



FOCAL

EFFICIENT EXPLORATION
OF CLIMATE DATA LOCALLY

Adaptačné opatrenia, zvýšenie odolnosti na negatívne aspekty klimatickej zmeny

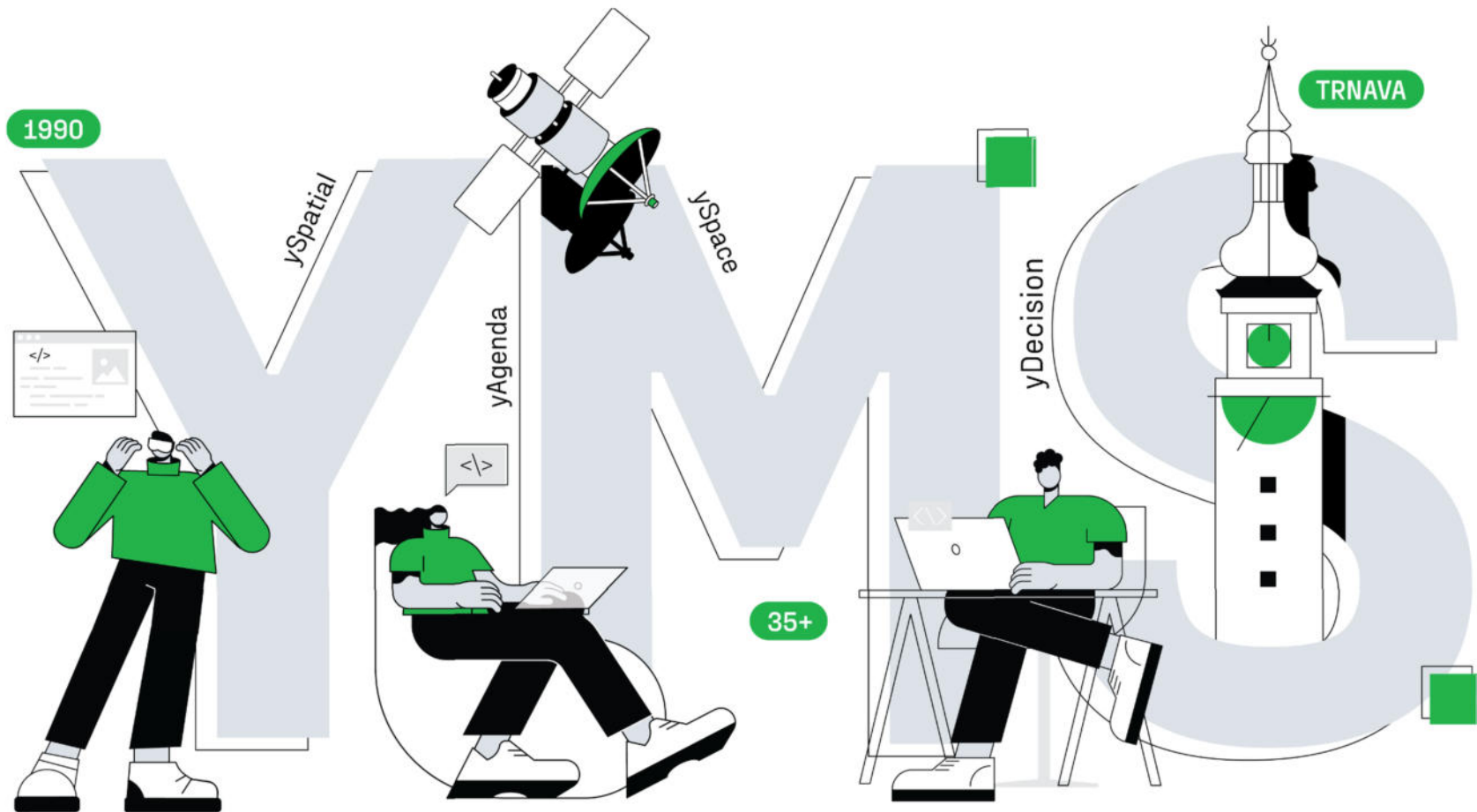
Radovan Hilbert
YMS, a.s.

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Funded by
the European Union
Project GA Nr. 101137787

VÝSKUMNÉ LABORATÓRIUM.



150 000

VÝSKUMNÝCH
HODÍN

11

REALIZOVANÝCH
PROJEKTOV

15

VÝSKUMNÝCH
PARTNERSTIEV

04

REGISTROVANÉ
ÚŽITKOVÉ VZORY
A PATENTY



YMS

TURN ON TECHNOLOGY

DETEKČIA A MONITOROVANIE OBJEKTOV
ALEBO JAVOV V PRIESTORE A ČASE

ySpace

- Inovatívny nástroj pre automatizované sťahovanie
- Univerzálne využitelný pre rôzne segmenty hospodárstva
- Spracovanie a vyhodnotenie údajov zo satelitného snímania

ySpace



YMS

TURN ON TECHNOLOGY

ELEKTRONICKÁ ORGANIZÁCIA

yAgenda

- Zjednotenie agendy v organizácii
- Prehľad o všetkých procesoch
- Zrychlí prácu aj komunikáciu
- Riadenie a rozvoj elektronických služieb

yAgenda



YMS

TURN ON TECHNOLOGY

MAPOVÝ PORTÁL

ySpatial

- Priestorové analýzy pre masy a tabuľky
- Zber, spracovanie, správa a aktualizácia informácií o aktívach
- Zjednotenie informácií do konzistentnej a jednotnej štruktúry

ySpatial



YMS

TURN ON TECHNOLOGY

INTELIGENTNÉ ROZHODDOVANIE
V PRIESTORE PRE VÁS BIZNIS.

yDecision

- Optimalizácia lokácií
- Cieľové opatrenia v priestore
- Evaluácia variantných riešení
- Efektívne riadenie zásahov v priestore

