



WROCLAW UNIVERSITY
OF ENVIRONMENTAL
AND LIFE SCIENCES

Decision Support Systems in Urban Planning

Dr Jan Kazak

Urban planning...

Smart decisions...

Who decide?

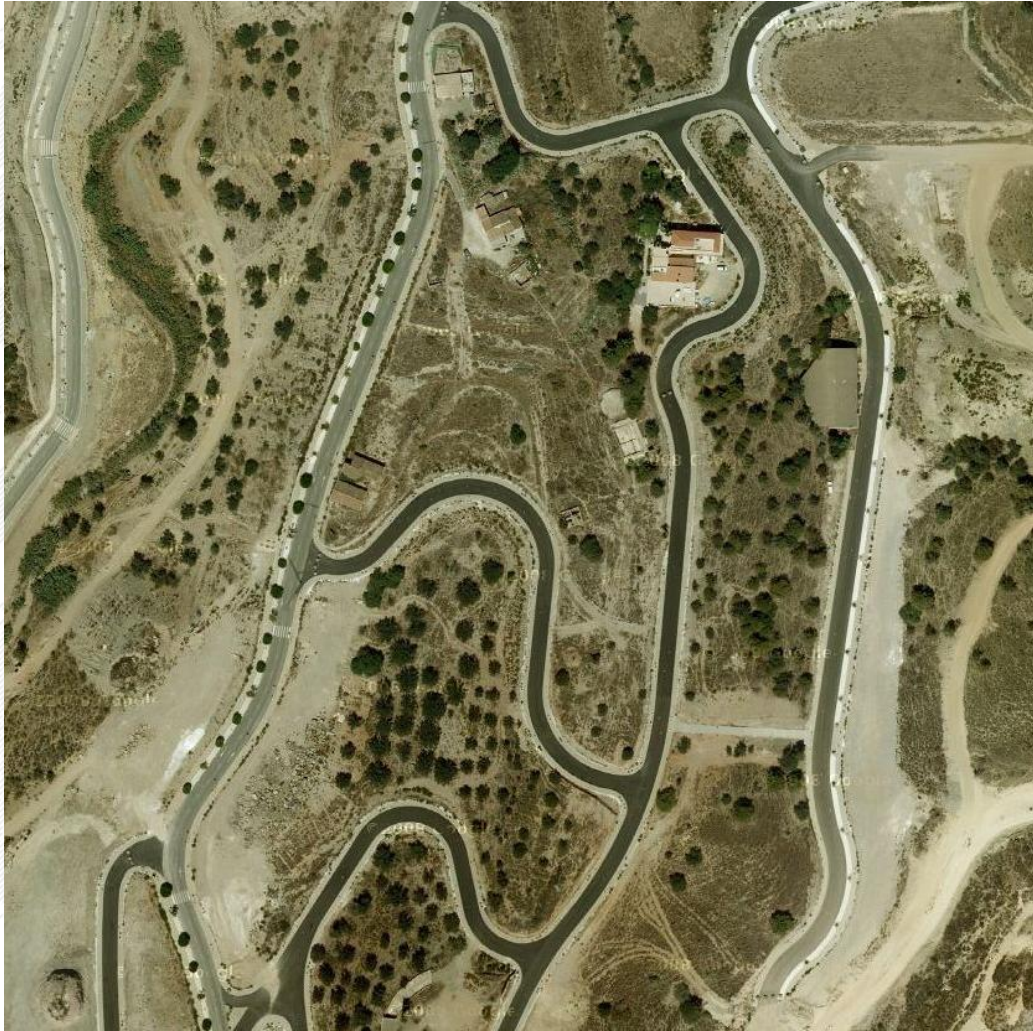


HikingArtist.com

If we want smart urban design
we have to know possible
impact of our decisions!

Examples

Urban design that did not meet local needs



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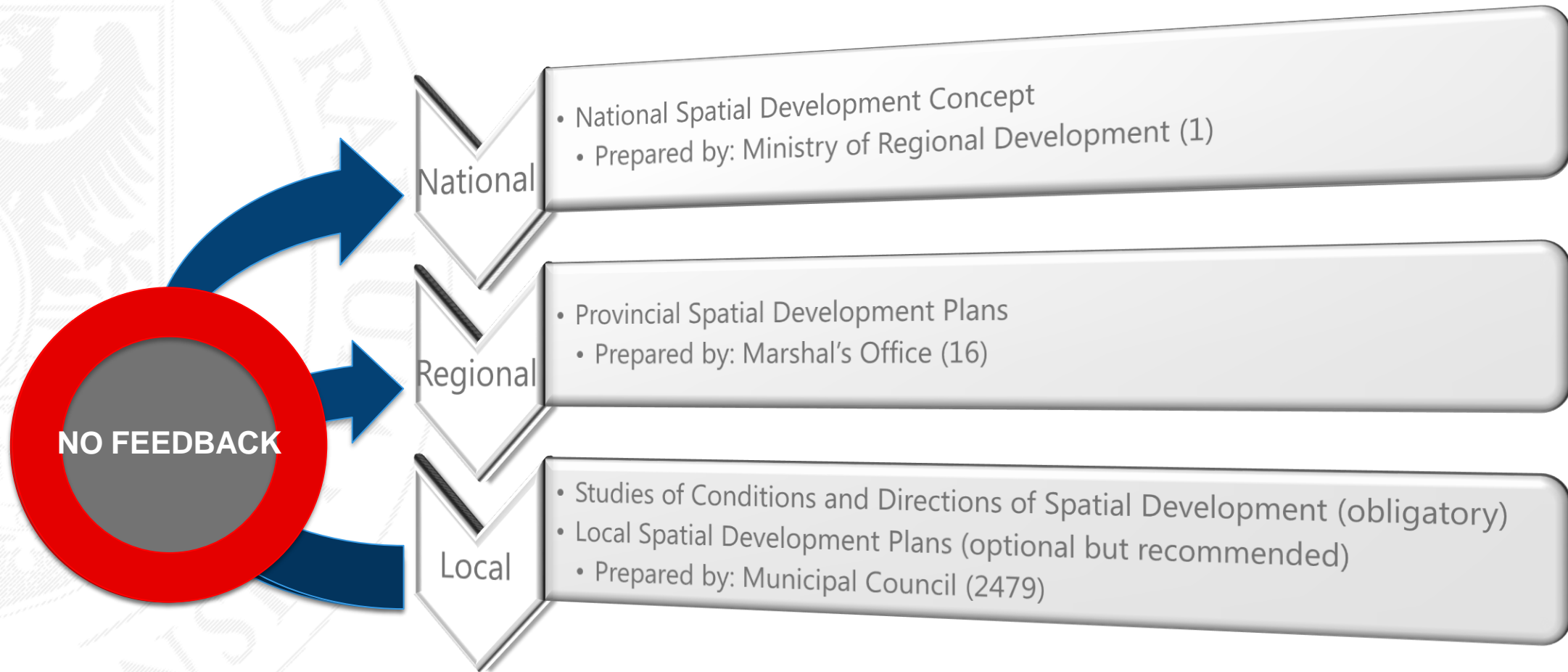
Examples

Urban design that did not meet local needs



Polish spatial planning system

Practise



Polish spatial planning system

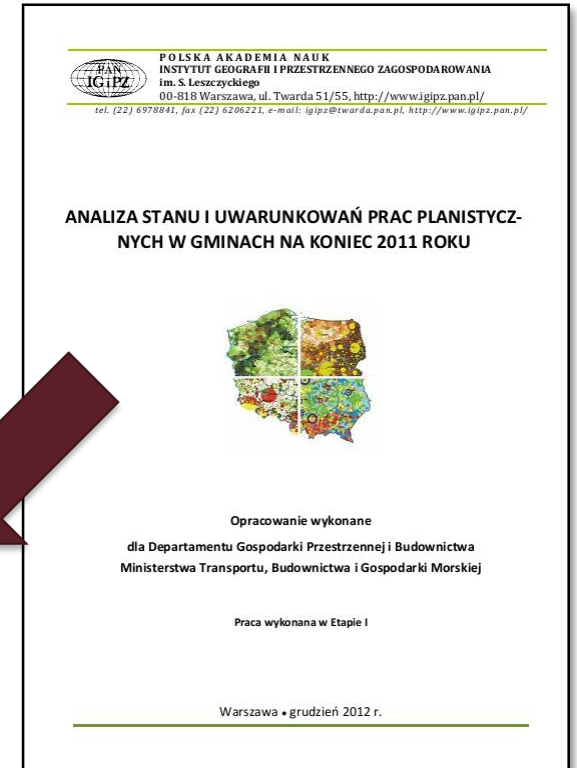
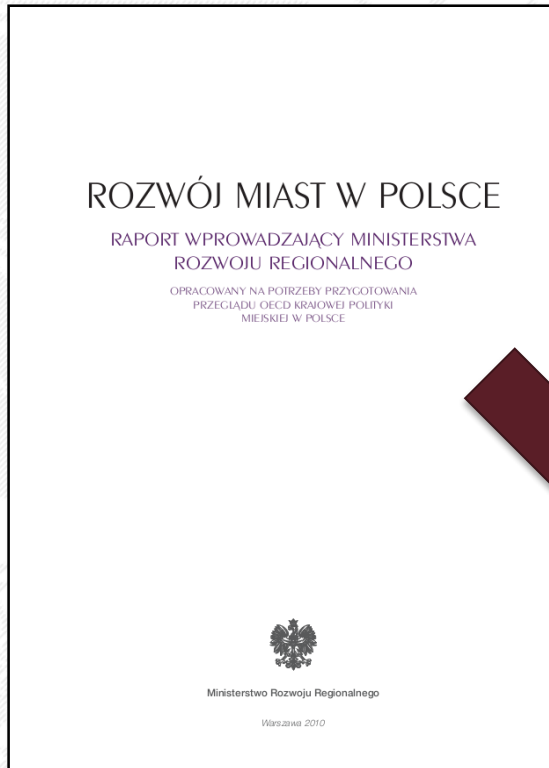
Practise

Report prepared for the
OECD review of National
Urban Policies

Analysis of the current
spatial planning situation
in Poland

About 1% of Poland is
covered by housing area

About 14% of Poland is
designed in spatial
planning documents for
housing area purposes



Effect

The diagram consists of two large, dark red arrows pointing in opposite directions. The left arrow points left and contains the text 'Social needs', 'Economical possibilities', and 'Environmental capacity'. The right arrow points right and contains the text 'Decisions in spatial planning documents'. The background features a faint, circular seal of the University of Wrocław with the text 'UNIVERSITAS VIENNA' and 'WROCLAW'.

