PARIS LODRON UNIVERSITY SALZBURG

BIP Healthy Urban Systems

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Z GIS

DEPARTMENT OF GEOINFORMATICS - Mobility Lab

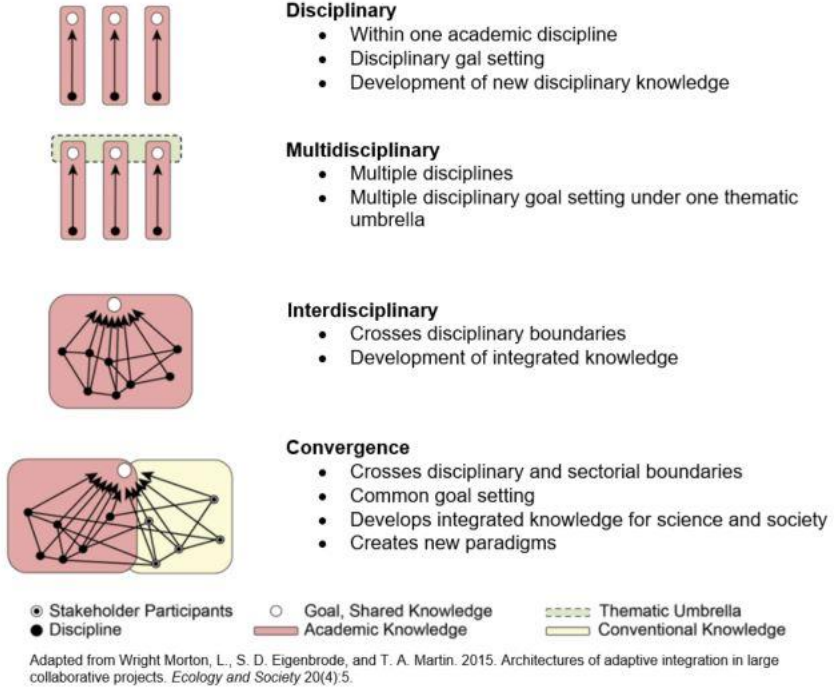
GHG emissions | Physical activity | Noise | Participation | Quality of Life | …

ICT | Transport | Sociology | Ecology | … | Geography

Public health | Economics | Transport planning | Urban planning | Sports sciences | Behavioural psychology

Inter-/transdisciplinary research

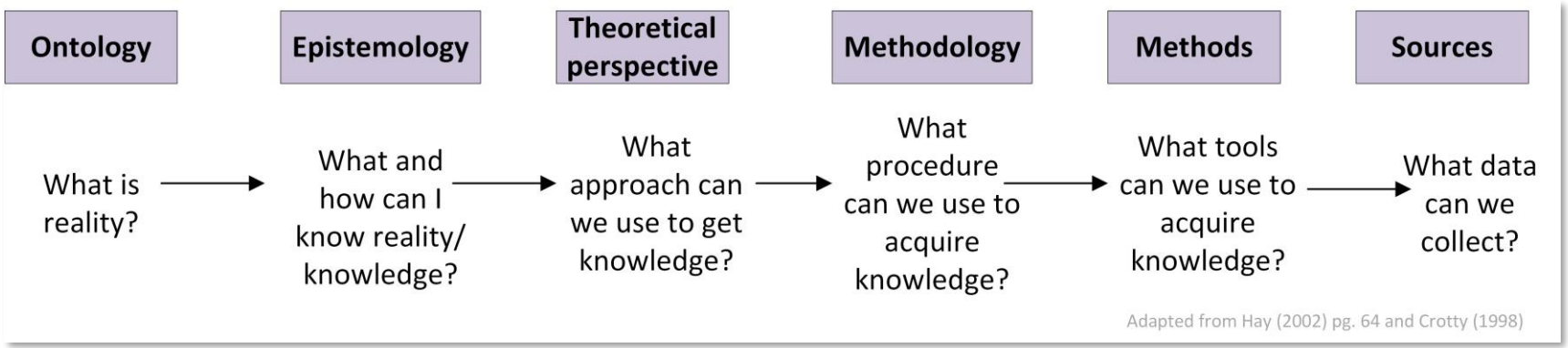
- Research within domain silos
  - Various different (complementary) approaches, methods
- Multiple domains
  - Multidisciplinarity
  - **Interdisciplinarity**
  - **Transdisciplinarity**



Adapted from Wright Morton, L., S. D. Eigenbrode, and T. A. Martin. 2015. Architectures of adaptive integration in large collaborative projects. *Ecology and Society* 20(4):5.

https://research.ncsu.edu/rdo/the-difference-between-multidisciplinary-interdisciplinary-and-convergence-research/

Epistemiology



https://salmapatel.co.uk/academia/the-research-paradigm-methodology-epistemology-and-ontology-explained-in-simple-language/

Determinants of health

- Determinants of health include
  - the **social** and **economic** environment,
  - the **physical** environment, and
  - the person's **individual** characteristics and behaviours
- Domains that are related to health determinants
  - Transport
  - Food and Agriculture
  - Housing
  - Waste
  - Energy
  - Industry
  - Urbanization
  - Water
  - Radiation
  - Nutrition and health
  - …

