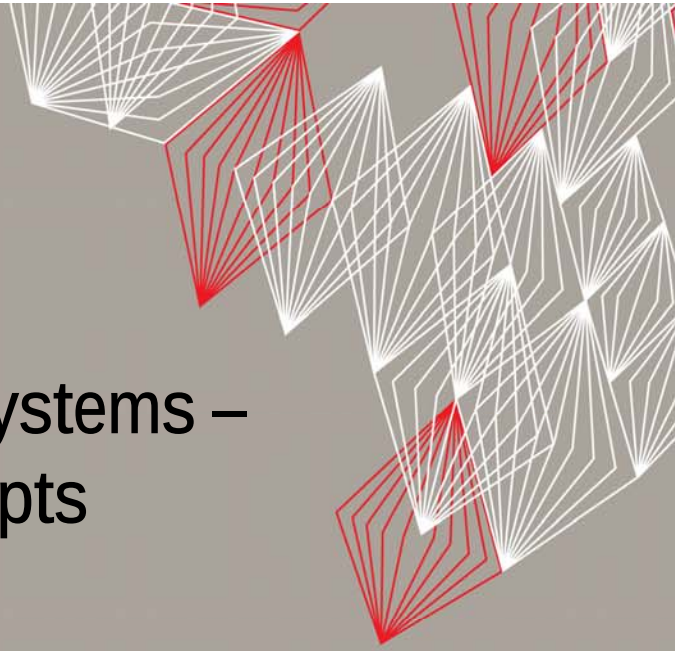
UNIVERSITY OF TWENTE.

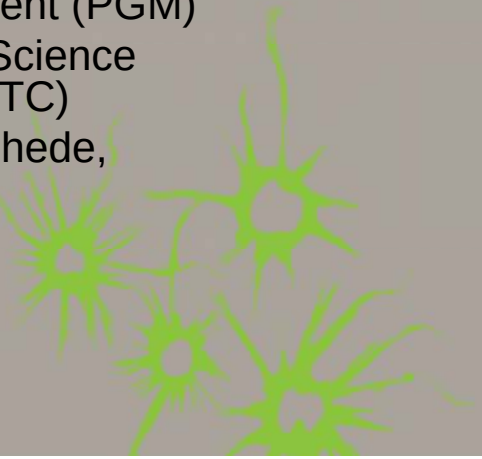
Spatial Decision Support Systems – Introduction to Concepts and Requirements

Technical Skills Course: Web-GIS and Spatial Data Infrastructure

CHANGES Project, Dortmund, 27 November 2012

Johannes Flacke
Department of Urban and Regional Planning and Geo-Information Management (PGM)
Faculty of Geo-Information Science and Earth Observation (ITC)
University of Twente, Enschede,
The Netherlands

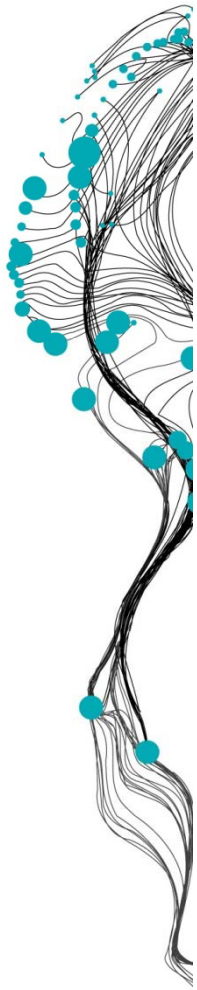




ITC FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

Content

1. **Spatial Decision Support Systems (SDSS) – What are we talking about?**
2. **Main concepts and requirements for SDSS**
3. **Barriers, pitfalls & challenges to successful SDSS implementation**



1. SPATIAL DECISION SUPPORT SYSTEMS – WHAT ARE WE TALKING ABOUT?

Evolution of Spatial Decision Support Systems (SDSS) – Influences, directions and milestones

- Broad availability of GIS tools and software since 1980s
- Development of Decision Support Systems (DSS) in management science since late 1970s

