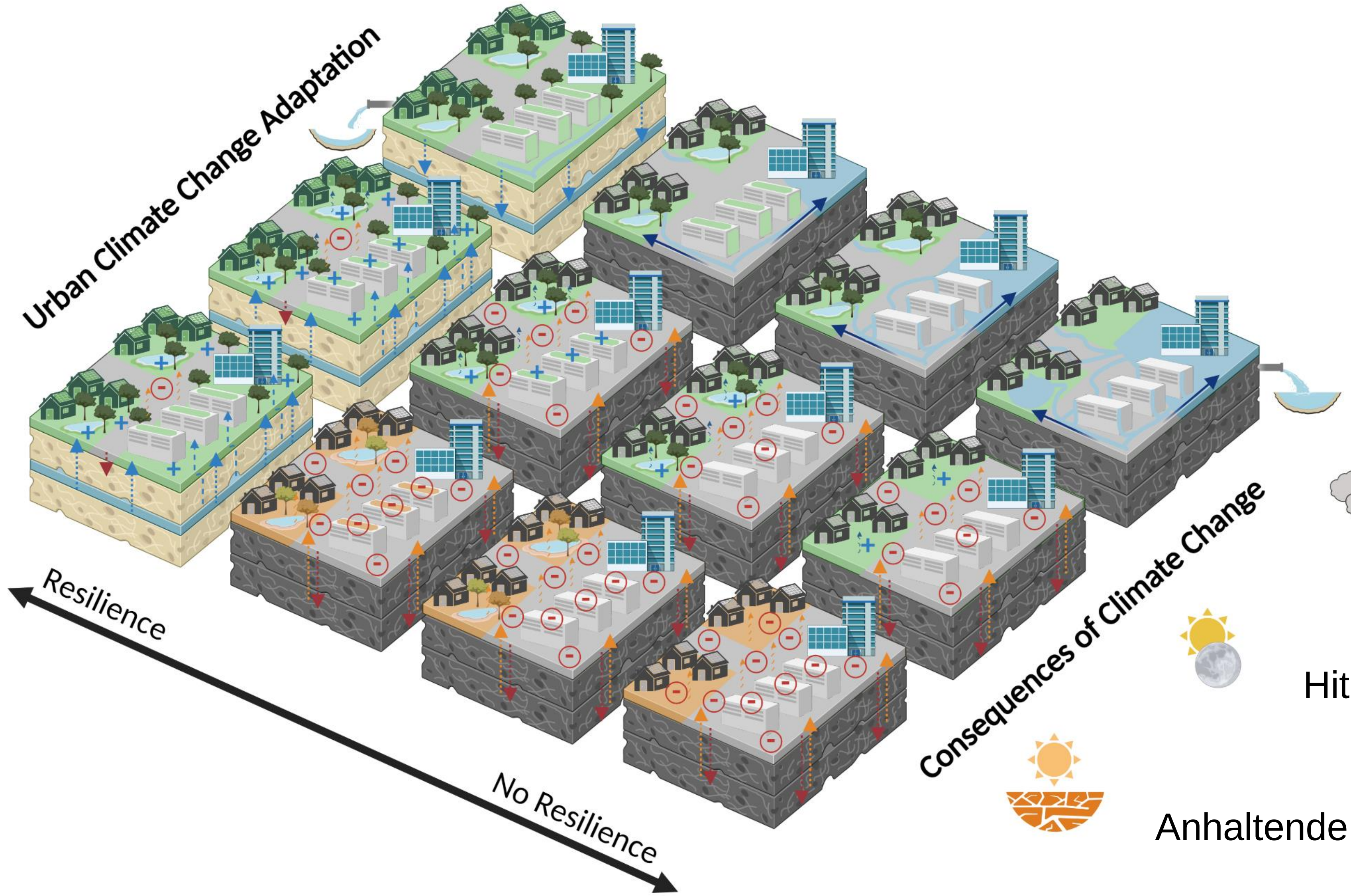
Beispielhafte Ergebnisse auf globaler bis mikroskalen Ebene