yDecision

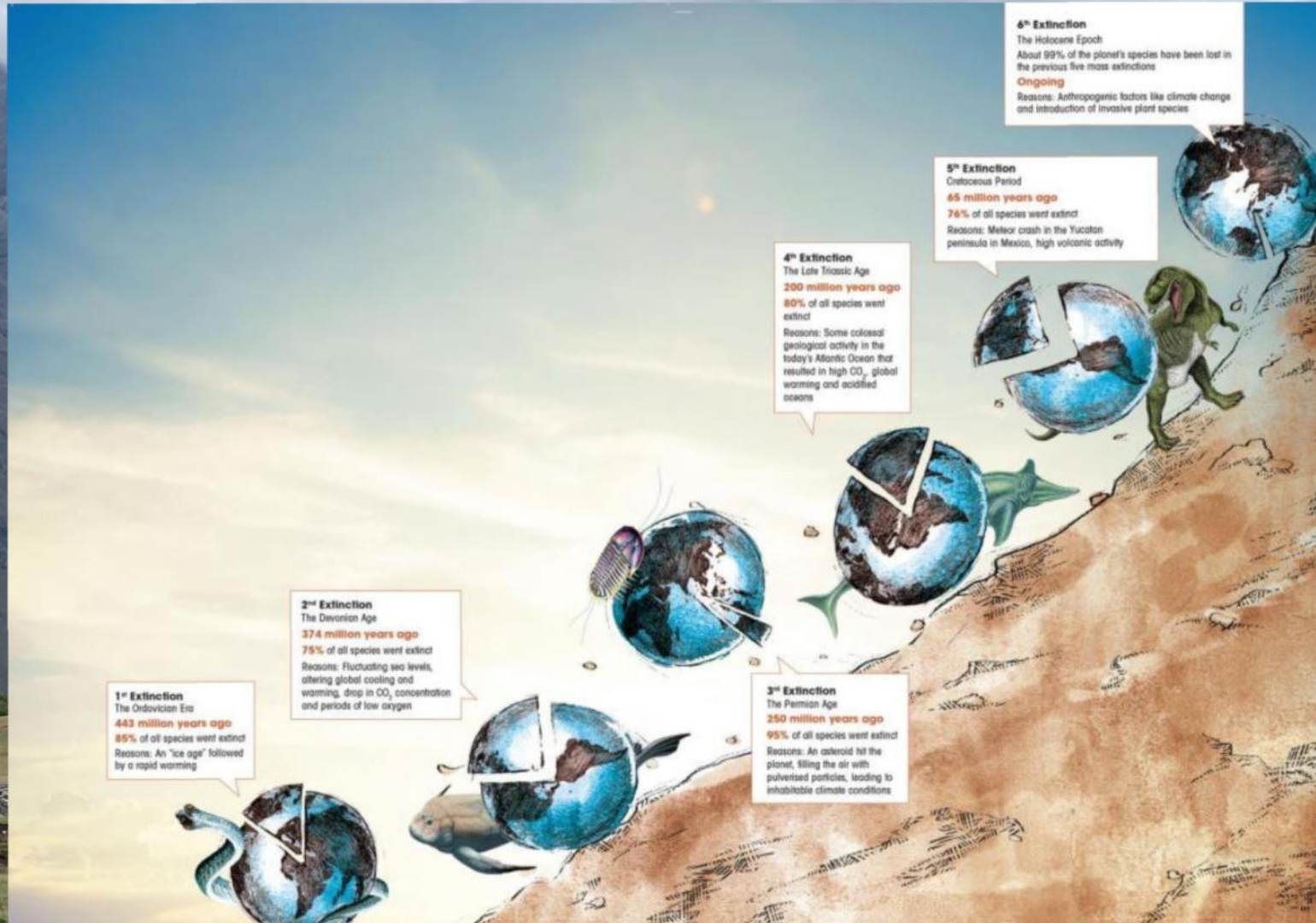


YMS.sk

Klimatická zmena

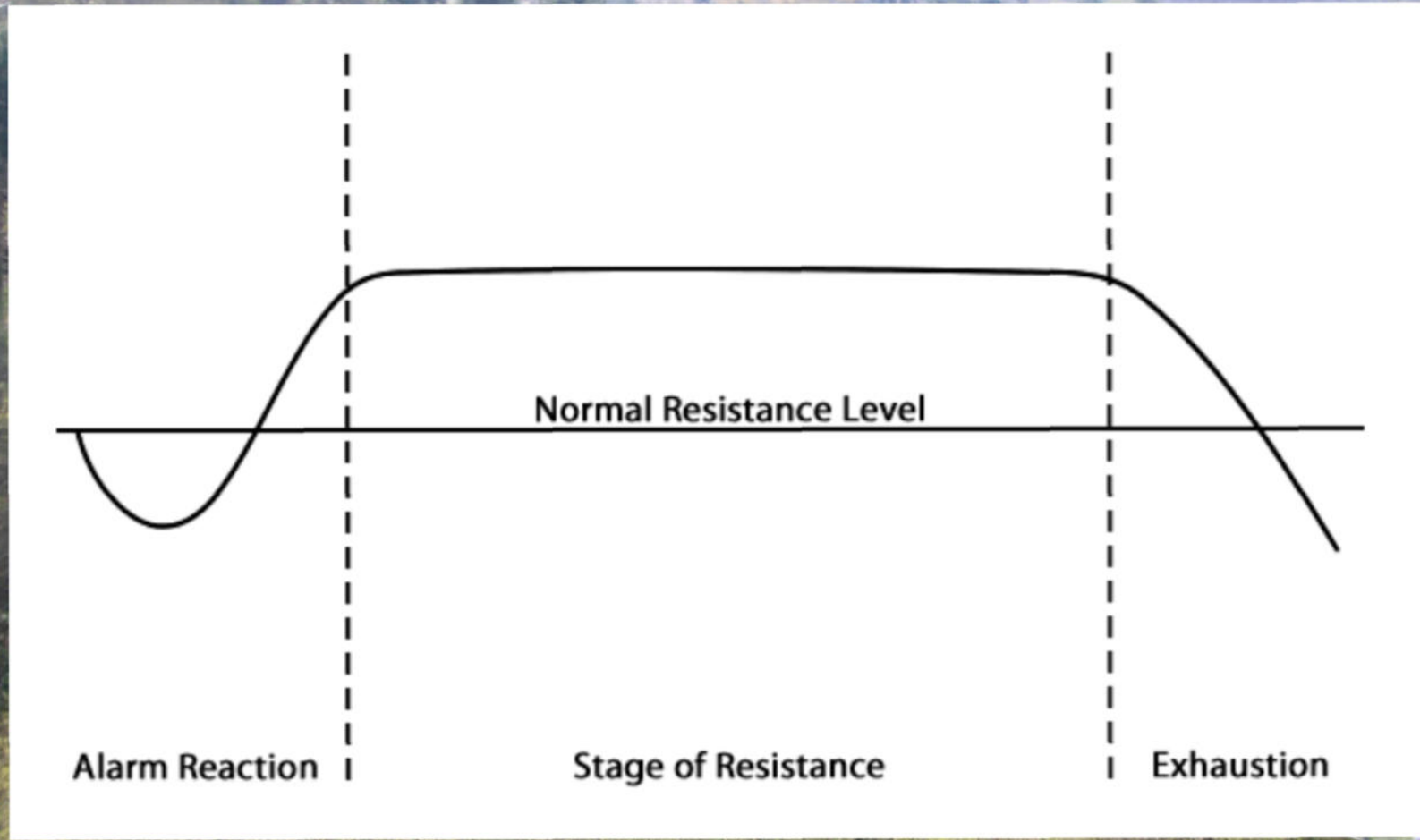


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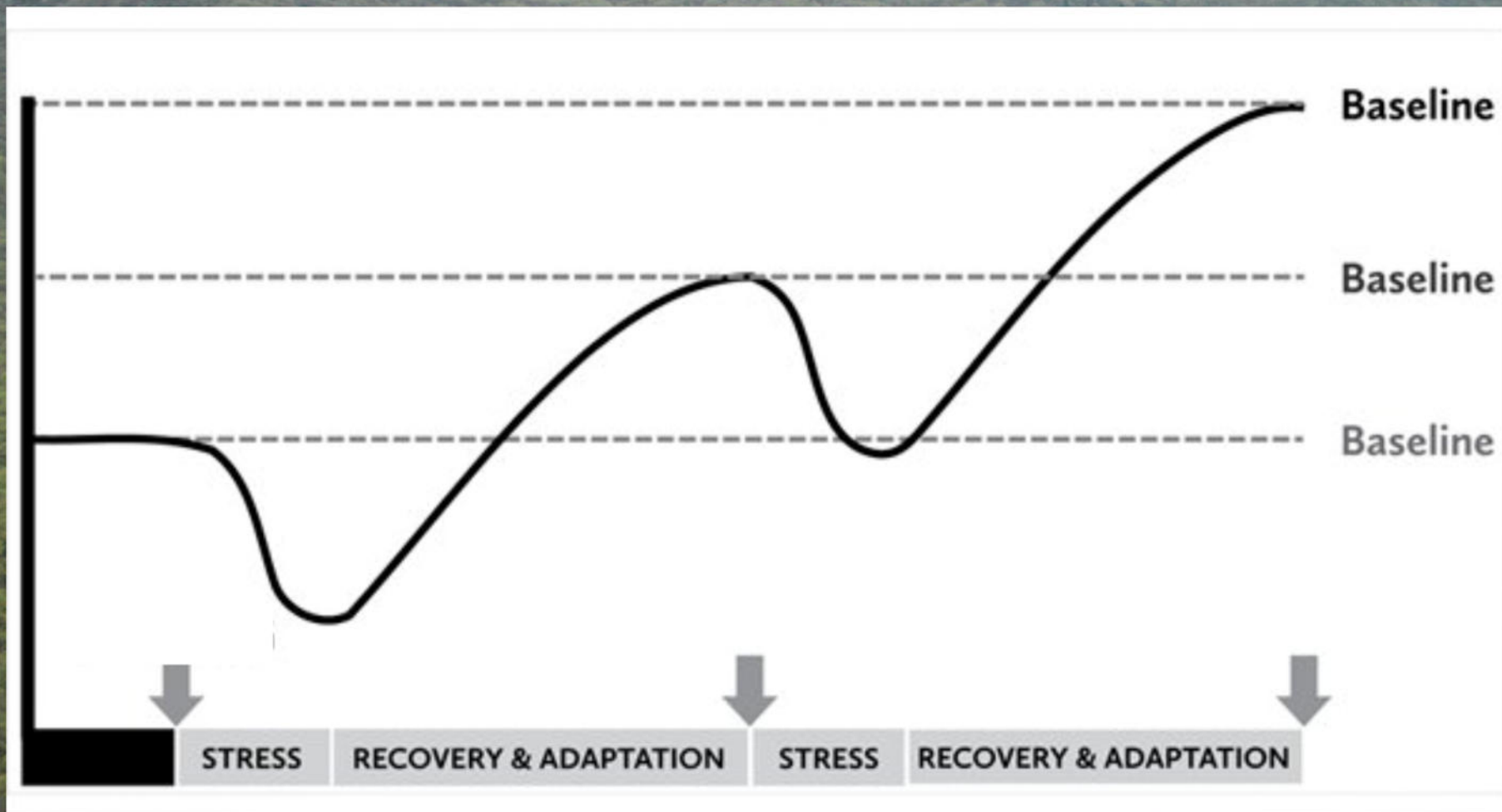




Jedna z možných reakcií na stres / riziko / zmeny



Iná možnosť



SCIENCE BRINGS KNOWLEDGE

???



