Imp_DroP

Impact of longer **Dro**ught **P**eriods on Climate in Greater Vienna: appropriate Mitigation measures

ACRP 13th call, KR20AC0K18165

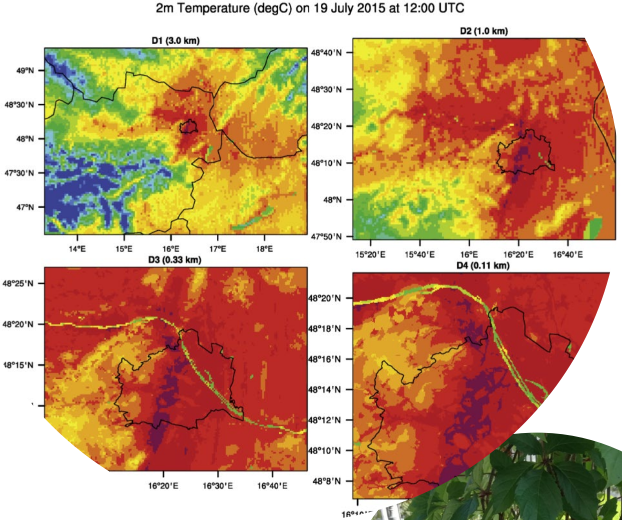
Applicant: BOKU_Met (Radiation, Climate, Agro)

Partners: BOKU_IVET, BOKU_IBLB, MA22, Subcontractors: Météo-France, Gartenbauschule Schönbrunn, IIASA

3 GOOD HEALTH AND WELL-BEING

11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION



(1) Thermal stress in urban areas is a growing problem during heat and drought episodes.

(2) Agricultural surroundings cannot provide daytime cooling effects during heat waves.

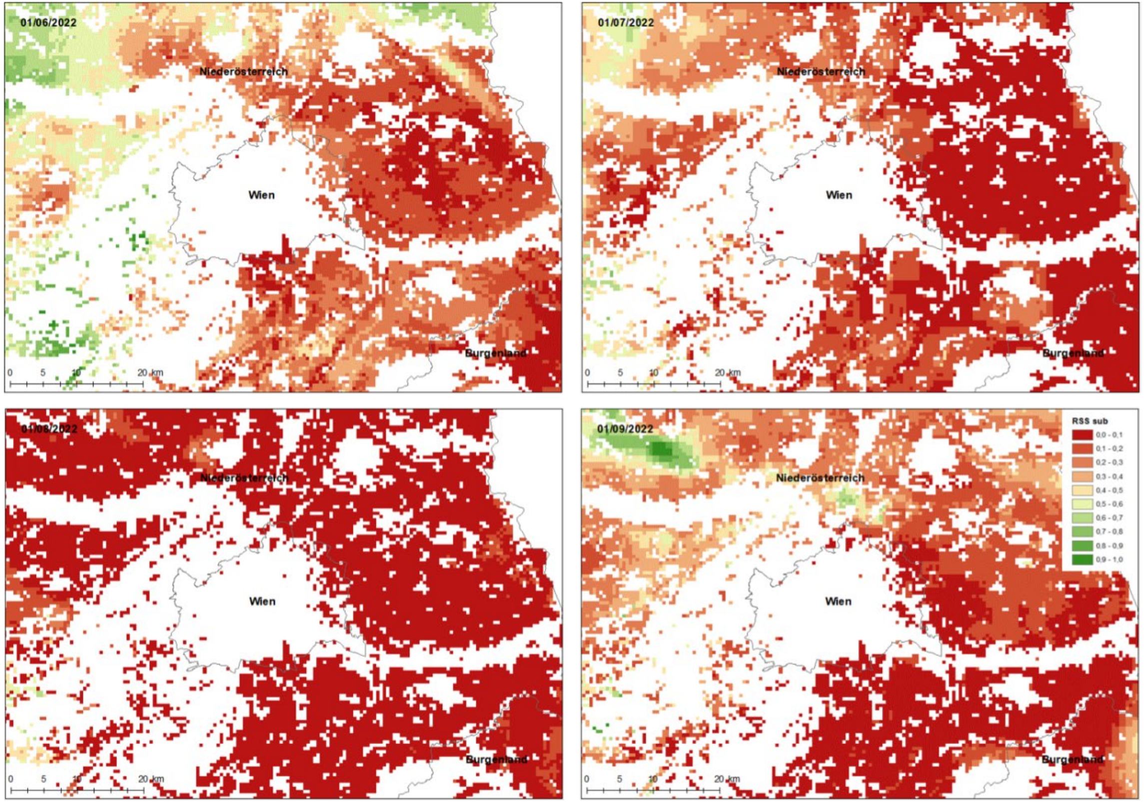
(3) Mitigation efforts focusing on use of vegetation rely on water.

(4) Local energy production using PV can reduce anthropogenic heat flux.

RQ1: What potential have vegetation surfaces to cool via evapotranspiration during drought periods from urban green areas, green roofs and surrounding (irrigated) agricultural areas / crop management changes

RQ2: How much heat release can be prevented by technological change within urban canyons. (HVAC, combustion engines,…).