Beispielhafte Ergebnisse auf globaler bis mikroskalen Ebene



Steigerung der Resilienz unserer Städte



Starkniederschlagsereignisse

Hitzetage und Tropennächte

Anhaltende Dürren

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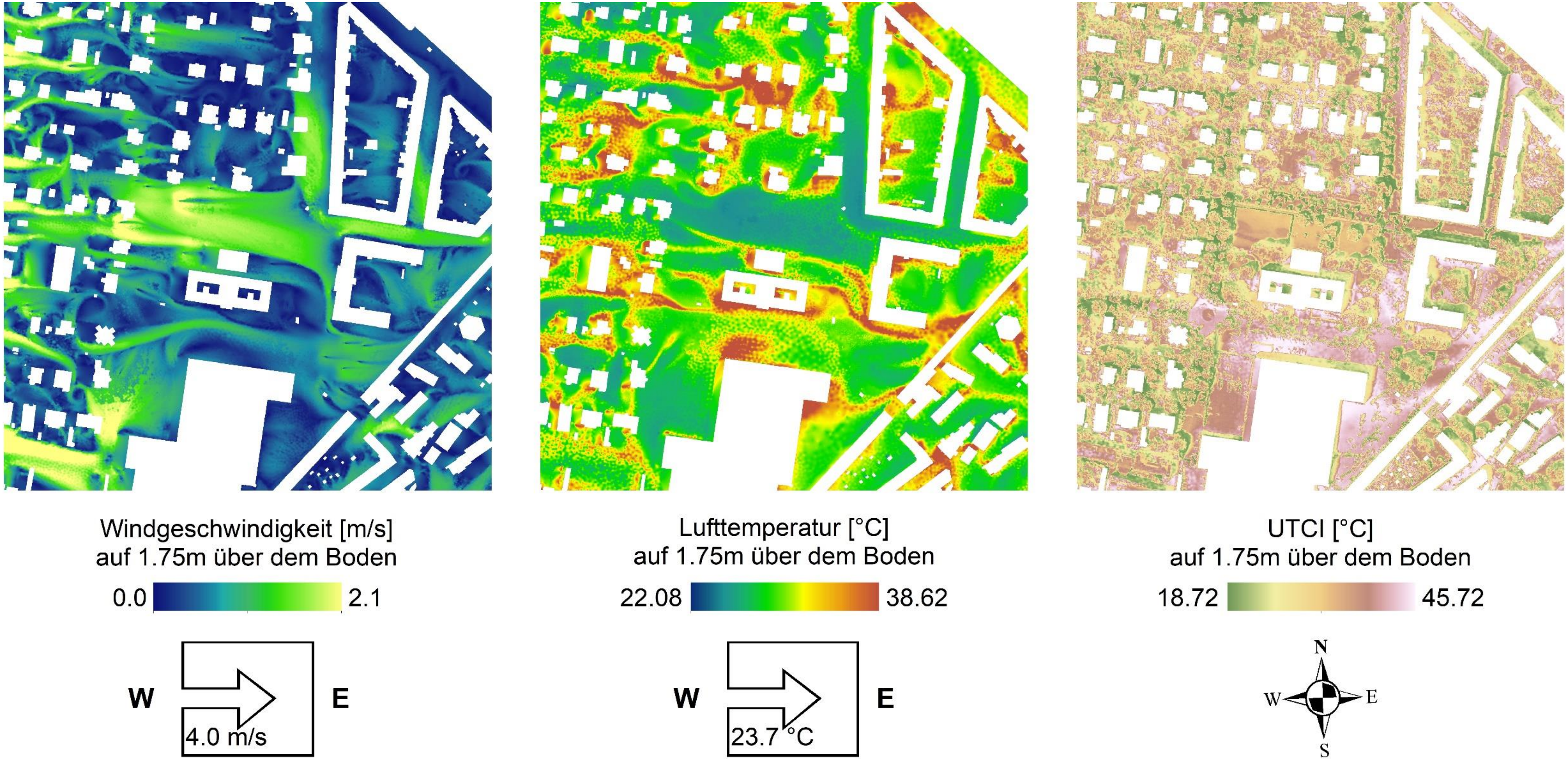
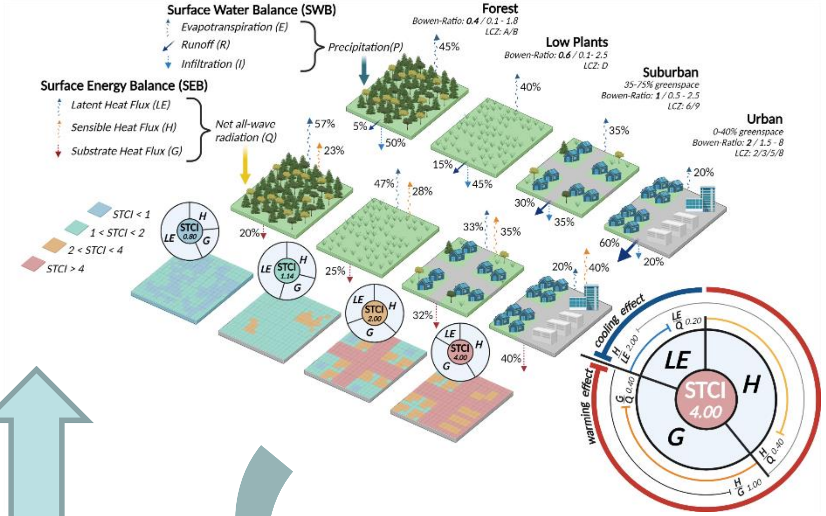
Einfluss meteorologischer Bedingungen auf das Mikroklima