MITIGATION & ADAPTATION

FOCAL



Climate Models
ESM

Research + tech Innovations
for faster, more efficient, targeted
assessments

Level 1

Level 3

impact assessment
on regional scale

services for
regional decision maker

EO data
provider

Level 2

Regional
Data

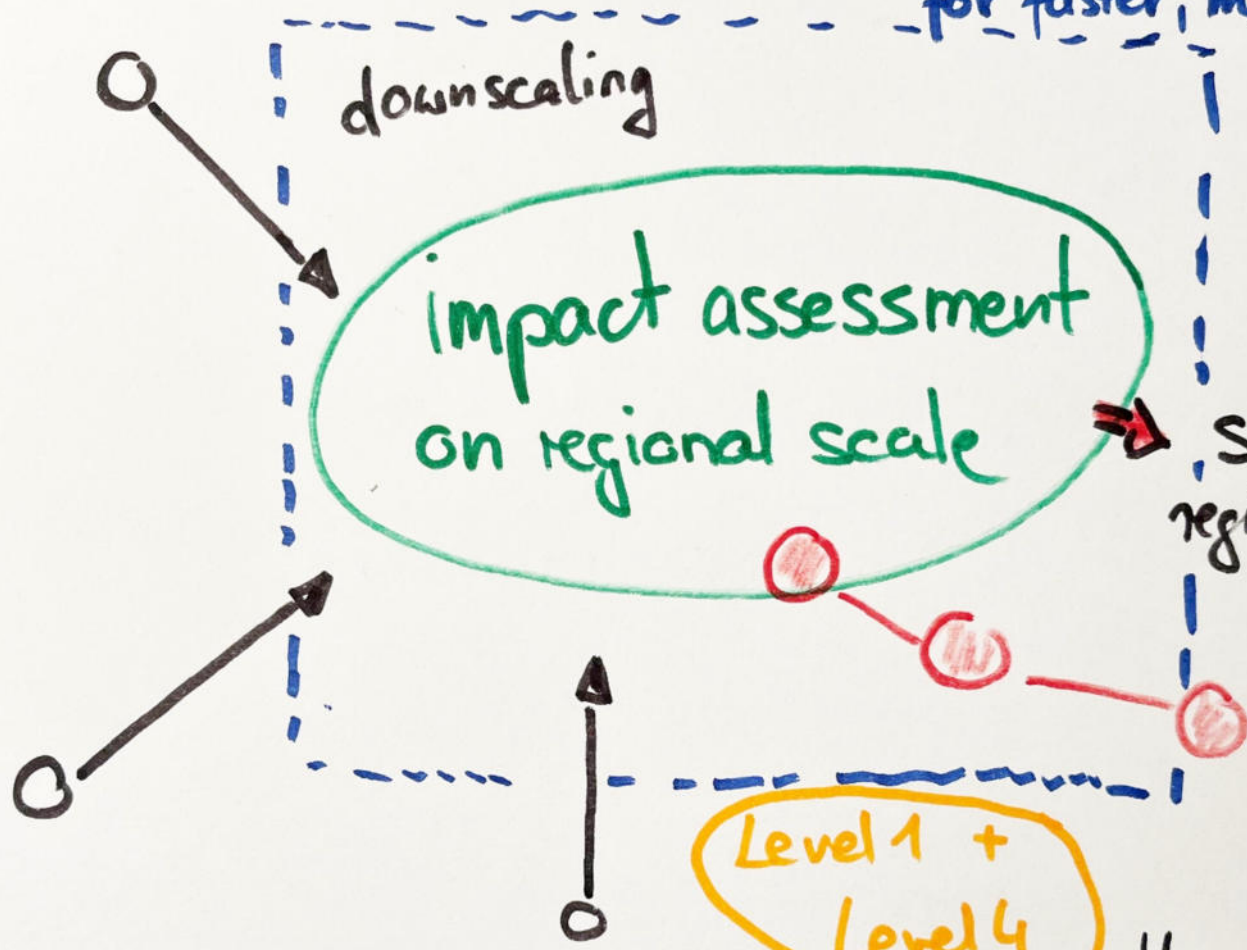
Level 1 +
Level 4



How will extreme weather
effect - forest
- urban climat

+ Mitigation strategies

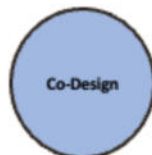
downscaling







Overview Objectives

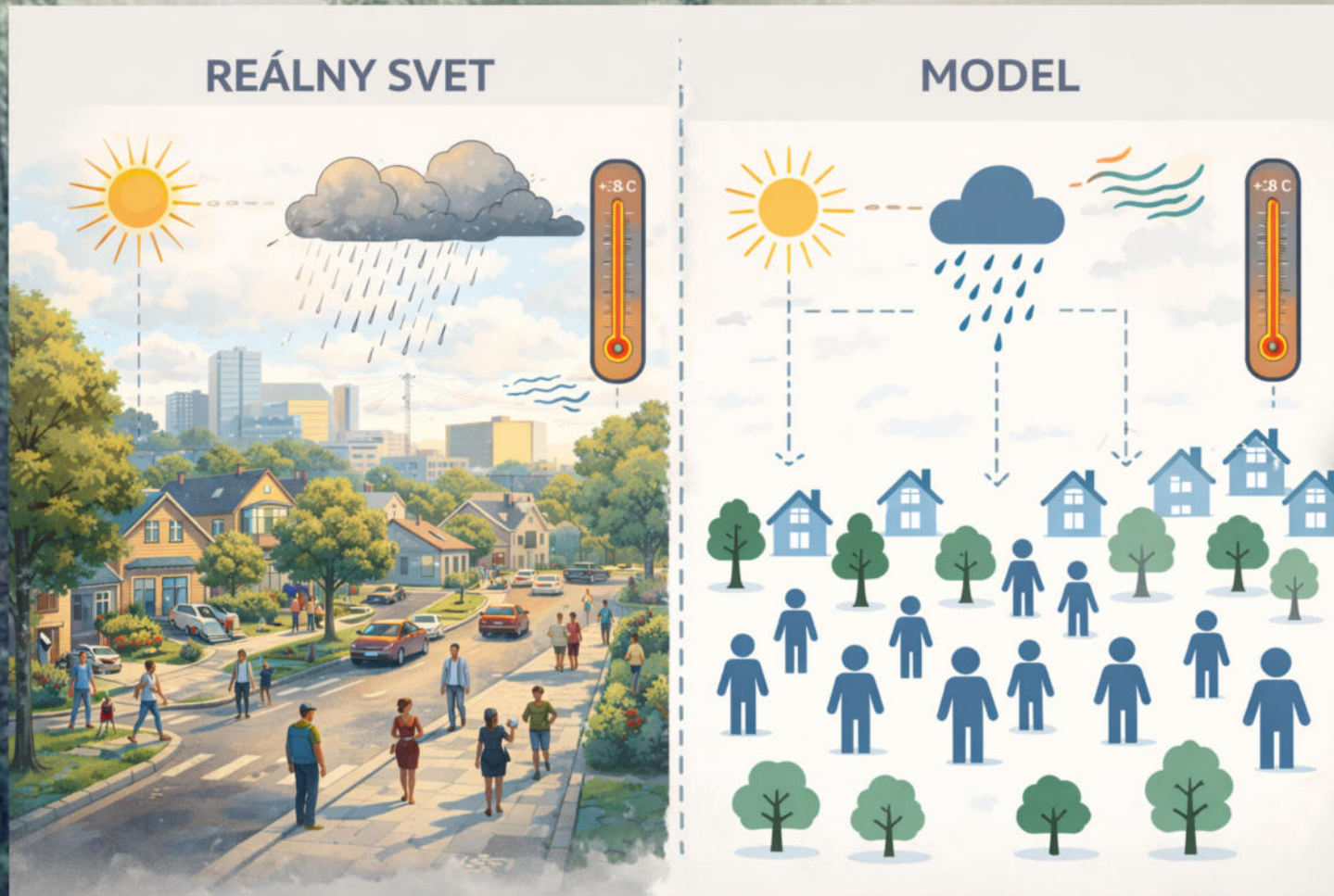


- **FOCAL Pilots:** define the requirements and demonstrate and evaluate the benefits from the Assessment Apps developed in the project
- **FOCAL System**
 - **FOCAL platform:** Faster and better support for climate and earth system modelling tasks (AI and data integration)
 - **FOCAL Modules:** enabling relevant assessment studies for climate mitigation and adaption strategies on regional or local scale
 - **FOCAL Assessment Apps:** design and develop Web-Apps for local assessments
- **FOCAL Cluster:** Establish long lasting cooperation between Earth System research, Earth Observation data providers, Data science and high-performance computing (HPC) infrastructures



