Deutsche Gesellschaft für Geographie | DGfG

Quantifying Landscape Temperature Mitigation of Forests and Wetlands

Charlotte Gohr [a,b], Jeanette S. Blumröder [a,b], Douglas Sheil [c,d], Pierre L. Ibisch [a,b]

[a] Centre for Econics and Ecosystem Management, Eberswalde University for Sustainable Development, Eberswalde, Germany

[b] Biosphere Reserves Institute, Eberswalde University for Sustainable Development, Eberswalde, Germany

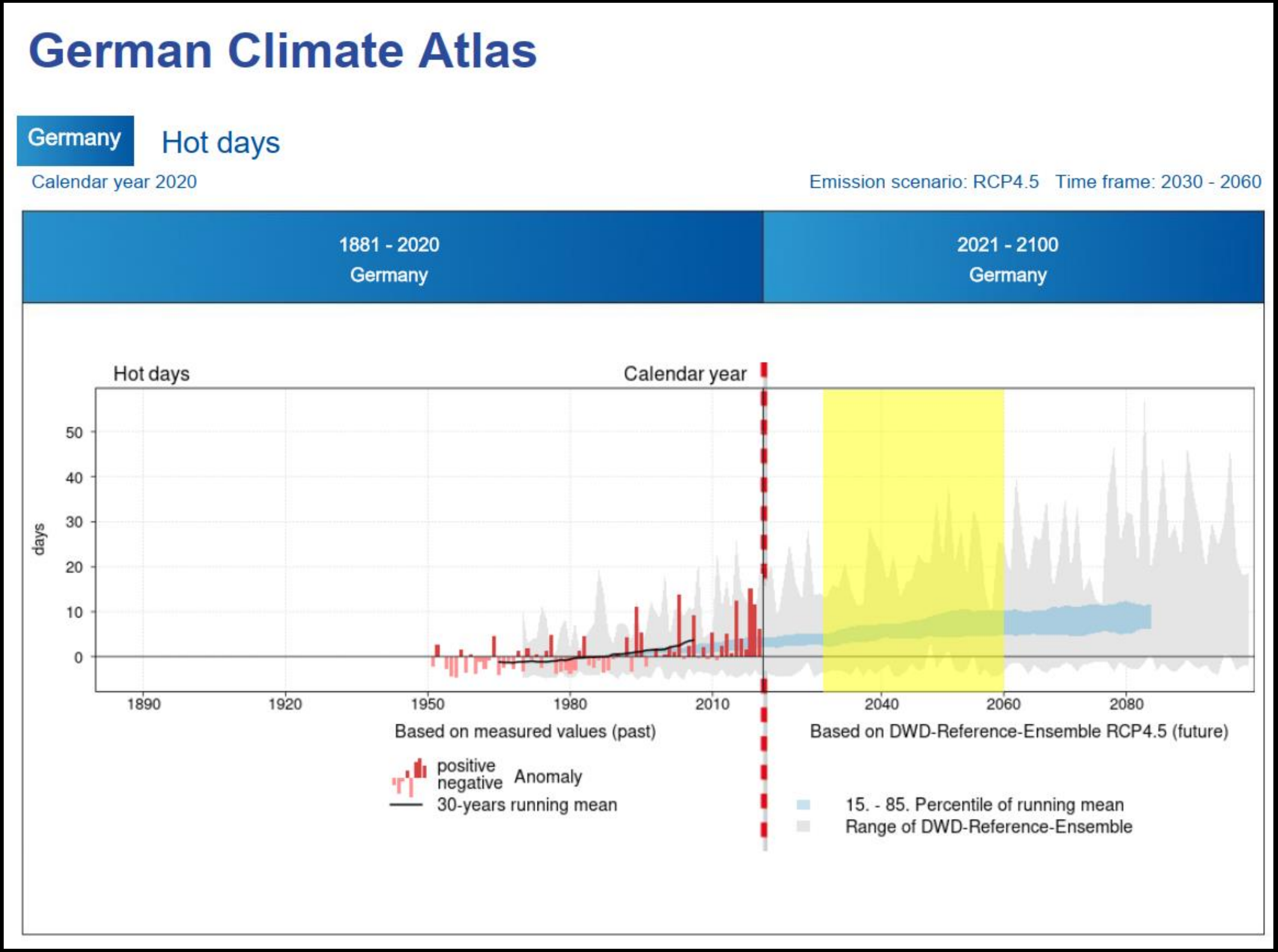
[c] Forest Ecology and Forest Management Group, Wageningen University & Research, Wageningen, Netherlands

[d] Center for International Forestry Research, P.O. Box 0113 BOCBD, Bogor, Indonesia