WP2a Data retrieval (1/22 - 10/23)



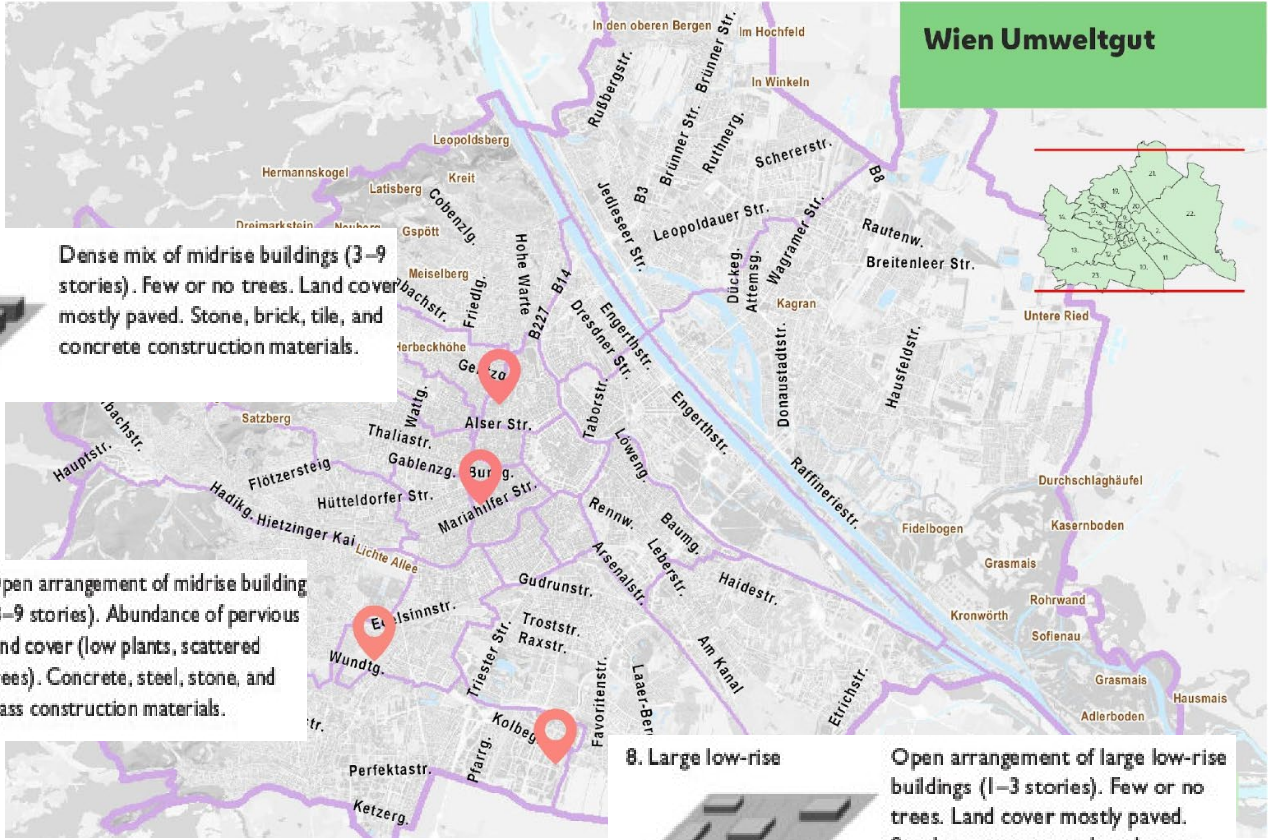
Monthly values of relative soil saturation of crop available water (RSS) of the surrounding agricultural areas of Vienna for the period between 1st of June 2022 until 1st of September 2022 (example)

Data on:

- water use (irrigation, …)
- energy use (oil, gas, electricity, …)
- drought indices (RSS, …)

WP2b Experimental investigations (1/22 - 10/23)

Locations of the experimental sites



2. Compact midrise

Dense mix of midrise buildings (3–9 stories). Few or no trees. Land cover mostly paved. Stone, brick, tile, and concrete construction materials.

5. Open midrise

Open arrangement of midrise building (3–9 stories). Abundance of pervious land cover (low plants, scattered trees). Concrete, steel, stone, and glass construction materials.

8. Large low-rise

Open arrangement of large low-rise buildings (1–3 stories). Few or no trees. Land cover mostly paved. Steel, concrete, metal, and stone construction materials.

1 Drought in Vienna

2 Lysimeter

3 Energy flow

4 Models

5 Outlook

scientific name	german name	habit	frost resistent	habitat demands	soil demands
Sedum album 'Coral Carpet'	Mauerpfeffer	flat, wide	hardy	sunny	permable, gravelly
Sedum spurium 'Purpurteppich'	Mauerpfeffer	dense, wide	hardy	sunny	permable, gravelly
Sedum hybridum 'Immergrünchen'	Mauerpfeffer	dense, wide	hardy	sunny	permable, gravelly
Sedum acre	Mauerpfeffer	flat, wide	hardy	sunny	permable, gravelly






Continuous measurements (since 2022/05)

