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An Urban Model for Analyzing Thermal Effects Dependent on Spatial Parameters

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Content

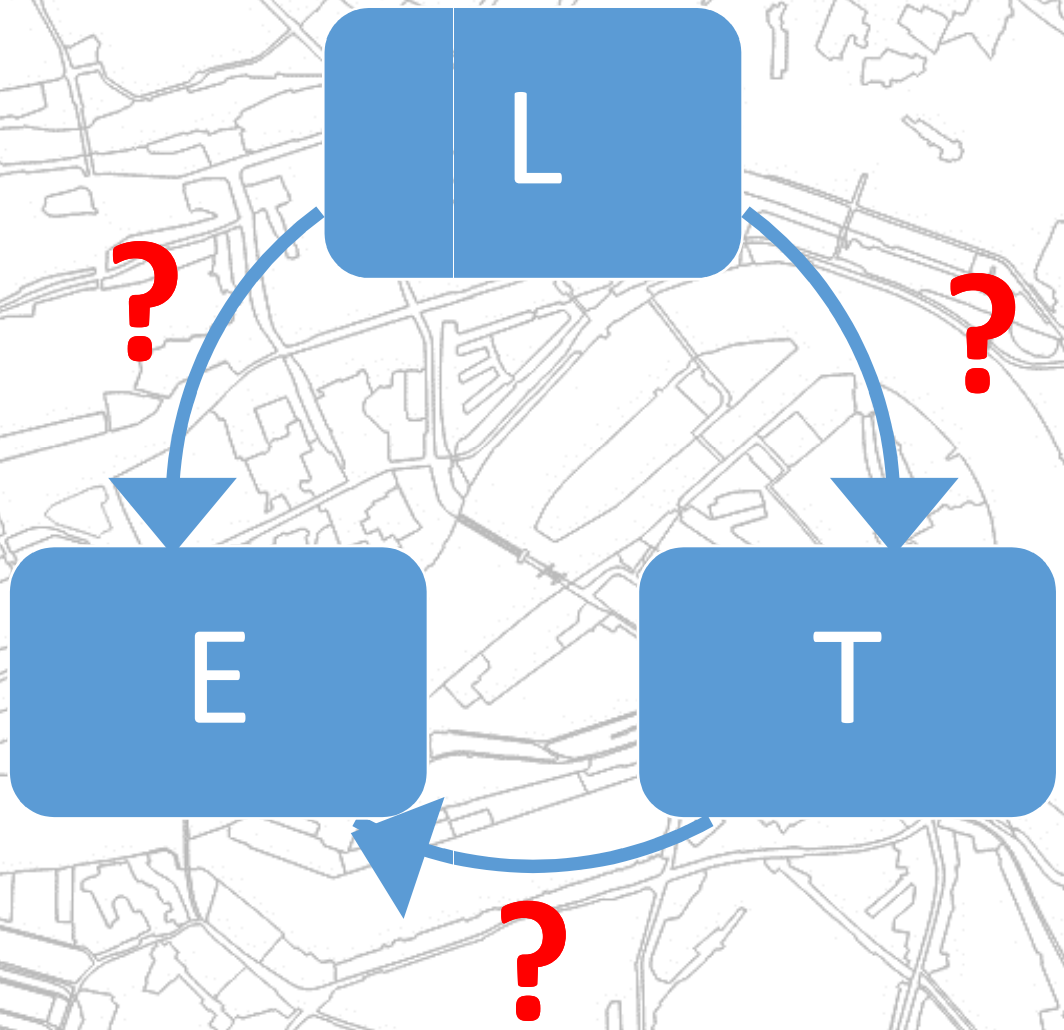
- Introduction
- Methodology
  - Spatial dimension
  - Temporal simulations
  - Specific research areas
- Research framework
- Results
- Q & A

Research Question

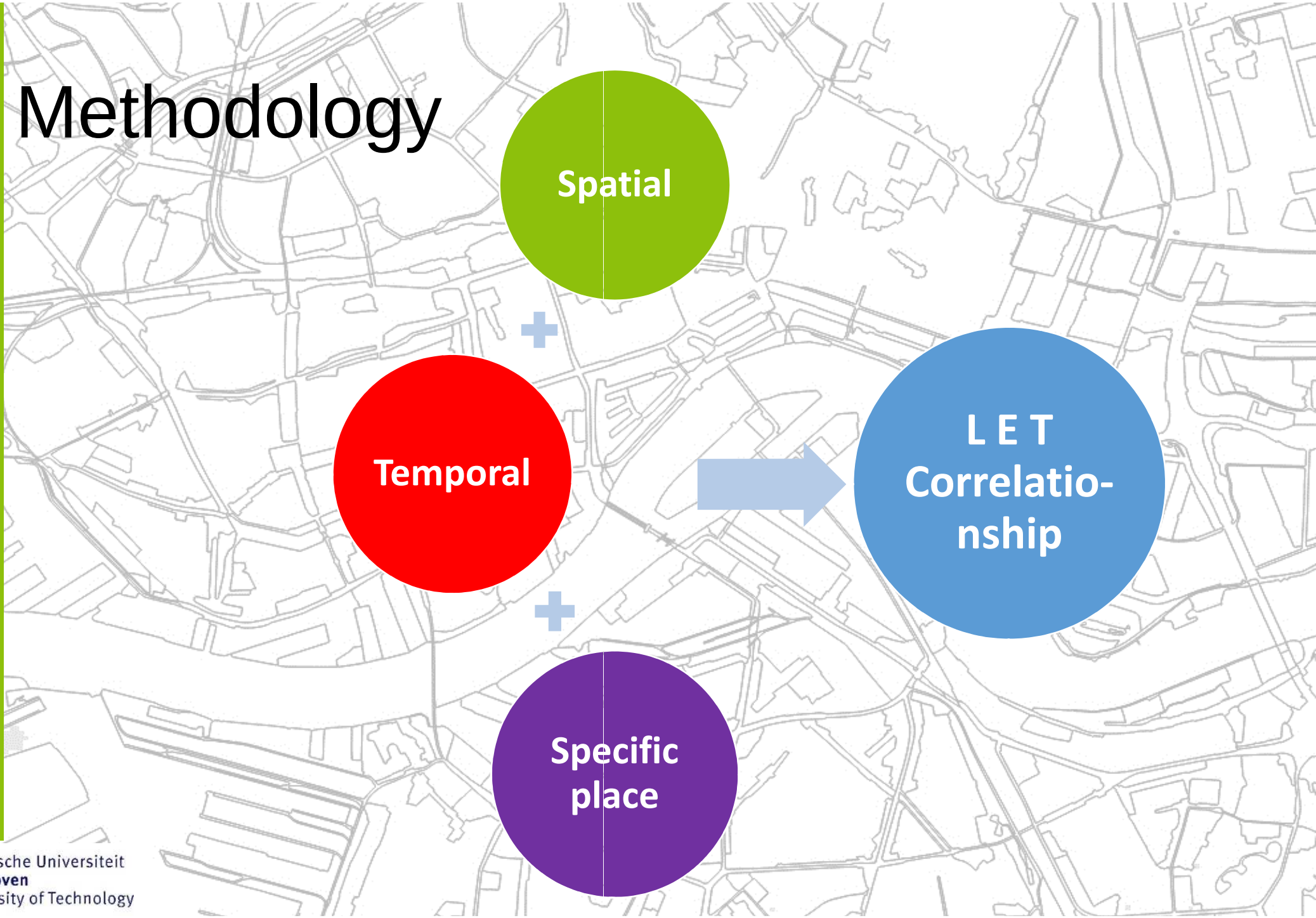
How can we plan the land use in a more sustainable way under the concern of temperature and energy consumptio

