



Corné van Elzakker

From map use research
to
usability research
in
geo-information processing



International Institute for Geo-Information Science and Earth Observation (ITC), Enschede, The Netherlands



- Education
- Research
- Advisory services

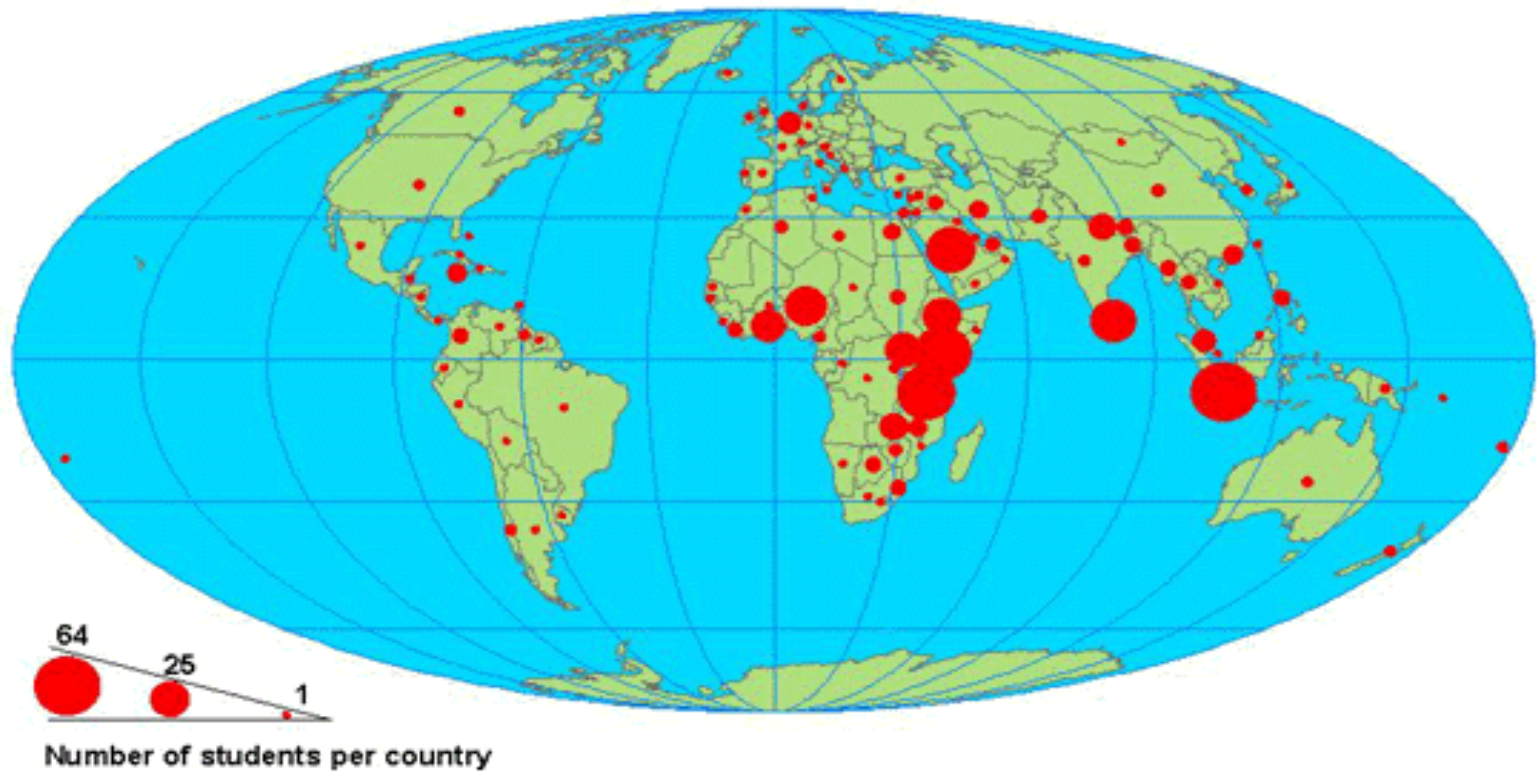
www.itc.nl



International Institute for Geo-Information Science and Earth Observation

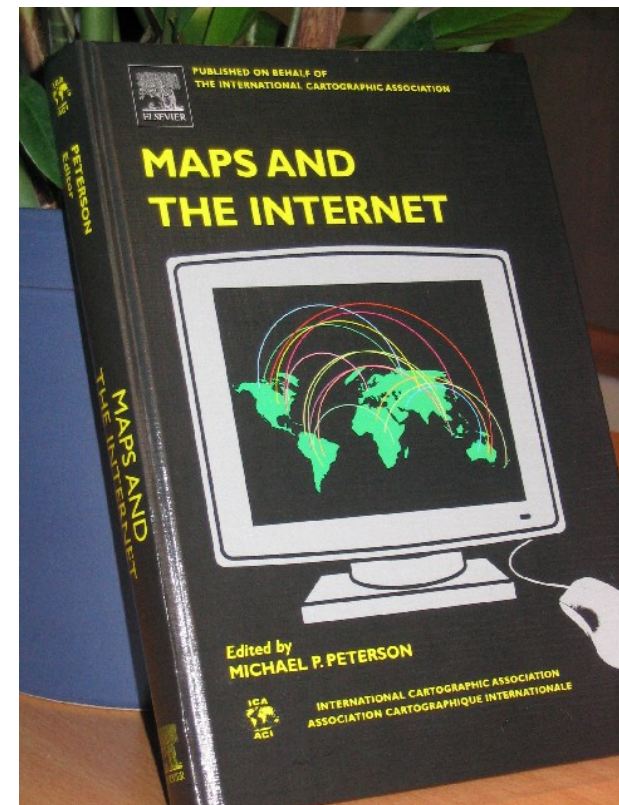
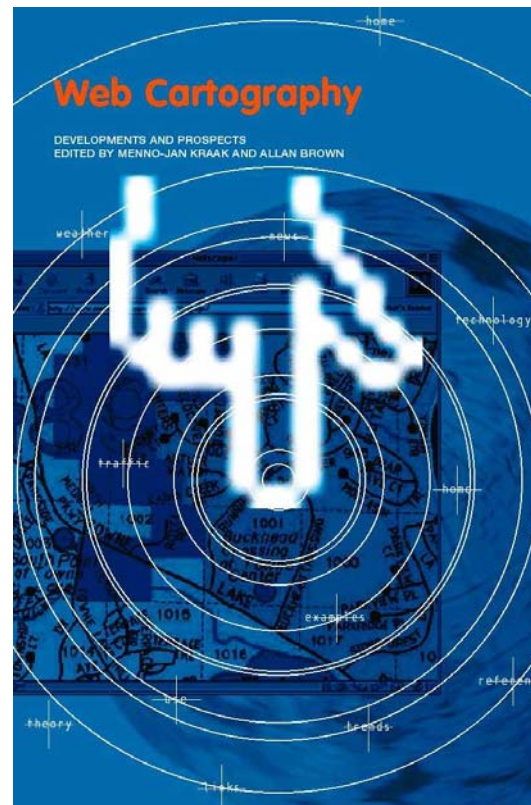


ORIGIN OF ITC CARTOGRAPHY STUDENTS 1971 - 1998



ITC Geo-information Processing Department

www.itc.nl/about_itc/organisation/science_departments/gip.asp



Education and Research in **Web Cartography**

Switchboard to the World's NSO websites

NSO's on the Web - Microsoft Internet Explorer

Address <http://kartoweb.itc.nl/nso/> Go Back Forward Stop Home Search Google G Settings

National Statistical Offices and the World Wide Web
The switchboard to 187 NSO websites worldwide



NORTH & MIDDLE AMERICA - SOUTH AMERICA - **WORLD** - AFRICA - ASIA - OCEANIA

Institute of Statistics (INSTAT) (Tirana, Albania)
<http://www.instat.gov.al/>

National language	English	Other languages	Keyword search	Census data retrieval format				Data download	Census data retrieval cost			Levels of aggregation			Individualized output of Census data				Geographical or map interface for retrieval
				Textual	Tabular	Chart	Map		Free	Registration	Other	National	2nd	3rd	4th	Tabular	Chart	Map	
•	•		•	•	•				•			•							

Done Internet

Outline Vienna seminar 02-03-2007



- Map use research since 1950s
- Research projects:
 - Use of maps in the exploration of geographic data
 - Use of Web maps in the retrieval of regional statistical data
 - Automated application-driven generalization of topographic information in order to derive base maps
 - Testing the usability of well-scaled mobile maps for consumers
- Agenda for usability research in geo-information processing and dissemination

