The **Portal Component, Strategic Perspectives and Review of Tactical plans to implement the IAUC Initiative, WUDAPT ; a worldwide urban database for climate and environmental modeling**

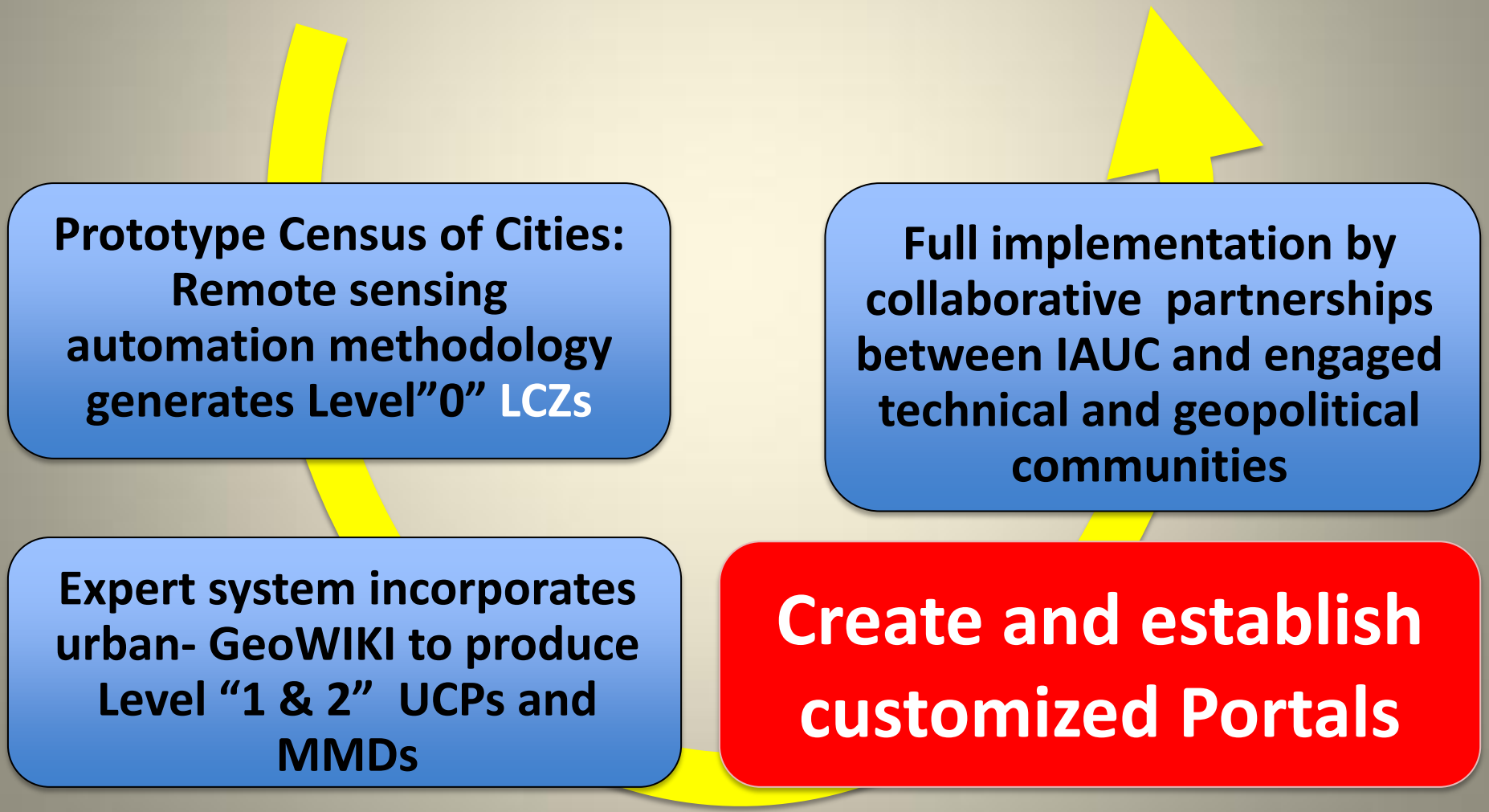
Jason Ching
Institute for the Environment at UNC, Chapel Hill, NC, USA