➔ development of Spatial Decision Support Systems (SDSS) since 1985

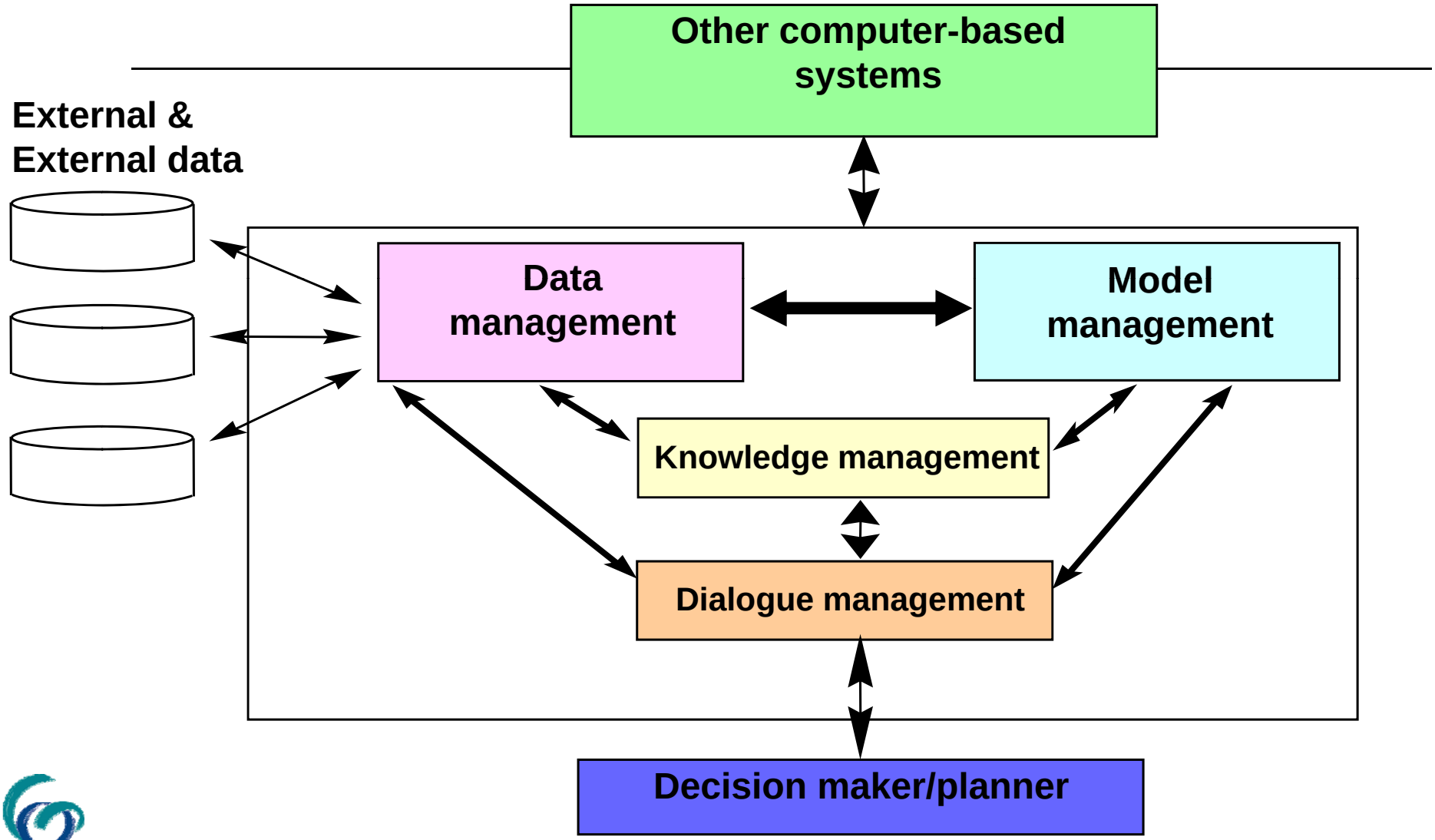
- Development in the field of Planning Support Systems (PSS), (Geertman and Stillwell 2003, 2009)
- Today: SDSS common tool used in various disciplines and domains, various technologies, different understandings and definitions

Definition of Spatial Decision Support Systems

- “Interactive computer systems designed to support a user or a group of users in achieving a higher effectiveness of decision making while solving a semi-structured spatial decision problem” (Sugumaran et al. 2007)

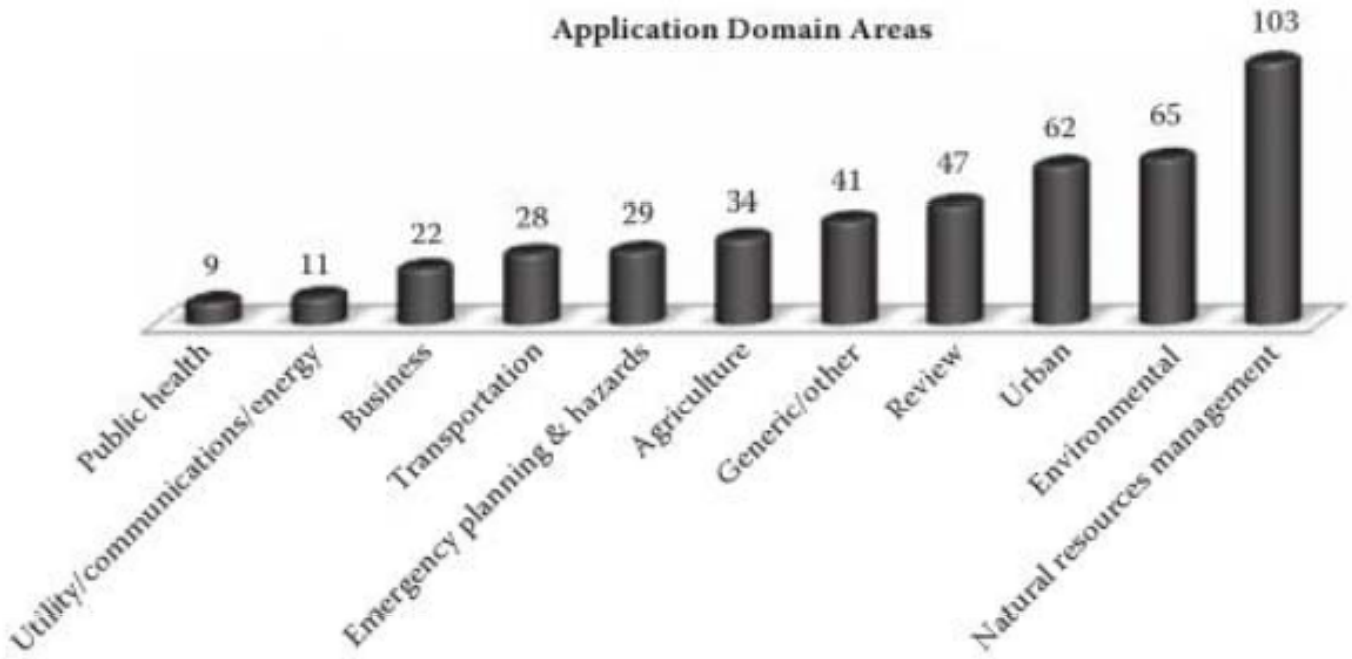
- having an explicit geographic component
- supporting rather than replacing the user’s decision making skills
- facilitate the use of data, models and structured decision processes in decision making