Types of map use research since the 1950s



- Functional map use research
- Perceptual and cognitive research

Types of map use research



More holistic, functional map use research

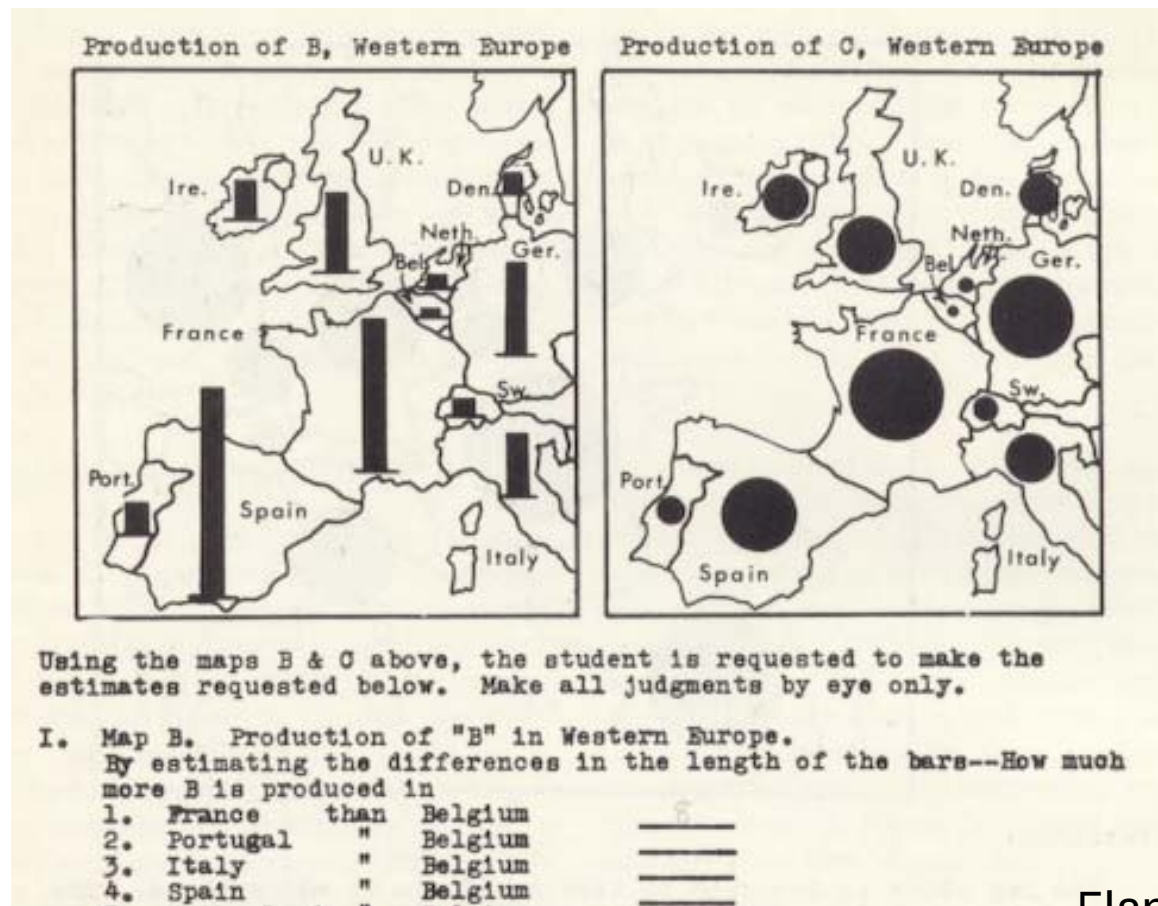


e.g. use of cycling maps, investigated by Dutch project group

www.geo-info.nl

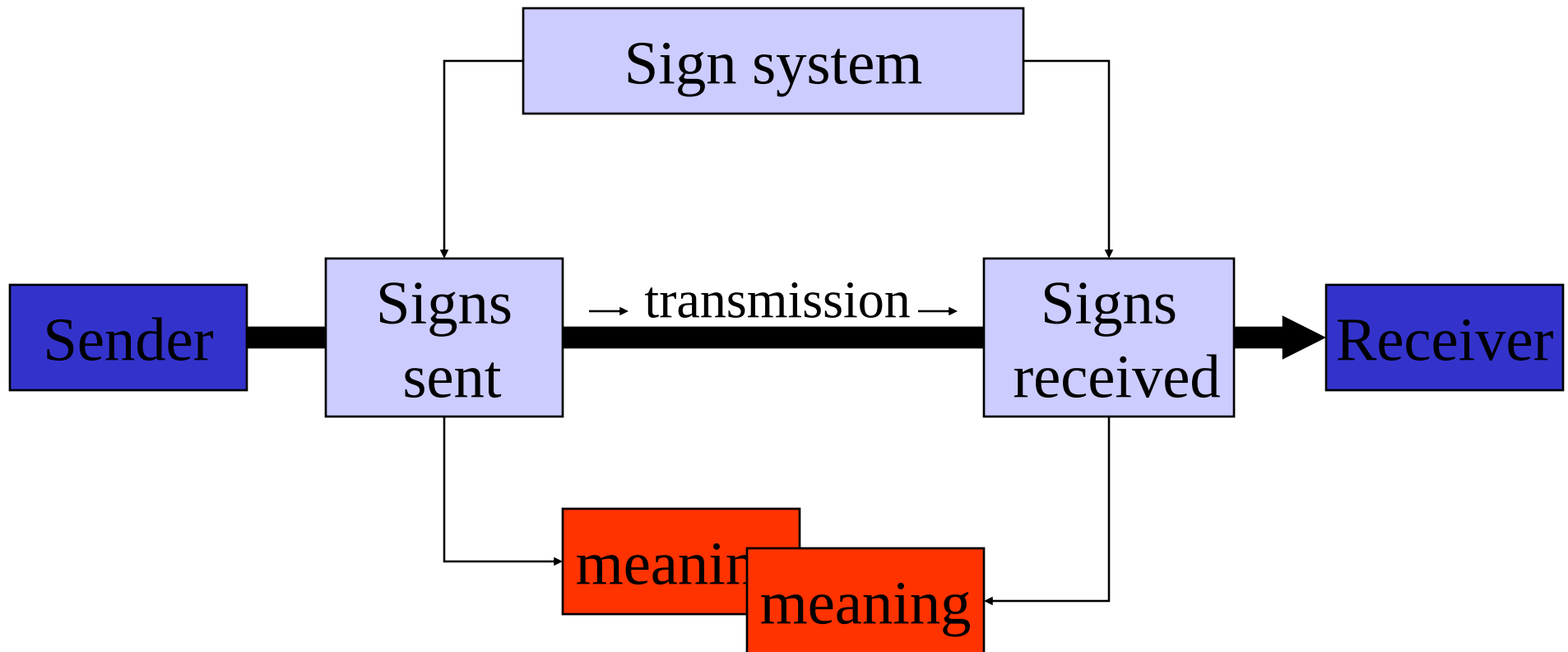
Types of map use research

Perceptual and cognitive research

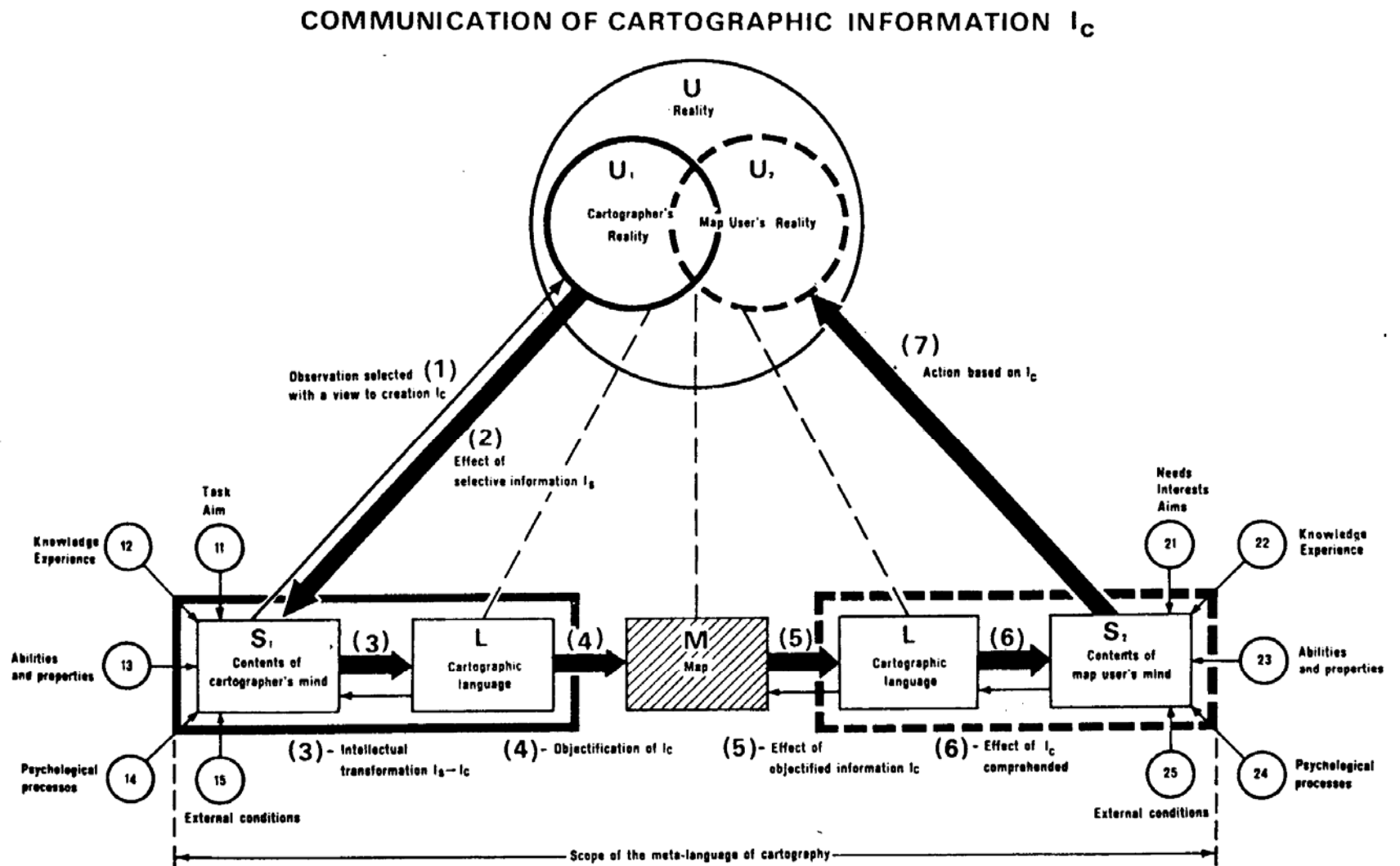


Flannery, 1971

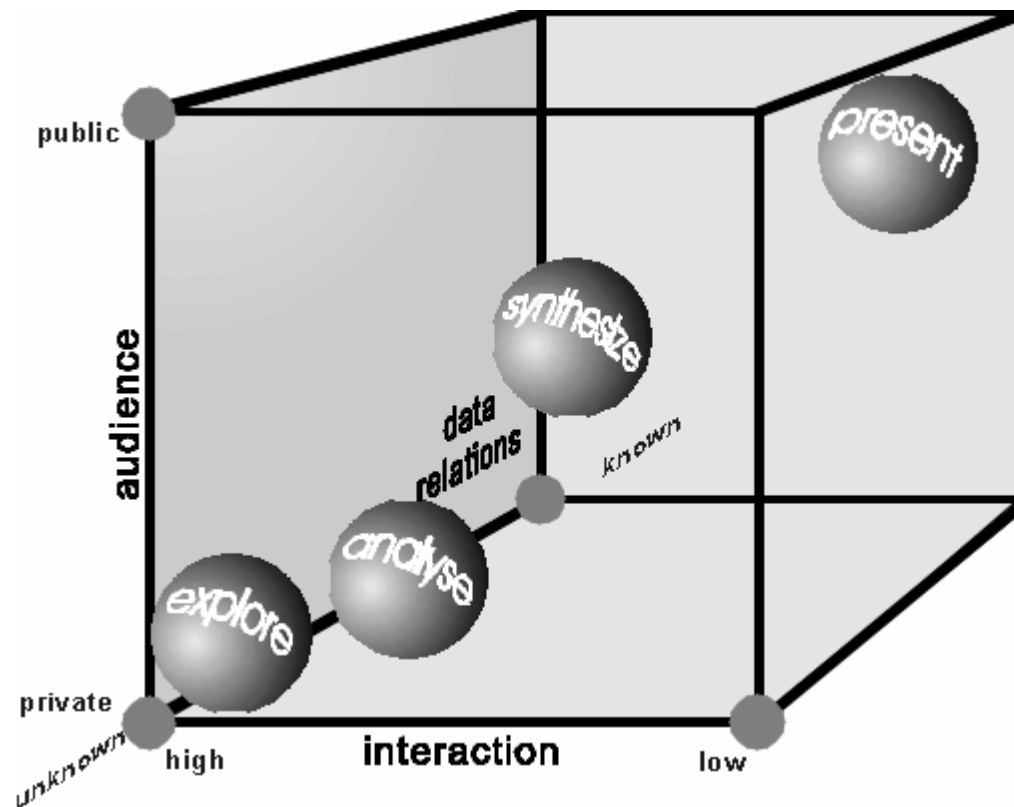
Simple model of one-way communication



Cartographic communication model Koláčný



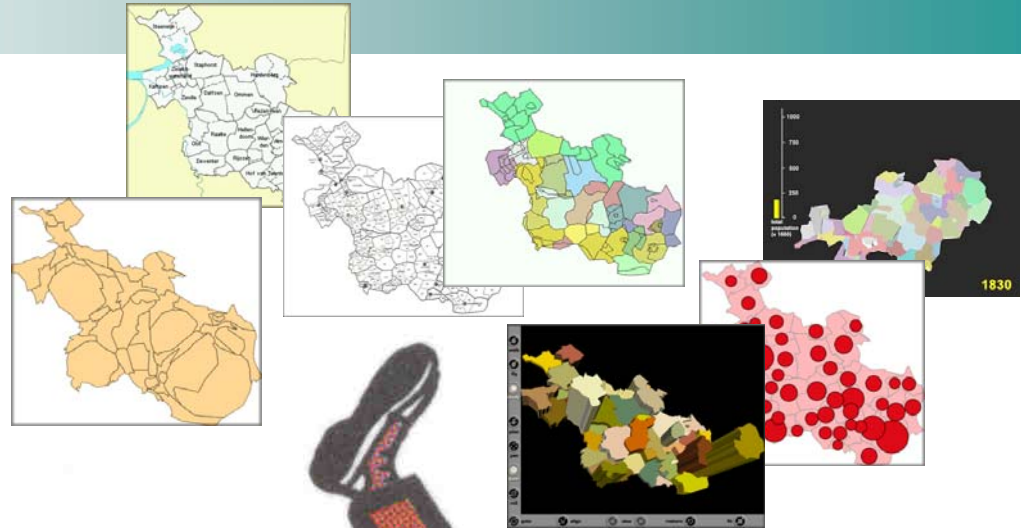
Map use goals positioned in map use cube



MacEachren & Kraak, 1997

Exploratory cartography

maps as tools
for discovery

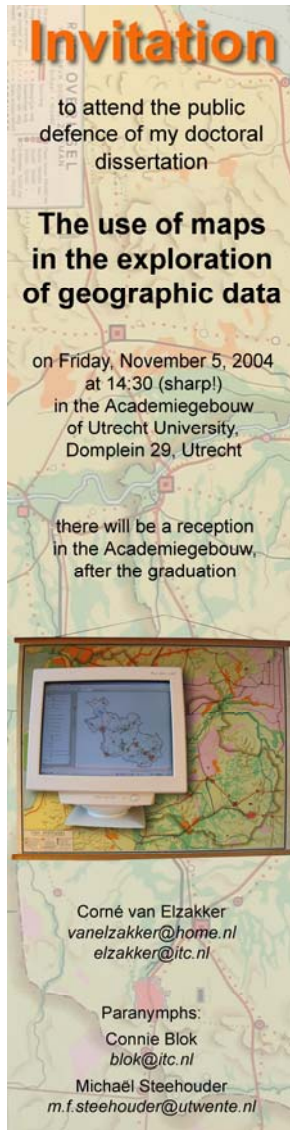


Outline



- Map use research since 1950s
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Map use research van Elzakker (2004)



Research into the use of maps in the exploration of geographic data:

the actual use of existing cartographic displays

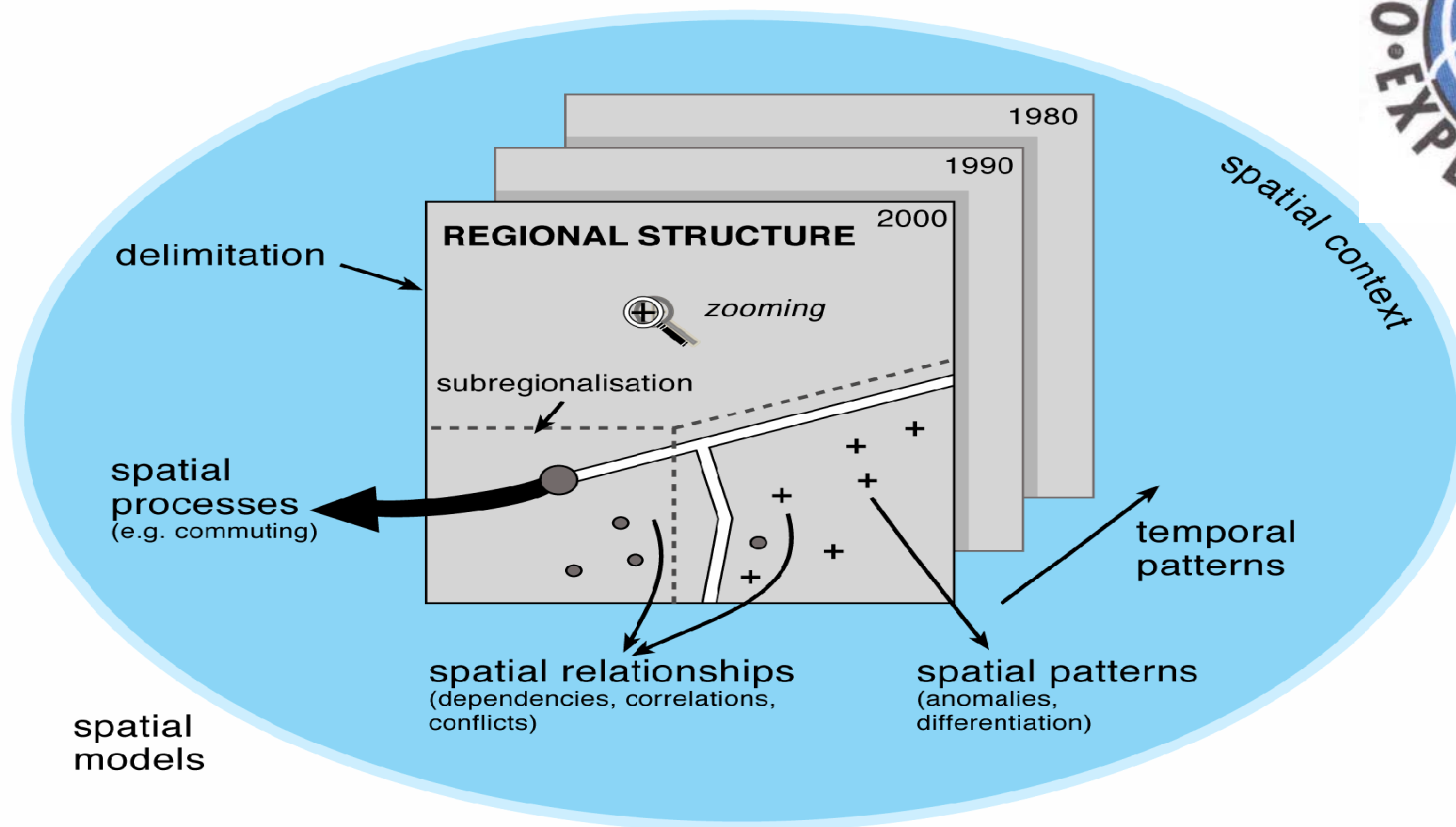
plus

the cognitive process of finding, selecting, retrieving, adjusting or generating 'private' map displays