Collaborators

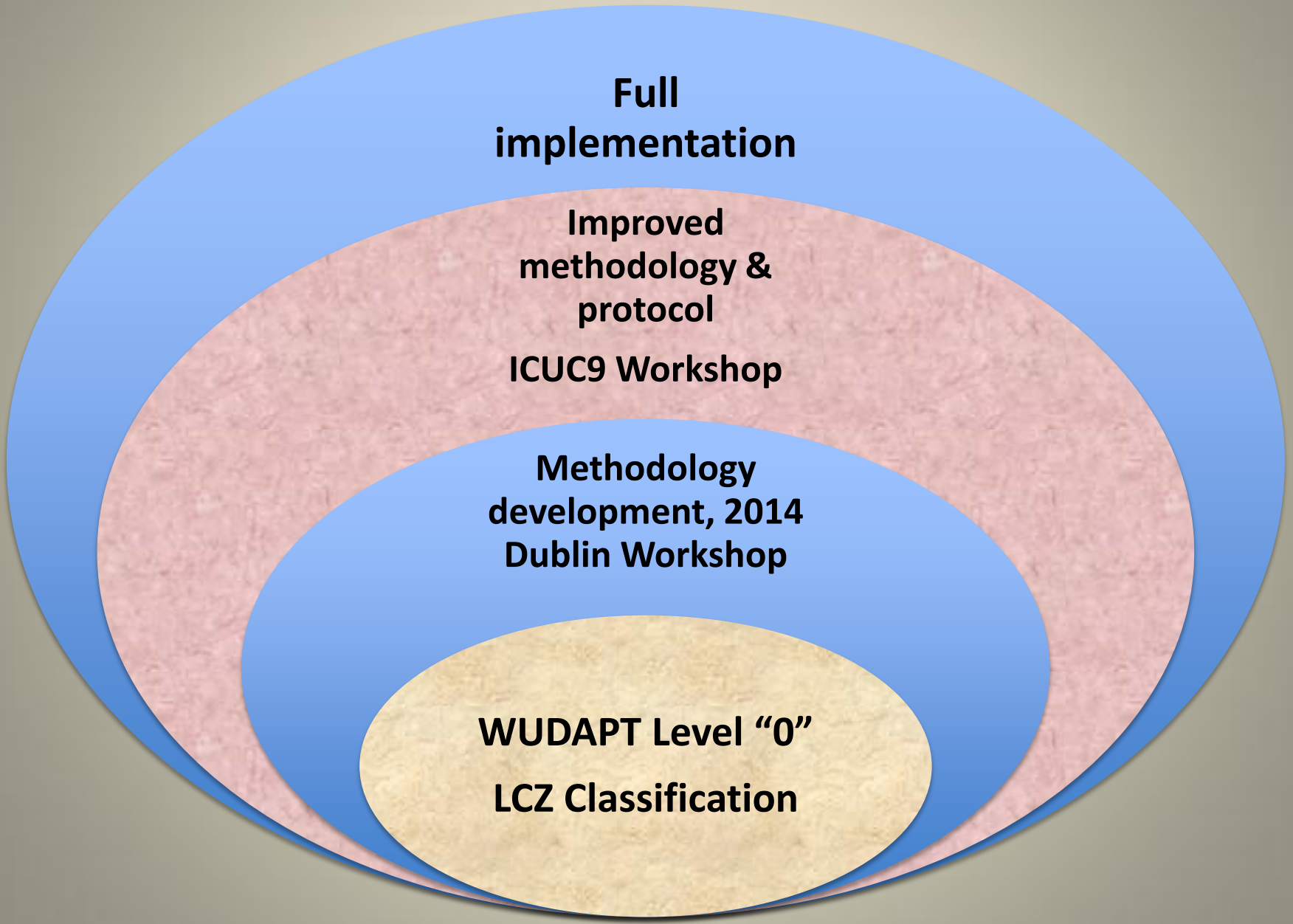
Gerald Mills, University College, Dublin
Linda See, IIASA
Benjamin Bechtel, U of Hamburg
Johannes Feddema, U of Kansas
Adel Hanna, UNC-IE
Grega Milcinski, Sinergise
Alberto Martilli, CIEMAT
Oscar Brousse, U of Strasburg
Fei Chen, UCAR/RAL
Sue Grimmond, U of Reading
Ian Stewart, U of Toronto
Xuemei Wang, Sun Yet Sen U
Chandana, Mitra (Auburn, U)

WUDAPT's critical elements

Prototype Census of Cities and Collaborative Partnerships



Progressive Staging of WUDAPT Level “0”



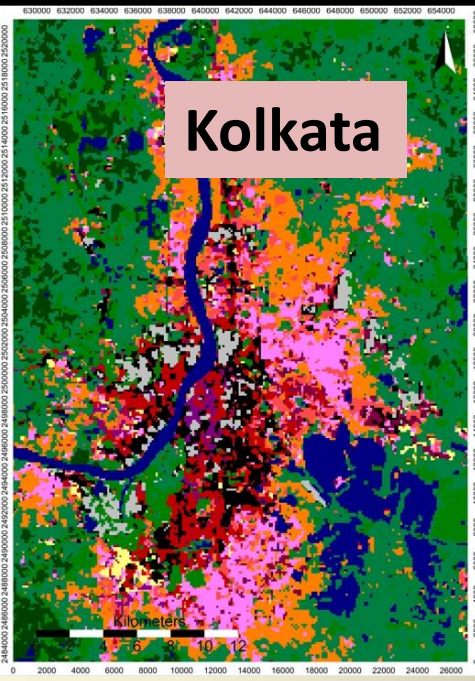
16 cities WUDAPT Level "0" generated at 2014 Workshop in Dublin Ireland

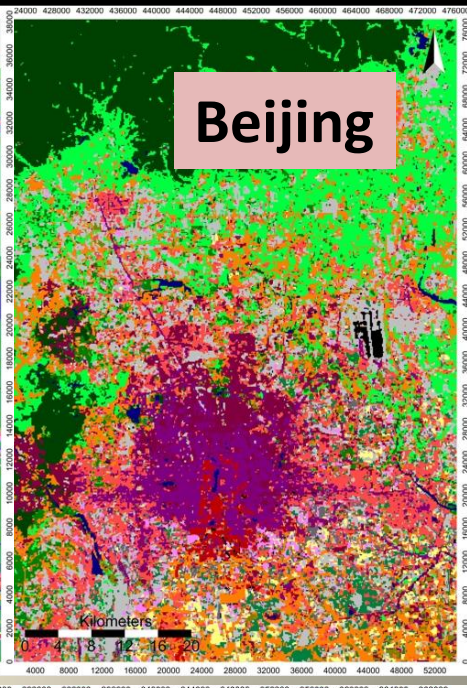
Rich diversity and complex distributions of climate zones observed within each city

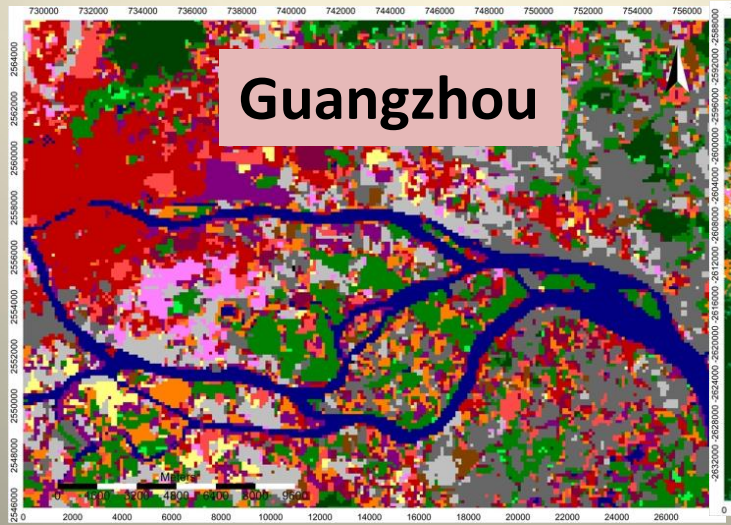
LCZ signature palate different and unique to each city