Social needs
Economical possibilities
Environmental capacity

Decisions in spatial
planning documents

Therefore, Decision Support Systems... (1)

A definition of **Decision Support Systems** (DSS) was first given in a research paper by Morton in the early 1970s, though these systems have been in common use since the **mid-1960s**.

Morton conducted his research within a Department of Management and Information Processing, and he was one of the forerunners of supporting complex decision-making processes partially by the computerization of the analyses. The development of DSS was possible thanks to the popularization of minicomputers, timeshare operating systems and distributed computing.

Michael Scott Morton



<http://mitsloan.mit.edu/faculty-and-research/faculty-directory/detail/?id=41412>

Therefore, Decision Support Systems... (2)

DSS are computerized systems designed **to help managers to choose one of several alternatives** in the case of an analysed problem. They allow automating part of the decision-making processes that require the analyses of large amounts of data in a relatively short period of time. DSS provide the structure which arrange such elements as models, participants, procedures, software, databases, communication and equipment. **Using DSS in unstructured or semistructured problems** allows the results to become more **readable for decision-makers.**

Principles of DSS (1)

Key features of the decision-making models used for DSS:

- **The ability to quantify the analysed elements.**

This is a particularly important step for multivariate analysis. The inability to express variables in numerical form gives rise to subjective judgments that cannot be supported by analysed systems.

Principles of DSS (2)

Key features of the decision-making models used for DSS:

- **The finity or infinity of possible outcomes of analysis.**

The model, in each case, will be different. A finite list of possible solutions, will supply the user ranking that compares different scenarios among themselves, prejudging which solution is the most optimal according to the model. In the case of an open list of solutions one deals with an iterative procedure. The model can test new solutions all the time without providing a guarantee that it found the most optimal answer to the question. On the other hand, such models usually verify a much larger number of possible solutions, and make it possible to compare more elements.

Principles of DSS (3)

Key features of the decision-making models used for DSS:

- **The uncertainty of the model.**

It has to be determined which elements are based on so-called robust data. This means that the value of these data has been examined previously and it is well-understood at the beginning of the construction of the model. Complementary to the robust data is the knowledge about uncertainties. It should be clarified what values come from assumptions or plans and they might be changed in the decision making process (social acceptance of different factors, values which describe standards of quality of life, etc.).

Principles of DSS (4)

Knowledge about the field of uncertainty is critical because it allows a user to specify the range of possible changes and the construction of different scenarios, for instance, pessimistic scenario, optimal scenario, most likely scenario or optimistic scenario.

More details:

Jan Kazak, Joost van Hoof, Szymon Szewranski, Challenges in the wind turbines location process in Central Europe – The use of spatial decision support systems, Renewable and Sustainable Energy Reviews, Volume 76, 2017, Pages 425-433, ISSN 1364-0321, <http://dx.doi.org/10.1016/j.rser.2017.03.039>.

Spatial Decision Support Systems... (1)

A special group of DSS is represented by **Spatial Decision Support Systems (SDSS)**. SDSS combine the ability to store, search and retrieve data based on **geographic information systems** with models and **algorithms to optimize decisions regarding spatial problems**.

These systems allow decision-makers to use multi-dimensional spatial criteria in order to make decisions about the location by testing different alternatives. Because of the methods used in the calculation process and the output of the whole analysis they are classified as part of spatial econometrics.

Spatial Decision Support Systems... (2)

The concept of SDSS evolved in the mid-1980s and by the end of this decade it was defined as the authoritative branch of GIS. The beginning of 1990s brought the development of research in that field.

One of the outcomes of the studies, important from the management point of view, was that **SDSS** users were choosing more suitable solutions and made **less errors in the decision making process**.

Crossland MD, Wynne BE, Perkins WC. Spatial decision support systems: an overview of technology and a test of efficacy. *Decis Support Syst* 1995;14(3):219–35.

SDSS are frequently used in the social sciences in order to explain the processes and mechanisms of decision-making among society.

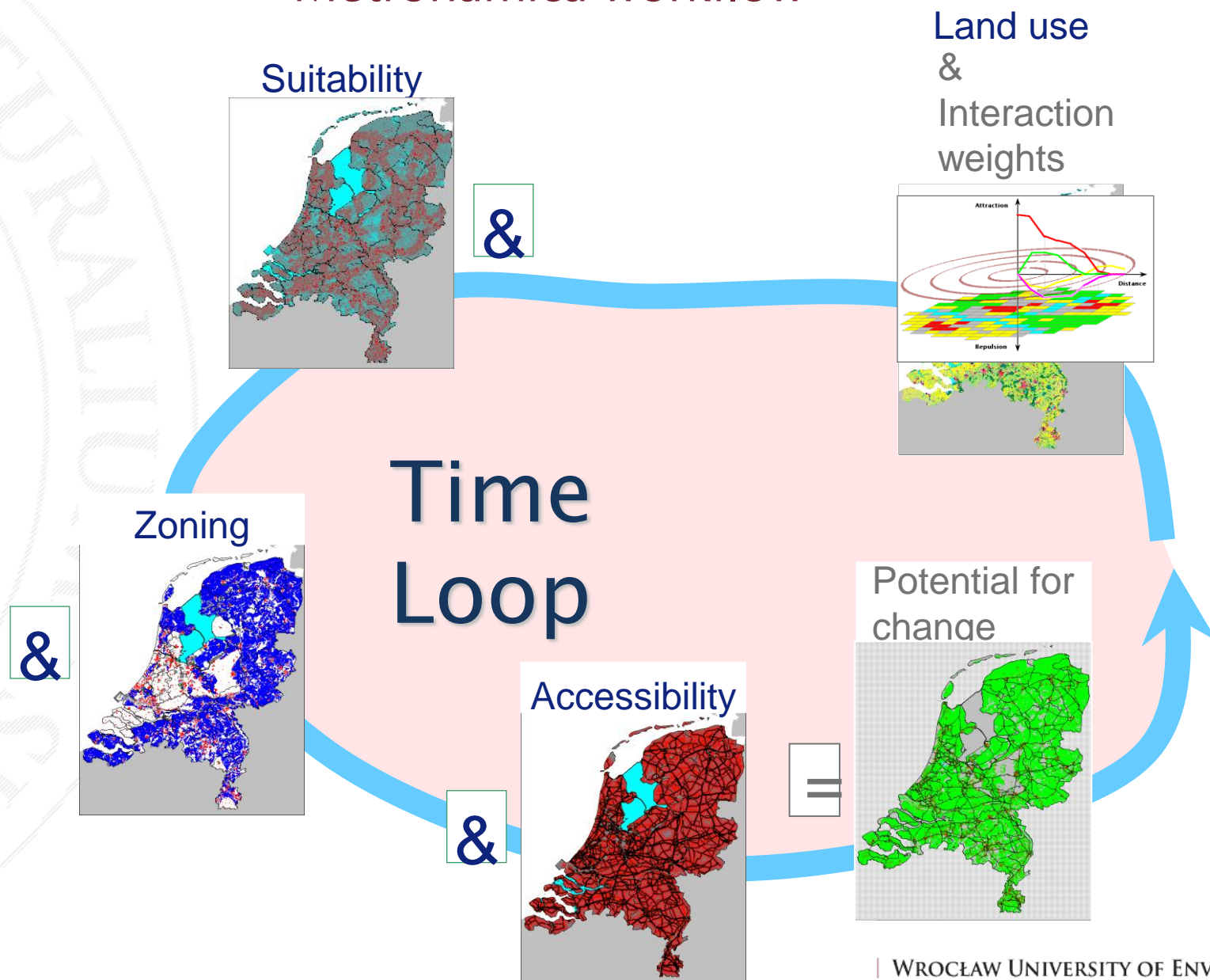
Pontius R, Jr., Si K. Spatial decision support systems. In: Wright JD, editor. Second edition. *International encyclopedia of the social & behavioral sciences*, 2015. Oxford: Elsevier; 2015. p. 136–41.

Questions for DDS

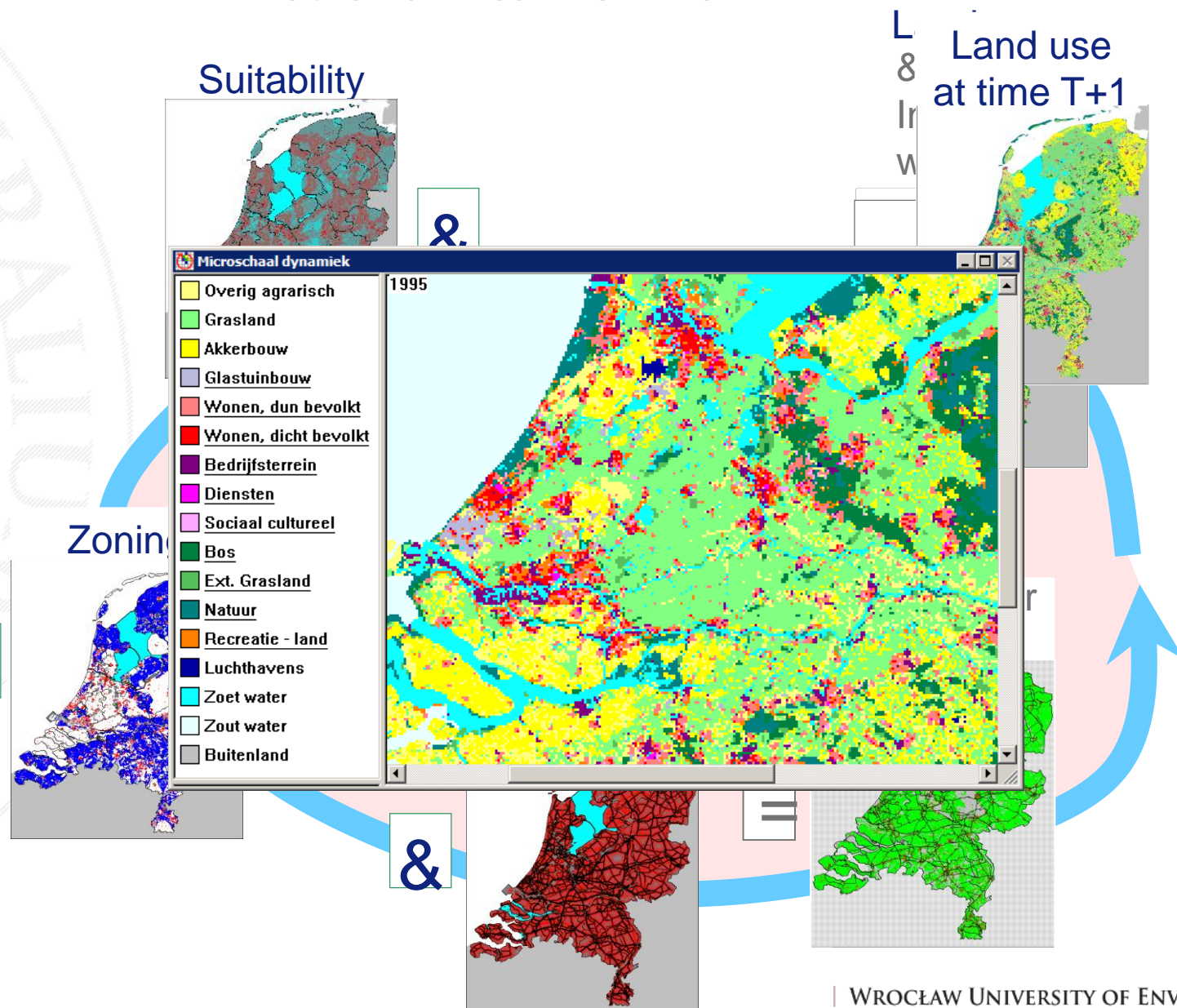
Where something
may happen?