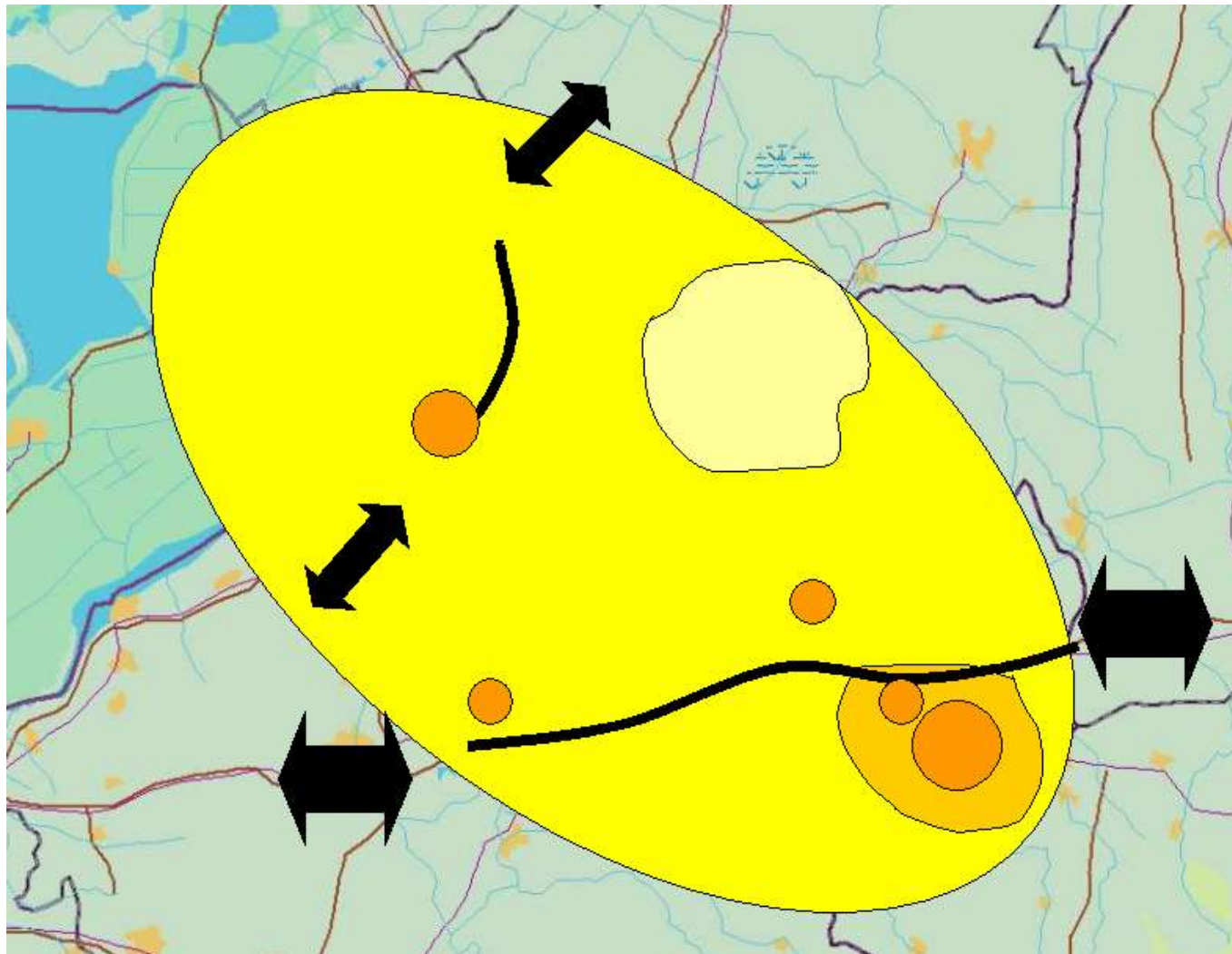
www.itc.nl/personal/elzakker

Regional exploratory studies

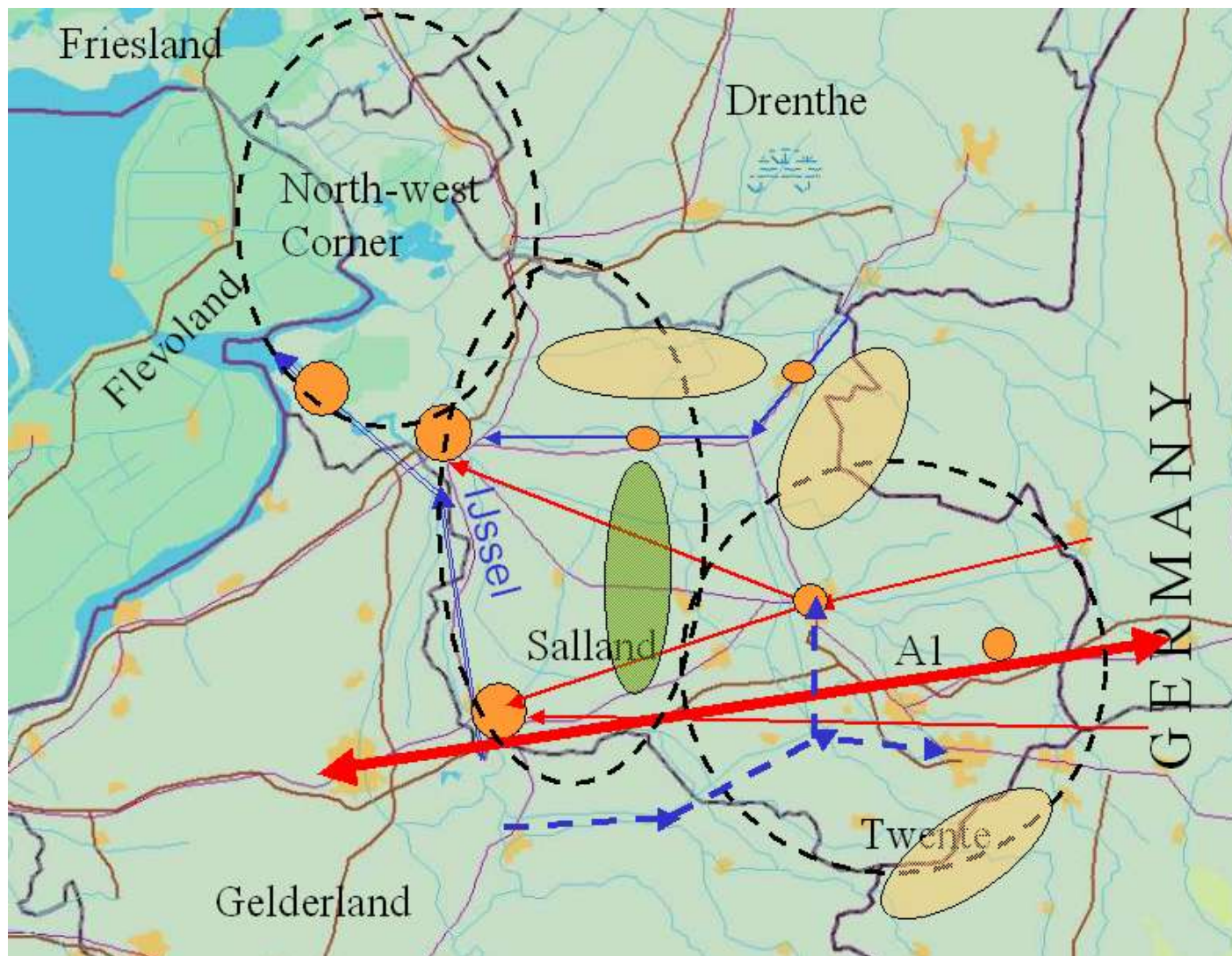
gaining insight into the geography of an unknown region



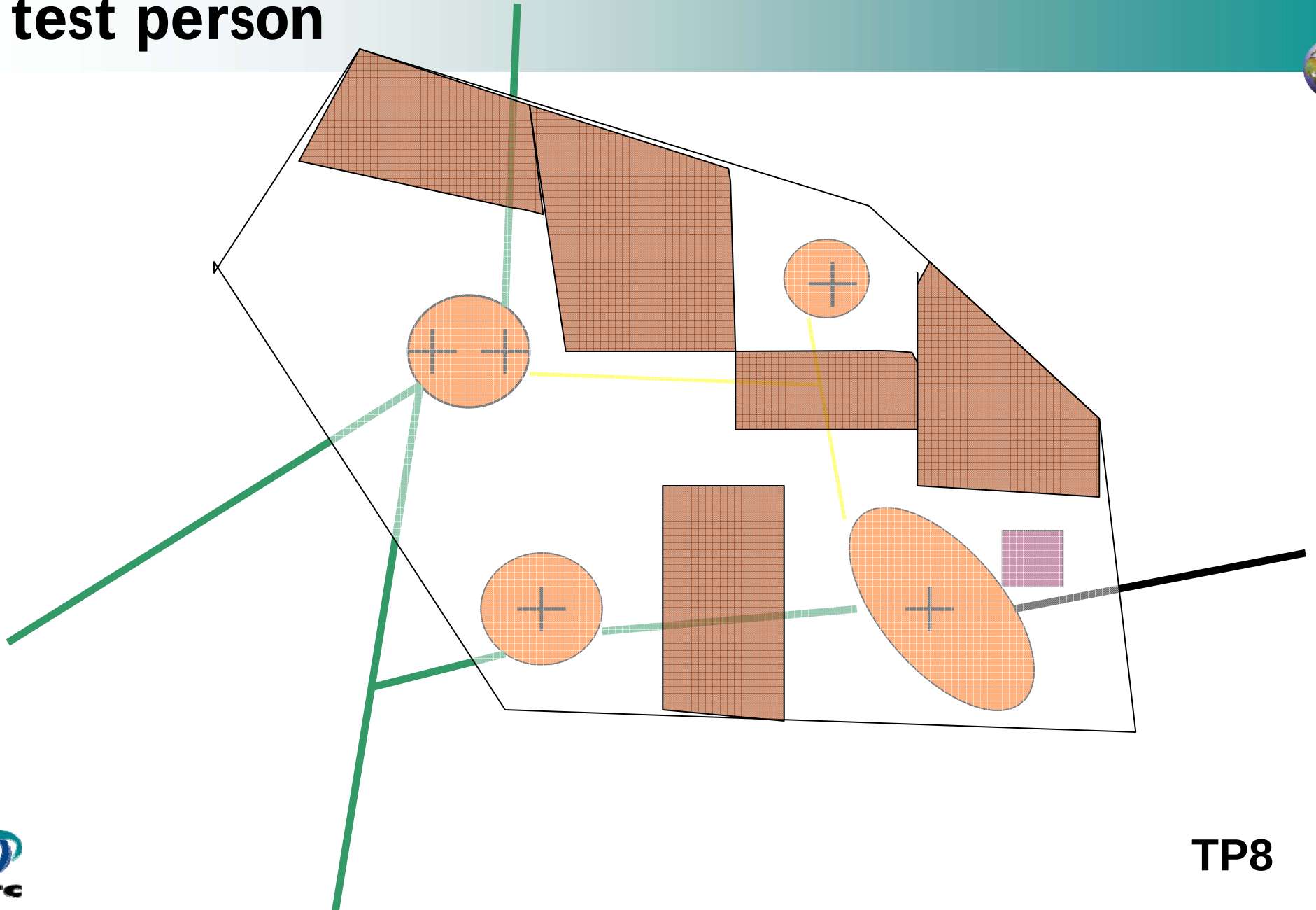
Graphical model constructed by one test person



Graphical model constructed by another test person



Graphical model constructed by another test person



Database of the Overijssel region



Available to the test persons:

- digital geographic (attribute and base map) data, to visualize within the ArcGIS environment
- existing paper maps and atlases
- existing digital maps (static, interactive or dynamic maps in different formats, ArcGIS 'Map documents', maps on CD-ROM or on diskette and Web maps)

Search results: tables with the paper & digital maps & data on the topic selected



SearchOnSubjectPO : Form

Search on subject

Find within Population (PO) all data on:

ALL all categories

POam Age and marital status

PObd

POde

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POpl

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QSearchWithinAttPOam : Select Query

04. Subcategory	a. Field name	b. Table name	05. Topic in E	06. Topic in D	08. Location	09. Area cov
POam - Age & ma	AGE0014_88	wmPOam_1988_1	Number of inha	Aantal inwoners	N:\gip\carto\Overijssel\NData	W = Overijse

QSearchWithinDigmPOam : Select Query

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POam - Age & ma	AGDF2	AGDF2_PercM	AGDF2_PercM	N:\gip\carto\Ove	Them07: Chr	W = Overijse	M = Municip	< 1:5
POam - Age & ma	AGDF41	AGDF41_PercC	AGDF41_PercC	N:\gip\carto\Ove	Them07: Chr	W = Overijse	M = Municip	< 1:5
POam - Age & ma	AGDF42	AGDF42_PercA	AGDF42_PercA	N:\gip\carto\Ove	Them07: Chr	W = Overijse	M = Municip	< 1:5