- City landscape structures & temperature change
- Optimal urban land use pattern
- Surface & layout changes
- A simulation tool

L-E-T Model



Methodology



Spatial dimension

L-E correlation

- SEA (Strategic environmental assessment) (L. White et al. 2013)
- Top-down approach (S. Mohammandi et al. 2013, L.G. Swan 2009)
- Bottom-up approach (S. Mohammandi et al. 2013, L.G. Swan 2009)
- Analytical framework (J.G. et al. 2013)

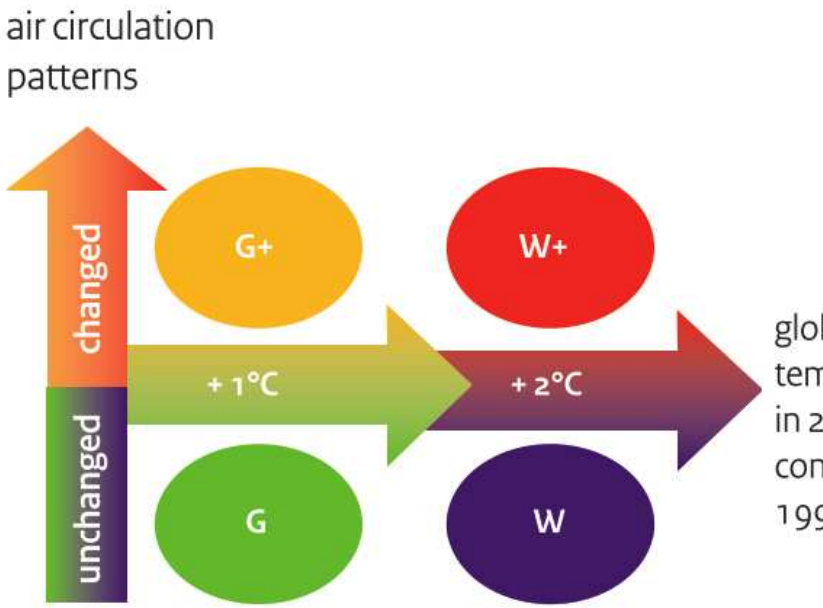
L-E-T correlation

- Prediction method: engineering, statiscal, neural network, support vector machine, grey models (H. Zhao et al. 2012)
- Systematic review methodology (D. E. Bowler 2010)
- Comapre countries difference (L. Pe´rez-Lombard et al. 2008)
- SWOT, land-use models (C. Agarwal et al. 2002)

Temporal simulations

L-T correlation

- KNMI'06 Scenarios (KNMI 2009)
- W/ W+ scenarios (KNMI 2009)
- G/ W scenarios (KNMI 2009)



E-T correlation

- Global climate models (GCMS) (KNMI 2006)
- Regional climate model (RCMS) (KNMI 2006)
- Climate changes for Netherlnads (KNMI 2006)

Temporal simulations

L-E-T correlation

- Scenarios to predict future weather (KNMI'14)
- Regional climate model RACMO2 (B,D.V. Hurk et al. 2014)
- EC-Earth model (B,D.V. Hurk et al. 2014)
- Climate Explorer of KMNI (B,D.V. Hurk et al. 2014)
- EU healthier environmental regulation (National Institute for Public Health and the Environment, Netherlands. 2004)
- EU environmental policies review (National Institute for Public Health and the Environment, Netherlands. 2004)

Specific research area

L-E correlation

- Urban Planning System (M. Wolsink et al. 2003)
- Sustainable urban form and energy demand (M. Wolsink et al. 2003)
- Knowledge of local conditions (M. Wolsink et al. 2003)

Specific research area

E-T correlation

- Land use inventory(W. Leduc et al. 2013)
- Energy demand inventory (W. Leduc et al. 2013)
- Local renewable/ residual energy potential analysis (W. Leduc et al. 2013)
- Clusters of spatial functions exploration (W. Leduc et al. 2013)
- Energetic linkages analysis (W. Leduc et al. 2013)
- Network patterns exploration (W. Leduc et al. 2013)

Specific research area

L-T correlation

- Regression analysis for nocturnal UHI (B.G. Heusinkveld et al. 2014)
- Relation between UHI and open water fraction (G.J. Steeneveld et al. 2014)
- Building types and energy consumption (B. Howard et al. 2012)
- Linear regression of UHI max and inhabitants number (L.W.A. van Hove et al. 2011)
- Cell analysis of urban morphology on temperature (S. J. Janssen et al. 2011)