Components **of SDSS (adapted from Turban, 1995)**



Application domains of SDSS

- A few generic SDSS and manifold specialized SDSS
- Several SDSS for specific purpose and study area, specific stakeholders



from: Sugumaran & DeGroote 2011, p. 395

2. MAIN CONCEPTS AND REQUIREMENTS FOR SDSS

Five Main Concepts relevant for setting up a SDSS

1. Types of spatial decision problems and definition of decision problems
2. Models for structuring the decision making process
3. Collaborative decision making, participants and stakeholders
4. Methods for spatial decision support
5. The role of scenarios in spatial decision making

2.1 Types of spatial decision problems and definition of decision problems

Spatial decision problems

- Semi-structured problems (multi-dimensional, goals & objectives not completely defined, larger number of alternatives)
- Degree of uncertainty inherent
- Potential conflicts between stakeholders involved

Types of spatial decision problems

1. Site selection
2. Location-allocation
3. Land use selection
4. Land use allocation

Recognition and definition of a decision problem

Decision problem is defined as a situation where an individual or a group perceives a difference between a present state and a desired state and where:

- The individual or group has alternative course of actions available
- The choice of action can have a significant effect on this perceived difference
- The individual or group is uncertain *a priori* as to which alternative should be selected

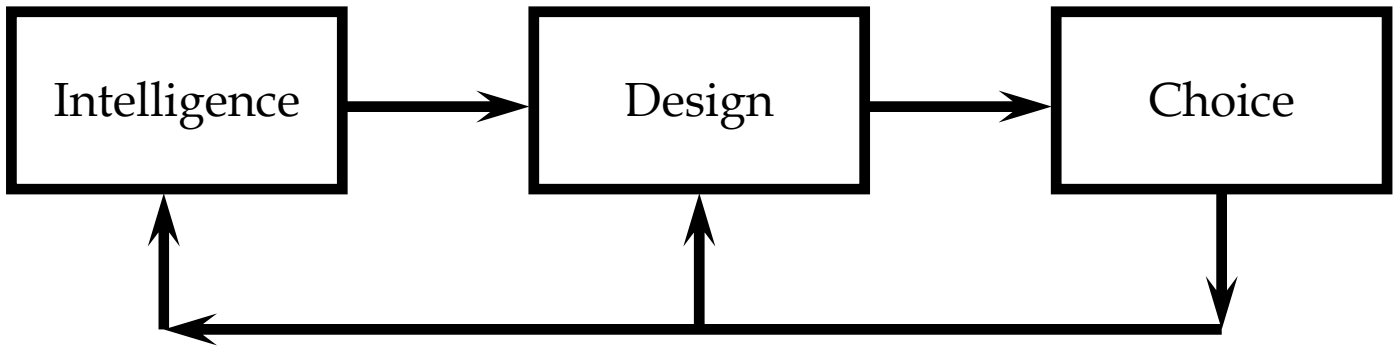
(Ackoff 1981)

2.2 Models for structuring the decision making process

- Decision making process is transforming information into instructions
- prototypical sequencing of process phases
- at any phase during the process, the workflow can go back to a previous phase if needed.