QSearchWithinPamPOam : Select Query

3. Subcategory	1. Identificatio	4. Map title in	5. Map title in	7. Maptype	8. Area cover	9. Mapping un	10. Scale
POam - Age & ma	Plano21	Age compositio	Leeftijdsopbouw	Them07: Chr	S = Overijss	M = Municip	< 1:500.000
POam - Age & ma	Plano22	Age compositio	Leeftijdsopbouw	Them07: Chr	S = Overijss	O = Other	< 1:500.000

Record: 1 of 2

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Test environment



Research material

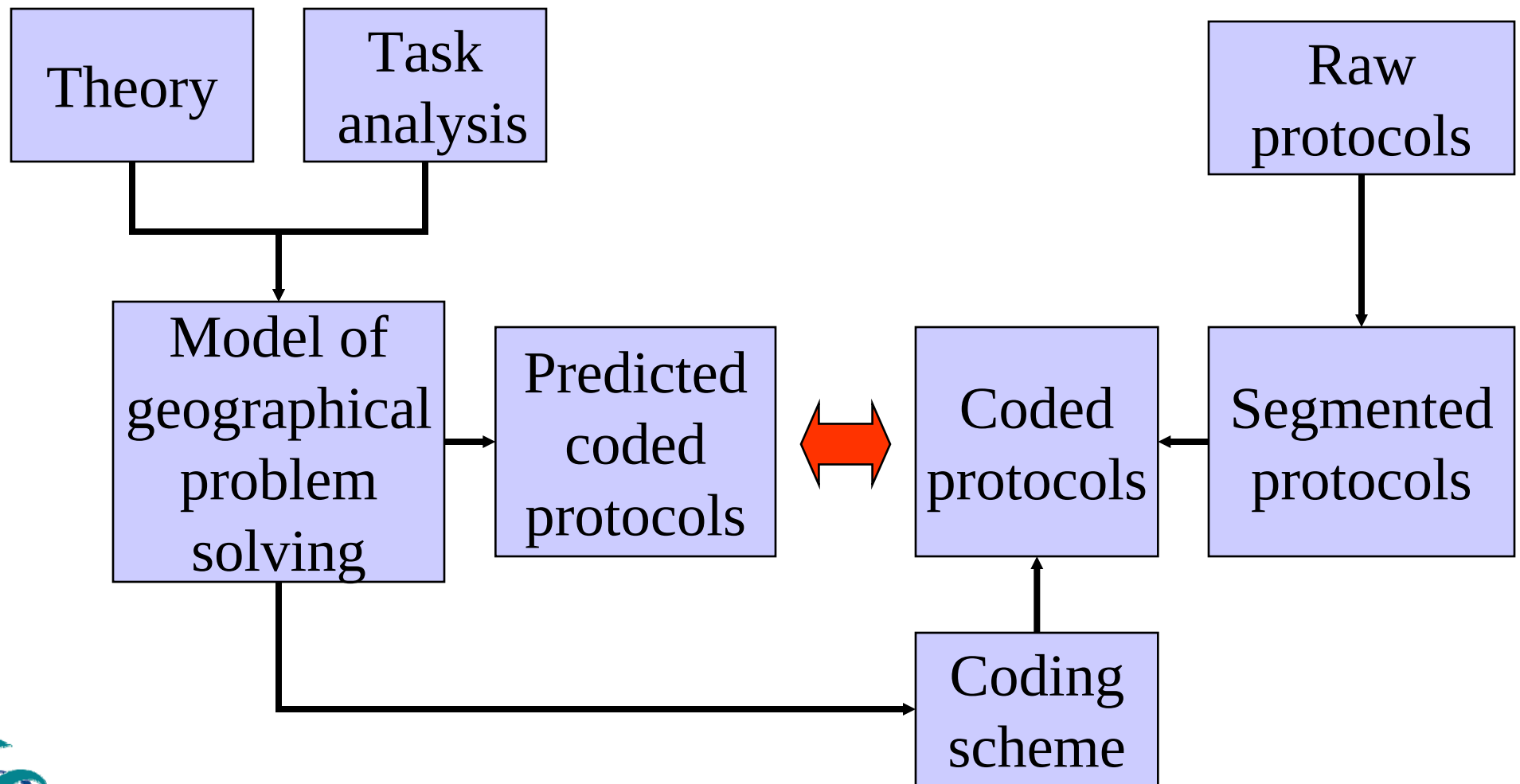


Research methodology applied



- questionnaire
- thinking aloud
- video recording
- screen transaction logging
- thinking aloud *in retrospect*
- analysis of verbal protocols
- analysis of action protocols
- product analysis (graphical model)

Verbal / action protocol analysis



Map selection matrix



Map selection matrix of: TP18

Sequential number of matrix = **5**
Start: 00:25 End: 01:10

Part A: Resulting map (display)

Identification	ACDP9_PopDensity_2001
Map title	Population density (people per km ²)

Part B: Geodata

1. Theme(s) associated for	Population distribution
2. Theme(s) selected	PCity
3. Date(s)/Year(s) associated for	
4. Date(s)/Year(s) selected	
Aggregation level associated for	
Aggregation level selected	
Geographic extent associated for	
Geographic extent selected	
Map scale associated for	
Map scale selected	

Part C: Map selection & basic geographic questions

	Map types	Map selection	Basic geographic questions
	topographic map thematic map physical planning map road map tourist map navigation map street map city map regional map satellite map digital map dynamic map interactive map		
4. selected these maps available (supply chain)			
5. selected for (demand chain)			
6. presented from spatial database			
7. What is the main theme of the map?			
8. What is the planned structure of the map?			
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100. What is the main theme of the map?			

Part D: Data representation

	Visual variables	Qualitative representation?
	position form color size shape value text dynamic symbol user interface?	
Nature of the data		
nominal point		
nominal line		
nominal area		
ordinal point		
ordinal line		
ordinal area		
interval point		
interval line		
interval area		
relative ratio point		
relative ratio line		
relative ratio area		
absolute ratio point		
absolute ratio line		
absolute ratio area		

Part E: Data representation

	Mapping method/map execution	Nature of the data
	nominal point symbol nominal line symbol nominal area symbol ordinal point symbol ordinal line symbol ordinal area symbol interval point symbol interval line symbol interval area symbol relative ratio point relative ratio line relative ratio area absolute ratio point absolute ratio line absolute ratio area	
Nature of the data		
nominal & static		
nominal & dynamic		
ordinal & static		
ordinal & dynamic		

Incorrect application of visual variables, mapping method or way of map execution: n.s.

Map use matrix

Map use matrix of: TP10

Sequential number of matrix =

Start: 0:11:36 End: 0:17:01

6

Map (display)	Map use tasks															
	Elementary				Intermediate				Temporal				Overall			
AGDF 6	recognize	identify	quantity / estimate	locate	position	define distance	encounter spatial links	explain location	find pattern	quantity spat. anomalies	define distribution	connect to outside world	determine changes	establish trends	detect processes	comprehend context
Map use activities																
Reading																
look at title / legend	1		2	8					8							13
view the map image		3	5	9					4							
click on / point at map (symbol)																
Analyse																
measure on the map																
count symbols																
highlight object(s)																
lookup on map no:																
compare with model / choropleth				10												
Adjustment																
overlay																
switch layer on/off																
change classification method																
pen																
change aggregation level																
zoom in																
zoom out																
change map orientation																
change snapshot in time																
change symbology																
new mapping method -																
go to Map selection matrix no.:																
Construction																
trace boundaries																
draw element model / choropleth				7			11									12

Net map usage time:

0:11:36 - 0:12:45
0:15:36 - 0:15:41

Time spent on model construction: 0:12:45 - 0:15:36
0:15:41 - 0:17:01



● = 1 ● = 2 ● = 3 ● = 4 ● = 5 ● = 6 ● = 7 ● = 8 ● = 9 ● = 10 ● = 11 ● = 12

28

Exploratory map use research results



Use of maps is very much of a supply-driven nature

- exploratory cartography is not as interactive, private or demand-driven as always assumed
- users prefer to start their geographic data exploration with ready-made maps that are immediately available
- they even prefer maps on paper and possibly combined into an atlas
- maps not selected on the basis of clear geographic questions
- in the earliest stages of regional exploratory studies users do not want to generate their own map displays, nor do they want to adjust existing ones or interact with them

Main reason: time factor!

Results



Users:

- devote little time to actually consulting the map
- do not carefully consult legends
- do not notice mistakes
- are not cartographically aware
- do not know which map types provide the best answers to which geographic questions

Experts use the maps for confirming / rejecting geographic hypotheses, as well as for executing high-level map use tasks

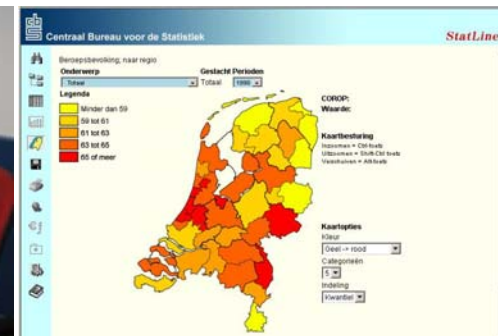
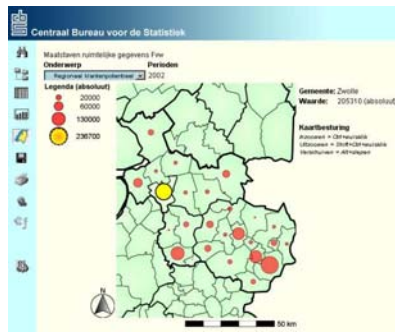
Novices use maps to come to grips with the task in hand and mostly stick to elementary map use tasks

Outline



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Testing the use of Web maps in the retrieval of regional statistical data



Corné van Elzaker (ITC, Enschede)

Pieter de Graaf (GIMA MSc student)

Duncan Beeckman (Statistics Netherlands)

StatLine (statline.cbs.nl) : online database of Statistics Netherlands



 **Centraal Bureau voor de Statistiek**

StatLine 

 **Zoeken**

Voer één of meer zoektermen in, kies één of meerdere perioden en klik op de 'Zoeken' knop.
Voor meer informatie, zie: [Zoeken Help](#)

Zoek in StatLine naar: periode:

Met behulp van:

Voorbeeld van vrij zoeken: verhuizingen buitenland, periode: 2001
Voorbeeld van geavanceerd zoeken: (varkens of mest) periode: (2000 of 2001)

 **Selecteren via themaboom**

Selecteer de gewenste tabel en gegevens met behulp van een verkennerachtige structuur (WebSelector).
In het linkerscherm van de WebSelector kiest u een tabel. De structuur van de gekozen tabel komt dan in het rechterscherm. Hier selecteert u de onderwerpen, perioden e.d. waarover u informatie wilt hebben.
Voor meer informatie, zie: [WebSelector Help](#)

 **Selecteren via de kaart** (alleen regionale kerncijfers)

Selecteer eerst het gebied waarover u informatie wilt hebben. In het tweede tabblad kunt u de onderwerpen kiezen. Momenteel zijn er alleen regionale kerncijfers via deze toegang beschikbaar. Kies in het derde tabblad tot slot de gewenste presentatievorm.
Voor meer informatie, zie: [Cartografische toegang Help](#)

Roles of interactive Web maps in geostatistical data dissemination



- Geographical interfaces for finding and retrieving data
- Web maps as a means of presentation
- Web maps for on-line analysis and exploration

Roles of interactive Web maps in geostatistical data dissemination



- Geographical interfaces for finding and retrieving data

StatLine interface for finding and retrieving data

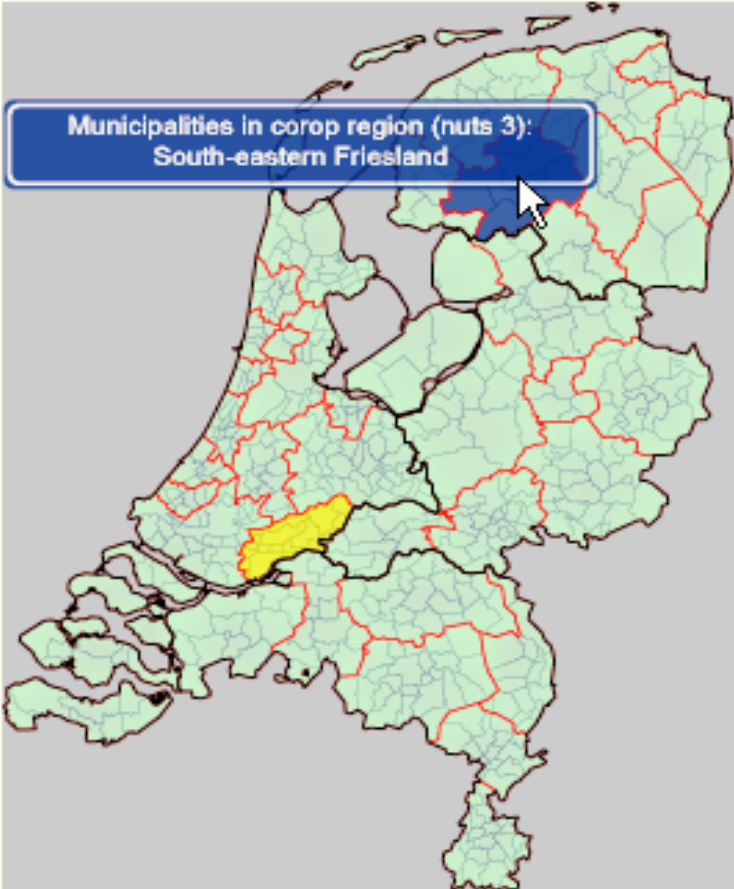


Select areas

Choose topic

Presentation

*You can select areas by clicking in the map or by choosing from the area list.
Zoom in: Press CTRL-key and drag mouse or choose zoomlevel
Zoom out: Press Shift-Ctrl and click in map
Pan: Press ALT-key and drag with mouse or drag red square in small map.*