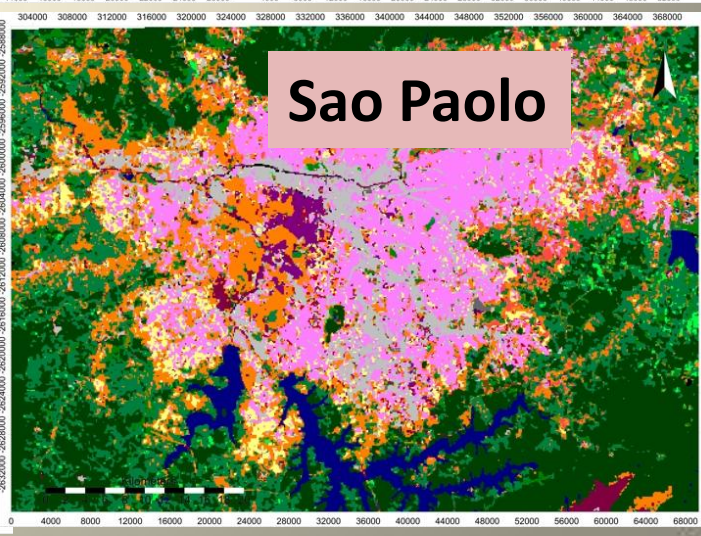
Distributions of "Form and Function" modeling parameters produce unique climate and meteorological responses to each urban area