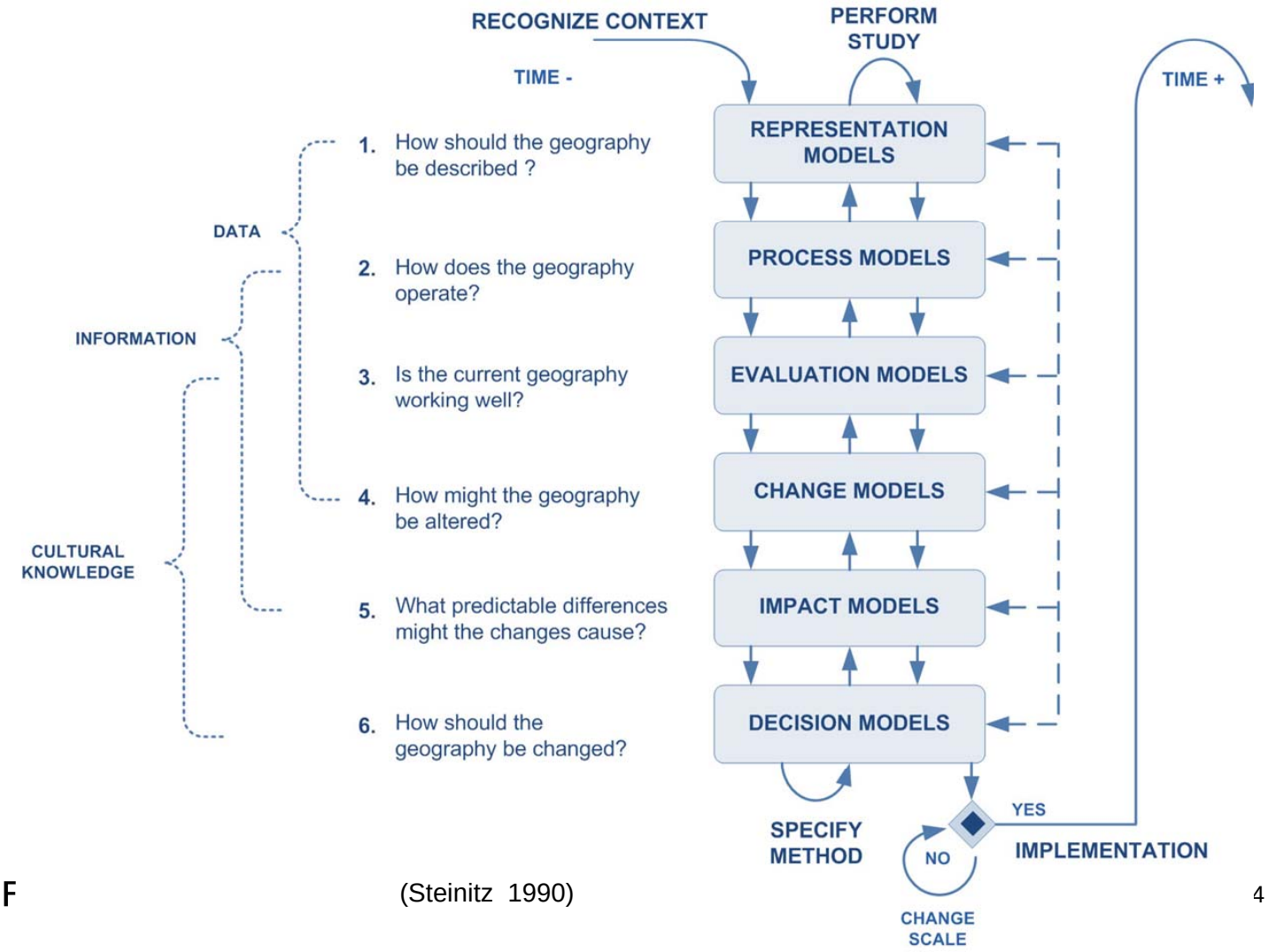
Simon's 3-Stage Decision Process Model

1. **Intelligence**
   - Identifying the problems that require a decision
2. **Design**
   - Inventing, developing, testing and analysing courses of action
3. **Choice**
   - Selecting a course of action



(Simon 1960)

Steinitz: Decision support strategy for landscape planning and design



(Steinitz 1990)

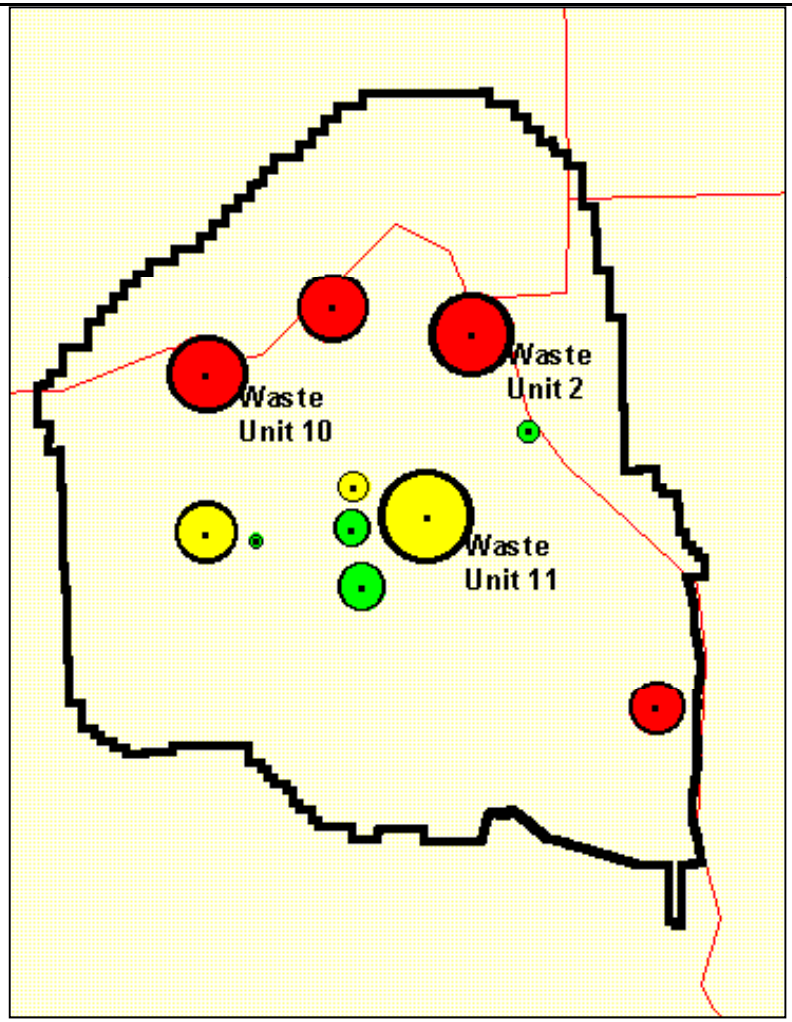
2.3 Collaborative decision making, participants and stakeholders

- Stakeholders should be included in all stages of the decision making process
- methods and tools for collaborative spatial decision making in all stages of the decision making process (e.g. brainstorming of evaluation criteria, consensus analysis, offline activities)
- Stakeholders can be a quite heterogeneous group, from laymen to experts
- Tension between problem solving objective of collaborative SDSS and exploration of diverse problem understanding objective (Ramsey 2009)