Choose information about

Municipalities

per

COROP region (NUTS 3)

in

2000

Areas:

Eastern Groningen

Delfzijl and surrounding area

Other Groningen

Northern Friesland

South-western Friesland

South-eastern Friesland

Northern Drenthe



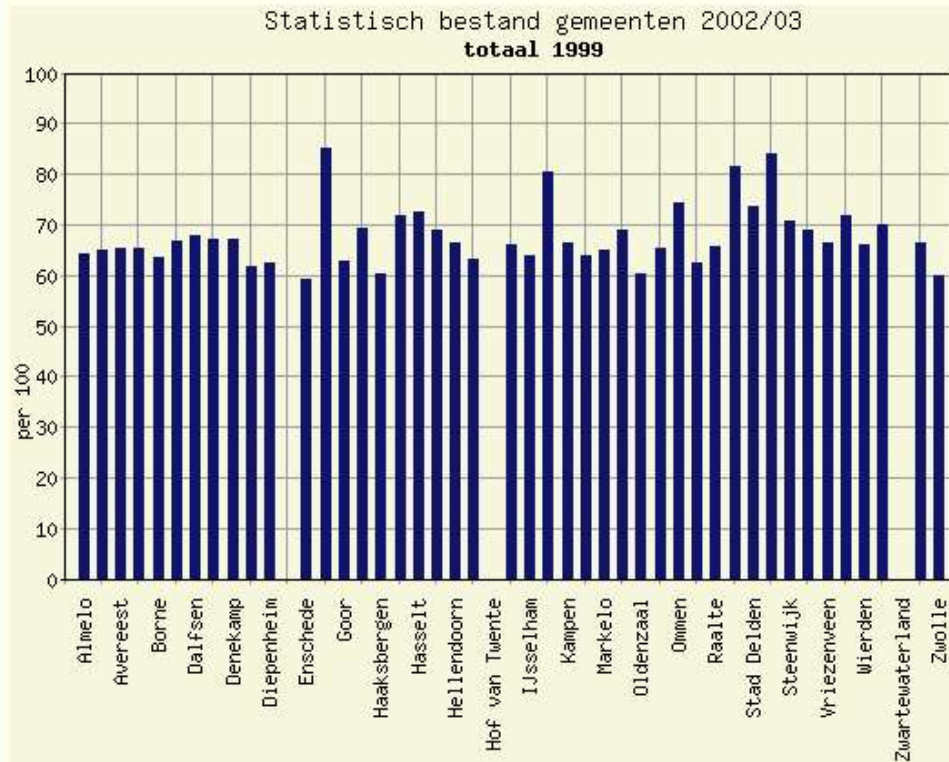
Zoom level

100%

StatLine Netherlands: output tables and charts



Centraal Bureau voor de Statistiek



Grafiekvorm

Histogram

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Centraal Bureau voor de Statistiek



Statistisch bestand gemeenten 2002/03

sleep hierheen om in laag te brengen

	Onderwerpen	Bevolking	
		Samenstelling	
		Demografische druk	
		totaal	
Gemeenten	Jaren	per 100	
Almelo	1999	64,2	
Ambt Delden	1999	65,1	
Avereest	1999	65,2	
Bathmen	1999	65,3	
Borne	1999	63,5	
Brederviede	1999	66,7	
Dalfsen	1999	67,8	
Den Ham	1999	67,0	
Denekamp	1999	67,1	
Deventer	1999	61,8	
Diepenheim	1999	62,3	
Diepenveen	1999	.	
Enschede	1999	59,1	
Genemuiden	1999	85,0	
Goor	1999	62,6	
Gramsbergen	1999	69,4	

StatLine: cartographic output



Select areas Choose topic Presentation

You can select multiple topics by pressing the CTRL key.

- ◆ Number of residents
- ◆ Men
- ◆ Women
- ◆ Urban and rural populations
- ◆ Population density
- ◆ Composition
- ◆ Development of the population
- ◆ Households
 - ◆ Number of households
 - ◆ One-person households
 - ◆ Households with children
 - ◆ Average household
- ◆ Births and deaths
- ◆ Removals
- ◆ Immigration and emigration

Excluding persons in institutional households.

Select areas Choose topic Presentation

Choose the presentation of the data

 ☒ Table

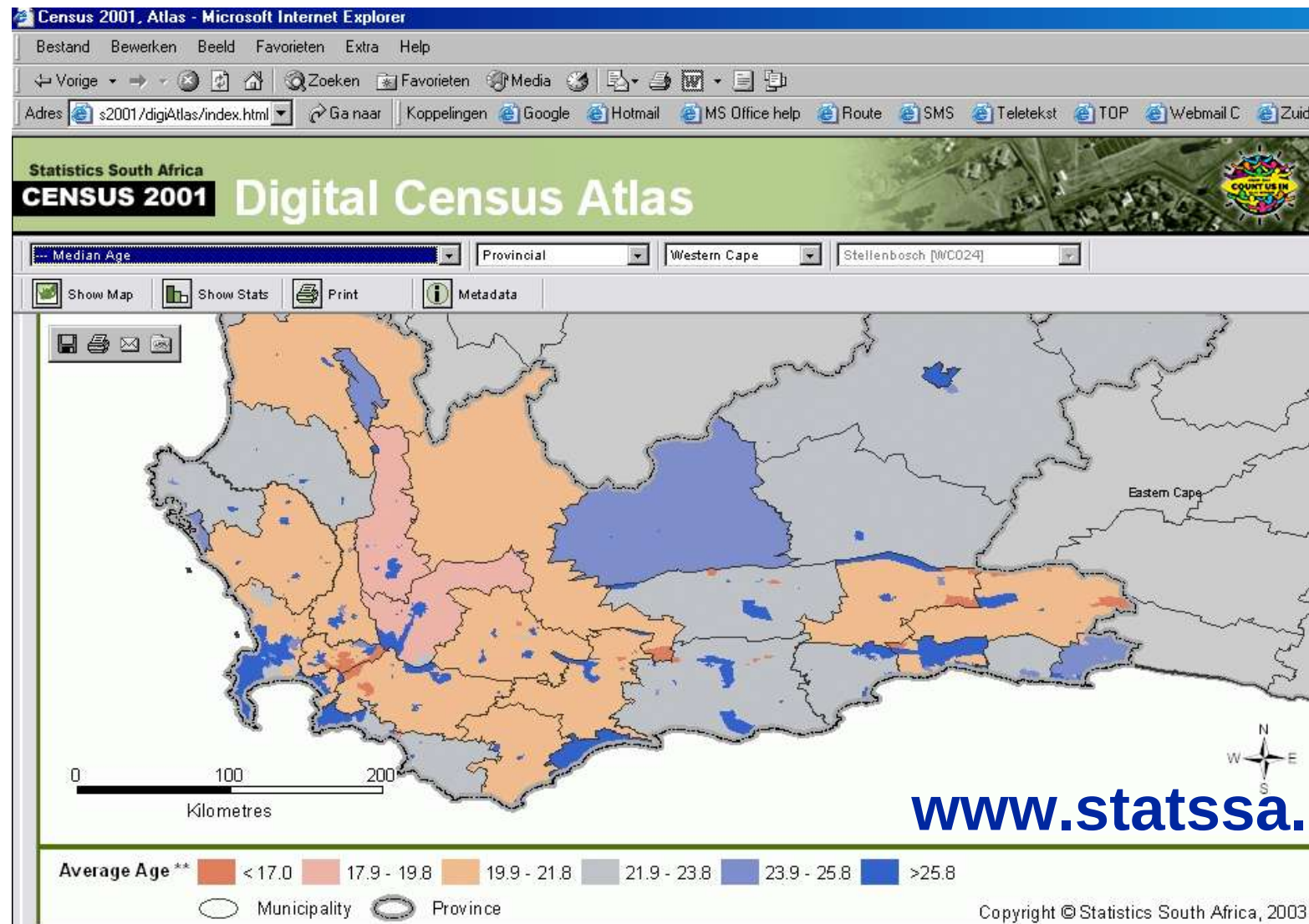
 ☐ Map

Roles of interactive Web maps in geostatistical data dissemination



- Geographical interfaces for finding and retrieving data
- Web maps as a means of presentation