Measured parameter	Name of sensors (Company)	Height	
Air temperature / relative humidity /atmospheric pressure	Atmos 14 (Meter)	1.5 m	at all stations
Wind speed	DS2 Sonic anemometer (Decagon)	1.5 m	at all stations
Soil humidity + soil temperature	ECH20 EC-5*, *** (Meter) Hydra Probe II** (Stevens) Decagon soil temp***	5 cm* , *** 20 cm depth**	*in all EXT pots ** in all INT pots *** green roofs sites
Long wave radiation emitted from vegetation	Infrared Radiometer SI-100 (Apogee Instruments)	40 cm above surface	On setup at JHS
Weight of pot	Lysimeter using weighting cell PW10A		all pots

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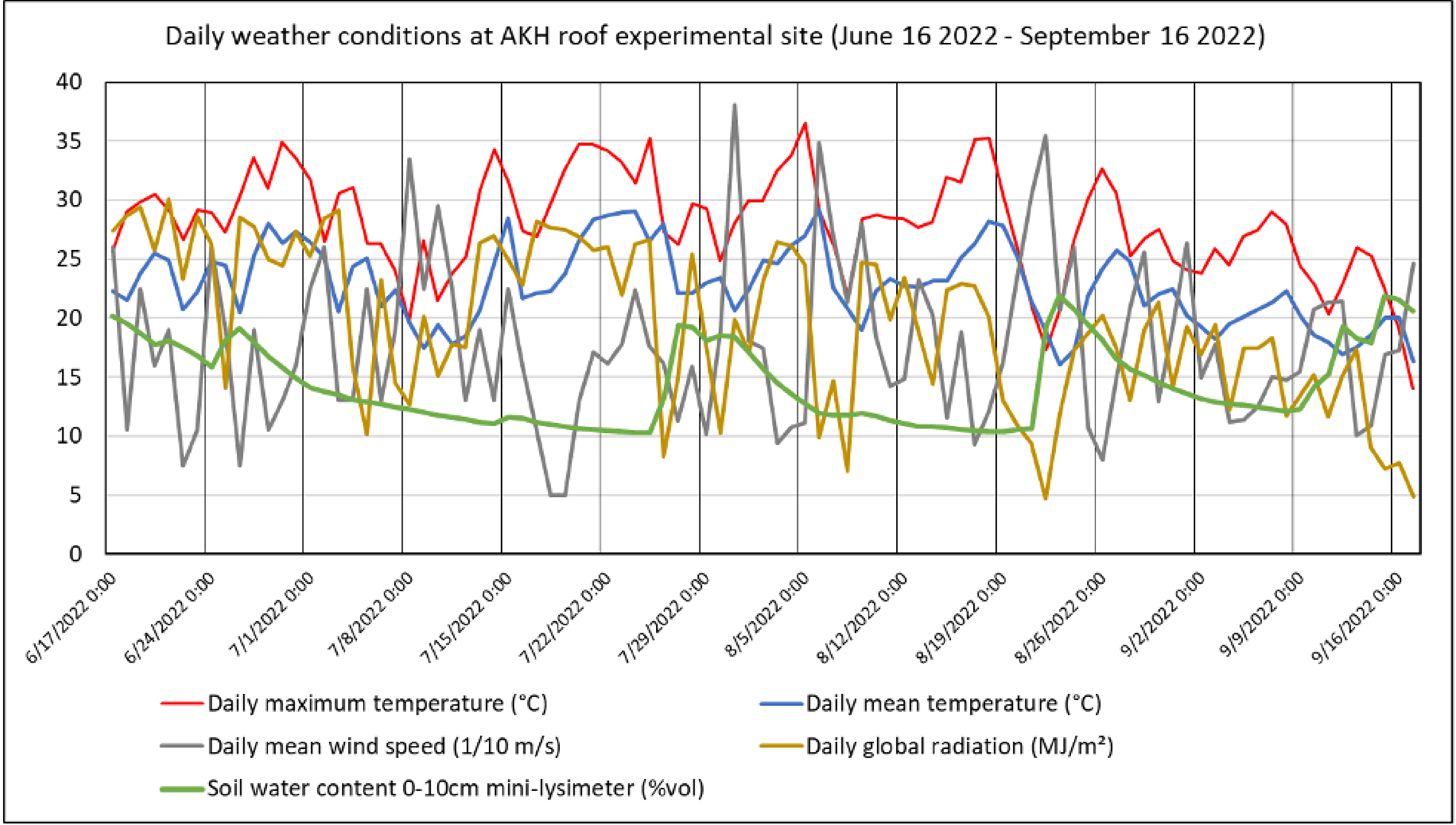
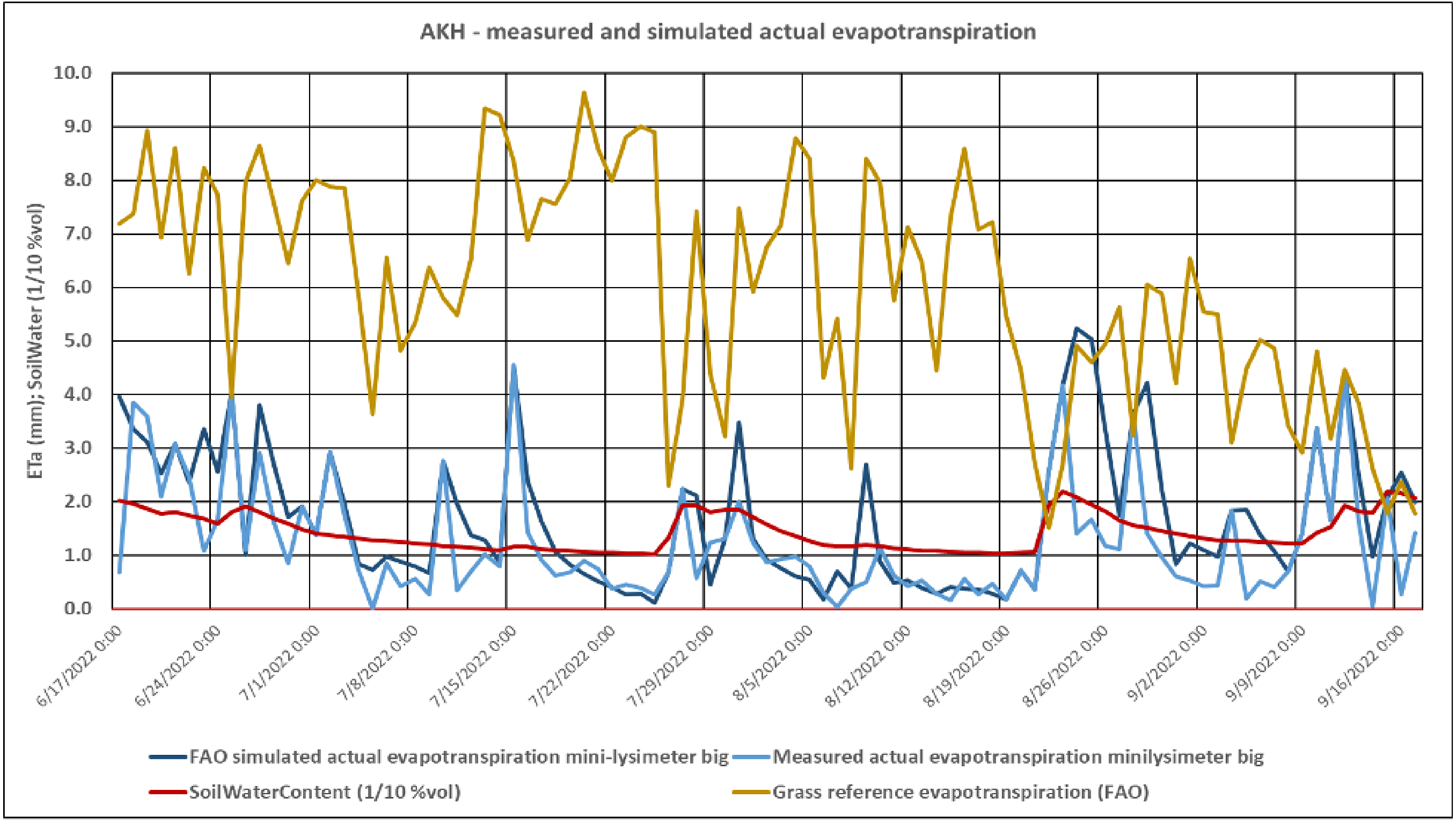
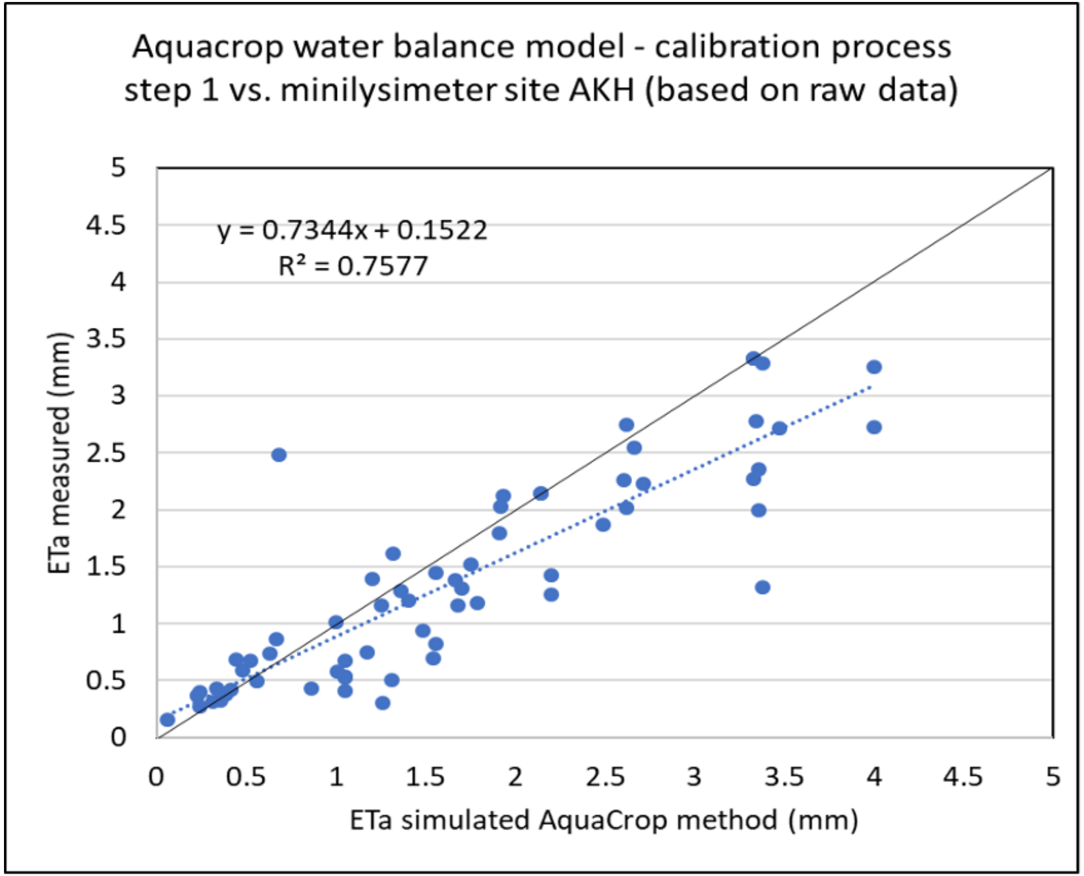