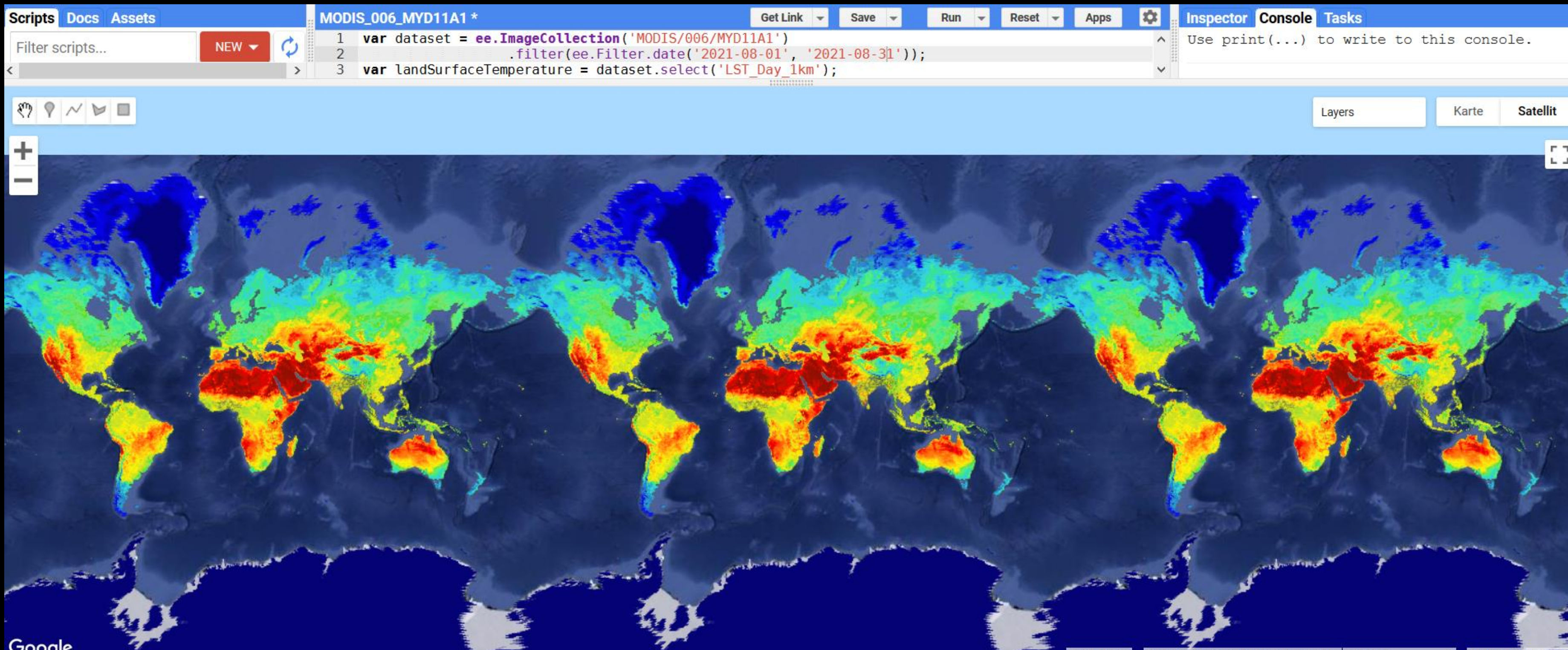
#GeoWoche2021

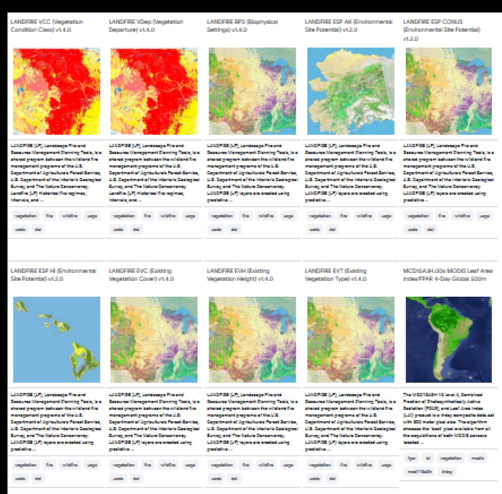
Quantifying Landscape Temperature Mitigation of Forests and Wetlands