What is the
possible possible
impact?

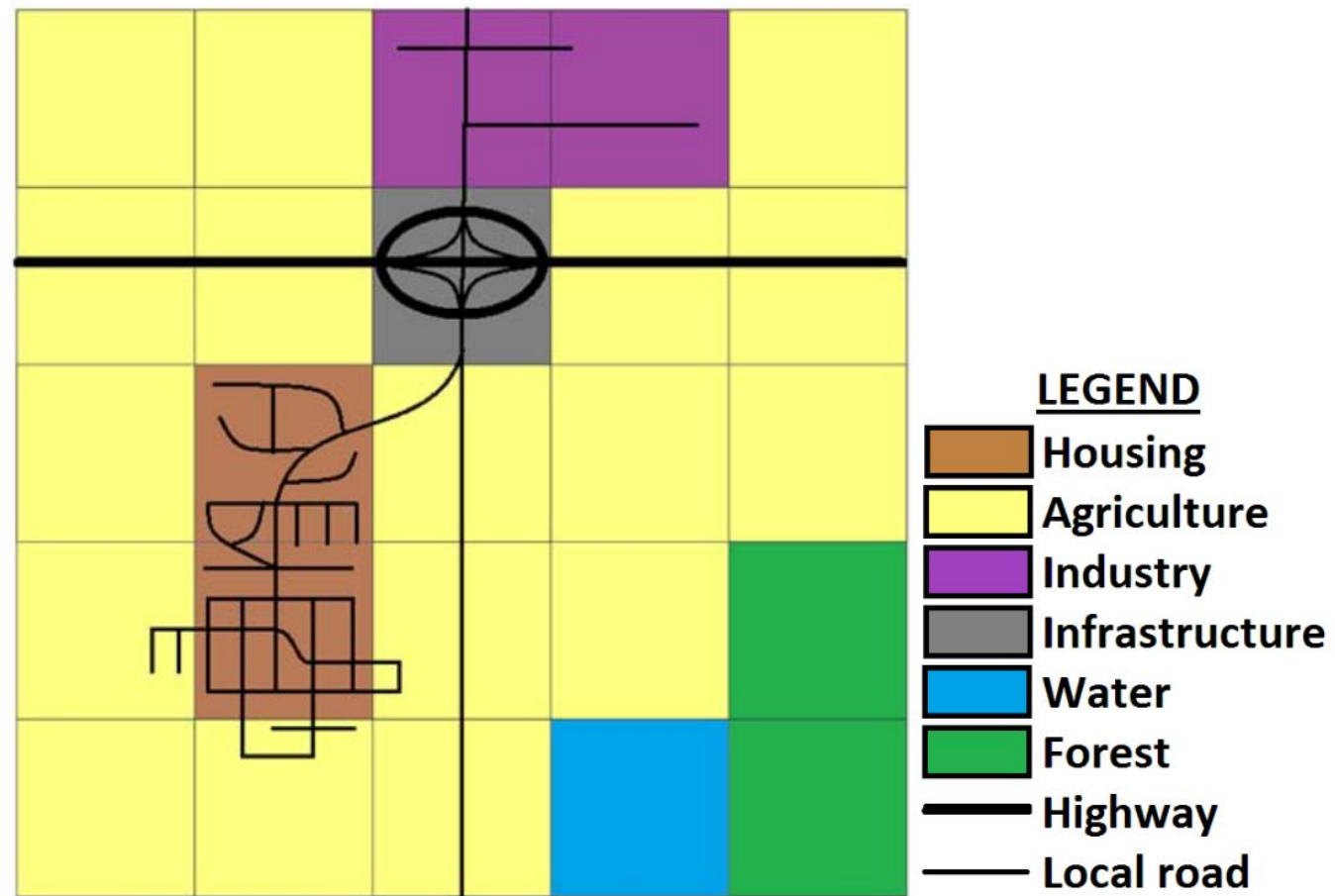
Metronamica workflow



Metronamica workflow

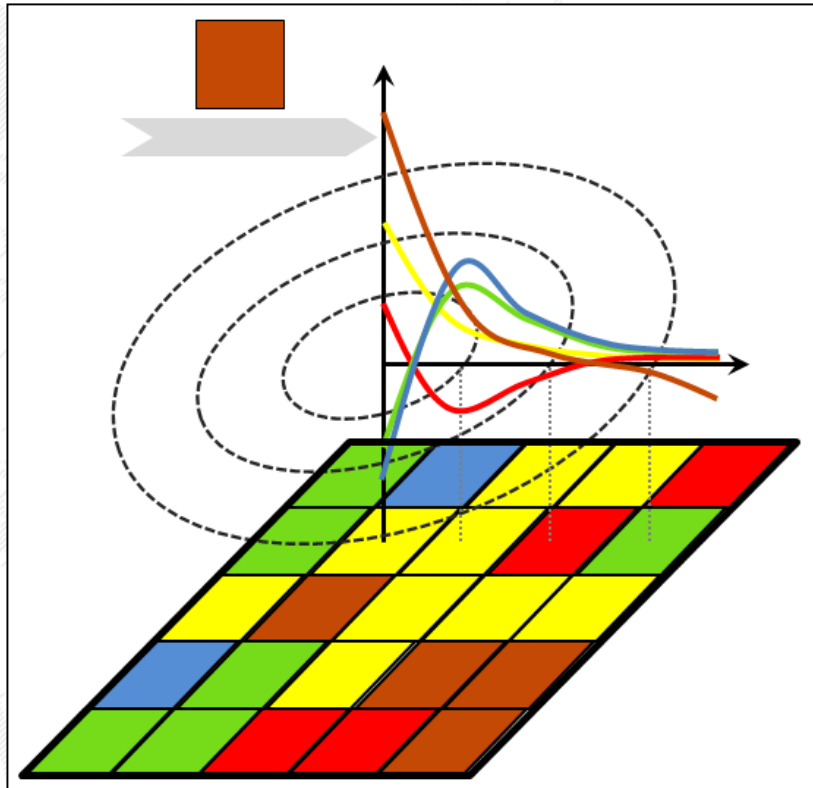
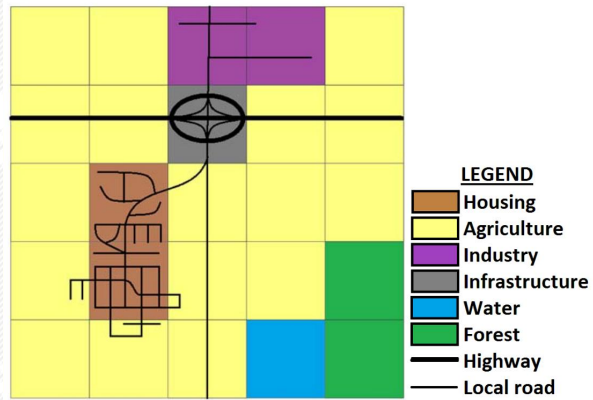


Metronamica workflow

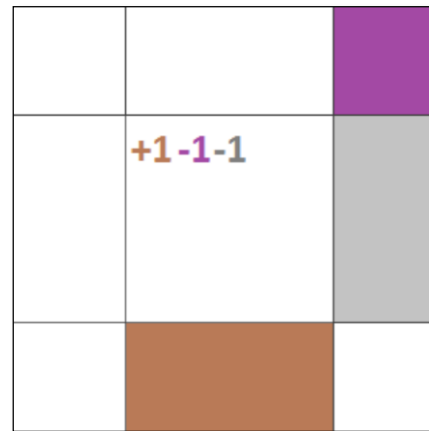


Metronamica workflow

Neighbourhood (interaction weights)

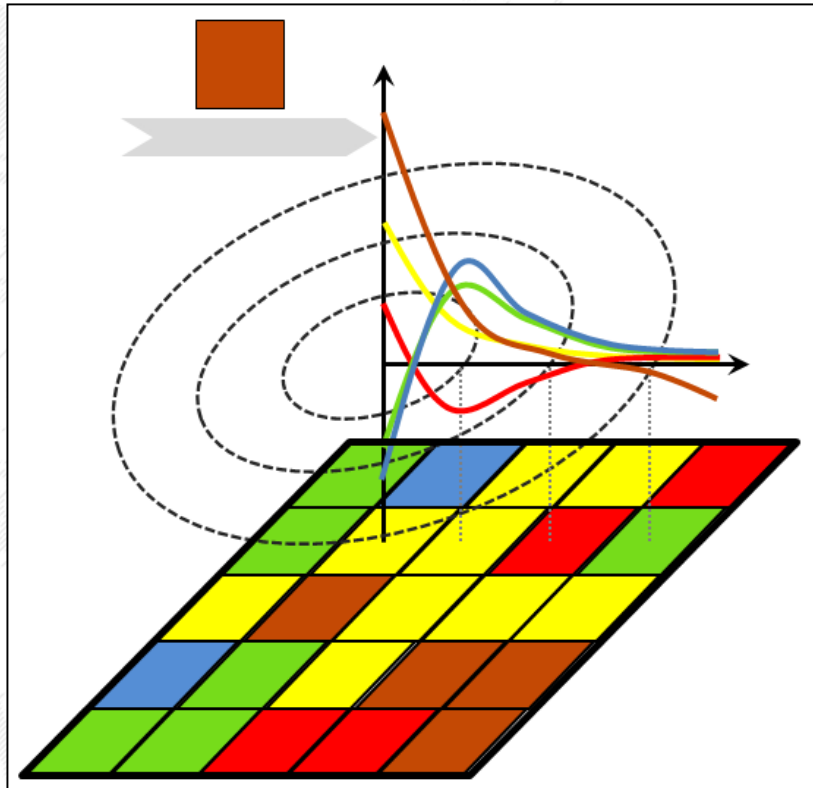
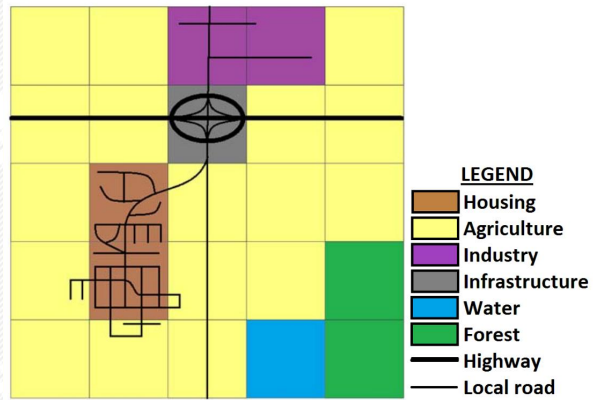