Daily weather conditions at AKH roof experimental site (June 16 2022 - September 16 2022)
40
35
30
25
20
15
10
5
0
6/17/2022 0:00
6/24/2022 0:00
7/1/2022 0:00
7/8/2022 0:00
7/15/2022 0:00
7/22/2022 0:00
7/29/2022 0:00
8/5/2022 0:00
8/12/2022 0:00
8/19/2022 0:00
8/26/2022 0:00
9/2/2022 0:00
9/9/2022 0:00
9/16/2022 0:00
Daily maximum temperature (°C)
Daily mean temperature (°C)
Daily mean wind speed (1/10 m/s)
Daily global radiation (MJ/m²)
Soil water content 0-10cm mini-lysimeter (%vol)

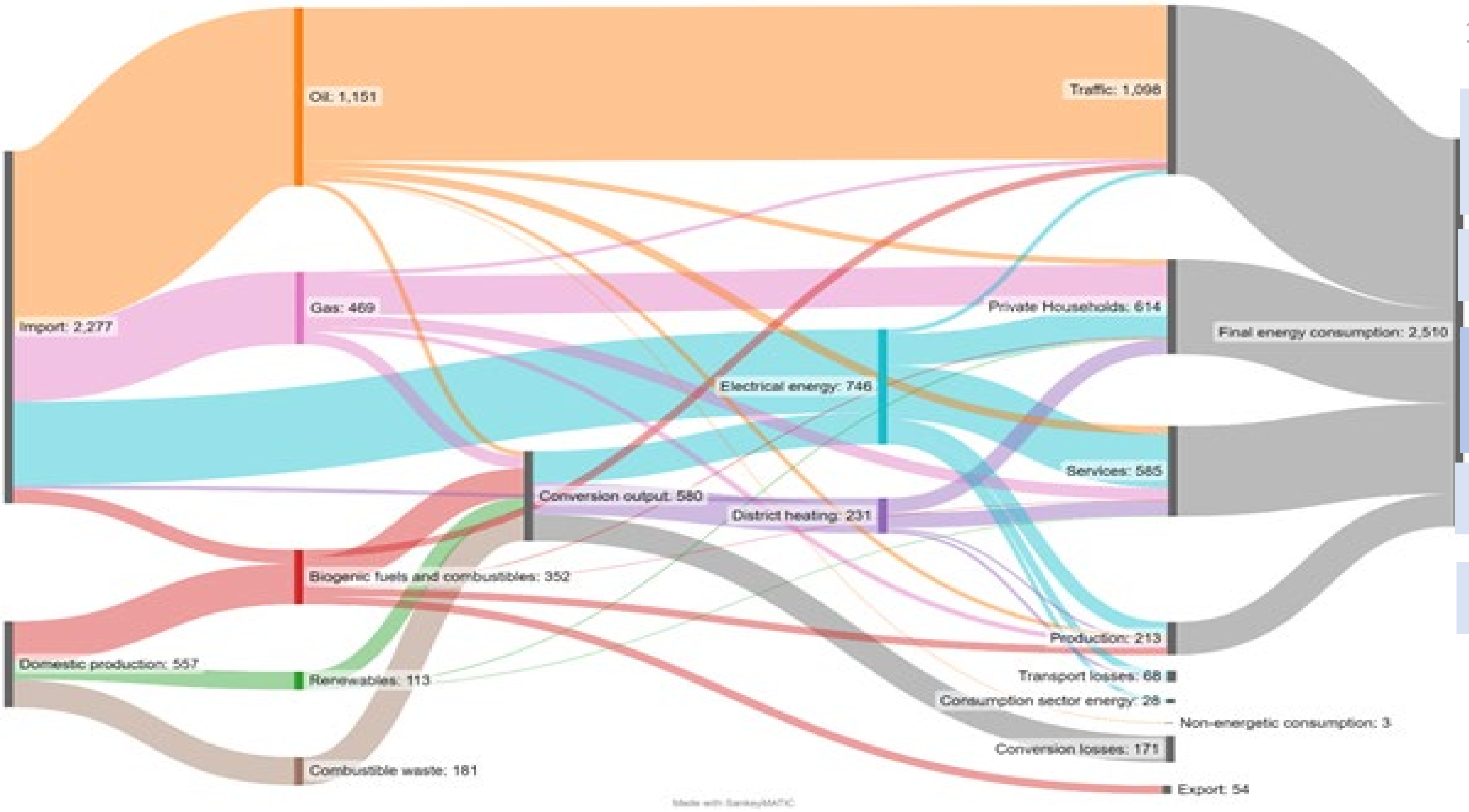

AKH - measured and simulated actual evapotranspiration
ETa (mm); SoilWater (1/10 %vol)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
6/17/2022 0:00
6/24/2022 0:00
7/1/2022 0:00
7/8/2022 0:00