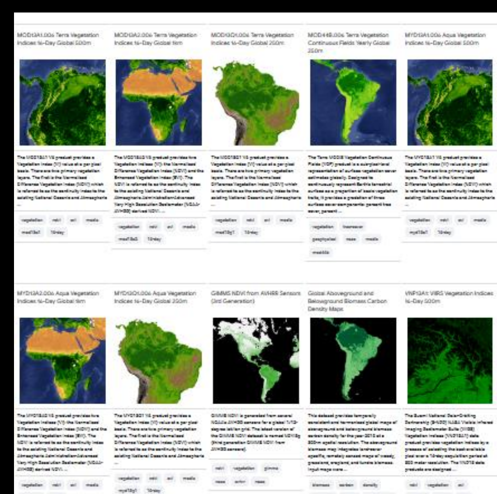
Charlotte Gohr



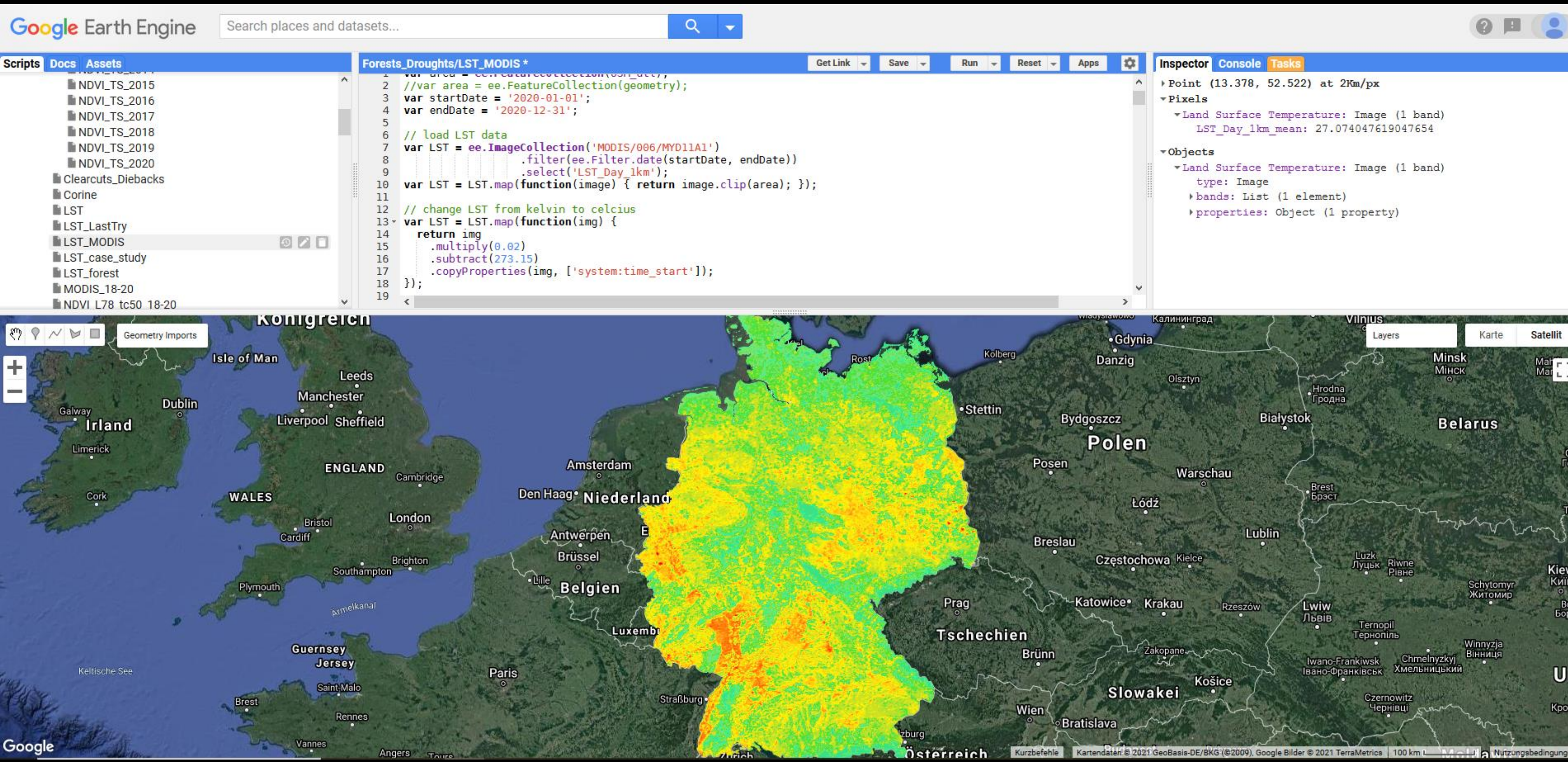
Deutscher Wetterdienst



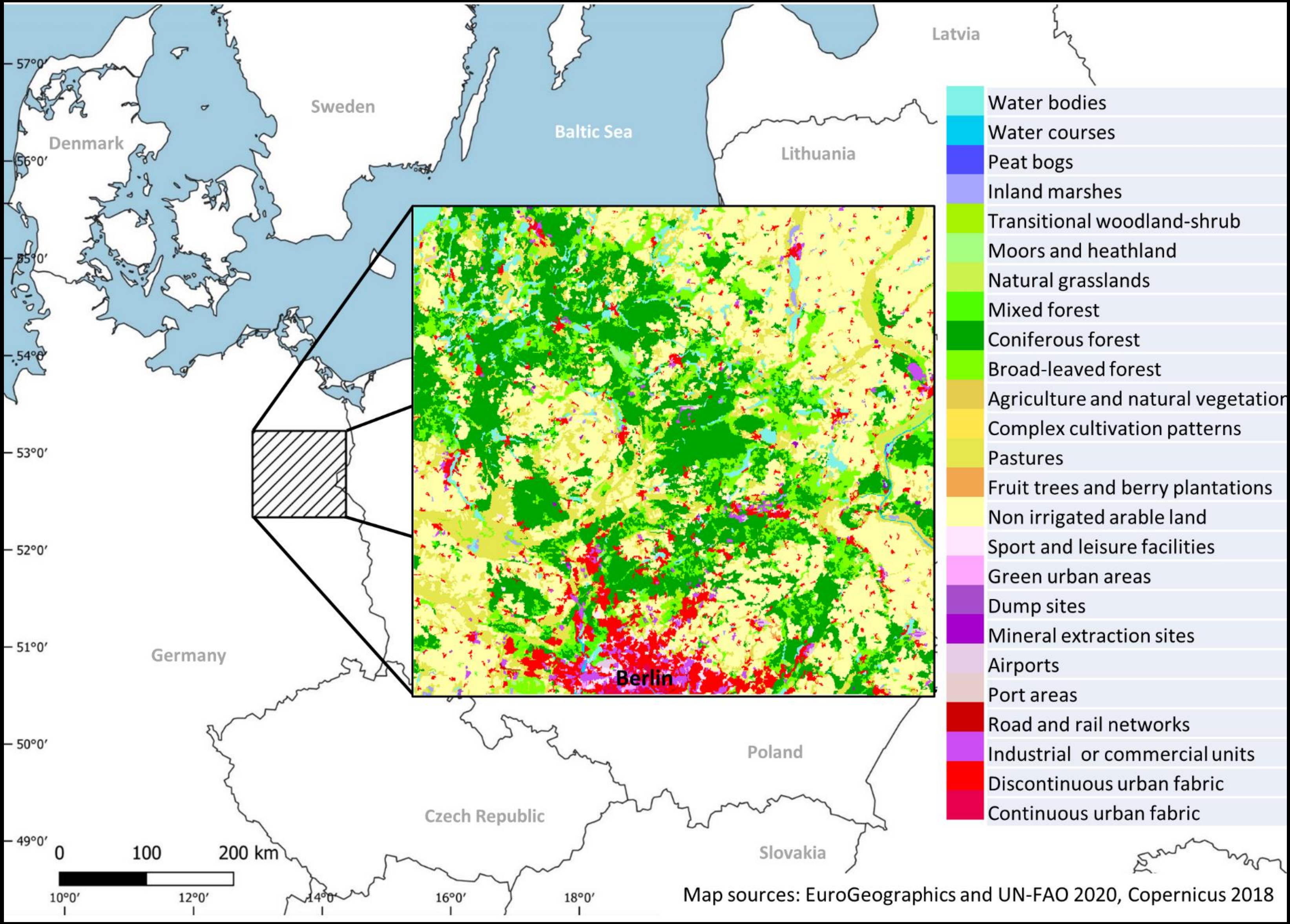




GoogleEarthEngine

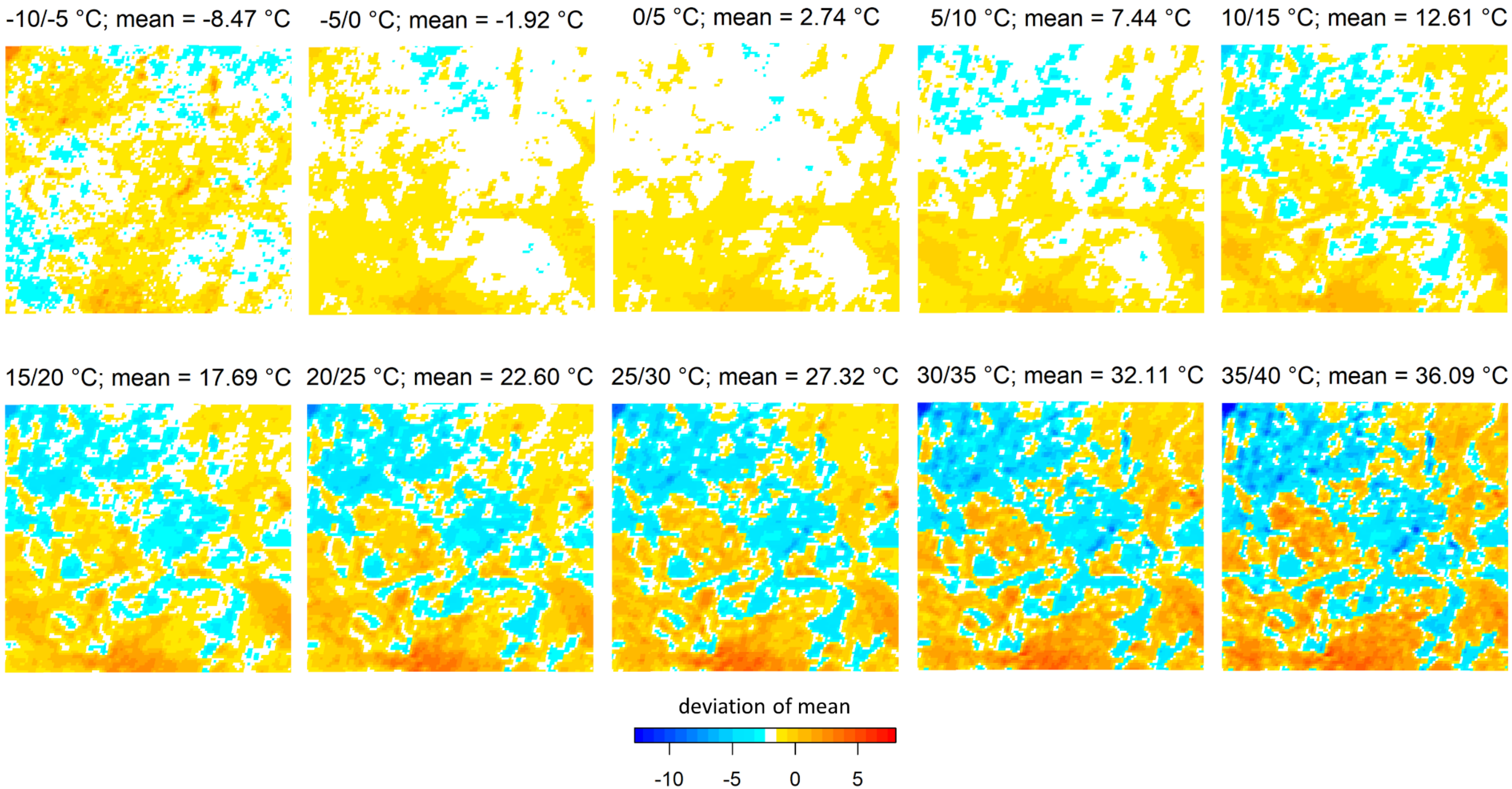

Google Earth Engine
Search places and datasets...
Scripts Docs Assets
NDVI_TS_2015
NDVI_TS_2016
NDVI_TS_2017
NDVI_TS_2018
NDVI_TS_2019
NDVI_TS_2020
Clearcuts_Diebacks
Corine
LST
LST_LastTry
LST_MODIS
LST_case_study
LST_forest
MODIS_18-20
NDVI_L78_tc50_18-20
Forests_Droughts/LST_MODIS *
Get Link Save Run Reset Apps
//var area = ee.FeatureCollection(geometry);
var startDate = '2020-01-01';
var endDate = '2020-12-31';
// load LST data
var LST = ee.ImageCollection('MODIS/006/MYD11A1')
.filter(ee.Filter.date(startDate, endDate))
.select('LST_Day_1km');
var LST = LST.map(function(image) { return image.clip(area); });
// change LST from kelvin to celcius
var LST = LST.map(function(img) {
return img
.multiply(0.02)
.subtract(273.15)
.copyProperties(img, ['system:time_start']);
});
Inspector Console Tasks
Point (13.378, 52.522) at 2Km/px
Pixels
Land Surface Temperature: Image (1 band)
LST_Day_1km_mean: 27.074047619047654
Objects
Land Surface Temperature: Image (1 band)
type: Image
bands: List (1 element)
properties: Object (1 property)
Geometry Imports
Layers
Karte Satellit
Google