https://www.who.int/news-room/questions-and-answers/item/determinants-of-health

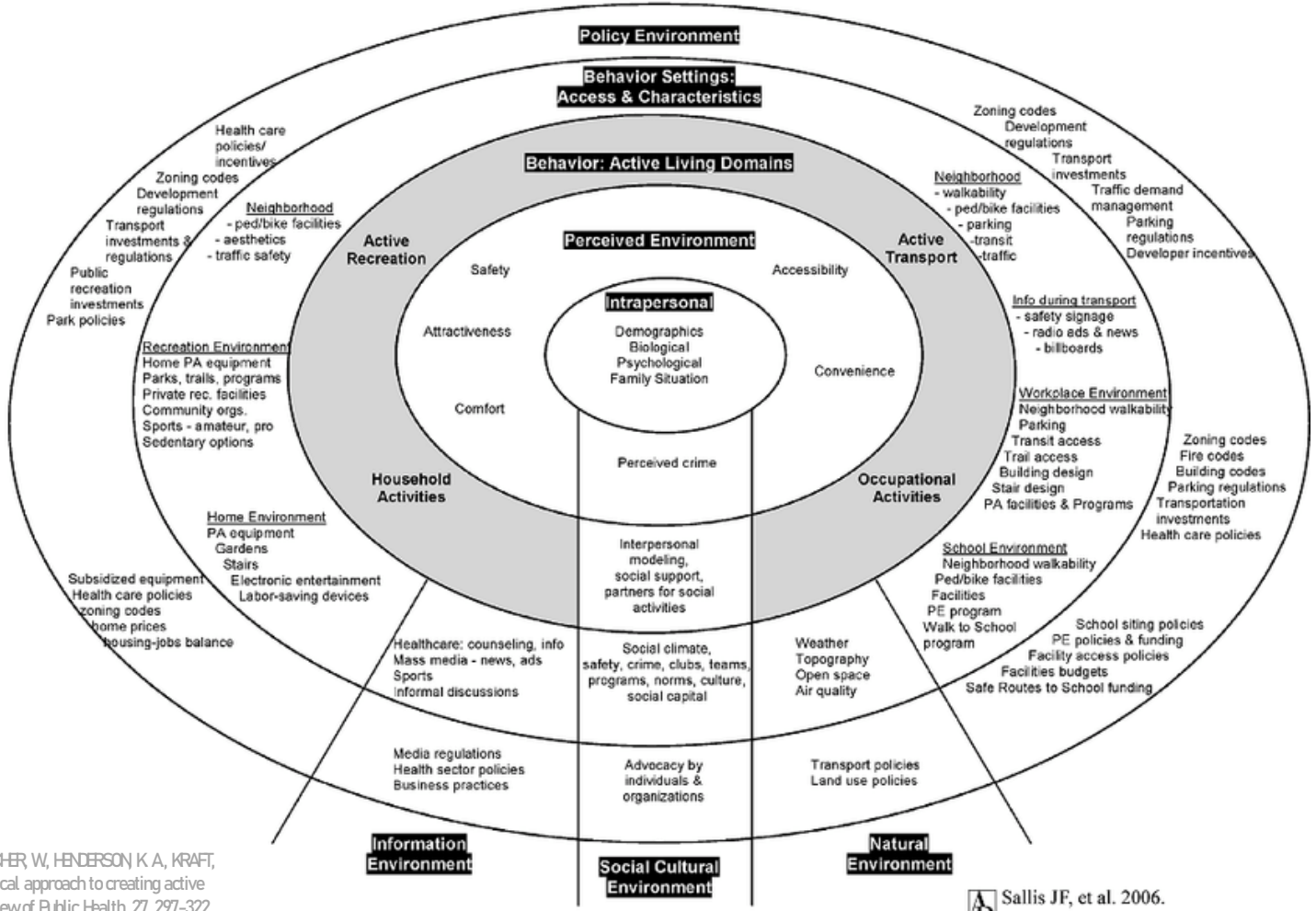
Socio-ecological model

- From isolated variables to a multi-layered, inter-related system
  - Socio-ecological model by Urie Bronfenbrenner: theory of human development
  - Transferred to numerous systems, e.g. health

(1) intrapersonal factors—characteristics of the individual such as knowledge, attitudes, behavior, self-concept, skills, etc. This includes the developmental history of the individual.
(2) interpersonal processes and primary groups—formal and informal social network and social support systems, including the family, work group, and friendship networks.
(3) institutional factors—social institutions with organizational characteristics, and formal (and informal) rules and regulations for operation.
(4) community factors—relationships among organizations, institutions, and informal networks within defined boundaries.
(5) public policy—local, state, and national laws and policies.

MCLEROY, K. R., BIBEAU, D., STECKLER, A. & GLANZ, K. 1988. An Ecological Perspective on Health Promotion Programs. Health Education Quarterly, 15, 351–377.

Ecological Model of Four Domains of Active Living



SALLIS, J. F., CERVERO, R. B., ASCHER, W., HENDERSON, K. A., KRAFT, M. K. & KERR, J. 2006. An ecological approach to creating active living communities. Annual Review of Public Health, 27, 297–322.

Sallis JF, et al. 2006.
Annu. Rev. Public Health 27:297–322

Measuring the impacts
Doughnut Economics framework (Raworth, 2017)

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Holistic System Model – Scenario Planning

- From problem statement to solutions:
  1. Scope (question) and focus (system level)
  2. Variables ≈ key factors ≈ indicators
  3. Outcome (“final product”)
  4. Participation, stakeholders: stages, format
  5. System interrelations, feedback loops
  6. Simulation, scenarios
  7. Evaluation

Entry points

- Entry points define **research questions** and decide on **methods**
- Possible entry points:
  - Stakeholders, actors
  - Addressed SDGs
  - Interventions
  - Health outcomes