Example

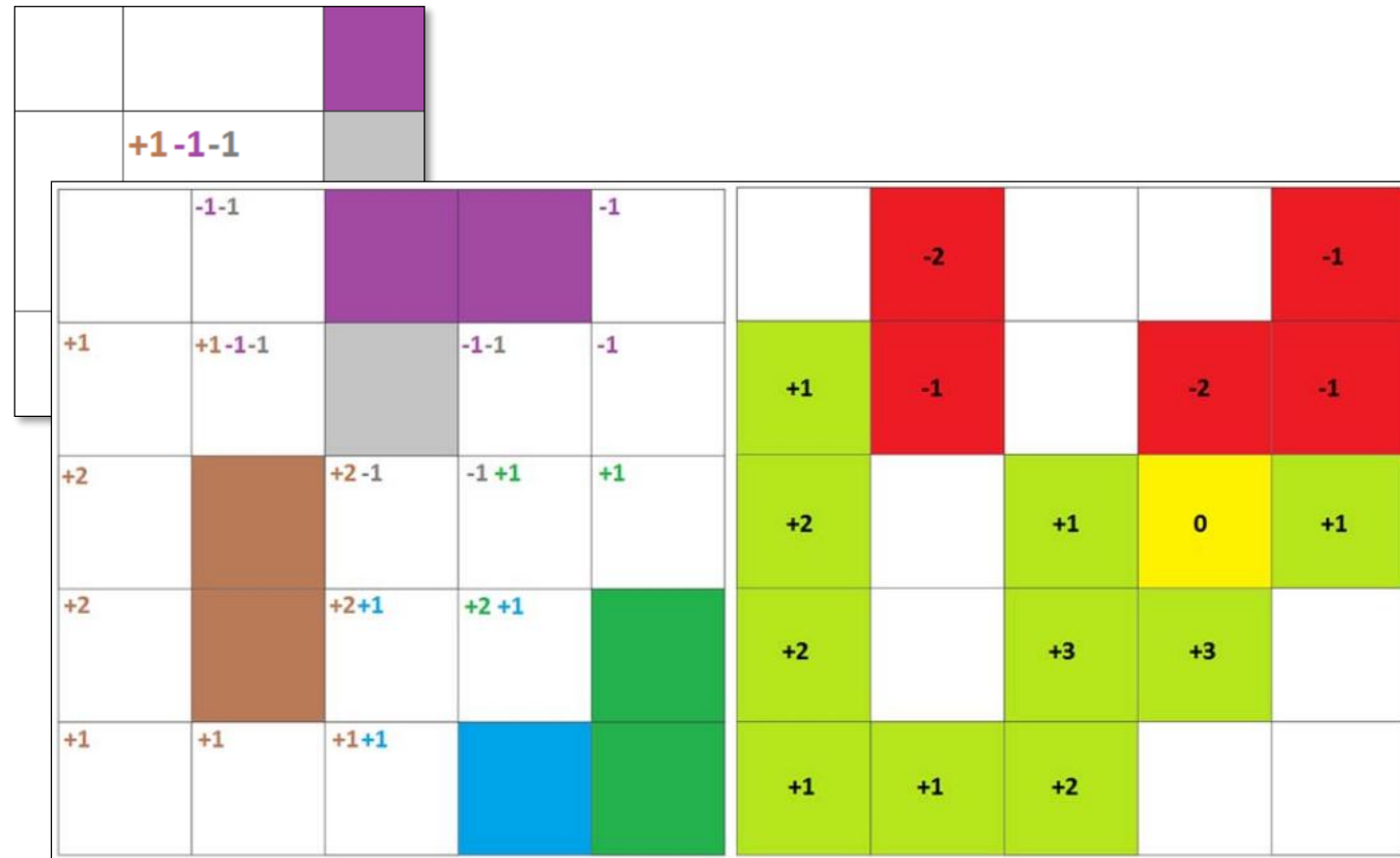


Metronamica workflow

Neighbourhood (interaction weights)

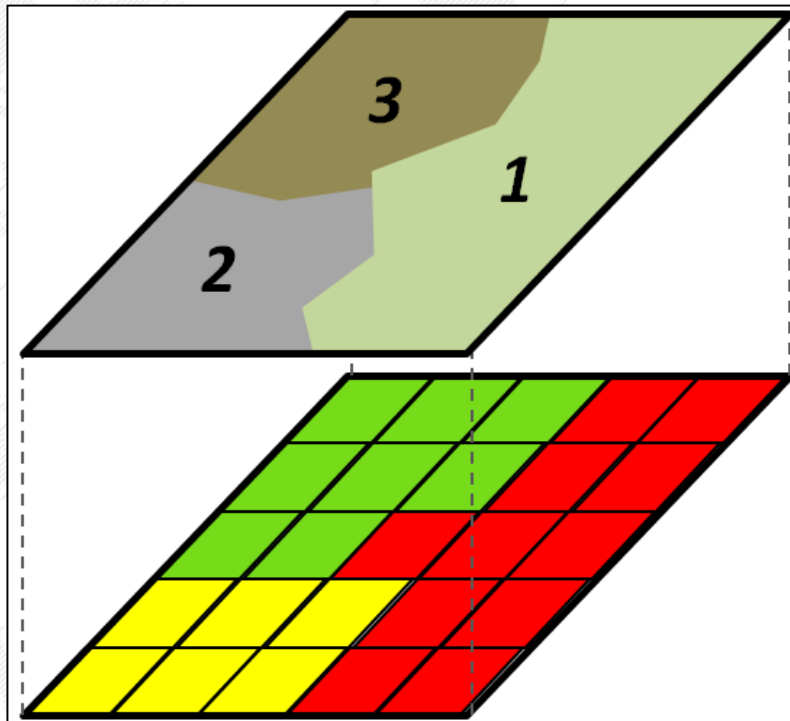
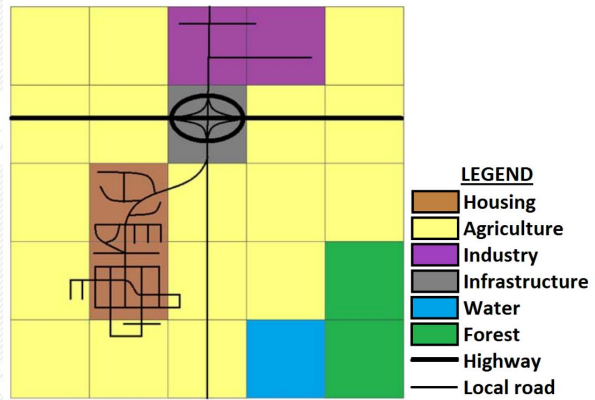