&

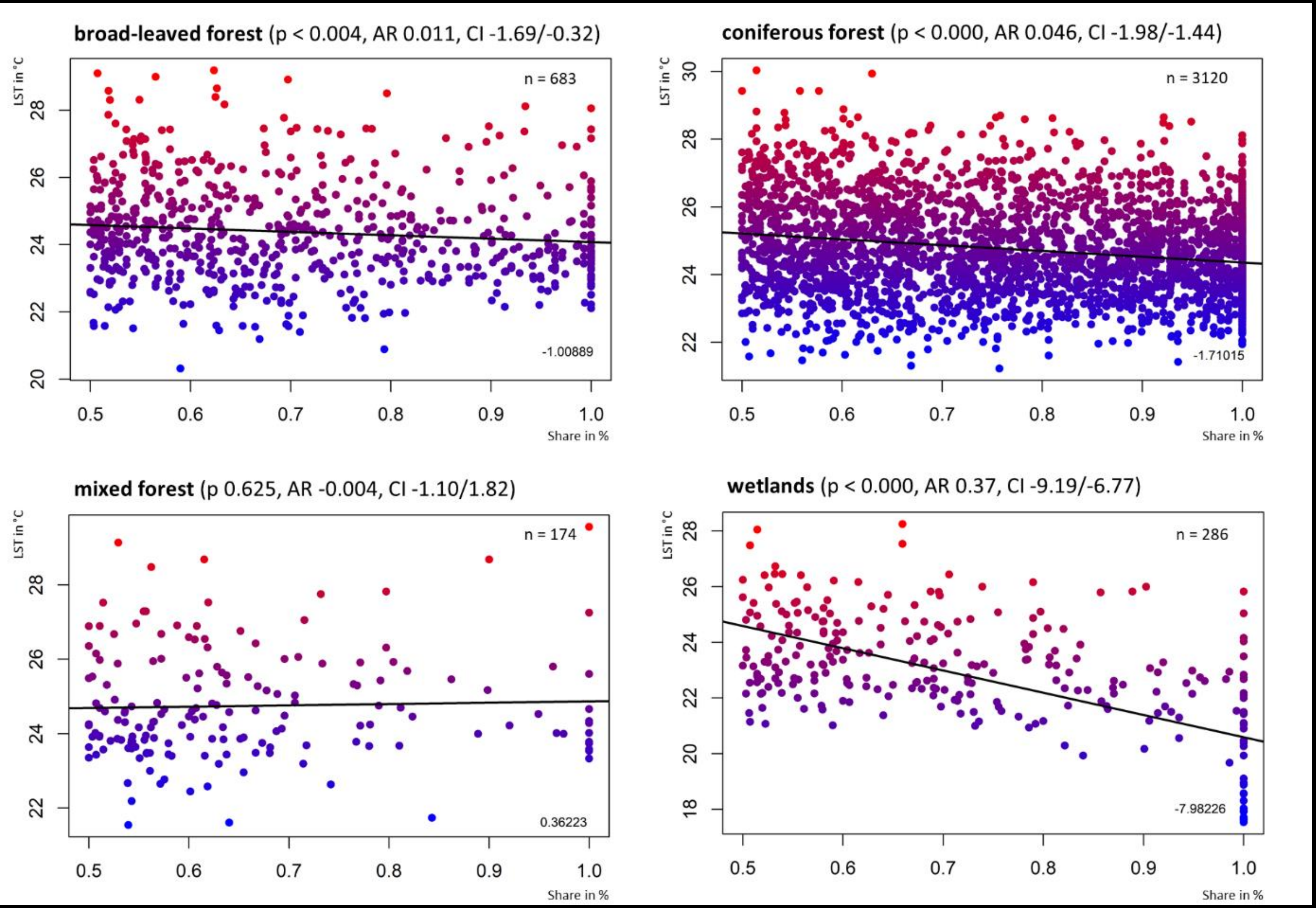


Gohr et al 2021

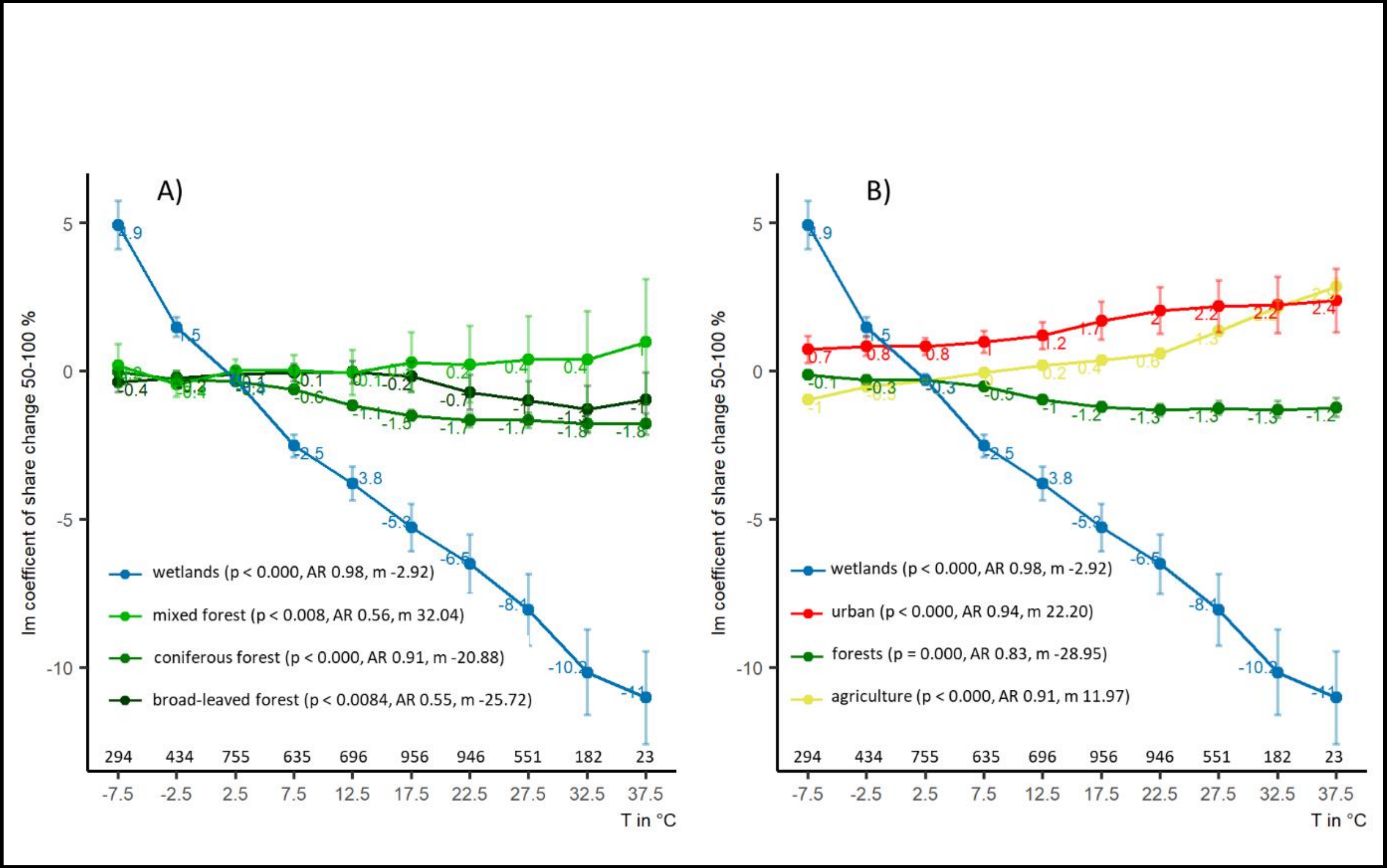
Time series 04-07-2002 to 31.12.2020, ~1.30 pm
MODIS Aqua LST, 6618 images
MODIS Aqua NDVI, 16-day composite, 426 images