Specific research area

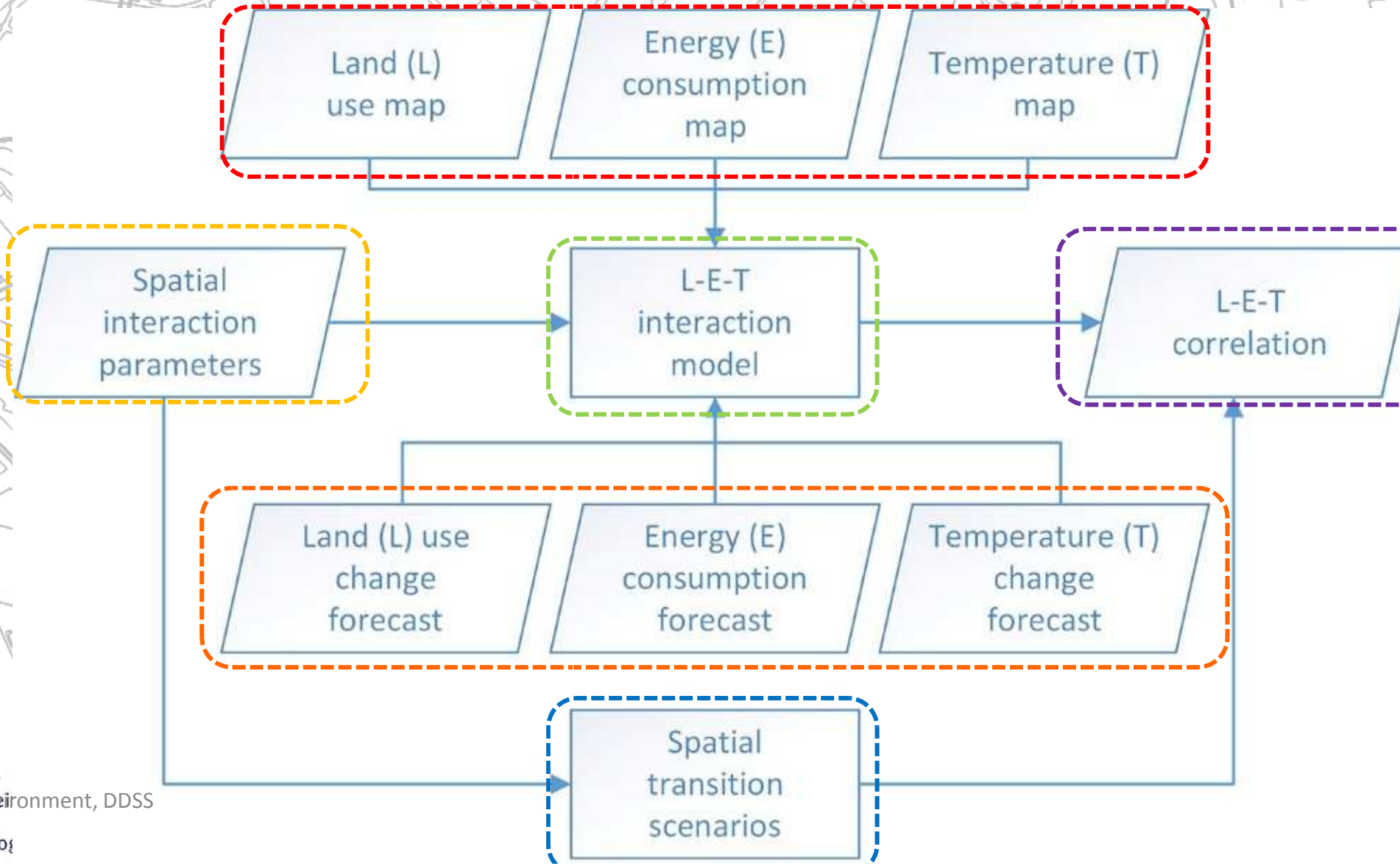
L-E-T correlation

- Spatial relationship of neighboring land uses and local temperature (J. Kim et al. 2013)
- Data collection from Cargo bike to model the urban climate (B. V. Hove et al. 2011)
- Model the impact of land use and climate change (L.A. House-Peter et al. 2011)