7/15/2022 0:00
7/22/2022 0:00
7/29/2022 0:00
8/5/2022 0:00
8/12/2022 0:00
8/19/2022 0:00
8/26/2022 0:00
9/2/2022 0:00
9/9/2022 0:00
9/16/2022 0:00
FAO simulated actual evapotranspiration mini-lysimeter big
Measured actual evapotranspiration minilysimeter big
SoilWaterContent (1/10 %vol)
Grass reference evapotranspiration (FAO)

WP3b Modelling of evaporative cooling potentials (01/22 - 12/23)



Comparison of 3-day average actual evapotranspiration measured by mini lysimeter vs. simulated by Aquacrop method (uncalibrated)

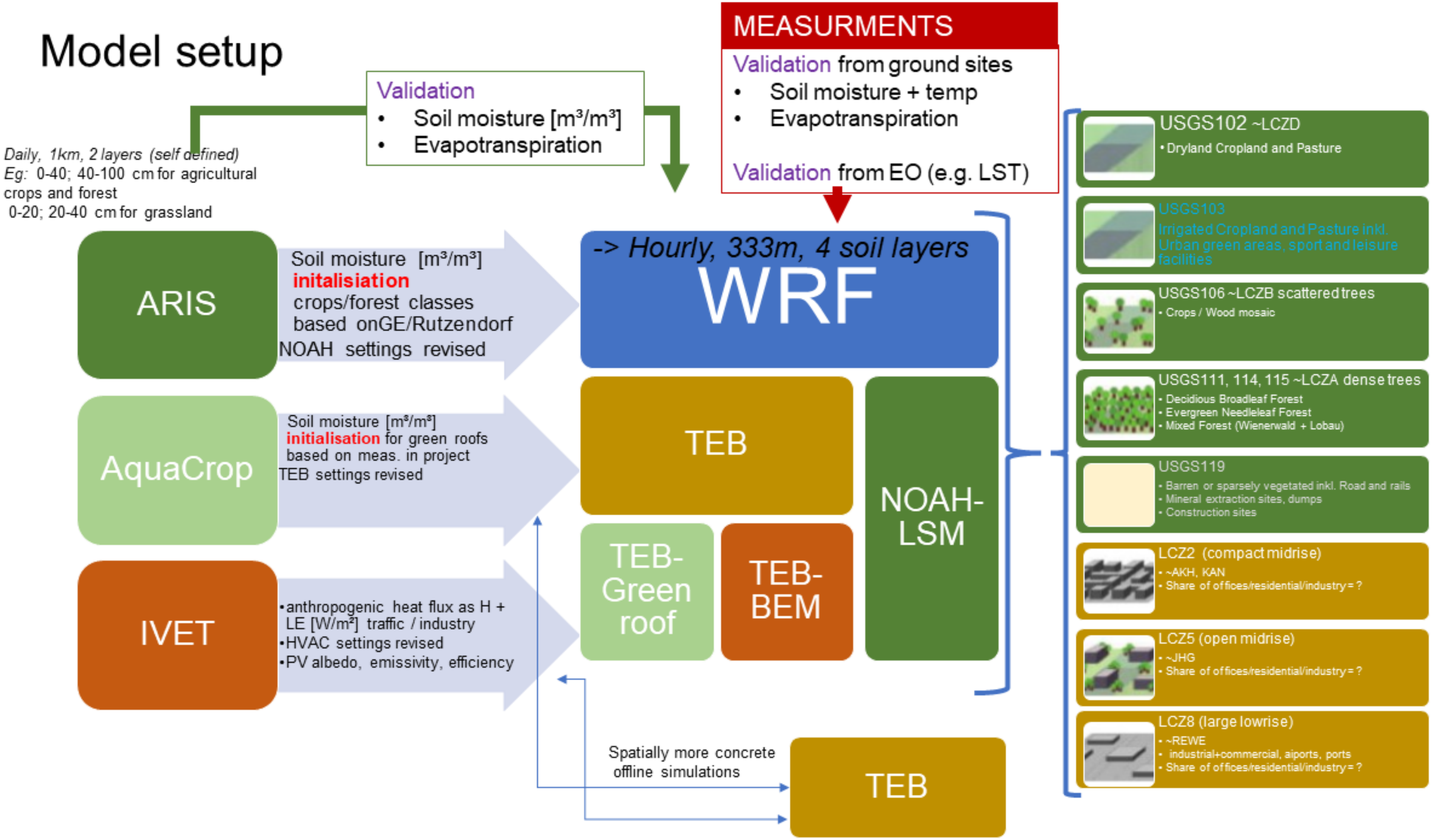
WP3a Quantification of anthropogenic heat (01/22 - 12/22)



Sankey flow chart for Vienna for August 2015 in GWh

WP5 Improvement and validation of models (10/22 - 12/23)