Gohr et al 2021

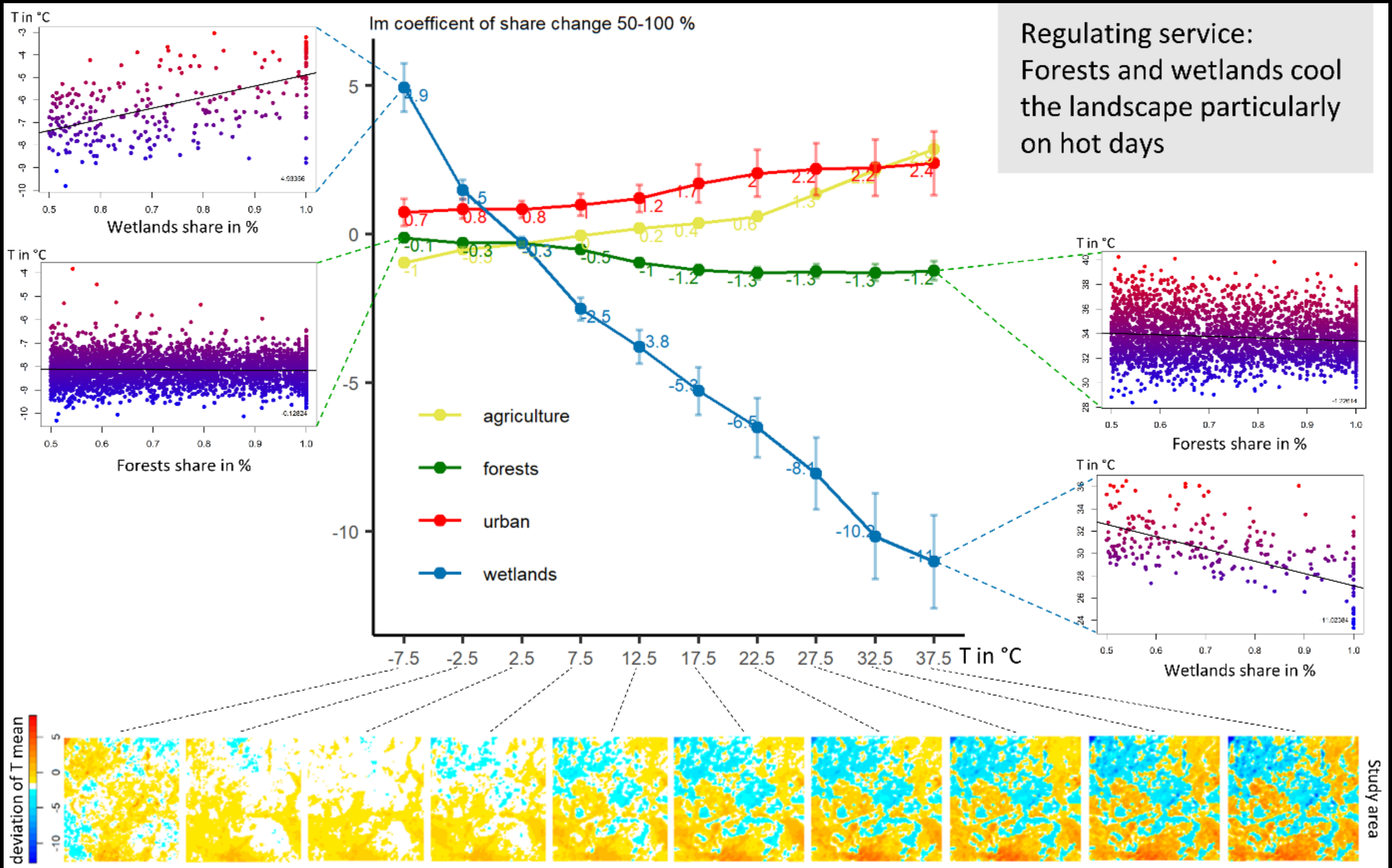


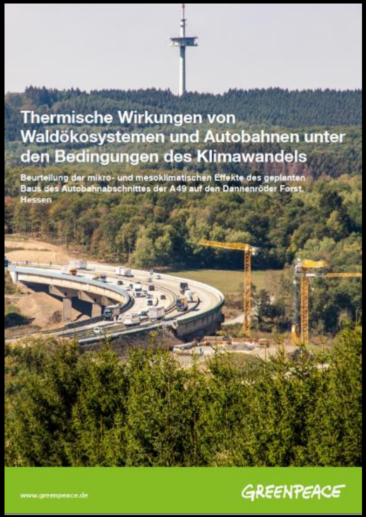
Gohr et al 2021



Gohr et al 2021

Regulating service:
Forests and wetlands cool the landscape particularly on hot days