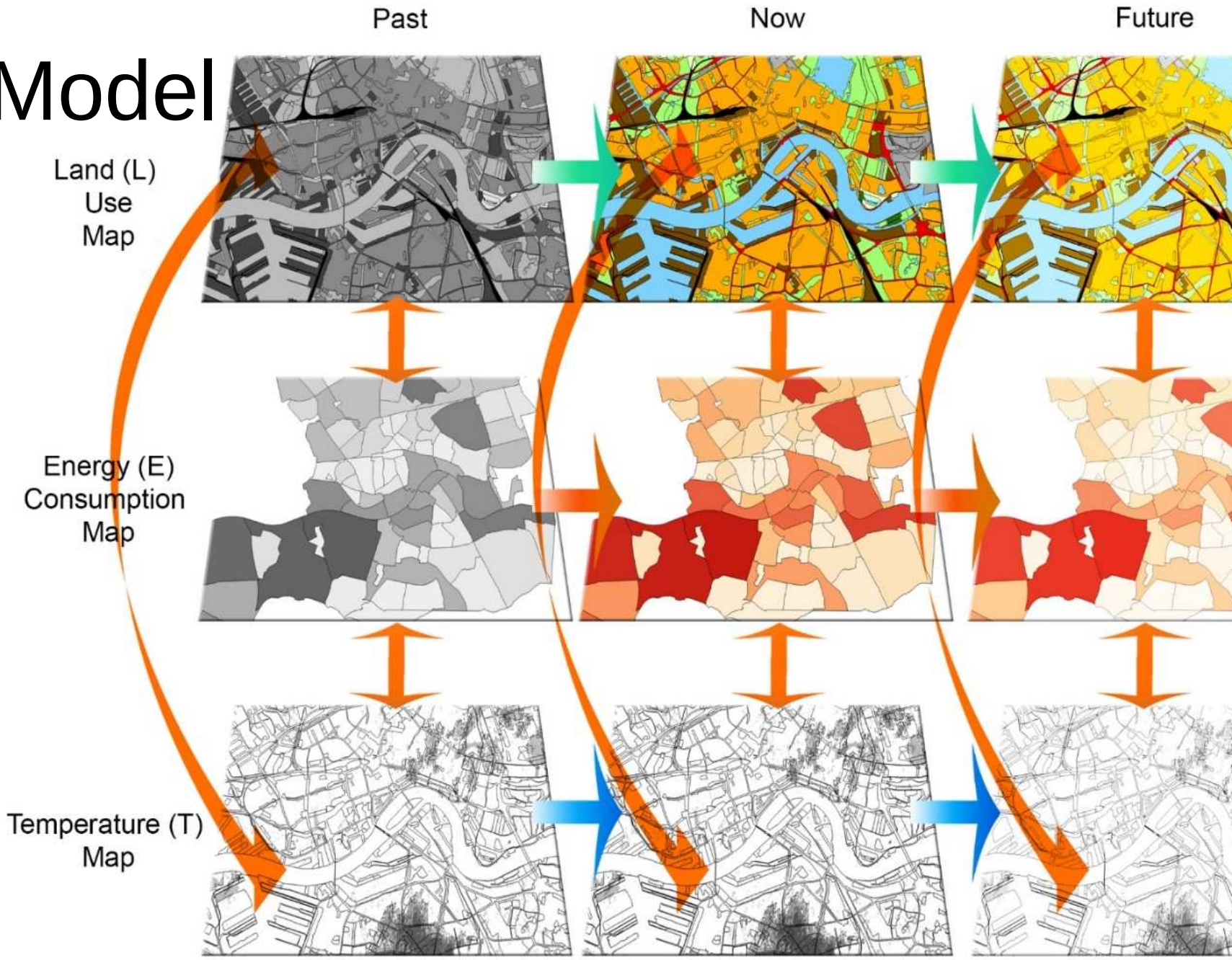
LET correlationships methods

Method	Spatial Scale	Variables	Land us change
• Statistical analysis • Engineering • Neural network	• Country • City • Neighbor • Zip code • Census block • Author defined	• Dependent variables • Independent variables	• Sprawl scenario • Dense scenario