LCZ Classes- Each urban area is unique



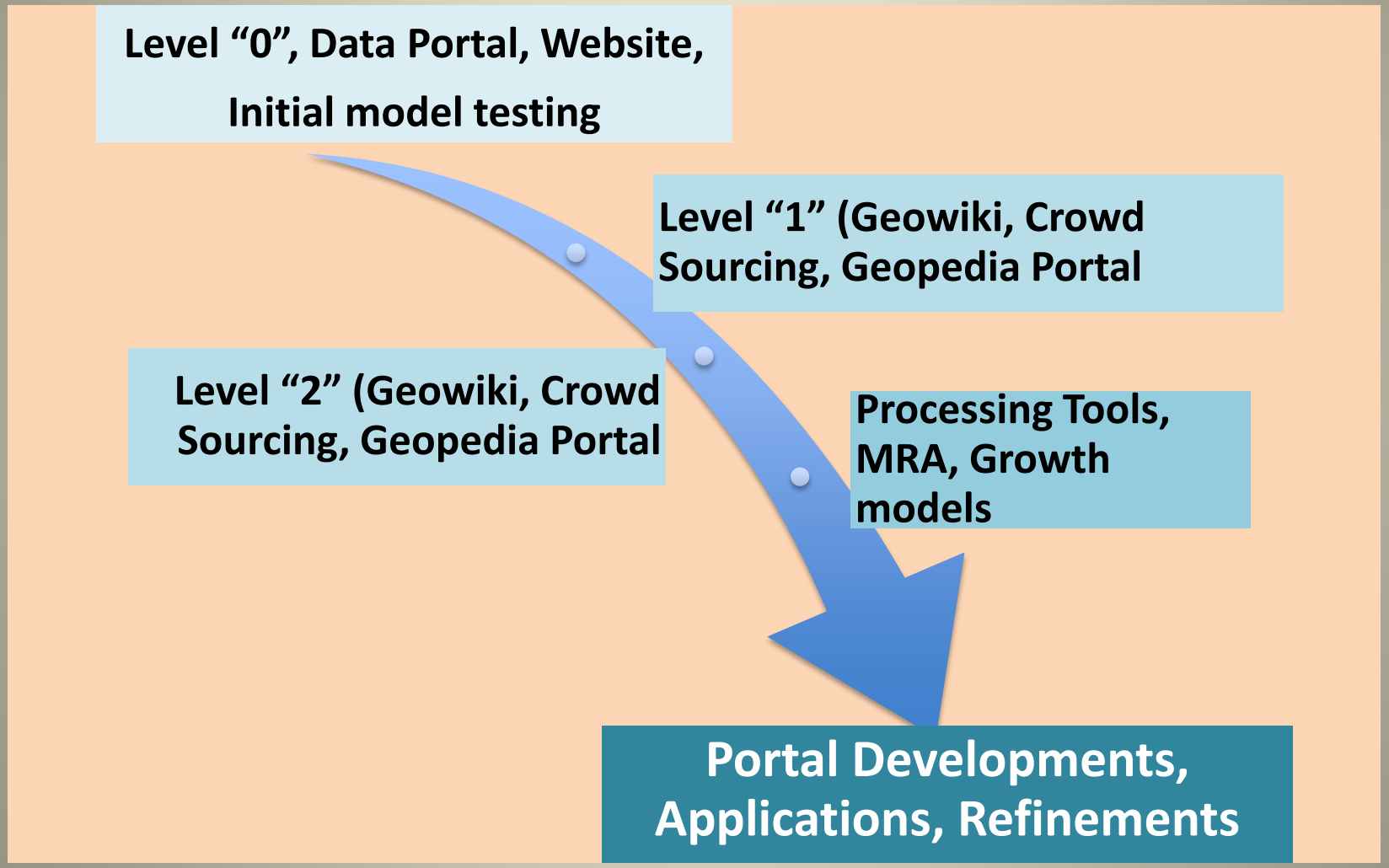






LCZ Classes

Comprehensive Implementation Stages



WUD---APT

World Urban Database

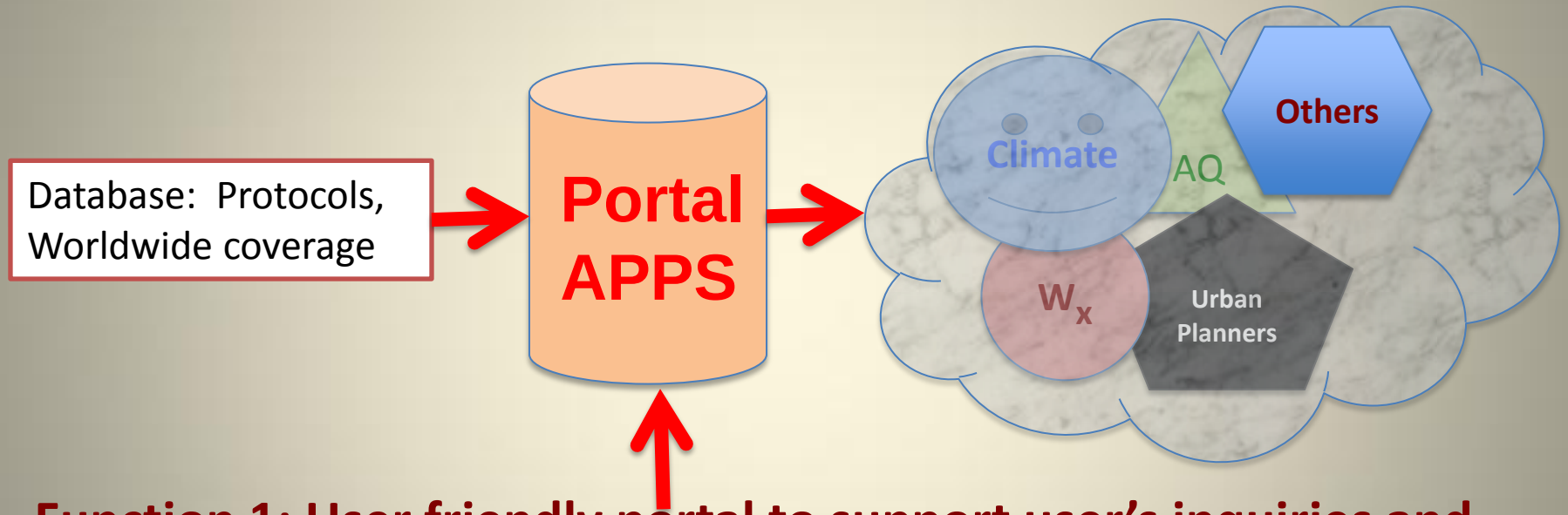
- Level “0”
  - Census of Cities as Local Climate Zone LCZ atlases
  - All world’s major urban areas
- Level “1”Form and function data “FIT FOR PURPOSE” Multi-scale “fine to meso”
- Community-based and accessible
- Evolutionary and dynamic

Access Portal Tools

- Database Functionalities:
  - Collection,
  - Processing,
  - Validation,
  - Storage and Retrievals
- APPS Functionalities
  - Generic and rudimentary
  - WPS/WRF Interface
  - Scale dependent analyses
  - Modeling apps
  - Base and projections

Conceptual Design Functionalities of WUDAPT

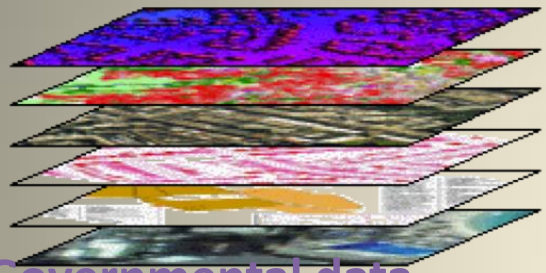
- **Open source** community framework
- **Worldwide coverage** of urban areas, all climate zones



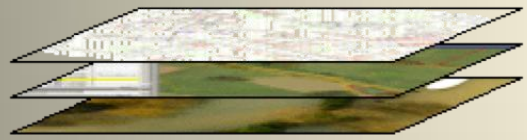
- **Function 1: User friendly portal to support user's inquiries and search inclusive of structured and unstructured information and supporting metadata- Ingestible to variety of user communities**
- **Function 2: Custom applications keyed to addressing variety of community needs**

WUDAPT Public Portal: Geopedia functions: database generation methodology, storage & access

GIS layers

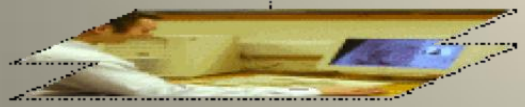


Governmental data

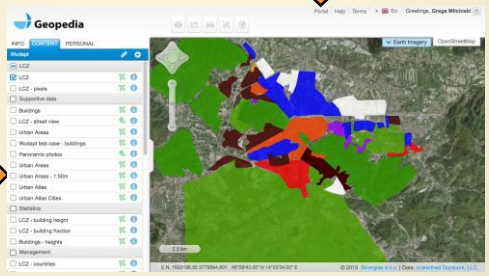


GMES (sentinel etc.)

Crowd-sourcing data



Local Experts
Open Street Maps
LCZs



GEOPEDIA

WUDAPT

Environmental models

Current modeling progress using WUDAPT. Processing WUDAPT Level "0" data to run WRF –Urban: the case for Madrid, Spain, Bousse & Martilli 2015

LCZ maps obtained by WUDAPT

120m Resolution

Closest pixel value

Fortran

Using *Stewart ID & Oke TR, 2012* supplement for Urban Fraction, Building & Roads Width and Heights

Using *Stewart ID, Oke TR & Scott E, 2014* for Building & Roads Heat Capacity and Thermal Conductivity

LCZs Values are 31-40 (31=LCZ1) Other classes 1-30 are from MODIS

New Land Use Index in WPS

333m Resolution

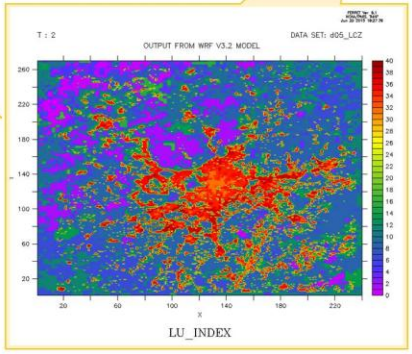
URBPARM.TBL

Running the WRF model

Statistical verification

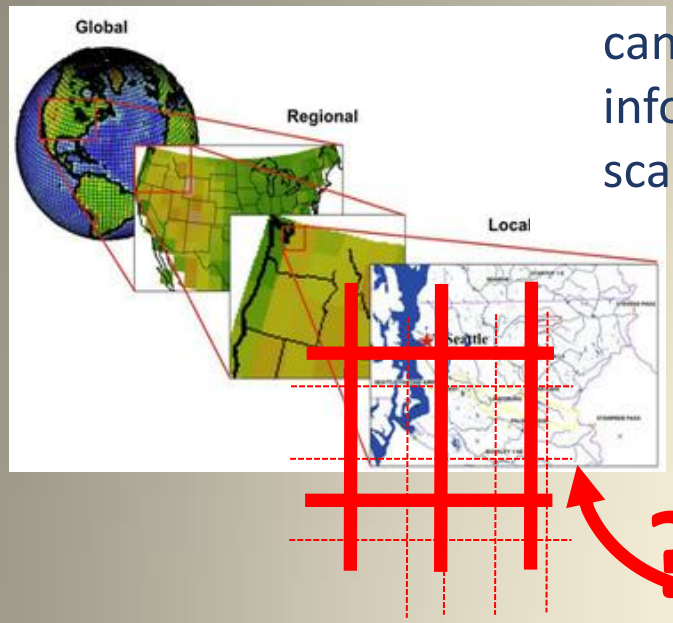
LCZs dependent results

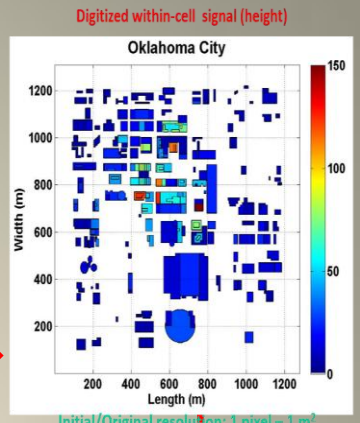
Needing supplementary datas for BEP-BEM (Roughness length, Capita/floor, Surface emissivity, Windows coverage ratio, AC system datas)
Assuming *Martilli A & Salamanca F , 2002/2010* values for now