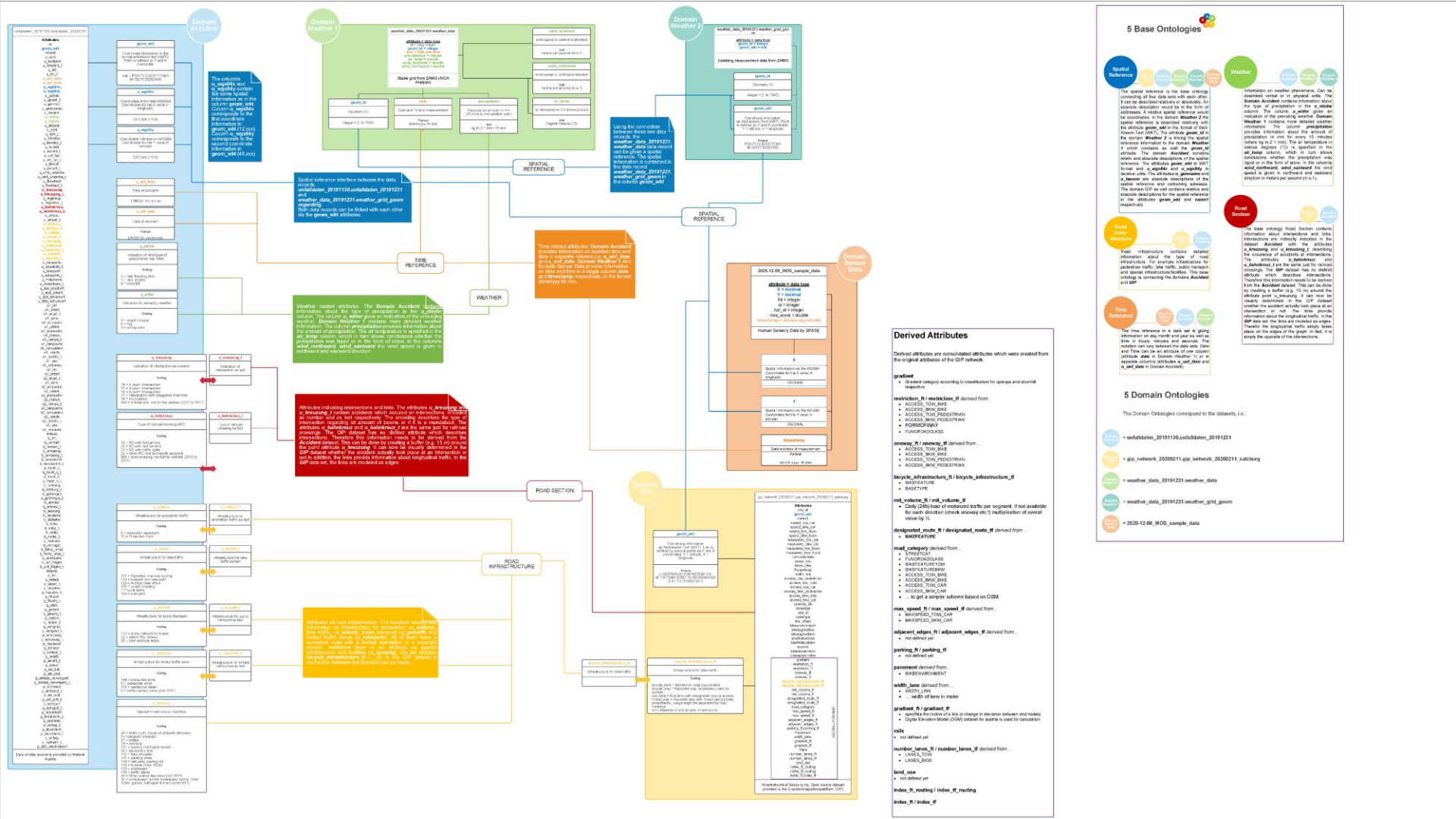
Use case Chavannes:
Health & Environment

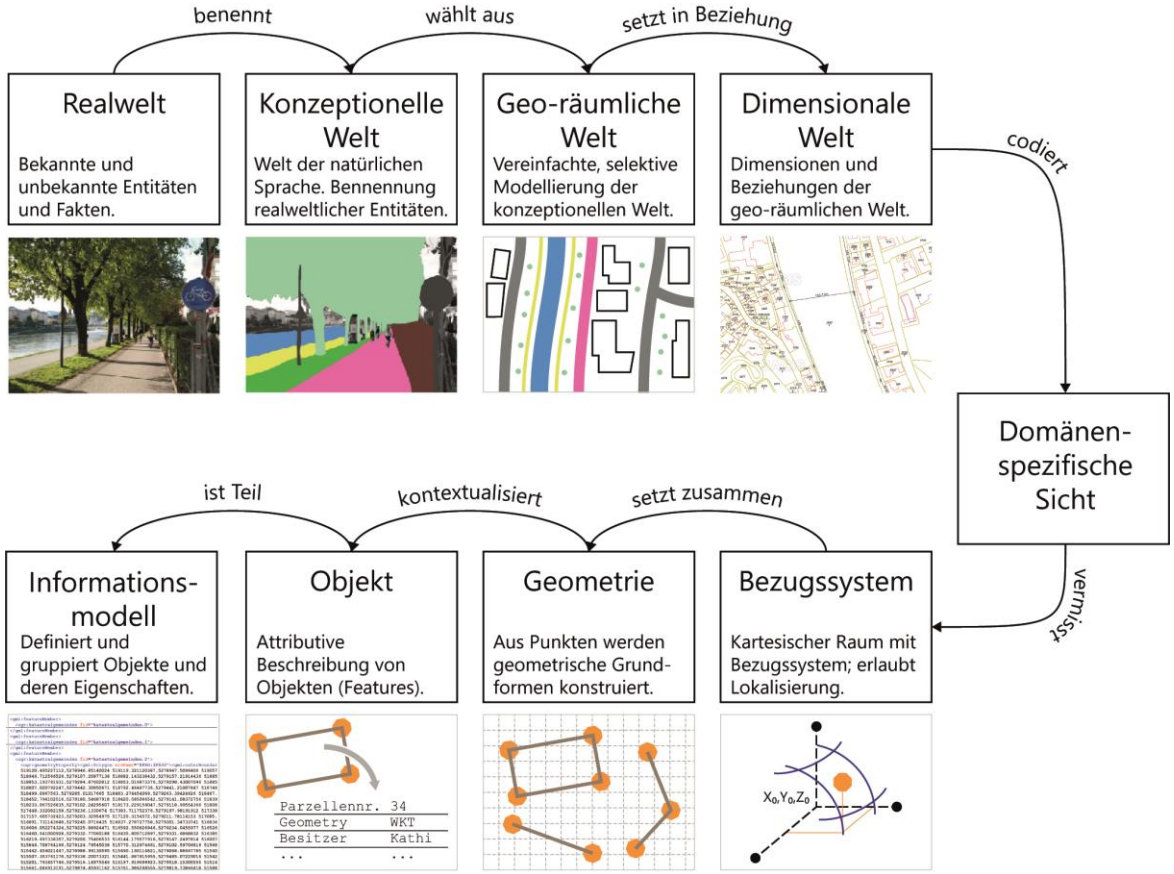
System boundaries

- System boundaries
  - **Topical**: components of system » indicators / variables representing a phenomenon
  - **Spatial scale:** geographical extent (caution: edge effects), level of detail, spatial reference units (regular grid, admin boundaries, …)
  - **Temporal scope:** time series (caution: change of environmental conditions, settings), extrapolation to future
- Definition of system decides on information » data demand

Information

- Information demand
  - Natural language
  - Ontologies » formalization of domain knowledge


Domain Accident
Domain Weather 1
Domain Weather 2
Domain Sensor Data
Domain GIP
SPATIAL REFERENCE
TIME REFERENCE
WEATHER
ROAD SECTION
ROAD INFRASTRUCTURE
Derived Attributes
5 Base Ontologies
5 Domain Ontologies



(Spatial) Data

- From natural language **description** of real-world to **objects**
- Model as abstraction

LOIDL, M 2020. Digital abstrahiert – räumliche Daten für die Mobilitätsforschung und Verkehrsplanung. In: ZAGEL, B. & LOIDL, M (eds.) Geo-IT in Mobilität und Verkehr. Berlin und Offenbach: Wichmann Verlag / VDE.