Research Framework



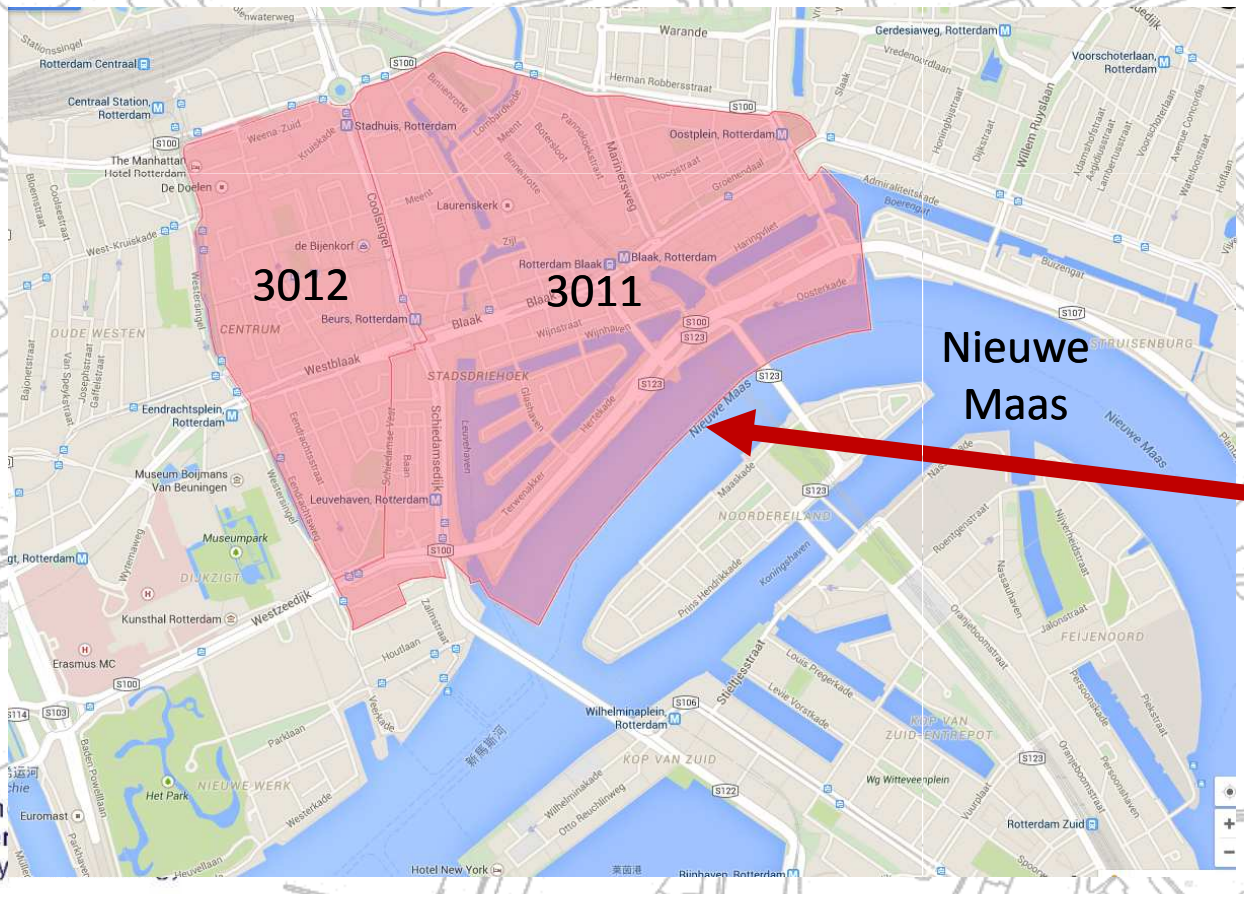
L-E-T Model


Past
Now
Future
Land (L) Use Map
Energy (E) Consumption Map
Temperature (T) Map

Research Area

Rotterdam: 51°55”51’N, 4° 28”45’E

Zip code: 3011, 3012



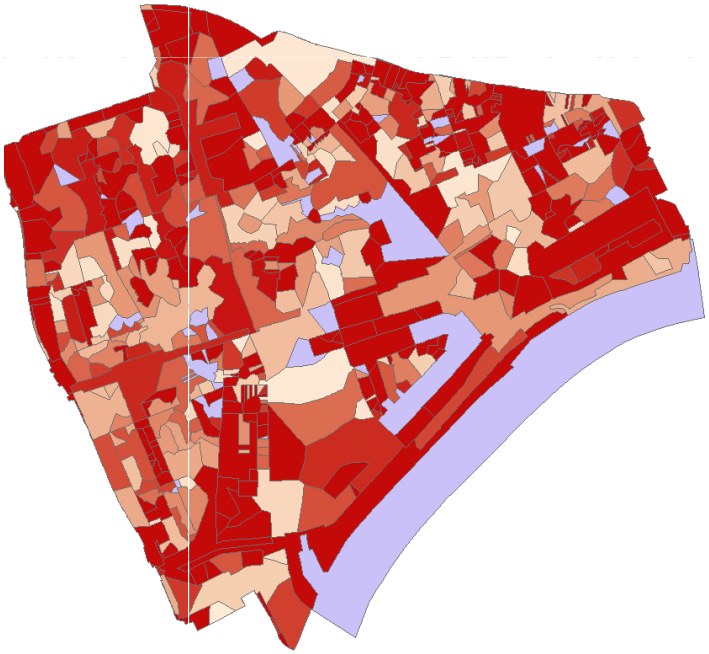
Source: Open Stre

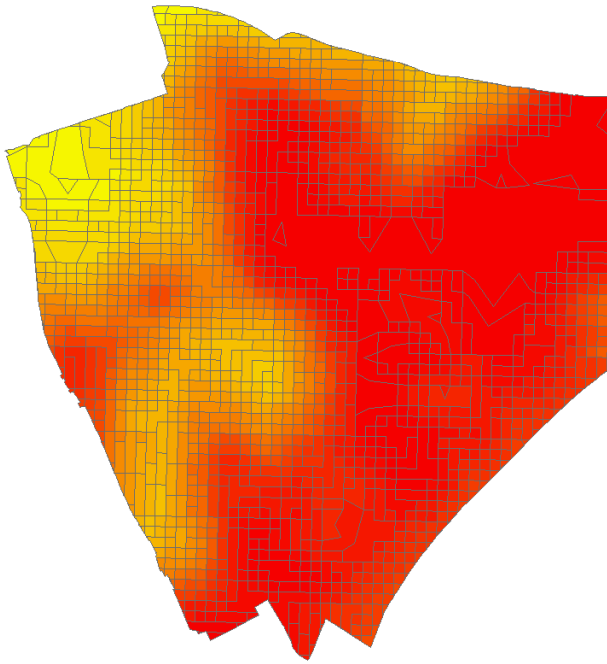
Land use & Energy & Temperature

Land use (L): DANS (Data Archiving Networked Services)

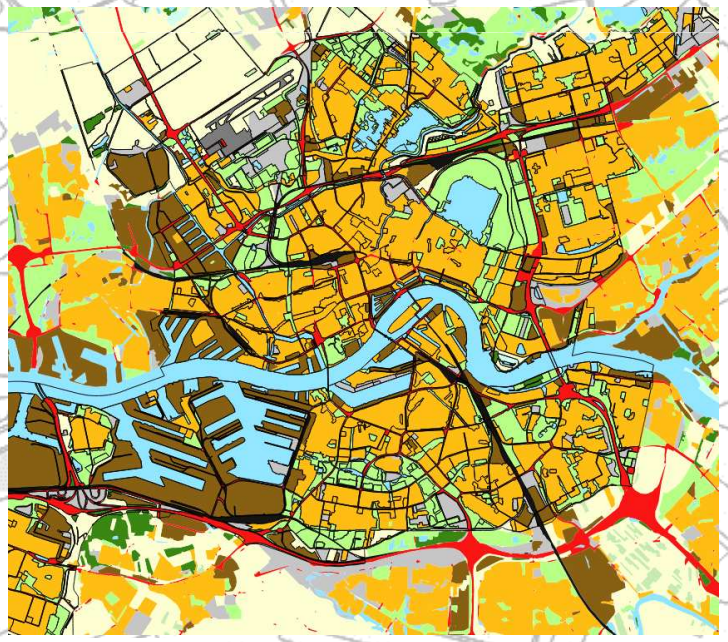
Energy Consumption (E): City of Rotterdam