Static Web map as means of presentation

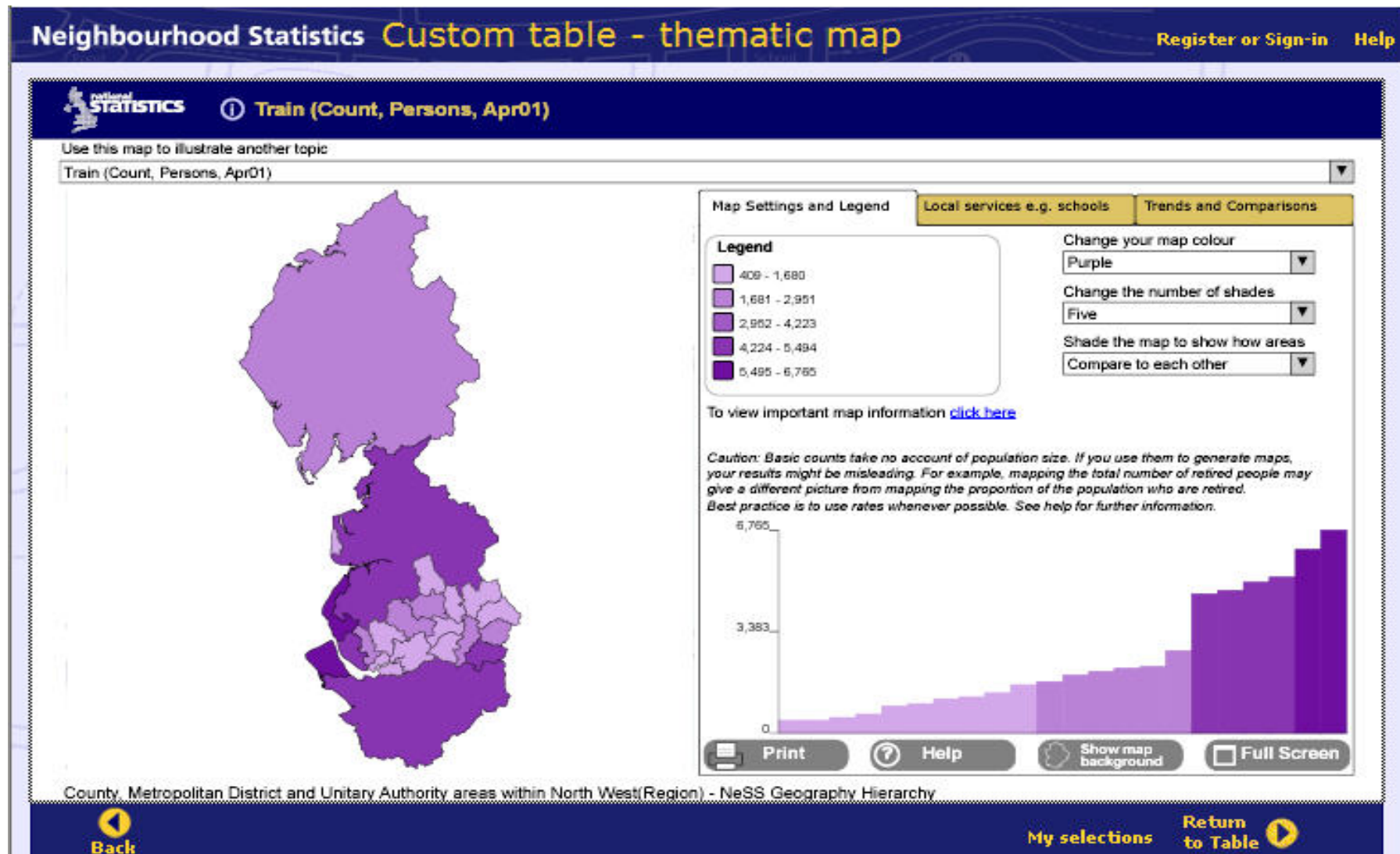


Roles of interactive Web maps in geostatistical data dissemination

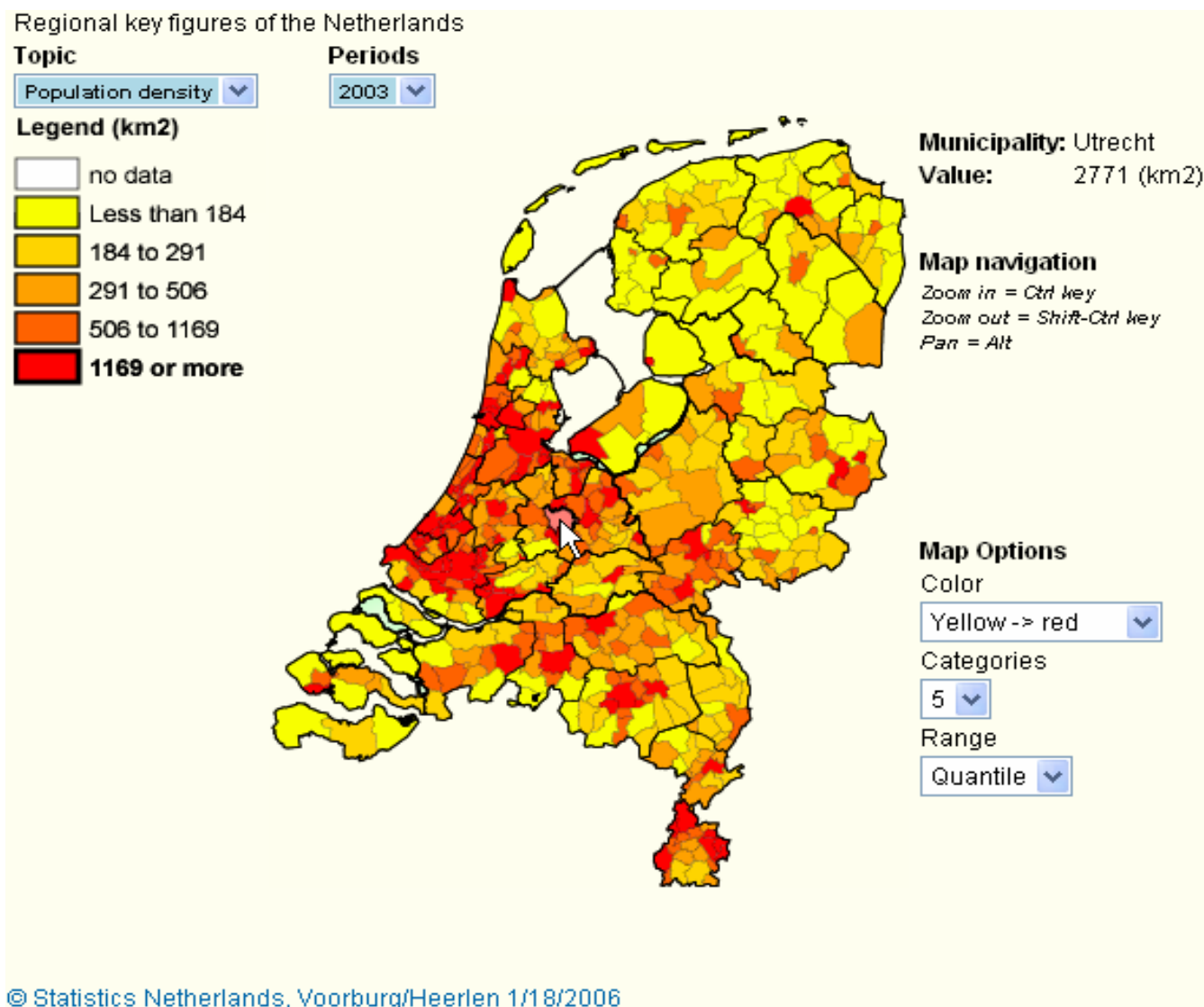


- Geographical interfaces for finding and retrieving data
- Web maps as a means of presentation
- Web maps for on-line analysis and exploration

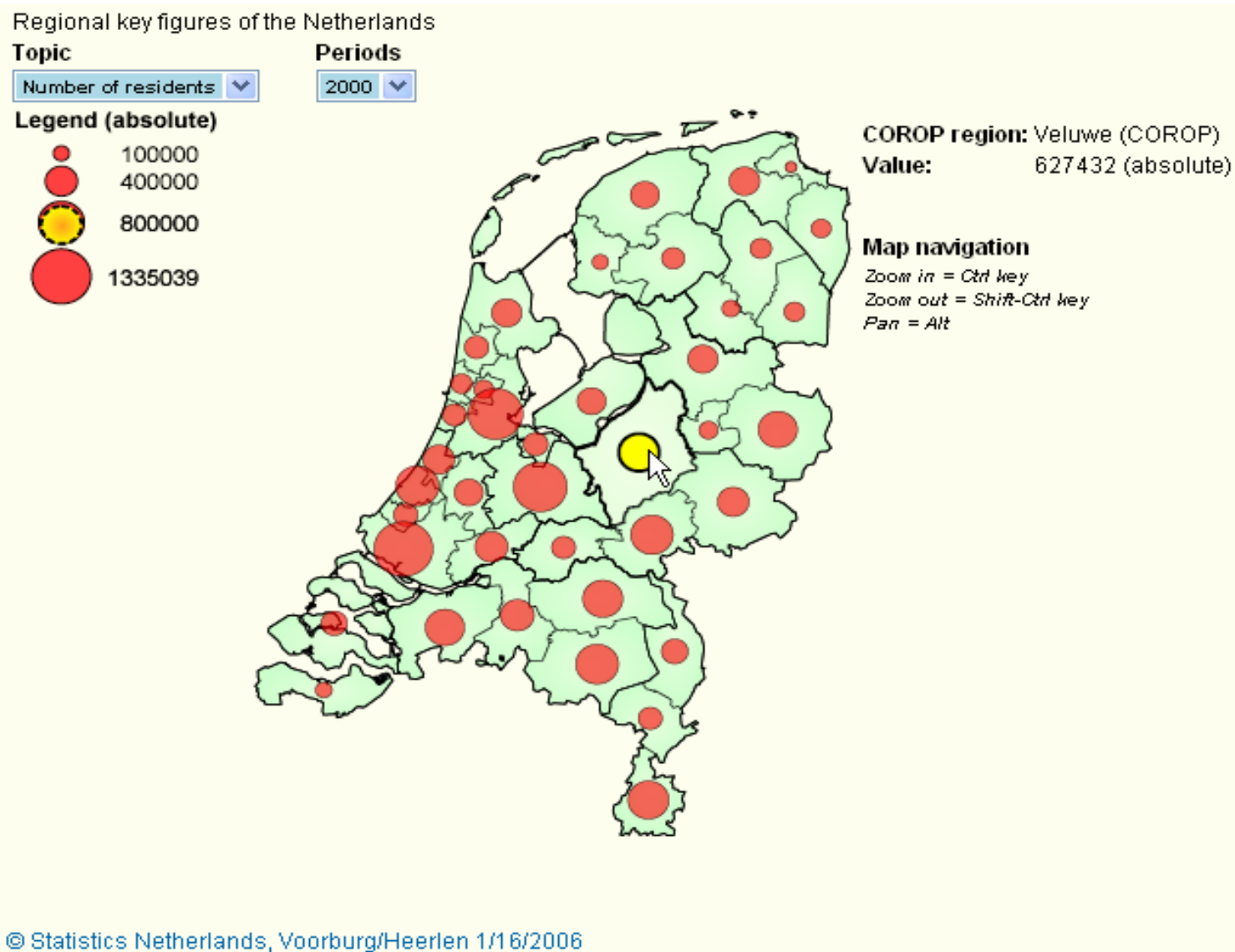
Interactive ONS Web map for on-line analysis and exploration



StatLine: more and more cartographic functionality with SVG



StatLine

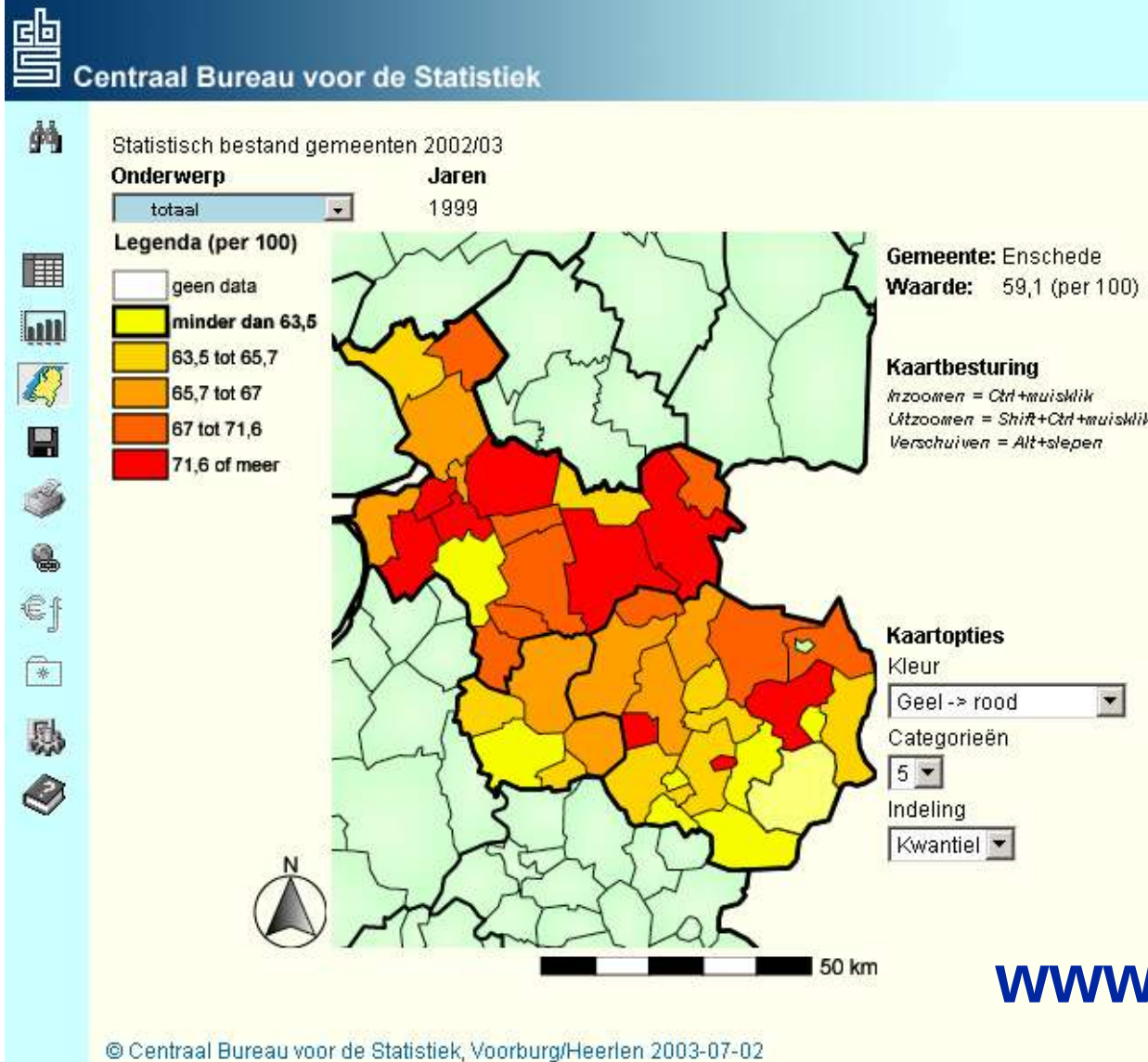


Interactivity SVG maps StatLine

- Mouseover to view data per administrative unit and highlight legend box
- Change year or subject
- Change colour scheme

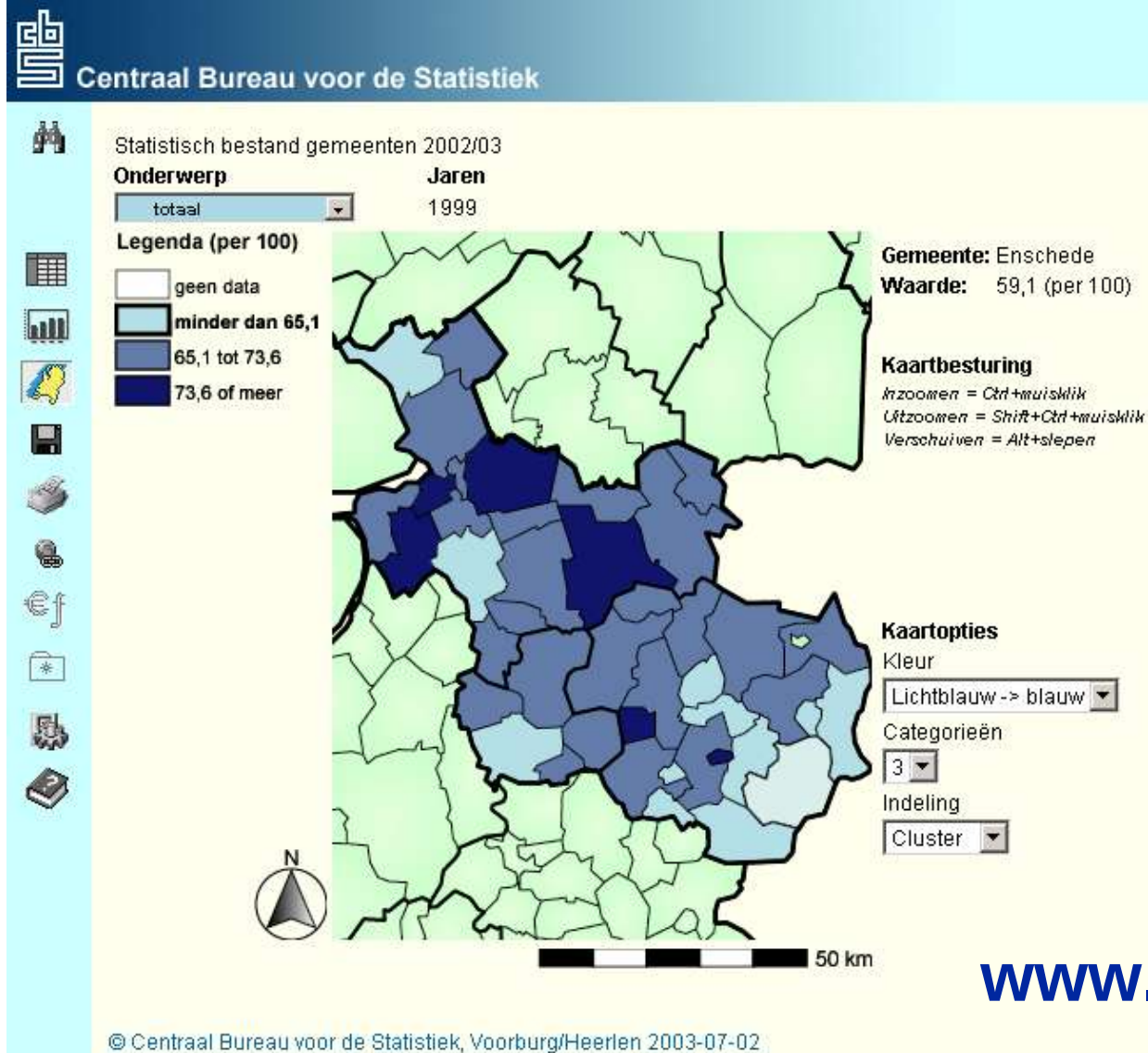


StatLine



www.cbs.nl

StatLine



Interactivity SVG maps StatLine

- Mouseover to view data per administrative unit and highlight legend box
- Change year or subject
- Change colour scheme
- Adjust classification method
- Change number of classes
- Zoom in & out
- Panning
- Selection of area of interest

Roles of interactive Web maps in geostatistical data dissemination



Does this all work in practice?