Data: qual. – quant.

- Quantitative data
  - Generated by technical sensors
  - Experimental research
  - Normative scenarios
  - Representation of physical reality
- Qualitative data
  - Generated by humans
  - Ethnography, discourse analysis, interviews, …
  - Explorative scenarios
  - Representation of human reality

Mixed-Methods Designs

Intervention design

- Test the effect of a treatment (experiment/trial setting) = quan
- Decide on role of qual data in research (before, during, afterwards)
- Conduct experiment/trial
- Determine impact of qual data: enhancement of quan results

Multistage evaluation design

- Test effectiveness of program or activities (evaluation over time)
- Identify parameters to be evaluated (need assessment, exploratory research)
- Define stages of evaluation, incl. instruments
- Determine quan/qual data need
- Conduct evaluation, refine instruments and integration

Social justice design

Convergent design

- Collect quan/qual data separately
- Merge results: data transformation, joint display, side-by-side comparison
- Discuss findings: confirmations, deviations

Explanatory sequential design

- Start with quan data collection
- Analyse quan data and formulate hypothesis for qual research
- Conduct qual research for explaining quan results
- Infere quan and qual results

Exploratory sequential design

- Start with qual data collection (explore the field)
- Develop and conduct quan investigation
- Compare findings of quan research with qual result and decide on generalizability

CRESWELL, J. W 2015. A concise introduction to mixed methods research, Thousand Oaks CA, SAGE, page 34 ff.

https://www.stadt-salzburg.at/presseaussendungen/2021/giselakai-und-ignaz-rieder-kai-werden-fahrradstrasse/

LOIDL, M, WERNER, C, FÜSSL, E, KRATOCHWIL, F. & RESCH, B. 2023. A mixed methods approach for capturing interactions of cyclists with mobility space. 1st International Conference Hybrid Societies. Chemnitz.

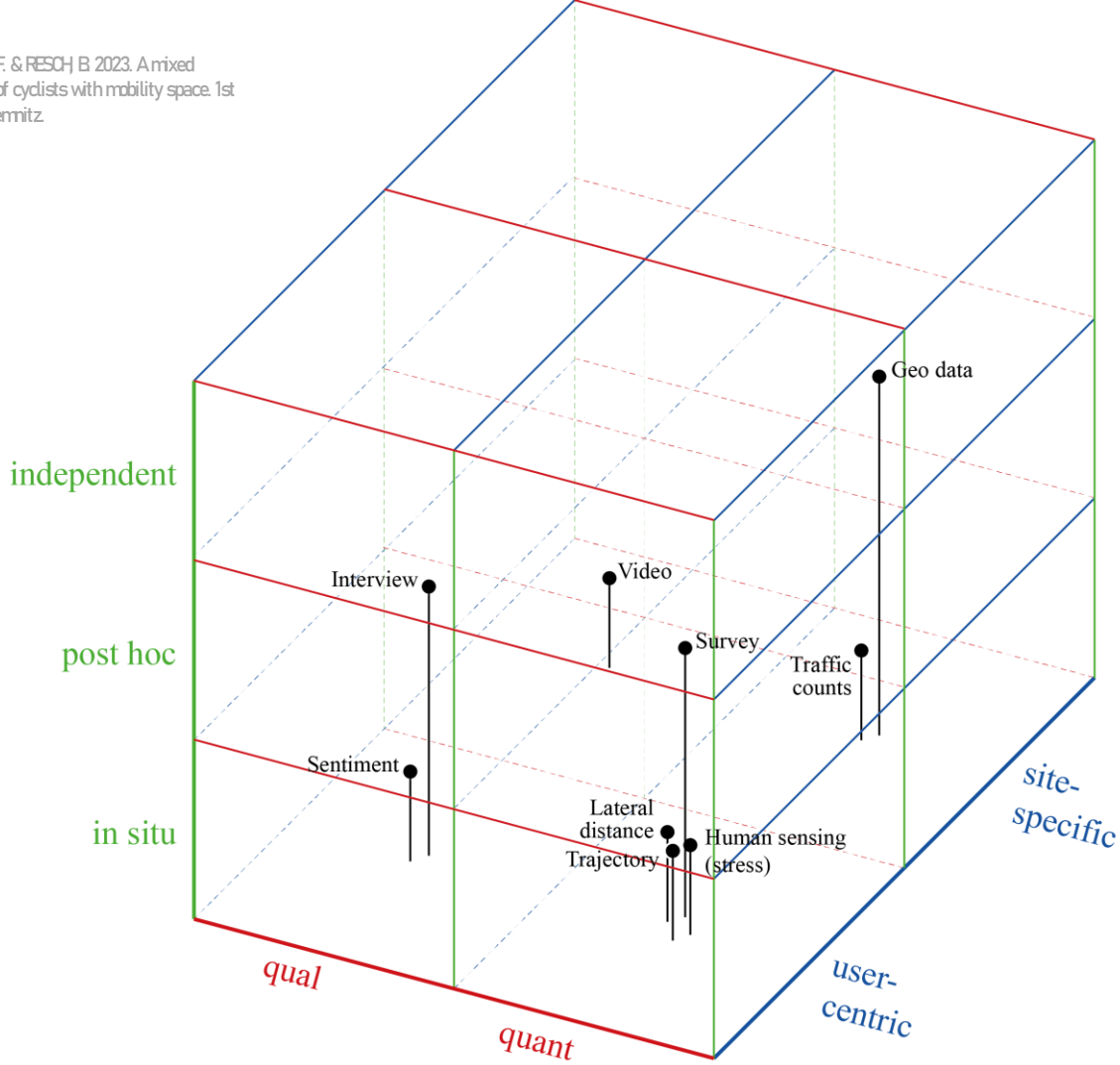
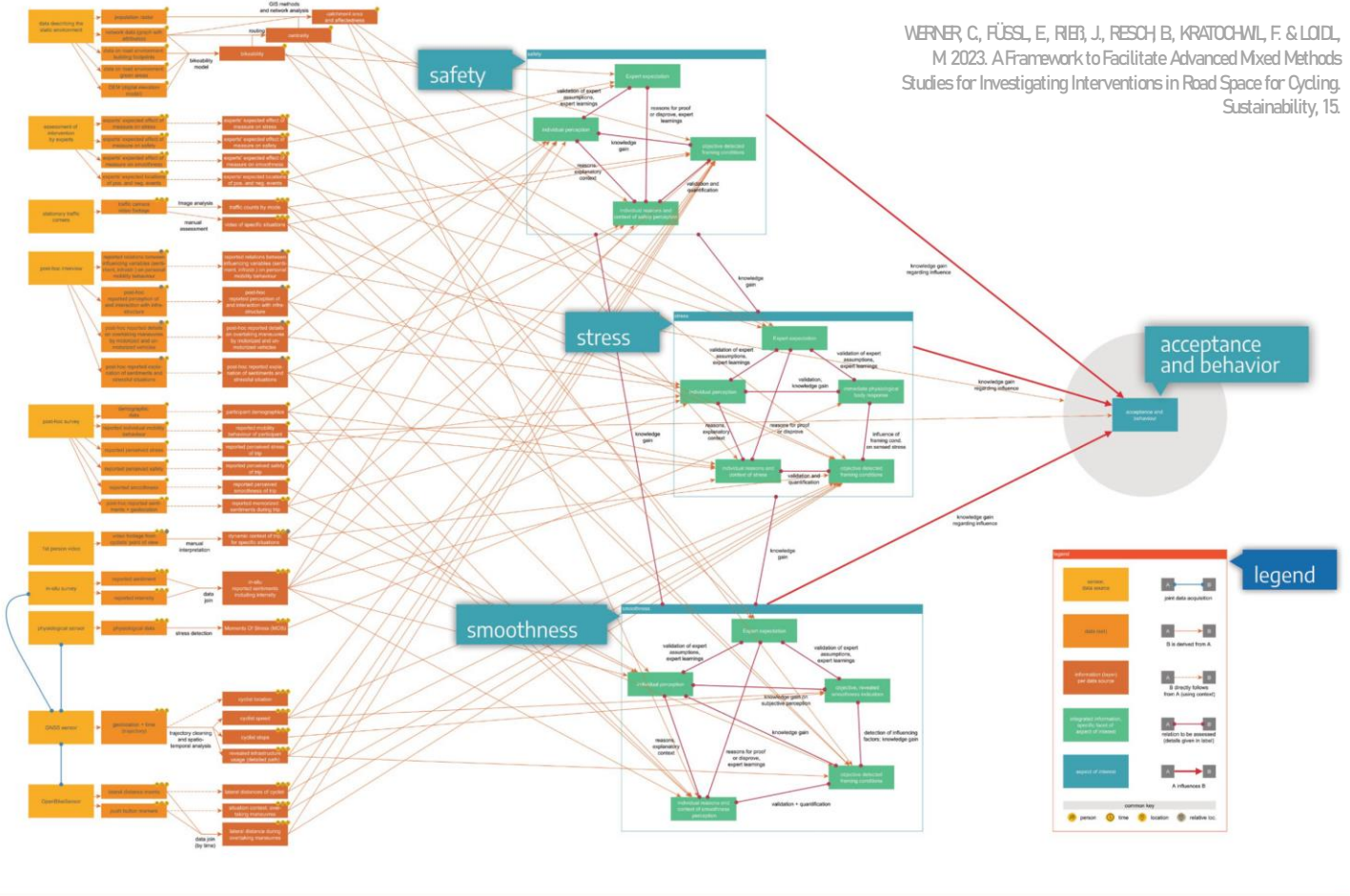