Modelovanie

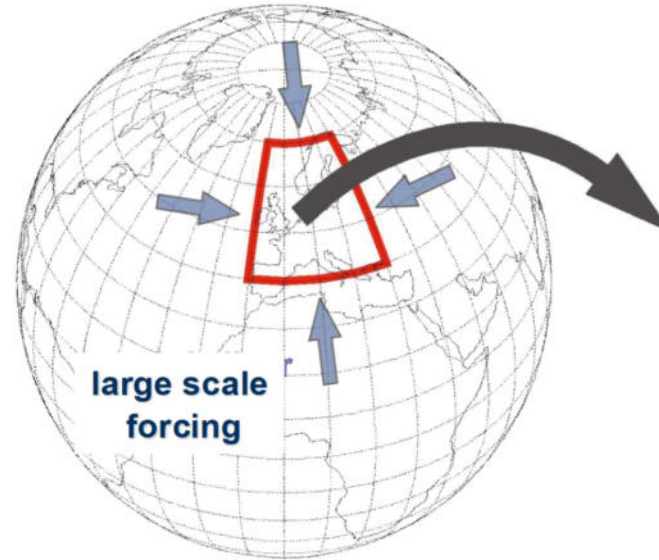
Podstatné zachovať, nepodstatné potlačiť



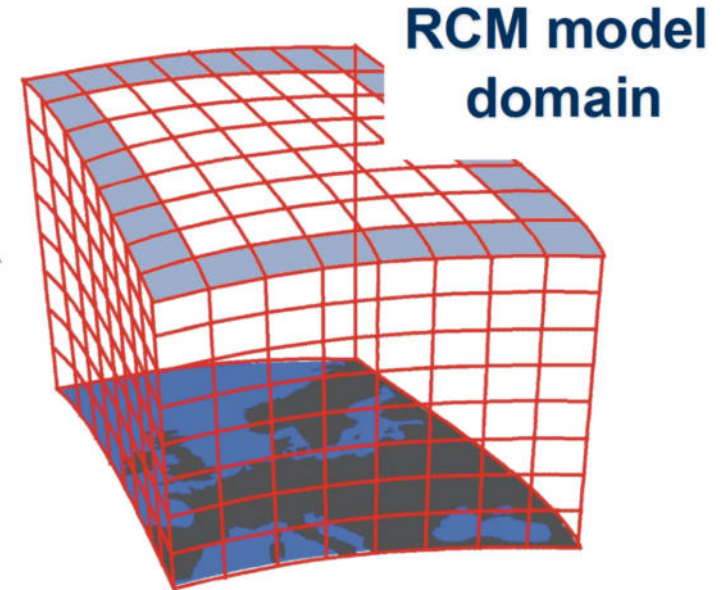
■ Dynamical Downscaling with Regional Climate Models (RCMs)

RCMs can be forced by:

- Reanalysis 3D-data as large scale forcing for RCM evaluation simulations
- GCM 3D output data for driving RCM historical simulations & future climate change projections



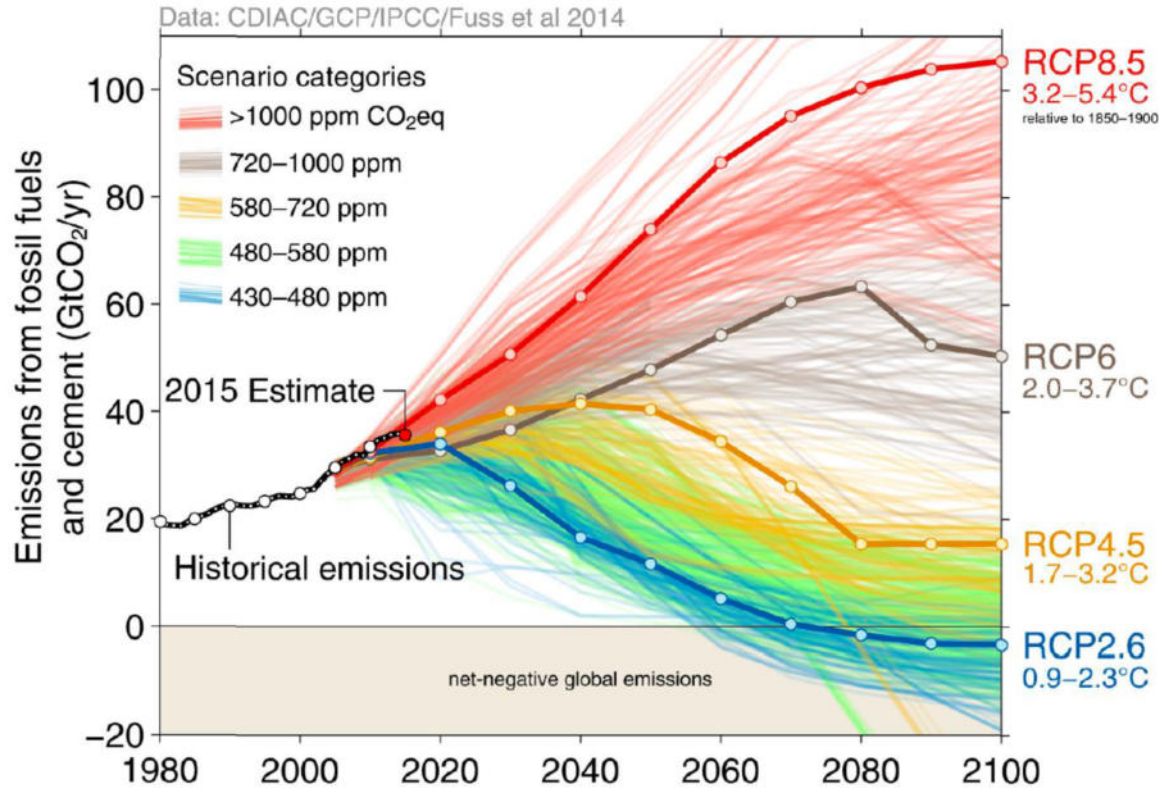
General Circulation Models GCMs
 $\Delta x(0^\circ)$: 400 km to 100 km (50 km)



Regional Climate Models RCMs
 Δx : 50 km to ~2.5 km

Modeling all relevant physical processes in a 3-D section of the globe
Internal computing timestep: 2 minutes - 12 seconds