Example

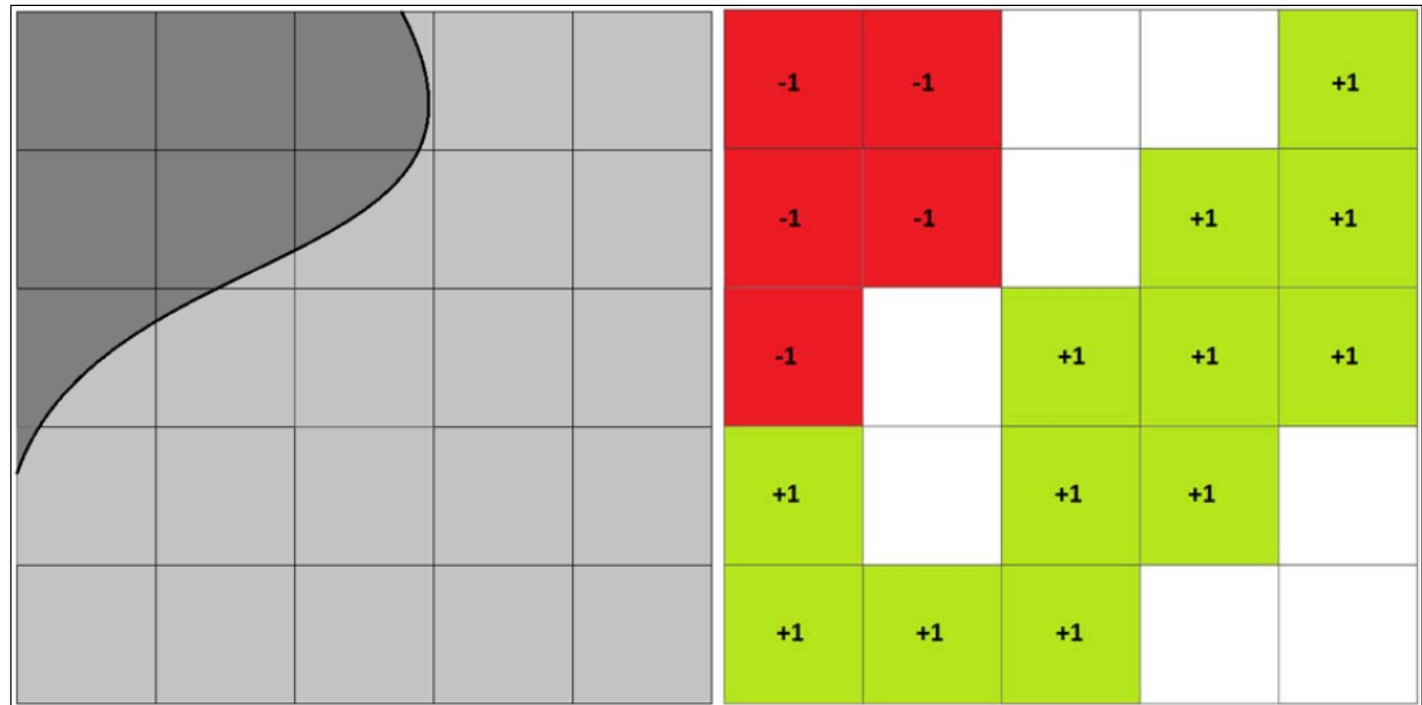


Metronamica workflow

Suitability & Zoning

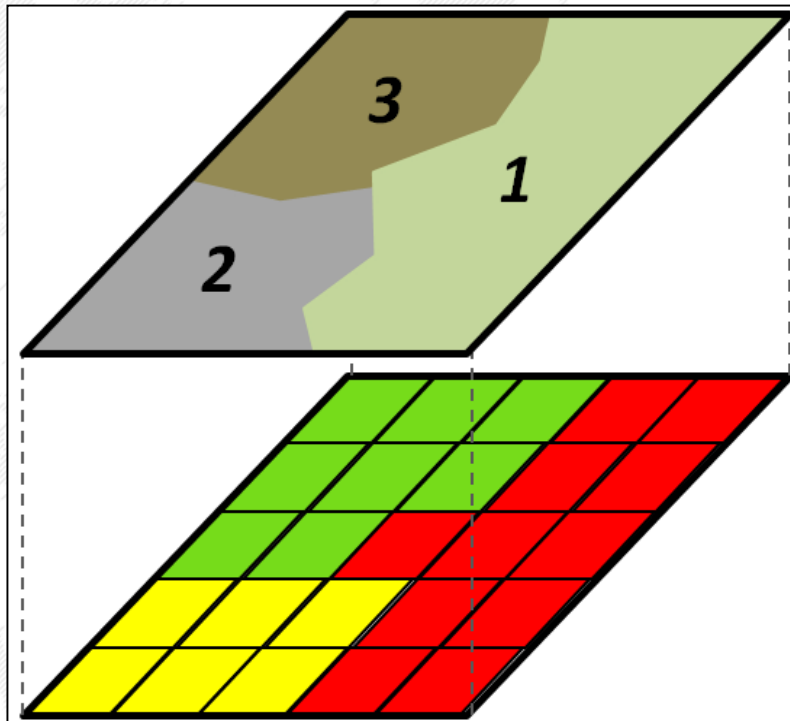
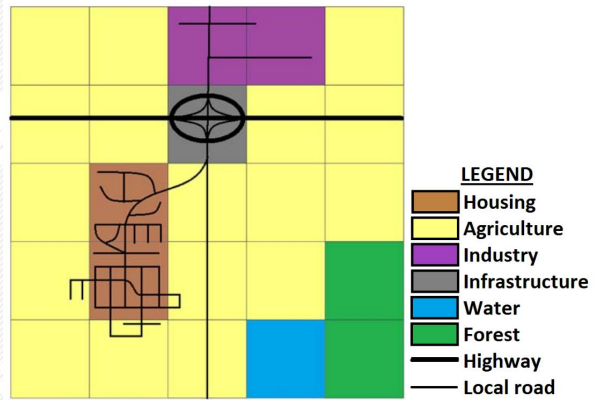


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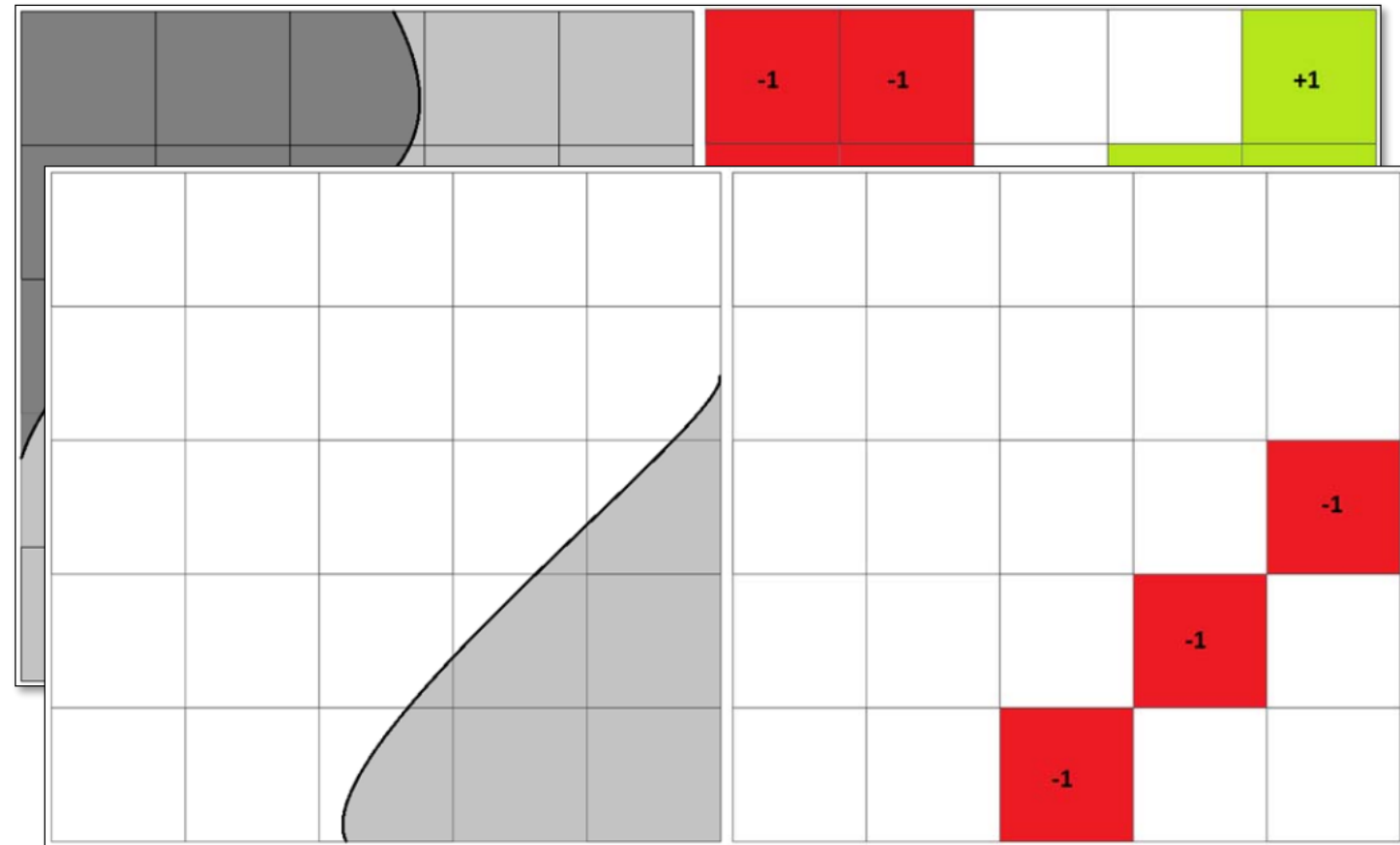


Metronamica workflow

Suitability & Zoning

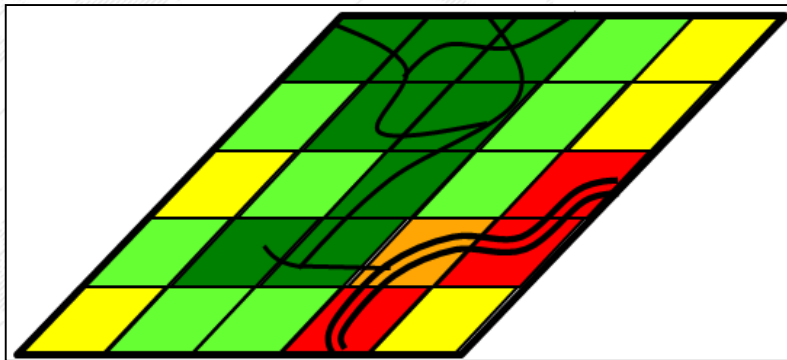
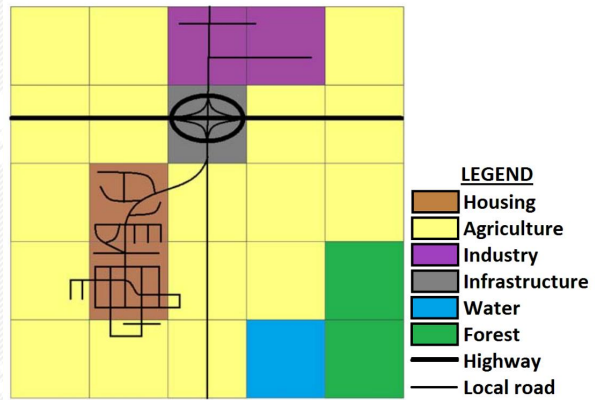