Table 1. Data sources and methods for data acquisition.

Category	Data Source	Method	Temporal Setting	Internal/ External [1]	Dynamic/ Static	Quantitative/ Qualitative	Type of Data Acquisition	Subjective/ Objective
social sciences	in situ geo-questionnaire (e.g., e-diary app)	micro-survey	in situ	internal	dynamic	quantitative/qualitative	self-reported	subjective view
	post-run geo-questionnaire	questionnaire	post hoc	internal	dynamic and static	quantitative/qualitative	self-reported	subjective view
	post-run interviews	interview	post hoc	internal	dynamic and static	qualitative	recorded and transcribed statements	subjective view
physical sensors	physiological measurements	human sensing	in situ	internal	dynamic (moving)	quantitative	measurements of physiological parameters	objective
	1st-person video	camera recording	in situ	external	dynamic (moving)	quantitative/qualitative	video recording	objective
	lateral distances (e.g., OpenBikeSensor)	ultrasonic distance sensing	in situ	external	dynamic (moving)	quantitative	distance measurements	objective
	button presses during overtakes	manual input: hardware push button	in situ	external	dynamic (moving)	quantitative	self-reported	subjective view
	traffic camera	camera recording	in situ	external	dynamic (stationary)	quantitative/qualitative	video recording	objective
	movement trajectory	GNSS, geolocation methods	in situ	external	dynamic (moving)	quantitative	recording of geolocation and time	objective
static spatial data	road network and environment	external data acquisition, GIS methods	independent	external	static	quantitative	spatial analyses	objective

[1] *internal* refers to aspects related to an individual, such as demographics but also individual sensation and reactions; *external* refers to observations more closely related to the (built) environment or which reveal how people interact with the environment as perceivable form the outside—see Section 3.1.



WERNER, C., FÜSSL, E., RIEß, J., RESCH, B., KRATOCHWIL, F. & LOIDL, M. 2023. A Framework to Facilitate Advanced Mixed Methods Studies for Investigating Interventions in Road Space for Cycling. Sustainability, 15.

color code

1 sensor / data source

2 data layer

3 information layer

4 integrated information

5 aspect of interest

Data assessment matrix

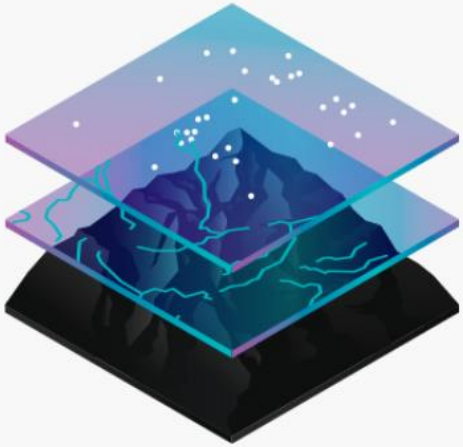
- Translates information demand into data requirements
- Identifies available data sets and assesses quality + suitability
- Ensures traceability
- Foundation for informed data acquisition strategy
- Developed and applied in interdisciplinary projects