Example of a consensus map

Size of the circle:
Degree of preference (small-weak; large-strong)

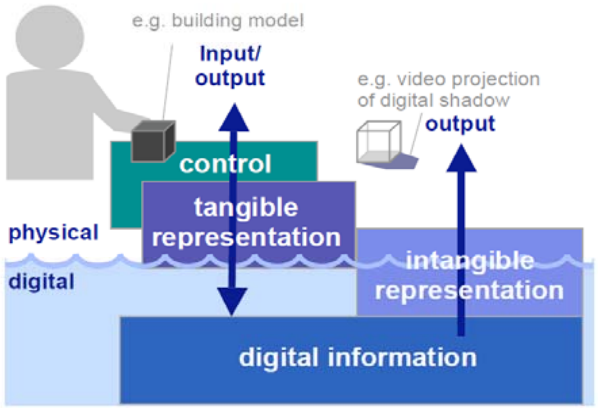
Colour of the circle:
Degree of consensus (green-high; yellow moderate; red-low)



From Jankowski and Nyerges 2001

Towards interactive decision support

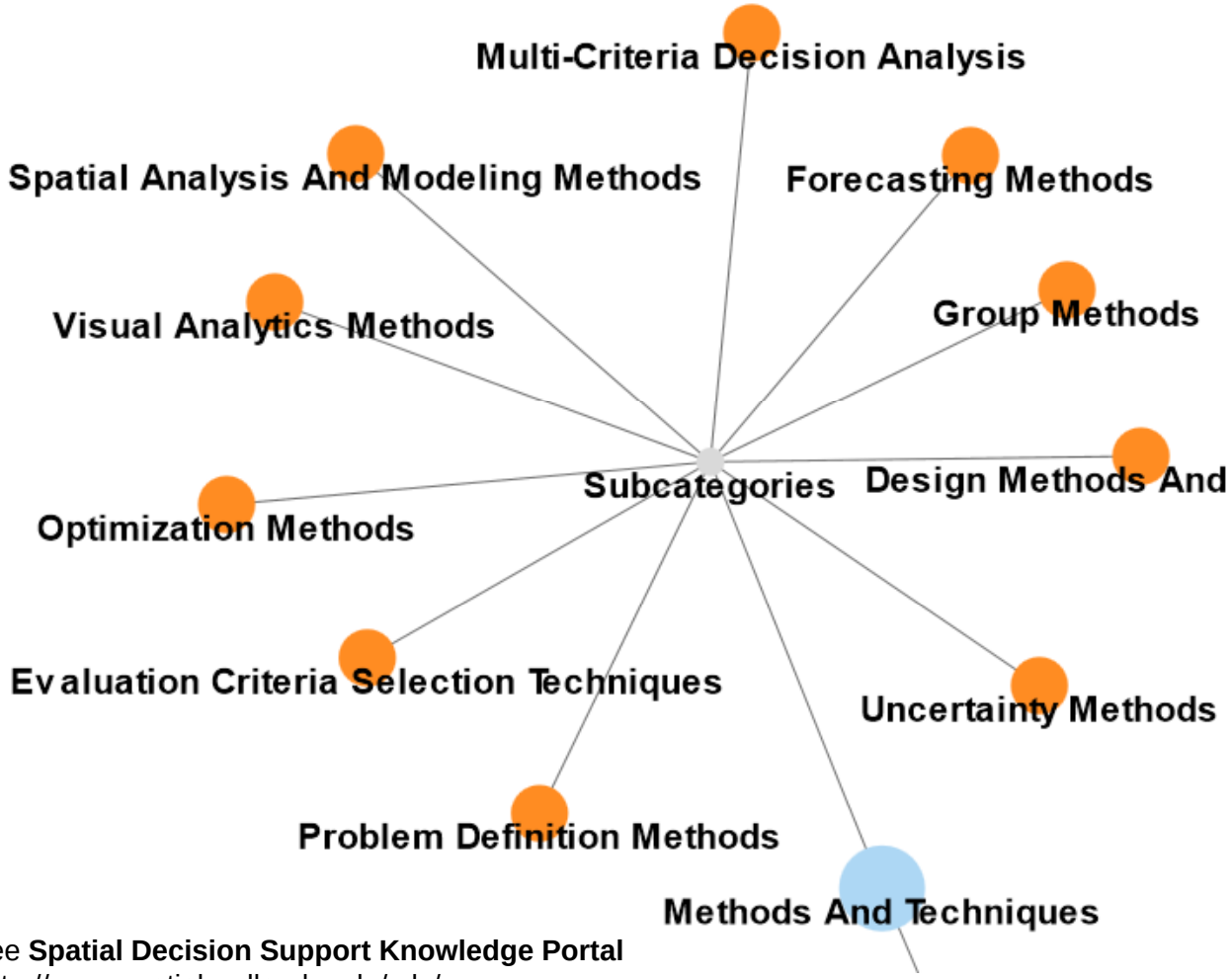
- SDSS with multi-user interfaces implemented in collaborative environments (e.g. Group Decision Rooms)
- User-friendly interfaces allow multiple users to provide input and generate real-time output to support negotiated spatial decisions
- Tangible User Interfaces (TUI) for improved improved user-content interactions and enhanced collaboration between stakeholder
- Hardware is existing, multi-user software still lacking