Emission scenarios: Representative Concentration Pathways RCPs



RCP8.5
> 1000 ppm CO₂-eq

RCP6.0
720-1000 ppm CO₂-eq

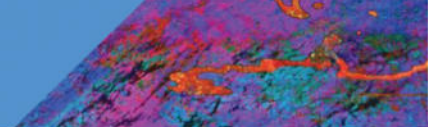
RCP4.5
580-720 ppm CO₂-eq

RCP2.6
430-480 ppm CO₂-eq
Large and sustained mitigation is required



Over 1000 scenarios from the IPCC Fifth Assessment Report are shown

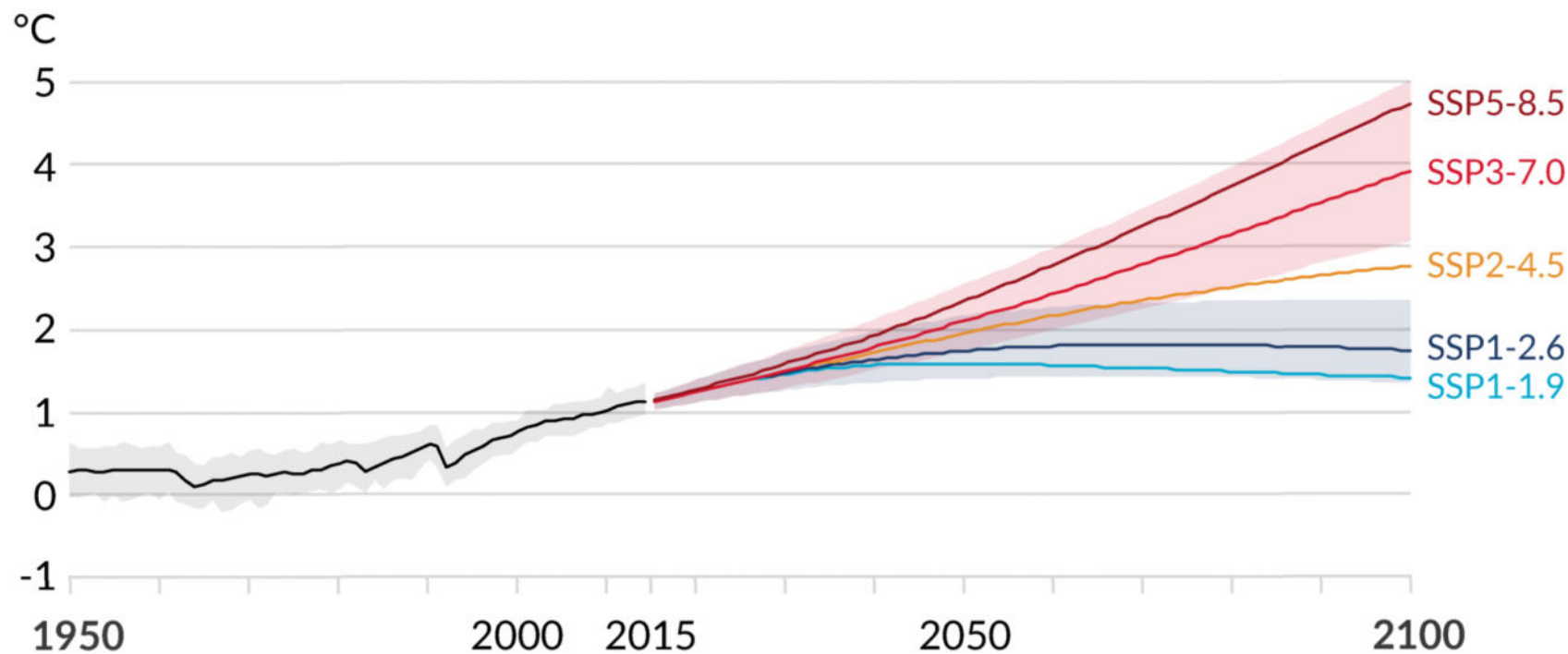
Source: *Global Carbon Budget 2015*, Data: *Fuss et al 2014*; *CDIAC / GCP / IPCC*
<http://www.globalcarbonproject.org/carbonbudget/15/presentation.htm>



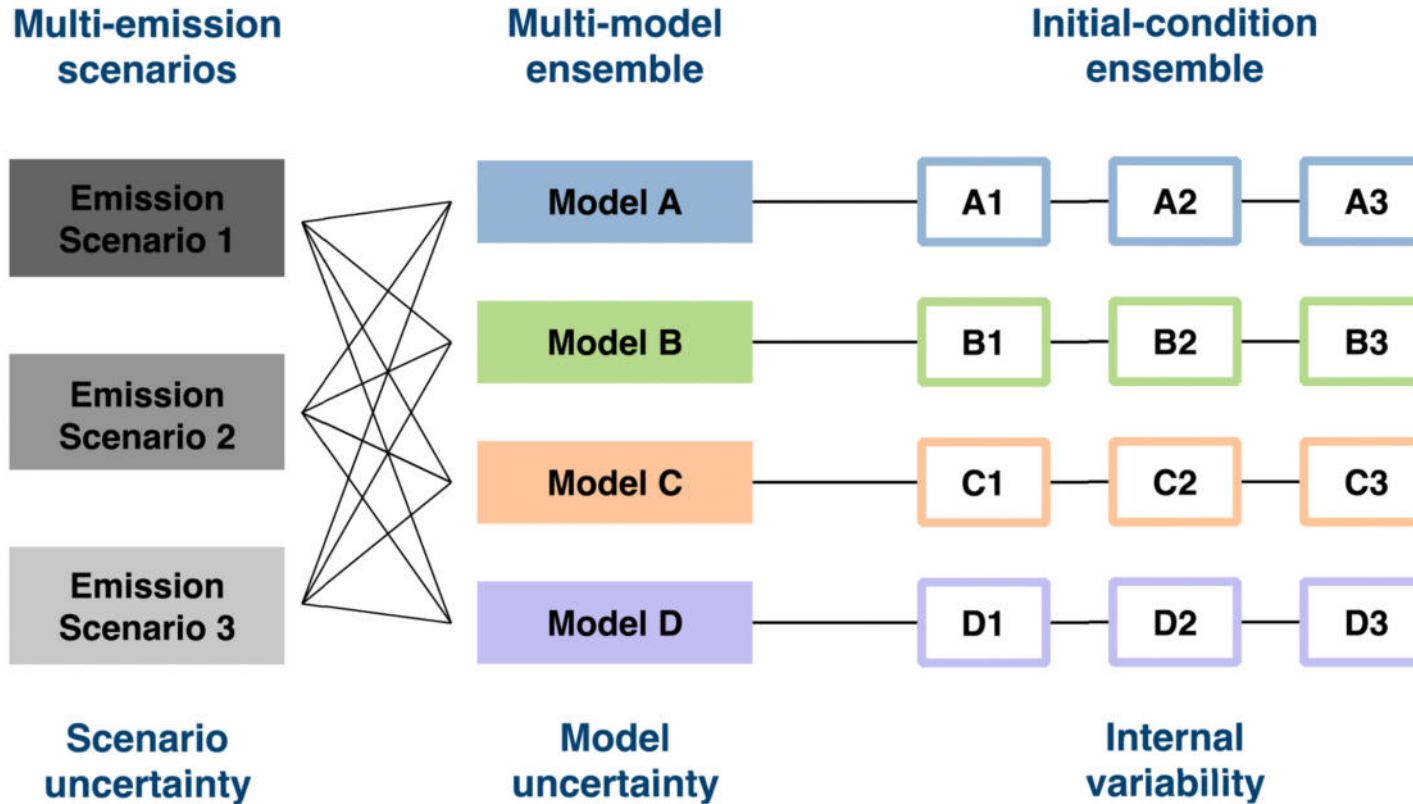
Human activities affect all the major climate system components, with some responding over decades and others over centuries

Figure SPM.8

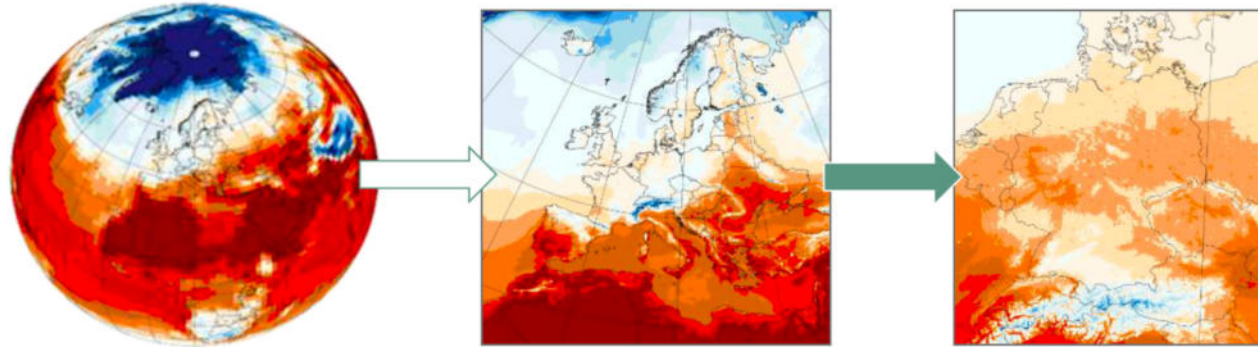
a) Global surface temperature change relative to 1850-1900



Ensemble simulations for robust climate change information



■ NUKLEUS CP-RCM downscaling to 3 km



CMIP5/6

EURO-CORDEX 0.11°

NUKLEUS 0.0275°

(1st phase until 2023, 2nd phase until 2026)

- ⇒ Data volume per simulation largely increased compared to EURO-CORDEX due to hourly data sets
- ⇒ Data is currently under evaluation within the project
- ⇒ Data will become publicly available in 2025

EURO-CORDEX downscaling contribution 12,5 km (small deviations from final protocol):

- 3 RCMs (CCLM, REMO, ICON-CLM) run
- Each RCM driven by 3 GCMs (MPI-ESM, MIROC, EC-Earth)
- Evaluation: **ERA5** (1979-2020)
- Scenario: **SSP3-7.0** (1950-2100)

NUKLEUS 3 km simulations:

- Region located over Germany (CEU-3)
- 3 RCMs (CCLM, REMO, ICON-CLM)
- **Evaluation: ERA5 (2005-2014)**
- Scenarios: **SSP3-7.0** 30-year time-slices
 - Historical period with **+0.5 °C***
 - Future period with **+2 °C***
 - Future period with **+3 °C***

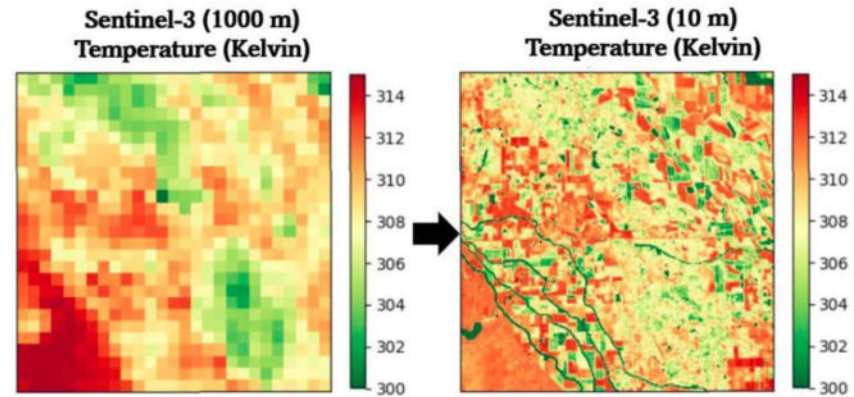
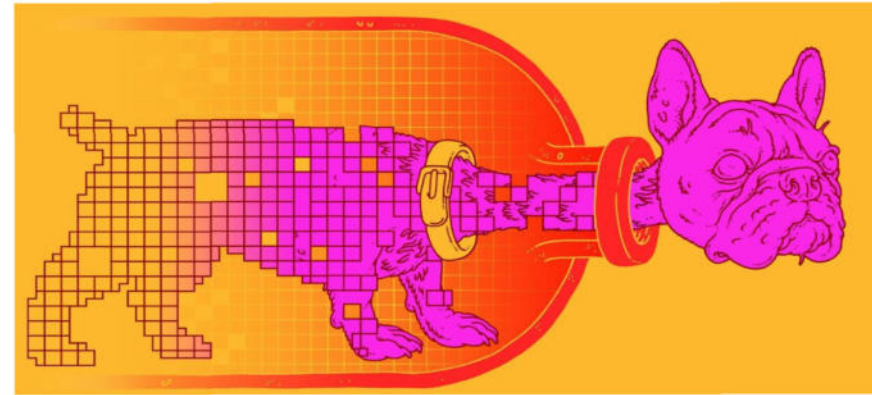
* global-mean-warming w.r.t. to pre-industrial times (HadCRUT5, 1891-1910)

AI

- Autoencoders
- Neural networks
- U-nets
- Vision-Transformers
- Physic-informed models
- World models

Hlavné ciele:

Image Super-Resolution
Predpovede





TURN ON TECHNOLOGY

AI super
rozlíšenie



Čo ideme downscalovat:

- Satelitné snímky
- Klimatické scenáre
- Historické údaje
- Teploty povrchu
- Iné



Pilotné nasadenie

Mestá



Lesné hospodárstvo



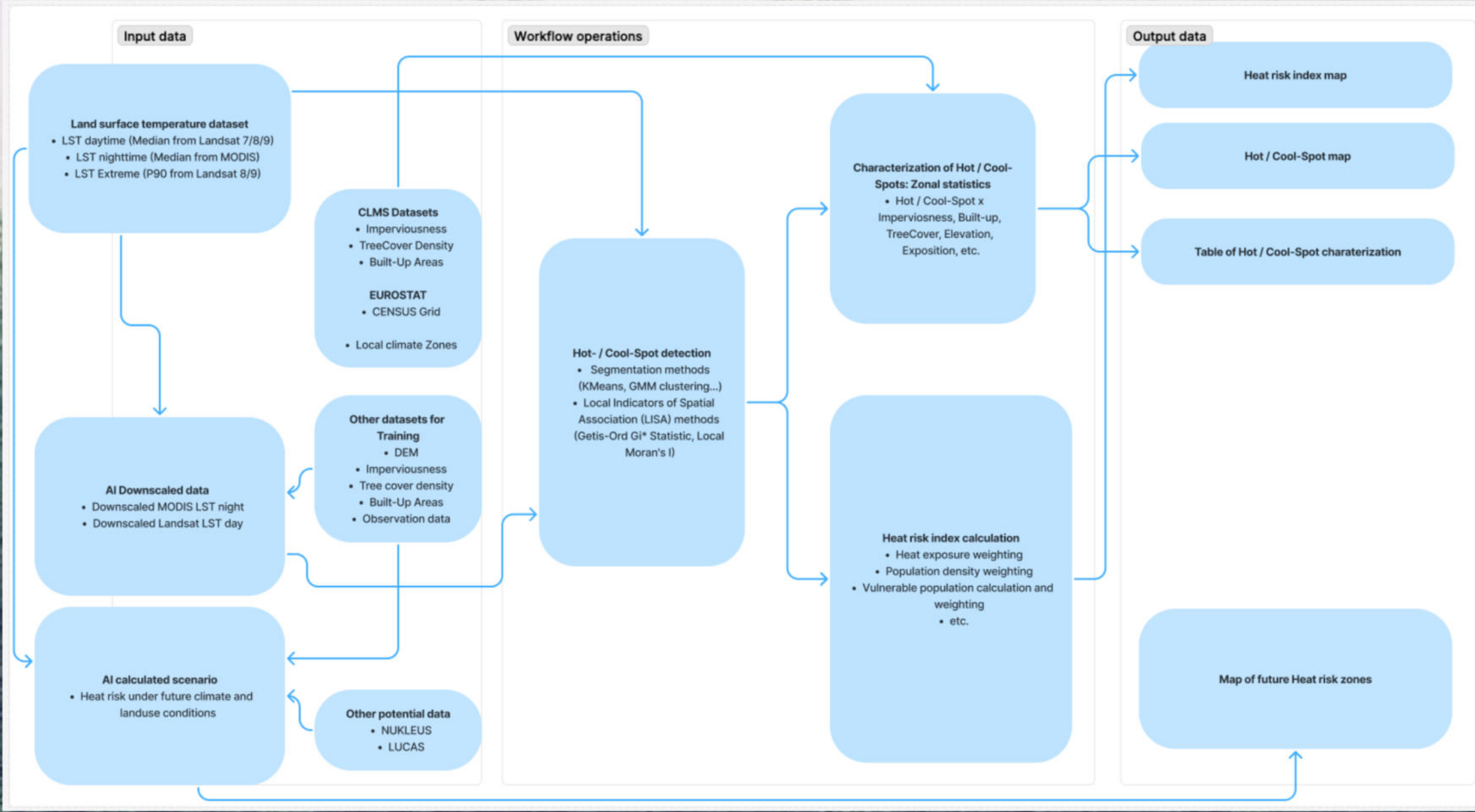
FOCAL

EFFICIENT EXPLORATION
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Assesses climate trends for the region under historical and future scenarios (+2°C, +3°C) Regional climate indicators, trends



WF1 - Climate Change Workflow



Identifies heat exposure and vulnerable population areas within the city: high-resolution heat maps, trends



WF2 - Urban Hot and Cool Spot Workflow

Input data

NUKLEUS dataset

Domain:

- EUR-11 (12.5 km)
- CEU-3 (3 km)

Data Format:

NetCDF

Variables:

- Maximum Temperature (tasmax)
- Minimum Temperature (tasmin)
- Mean Temperature (tas)
- Precipitation (pr)
- Surface Wind (sfcwind)
- Relative Humidity (hurs)

Time span:

- Historical 1961 - 1990
- ssp370-GWL2
- ssp370-GWL3

Other Datasets:

- NUTS3 shapefiles
- ...

AI Downscaled data

Data Format:

NetCDF

Variables:

- Maximum Temperature (tasmax)
- Minimum Temperature (tasmin)
- Mean Temperature (tas)
- Precipitation (pr)
- Surface Wind (sfcwind)
- Relative Humidity (hurs)

Spatial resolution:

500mx500m

Time span:

Same as inputs

Workflow operations

Calculation of Indices:

- Pre-defined
- User-defined

List of Indices:

Pre-defined:

- Daily mean temperature
- Daily minimum temperature
- Daily maximum temperature
- Average precipitation
- Mean near-surface wind speed
- Hot spell maximum length
- Hot spell frequency
- Number of wet days
- Number of dry days
- Dry spell frequency
- Dry spell maximum length
- Calm days
- Cold spell days
- Cold spells frequency
- Cold spells maximum length
- Universal Thermal Climate Index (UTCI)
- Physiological equivalent temperature
- Summer Days ($T_x > 25^{\circ}\text{C}$)
- Hot Days ($T_x > 30^{\circ}\text{C}$)
- Very Hot Days ($T_x > 35^{\circ}\text{C}$)
- Extremely Hot Days ($T_x > 40^{\circ}\text{C}$)
- Ice Days ($T_x < 0^{\circ}\text{C}$)
- UTCI
- PET

...