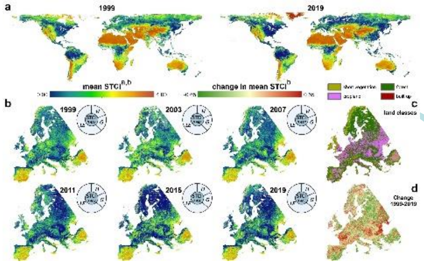


Zusammenfassung

STCI

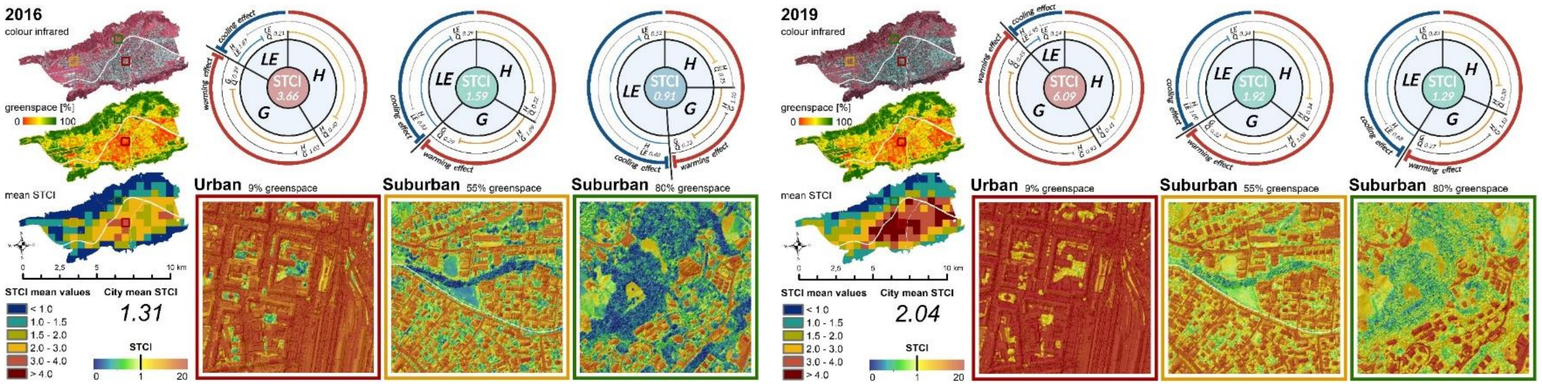


H_2O



H_2O

- Verbesserung der Energie- und Wasserbilanz
- Infiltration, Evapotranspiration und **Speicherung** des Niederschlagswassers in Städten
- Integration eines klimasensiblen Wassermanagements in die Stadtplanung



Referenzen

Back, Y. et al. A rapid fine-scale approach to modelling urban bioclimatic conditions. Science of the Total Environment 756, 143732 (2021).

Bastin, J-F. et al. Understanding climate change from a global analysis of city analogues. PLoS ONE 14, 1-13 (2019).

Berg, A. et al. Land-atmosphere feedbacks amplify aridity increase over land under global warming. Nature Climate Change 6, 869-874 (2021).

Bonneau, J. et al. Stormwater infiltration and the ‘urban karst’ - a review. Journal of Hydrology 552, 141-150 (2017).

Butler, D. & Parkinson, J. Towards sustainable urban drainage. Water Science & Technology 35, 53-63 (1997).

Chrysoulakis, N. et al. Urban energy exchanges monitoring from space. Nature Scientific Report 8, 11498 (2018).

Duveiller, G. et al. The mark of vegetation change on Earth’s surface energy balance. Nature Communications 9, 679 (2018).

Fletcher, T.D. et al. SUDS, LID, BMPs, WSUD and more - The evolution and application of terminology surrounding urban drainage. Urban Water Journal 12, 525-542 (2014).

Lai, D. et al. A review of mitigating strategies to improve the thermal environment and thermal comfort in urban outdoor spaces. Science of the Total Environment 661, 337-353 (2019).

Mahmood, R. et al. Land cover changes and their biogeophysical effects on climate. Int. J. Climatol. 34, 929-953 (2014).

Manoli, G. et al. Magnitude of urban heat islands largely explained by climate and population. Nature 573, 55-60 (2019).

Nguyen, T.T. et al. Implementation of a specific urban water management - Sponge City. Science of the Total Environment 652, 147-162 (2019).

Oke, T.R. The energetic basis of the urban heat island. Quarterly Journal of the Royal Meteorological Society 108, 1-24 (1982).

Pascolini-Campbell, M. et al. A 10 per cent increase in global land evapotranspiration from 2003 to 2019. Nature 593, 543-547 (2021).

Rydin, Y. et al. Shaping cities for health: complexity and the planning of urban environments in the 21st century. The Lancet 379, 2079-2108 (2012).

Schwingshackl, C. et al. Quantifying spatiotemporal variations of soil moisture control on surface energy balance and near-surface air temperature. Journal of Climate 30, 7105-7124 (2017).

Seneviratne, S.I. et al. Investigating soil moisture-climate interactions in a changing climate: A review. Earth-Science Review 99, 125-161 (2010).

Willems, P. et al. Impacts of Climate Change on Rainfall Extremes and urban Drainage Systems. International Water Association (IWA) Publishing (2012).

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