Temperature (T): Landsat-USGS



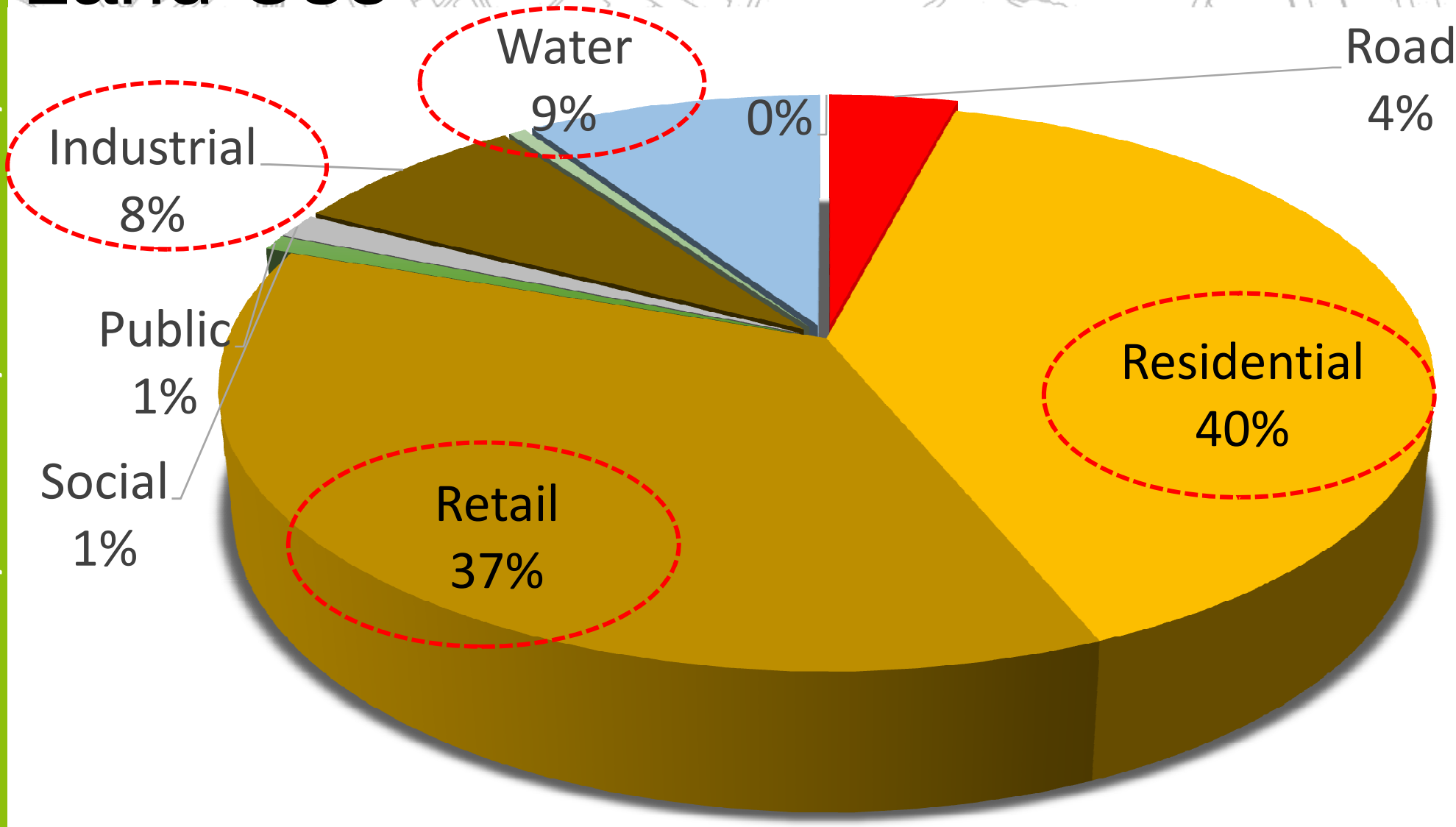


Land Use



Coding group	Coding	Land use type	Coding group	Coding	Land use ty
1	10	Rail area	5	50	Greenhouse cultivation
	11	Road area		51	Other agr area
	12	Airport	6	60	Forest
2	20	Residential area		61	Natural area,
	21	Retail and bars		62	Natural area,
	22	Public facilities	7	70	Ijsselmeer
	23	Social & cultural		71	Closed sea
	24	Industrial areas		72	Rijn & Maas
3	30	Dump		73	Border lake
	31	Wreck/storage place		74	Water winnir
	32	Cemetry		75	Water are leisure
	33	Mineral production place		76	Enclosed w mineral prod
	34	Construction area		77	Overflow are
	35	Other open space		78	Other water
4	40	Park	8	80	Wadden sea Dollard
	41	Sport		81	Oosterschelc
	42	Comminuty garden		82	Westerschelc
	43	Leisure (short stay)		83	North sea
	44	Leisure (long stay)	9	90	Foreign cour