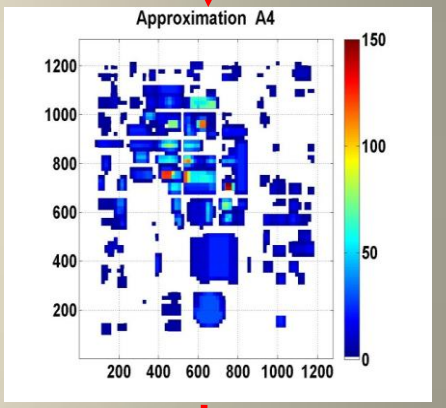


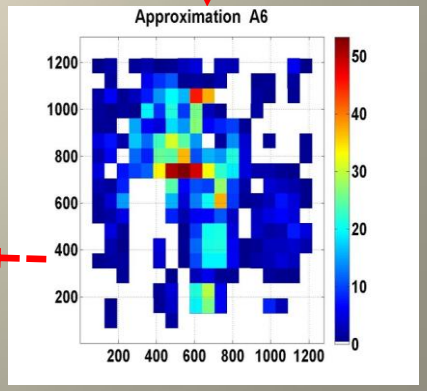
Land Use of Madrid in WPS (Brousse O., 2015)

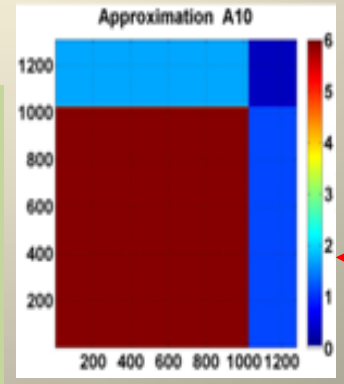
2. How do representation of urban canopies (resolved and sub-grid information) change with scale/model resolution?











1. What is the macroscopic feedback of urban canopies into larger scale models and what is the sub-grid scale Information for parameterization?

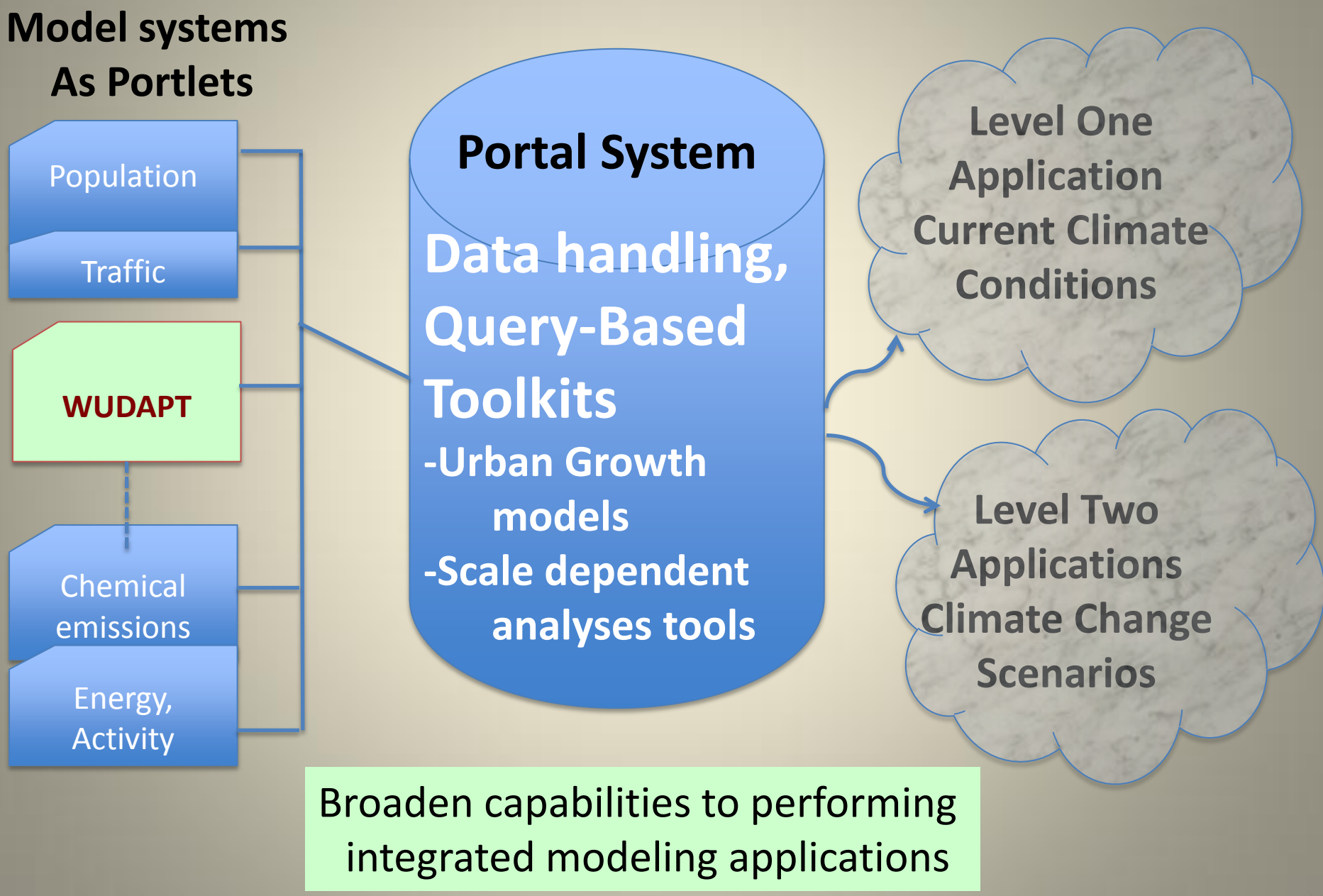
Adding Multi-Resolution Analysis (MRA) into WUDAPT