Tangible user interface

2.4 Methods and techniques for spatial decision support

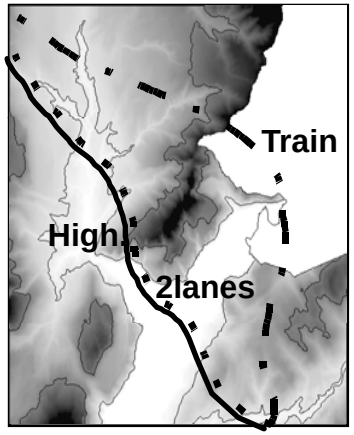
- Broad variety of (spatial) modelling techniques is included in SDSS
- Several methods originally developed for non-spatial problems, but can as well be adapted to spatial decision making



See **Spatial Decision Support Knowledge Portal**
http://www.spatial.redlands.edu/sds/

Multi-criteria analysis

Impact assessment



Area of concern	Individual concerns	Descriptors	highway	2-lane road	train
Economic effects	Cost	Total cost (mln. $)	200	250	500
	Accessibility	Travel time (---/+++)	+++	++	+
	Capacity	Passengers (mln/km/yr)	30	30	40
Environmental impacts	Pollution	NOx emissions (tons/yr)	1000	750	100
	Landscape	Visuality (---/+++)	---	--	-

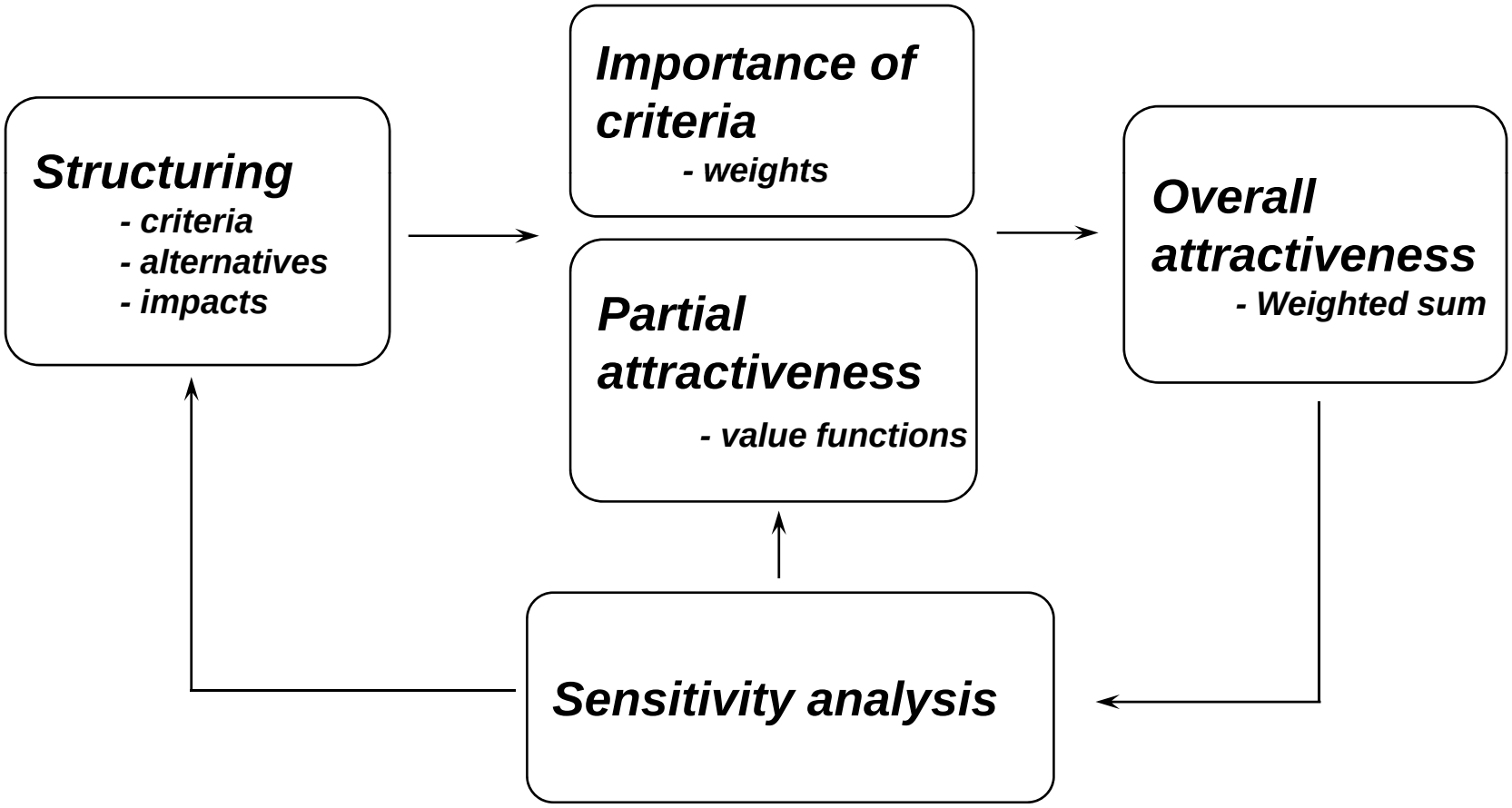
Alternatives

Value tree / criteria tree

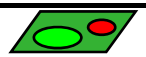
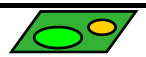
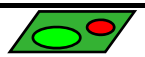
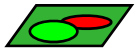
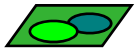
Effects / impacts

- Structuring and rationalizing the decision problem: and simplify complexity.