Lage der Wälder dramatisch

Konzept zur Förderung der

Funktionen und Leistungen von Waldökosystemen

in Deutschland

Pierre L. Ibisch, Jeanette S. Blumröder, Charlotte Gohr, Lars Schmidt


Ecological Informatics 66 (2021) 101442

Contents lists available at ScienceDirect

Ecological Informatics

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

Quantifying the mitigation of temperature extremes by forests and wetlands in a temperate landscape

Charlotte Gohr [a,b,*], Jeanette S. Blumröder [a,b], Douglas Sheil [c,d], Pierre L. Ibisch [a,b]

[a] Centre for Econics and Ecosystem Management, Eberswalde University for Sustainable Development, Eberswalde, Germany
[b] Biosphere Reserves Institute, Eberswalde University for Sustainable Development, Eberswalde, Germany
[c] Forest Ecology and Forest Management Group, Wageningen University & Research, Wageningen, Netherlands
[d] Center for International Forestry Research, P.O. Box 0113 BOCBD, Bogor, Indonesia

ARTICLE INFO

Keywords:
Surface cooling
Climate change mitigation
Ecological indicators
Forests
Land surface temperature
NDVI

ABSTRACT

As a result of ongoing climate change and more frequent heat events, the regulating services of land cover in terms of moderating and mitigating local temperatures are increasingly important. While the reduced temperatures found in forests and wetlands are recognized, their wider contribution to regional landscape cooling remains largely uncharacterized and unquantified. Herein, we propose and test a new method that estimates the temperature response and inertia of landscapes in high temperatures, based on land cover share. In order to achieve this goal, we combined the MODIS daytime land surface temperature (henceforth LST) time series and CORINE land cover data. We classified the time series in two ways, i.e. by stepwise temperature range (−10/−5 °C to +35/+40 °C) and by the occurrence of hot days (days with a mean LST ≥ 30 °C). As an explanatory variable, we developed and used a *greenest pixel composite* of the MODIS normalized difference vegetation index (NDVI) time series. In our study area, covering parts of northeastern Germany and western Poland, the fragmented landscape has heterogeneous temperature patterns, including urban heat islands, warm agricultural areas, cool forests and cold wetlands. We found that at high temperature ranges only forests and wetlands remained comparably cool, with LSTs up to 20.8 °C lower than the maximum LST in the study area. The analysis of land cover shares and LSTs revealed the substantial cooling effect of forests and wetlands in line with increasing land cover share in higher temperature ranges, as well as on hot days. The relation between LST and the NDVI indicated vegetation cover as the cause. We propose the corresponding metrics to quantify landscape-level temperature regulation. Equally, we advocate for management to identify these ecosystem services and their current and potential contributions, along with implications for sustaining and increasing, both tree cover and wetlands and thereby adapting landscapes to climate change.

1. Introduction

Increases in temperature, which are among the most dangerous impacts of climate change, threaten socioeconomic activities (Chen et al., 2020), ecosystem functioning (Fisher et al., 2017) and human health (Luber and McGeehin, 2008; Mora et al., 2017). Human mortality estimates based on data from climate-related heat exposure and deaths in 732 locations over 43 countries suggest a mean of 37.0% (range 20.5–76.3%) between 1991 and 2018, with increased mortality seen on all continents (Vicedo-Cabrera et al., 2021). Heat also contributes to other climate-related challenges such as increased water-stress and drought (Fisher et al., 2017; Teuling et al., 2013). One way to avoid these negative effects is to prevent or moderate temperature extremes (Hatfield and Prueger, 2015).

The relationship between remotely sensed *land surface temperature* (LST) and land cover has been investigated in various contexts (Alkama and Cescatti, 2016; Bonan, 2008; Bright et al., 2017; Jin and Dickinson, 2010). Different land covers are associated with different thermal properties, especially the heat island effects that occur in urban and other built-up areas (Bartesaghi-Koc et al., 2020; Feizizadeh and Blaschke, 2013; Liu et al., 2018; Su et al., 2010; Tran et al., 2017). Land cover proportion has been used in a study of an urban area to investigate to what extent landscape metrics can explain LST (Liu et al., 2018), as well as for a vegetation fraction cover analysis (Duveiller et al., 2018;

* Corresponding author at: Schicklerstr. 5, 16225 Eberswalde, Germany.
E-mail address: charlotte.gohr@hnee.de (C. Gohr).

https://doi.org/10.1016/j.ecoinf.2021.101442
Received 5 July 2021; Received in revised form 22 September 2021; Accepted 27 September 2021
Available online 1 October 2021

Eberswalde University for Sustainable Development
Biosphere Reserves Institute

Centre for Econics and Ecosystem Management