Consideration for Portal: Urban Planning-Growth Model APPS

- **SLEUTH** urban growth and land use change model, simulates four types of urban land use change:
  - spontaneous growth,
  - new spreading center growth,
  - edge growth, and
  - road-influenced growth.
- **SynCity** (Synthetic City) –Sub-models (Layout, Agent Activity & Resource Technology Network (RTN))
- **MARS (Metropolitan Activity Relocation Simulator)**

  Strategic, dynamic, integrated urban land use and transport model

Conceptual hierarchical urban modeling systems incorporating WUDAPT



Two Examples of emerging Portal Apps using WUDAPT

- Risk Assessments (Heat stress) current and climate projection modeling

- Systemic modeling approach

Example 1: APP/Portal for heat stress advisories for extreme heat wave situations in urban areas under current and future climates

(Hanna, Pinto and Ching, ICUC9 (2015)

Goals: Heat stress indices (WBGT, Tmrt, PETs) for:

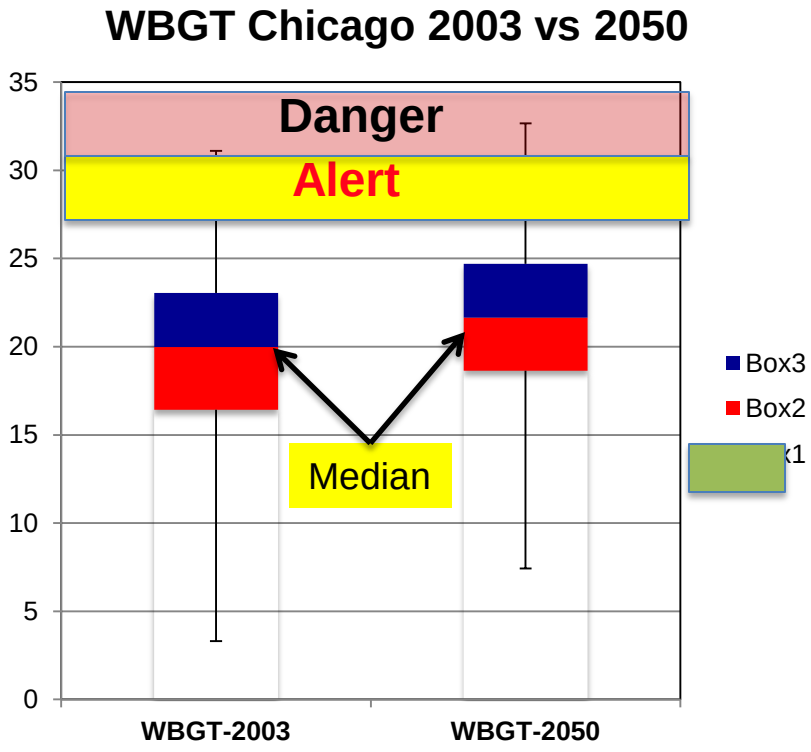
- Enhanced mortality, morbidity risks
- Safe activity levels, comfort/discomfort advisories

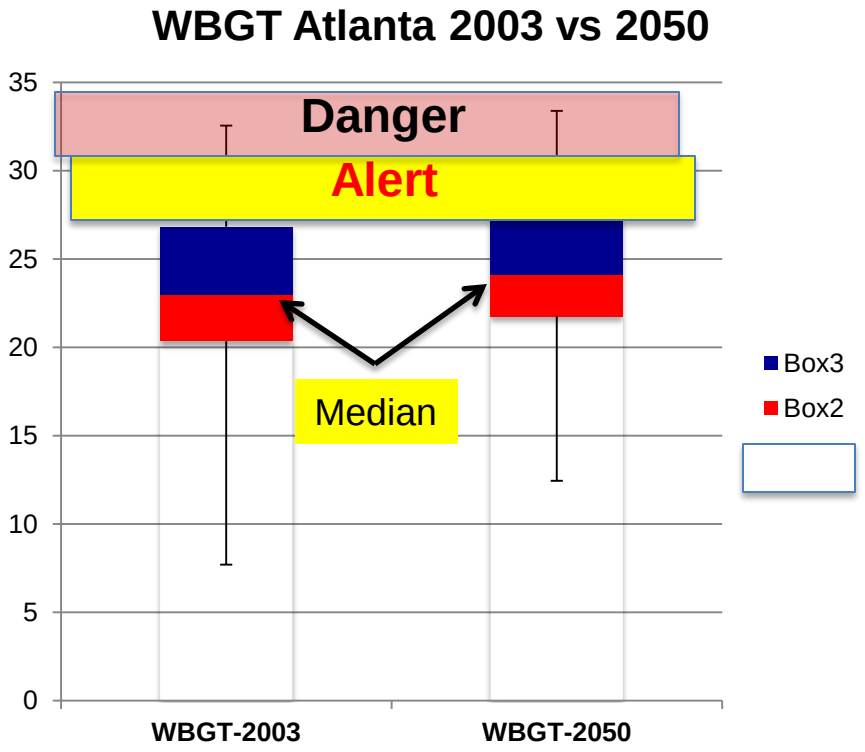
Method: Customized APPS (using portlets?) for:

- ***Operational O(10km)*** weather and climate model now and futurecasts outputs ***with Intra-urban variation using Sky View Factor as weights based on Level "0" table lookups***
- **Fine grid customized and urbanized** Wx model outputs [O (1km)] utilizing ***MRA portlet generates appropriate UCPs to mesoscale models)***