User-defined:

- Number of days with mean temperature above a given threshold
- Number of days with maximum temperature above a given threshold
- Number of days with maximum temperature below a given threshold
- Number of days with minimum temperature above a given threshold
- Number of days with minimum temperature below a given threshold

Output data

Visualization of climate indices (e.g.):

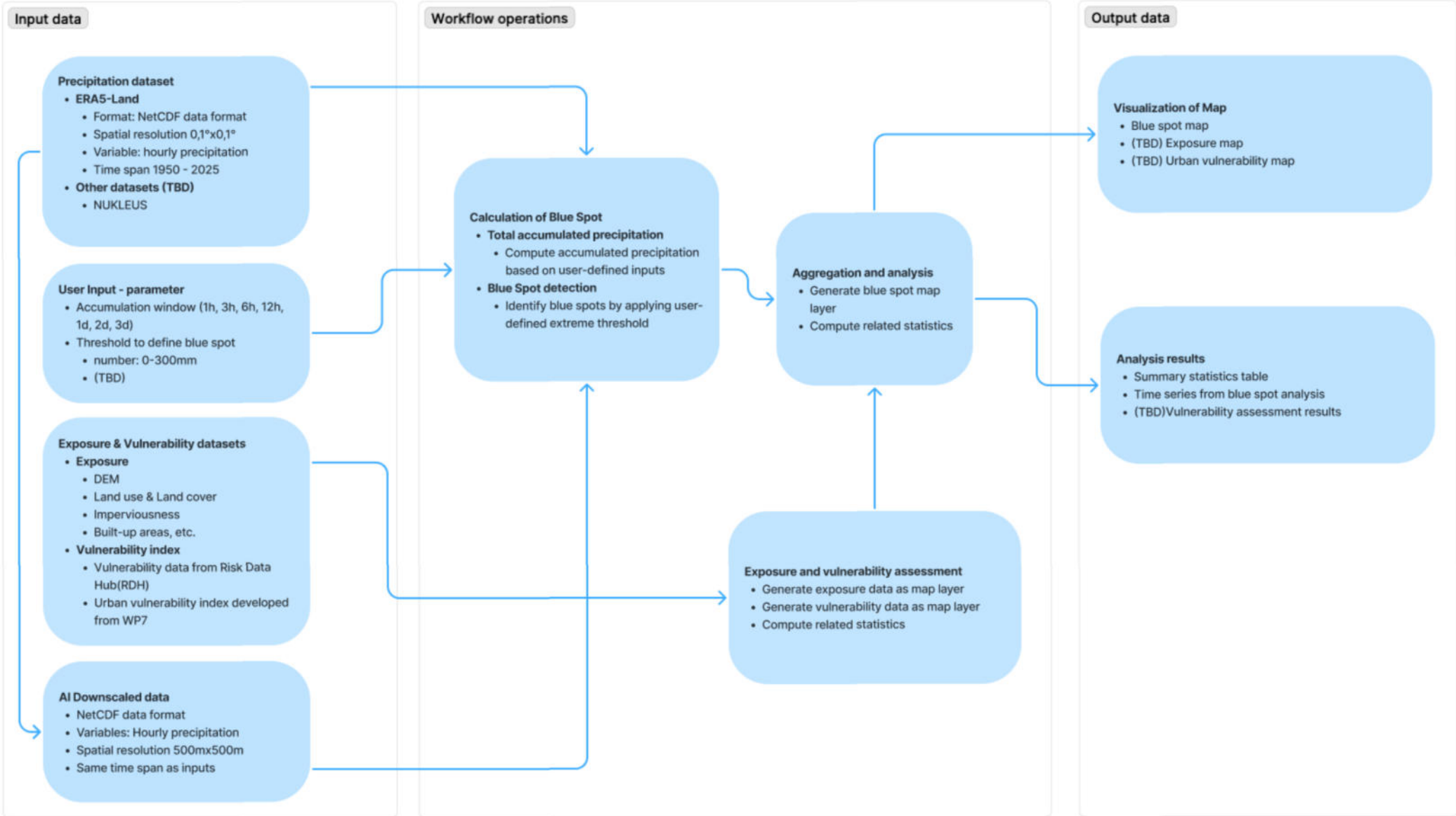
- Map of absolute values
- Map of climate change signal
- Bar plot of absolute values
- Bar plot of climate change signals
- Line plots of mean annual cycle
- Line plots of differences of mean annual cycles
- Line plots of time series
- Line plots of differences of time series

...

Assesses where and how intensely extreme rainfall is likely to occur in the city: maps of extreme rainfall hotspots, intensity patterns



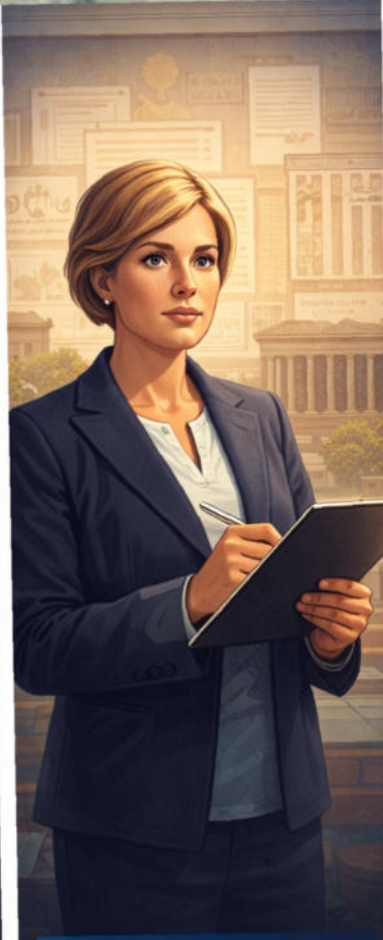
WF3 - Urban Blue Spot Workflow



Koncept: "User personas"