Information demand	Project aims	Data	Relevance
▪ Information (natural language) ▪ Type of measurement ▪ Extent (temporal, spatial) ▪ Resolution (temporal, spatial) ▪ Measurement unit	▪ Purpose ▪ Outcome ▪ Aspect ▪ Comment	▪ Dataset ▪ Type ▪ Type of measurement ▪ Composition ▪ Resolution (temporal, spatial) ▪ Update frequency ▪ Sensitivity (privacy, GDPR) ▪ Source ▪ Cost ▪ Data Governance ▪ Data sharing service ▪ Documentation	▪ Availability (1-5) ▪ Importance (1-5) ▪ Suitability (1-5) ▪ Acquisition effort (1-5) ▪ General remarks ▪ Assessment index ▪ Availability type

1 : n

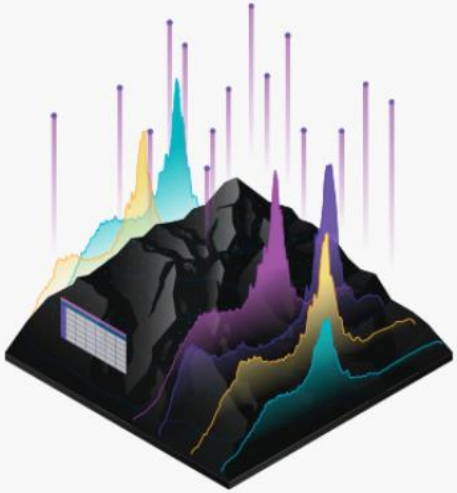
Information demand		**Id**	1
		Information	rainfall
		Type of measurement	forecast
	Extent	**Temporal**	Jan-2023 - Apr 2024
		Spatial	Salzburg city
	Resolution	**Temporal**	hour
		Spatial (geometry type)	Salzburg city
		Measurement unit	mm/h, mm/day
Project aims		**Purpose**	nudges dashboard
		Outcome	short-term nudging effect dahsboard visualization
		Aspect	weather
		Comment	Do i make it home dry or schould I wait for another 60 min?
Data		**Datasets**	DWD Open Data Weather
		Type	primary
		Type of measurement	forecast
		Composition	hourly forecast of precipitation in mm/h at measurement station
	Resolution	**Temporal**	60 min
		Spatial	Salzburg
		Update frequency	daily
		Sensitivity	-
		Source	Deutscher Wetterdienst
		Cost	free
		Data Governance	present
		Data sharing service	web service
		Documentation	present
Relevance		**Availability**	1
		Importance	5
		Suitability	5
		Acquisition effort	5
		General remarks	https://opendata.dwd.de
		Assessment index	30
		Availability type	available free

Geographic Information Systems



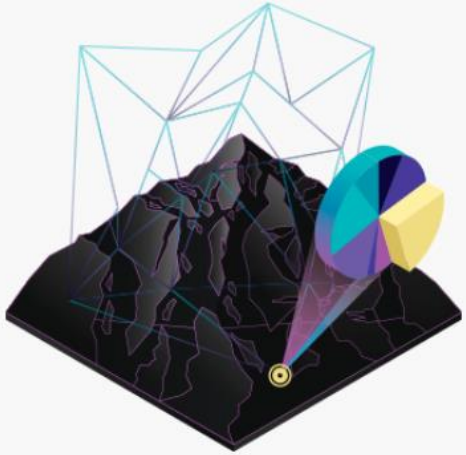
Maps

Maps are the geographic container for the data layers and analytics you want to work with. GIS maps are easily shared and embedded in apps, and accessible by virtually everyone, everywhere.



Data

GIS integrates many different kinds of data layers using spatial location. Most data has a geographic component. GIS data includes imagery, features, and basemaps linked to spreadsheets and tables.



Analysis

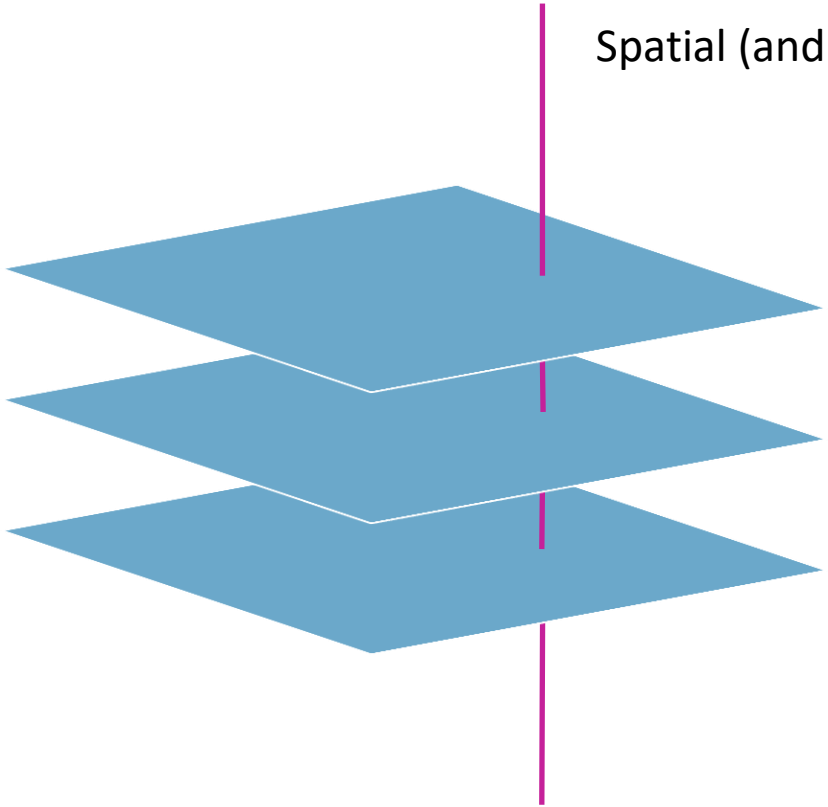
Spatial analysis lets you evaluate suitability and capability, estimate and predict, interpret and understand, and much more, lending new perspectives to your insight and decision-making.