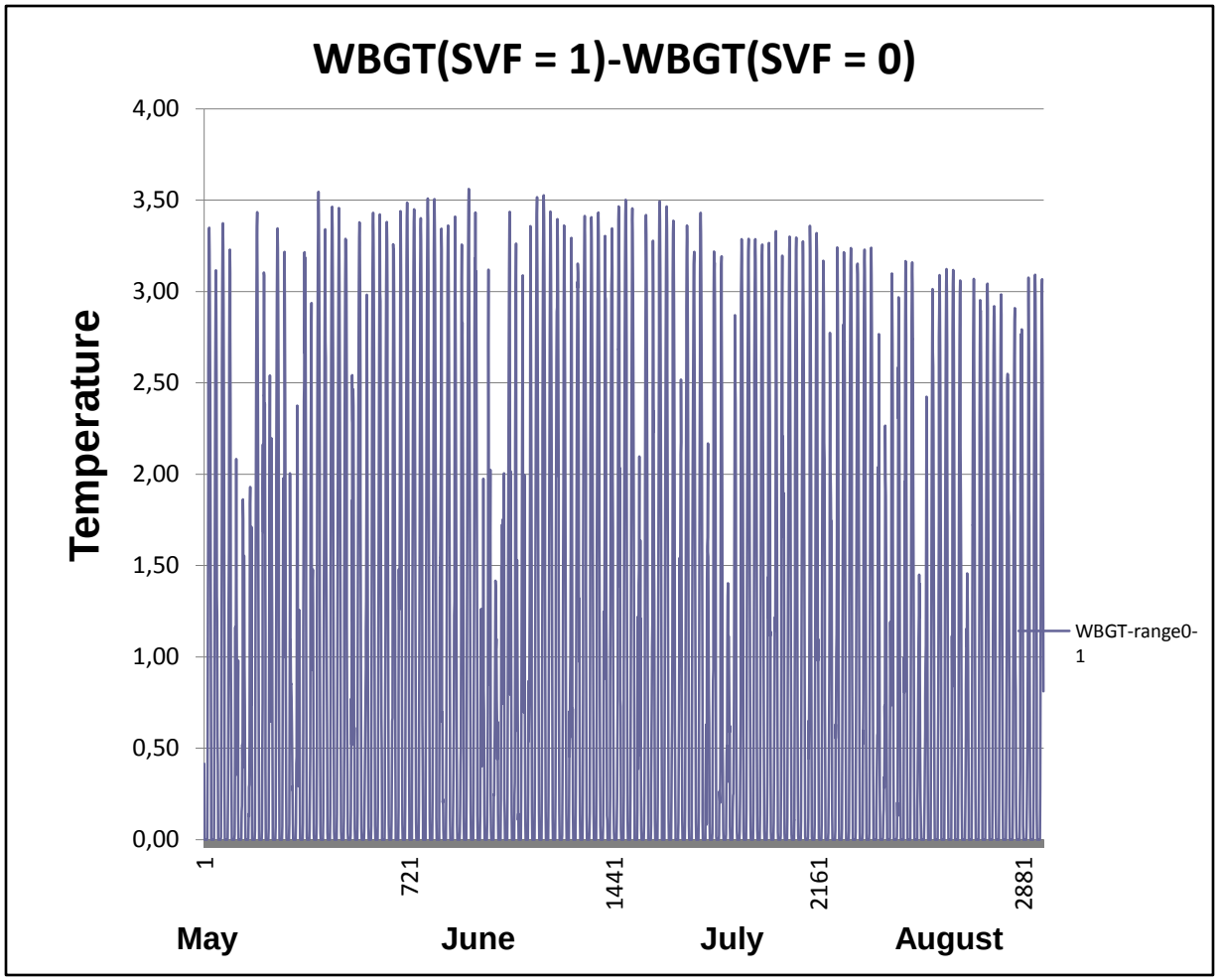
Summer Heat Stress (WBGT) Index for Atlanta and Chicago 2003, 2050

Overall increase across the Distribution for both cities from 2003 to 2050





Sensitivity of WBGT to Sky View Factor (SVF)



Differences of more than 3.0 are seen particularly during June and July

1/3 the range of concern of heat stress risk levels

Significant diurnal variability in WBGT

Portal APPS options

Context: Urban adaptation planning for Baseline and Climate Change impacts projections (Masson et al., 2014)

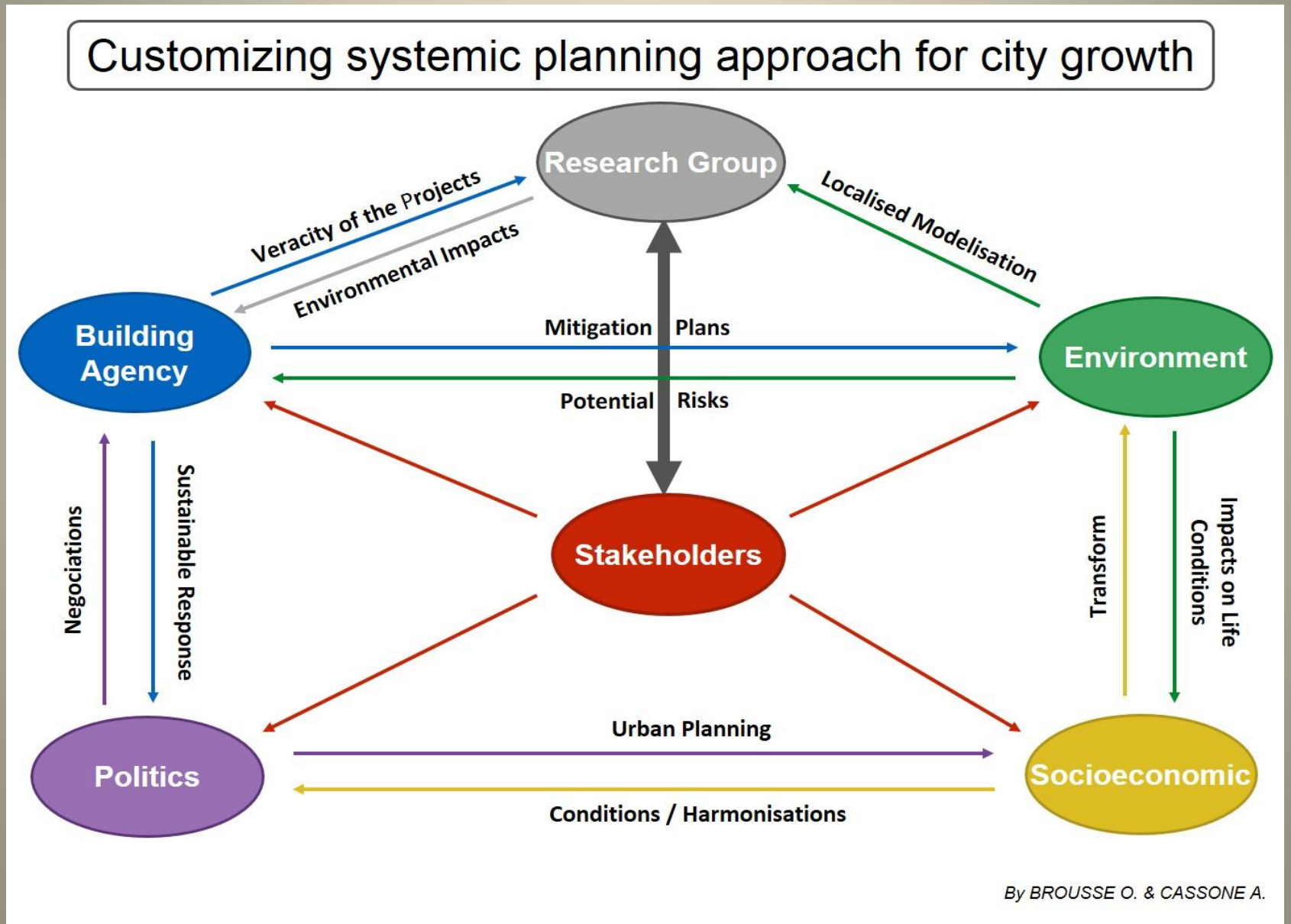
Impact (risks) and direct outcome modeling