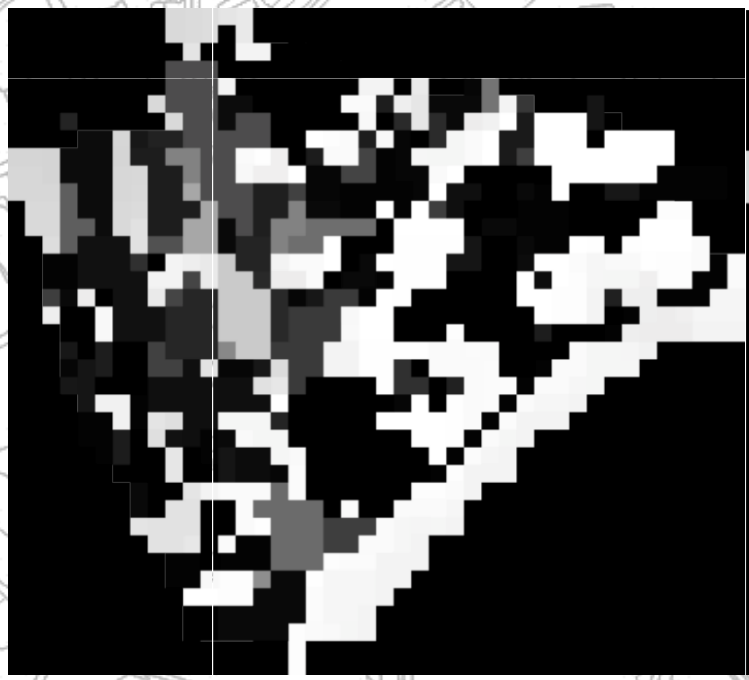
Land Use


Water
9%
0%
Road
4%
Industrial
8%
Public
1%
Social
1%
Residential
40%
Retail
37%

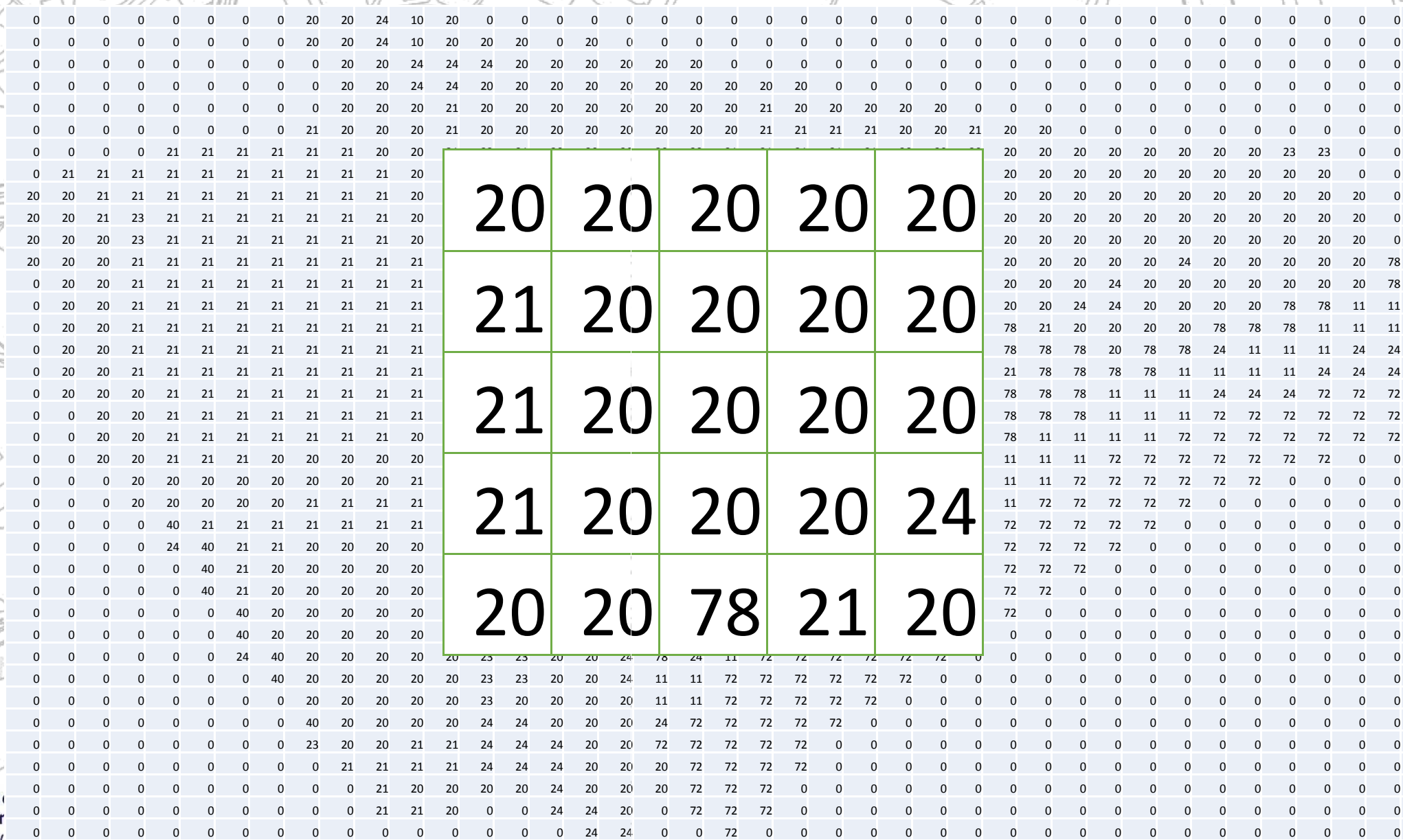
FME (File Management Engine)

Cell size: 50*50 m^2

Selected Area: 25,075 m^2



FME to Excel- Land Use



20	20	20	20	20
21	20	20	20	20
21	20	20	20	20
21	20	20	20	24
20	20	78	21	20

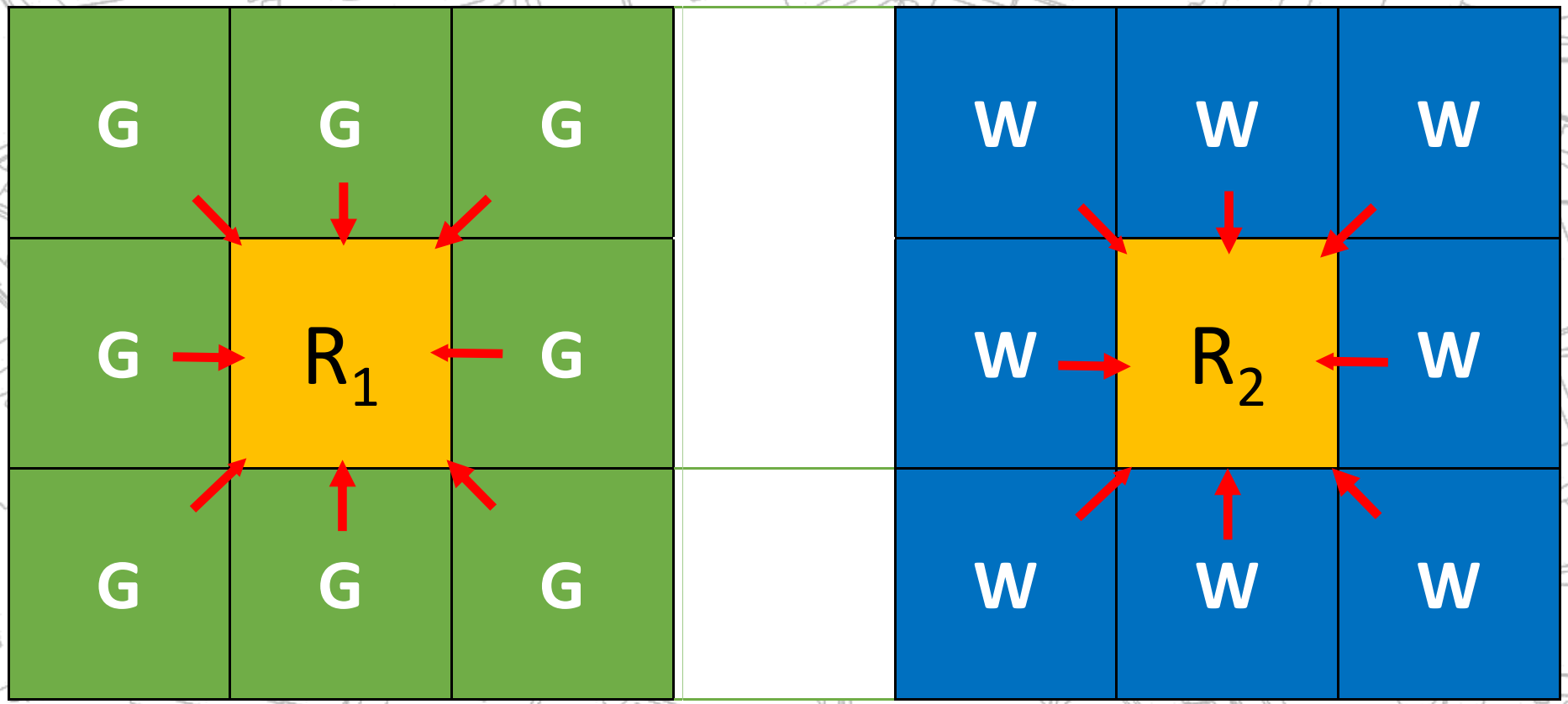
Introduction/ Method/ Framework/ Results

FME to Excel- Electricity Consumption

12.43004	12.43004	12.43004	12.43004	12.43004
91.54149	12.43004	12.43004	65.06169	23.13561
12.43004	12.43004	12.43004	23.13561	23.13561
12.43004	65.06169	65.06169	23.13561	23.13561
123.344	8.724556	8.724556	65.06169	23.13561

Hypothetical Model

Difference between R_1 and R_2 ?