Apps

Apps provide focused user experiences for getting work done and bringing GIS to life for everyone. GIS apps work virtually everywhere: on your mobile phones, tablets, in web browsers, and on desktops.

https://www.esri.com/en-us/what-is-gis/overview

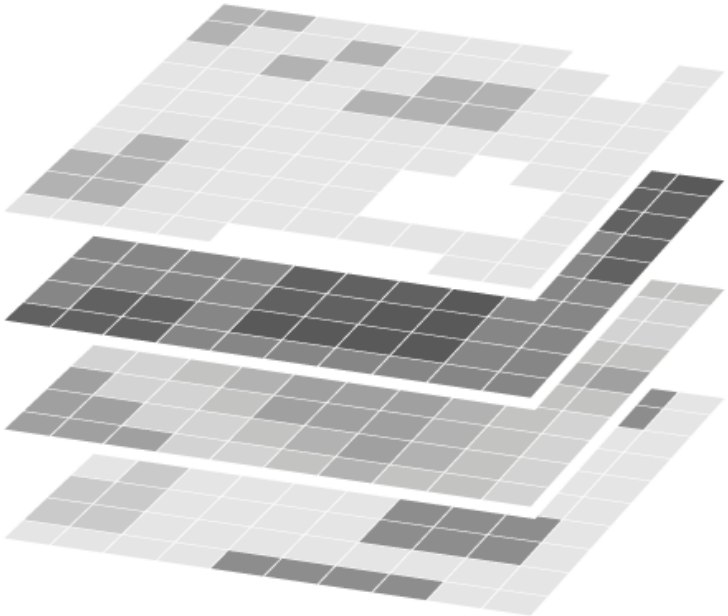
Spatial (and temporal) Overlay

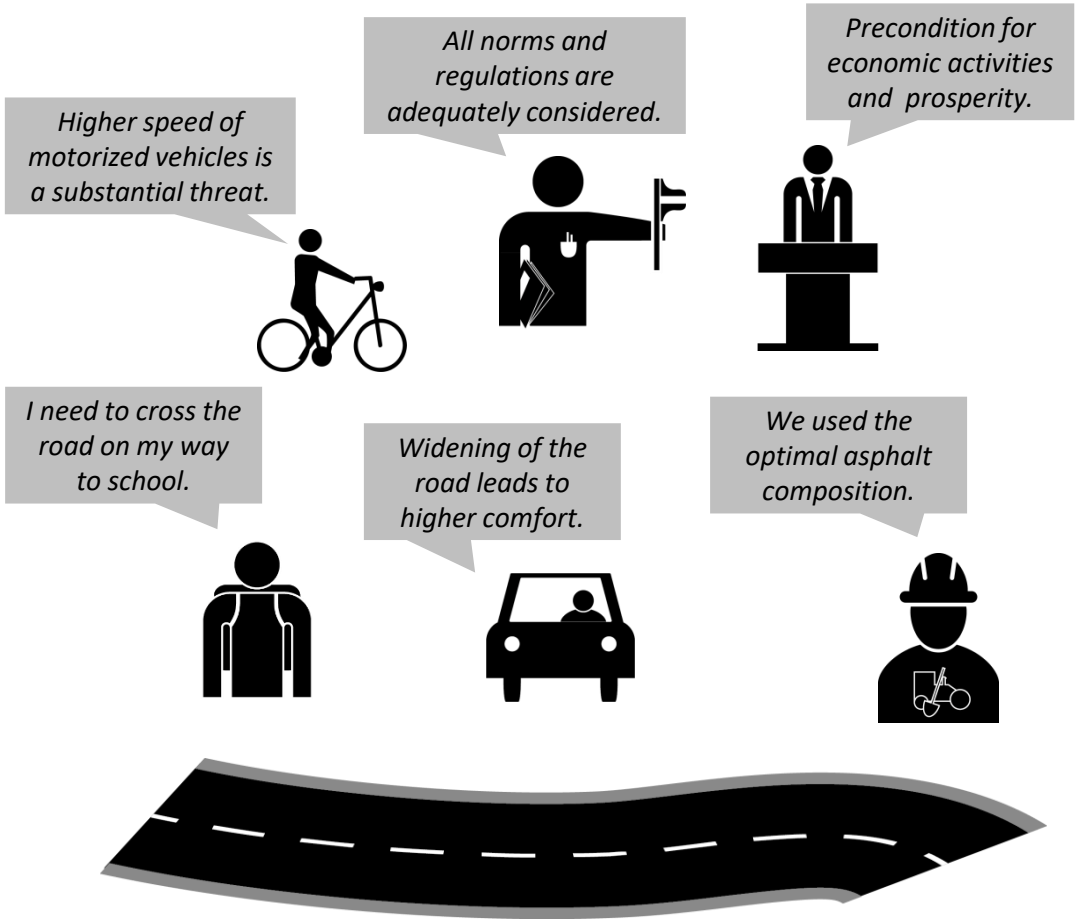


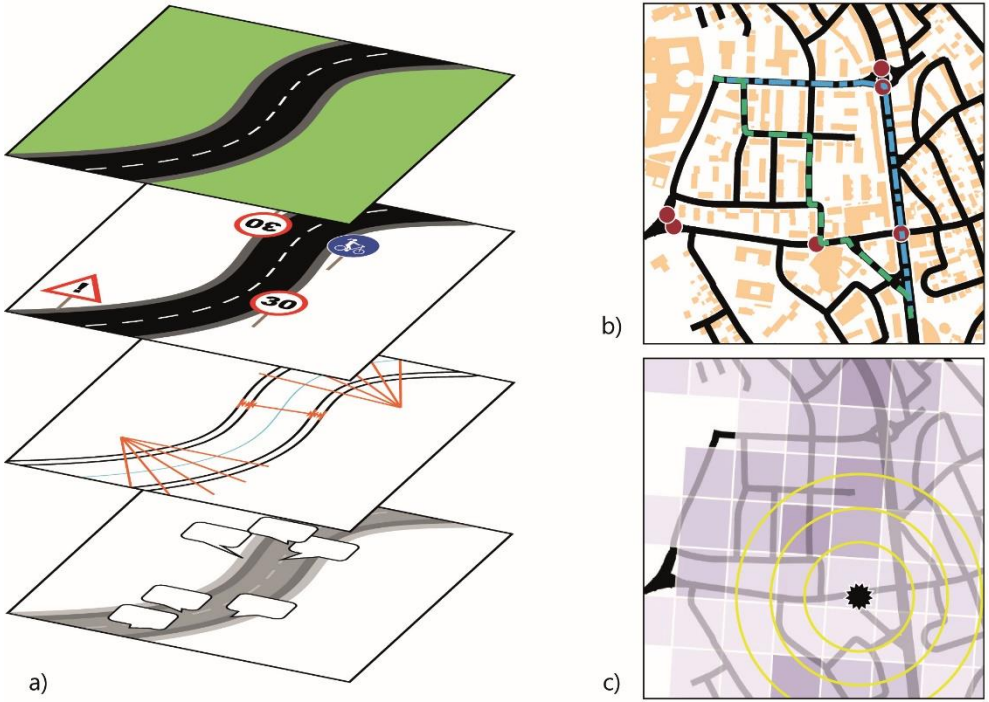
Current position of object

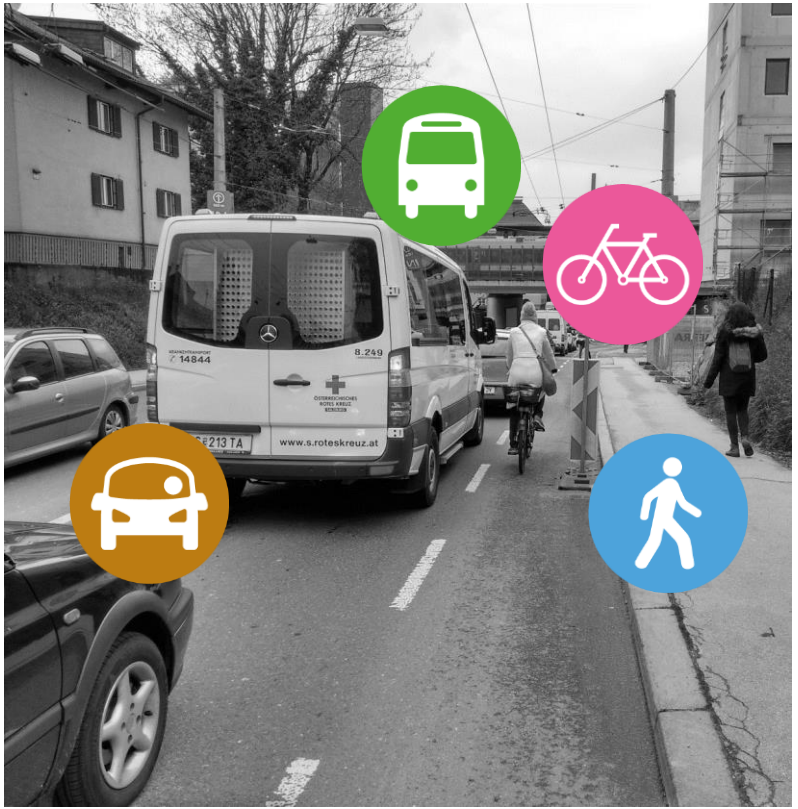
Collective, qualitative assessment of environment

Spatial context, physical environment




Higher speed of motorized vehicles is a substantial threat.
All norms and regulations are adequately considered.