- Climate projection model tools
- Scale dependent weather prediction model tools
- Air quality and exposure modeling tools
- City long term planning modeling tools
- Off line Vulnerabilities, Adaptation and Risk assessment modeling tools

Systemic modeling (interdisciplinary)

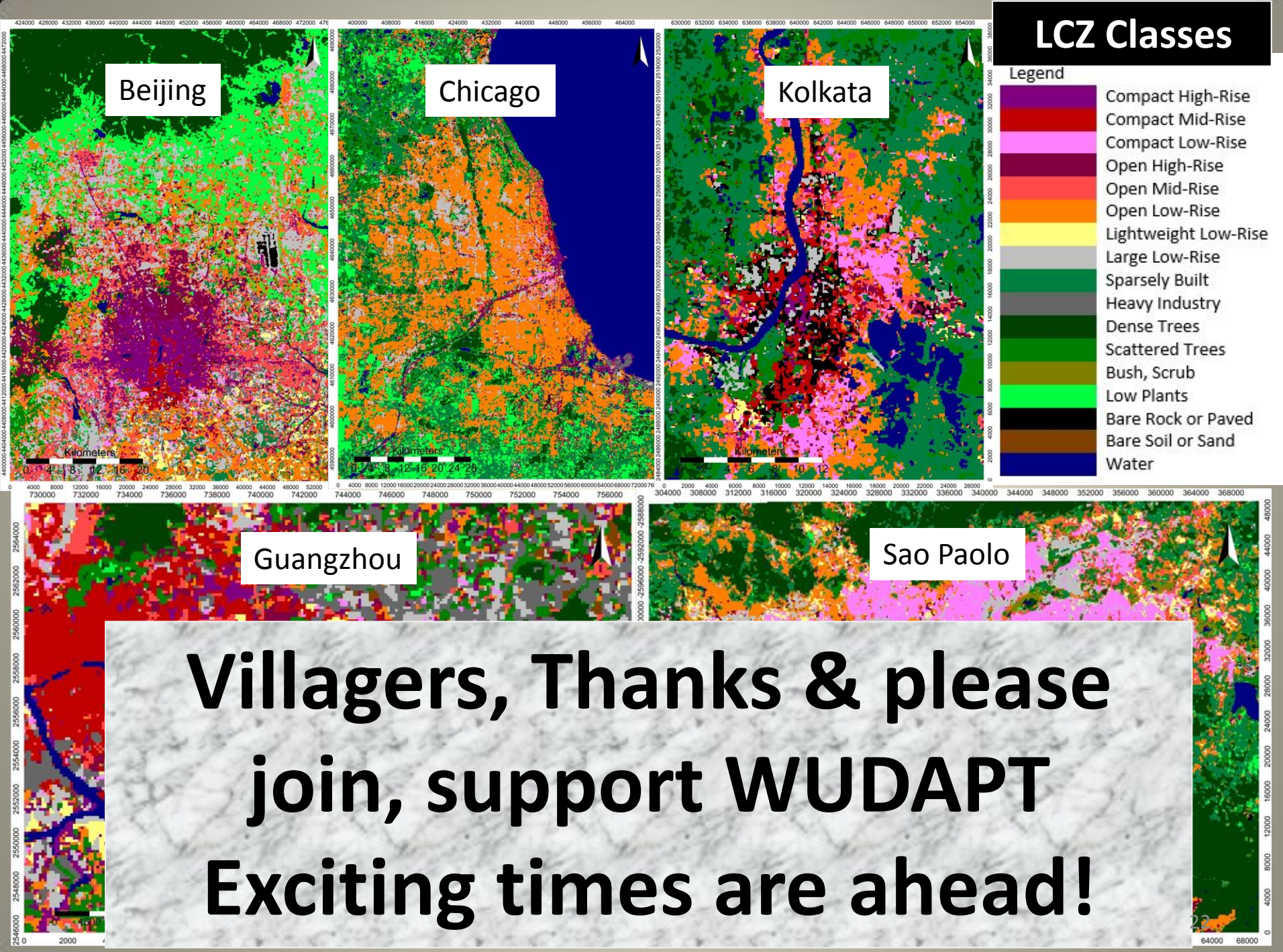
- Baseline and climate change projections
- City models for adaptation strategies
- Physical modeling for impacts
- Indicators and outcomes

Example 2: Systemic-type modeling that incorporates WUDAPT into environmental models (e.g., WRF, TEB by Strasburg Research Group)



Countries with active WUDAPT collaborators: Produced 16 Level "0" (LCZ) cities @ 2014 Dublin workshop

Summary and Steps Forward


LCZ Classes
Legend
Compact High-Rise
Compact Mid-Rise
Compact Low-Rise
Open High-Rise
Open Mid-Rise
Open Low-Rise
Lightweight Low-Rise
Large Low-Rise
Sparsely Built
Heavy Industry
Dense Trees
Scattered Trees
Bush, Scrub
Low Plants
Bare Rock or Paved
Bare Soil or Sand
Water
Beijing
Chicago
Kolkata
Guangzhou
Sao Paolo
Villagers, Thanks & please join, support WUDAPT
Exciting times are ahead!