Algorithm

Center

Neighbor

$$y = \beta_1 x_1 + \beta_2 x_2$$

y : *natural logarithm of electricity consumption in central cell*

β_1 : *electricity consumption regression correlation of central land use*

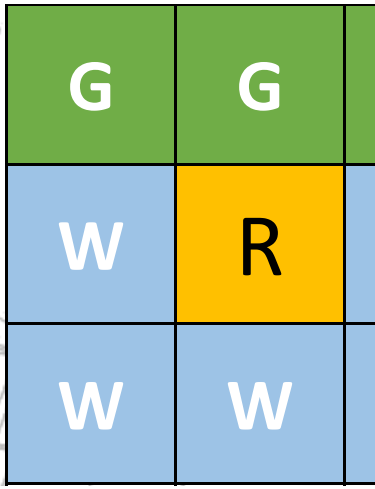
β_2 : *electricity consumption regression correlation of neighboring lan*

x_1 : *land use % of central cell*

x_2 : *land use % of neighboring cell*

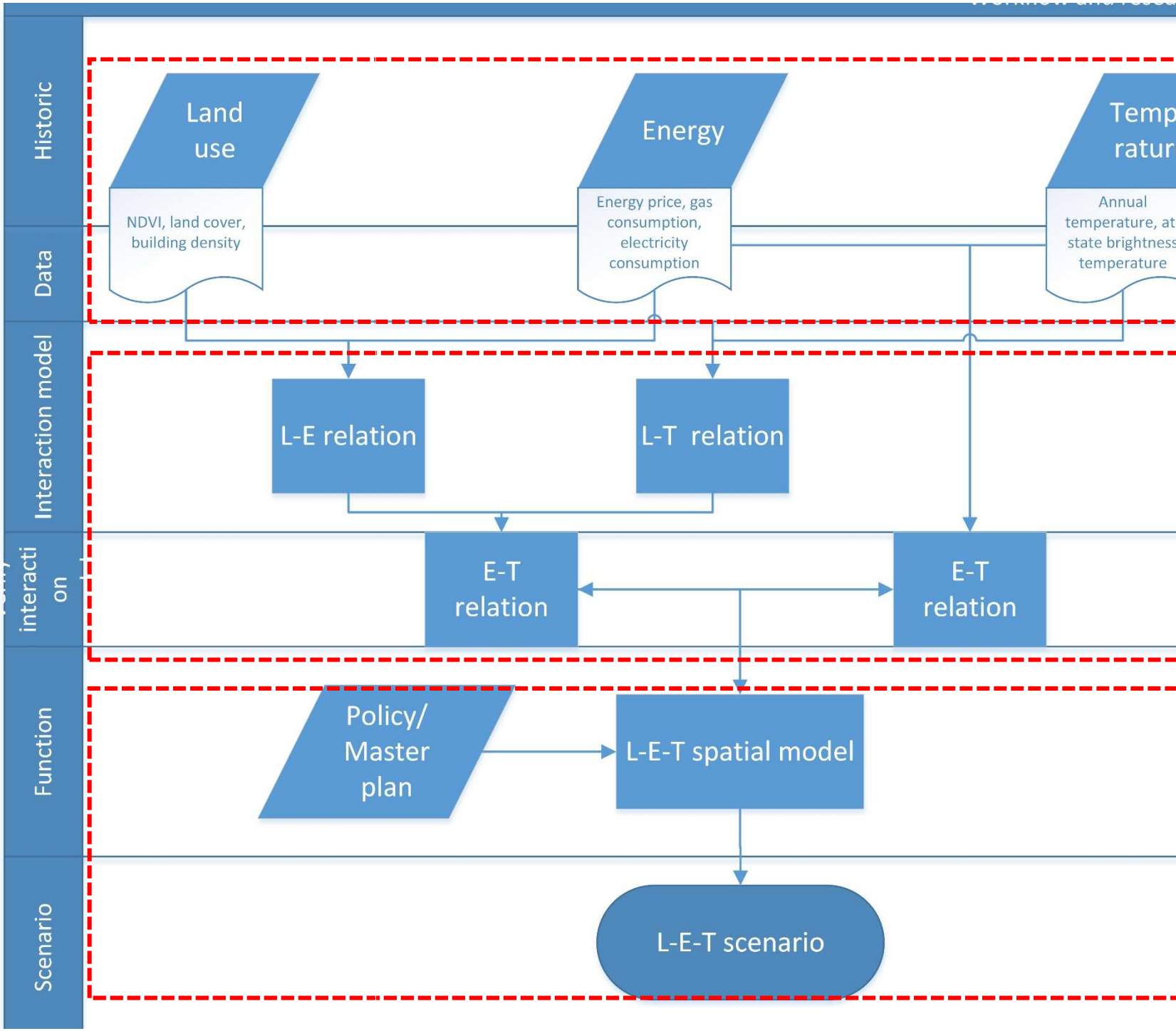
Algorithm-example

$$y = \beta_1 x_1 + \beta_2 x_2$$



		Residential	Green	Water
y	*natural logarithm of electricity*			
β_1	*regression correlation of central cell*	*regression correlation of residental to residential*		
β_2	*regression correlation of neighboring cell*		*regression correlation of green to residential*	*regression correlation of water to residentia*
x_1	*land use % of central cell*	1	0	0
x_2	*land use % of neighboring cell*	0	3/8	5/8

Further steps



Thank You for Your Attent

Q & A

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