Model setup



WP4 Definition and preparation of scenarios and input parameters (10/22 - 12/23)

Selection criteria for meteorological data

- **Goal**: Find periods with heat and dry conditions
- **Approach**: using the cumulative water balance (NPET = PET-Precipitation) and climatologically extreme heat waves

- NPET not exceeding 5 mm
- 80% quantile of the maximum temperature
- 2 years return period
- based on ÖKS15
- climate scenarios RCP2.6, 4.5 and RCP8.5

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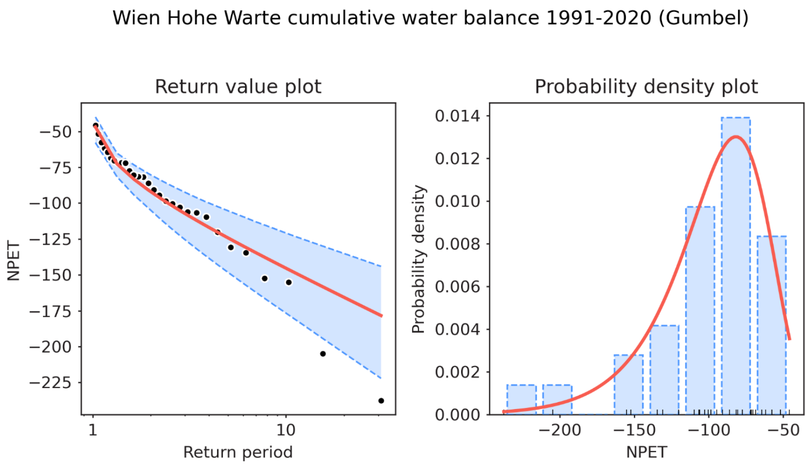
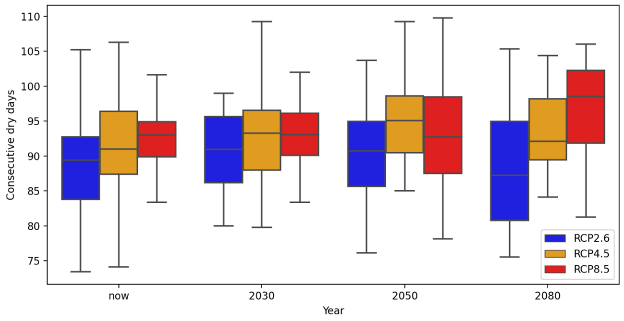


Climate change signal of consecutive dry days from ÖKS15 models for near-time (2030), mid-century (2050) and end od century (2080) projections



Climate change signal of consecutive dry days from ÖKS15 models for near-time (2030), mid-century (2050) and end of century (2080) projections

Summary:

- ❑ Established in-situ experimental measurements
- ❑ Quantification of anthropogenic heat for each pixel as a function of anthropogenic heat sources for different seasons of the year and future development scenarios
- ❑ Validated evaporative cooling effects
- ❑ First model results
- ❑ Climate scenarios defined
- ❑ List of Stakeholders prepared

Outlook:

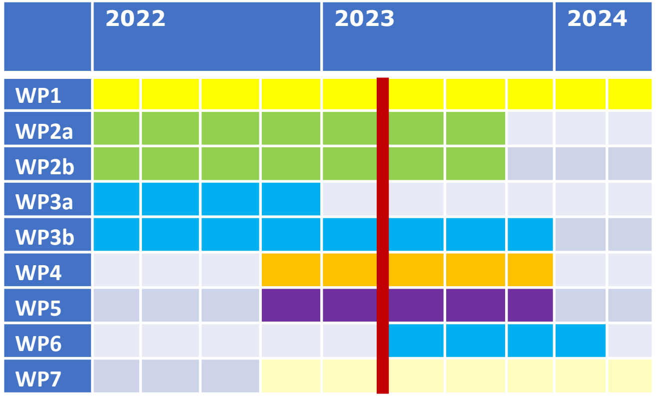
- ❑ Boundary conditions: available energy during drought period
  - ❑ Water for evaporative cooling
  - ❑ Imported and domestic energy producing waste heat
- ❑ Definition of present and future urban parameters and settings
- ❑ Update vegetation and soil parameters for region