Example

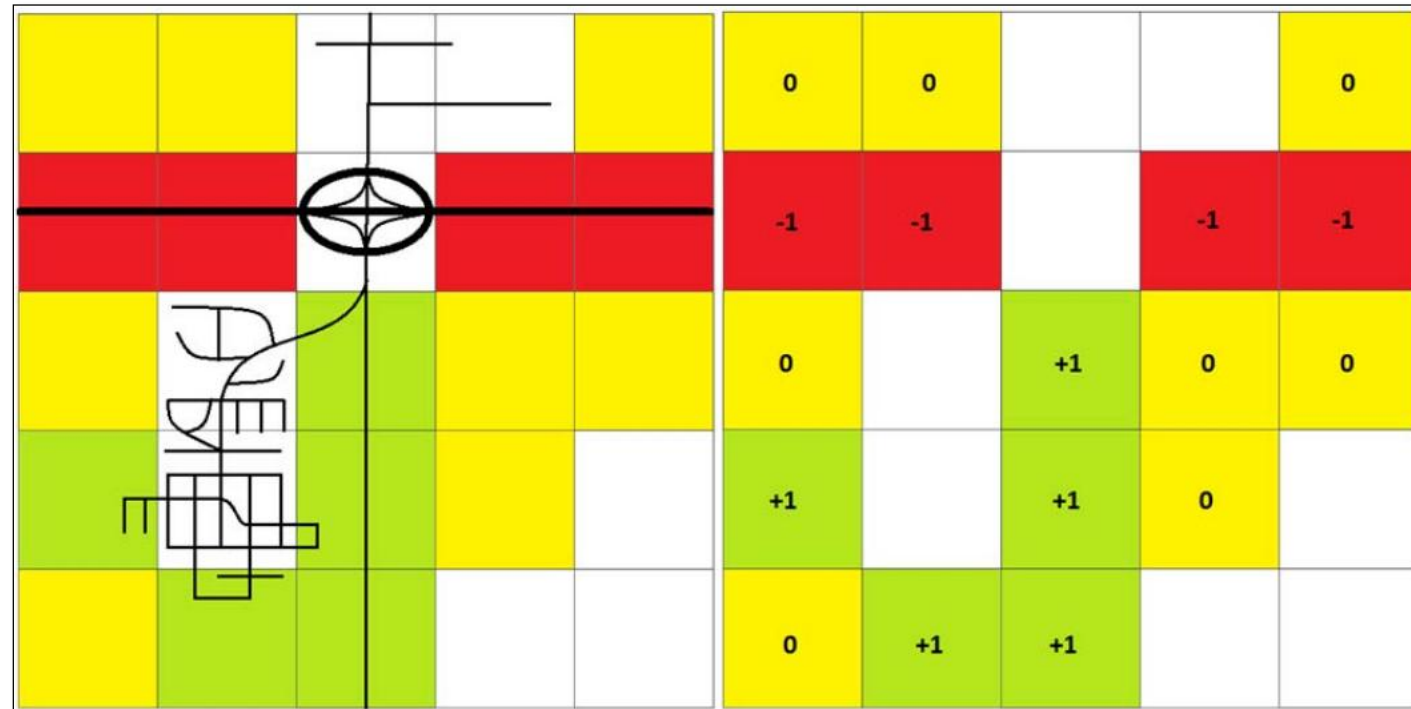


Metronamica workflow

Accessibility

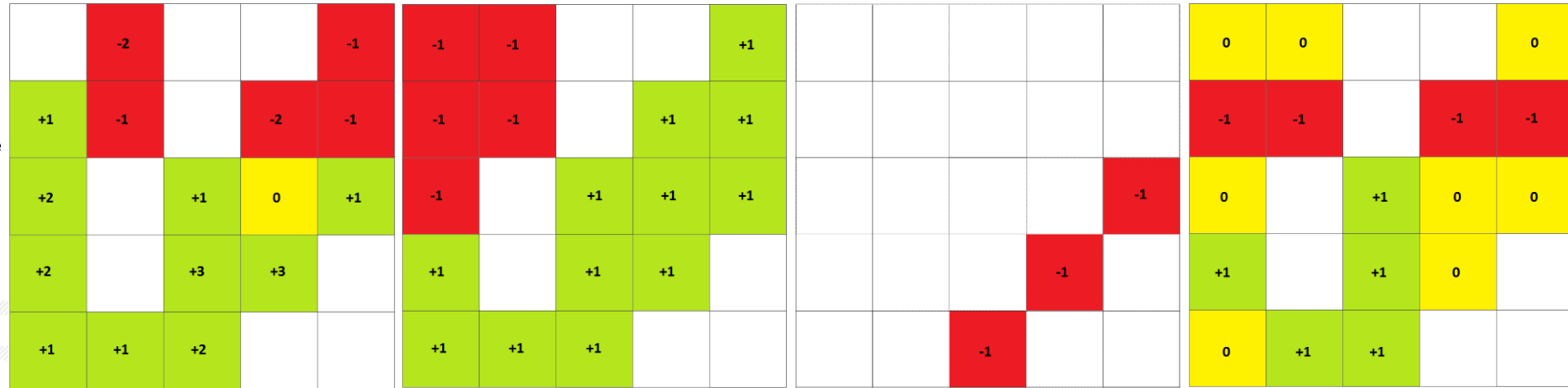
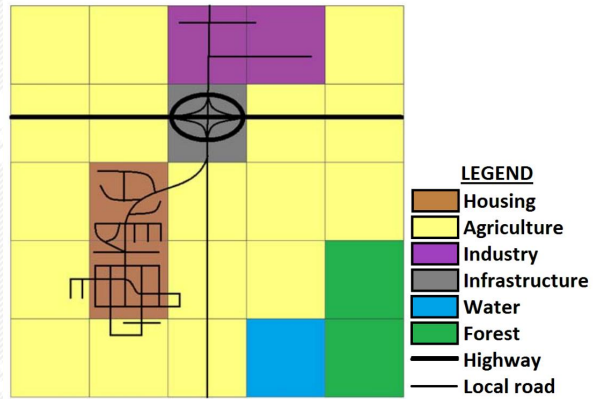


Example



Metronamica workflow

Total potential for land use change



More details :

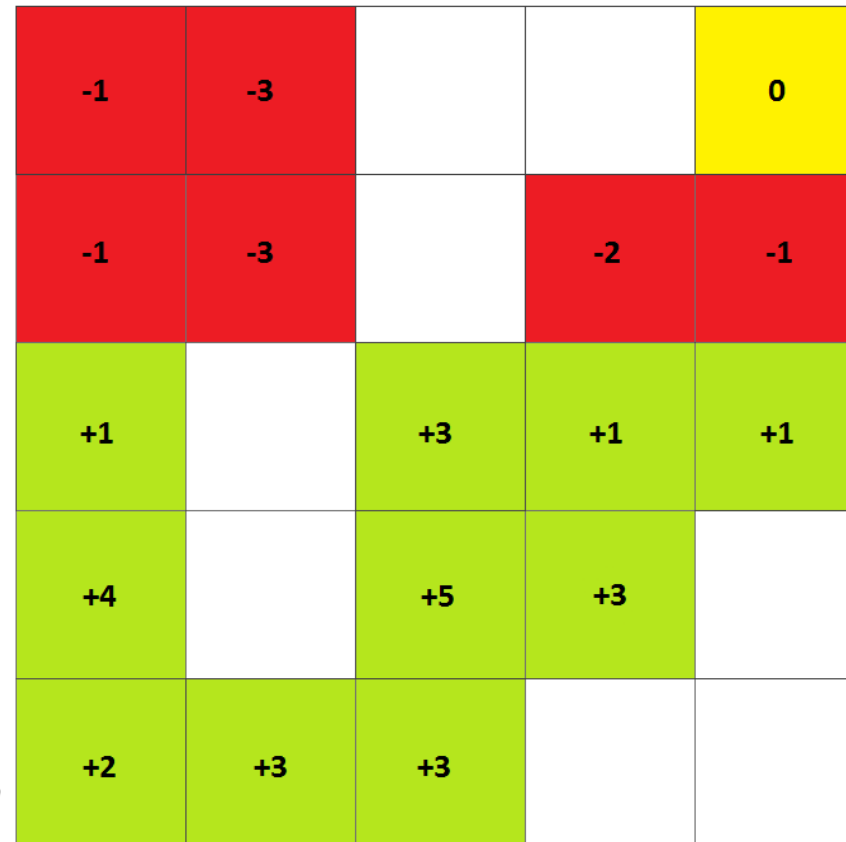
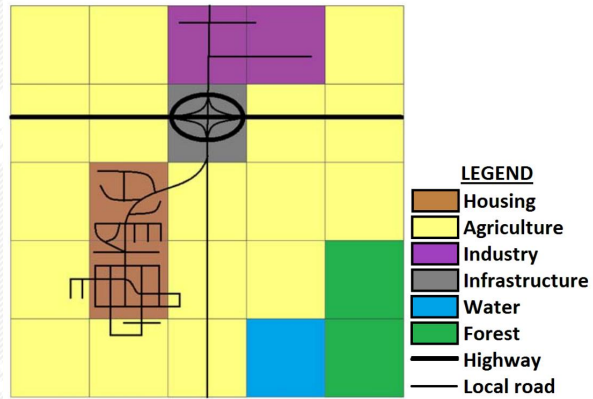
Kazak J., Wang T., Szewrański S. 2015, *Analysis of Land Use Transformation*

Potential in Spatial Management, Real Estate Management and Valuation,

Vol. 23, No. 1, pp. 5-14. DOI: 10.1515/remav-2015-0001 .