- *What is the use and the effectiveness of the current cartographic entry on the website of Statistics Netherlands?*
- *Which problems do users come across when using it?*
- *What functionalities are missing according to the user?*

User research executed by Pieter de Graaf
from September 2005 until February 2006.

Applied research methodology



- questionnaire before test session
- thinking aloud during task execution
- real-time analysis in observatory room
- video recording
- screen transaction logging
- questionnaire after test session
- analysis of research materials (tapes)

Test environments at 3 locations



Three different user groups



- General interest (5 subjects)
- Business interest (7 subjects)
- Scientific interest (7 subjects)

Had to execute tasks of different complexity. *e.g.*

- Which part of the province of Overijssel was most densely populated in 2003?
- For each COROP-region in the western part of the Netherlands, present in a map the area farming land per 1,000 inhabitants.

Some results



- users are not very critical (take for granted what is presented)
- only limited interaction with map display
- users want to print the map
- many recommendations to improve aspects of the cartographic functionality
- users' awareness of the potential roles of Web map displays in the retrieval, exploration, analysis and presentation of regional statistical data must be increased

Outline



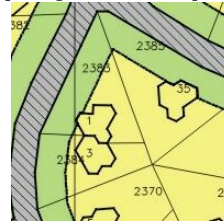
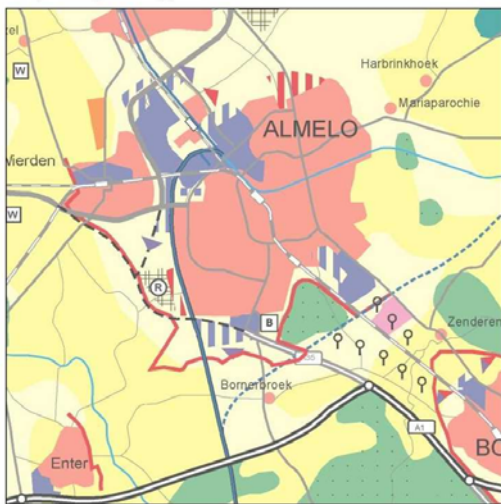
- Map use research since 1950s
- Research projects:
 - Use of maps in the exploration of geographic data
 - Use of Web maps in the retrieval of regional statistical data
 - Automated application-driven generalization of topographic information in order to derive base maps
 - Testing the usability of well-scaled mobile maps for consumers
- Agenda for usability research in geo-information processing and dissemination

Automated application-driven generalization of base maps

part of RGI project:

Generation and use of base maps for integrated querying of digital
physical plans

streekplan Overijssel 2000+, plankaart 2: functiekaart



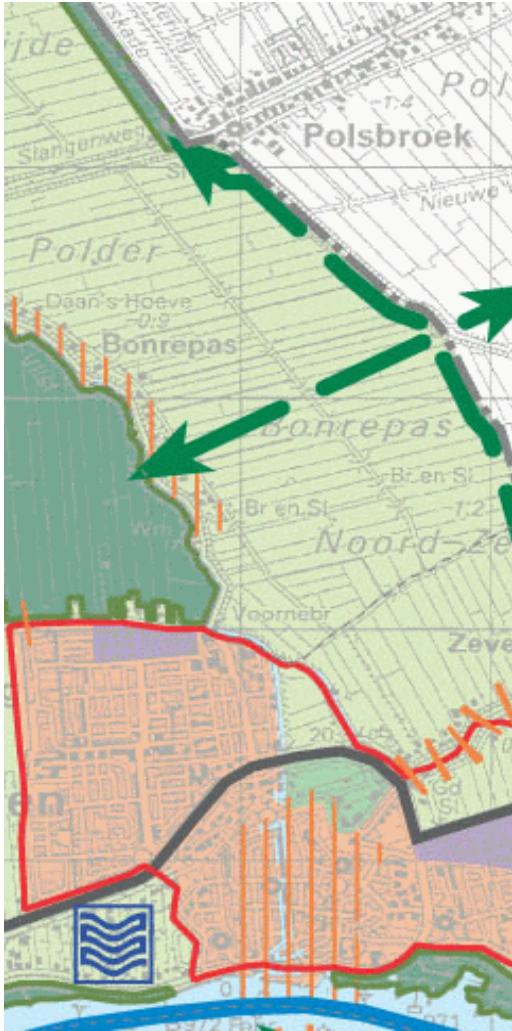
*Eddie Poppe / Theodor Foerster / Jantien Stoter /
Corné van Elzakker (ITC, Enschede)*

What is a *base map*?



- A base map is a map layer which provides a topographic setting for a thematic map.
- Main functions:
 - To facilitate localization and orientation
 - To highlight geographical relations between the thematic information and the topographic information

What is the *problem* with base maps?



Usually not adapted to user and use!

- use is often made of existing topographic maps (with a thematic layer on top of it)
- pre-defined, fixed scale levels
- no specific purpose (multi-purpose)

Solution: *generalization*



- *(digital) generalization*: “the process of deriving, from a data source, a symbolically or digitally-encoded cartographic data set through the application of spatial and attribute transformations”.
McMaster & Shea, 1992
- ... according to user and use requirements (application)!



Specification of requirements



- Which topographic information is *required* to carry out the map use tasks properly at each scale (level)?
 - ➡ *model generalization*
- How should this information be *represented* on the base map at each scale (level)?
 - ➡ *cartographic generalization*

Specification of requirements



- Which *functionality* is required to support the users' tasks?
- ➡ Grouping of requirements in *user profiles*

Research question and objective

- *Research question*: In which way can users' needs drive the automated generalization of base maps?
- *Research objective*: to develop a methodology for the production of base maps for specific applications from one single detailed topographic database.

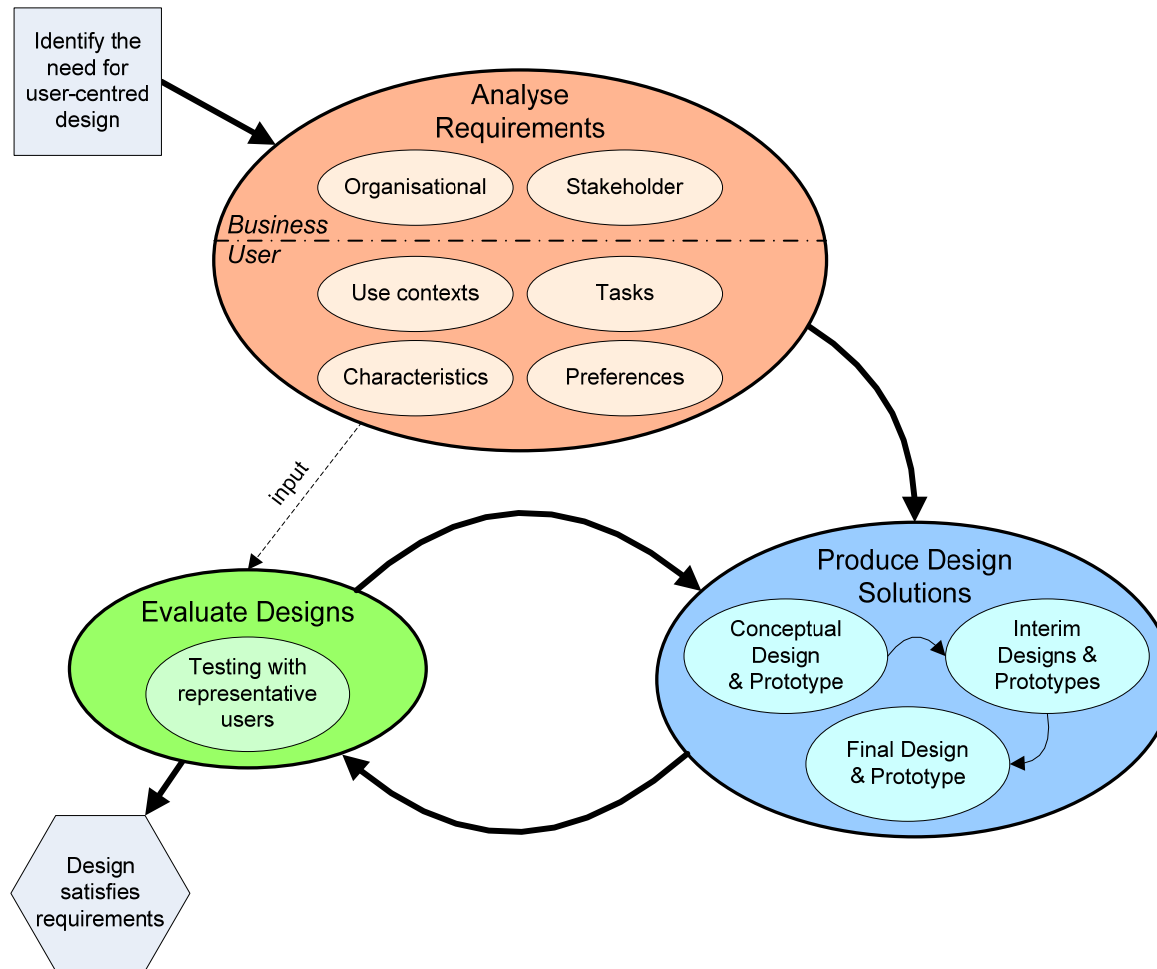


Implications for the research project



- *Know the user!*
- *Know the use!*
- *How?*
 - *User Centred Design* (UCD)
 - *Task Analysis*

User-centred design of geospatial data dissemination systems



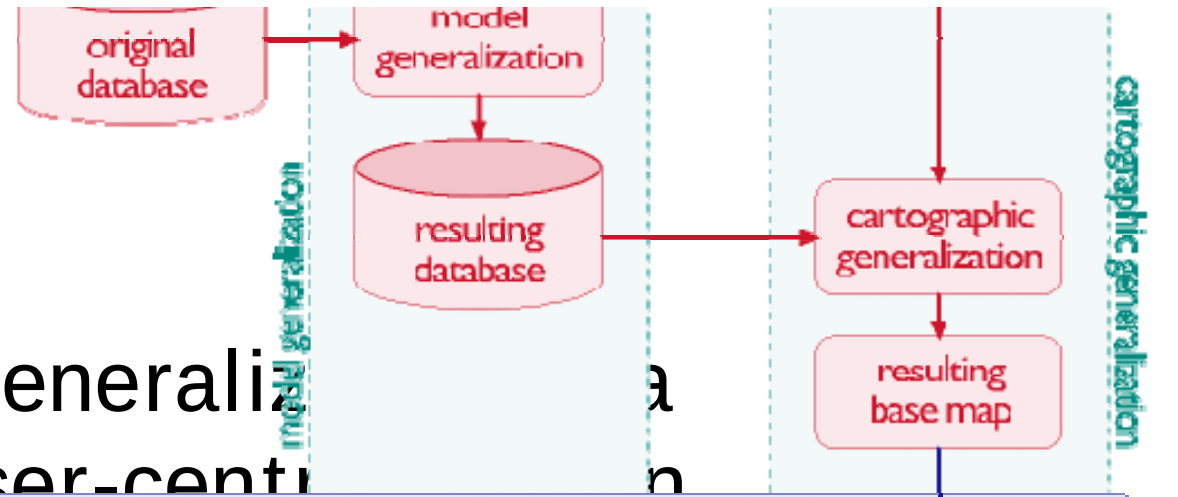
source:

van Elzakker, C.P.J.M. & K. Wealands (2007), *Use and users of multimedia cartography*. In: W. Cartwright; M.P. Peterson & G. Gartner (eds.), *Multimedia Cartography, Second Edition*. Berlin etc. : Springer. Chapter 34, pp. 487 – 504.

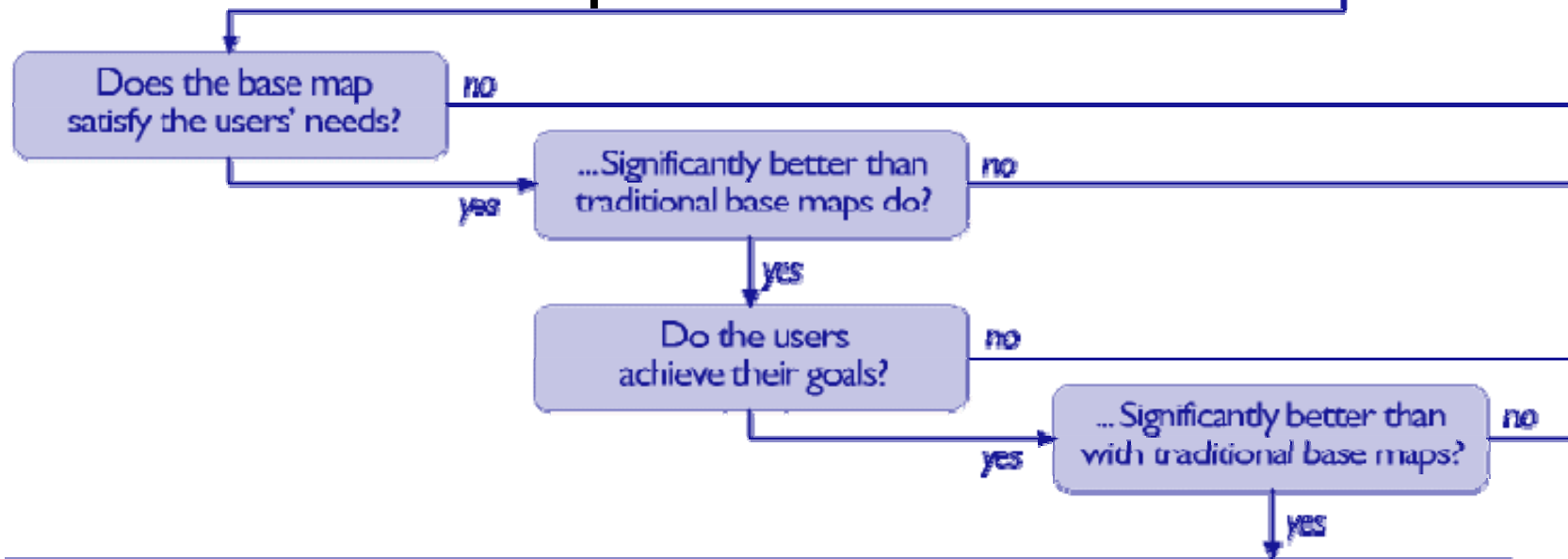
in the same book, also see:

Kramers, R.E. (2007), *The Atlas of Canada – User Centred Development*, Chapter 11, pp. 139 – 160.