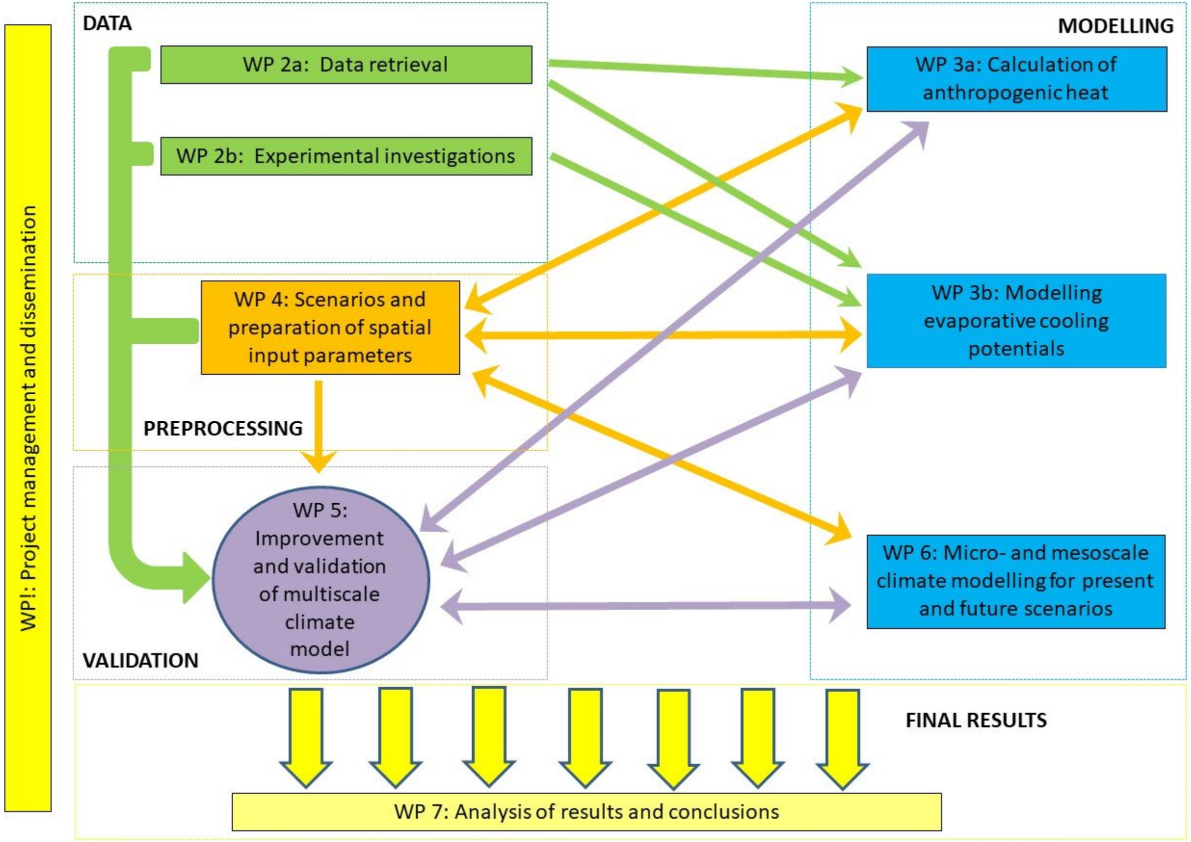
WP5 Improvement and validation of models (10/22 - 12/23)

WP6 Micro and mesoscale climate modelling for present and future scenario (4/23 – 3/24)

WP7 Analysis of results and conclusions for scientists and policy makers (10/22 - 6/24)

Thank you for your attention!


2022
2023
2024
WP1
WP2a
WP2b
WP3a
WP3b
WP4
WP5
WP6
WP7


WPI: Project management and dissemination
DATA
WP 2a: Data retrieval
WP 2b: Experimental investigations
PREPROCESSING
WP 4: Scenarios and preparation of spatial input parameters
VALIDATION
WP 5: Improvement and validation of multiscale climate model
MODELLING
WP 3a: Calculation of anthropogenic heat
WP 3b: Modelling evaporative cooling potentials
WP 6: Micro- and mesoscale climate modelling for present and future scenarios
FINAL RESULTS
WP 7: Analysis of results and conclusions

M	WP	Date	Name of Milestone completed ✓ partly completed ✓	
1.1	1	01/22	Kick-off meeting	✓ (completed)
2b.1	2	3/22	Established in-situ experimental measurements	✓ (completed)
3a.1+2	3	12/22	Quantification of anthropogenic heat for each pixel as a function of anthropogenic heat sources for different seasons of the year and future development scenarios	✓ (completed)
3b.1	3	12/22	Validated evaporative cooling effects	✓ (completed)
4.1,4,5	4	12/22	Meteorological fields for model evaluation prepared, Model input parameters for simulations of present, past and future prepared	✓ (partly completed)
1.3	1	01/23	Interim report year 1	✓ (completed)
4.2	4	3/23	Meteorological fields for historical heat waves prepared	✓ (partly completed)
1.2	1	04/23	Presentation at Scientific meeting (Klimatag)	✓ (completed)
4.4	4	06/23	Meteorological fields for future heat wave prepared	✓ (partly completed)
5.1	5	07/23	Improvement implemented in TEB	✓ (partly completed)
5.2	5	09/23	Improvement implemented in WRF-TEB	✓ (partly completed)

M	WP	Date	Name of Milestone	
2a.2	2	9/23	Overview of collected data	
2b.2	2	9/23	Overview of collected measurement data	
3b.2-4	3	9/23	Calibrated dynamic soil-plant growth model, SWC, quantification of irrigation need	
5.3	5	12/23	Validation of WRF-TEB done	
1.3	1	01/24	Interim report (year 2)	
6.1	6	03/24	Modelling with TEB-WRF	
1.5	1	3/24	Meeting with stakeholders	✓
7.1,2,4-6	7	6/24	Analysis of sensitivity study for local scale and scenarios, Maps of Evapotranspiration and Irrigation Needs, Vegetation cooling potential, Thermal Comfort	
7.3	7	6/24	Maps of Anthropogenic heat	
1.3+7.7	1, 7	6/24	Final recommendations and final reports	
1.4	1	6/24	International publication	