Metronamica workflow

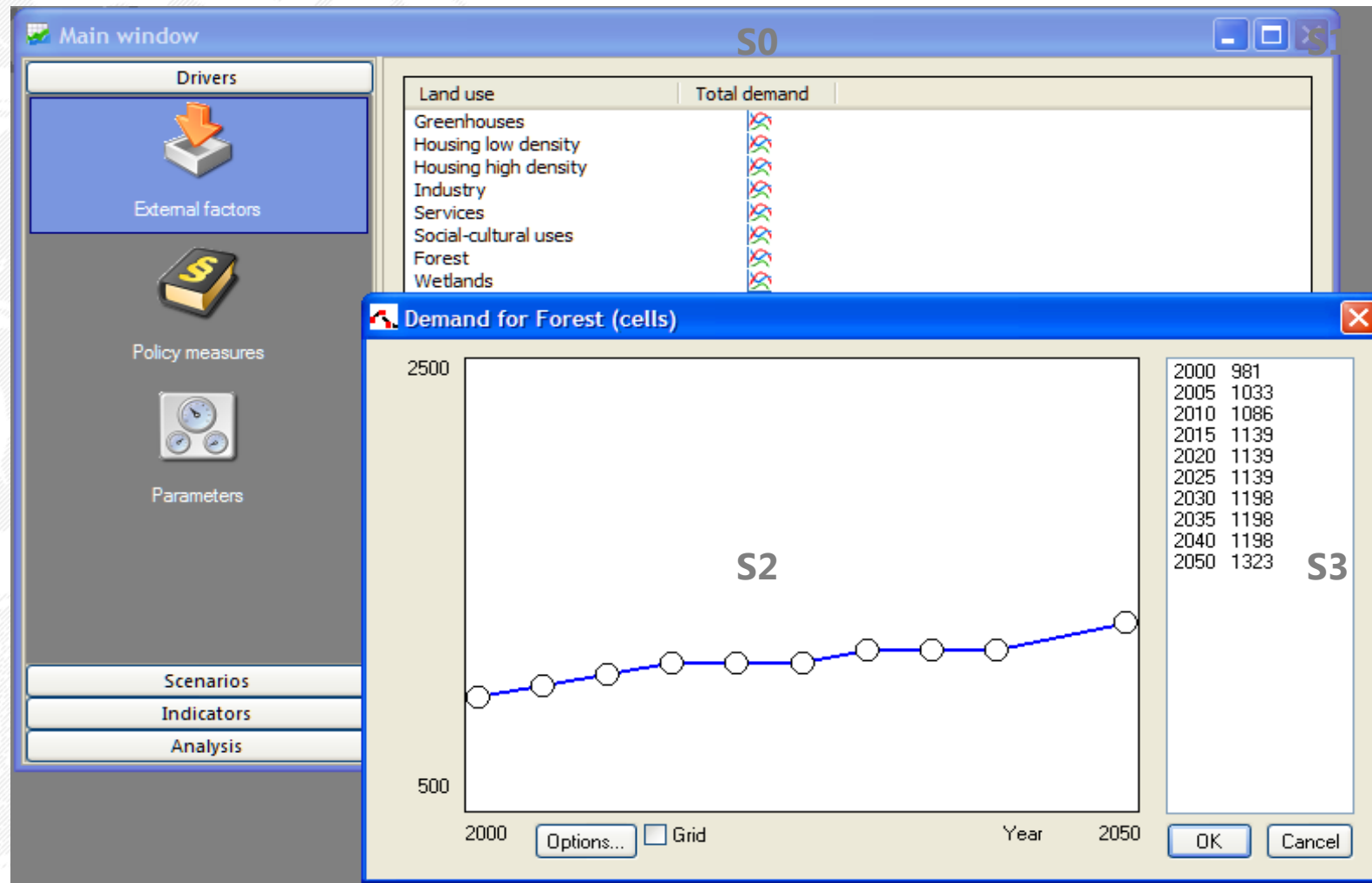
Total potential for land use change



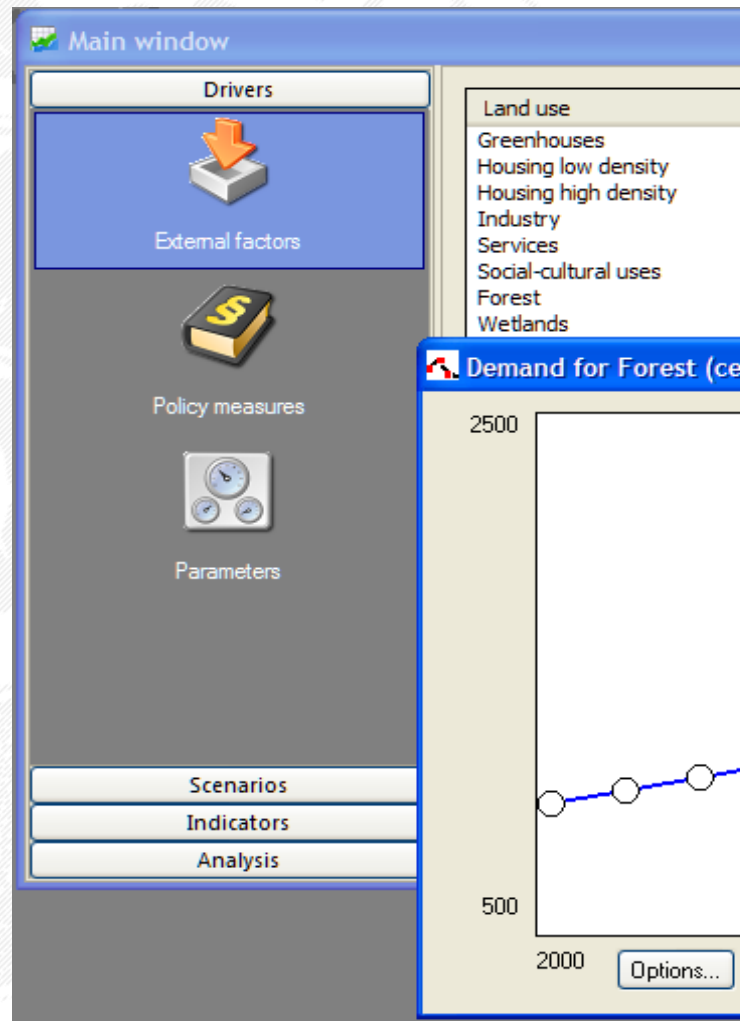
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Kazak J., Wang T., Szewrański S. 2015, *Analysis of Land Use Transformation Potential in Spatial Management, Real Estate Management and Valuation*, Vol. 23, No. 1, pp. 5-14. DOI: 10.1515/remav-2015-0001 .