Urban Planner



City Official



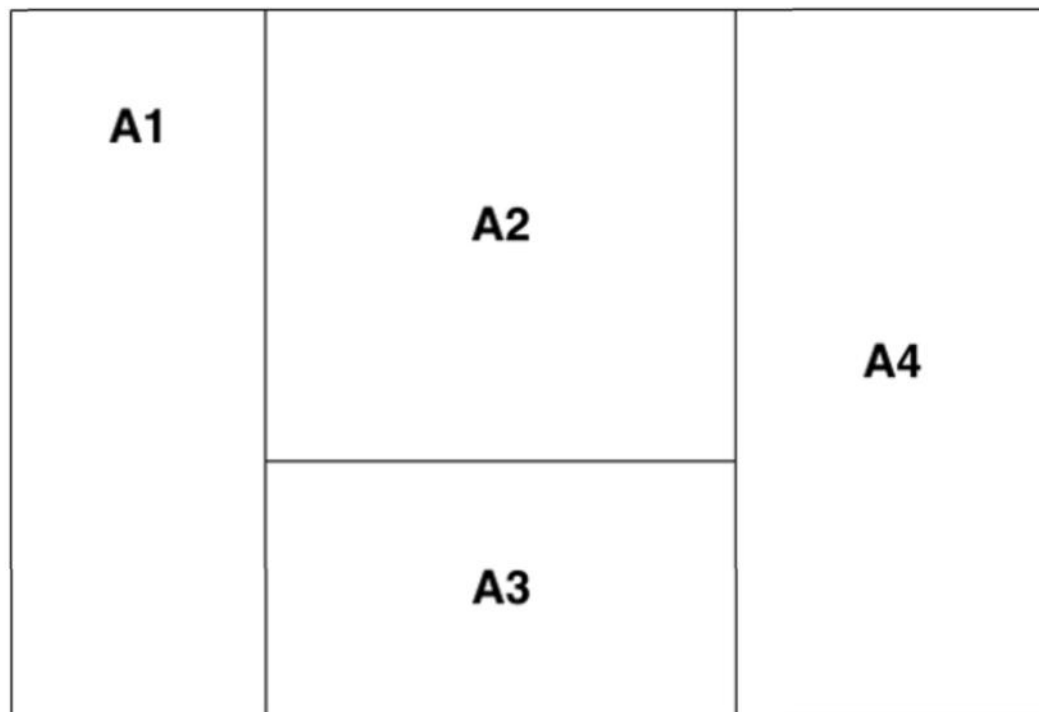
Data Analyst



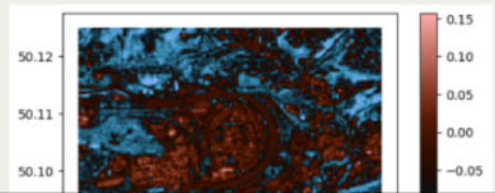
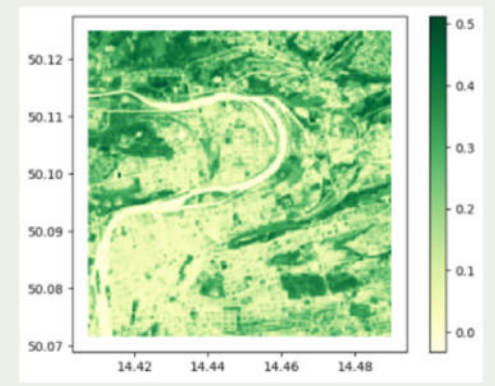
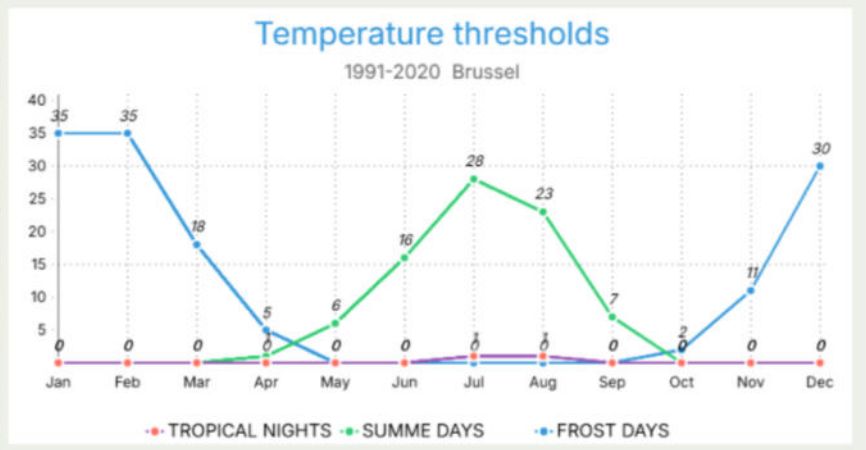
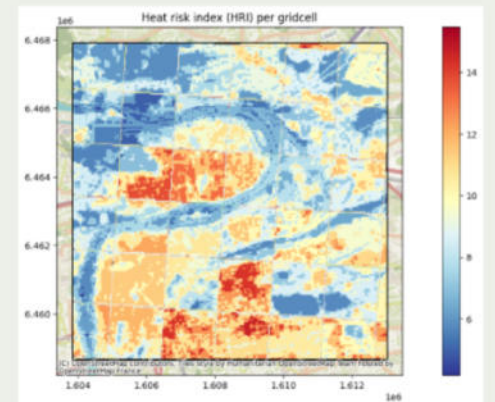
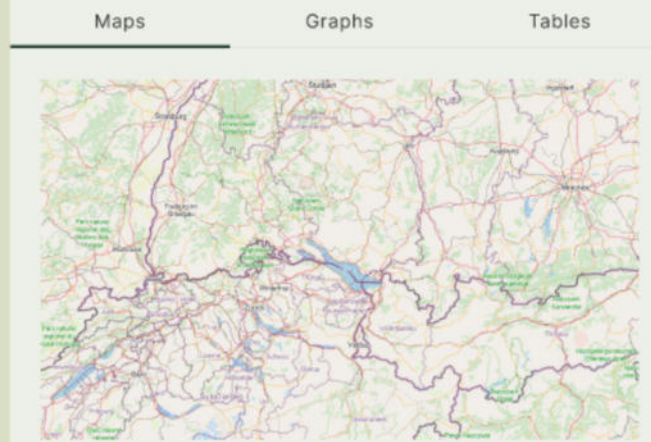
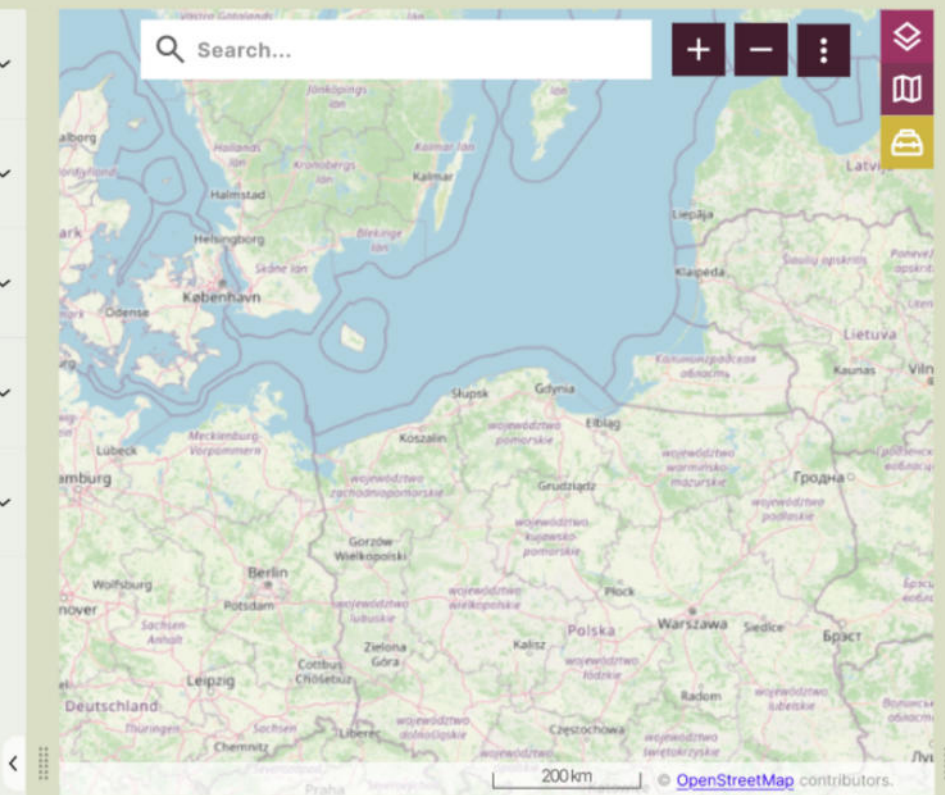
Community Representative

Web application

- Single page web app



- Data Sources
Select an Item
▾
- Area of interest (Spatial filter)
Select an Item
▾
- Climate Indicators
Select an Item
▾
- Temporal aggregation
Select an Item
▾
- Spatial aggregation
Select an Item
▾



Calculate With AI Calculate

Source:

GIS alfa a omega riešenia



- Temporálne multidimenzionálne dáta
- Dátové štandardy (NetCDF, HDF, GRB ...)
- Big dáta
- STAC, GeoRAG
- S3 storage vs Rasdaman
- STEEP platforma
- Tvorba Geo-AI models
- JackDaw GeoAI ChatBot

DÁTOVÁ VRSTVA



Klimatické údaje



Satelítne snímky



Lokálne dáta



Databázy a senzory

APLIKAČNÁ VRSTVA



Workflows moduly



Dátový konektor



Analytické moduly



API a integrácie

PREZENTAČNÁ VRSTVA



Web aplikácia pre URBAN pilot



Web aplikácia pre FOREST pilot



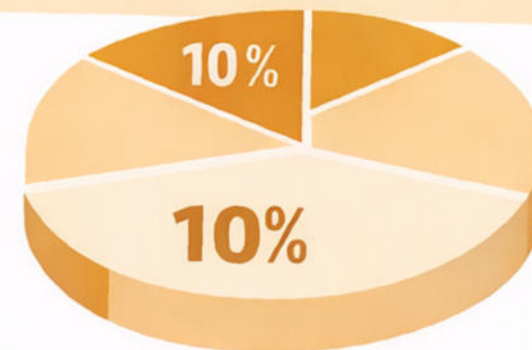
UI



Porozumenie a príprava údajov



Vyhľadanie správnych údajov v čase a ich spracovanie



UX/UI

A čo **d'alej?**

Ďalšie kroky



Finalizácia aplikácií



Networking



Partner cities – replicators



Permanent demonstrators

Ďakujem za pozornosť



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