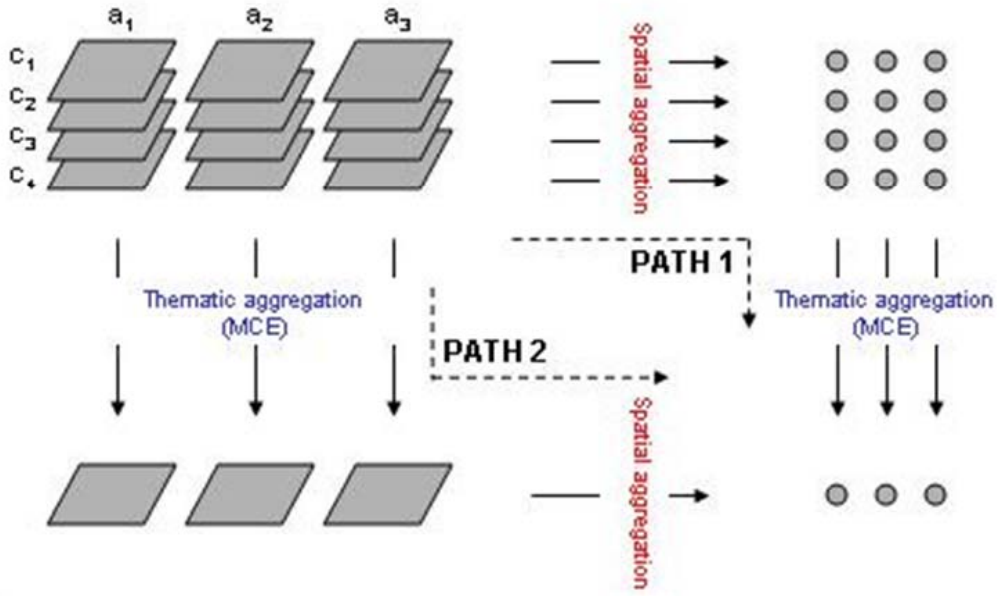
Phases in multi-criteria analysis



Spatial multi-criteria analysis

	A1	A2	A3
C1			
C2			
C3			
C4			

- Proximity criteria
- Neighbourhood criteria
- Spatial constraints e.g.



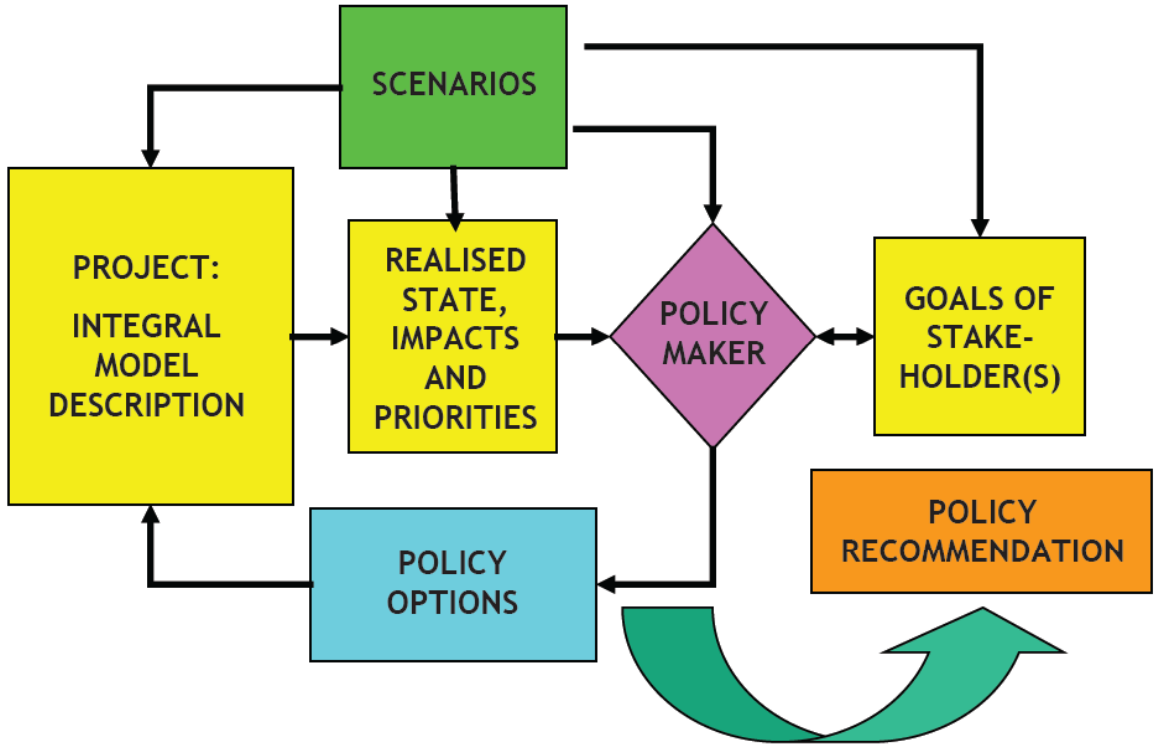
2.5 The role of scenarios in spatial decision making

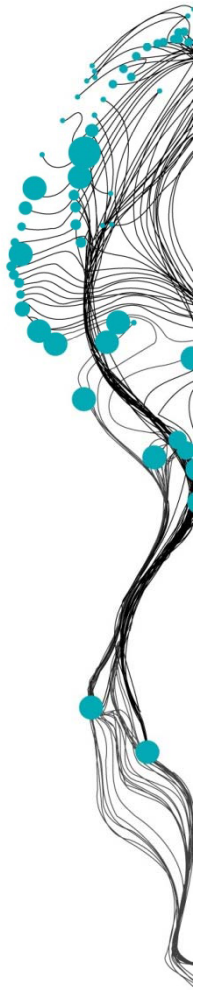
"A scenario is a statement of assumptions and configurations concerning the operating environment of a particular system at a particular time." (Turban et al. 2005)

Scenarios
Exogenous variables

Alternatives/policy options
Endogenous variables

Policy formulation process: controllable options and uncontrollable scenario parameters affect projects





3. BARRIERS, PITFALLS & CHALLENGES TO SUCCESSFUL SDSS IMPLEMENTATION

Barriers and pitfalls

"**How to support decisions nobody wants to make**?" (Groenlund 2005)

Several SDSS are prototypes, conceptual frameworks, or utilized only in academic exercises.