Generalization user-centred



5. Evaluate designs against requirements



6. Final design



Application of research methods



know the user

‘professionals’

- questionnaires preceding focus groups or interviews

know the use

- focus groups if possible, otherwise interviews

‘consumers’

- questionnaires and, if possible, focus groups or interviews at user panels
- observations and interviews at participation events
- interviews at information desks of government bodies

Results

- No results yet; user research has just started.
- Problem ahead: to translate the results into rules and constraints that trigger the automatic generalization process.

www.durpondergronden.nl

Outline



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Building a usability testing methodology for mobile geo-applications

part of the RGI project:

Usable (and well scaled) mobile maps for consumers



Ioannis Delikostidis & Corné van Elzakker (ITC, Enschede)



Usable (and well scaled) mobile maps for consumers



Dutch research project:

- kick off in 2006
- led by Prof. Peter van Oosterom (TU Delft)
- keywords:
 - User-Centred Design
 - generalization
 - mobile geo-applications

www.gdmc.nl/uwsm2/

Generalization & mobile geo-applications



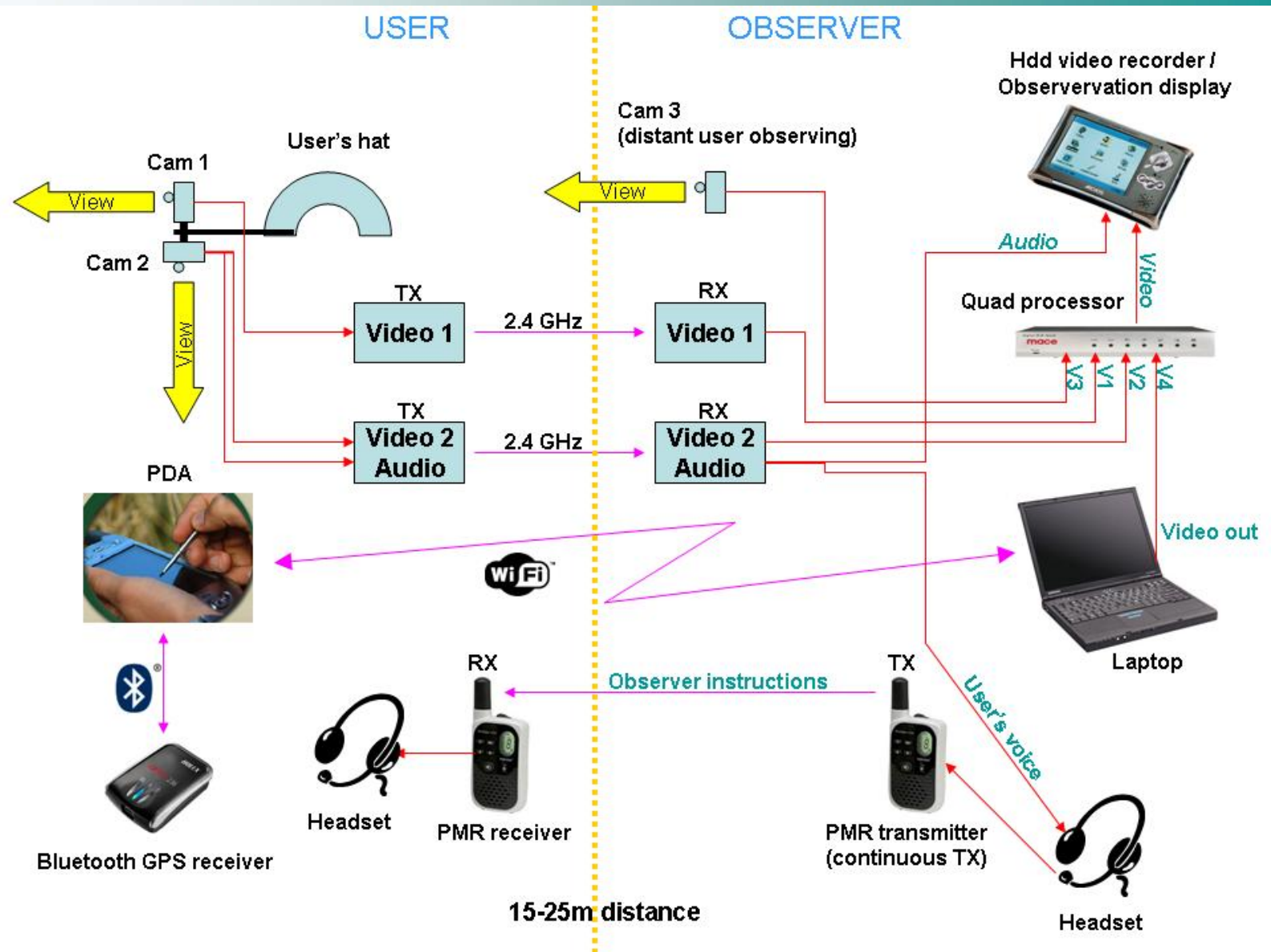
- Zooming = way of interaction with map interface
- Progressive transfer of geo-information (e.g. first retrieve 'rough' representations and get additional detail when required)
- Continuous change of map scale (animation) to help users orient themselves
- Application of GAP-face tree / GAP-edge forest concepts in variable scale topological data structures.

Usable (and well scaled) mobile maps for consumers



- Development of prototypes through UCD techniques
- Two use cases:
 - parking service in Amsterdam
 - tourist navigation
- Evaluation of the usability of the prototypes
- This work package: development of methodology for usability evaluation

Developed field observation system for testing mobile geo-applications



Field observation system for testing mobile geo-applications



User



Observer

Video's



- *User / test person and observer in action*
- *Resulting synchronized research mats*

play video

Outline



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Importance of the user ...



ICA conference Durban, 2003:

“User”

mentioned

in 69% of the 346 papers!

Not only *MAP* use research



Some use topics addressed in ICA seminar Madrid 2005:

- Use of search engines to find maps on the Internet (*Peterson*)
- User-centred design of Atlas of Canada (*Williams*)
- Usability techniques to evaluate geovisualization in teaching and learning (*Marsh*)
- Observing computer based mapping activity: review of research approaches (*Owen*)
- Users national atlas information systems (*Trainor*)

Not only *MAP* use research



Some other topics addressed in ICA Madrid/A Coruña:

- User need analysis for Cybercartographic Atlas of Antarctica (*Caquard*)
- User guides for Atlas Scolaire du Québec (*Anderson*)
- The many dimensions of map use (*Carter*)
- Usability tests and rendering methods in real-time 3D geovisualization (*Nielsen*)

Not only *MAP* use issues ...



But also use and user issues related to, e.g.:

- Data and databases
- Other output formats
- Software and information systems
- Hardware
- Interfaces

From map use research to usability research in
geo-information processing



The ICA Working Group on Use and User Issues and its activities

Use and user issues



- The user
- Usability
- Improving user abilities

The user

- User characteristics / profiles
- Use context
- User requirements
- Use goals
- Task analysis and modeling

Usability



- User-centered design
- Methods and techniques of evaluation/testing

Usability testing: methods and techniques



- Qualitative
- Quantitative

- Interviews
- Focus groups
- Thinking aloud
- Questionnaires
- Performance analysis
- fMRI scanning
- Eye-movement
- ...

Improving user abilities



- User training (e.g. children, visually impaired people)
- Participatory / collaborative mapping
- Map use in education and training

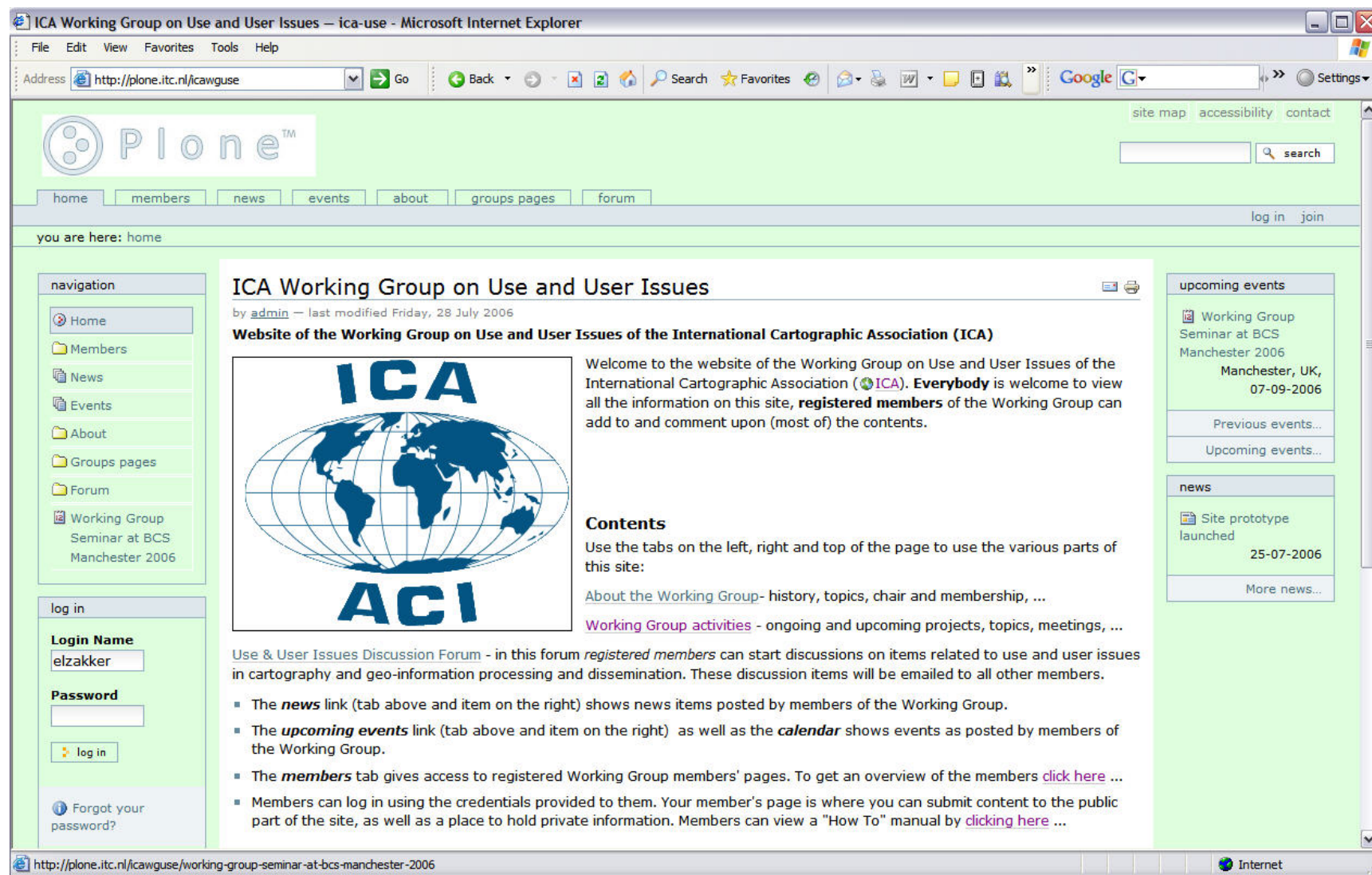
Terms of Reference 2005 - 2007

ICA Working Group on Use and User Issues



- Set up an on-line bibliographical database
- Set up a forum on the Web to exchange knowledge
- Set up a database of individuals with expertise in various use and user issues and denote it with keywords to stimulate exchange of information

Website <http://plone.itc.nl/icawguse>



Terms of Reference 2005 - 2007

ICA Working Group on Use and User Issues



- Set up an on-line bibliographical database
- Set up a forum on the Web to exchange knowledge
- Set up a database of individuals with expertise in various use and user issues and denote it with keywords to stimulate exchange of information
- Foster publications on use and user issues
- Promote sessions on use and user issues at ICC 2007 in Moscow, August 2007
- Organize workshops / seminars

Are you ...

... interested in participating
in the work of the ICA Working Group on
Use and User Issues?

Dr. Corné van Elzakker
ITC, P.O. Box 6,
7500 AA Enschede, The Netherlands

elzakker@itc.nl

www.itc.nl/personal/elzakker

Map use tasks in regional exploratory studies (examples)



Geographical questions	Tasks
<i>Elementary</i>	
What is there?	to <i>recognize</i> objects
<i>Intermediate</i>	
Why is it there?	to <i>explain</i> a location
<i>Temporal</i>	
Has that object always been there?	to <i>determine</i> changes
<i>Overall</i>	
Can different sub-regions be identified?	to <i>regionalize</i>

Map use activities (examples)



Stages in map use	Activities
<i>Selection</i>	to <i>select</i> from maps available
	to <i>search</i> for existing maps
	to <i>generate</i> maps from database
<i>Reading</i>	to <i>look</i> at the legend
	to <i>click</i> on a symbol
<i>Analysis</i>	to <i>measure</i> on the map
	to <i>juxtapose</i> map displays
<i>Adjustment</i>	to <i>change</i> the mapping method
	to <i>pan</i> or to <i>zoom</i>
<i>Model construction</i>	to <i>draw elements of chorème</i>