Metronamica workflow

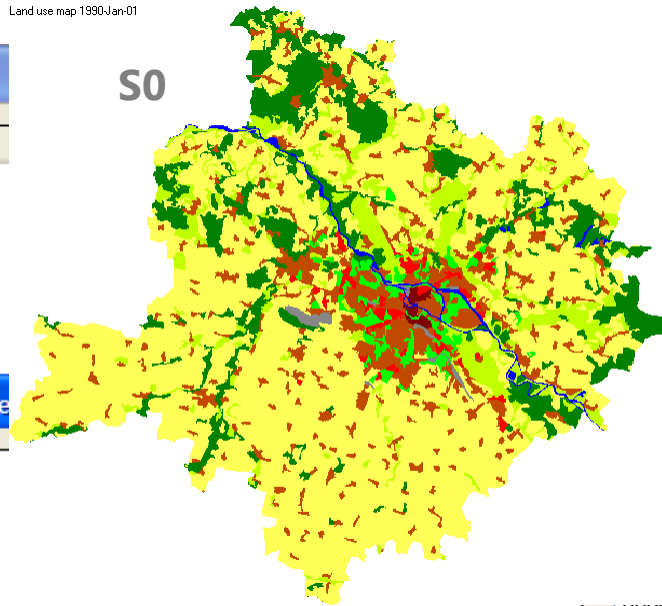


Metronamica workflow



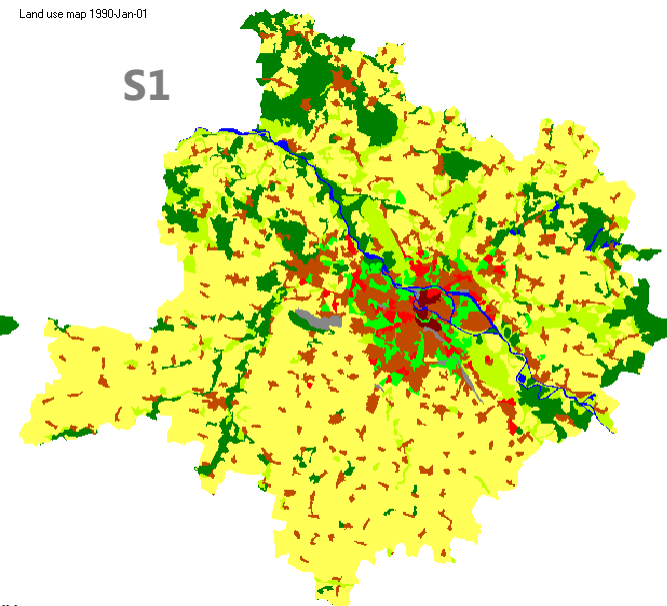
Land use map 1990-Jan-01

S0



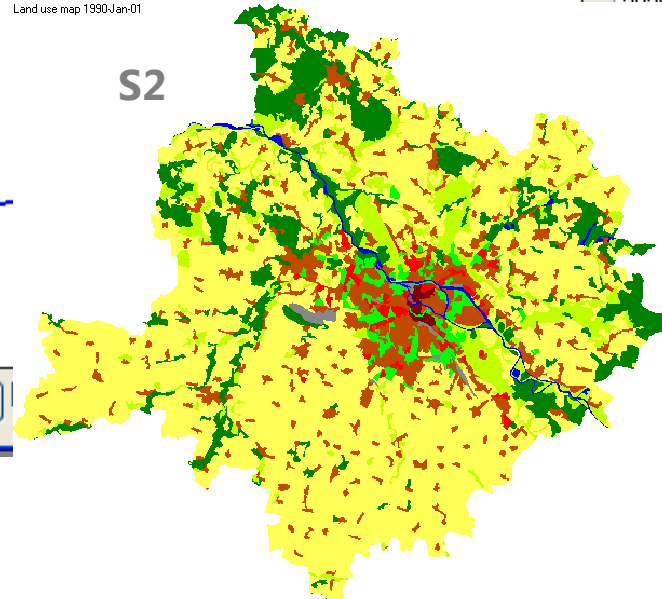
Land use map 1990-Jan-01

S1



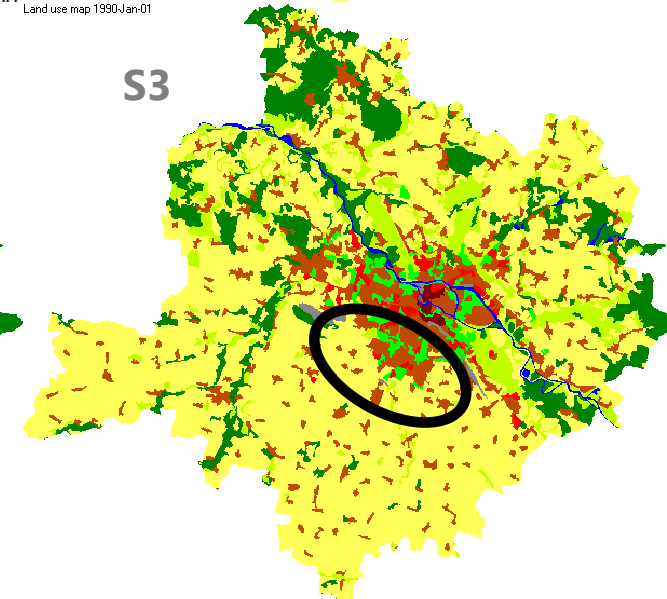
Land use map 1990-Jan-01

S2

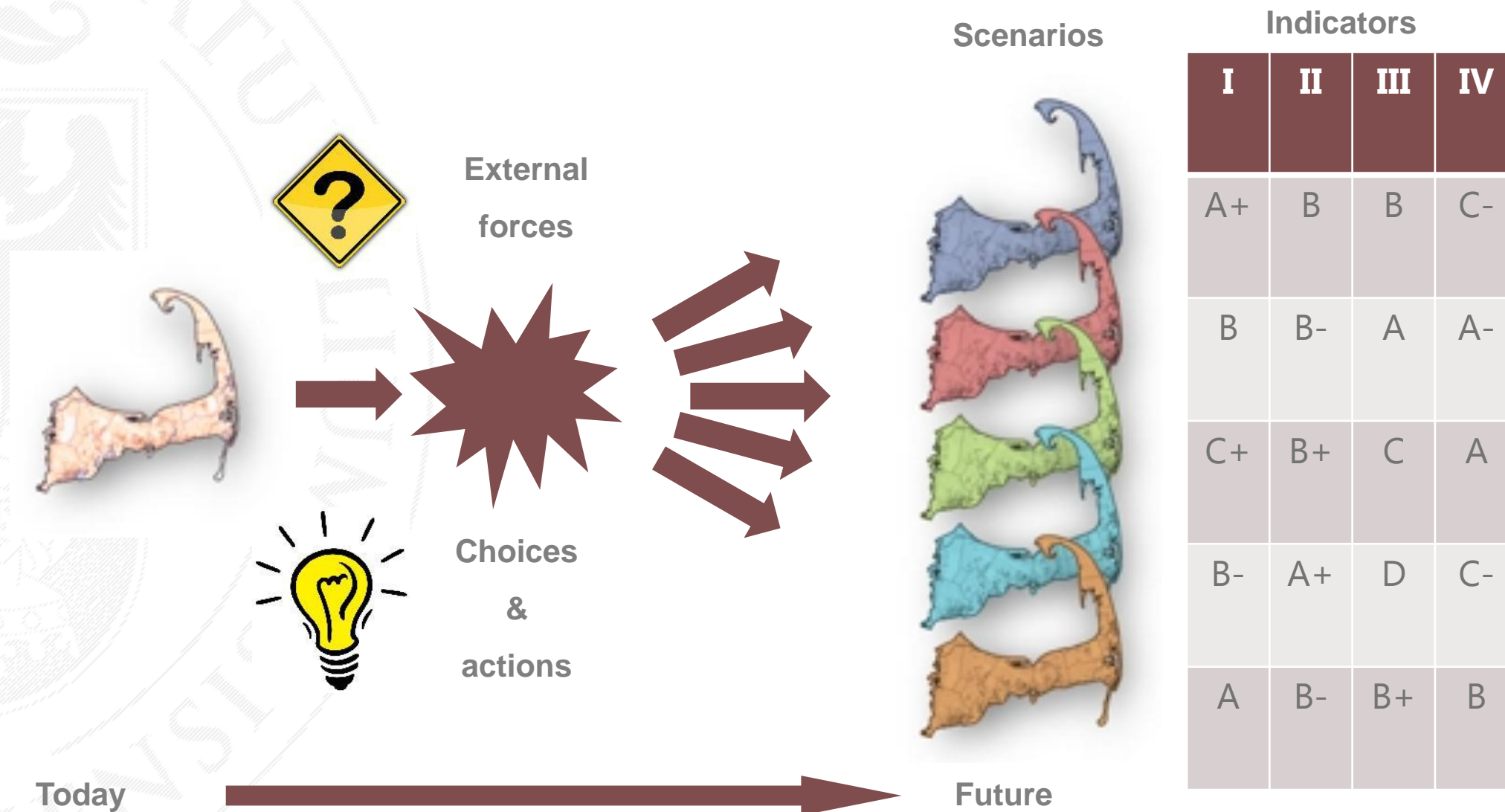


Land use map 1990-Jan-01

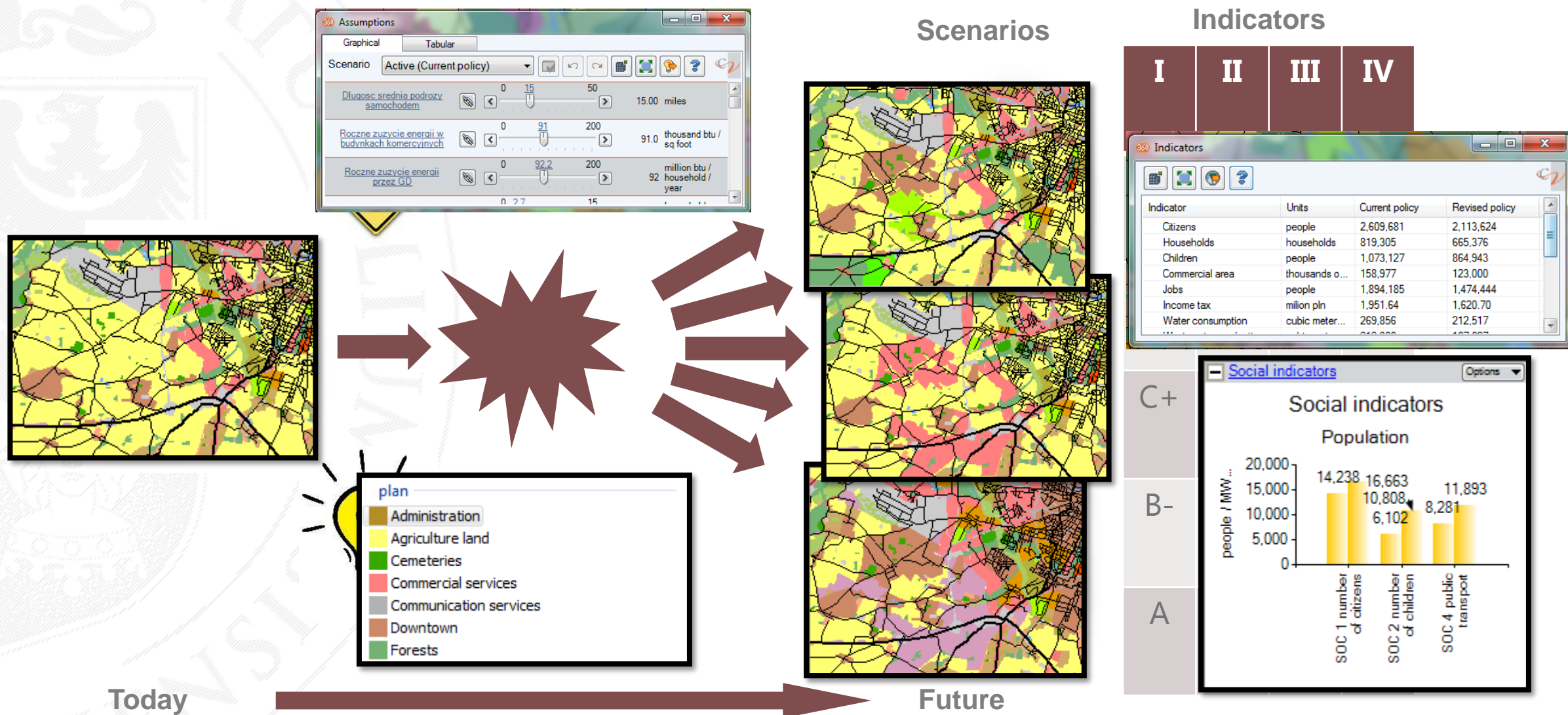
S3



CommunityViz workflow



CommunityViz workflow



Scenario components

SAME FOR ALL SCENARIOS

- Map layers
- Symbology for each layer
- Whether a layer is dynamic
- Reference layers including all features and attribute values
- Dynamic attributes *formulas*
- Indicators *formulas*
- Charts *created*
- Assumptions *created*
- Alerts *created*

MAY BE DIFFERENT FOR ALL SCENARIOS

- *Features* within map layers
- Dynamic attributes *values*
- Indicators *values*
- Charts *values*
- Assumptions *values*
- Alerts *currently triggered*

Best practices for scenario analysis

- Use ~5 or fewer scenarios per project

Clearly distinguishable themes

- Set up your analysis first, then start adding scenarios

- Make fair, „apples-to-apples” comparisons

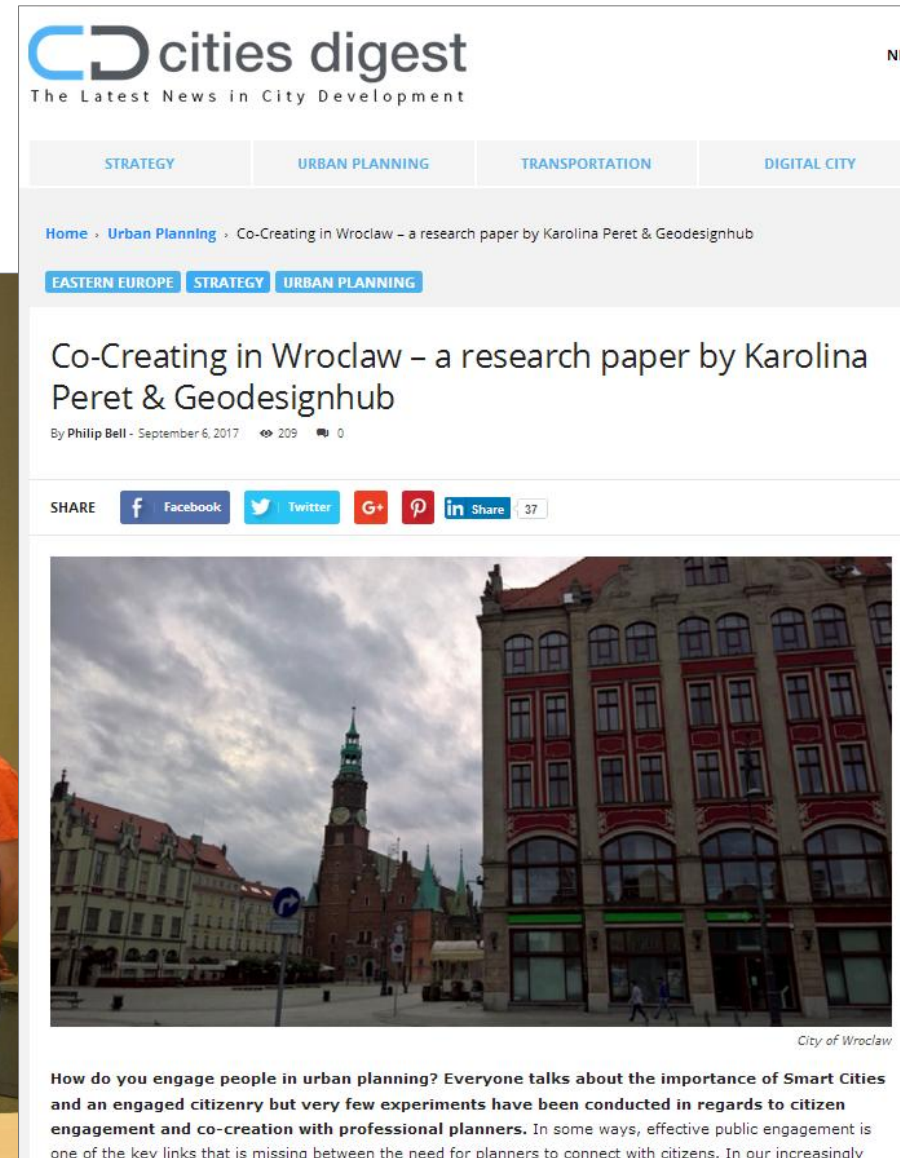
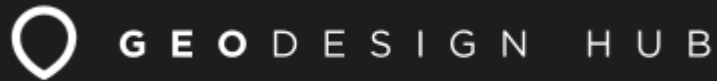
Lock assumptions together unless there is a reason not to

Avoid favourite until late in the process

Case studies

- Wrocław Larger Urban Zone (Poland) - a spatial policies assessment of the potential cumulative capacity. Calculations covered housing, population, employment and other economic estimates.
- San Sebastian (Spain) - indicator-based assessment of a masterplan with a special focus on public transport planning.
- Sepolno (Poland) - selecting optimal real estate for different people according to their needs (suitability analysis).
- Mazury (Poland) - selecting optimal locations for a new development (suitability analysis).

Recent projects





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