Reasons for SDSS not being used

- Specification of alternatives
- Guidance of the user
- Presentation of output
- Support for evaluation of results

After Uran & Janssen 2003

Technical challenges of SDSS development

- Spatial data availability, compatibility, and integration: standards, web-services, data quality
- Model integration and usability: linking models to other components in the SDSS, involving the user in model development
- Guidance through user interfaces: intuitive, ease of use
- Output presentation: 3D models, visualization

After: Sugumaran and DeGroote 2011

Implementation-oriented challenges of SDSS

- Engaging the user in SDSS development: participatory development process
- Strengthening individual and organisational capacities to use SDSS: internal champion to promote SDSS
- SDSS longevity and sustainability: include costs for training, support, and maintenance in SDSS development, use software that allows model expansion and re-use

After: McIntosh et al. 2011

The end.
Thank you!

Dr. Johannes Flacke

Assistant Professor for Spatial Planning and Decision Support Systems
Department of Urban & Regional Planning and Geo-Information Management (PGM)

Faculty of Geo-Information Science and Earth Observation (ITC)
University of Twente, Enschede, The Netherlands
PO Box 6, 7500 AA Enschede, The Netherlands
Tel: +31-534874381
E-mail: flacke@itc.nl
http://www.itc.nl

References

- Ackoff, 1981, The art and science of mess management, Interfaces 11(1) pp. 20-26
- Rittel, H.; Webber, M. (1973): Dilemmas in a general theorie of planning. In policy science 4, pp. 155–169.
- Groenlund, A.: DSS in a local government context - How to support decisions nobody wants to make? In Wimmer et al. (Hrsg.) (Ed.): Electronic Government. Workshop and Poster Proceedings of the Fourth International EGOV Conference (Schriftenreihe Informatik, 15), pp. 69–80.
- Geertman, S.; Geertman, S. (Eds.) (2003): Planning support systems in practice. With 38 tables. Berlin: Springer (Advances in spatial science).
- Geertman, Stan; Stillwell, John (Eds.) (2009): Planning Support Systems. Best practice and new methods. [Dordrecht]: Springer (Geojournal / Library, 95).
- Uran, O.; Janssen, R. (2003): Why are spatial decision support systems not used? Some experiences from the Netherlands. In Computers, Environment and Urban Systems 27, pp. 511–526.
- Simon, Herbert A. . The new science of management decision. The Ford distinguished lectures. Vol 3 , New York, NY, US: Harper & Brothers. (1960).
- Carl Steinitz, Hector Arias, Scott Bassett, Michael Flaxman, Thomas Goode, Thomas Maddock, David Mouat, Richard Peiser, Allan Shearer (1990): Alternative Futures for Changing Landscapes: The Upper San Pedro River Basin In Arizona And Sonora Sugumaran, Ramanathan; Degroote, John (2011): Spatial decision support systems. Principles and Practice. Boca Raton: Taylor & Francis.
- Malczewski, Jacek (1999): GIS and multicriteria decision analysis. New York, NY: Wiley.
- Nyerges, Timothy L.; Jankowski, Piotr (2010): Regional and urban GIS. A decision support approach. New York: Guilford Press.
- Jankowski, Piotr; Nyerges, Timothy L. (2001): Geographic information systems for group decision making. Towards a participatory, geographic information science / Piotr Jankowski and Timothy Nyerges. London: Taylor & Francis (Research monographs in GIS series).
- TURBAN, E., ARONSON, J. E. & LINAG, T. P. (2005): Decision support systems and intelligent
- systems.- Prentice Hall, New York.

Open PhD position

- See http://www.jufo-salus.de/#ausschreibung_en

Jufo-Salus ¶

Junior·Research·Group·Salus:·Healthy·and·Equal·Cities¶

For·the·junior·research·group·Salus·within·the·German·research·programme·„Stadt·der·Zukunft:·Gesunde·Nachhaltige·Metropolen“·of·the·Fritz·und·Hildegard·Berg-Stiftung·the·**ITC,·University·of·Twente,**·Enschede·is·offering·¶

1·PhD·Scholarship·on¶

Interactive·Decision·Support·for·Collaborative·Spatial·Planning·and·Decision·Making.¶

The·Junior·Research·Group·Salus·analyses·social·inequalities,·cumulative·exposure·and·health·impacts·within·cities·and·explores·strategies·of·planning·and·public·health·for·attaining·healthy·and·equal·cities.·The·junior·research·group·strives·to·initiate·an·interdisciplinary·and·international·dialogue·amongst·public·health,·environment,·and·spatial·planning.·Five·PhD·students·will·research·at·the·universities·involved·and·build·the·core·of·this·junior·research·group.·The·German·municipalities·of·Dortmund·and·Munich·are·case·study·cities·in·this·project.¶