Precondition for economic activities and prosperity.
I need to cross the road on my way to school.
Widening of the road leads to higher comfort.
We used the optimal asphalt composition.



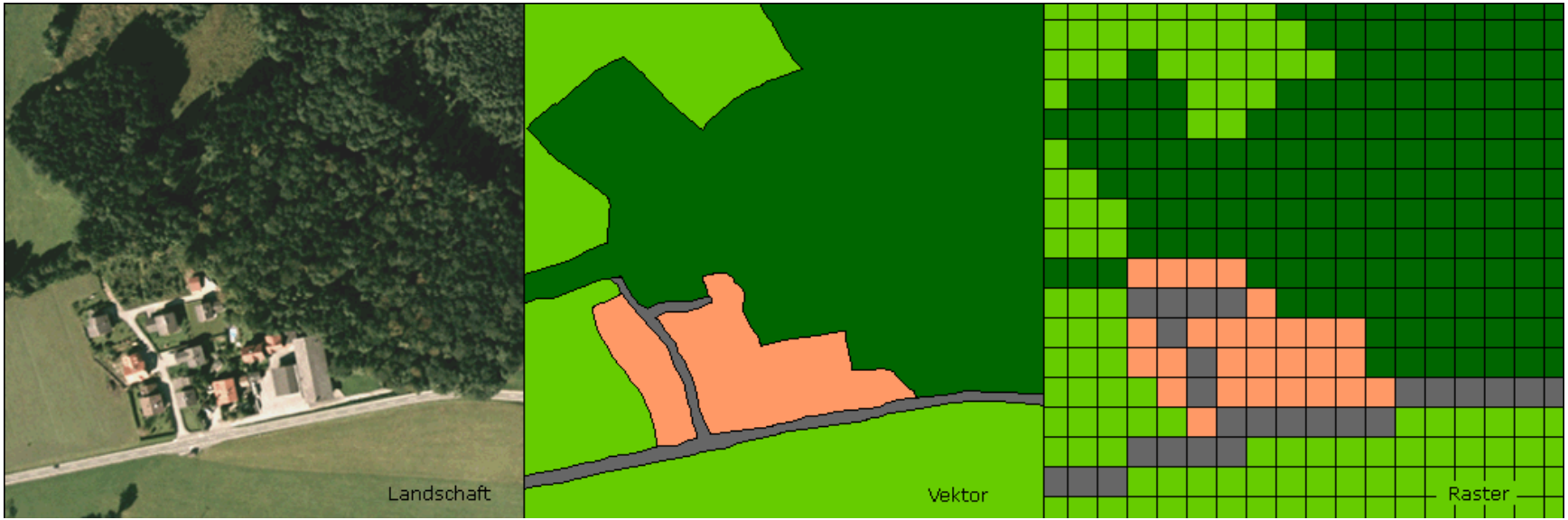


Integrated, cross-domain approaches

Modelling in a GIS

- Spatial (de facto / fiat) objects constituting space
  - Continuous surfaces
  - Discrete objects
- Spatial relations
  - Geometry (shape, size, distance, …)
  - Topology (neighbourhood relations)
- GIS as Model
  - Abstraction, simplification, purpose-driven

Vector-/Raster-Model



Discrete objects:
crisp boundaries

Continuous surfaces:
fuzzy boundaries